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1.1 Development Cycle

Creating and Deleting Indexes

Diagnostic Tools

Django and MongoDB

Monitoring
Older Downloads

PyMongo and mod_wsgi

Python Tutorial

Recommended Production Architectures

Shard v0.7
Simple auto-sharding suitable for things such as file attachment chunks.
Easy addition and removal of nodes from live systems.

v0.8 Details
Existing Core Functionality
- Basic Mongo database functionality: inserts, deletes, queries, indexing.
Master / Slave Replication
Replica Pairs
Server-side javascript code execution

New to v0.8

- Drivers for Java, C++, Python, Ruby.
- db shell utility
- (Very) basic security
- $or
- Clean up logging
- Performance test baseline
- getlasterror
- Large capped collections
- Bug fixes (compound index keys, etc.)
- Import/Export utility
- Allow any _id that is unique, and verify uniqueness

Wanted, but may not make it

- AMI's
- Unlock eval()?
- Better disk full handling
- better replica pair negotiation logic (for robustness)

v0.9 Details

v0.9 adds stability and bug fixes over v0.8.

The biggest addition to v0.9 is a completely new and improved query optimizer.

v1.0 Details

v1.5 Details

v2.0 Details

Building SpiderMonkey

Redirection Notice
This page should redirect to Building Spider Monkey.

Documentation
Dot Notation

Dot Notation

Getting the Software

Placeholder - $$$ TODO

Language Support

Mongo Administration Guide

Working with Mongo Objects and Classes in Ruby
Internals

Cursors

Tailable Cursors

See `p/db/dbclient.h` for example of how, on the client side, to support tailable cursors.

Set

```c
Option_CursorTailable = 2
```

in the `queryOptions` int field to indicate you want a tailable cursor.

If you get back no results when you query the cursor, keep the cursor live if cursorid is still nonzero. Then, you can issue future `getMore` requests for the cursor.

If a `getMore` request has the `resultFlag` `ResultFlag_CursorNotFound` set, the cursor is not longer valid. It should be marked as "dead" on the client side.

```c
ResultFlag_CursorNotFound = 1
```

See the `Queries and Cursors` section of the `Mongo Developers' Guide` for more information about cursors.

See Also

- The `Queries and Cursors` section of the `Mongo Developers' Guide` for more information about cursors
Mongo Database Administration

Redirection Notice
This page should redirect to Developer FAQ.

Mongo Concepts and Terminology

Redirection Notice
This page should redirect to Manual.

MongoDB - A Developer's Tour

Redirection Notice
This page should redirect to Manual.

Updates

Redirection Notice
This page should redirect to Updating.

Structuring Data for Mongo

Redirection Notice
This page should redirect to Inserting.

Design Overview

Redirection Notice
This page should redirect to Developer Zone.

Document-Oriented Datastore
Why so many "Connection Accepted" messages logged?

Why are my datafiles so large?

Storing Files

Introduction - How Mongo Works

Optimizing Mongo Performance

Mongo Usage Basics

Server-Side Processing
Redirection Notice
This page should redirect to Server-side Code Execution.

Home

MongoDB Documentation

Popular

- Home Page
- Developer Manual
- Sys Admin Docs
- Language Drivers
- Tutorial
- Downloads

Quick Links

- Use Cases | Philosophy
- Hosting Center
- Blog | Articles | twitter
- Source Code | Licensing | Examples | BugDB

Support

- Support forums: mongodb-user | more...
- IRC: irc.freenode.net/#mongodb
- Commercial support: 10gen
- Training: 10gen
- Consulting

Events

- May 21 – MongoNYC
- May 24-25 – MI Training
- More events

Languages and Drivers

- C | C++ | C# & .NET | ColdFusion | Erlang | Factor | Java | Javascript | PHP | Python | Ruby | Perl | More...

Quickstart

✅ For an even quicker start go to http://try.mongodb.org/

- Unix
  - Setup
    - OS X 32-bit
    - OS X 64-bit
    - Linux 32-bit
    - Linux 64-bit
  - Running
Getting started with MongoDB is easy. For a longer description, please see Getting Started.

Unix

The following instructions assume a modern *NIX distribution.

If you are running an old version of Linux and the database doesn't start, try the "legacy static" version on the Downloads page.

Ubuntu and Debian users can now install nightly snapshots via apt. See Ubuntu and Debian packages for details.

Setup

**OS X 32-bit**

```bash
# make default directory for data
$ mkdir -p /data/db

# using curl, get the pre-built distro
$ curl -O http://downloads.mongodb.org/osx/mongodb-osx-i386-latest.tgz

# unpack
$ tar xzf mongodb-osx-i386-latest.tgz
```

**OS X 64-bit**

```bash
# make default directory for data
$ mkdir -p /data/db

# using curl, get the pre-built distro
$ curl -O http://downloads.mongodb.org/osx/mongodb-osx-x86_64-latest.tgz

# unpack
$ tar xzf mongodb-osx-x86_64-latest.tgz
```

**Linux 32-bit**

```bash
# make default directory for data
$ mkdir -p /data/db

# using curl, get the pre-built distro
$ curl -O http://downloads.mongodb.org/linux/mongodb-linux-i686-latest.tgz

# unpack
$ tar xzf mongodb-linux-i686-latest.tgz
```

**Linux 64-bit**

```bash
# make default directory for data
$ mkdir -p /data/db

# using curl, get the pre-built distro
$ curl -O http://downloads.mongodb.org/linux/mongodb-linux-x86_64-latest.tgz

# unpack
$ tar xzf mongodb-linux-x86_64-latest.tgz
```
Running

```bash
# run the database in the background - better would be to run in a separate terminal window if testing
./mongodb-xxxxxxx/bin/mongod &
# run the mongo shell. by default it connects to localhost:
./mongodb-xxxxxxx/bin/mongo
> db.foo.save( { a : 1 } )
> db.foo.find()
```

For more information about the shell, see the shell reference guide.

To get started in your language, check out a driver tutorial.

Windows

Setup

32-bit

Create a the folders data and db such that C:\data\db exists. This is the default location for database files.

Download and extract the 32-bit .zip.

64-bit

Create a the folders data and db such that C:\data\db exists. This is the default location for database files.

Download and extract the 64-bit .zip.

Making Sure It Works

Start a command line and run:

```bash
mongod-xxxxxxx\bin\mongod.exe
```

Start another command line and run the Mongo shell (mongo.exe, not mongod.exe):

```bash
mongod-xxxxxxx\bin\mongo.exe
> db.foo.save( { a : 1 } )
> db.foo.find()
```

For more information about the shell, see the shell reference guide.

To get started in your language, check out a driver tutorial.

See Also

- Starting and Stopping the Database

Downloads

MongoDB Downloads

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<tr>
<td>Dev (unstable)</td>
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<tr>
<td>1.5.0</td>
<td>os x 10.5+</td>
<td>download</td>
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<tr>
<td>1.5.x nightly</td>
<td>os x 10.5+</td>
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</tbody>
</table>

- See Version Numbers
- The Linux legacy-static builds are only recommended for older systems. If you try to run and get a floating point exception, try the legacy-static builds. Otherwise you should use the regular ones.
- Currently the mongod server must run on little-endian CPU (Intel) so if you are using a ppc OS X, mongod will not work.
- 32-bit builds are limited 2gb of data. See [http://blog.mongodb.org/post/13778967/32-bit-limitations](http://blog.mongodb.org/post/13778967/32-bit-limitations) for more info
- See [http://buildbot.mongodb.org/waterfall](http://buildbot.mongodb.org/waterfall) for details of builds and completion times.

### Included in Distributions

- The MongoDB database server
- The MongoDB shell
- Backup and restore tools
- Import and export tools
- GridFS tool
- The MongoDB C++ client

### Drivers

Information on how to separately download or install the drivers and tools can be found on the Drivers page.

<table>
<thead>
<tr>
<th>Language</th>
<th>Packages</th>
<th>Source</th>
<th>API Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Python</td>
<td>bundles</td>
<td>github</td>
<td>api</td>
</tr>
<tr>
<td>PHP</td>
<td>pecl</td>
<td>github</td>
<td>api</td>
</tr>
<tr>
<td>Ruby</td>
<td>gemcutter</td>
<td>github</td>
<td>api</td>
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<tr>
<td>Java</td>
<td>jar</td>
<td>github</td>
<td>api</td>
</tr>
<tr>
<td>Perl</td>
<td>cpan</td>
<td>github</td>
<td>api</td>
</tr>
<tr>
<td>C++</td>
<td>included in database</td>
<td>github</td>
<td>api</td>
</tr>
</tbody>
</table>

See Drivers for more information and other languages.

### Source Code

Source code for MongoDB and all drivers
Packages

MongoDB is included in several different package managers:

- For MacPorts, see the mongodb and mongodb-devel packages.
- For FreeBSD, see the mongodb and mongodb-devel packages.
- For Homebrew, see the mongodb formula.
- For ArchLinux, see the mongodb package in the AUR.

Documentation

Pre-Exported

You can export yourself: HTML, PDF, or XML.

Logos

MongoDB logos are available for download as attachments on this page.

Powered By MongoDB Badges

We've made badges in beige, brown, blue and green for use on your sites that are powered by MongoDB. They are available below and in multiple sizes as attachments on this page.

![MongoDB Badges](image)

Training

If you're just getting started with MongoDB, consider registering for an upcoming training course.

1.0 Changelist

Wrote MongoDB. See documentation.

1.2.x Release Notes

New Features

- More indexes per collection
- Faster index creation
- Map/Reduce
- Stored JavaScript functions
- Configurable fsync time
- Several small features and fixes

DB Upgrade Required

There are some changes that will require doing an upgrade if your previous version is <= 1.0.x. If you're already using a version >= 1.1.x then these changes aren't required. There are 2 ways to do it:

- `--upgrade`
  - stop your mongod process
  - run `./mongod --upgrade`
  - start mongod again
- use a slave
  - start a slave on a different port and data directory
  - when its synced, shut down the master, and start the new slave on the regular port.

Ask in the forums or IRC for more help.
Replication Changes

- There have been minor changes in replication. If you are upgrading a master/slave setup from <= 1.1.2 you have to update the slave first.

mongoimport

- mongoimportjson has been removed and is replaced with mongoimport that can do json/csv/tsv

field filter changing

- We've changed the semantics of the field filter a little bit. Previously only objects with those fields would be returned. Now the field filter only changes the output, not which objects are returned. If you need that behavior, you can use $exists

other notes

http://www.mongodb.org/display/DOCS/1.1+Development+Cycle

1.4 Release Notes

We're pleased to announce the 1.4 release of MongoDB. 1.4 is a drop in replacement for 1.2. To upgrade you just need to shutdown mongod, then restart with the new binaries. (Users upgrading from release 1.0 should review the 1.2 release notes, in particular the instructions for upgrading the DB format.)

Release 1.4 includes the following improvements over release 1.2:

Core server enhancements

- concurrency improvements
- indexing memory improvements
- background index creation
- better detection of regular expressions so the index can be used in more cases

Replication & Sharding

- better handling for restarting slaves offline for a while
- fast new slaves from snapshots (--fastsync)
- configurable slave delay (--slavedelay )
- replication handles clock skew on master
- $inc replication fixes
- sharding alpha 3 - notably 2 phase commit on config servers

Deployment & production

- configure "slow threshold" for profiling
- ability to do fsync + lock for backing up raw files
- option for separate directory per db (--directoryperdb)
- http://localhost:28017/_status to get serverStatus via http
- REST interface is off by default for security (--rest to enable)
- can rotate logs with a db command, logRotate
- enhancements to serverStatus command (db.serverStatus()) - counters and replication lag stats
- new mongostat tool

Query language improvements

- $all with regex
- $not
- partial matching of array elements $elemMatch
- $ operator for updating arrays
- $addToSet
- $unset
- $pull supports object matching
- $set with array indices

Geo

- 2d geospatial search
- geo $center and $box searches
10gen publishes apt-gettable packages. Our packages are generally fresher than those in Debian or Ubuntu. We publish 3 distinct packages, named "mongodb-stable", "mongodb-unstable", "mongodb-snapshot", corresponding to our latest stable release, our latest development release, and the most recent git checkout at the time of building. Each of these packages conflicts with the others, and with the "mongodb" package in Debian/Ubuntu.

The packaging is still a work-in-progress, so we invite Debian and Ubuntu users to try them out and let us know how the packaging might be improved.

To use the packages, add a line to your /etc/apt/sources.list, then 'aptitude update' and one of 'aptitude install mongodb-stable', 'aptitude install mongodb-unstable' or 'aptitude install mongodb-snapshot'.

For Ubuntu Lucid (10.4) (built using a prerelease installation)

deb http://downloads.mongodb.org/distros/ubuntu 10.4 10gen

for Ubuntu Karmic (9.10)

deb http://downloads.mongodb.org/distros/ubuntu 9.10 10gen

for Ubuntu Jaunty (9.4)

deb http://downloads.mongodb.org/distros/ubuntu 9.4 10gen

for Debian Lenny (5.0)

deb http://downloads.mongodb.org/distros/debian 5.0 10gen

These packages are snapshots of our git master branch, and we plan to update them frequently, so package version numbers will be of the form YYYYMMDD; when reporting issues with these packages, please include the package version in your report.

The public gpg key used for signing these packages follows. It should be possible to import the key into apt's public keyring with a command like this:

```
sudo apt-key adv --keyserver keyserver.ubuntu.com --recv 7F0CEB10
```

To configure these packages beyond the defaults, have a look at /etc/mongodb.conf, and/or the initialization script, (/etc/init.d/mongodb on older, non-Upstart systems, /etc/init/mongodb.conf on Upstart systems). Most mongodb operational settings are in /etc/mongodb.conf; a few other settings are in the initialization script. Note that if you customize the userid in the initialization script or the dbpath or logpath settings in /etc/mongodb.conf, you must ensure that the directories and files you use are writable by the userid you run the server as.

Packages for other distros coming soon!
Version Numbers

MongoDB uses the Odd-numbered versions for development releases.

There are 3 numbers in a MongoDB version: A.B.C

- A is the major version. This will rarely change and signify very large changes
- B is the release number. This will include many changes including features and things that possible break backwards compatibility. Even Bs will be stable branches, and odd Bs will be development.
- C is the revision number and will be used for bugs and security issues.

For example:

- 1.0.0 : first GA release
- 1.0.x : bug fixes to 1.0.x - highly recommended to upgrade, very little risk
- 1.1.x : development release. This will include new features that are not full finished, and works in progress. Some things may be different than 1.0
- 1.2.x : second GA release. This will be the culmination of the 1.1.x release.

Getting Started

Getting started with MongoDB is easy:

- Download Mongo
- Install the Software
  - Create a Directory for Data
  - Installation Layout
- Running Mongo
- Learn About MongoDB

Download Mongo

MongoDB is available either in pre-built distribution for Linux, OS X and Windows, or via source You can find the available pre-built distributions of...
MongoDB on the Downloads page.

Once you have the binary downloaded, either unzip or untar the distribution. For the purposes of this document, we'll call that the "mongo home directory".

Install the Software

Installation of MongoDB is easy. Once you've downloaded the software and unpacked the distribution into the MongoDB home directory, you'll need to create a directory for MongoDB to store its data files.

Create a Directory for Data

By default, MongoDB will store data in /data/db on Unix-like systems (e.g. Linux and OS X), and in c:\data\db in Windows. MongoDB will not create these directories, so please create them. They'll need to have read, write and directory creation permissions for Mongo to perform all of its usual operations. You can also specify a different directory with the --dbpath flag.

You may also choose to get one of the many drivers or other tools to work with MongoDB, although the included mongo shell is enough to start experimenting.

Installation Layout

Once installed, you should see the following general structure.

```
|-- bin
  |-- mongo              {the database shell}
  |-- mongod             {the core database server}
  |-- mongos             {auto-sharding process}
  |-- mongodump          {dump/export utility}
  |-- mongorestore       {restore/import utility}
  `-- include
      |-- client
      |-- db
      |-- grid
      `-- util
|-- lib
|-- lib64
```

Running Mongo

Running the database is as easy as starting the server. On Linux, and assuming you are in the MongoDB home directory, just type

```
$ bin/mongod
```

which will start the database. For further information on running MongoDB, please see Mongo Administration Guide

For command line help:

```
bin/mongod --help
```

To run the shell:

```
bin/mongo {--help}
```

Learn About MongoDB

Once you have MongoDB installed and running, review the tutorial.

Drivers

MongoDB currently has client support for the following programming languages:
**mongodb.org Supported**

- C
- C++
- Java
- Javascript
- Perl
- PHP
- Python
- Ruby

**Community Supported**

- REST
- C# and .NET
- Clojure
- ColdFusion
  - Blog post: Part 1 | Part 2 | Part 3
- Erlang
  - emongo - An Erlang MongoDB driver that emphasizes speed and stability. “The most emo of drivers.”
  - Erfmongo - an almost complete MongoDB driver implementation in Erlang
- Factor
- Fantom
  - http://bitbucket.org/liamtask/fantomongo/wiki/Home
- F#
  - http://gist.github.com/218388
- Go
  - gomongo
- Groovy
  - See JVM Languages
- Haskell
  - http://hackage.haskell.org/package/mongoDB
- JavaScript
  - A CommonJS JavaScript wrapper of the Mongo Java library (http://github.com/mrclash/narwhal-mongodb)
- PHP
  - Asynchronous PHP driver using libevent
- PowerShell
  - Blog post
- Ruby
  - MongoMapper
  - RMongo - another Ruby driver for MongoDB
- Scala
  - See JVM Languages
- Scheme (PLT)
  - docs
  - Smalltalk

**Get Involved, Write a Driver!**

- Writing Drivers and Tools

**C Sharp Language Center**

**C# Drivers**

- mongodb-csharp driver
- simple-mongodb driver
- NoRM

**F#**

- F# Example

**Community Articles**

- A List of C# MongoDB Tools
• Experimenting with MongoDB from C#
• Using MongoDB from C#
• Introduction to MongoDB for .NET
• Using Json.NET and Castle Dynamic Proxy with MongoDB
• Implementing a Blog Using ASP.NET MVC and MongoDB

Tools

• MongoDB.Emitter Document Wrapper
• log4net appender

Support

• http://groups.google.com/group/mongodb-csharp
• http://groups.google.com/group/mongodb-user
• IRC: #mongodb on freenode

See Also

• C++ Language Center

Driver Syntax Table

The wiki generally gives examples in JavaScript, so this chart can be used to convert those examples to any language.

<table>
<thead>
<tr>
<th>JavaScript</th>
<th>Python</th>
<th>PHP</th>
<th>Ruby</th>
</tr>
</thead>
<tbody>
<tr>
<td>[]</td>
<td>[]</td>
<td>array()</td>
<td>[]</td>
</tr>
<tr>
<td>{}</td>
<td>{}</td>
<td>new stdClass</td>
<td>{}</td>
</tr>
<tr>
<td>{ x: 1 }</td>
<td>{&quot;x&quot;: 1}</td>
<td>array('x' =&gt; 1)</td>
<td>{'x' =&gt; 1}</td>
</tr>
<tr>
<td>connect(&quot;www.example.net&quot;)</td>
<td>Connection(&quot;www.example.net&quot;)</td>
<td>new Mongo(&quot;www.example.net&quot;)</td>
<td>Mongo.new(&quot;www.example.net&quot;)</td>
</tr>
<tr>
<td>cursor.next()</td>
<td>cursor.next()</td>
<td>$cursor-&gt;getNext()</td>
<td>cursor.next_object()</td>
</tr>
<tr>
<td>cursor.hasNext()</td>
<td>*</td>
<td>$cursor-&gt;hasNext()</td>
<td>*</td>
</tr>
<tr>
<td>collection.findOne()</td>
<td>collection.find_one()</td>
<td>$collection-&gt;findOne()</td>
<td>collection.find_one()</td>
</tr>
<tr>
<td>db.eval()</td>
<td>db.eval()</td>
<td>$db-&gt;execute()</td>
<td>db.eval()</td>
</tr>
</tbody>
</table>

* does not exist in that language

Javascript Language Center

MongoDB can be

• Used by clients written in Javascript;
• Uses Javascript internally server-side for certain options such as map/reduce;
• Has a shell that is based on Javascript for administrative purposes.

SpiderMonkey

The MongoDB shell extends SpiderMonkey. See the MongoDB shell documentation.

V8 and node.js

• http://github.com/orlandov/node-mongodb
• http://github.com/christkv/node-mongodb-native
• http://github.com/erh/mongo-v8-driver/tree/master

Server-Side Javascript
Javascript may be executed in the MongoDB server processes for various functions such as query enhancement and map/reduce processing. See Server-side Code Execution.

JVM Languages

There are many wrappers for the Java driver for other JVM Languages.

- Clojure
  - http://github.com/somnium/congomongo
- Groovy
  - Blog post: Groovy Tutorial for MongoDB
  - Blog post: MongoDB made more Groovy
- Scala
  - mongo-scala-driver is a thin wrapper around mongo-java-driver to make working with MongoDB more Scala-like.
    - Wiki
    - Mailing list

Python Language Center

Redirect Notice
This page should redirect to http://api.mongodb.org/python.

PHP Language Center

Installing the PHP Driver

*NIX

Run:

```
sudo pecl install mongo
```

See the installation docs for configuration information and OS-specific installation instructions.

Windows

Download one of the binaries and place it on your extension path. For more information, see the Windows section of the installation docs.

Using the PHP Driver

To get started, see the Tutorial. Also check out the API Documentation.

GUIs

Opricot

Opricot is a hybrid GUI/CLI/Scripting web frontend implemented in PHP to manage your MongoDB servers and databases. Use as a point-and-click adventure for basic tasks, utilize scripting for automated processing or repetitive things.

Opricot combines the following components to create a fully featured administration tool:

- An interactive console that allows you to either work with the database through the UI, or by using custom Javascript.
- A set of simple commands that wrap the Javascript driver, and provide an easy way to complete the most common tasks.
- Javascript driver for Mongo that works on the browser and talks with the AJAX interface.
- Simple server-side AJAX interface for communicating with the MongoDB server (currently available for PHP).
PHPMoAdmin

PHPMoAdmin is a MongoDB administration tool for PHP built on a stripped-down version of the Vork high-performance framework.

- Nothing to configure - place the moadmin.php file anywhere on your web site and it just works!
- Fast AJAX-based XHTML 1.1 interface operates consistently in every browser!
- Self-contained in a single 75kb file!
- Works on any version of PHP5 with the MongoDB NoSQL database installed & running.
- Option to enable password-protection for one or more users; to activate protection, just add the username-password(s) to the array at the top of the file.
- E_STRICT PHP code is formatted to the Zend Framework coding standards + fully-documented in the phpDocumentor DocBlock standard.
- All textareas can be resized by dragging/stretching the lower-right corner.
- Free & open-source! Release under the GPLv3 FOSS license!
- Multiple design themes to choose from
- Instructional error messages - phpMoAdmin can be used as a PHP-Mongo connection debugging tool

Library and Framework Tools

CakePHP

- MongoDB datasource for CakePHP. There's also an introductory blog post on using it with Mongo.

Drupal
• **MongoDB Integration** - Views (query builder) backend, a watchdog implementation (logging), and field storage.

**Kohana Framework**

• **Mango** at github
  An ActiveRecord-like library for PHP, for the Kohana PHP Framework. See also PHP Language Center#MongoDb PHP ODM further down.

**Lithium**

Lithium supports Mongo out-of-the-box.

• Tutorial on creating a blog backend.

**Log4php**

• A log4php appender for MongoDB

**Memcached**

• **MongoNode**
  PHP script that replicates MongoDB objects to Memcached.

**Symfony 2**

• **Symfony 2 Logger**
  A centralized logger for Symfony applications. See the blog post.

• sfMongoSessionStorage - manages session storage via MongoDB with symfony.

• sfStoragePerformancePlugin - This plugin contains some extra storage engines (MongoDB and Memcached) that are currently missing from the Symfony (>= 1.2) core.

**Vork**

Vork, the high-performance enterprise framework for PHP natively supports MongoDB as either a primary datasource or used in conjunction with an RDBMS. Designed for scalability & Green-IT, Vork serves more traffic with fewer servers and can be configured to operate without any disk-IO.

Vork provides a full MVC stack that outputs semantically-correct XHTML 1.1, complies with Section 508 Accessibility guidelines & Zend-Framework coding-standards, has SEO-friendly URLs, employs CSS-reset for cross-browser display consistency and is written in well-documented object-oriented E_STRICT PHP5 code.

An extensive set of tools are built into Vork for ecommerce (cc-processing, SSL, PayPal, AdSense, shipment tracking, QR-codes), Google Maps, translation & internationalization, Wiki, Amazon Web Services, Social-Networking (Twitter, Meetup, ShareThis, YouTube, Flickr) and much more.

**Zend Framework**

• **Shanty Mongo** is a prototype mongodb adapter for the Zend Framework. It’s intention is to make working with mongodb documents as natural and as simple as possible. In particular allowing embedded documents to also have custom document classes.

• **ZF Cache Backend**
  A ZF Cache Backend for MongoDB. It support tags and auto-cleaning.

• There is a Zend_Nosql_Mongo component proposal.

**Stand-Alone Tools**

**ActiveMongo**

**ActiveMongo** is a really simple ActiveRecord for MongoDB in PHP.

There’s a nice introduction to get you started at [http://crodas.org/activemongo.php](http://crodas.org/activemongo.php).

**MapReduce API**

A MapReduce abstraction layer. See the blog post.

• **MongoDB-MapReduce-PHP** at github
MongoDB PHP ODM

MongoDB PHP ODM is a simple object wrapper for the Mongo PHP driver classes which makes using Mongo in your PHP application more like ORM, but without the suck. It is designed for use with Kohana 3 but will also integrate easily with any PHP application with almost no additional effort.

Mongodloid

A nice library on top of the PHP driver that allows you to make more natural queries (\$query->query('a == 13 AND b >= 8 && c % 3 == 4');), abstracts away annoying $-syntax, and provides getters and setters.

- Project Page
- Downloads
- Documentation

Morph

A high level PHP library for MongoDB. Morph comprises a suite of objects and object primitives that are designed to make working with MongoDB in PHP a breeze.

- Morph at code.google.com

simplemongophp

Very simple layer for using data objects see blog post

- simplemongophp at github

Installing the PHP Driver

⚠️ Redirection Notice

PHP - Storing Files and Big Data

⚠️ Redirection Notice
This page should redirect to http://www.php.net/manual/en/class.mongogridfs.php.

Troubleshooting the PHP Driver

⚠️ Redirection Notice

Ruby Language Center

This is an overview of the available tools and suggested practices for using Ruby with MongoDB. Those wishing to skip to more detailed discussion should check out the Ruby Driver Tutorial, Getting started with Rails or Rails 3, and MongoDB Data Modeling and Rails. There are also a number of good external resources worth checking out.

- Ruby Driver
  - Installing / Upgrading
  - BSON
- Object Mappers
- Notable Projects

Ruby Driver
Install the C extension for any performance-critical applications.

The MongoDB Ruby driver is the 10gen-supported driver for MongoDB. It's written in pure Ruby, with a recommended C extension for speed. The driver is optimized for simplicity. It can be used on its own, but it also serves as the basis for various object-mapping libraries.

- Tutorial
- Ruby Driver README
- API Documentation
- Source Code

Installing / Upgrading

The ruby driver is hosted at Rubygems.org. Before installing the driver, make sure you're using the latest version of rubygems (currently 1.3.6):

```bash
$ gem update --system
```

Then install the gems:

```bash
$ gem install mongo
```

To stay on the bleeding edge, check out the latest source from github:

```bash
$ git clone git://github.com/mongodb/mongo-ruby-driver.git
$ cd mongo-ruby-driver/
```

Then, install the driver from there:

```bash
$ rake gem:install
```

BSON

In versions of the Ruby driver prior to 0.20, the code for serializing to BSON existed in the mongo gem. Now, all BSON serialization is handled by the required bson gem.

```bash
gem install bson
```

For significantly improved performance, install the bson extensions gem:

```bash
gem install bson_ext
```

As long it's in Ruby's load path, bson_ext will be loaded automatically when you require bson.

Note that beginning with version 0.20, the mongo_ext gem is no longer used.

To learn more about the Ruby driver, see the Ruby Tutorial.

Object Mappers

If you need validations, associations, and other high-level data modeling functions, consider using one of the available object mappers. Many of these exist in the Ruby ecosystem; here we host a list of the most popular ones.

Notable Projects

Tools for working with MongoDB in Ruby are being developed daily. A partial list can be found in the Projects and Libraries section of our external resources page.
Ruby Tutorial

This tutorial gives many common examples of using MongoDB with the Ruby driver. If you’re looking for information on data modeling, see MongoDB Data Modeling and Rails. Links to the various object mappers are listed on our object mappers page.

Interested in GridFS? Checkout GridFS in Ruby.

As always, the latest source for the Ruby driver can be found on github.

- Installation
- A Quick Tour
  - Using the RubyGem
  - Making a Connection
  - Listing All Databases
  - Dropping a Database
  - Authentication (Optional)
  - Getting a List Of Collections
  - Getting a Collection
  - Inserting a Document
  - Finding the First Document In a Collection using find_one()
  - Adding Multiple Documents
  - Counting Documents in a Collection
  - Using a Cursor to get all of the Documents
  - Getting a Single Document with a Query
  - Getting a Set of Documents With a Query
  - Querying with Regular Expressions
  - Creating An Index
  - Getting a List of Indexes on a Collection
  - Database Administration

- See Also

Installation

The mongo-ruby-driver gem is served through Rubygems.org. To install, make sure you have the latest version of rubygems.

```
gem update --system
```

Next, install the mongo and mongo_ext rubygems:

```
gem install mongo
  gem install mongo_ext
```

After installing, you may want to look at the examples directory included in the source distribution. These examples walk through some of the basics of using the Ruby driver.

The full API documentation can be viewed here.

A Quick Tour

Using the RubyGem

All of the code here assumes that you have already executed the following Ruby code:

```
require 'rubygems'  # not necessary for Ruby 1.9
require 'mongo'
```

Making a Connection

An Mongo::Connection instance represents a connection to MongoDB. You use a Connection instance to obtain an Mongo:DB instance, which represents a named database. The database doesn't have to exist - if it doesn't, MongoDB will create it for you.

You can optionally specify the MongoDB server address and port when connecting. The following example shows three ways to connect to the database "mydb" on the local machine:
At this point, the `db` object will be a connection to a MongoDB server for the specified database. Each DB instance uses a separate socket connection to the server.

If you're trying to connect to a replica pair, see Replica Pairs in Ruby.

**Listing All Databases**

```ruby
m = Mongo::Connection.new # (optional host/port args)
m.database_names.each { |name| puts name }
m.database_info.each { |info| puts info.inspect }
```

**Dropping a Database**

```ruby
m.drop_database('database_name')
```

**Authentication (Optional)**

MongoDB can be run in a secure mode where access to databases is controlled through name and password authentication. When run in this mode, any client application must provide a name and password before doing any operations. In the Ruby driver, you simply do the following with the connected mongo object:

```ruby
auth = db.authenticate(my_user_name, my_password)
```

If the name and password are valid for the database, `auth` will be `true`. Otherwise, it will be `false`. You should look at the MongoDB log for further information if available.

**Getting a List Of Collections**

Each database has zero or more collections. You can retrieve a list of them from the `db` (and print out any that are there):

```ruby
db.collection_names.each { |name| puts name }
```

and assuming that there are two collections, name and address, in the database, you would see

```
name
address
```

as the output.

**Getting a Collection**

You can get a collection to use using the `collection` method:

```ruby
coll = db.collection("testCollection")
```

This is aliased to the `[]` method:

```ruby
coll = db["testCollection"]
```

Once you have this collection object, you can now do things like insert data, query for data, etc.

**Inserting a Document**

```ruby
```
Once you have the collection object, you can insert documents into the collection. For example, let's make a little document that in JSON would be represented as

```json
{
    "name": "MongoDB",
    "type": "database",
    "count": 1,
    "info": {
        "x": 203,
        "y": 102
    }
}
```

Notice that the above has an "inner" document embedded within it. To do this, we can use a Hash or the driver's OrderedHash (which preserves key order) to create the document (including the inner document), and then simply insert it into the collection using the `insert()` method.

```ruby
doc = {
    "name": "MongoDB",
    "type": "database",
    "count": 1,
    "info": {
        "x": 203,
        "y": 102
    }
}
coll.insert(doc)
```

Finding the First Document In a Collection using `find_one()`

To show that the document we inserted in the previous step is there, we can do a simple `find_one()` operation to get the first document in the collection. This method returns a single document (rather than the Cursor that the `find()` operation returns), and it's useful for things where there only is one document, or you are only interested in the first. You don't have to deal with the cursor.

```ruby
my_doc = coll.find_one()
puts my_doc.inspect
```

and you should see:

```json
{
    "_id":<Mongo::ObjectID:0x118576c ...>,
    "name": "MongoDB",
    "info": {
        "x": 203,
        "y": 102
    },
    "type": "database",
    "count": 1
}
```

Note the `_id` element has been added automatically by MongoDB to your document. Remember, MongoDB reserves element names that start with `_` for internal use.

Adding Multiple Documents

In order to do more interesting things with queries, let's add multiple simple documents to the collection. These documents will just be

```json
{
    "i": value
}
```

and we can do this fairly easily:

```ruby
100.times { |i| coll.insert("i" => i) }
```

Notice that we can insert documents of different "shapes" into the same collection. These records are in the same collection as the complex record we inserted above. This aspect is what we mean when we say that MongoDB is "schema-free".

Counting Documents in a Collection

Now that we've inserted 101 documents (the 100 we did in the loop, plus the first one), we can check to see if we have them all using the `count()` method.

```ruby
puts coll.count()
```

and it should print 101.
Using a Cursor to get all of the Documents

In order to get all the documents in the collection, we will use the `find()` method. The `find()` method returns a Cursor object which allows us to iterate over the set of documents that matched our query. The Ruby driver's Cursor is enumerable. So to query all of the documents and print them out:

```ruby
coll.find().each { |row| puts row.inspect }
```

and that should print all 101 documents in the collection.

Getting a Single Document with a Query

We can create a query hash to pass to the `find()` method to get a subset of the documents in our collection. For example, if we wanted to find the document for which the value of the "i" field is 71, we would do the following:

```ruby
coll.find("i" => 71).each { |row| puts row.inspect }
```

and it should just print just one document:

```json
{"_id"=><Mongo::ObjectID:0x117de90 ...>, "i"=>71}
```

Getting a Set of Documents With a Query

We can use the query to get a set of documents from our collection. For example, if we wanted to get all documents where "i" > 50, we could write:

```ruby
coll.find("i" => { "$gt" => 50}).each { |row| puts row }
```

which should print the documents where i > 50. We could also get a range, say 20 < i <= 30:

```ruby
coll.find("i" => { "$gt" => 20, "$lte" => 30}).each { |row| puts row }
```

Querying with Regular Expressions

Regular expressions can be used to query MongoDB. To find all names that begin with 'a':

```ruby
coll.find("name" => /^a/)
```

You can also construct a regular expression dynamically. To match a given search string:

```ruby
search_string = params['search']
# Constructor syntax
coll.find("name" => Regexp.new(search_string))
# Literal syntax
coll.find("name" => /#{search_string}/)
```

Although MongoDB isn't vulnerable to anything like SQL-injection, it may be worth checking the search string for anything malicious.

Creating An Index

MongoDB supports indexes, and they are very easy to add on a collection. To create an index, you specify an index name and an array of field names to be indexed, or a single field name. The following creates an ascending index on the "i" field:
To specify complex indexes or a descending index you need to use a slightly more complex syntax - the index specifier must be an Array of [field name, direction] pairs. Directions should be specified as Mongo::ASCENDING or Mongo::DESCENDING:

```ruby
# explicit "ascending"
coll.create_index(["i", ASCENDING])
```

Getting a List of Indexes on a Collection

You can get a list of the indexes on a collection using `coll.index_information()`.

Database Administration

A database can have one of three profiling levels: off (:off), slow queries only (:slow_only), or all (:all). To see the database level:

```ruby
puts db.profiling_level  # => off (the symbol :off printed as a string)
db.profiling_level = :slow_only
```

Validating a collection will return an interesting hash if all is well or raise an exception if there is a problem.

```ruby
p db.validate_collection('coll_name')
```

See Also

- Ruby Driver RDoc
- MongoDB Manual

Replica Pairs in Ruby

Here follow a few considerations for those using the Ruby driver with MongoDB and replica pairing.

- Setup
- Connection Failures
- Recovery
- Testing
- Further Reading

Setup

First, make sure that you've correctly paired two `mongod` instances. If you want to do this on the same machine for testing, make sure you've created two data directories. The init commands are as follows:

```bash
./mongod --pairwith localhost:27018 --dbpath /data/left --port 27017
./mongod --pairwith localhost:27017 --dbpath /data/right --port 27018
```

When you instantiate a Ruby connection, you'll have to make sure that the driver knows about both instances:

```ruby
@connection = Connection.new([['localhost', 27017], ['localhost', 27018]])
```

Connection Failures

Imagine that our master node goes offline. How will the driver respond?

At first, the driver will try to send operations to what was the master node. These operations will fail, and the driver will raise a `ConnectionFailure` exception. It then becomes the client's responsibility to decide how to handle this.

If the client decides to retry, it's not guaranteed that the former slave will have been promoted to master yet, so it's still possible that the driver will
raise another `ConnectionFailure`. However, once the former slave has become master, typically within a few seconds, subsequent operations will succeed.

**Recovery**

Driver users may wish to wrap their database calls with failure recovery code. Here’s one possibility:

```ruby
# Ensure retry upon failure
def rescue_connection_failure(max_retries=5)
  success = false
  retries = 0
  while !success
    begin
      yield
      success = true
      rescue Mongo::ConnectionFailure => ex
        retries += 1
      raise ex
    rescue ex if retries >= max_retries
    sleep(1)
  end
  end
end

defence_connection_failure do
  @db.collection('users').count()
end
```

Of course, the proper way to handle connection failures will always depend on the individual application. We encourage object-mapper and application developers to publish any promising results.

**Testing**

The Ruby driver (>= 0.17.2) includes some unit tests for verifying proper replica pair behavior. They reside in `tests/replica`. You can run them individually with the following rake tasks:

```
rake test:pair_count
rake test:pair_insert
rake test:pair_query
```

Make sure you have a replica pair running locally before trying to run these tests.

**Further Reading**

- Replica Pairs
- Pairing Internals

**GridFS in Ruby**

GridFS, which stands for “Grid File Store,” is a specification for storing large files in MongoDB. It works by dividing a file into manageable chunks and storing each of those chunks as a separate document. GridFS requires two collections to achieve this: one collection stores each file’s metadata (e.g., name, size, etc.) and another stores the chunks themselves. If you’re interested in more details, check out the [GridFS Specification](#).

Prior to version 0.19, the MongoDB Ruby driver implemented GridFS using the GridFS::GridStore class. This class has been deprecated in favor of two new classes: Grid and GridFileSystem. These classes have a much simpler interface, and the rewrite has resulted in a significant speed improvement. **Reads are over twice as fast, and write speed has been increased fourfold.** 0.19 is thus a worthwhile upgrade.

- The Grid class
  - Saving files
  - File metadata
  - Safe mode
  - Deleting files
- The GridFileSystem class
  - Saving files
  - Deleting files
The Grid class

The Grid class represents the core GridFS implementation. Grid gives you a simple file store, keyed on a unique ID. This means that duplicate filenames aren’t a problem. To use the Grid class, first make sure you have a database, and then instantiate a Grid:

```ruby
@db = Mongo::Connection.new.db('social_site')
@grid = Grid.new(@db)
```

Saving files

Once you have a Grid object, you can start saving data to it. The data can be either a string or an IO-like object that responds to a #read method:

```ruby
# Saving string data
id = @grid.put("here's some string / binary data")

# Saving IO data and including the optional filename
image = File.open("me.jpg")
id2   = @grid.put(image, :filename => "me.jpg")
```

Grid#put returns an object id, which you can use to retrieve the file:

```ruby
# Get the string we saved
file = @grid.get(id)

# Get the file we saved
image = @grid.get(id2)
```

File metadata

There are accessors for the various file attributes:

```ruby
image.filename
# => "me.jpg"

image.content_type
# => "image/jpg"

image.file_length
# => 502357

image.upload_date
# => Mon Mar 01 16:18:30 UTC 2010

# Read all the image's data at once
image.read

# Read the first 100k bytes of the image
image.read(100 * 1024)
```

When putting a file, you can set many of these attributes and write arbitrary metadata:
Safe mode

A kind of safe mode is built into the GridFS specification. When you save a file, and MD5 hash is created on the server. If you save the file in safe mode, an MD5 will be created on the client for comparison with the server version. If the two hashes don't match, an exception will be raised.

Deleting files

Deleting a file is as simple as providing the id:

```ruby
@grid.delete(id2)
```

The GridFileSystem class

GridFileSystem is a light emulation of a file system and therefore has a couple of unique properties. The first is that filenames are assumed to be unique. The second, a consequence of the first, is that files are versioned. To see what this means, let's create a GridFileSystem instance:

```
Saving files
@db = Mongo::Connection.new.db("social_site")
@fs = GridFileSystem.new(@db)
```

Now suppose we want to save the file 'me.jpg.' This is easily done using a filesystem-like API:

```
image = File.open("me.jpg")
@fs.open("me.jpg", "w") do |f|
  f.write image
end
```

We can then retrieve the file by filename:

```
image = @fs.open("me.jpg", "r") { |f| f.read }
```

No problems there. But what if we need to replace the file? That too is straightforward:

```
image = File.open("me-dancing.jpg")
@fs.open("me.jpg", "w") do |f|
  f.write image
end
```
But a couple things need to be kept in mind. First is that the original 'me.jpg' will be available until the new 'me.jpg' saves. From then on, calls to the #open method will always return the most recently saved version of a file. But, and this the second point, old versions of the file won't be deleted. So if you're going to be rewriting files often, you could end up with a lot of old versions piling up. One solution to this is to use the :delete_old options when writing a file:

```ruby
gem open = File.open("me-dancing.jpg")
gem.open("me.jpg", "w", :delete_old => true) do |f|
  f.write image
end
```

This will delete all but the latest version of the file.

**Deleting files**

When you delete a file by name, you delete all versions of that file:

```ruby
@fs.delete("me.jpg")
```

**Metadata and safe mode**

All of the options for storing metadata and saving in safe mode are available for the GridFileSystem class:

```ruby
image = File.open("me.jpg")
gem.open('my-avatar.jpg', w, :
  :content_type => "application/jpg",
  :metadata => {'description' => "taken on 3/1/2010 after a game of ultimate"},
  :_id => 'a-unique-id-to-use-instead-of-the-automatically-generated-one',
  :safe => true) { |f| f.write image }
```

**Advanced Users**

Astute code readers will notice that the Grid and GridFileSystem classes are merely thin wrappers around an underlying GridIO class. This means that it’s easy to customize the GridFS implementation presented here; just use GridIO for all the low-level work, and build the API you need in an external manager class similar to Grid or GridFileSystem.

**Rails - Getting Started**

Using Rails 3? See Rails 3 - Getting Started

This tutorial describes how to set up a simple Rails application with MongoDB, using MongoMapper as an object mapper. We assume you’re using Rails versions prior to 3.0.

- **Configuration**
- **Testing**
- **Coding**

**Using a Rails Template**

All of the configuration steps listed below, and more, are encapsulated in this Rails template (raw version), based on a similar one by Ben Scofield. You can create your project with the template as follows:

```bash
rails project_name -m "http://gist.github.com/gists/219223.txt"
```

Be sure to replace `project_name` with the name of your project.

If you want to set up your project manually, read on.

**Configuration**

1. We need to tell MongoMapper which database we'll be using. Save the following to `config/initializers/database.rb`:
MongoMapper.database = "db_name-#{Rails.env}"

Replace db_name with whatever name you want to give the database. The Rails.env variable will ensure that a different database is used for each environment.

2. If you’re using Passenger, add this code to config/initializers/database.rb.

   ```ruby
   if defined?(PhusionPassenger)
     PhusionPassenger.on_event(:starting_worker_process) do |forked|
       MongoMapper.connection.connect_to_master if forked
       end
     end
   end
   ```

3. Clean out config/database.yml. This file should be blank, as we’re not connecting to the database in the traditional way.

4. Remove ActiveRecord from environment.rb.

   ```ruby
   config.frameworks -= [:active_record]
   ```

5. Add MongoMapper to the environment. This can be done by opening config/environment.rb and adding the line:

   ```ruby
   config.gem 'mongo_mapper'
   ```

Once you’ve done this, you can install the gem in the project by running:

```ruby
rake gems:install
rake gems:unpack
```

### Testing

It’s important to keep in mind that with MongoDB, we cannot wrap test cases in transactions. One possible work-around is to invoke a teardown method after each test case to clear out the database.

To automate this, I’ve found it effective to modify ActiveSupport::TestCase with the code below.

```ruby
# Drop all columns after each test case.
def teardown
  MongoMapper.database.collections.each do |coll|
    coll.remove
  end
end

# Make sure that each test case has a teardown method to clear the db after each test.
def inherited(base)
  base.define_method teardown do
    super
  end
end
```

This way, all test classes will automatically invoke the teardown method. In the example above, the teardown method clears each collection. We might also choose to drop each collection or drop the database as a whole, but this would be considerably more expensive and is only necessary if our tests manipulate indexes.

Usually, this code is added in test/test_helper.rb. See the aforementioned rails template for specifics.

### Coding

If you’ve followed the foregoing steps (or if you’ve created your Rails with the provided template), then you’re ready to start coding. For help on that, you can read about modeling your domain in Rails.
Rails 3 - Getting Started

It's not difficult to use MongoDB with Rails 3. Most of it comes down to making sure that you're not loading ActiveRecord and understanding how to use Bundler, the new Ruby dependency manager.

- Install the Rails 3 Pre-release
- Configure your application
  - Bundling and Initialize
    - Bundling
    - Initializing
- ActiveModel Compatibility
- Conclusion
- See also

Install the Rails 3 Pre-release

If you haven't done so already, install the Rails 3 pre-release. This requires installing the dependencies manually and then installing the Rails 3 pre-release gem:

```bash
# Use sudo if your setup requires it
gem install tzinfo builder ll8n memcache-client rack \ 
rake rack-test rack-mount erubis mail text-format \ 
thor bundler

gem install rails --prerelease
```

Configure your application

The important thing here is to avoid loading ActiveRecord. One way to do this is with the `--skip-activerecord` switch. So you'd create your app skeleton like so:

```bash
rails my_app --skip-activerecord
```

Alternatively, if you've already created your app (or just want to know what this actually does), have a look at `config/application.rb` and change the first lines from this:

```ruby
require "rails/all"
```

...to this:

```ruby
require "action_controller/railtie"
require "action_mailer/railtie"
require "active_resource/railtie"
require "rails/test_unit/railtie"
```

It's also important to make sure that the reference to active_record in the generator block is commented out:

```ruby
# Configure generators values. Many other options are available, be sure to check the documentation.
# config.generators do |g|
#   g.orm :active_record
#   g.template_engine :erb
#   g.test_framework :test_unit, :fixture => true
# end
```

As of this this writing, it's commented out by default, so you probably won't have to change anything here.
**Bundle and Initialize**

The final step involves bundling any gems you'll need and then creating an initializer for connecting to the database.

**Bundling**

Edit **Gemfile**, located in the Rails root directory. By default, our **Gemfile** will only load Rails:

```ruby
# Edit this Gemfile to bundle your application's dependencies.

source 'http://gemcutter.org'

# Edit this Gemfile to bundle your application's dependencies.

gem "rails", "3.0.0.beta"

# Edit this Gemfile to bundle your application's dependencies.

require 'rubygems'
require 'mongo'
source 'http://gemcutter.org'

# Edit this Gemfile to bundle your application's dependencies.

gem "rails", "3.0.0.beta"

# Edit this Gemfile to bundle your application's dependencies.

require 'rubygems'
require 'mongo'
source 'http://gemcutter.org'

# Edit this Gemfile to bundle your application's dependencies.

gem "rails", "3.0.0.beta"

# Edit this Gemfile to bundle your application's dependencies.

require 'rubygems'
require 'mongo'
source 'http://gemcutter.org'

# Edit this Gemfile to bundle your application's dependencies.

gem "rails", "3.0.0.beta"

# Edit this Gemfile to bundle your application's dependencies.

require 'rubygems'
require 'mongo'
source 'http://gemcutter.org'

# Edit this Gemfile to bundle your application's dependencies.

gem "rails", "3.0.0.beta"

# Edit this Gemfile to bundle your application's dependencies.

require 'rubygems'
require 'mongo'
source 'http://gemcutter.org'

# Edit this Gemfile to bundle your application's dependencies.

gem "rails", "3.0.0.beta"
```

Normally, using MongoDB will simply mean adding whichever **OM framework** you want to work with, as these will require the "mongo" gem by default.

```
# Edit this Gemfile to bundle your application's dependencies.

source 'http://gemcutter.org'

# Edit this Gemfile to bundle your application's dependencies.

gem "rails", "3.0.0.beta"

# Edit this Gemfile to bundle your application's dependencies.

require 'rubygems'
require 'mongo'
source 'http://gemcutter.org'

# Edit this Gemfile to bundle your application's dependencies.

gem "rails", "3.0.0.beta"

# Edit this Gemfile to bundle your application's dependencies.

require 'rubygems'
require 'mongo'
source 'http://gemcutter.org'

# Edit this Gemfile to bundle your application's dependencies.

gem "rails", "3.0.0.beta"
```

However, there's currently an issue with loading mongo_ext, as the current gemspec isn't compatible with the way Bundler works. We'll be fixing that soon; just pay attention to this issue.

In the meantime, you can use the following work-around:

```
# Edit this Gemfile to bundle your application's dependencies.

source 'http://gemcutter.org'

# Edit this Gemfile to bundle your application's dependencies.

gem "rails", "3.0.0.beta"

# Edit this Gemfile to bundle your application's dependencies.

require 'rubygems'
require 'mongo'
source 'http://gemcutter.org'

# Edit this Gemfile to bundle your application's dependencies.

gem "rails", "3.0.0.beta"

# Edit this Gemfile to bundle your application's dependencies.

require 'rubygems'
require 'mongo'
source 'http://gemcutter.org'

# Edit this Gemfile to bundle your application's dependencies.

gem "rails", "3.0.0.beta"
```

Requiring **rubygems** and **mongo** before running the **gem** command will ensure that **mongo_ext** is loaded. If you'd rather not load **rubygems**, just make sure that both **mongo** and **mongo_ext** are in your load path when you require **mongo**.

Once you've configured your **Gemfile**, run the bundle installer:

```
bundle install
```

**Initializing**

Last item is to create an initializer to connect to MongoDB. Create a Ruby file in **config/initializers**. You can give it any name you want; here we'll call it **config/initializers/mongo.rb**:

```
require 'mongo_mapper'

MongoMapper.connection = Mongo::Connection.new('localhost', 27017)
MongoMapper.database = "#myapp-#{Rails.env}"

if defined?(PhusionPassenger)
  PhusionPassenger.on_event(:starting_worker_process) do |forked|
    if forked
      MongoMapper.connection.connect_to_master
    end
  end
end
```

**Running Tests**
A slight modification is required to get rake test working (thanks to John P. Wood). Create a file lib/tasks/mongo.rake containing the following:

```ruby
namespace :db do
  namespace :test do
    task :prepare do
      # Stub out for MongoDB
    end
  end
end
```

Now the various rake test tasks will run properly. See John's post for more details.

### ActiveModel Compatibility

ActiveModel is a series of interfaces designed to make any object-mapping library compatible with the various helper methods across the Rails stack. To see the status of ActiveModel integration on the various object mappers, see our object mappers page.

Briefly, Mongoid supports ActiveModel via a prerelease branch. MongoMapper will be adding support in the near future. In the meantime, use the MongoMapper Rails 3 Branch.

### Conclusion

That should be all. You can now start creating models based on whichever OM you've installed.

Note that this document is a work in progress. If you have any helpful comments, please add them below.

### See also

- Rails 3 App skeleton with MongoMapper
- Rails 3 Release Notes

### MongoDB Data Modeling and Rails

This tutorial discusses the development of a web application on Rails and MongoDB. MongoMapper will serve as our object mapper. The goal is to provide some insight into the design choices required for building on MongoDB. To that end, we'll be constructing a simple but non-trivial social news application. The source code for newsmonger is available on github for those wishing to dive right in.

- Modeling Stories
  - Caching to Avoid N+1
  - A Note on Denormalization
  - Fields as arrays
  - Atomic Updates
- Modeling Comments
  - Linear, Embedded Comments
  - Nested, Embedded Comments
  - Comment collections
- Unfinished business

Assuming you've configured your application to work with MongoMapper, let's start thinking about the data model.

### Modeling Stories

A news application relies on stories at its core, so we'll start with a Story model:
class Story
  include MongoMapper::Document

  key :title, String
  key :url, String
  key :slug, String
  key :voters, Array
  key :votes, Integer, :default => 0
  key :relevance, Integer, :default => 0

  # Cached values.
  key :comment_count, Integer, :default => 0
  key :username, String

  # Note this: ids are of class ObjectId.
  key :user_id, ObjectId

  # Relationships.
  belongs_to :user

  # Validations.
  validates_presence_of :title, :url, :user_id
end

Obviously, a story needs a title, url, and user_id, and should belong to a user. These are self-explanatory.

Caching to Avoid N+1

When we display our list of stories, we'll need to show the name of the user who posted the story. If we were using a relational database, we could perform a join on users and stores, and get all our objects in a single query. But MongoDB does not support joins and so, at times, requires bit of denormalization. Here, this means caching the 'username' attribute.

A Note on Denormalization

Relational purists may be feeling uneasy already, as if we were violating some universal law. But let's bear in mind that MongoDB collections are not equivalent to relational tables; each serves a unique design objective. A normalized table provides an atomic, isolated chunk of data. A document, however, more closely represents an object as a whole. In the case of a social news site, it can be argued that a username is intrinsic to the story being posted.

What about updates to the username? It's true that such updates will be expensive; happily, in this case, they'll be rare. The read savings achieved in denormalizing will surely outweigh the costs of the occasional update. Alas, this is not hard and fast rule: ultimately, developers must evaluate their applications for the appropriate level of normalization.

Fields as arrays

With a relational database, even trivial relationships are blown out into multiple tables. Consider the votes a story receives. We need a way of recording which users have voted on which stories. The standard way of handling this would involve creating a table, 'votes', with each row referencing user_id and story_id.

With a document database, it makes more sense to store those votes as an array of user ids, as we do here with the 'voters' key.

For fast lookups, we can create an index on this field. In the MongoDB shell:

    db.stories.ensureIndex('voters');

Or, using MongoMapper, we can specify the index in config/initializers/database.rb:

    Story.ensure_index([['voters', 1]])
    Mongomapper.ensure_indexes!

To find all the stories voted on by a given user:

    Story.all(:conditions => {:voters => @user.id})
**Atomic Updates**

Storing the voters array in the Story class also allows us to take advantage of atomic updates. What this means here is that, when a user votes on a story, we can

1. ensure that the voter hasn't voted yet, and, if not,
2. increment the number of votes and
3. add the new voter to the array.

MongoDB's query and update features allows us to perform all three actions in a single operation. Here's what that would look like from the shell:

```javascript
// Assume that story_id and user_id represent real story and user ids.
db.stories.update({_id: story_id, voters: {'$ne': user_id}},
                  {'$inc': {votes: 1}, '$push': {voters: user_id}});
```

What this says is "get me a story with the given id whose voters array does not contain the given user id and, if you find such a story, perform two atomic updates: first, increment votes by 1 and then push the user id onto the voters array."

This operation highly efficient; it's also reliable. The one caveat is that, because update operations are "fire and forget," you won't get a response from the server. But in most cases, this should be a non-issue.

A MongoMapper implementation of the same update would look like this:

```ruby
def self.upvote(story_id, user_id)
  collection.update({'_id' => story_id, 'voters' => {'$ne' => user_id}},
                    {'$inc' => {'votes' => 1}, '$push' => {'voters' => user_id}})
end
```

**Modeling Comments**

In a relational database, comments are usually given their own table, related by foreign key to some parent table. This approach is occasionally necessary in MongoDB; however, it's always best to try to embed first, as this will achieve greater query efficiency.

**Linear, Embedded Comments**

Linear, non-threaded comments should be embedded. Here are the most basic MongoMapper classes to implement such a structure:

```ruby
class Story
  include MongoMapper::Document
  many :comments
end

class Comment
  include MongoMapper::EmbeddedDocument
  key :body, String
  belongs_to :story
end
```

If we were using the Ruby driver alone, we could save our structure like so:

```ruby
@stories = @db.collection('stories')
@document = {:title => "MongoDB on Rails",
             :comments => [{:body => "Revelatory! Loved it!",
                            :username => "Matz"
                          }]
@stories.save(@document)
```

Essentially, comments are represented as an array of objects within a story document. This simple structure should be used for any one-to-many
relationship where the many items are linear.

**Nested, Embedded Comments**

But what if we’re building threaded comments? An admittedly more complicated problem, two solutions will be presented here. The first is to represent the tree structure in the nesting of the comments themselves. This might be achieved using the Ruby driver as follows:

```ruby
@stories = @db.collection('stories')
@document = {:title => "MongoDB on Rails",
             :comments => [{:body => "Revelatory! Loved it!",
                           :username => "Matz",
                           :comments => [{:body => "Agreed.",
                                         :username => "rubydev29"
                           }]
             }
}
@stories.save(@document)
```

Representing this structure using MongoMapper would be tricky, requiring a number of custom mods.

But this structure has a number of benefits. The nesting is captured in the document itself (this is, in fact, how Business Insider represents comments). And this schema is highly performant, since we can get the story, and all of its comments, in a single query, with no application-side processing for constructing the tree.

One drawback is that alternative views of the comment tree require some significant reorganizing.

**Comment collections**

We can also represent comments as their own collection. Relative to the other options, this incurs a small performance penalty while granting us the greatest flexibility. The tree structure can be represented by storing the unique path for each leaf (see Mathias's original post on the idea). Here are the relevant sections of this model:

```ruby
class Comment
  include MongoMapper::Document

  key :body, String
  key :depth, Integer, :default => 0
  key :path, String, :default => 

  # Note: we're intentionally storing parent_id as a string
  key :parent_id, String
  key :story_id, ObjectId
  timestamps!

  # Relationships.
  belongs_to :story

  # Callbacks.
  after_create :set_path

  private

  # Store the comment's path.
  def set_path
    unless self.parent_id.blank?
      parent = Comment.find(self.parent_id)
      self.story_id = parent.story_id
      self.depth = parent.depth + 1
      self.path = parent.path + ":" + parent.id
    end
    save
  end
end
```

The path ends up being a string of object ids. This makes it easier to display our comments nested, with each level in order of karma or votes. If we specify an index on story_id, path, and votes, the database can handle half the work of getting our comments in nested, sorted order.
The rest of the work can be accomplished with a couple grouping methods, which can be found in the newsmonger source code.

It goes without saying that modeling comments in their own collection also facilitates various site-wide aggregations, including displaying the latest, grouping by user, etc.

**Unfinished business**

Document-oriented data modeling is still young. The fact is, many more applications will need to be built on the document model before we can say anything definitive about best practices. So the foregoing should be taken as suggestions, only. As you discover new patterns, we encourage you to document them, and feel free to let us know about what works (and what doesn’t).

Developers working on object mappers and the like are encouraged to implement the best document patterns in their code, and to be wary of recreating relational database models in their apps.

**Object Mappers for Ruby and MongoDB**

Although it’s possible to use the Ruby driver by itself, sometimes you want validations, associations, and many of the other conveniences provided by ActiveRecord. Here, then, is a list of the most popular object mappers available for working with Ruby and MongoDB.

- **Recommendations**
- **Libraries**
  - MongoMapper
  - Mongoid
  - MongoRecord
  - MongoDoc
  -MongoModel
  - Candy

**Recommendations**

Just for the record, 10gen doesn’t recommend any one object mapper over the others. What we do advise is that you get to know how the database itself works. This is best accomplished by playing with the shell and experimenting with the Ruby driver (or any of the other drivers, for that matter).

Once you understand how MongoDB works, you’ll be in a good position to choose the object mapper that best suits your needs. So long as you pick an OM that’s used in production and is actively developed, you really can’t make a bad choice.

**Libraries**

**MongoMapper**

John Nunemaker’s OM. **Used in production** and actively-developed. ActiveModel support forthcoming.

**Installation:**

- gem install mongo_mapper

**Source:**

- mongo_mapper on github

**Documentation:**

- MongoMapper on google groups
- #mongomapper on freenode.

**Articles:**

- Getting Started with MongoMapper
- MongoMapper and Rails
- More MongoMapper Awesomeness.

**Mongoid**

Durran Jordan’s OM. **Used in production** and actively-developed. Supports ActiveModel and Rails 3.

**Installation:**

- gem install mongoid

**Source:**
• mongoid on github

Documentation:
  • Docs at mongoid.org

MongoRecord
10gen's original OM.

Notes:
MongoRecord is an ActiveRecord-like OM, and the first of its kind developed for MongoDB. Favored by a contingent of developers for its simplicity, MongoRecord currently receives a lot of love from Nate Wiger.

Installation:
  • gem install mongo_record

Source:
  • mongo-record on github

MongoDoc
MongoDoc is a simple, fast ODM for MongoDB. The project will eventually be merged into Mongoid.

Installation:
  • gem install mongodoc

Source:
  • mongodoc on github

MongoModel
Sam Pohlenz's OM. Actively-developed.

Notes:
An OM with emphasis on ActiveModel compatibility.

Installation:
  • gem install mongomodel

Source:
  • mongomodel on github

Candy
Stephen Eley's OM. Actively-developed.

Notes:
From the README:
Candy's goal is to provide the simplest possible object persistence for the MongoDB database. By "simple" we mean "nearly invisible." Candy doesn't try to mirror ActiveRecord or DataMapper. Instead, we play to MongoDB's unusual strengths – extremely fast writes and a set of field-specific update operators – and do away with the cumbersome, unnecessary methods of last-generation workflows.

Installation:
  • gem install candy

Source:
  • candy on github

Ruby External Resources
There are a number of good resources appearing all over the web for learning about MongoDB and Ruby. A useful selection is listed below. If you
know of others, do let us know.

- Screencasts
- Presentations
- Articles
- Projects
- Libraries

**Screencasts**

**Introduction to MongoDB - Part I**
An introduction to MongoDB via the MongoDB shell.

**Introduction to MongoDB - Part II**
In this screencast, Joon You teaches how to use the Ruby driver to build a simple Sinatra app.

**Introduction to MongoDB - Part III**
For the final screencast in the series, Joon You introduces MongoMapper and Rails.

**RailsCasts: MongoDB & MongoMapper**
Ryan Bates' RailsCast introducing MongoDB and MongoMapper.

**Presentations**

**Introduction to MongoDB (Video)**
Mike Dirolf's introduction to MongoDB at Pivotal Labs, SF.

**MongoDB: A Ruby Document Store that doesn't rhyme with 'Ouch' (Slides)**
Wynn Netherland's introduction to MongoDB with some comparisons to CouchDB.

**MongoDB (is) for Rubyists (Slides)**
Kyle Banker's presentation on why MongoDB is for Rubyists (and all human-oriented programmers).

**Introduction to Mongoid and MongoDB (Video)**
Durran Jordan discusses Mongoid, MongoDB, and how HashRocket uses these tools in production.

**Articles**

**Why I Think Mongo is to Databases What Rails was to Frameworks**
What if a key-value store mated with a relational database system?
John Nunemaker's articles on MongoDB.

A series of articles on aggregation with MongoDB and Ruby:
1. Part I: Introduction of Aggregation in MongoDB
2. Part II: MongoDB Grouping Elaborated
3. Part III: Introduction to Map-Reduce in MongoDB

**Projects**

**Mongo Queue**
An extensible thread safe job/message queueing system that uses mongodb as the persistent storage engine.

**Resque-mongo**
A port of the Github's Resque to MongoDB.

**Mongo Admin**
A Rails plugin for browsing and managing MongoDB data. See the live demo.

**Sinatra Resource**
Resource Oriented Architecture (REST) for Sinatra and MongoMapper.

**Shorty**
A URL-shortener written with Sinatra and the MongoDB Ruby driver.

**NewsMonger**
A simple social news application demonstrating MongoMapper and Rails.

**Data Catalog API**
From Sunlight Labs, a non-trivial application using MongoMapper and Sinatra.

**Watchtower**
An example application using Mustache, MongoDB, and Sinatra.
Libraries

ActiveExpando
An extension to ActiveRecord to allow the storage of arbitrary attributes in MongoDB.

ActsAsTree (MongoMapper)
ActsAsTree implementation for MongoMapper.

Machinist adapter (MongoMapper)
Machinist adapter using MongoMapper.

Mongo-Delegate
A delegation library for experimenting with production data without altering it. A quite useful pattern.

Remarkable Matchers (MongoMapper)
Testing / Matchers library using MongoMapper.

OpenIdAuthentication, supporting MongoDB as the datastore
Brandon Keepers’ fork of OpenIdAuthentication supporting MongoDB.

MongoTree (MongoRecord)
MongoTree adds parent / child relationships to MongoRecord.

Merb_MongoMapper
A plugin for the Merb framework for supporting MongoMapper models.

Mongolytics (MongoMapper)
A web analytics tool.

Rack-GridFS
A Rack middleware component that creates HTTP endpoints for files stored in GridFS.

Frequently Asked Questions - Ruby

This is a list of frequently asked questions about using Ruby with MongoDB. If you have a question you'd like to have answered here, please add it in the comments.

- Can I run [insert command name here] from the Ruby driver?
- Does the Ruby driver support an EXPLAIN command?
- I see that BSON supports a symbol type. Does this mean that I can store Ruby symbols in MongoDB?
- Why can’t I access random elements within a cursor?

Can I run [insert command name here] from the Ruby driver?

Yes. You can run any of the available database commands from the driver using the DB#command method. The only trick is to use an OrderedHash when specifying the command. For example, here’s how you’d run an asynchronous fsync from the driver:

```ruby
# This command is run on the admin database.
@db = Mongo::Connection.new.db('admin')

# Build the command.
cmd = OrderedHash.new
    cmd['fsync'] = 1
    cmd['async'] = true

# Run it.
@db.command(cmd)
```

It's important to keep in mind that some commands, like `fsync`, must be run on the `admin` database, while other commands can be run on any database. If you're having trouble, check the command reference to make sure you're using the command correctly.

Does the Ruby driver support an EXPLAIN command?

Yes. `explain` is, technically speaking, an option sent to a query that tells MongoDB to return an explain plan rather than the query’s results. You can use `explain` by constructing a query and calling `explain` at the end:
@collection = @db['users']
result = @collection.find({:name => "jones"}).explain

The resulting explain plan might look something like this:

```json
{
"cursor":"BtreeCursor name_1",
"startKey": "name":"Jones",
"endKey": "name":"Jones",
"nsCasted":1,
"nScanned":1,
"millis":0,
"oldPlan":{
"cursor":"BtreeCursor name_1",
"startKey": "name":"Jones",
"endKey": "name":"Jones"
},
"allPlans":{
"cursor":"BtreeCursor name_1",
"startKey": "name":"Jones",
"endKey": "name":"Jones"
}
}
```

Because this collection has an index on the "name" field, the query uses that index, only having to scan a single record. "n" is the number of records the query will return. "millis" is the time the query takes, in milliseconds. "oldPlan" indicates that the query optimizer has already seen this kind of query and has, therefore, saved an efficient query plan. "allPlans" shows all the plans considered for this query.

I see that BSON supports a symbol type. Does this mean that I can store Ruby symbols in MongoDB?

You can store Ruby symbols in MongoDB, but only as values. BSON specifies that document keys must be strings. So, for instance, you can do this:

```ruby
@collection = @db['test']
boat_id = @collection.save({:vehicle => :boat})
car_id  = @collection.save({:vehicle => :car})

@collection.find_one('_id' => boat_id)
{
"_id" => ObjectID('4bb372a8238d3b5c8c000001'),
"vehicle" => :boat
}

@collection.find_one('_id' => car_id)
{
"_id" => ObjectID('4bb372a8238d3b5c8c000002'),
"vehicle" => :car
}
```

Notice that the symbol values are returned as expected, but that symbol keys are treated as strings.

Why can't I access random elements within a cursor?

MongoDB cursors are designed for sequentially iterating over a result set, and all the drivers, including the Ruby driver, stick closely to this directive. Internally, a Ruby cursor fetches results in batches by running a MongoDB `getmore` operation. The results are buffered for efficient iteration on the client-side.

What this means is that a cursor is nothing more than a device for returning a result set on a query that's been initiated on the server. Cursors are not containers for result sets. If we allow a cursor to be randomly accessed, then we run into issues regarding the freshness of the data. For instance, if I iterate over a cursor and then want to retrieve the cursor's first element, should a stored copy be returned, or should the cursor re-run the query? If we returned a stored copy, it may not be fresh. And if the the query is re-run, then we're technically dealing with a new cursor.

To avoid those issues, we're saying that anyone who needs a flexible access to the results of a query should store those results in an array and then access the data as needed.
Java Driver Concurrency

The Java MongoDB driver is thread safe. If you are using in a web serving environment, for example, you should create a single Mongo instance, and you can use it in every request. The Mongo object maintains an internal pool of connections to the database (default pool size of 10).

However, if you want to ensure complete consistency in a "session" (maybe an HTTP request), you probably want the driver to use the same socket for that session (which isn't necessarily the case since Mongo instances have built-in connection pooling). This is only necessary for a write heavy environment, where you might read data that you wrote.

To do that, you would do something like:

```java
DB db...;
db.requestStart();
    code....
db.requestDone();
```

Java - Saving Objects Using DBOBJECT

The Java driver provides a DBOBJECT interface to save custom objects to the database.

For example, suppose one had a class called Tweet that they wanted to save:

```java
public class Tweet implements DBOBJECT {
    /* ... */
}
```

Then you can say:

```java
Tweet myTweet = new Tweet();
myTweet.put("user", userId);
myTweet.put("message", msg);
myTweet.put("date", new Date());
collection.insert(myTweet);
```

When a document is retrieved from the database, it is automatically converted to a DBOBJECT. To convert it to an instance of your class, use `DBCollection.setObjectClass()`:

```java
collection.setObjectClass(Tweet);
Tweet myTweet = (Tweet)collection.findOne();
```
Java Tutorial

- Introduction
- A Quick Tour
  - Making A Connection
  - Authentication (Optional)
  - Getting A List Of Collections
  - Getting A Collection
  - Inserting a Document
  - Finding the First Document In A Collection using `findOne()`
  - Adding Multiple Documents
  - Counting Documents In A Collection
  - Using a Cursor to Get All the Documents
  - Getting A Single Document with A Query
  - Getting A Set of Documents With a Query
  - Creating An Index
  - Getting a List of Indexes on a Collection
- Quick Tour of the Administrative Functions
  - Getting A List of Databases
  - Dropping A Database

Introduction

This page is a brief overview of working with the MongoDB Java Driver.
For more information about the Java API, please refer to the [online API Documentation for Java Driver](#).

A Quick Tour

Using the Java driver is very simple. First, be sure to include the driver jar `mongo.jar` in your classpath. The following code snippets come from the examples/QuickTour.java example code found in the driver.

Making A Connection

To make a connection to a MongoDB, you need to have at the minimum, the name of a database to connect to. The database doesn't have to exist - if it doesn't, MongoDB will create it for you.

Additionally, you can specify the server address and port when connecting. The following example shows three ways to connect to the database `mydb` on the local machine:

```java
import com.mongodb.Mongo;
import com.mongodb.DB;
import com.mongodb.DBCollection;
import com.mongodb.DBObject;
import com.mongodb.DBCursor;

Mongo m = new Mongo();
Mongo m = new Mongo( "localhost" );
Mongo m = new Mongo( "localhost", 27017 );

DB db = m.getDB( "mydb" );
```

At this point, the `db` object will be a connection to a MongoDB server for the specified database. With it, you can do further operations.

Note: The `Mongo` object instance actually represents a pool of connections to the database; you will only need one object of class `Mongo` even with multiple threads. See the concurrency doc page for more information.

Authentication (Optional)

MongoDB can be run in a secure mode where access to databases is controlled through name and password authentication. When run in this mode, any client application must provide a name and password before doing any operations. In the Java driver, you simply do the following with the connected mongo object:

```java
boolean auth = db.authenticate(myUserName, myPassword);
```

If the name and password are valid for the database, `auth` will be `true`. Otherwise, it will be `false`. You should look at the MongoDB log for
further information if available.

Most users run MongoDB without authentication in a trusted environment.

Getting A List Of Collections

Each database has zero or more collections. You can retrieve a list of them from the db (and print out any that are there):

```java
Set<String> colls = db.getCollectionNames();
for (String s : colls) {
    System.out.println(s);
}
```

and assuming that there are two collections, name and address, in the database, you would see

```
name
address
```

as the output.

Getting A Collection

To get a collection to use, just specify the name of the collection to the `getDbCollection(String collectionName)` method:

```
DBCollection coll = db.getCollection("testCollection")
```

Once you have this collection object, you can now do things like insert data, query for data, etc.

Inserting a Document

Once you have the collection object, you can insert documents into the collection. For example, let's make a little document that in JSON would be represented as

```
{
    "name" : "MongoDB",
    "type" : "database",
    "count" : 1,
    "info" : {
        "x" : 203,
        "y" : 102
    }
}
```

Notice that the above has an “inner” document embedded within it. To do this, we can use the `BasicDBObject` class to create the document (including the inner document), and then just simply insert it into the collection using the `insert()` method.

```java
BasicDBObject doc = new BasicDBObject();
    doc.put("name", "MongoDB");
    doc.put("type", "database");
    doc.put("count", 1);
    BasicDBObject info = new BasicDBObject();
    info.put("x", 203);
    info.put("y", 102);
    doc.put("info", info);
    coll.insert(doc);
```
Finding the First Document In A Collection using `findOne()`

To show that the document we inserted in the previous step is there, we can do a simple `findOne()` operation to get the first document in the collection. This method returns a single document (rather than the `DBCursor` that the `find()` operation returns), and it's useful for things where there only is one document, or you are only interested in the first. You don't have to deal with the cursor.

```java
DBObject myDoc = coll.findOne();
System.out.println(myDoc);
```

and you should see

```java
{ "_id": "49902cde5162504500b45c2c", "name": "MongoDB", "type": "database", "count": 1, "info": { "x": 203, "y": 102 }, "_ns": "testCollection" }
```

Note the `_id` and `_ns` elements have been added automatically by MongoDB to your document. Remember, MongoDB reserves element names that start with `_` for internal use.

Adding Multiple Documents

In order to do more interesting things with queries, let's add multiple simple documents to the collection. These documents will just be

```java
{ "i" : value }
```

and we can do this fairly efficiently in a loop

```java
for (int i=0; i < 100; i++) {
    coll.insert(new BasicDBObject().append("i", i));
}
```

Notice that we can insert documents of different "shapes" into the same collection. This aspect is what we mean when we say that MongoDB is "schema-free".

Counting Documents in A Collection

Now that we've inserted 101 documents (the 100 we did in the loop, plus the first one), we can check to see if we have them all using the `getCount()` method.

```java
System.out.println(coll.getCount());
```

and it should print 101.

Using a Cursor to Get All the Documents

In order to get all the documents in the collection, we will use the `find()` method. The `find()` method returns a `DBCursor` object which allows us to iterate over the set of documents that matched our query. So to query all of the documents and print them out:

```java
DBCursor cur = coll.find();
while(cur.hasNext()) {
    System.out.println(cur.next());
}
```

and that should print all 101 documents in the collection.

Getting A Single Document with A Query

We can create a `query` to pass to the `find()` method to get a subset of the documents in our collection. For example, if we wanted to find the document for which the value of the "i" field is 71, we would do the following:
BasicDBObject query = new BasicDBObject();
    query.put("i", 71);
    cur = coll.find(query);
    while(cur.hasNext()) {
        System.out.println(cur.next());
    }

and it should just print just one document

    { 
        ".id": "49903677516250c1008d624e", 
        "i": 71,
        ".ns": "testCollection"
    }

Getting A Set of Documents With a Query

We can use the query to get a set of documents from our collection. For example, if we wanted to get all documents where "i" > 50, we could write:

query = new BasicDBObject();
    query.put("i", new BasicDBObject("$gt", 50)); // e.g. find all where i > 50
    cur = coll.find(query);
    while(cur.hasNext()) {
        System.out.println(cur.next());
    }

which should print the documents where i > 50. We could also get a range, say 20 < i <= 30:

query = new BasicDBObject();
    query.put("i", new BasicDBObject("$gt", 20).append("$lte", 30)); // i.e. 20 < i <= 30
    cur = coll.find(query);
    while(cur.hasNext()) {
        System.out.println(cur.next());
    }

Creating An Index

MongoDB supports indexes, and they are very easy to add on a collection. To create an index, you just specify the field that should be indexed, and specify if you want the index to be ascending (1) or descending (-1). The following creates an ascending index on the "i" field:

coll.createIndex(new BasicDBObject("i", 1)); // create index on "i", ascending

Getting a List of Indexes on a Collection

You can get a list of the indexes on a collection:

List<DBObject> list = coll.getIndexInfo();
    for (DBObject o : list) {
        System.out.println(o);
    }

and you should see something like
Quick Tour of the Administrative Functions

Getting A List of Databases

You can get a list of the available databases:

```java
Mongo m = new Mongo();
for (String s : m.getDatabaseNames()) {
    System.out.println(s);
}
```

Dropping A Database

You can drop a database by name using the `Mongo` object:

```java
m.dropDatabase("my_new_db");
```

Java Types

Object Ids

`com.mongodb.ObjectId` is used to autogenerate unique ids.

```java
ObjectId id = new ObjectId();
ObjectId copy = new ObjectId(id);
```

Regular Expressions

The Java driver uses `java.util.regex.Pattern` for regular expressions.

```java
Pattern john = Pattern.compile("joh?n", CASE_INSENSITIVE);
BasicDBObject query = new BasicDBObject("name", john);

// finds all people with "name" matching /joh?n/i
DBCursor cursor = collection.find(query);
```

Dates/Times

The `java.util.Date` class is used for dates.

```java
Date now = new Date();
BasicDBObject time = new BasicDBObject("ts", now);

collection.save(time);
```

Database References

`com.mongodb.DBRef` can be used to save database references.
DBRef addressRef = new DBRef(db, "foo.bar", address_id);
DBObject address = addressRef.fetch();

DBObject person = BasicDBObjectBuilder.start()
  .add("name", "Fred")
  .add("address", addressRef)
  .get();
collection.save(person);

DBObject fred = collection.findOne();
// address reference is returned as a DBObject, not a DBRef
DBObject addressObj = (DBObject)fred.get("address");

**Binary Data**

An array of bytes (byte[]) can be used for binary data.

**C++ Language Center**

A C++ driver is available for communicating with the MongoDB. As the database is written in C++, the driver actually uses some core MongoDB code -- this is the same driver that the database uses itself for replication.

The driver has been compiled successfully on Linux, OS X, Windows, and Solaris.

- API Documentation
- C++ Tutorial
- HOWTO
  - Connecting
  - Tailable Cursors
- Mongo Database and C++ Driver Source Code (at github). See the client subdirectory for client driver related files.

**Additional Notes**

- The Building documentation covers compiling the entire database, but some of the notes there may be helpful for compiling client applications too.
- There is also a pure C driver for MongoDB. For true C++ apps we recommend using the C++ driver.

**C++ Tutorial**

- Installing the Driver Library and Headers
  - Unix
    - From Source
    - From Distribution
  - Windows
- Compiling
- Writing Client Code
  - Connecting
  - BSON
  - Inserting
  - Querying
  - Indexing
  - Sorting
  - Updating
- Further Reading

This document is an introduction to usage of the MongoDB database from a C++ program.

First, install Mongo -- see Getting Started for details.

Next, you may wish to take a look at the Developer's Tour guide for a language independent look at how to use MongoDB. Also, we suggest some basic familiarity with the mongo shell -- the shell is one's primary database administration tool and is useful for manually inspecting the contents of a database after your C++ program runs.
Installing the Driver Library and Headers

A good source for general information about setting up a MongoDB development environment on various operating systems is the building page.

Unix

From Source

For Unix, the Mongo driver library is libmongoclient.a.

When installing from source, use scons install to install the libraries. By default library and header files are installed in /usr/local. You can use --prefix to change the install path: scons --prefix /opt/mongo install.

From Distribution

The normal db distribution includes the C++ driver. You can just unzip wherever you like.

Windows

The MongoDB Windows binary packages include a file lib/mongoclient.lib. Include this library in your client project.

For more information on Boost setup see the Building for Windows page.

Compiling

The C++ drivers requires the boost libraries to compile. Be sure boost is on your include and lib paths.

Writing Client Code

Note: for brevity, the examples below are simply inline code. In a real application one will define classes for each database object typically.

Connecting

Let's make a tutorial.cpp file that connects to the database (see client/examples/tutorial.cpp for full text of the examples below):

```cpp
#include <iostream>
#include "client/dbclient.h"

using namespace mongo;

void run() {
    DBClientConnection c;
    c.connect("localhost");
}

int main() {
    try {
        run();
        cout << "connected ok" << endl;
    } catch( DBException &e ) {
        cout << "caught " << e.what() << endl;
    }
    return 0;
}
```

If you are using gcc on Linux or OS X, you would compile with something like this, depending on location of your include files and libraries:

```sh
$ g++ tutorial.cpp -lmongoclient -lboost_thread-mt -lboost_filesystem -lboost_program_options -o tutorial
$ ./tutorial
tutorial connected ok
$
depending on your boost version you might need to link against the boost_system library as well: -lboost_system. Also, you may need to append "-mt" to boost_filesystem and boost_program_options.

**BSON**

The Mongo database stores data in BSON format. BSON is a binary object format that is JSON-like in terms of the data which can be stored (some extensions exist, for example, a Date datatype).

To save data in the database we must create objects of class BSONObj. The components of a BSONObj are represented as BSONElement objects. We use BSONObjBuilder to make BSON objects, and BSONObjIterator to enumerate BSON objects.

Let’s now create a BSON “person” object which contains name and age. We might invoke:

```cpp
BSONObjBuilder b;
b.append("name", "Joe");
b.append("age", 33);
BSONObj p = b.obj();
```

Or more concisely:

```cpp
BSONObj p = BSONObjBuilder().append("name", "Joe").append("age", 33).obj();
```

We can also create objects with a stream-oriented syntax:

```cpp
BSONObjBuilder b;
b << "name" << "Joe" << "age" << 33;
BSONObj p = b.obj();
```

The macro BSON lets us be even more compact:

```cpp
BSONObj p = BSON("name" << "Joe" << "age" << 33 );
```

Use the GENOID helper to add an object id to your object. The server will add an _id automatically if it is not included explicitly.

```cpp
BSONObj p = BSON( GENOID << "name" << "Joe" << "age" << 33 );
// result is: { _id : ..., name : "Joe", age : 33 }
```

GENOID should be at the beginning of the generated object. We can do something similar with the non-stream builder syntax:

```cpp
BSONObj p =
BSONObjBuilder().genOID().append("name","Joe").append("age",33).obj();
```

**Inserting**

We now save our person object in a persons collection in the database:

```cpp
c.insert("tutorial.persons", p);
```

The first parameter to insert is the namespace. tutorial is the database and persons is the collection name.

**Querying**

Let’s now fetch all objects from the persons collection, and display them. We’ll also show here how to use count().

```cpp
// result is: { _id : ..., name : "Joe", age : 33 }
```
cout << "count:" << c.count("tutorial.persons") << endl;

auto_ptr<DBClientCursor> cursor =
c.query("tutorial.persons", emptyObj);
while( cursor->more() )
   cout << cursor->next().toString() << endl;

emptyObj is the empty BSON object -- we use it to represent {} which indicates an empty query pattern (an empty query is a query for all objects).

We use BSONObj::toString() above to print out information about each object retrieved. BSONObj::toString is a diagnostic function which prints an abbreviated JSON string representation of the object. For full JSON output, use BSONObj::jsonString.

Let's now write a function which prints out the name (only) of all persons in the collection whose age is a given value:

```cpp
void printIfAge(DBClientConnection& c, int age) {
    auto_ptr<DBClientCursor> cursor =
c.query("tutorial.persons", QUERY("age" << age));
    while( cursor->more() ) {
        BSONObj p = cursor->next();
        cout << p.getStringField("name") << endl;
    }
}
```

getStringField() is a helper that assumes the "name" field is of type string. To manipulate an element in a more generic fashion we can retrieve the particular BSONElement from the enclosing object:

```cpp
BSONElement name = p["name"];
// or:
//BSONElement name = p.getField("name");
```

See the api docs, and jsobj.h, for more information.

Our query above, written as JSON, is of the form

```json
{ age : <agevalue> }
```

Queries are BSON objects of a particular format -- in fact, we could have used the BSON() macro above instead of QUERY(). See class Query in dbclient.h for more information on Query objects, and the Sorting section below.

In the mongo shell (which uses javascript), we could invoke:

```javascript
use tutorial;
db.persons.find( { age : 33 } );
```

**Indexing**

Let's suppose we want to have an index on age so that our queries are fast. We would use:

```cpp
c.ensureIndex("tutorial.persons", fromjson("{age:1}"));
```

The ensureIndex method checks if the index exists; if it does not, it is created. ensureIndex is intelligent and does not repeat transmissions to the server; thus it is safe to call it many times in your code, for example, adjacent to every insert operation.

In the above example we use a new function, fromjson. fromjson converts a JSON string to a BSONObj. This is sometimes a convenient way to specify BSON. Alternatively we could have written:

```cpp
c.ensureIndex("tutorial.persons", BSON("age" << 1));
```

**Sorting**
Let's now make the results from printIfAge sorted alphabetically by name. To do this, we change the query statement from:

```c++
auto_ptr<DBClientCursor> cursor = c.query("tutorial.persons", QUERY("age" << age ) );
```

to

```c++
to auto_ptr<DBClientCursor> cursor = c.query("tutorial.persons", QUERY( "age" << age ).sort("name") );
```

Here we have used Query::sort() to add a modifier to our query expression for sorting.

**Updating**

Use the update() method to perform a database update. For example the following update in the mongo shell:

```shell
> use tutorial
> db.persons.update( { name : 'Joe', age : 33 },
...                  { $inc : { visits : 1 } } )
```

is equivalent to the following C++ code:

```c++
db.update( "tutorial.persons" ,
            BSON("name" << "Joe" << "age" << 33 ),
            BSON("$inc" << BSON("visits" << 1 ) ) );
```

**Further Reading**

This overview just touches on the basics of using Mongo from C++. There are many more capabilities. For further exploration:

- See the language-independent Developer's Tour;
- Experiment with the mongo shell;
- Review the doxygen API docs;
- See connecting pooling information in the API docs;
- See GridFS file storage information in the API docs;
- See the HOWTO pages under the C++ Language Center
- Consider getting involved to make the product (either C++ driver, tools, or the database itself) better!

**Connecting**

The C++ driver includes several classes for managing collections under the parent class DBClientInterface.

In general, you will want to instantiate either a DBClientConnection object, or a DBClientPaired object. DBClientConnection is our normal connection class for a connection to a single MongoDB database server (or shard manager). We use DBClientPaired to connect to database replica pairs.

**Perl Language Center**

- Installing
  - CPAN
  - Manual (Non-CPAN) Installation
  - Big-Endian Systems
- Next Steps
- Other MongoDB Perl Tools
  - MojoX::Session::Store::MongoDB

⚠️ Start a MongoDB server instance (mongod) before installing so that the tests will pass. Some tests may be skipped if you are not running a recent version of the database (>= 1.1.3).

**Installing**
The Perl driver is available through CPAN as the package MongoDB. It should build cleanly on *NIX and Windows (via Strawberry Perl).

**Manual (Non-CPAN) Installation**

If you would like to try the latest code or are contributing to the Perl driver, it is available at Github. There is also documentation generated after every commit.

You can see if it's a good time to grab the bleeding edge code by seeing if the build is green.

To build the driver, run:

```
$ perl Makefile.PL
$ make
$ make test # make sure mongod is running, first
$ sudo make install
```

Please note that the tests will not pass without a mongod process running.

**Big-Endian Systems**

The driver will work on big-endian machines, but the database will not. The tests assume that mongod will be running on localhost unless %ENV(MONGOD) is set. So, to run the tests, start the database on a little-endian machine (at, say, "example.com") and then run the tests with:

```
MONGOD=example.com make test
```

A few tests that require a database server on "localhost" will be skipped.

**Next Steps**

There is a tutorial and API documentation on CPAN.

If you're interested in contributing to the Perl driver, check out Contributing to the Perl Driver.

**Other MongoDB Perl Tools**

MojoX::Session::Store::MongoDB

MojoX::Session::Store::MongoDB is a store for MojoX::Session that stores a session in a MongoDB database. Created by Ask Bjørn Hansen.

**Contributing to the Perl Driver**

The easiest way to contribute is to file bugs and feature requests on Jira.

If you would like to help code the driver, read on...

**Finding Something to Help With**

**Fixing Bugs**

You can choose a bug on Jira and fix it. Make a comment that you're working on it, to avoid overlap.

**Writing Tests**

The driver could use a lot more tests. We would be grateful for any and all tests people would like to write.
**Adding Features**

If you think a feature is missing from the driver, you’re probably right. Check on IRC or the mailing list, then go ahead and create a Jira case and add the feature. The Perl driver was a bit neglected for a while (although it's now getting a lot of TLC) so it's missing a lot of things that the other drivers have. You can look through their APIs for ideas.

**Contribution Guidelines**

The best way to make changes is to create an account on [Github], fork the driver, make your improvements, and submit a merge request.

To make sure your changes are approved and speed things along:

- Write tests. Lots of tests.
- Document your code.
- Write POD, when applicable.

Bonus (for C programmers, particularly):

- Make sure your change works on Perl 5.8, 5.10, Windows, Mac, Linux, etc.

**Code Layout**

The important files:

```plaintext
| perl_mongo.c # serialization/deserialization
| mongo_link.c # connecting to, sending to, and receiving from the database
- lib
  - MongoClient.pm # connection, queries, inserts... everything comes through here
  | Database.pm
  | Collection.pm
  | Cursor.pm
  | OID.pm
  | GridFS.pm
  - GridFS
    | File.pm
- xs
  | Mongo.xs
  | Connection.xs
  | Cursor.xs
  | OID.xs
```

**Perl Tutorial**

⚠️ **Redirection Notice**

This page should redirect to [http://search.cpan.org/dist/MongoDB/lib/MongoDB/Tutorial.pod](http://search.cpan.org/dist/MongoDB/lib/MongoDB/Tutorial.pod).

**Online API Documentation**

MongoDB API and driver documentation is available online. It is updated daily.

- Java Driver API Documentation
- C++ Driver API Documentation
- Python Driver API Documentation
- Ruby Driver API Documentation
- PHP Driver API Documentation

**Writing Drivers and Tools**
Overview - Writing Drivers and Tools

This section contains information for developers that are working with the low-level protocols of Mongo - people who are writing drivers and higher-level tools.

Documents of particular interest:

<table>
<thead>
<tr>
<th>Description</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description of the BSON binary document format. Fundamental to how Mongo and its client software works.</td>
<td>bsonspec.org</td>
</tr>
<tr>
<td>Specification for the basic socket communications protocol used between Mongo and clients.</td>
<td></td>
</tr>
<tr>
<td>Description of what functionality is expected from a Mongo Driver</td>
<td></td>
</tr>
<tr>
<td>Specification of GridFS - a convention for storing large objects in Mongo</td>
<td></td>
</tr>
<tr>
<td>Description of the extended JSON protocol for the REST-ful interface (ongoing development)</td>
<td></td>
</tr>
</tbody>
</table>

Additionally we recommend driver authors take a look at existing driver source code as an example.

bsonspec.org

Mongo Driver Requirements

This is a high-level list of features that a driver for MongoDB might provide. We attempt to group those features by priority. This list should be taken with a grain of salt, and probably used more for inspiration than as law that must be adhered to. A great way to learn about implementing a driver is by reading the source code of any of the existing drivers, especially the ones listed as "mongodb.org supported".

High priority

- BSON serialization/deserialization
- full cursor support (e.g. support OP_GET_MORE operation)
- close exhausted cursors via OP_KILL_CURSORS
- support for running database commands
- handle query errors
- convert all strings to UTF-8 (part of proper support for BSON)
- hint, explain, count, $where
- database profiling: set/get profiling level, get profiling info
- advanced connection management (replica pairs, slave okay)
- automatic reconnection

Medium priority

- validate a collection in a database
- buffer pooling
- Tailable cursor support

A driver should be able to connect to a single server. By default this must be localhost:27017, and must also allow the server to be specified by hostname and port.

```java
Mongo m = new Mongo(); // go to localhost, default port

Mongo m = new Mongo(String host, int port);
```

How the driver does this is up to the driver - make it idiomatic. However, a driver should make it explicit and clear what is going on.

Pair Mode Connection

A driver must be able to support "Pair Mode" configurations, where two mongod servers are specified, and configured for hot-failover.

The driver should determine which of the pair is the current master, and send all operations to that server. In the event of an error, either socket error or a "not a master" error, the driver must restart the determination process. It must not assume the other server in the pair is now the master.
A driver may optionally allow a driver to connect deliberately to the "non-master" in the pair, for debugging, admin or operational purposes.

1. **Cluster Mode** Connect to master in master-slave cluster

   ```java
   ServerCluster sc = new ServerCluster(INETAddr...); // again, give one and discover?
   Mongo m = new Mongo(sc);
   ```

   ```java
   sc.setTarget(...)
   Mongo m = new Mongo(sc);
   ```

   ## Connect to slave in read-only mode in master-slave cluster

   ```java
   ServerPair sp = new ServerPair(INETAddr...);
   sp.setTarget(ServerPair.SHADOW_MASTER);
   Mongo m = new Mongo(sp);
   ```

Other than that, we need a way to get a DB object:

```java
Mongo m = new Mongo();
DB db = m.getDB(name);
```

And a list of db names (useful for tools...):

```java
List<String> getDBNameList();
```

**Database Object**

**Simple operations on a database object**:
/**
 * get name of database
 */
String dbName = db.getName();

/**
 * Get a list of all the collection names in this database
 */
List<String> cols = db.getCollectionNames();

/**
 * get a collection object. Can optionally create it if it
 * doesn't exist, or just be strict. (XJDM has strictness as an option)
 */
Collection coll = db.getCollection(string);

/**
 * Create a collection w/ optional options. Can fault
 * if the collection exists, or can just return it if it already does
 */
Collection coll = db.createCollection( string);
Collection coll = db.createCollection( string, options);

/**
 * Drop a collection by its name or by collection object.
 * Driver could invalidate any outstanding Collection objects
 * for that collection, or just hope for the best.
 */
boolean b = db.dropCollection(name);
boolean b = db.dropCollection(Collection);

/**
 * Execute a command on the database, returning the
 * BSON doc with the results
 */
Document d = db.executeCommand(command);

/**
 * Close the [logical] database
 */
void db.close();

/**
 * Erase / drop an entire database
 */
bool dropDatabase(dbname)

---

Database Administration

These methods have to do with database metadata: profiling levels and collection validation. Each admin object is associated with a database. These methods could either be built into the Database class or provided in a separate Admin class whose instances are only available from a database instance.
/* get an admin object from a database object. */
Admin admin = db.getAdmin();

/**
 * Get profiling level. Returns one of the strings "off", "slowOnly", or
 * "all". Note that the database returns an integer. This method could
 * return an int or an enum instead --- in Ruby, for example, we return
 * symbols.
 */
String profilingLevel = admin.getProfilingLevel();

/**
 * Set profiling level. Takes whatever getProfilingLevel() returns.
 */
admin.setProfilingLevel("off");

/**
 * Retrieves the database's profiling info.
 */
Document profilingInfo = admin.getProfilingInfo();

/**
 * Returns true if collection is valid; raises an exception if not.
 */
boolean admin.validateCollection(collectionName);

Collection Basic Ops

/**
 * full query capabilities - limit, skip, returned fields, sort, etc
 */
Cursor find(...);
void insert(...) // insert one or more objects into the collection, local variants on args
void remove(query) // remove objects that match the query
void modify(selector, modifier) // modify all objects that match selector w/ modifier object
void replace(selector, object) // replace first object that match selector w/ specified object
void repsert(selector, object) // replace first object that matches, or insert **upsert w/
// modifier makes no logical sense*
long getCount();
long getCount(query);

Index Operations

void createIndex( index_info)
void dropIndex(name)
void dropIndexes()
List<info> getIndexInformation()

Misc Operations

document explain(query)
options getOptions();
string getName();
void close();

Cursor Object
Spec, Notes and Suggestions for Mongo Drivers

Assume that the BSON objects returned from the database may be up to 4MB. This size may change over time but for now the limit is 4MB per object. We recommend you test your driver with 4MB objects.

See Also

- Driver Requirements
- BSON
- The main Database Internals page

Feature Checklist for Mongo Drivers

Functionality Checklist

This section lists tasks the driver author might handle.

Essential

- BSON serialization/deserialization
- Basic operations: query, save, update, remove, ensureIndex, findOne, limit, sort
- Fetch more data from a cursor when necessary (dbGetMore)
- Sending of KillCursors operation when use of a cursor has completed (ideally for efficiently these are sent in batches)
- Convert all strings to utf8
- Authentication

Recommended

- automatic doc_id generation (important when using replication)
- Database $cmd support and helpers
- Detect { $err: ... } response from a db query and handle appropriately --see Error Handling in Mongo Drivers
- Automatically use the proper half of a db server replica pair
- ensureIndex commands should be cached to prevent excessive communication with the database. (Or, the driver user should be informed that ensureIndex is not a lightweight operation for the particular driver.)
- Support for objects up to 4MB in size

More Recommended

- lasterror helper functions
- count() helper function
- $where clause
- eval()
- File chunking
- hint fields
- explain helper
- Automatic _id index creation (maybe the db should just do this???)

More Optional

- addUser, logout helpers
- Allow client user to specify Option_SlaveOk for a query
- Tailable cursor support
- In/out buffer pooling (if implementing in a garbage collected languages)

More Optional

- [connection pooling]
- Automatic reconnect on connection failure
- DBRef Support:
  - Ability to generate easily
  - Automatic traversal
Conventions for Mongo Drivers

**Interface Conventions**

It is desirable to keep driver interfaces consistent when possible. Of course, idioms vary by language, and when they do adaptation is appropriate. However, when the idiom is the same, keeping the interfaces consistent across drivers is desirable.

**Terminology**

In general, use these terms when naming identifiers. Adapt the names to the normal "punctuation" style of your language -- `foo_bar` in C might be `fooBar` in Java.

- `database` - what does this mean?
- `collection`
- `index`

**Driver Testing Tools**

**Object IDs**

- `driverOIDTest` for testing `toString`

```plaintext
> db.runCommand( { "driverOIDTest" : new ObjectId() } )
{ "oid" : ObjectID("4b8991f221752a6e61a88267"),
  "str" : "4b8991f221752a6e61a88267",
  "ok" : 1
}
```

**Mongo Wire Protocol**

- **Introduction**
- **Messages Types and Formats**
  - Standard Message Header
  - Request Opcodes
- **Client Request Messages**
  - `OP_UPDATE`
  - `OP_INSERT`
  - `OP_QUERY`
  - `OP_GETMORE`
  - `OP_DELETE`
  - `OP_KILL_CURSORS`
  - `OP_MSG`
- **Database Response Messages**
  - `OP_REPLY`

**Introduction**

The Mongo Wire Protocol is a simple socket-based, request-response style protocol. Clients communicate with the database server through a regular TCP/IP socket.

**Default Socket Port**

The default port is 27017, but this is configurable and will vary.
Clients should connect to the database with a regular TCP/IP socket. Currently, there is no connection handshake.

To describe the message structure, a C-like `struct` is used. The types used in this document (`cstring`, `int32`, etc.) are the same as those defined in the BSON specification. The standard message header is typed as `MsgHeader`. Integer constants are in capitals (e.g. `ZERO` for the integer value of 0).

In the case where more than one of something is possible (like in a `OP_INSERT` or `OP_KILL_CURSORS`), we again use the notation from the BSON specification (e.g. `int64*`). This simply indicates that one or more of the specified type can be written to the socket, one after another.

**Byte Ordering**

Note that like BSON documents, all data in the mongo wire protocol is little-endian.

**Messages Types and Formats**

There are two types of messages, client requests and database responses, each having a slightly different structure.

**Standard Message Header**

In general, each message consists of a standard message header followed by request-specific data. The standard message header is structured as follows:

```c
struct {
    int32   messageLength; // total message size, including the 4 bytes of length
    int32   requestID;     // client or database-generated identifier for this message
    int32   responseTo;   // requestID from the original request (used in responses from db)
    int32   opCode;        // request type - see table below
}
```

- **messageLength**: This is the total size of the message in bytes. This total includes the 4 bytes that holds the message length.
- **requestID**: This is a client or database-generated identifier that uniquely identifies this message. For the case of client-generated messages (e.g. `CONTRIB:OP_QUERY` and `CONTRIB:OP_GET_MORE`), it will be returned in the `responseTo` field of the `CONTRIB:OP_REPLY` message. Along with the `responseTo` field in responses, clients can use this to associate query responses with the originating query.
- **responseTo**: In the case of a message from the database, this will be the `requestID` taken from the `CONTRIB:OP_QUERY` or `CONTRIB:OP_GET_MORE` messages from the client. Along with the `requestID` field in queries, clients can use this to associate query responses with the originating query.
- **opCode**: Type of message. See the table below in the next section.

**Request Opcodes**

<table>
<thead>
<tr>
<th>Opcode Name</th>
<th>OpCode value</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>OP_REPLY</td>
<td>1</td>
<td>Reply to a client request. <code>responseTo</code> is set</td>
</tr>
<tr>
<td>OP_MSG</td>
<td>1000</td>
<td>generic msg command followed by a string</td>
</tr>
<tr>
<td>OP_UPDATE</td>
<td>2001</td>
<td>update document</td>
</tr>
<tr>
<td>OP_INSERT</td>
<td>2002</td>
<td>insert new document</td>
</tr>
<tr>
<td>RESERVED</td>
<td>2003</td>
<td>formerly used for <code>OP_GET_BY_OID</code></td>
</tr>
<tr>
<td>OP_QUERY</td>
<td>2004</td>
<td>query a collection</td>
</tr>
<tr>
<td>OP_GET_MORE</td>
<td>2005</td>
<td>Get more data from a query. See Cursors</td>
</tr>
<tr>
<td>OP_DELETE</td>
<td>2006</td>
<td>Delete documents</td>
</tr>
</tbody>
</table>
**Client Request Messages**

<table>
<thead>
<tr>
<th>TableOfContents</th>
</tr>
</thead>
</table>

Clients can send all messages except for CONTRIB:OP_REPLY. This is reserved for use by the database.

Note that only the CONTRIB:OP_QUERY and CONTRIB:OP_GET_MORE messages result in a response from the database. There will be no response sent for any other message.

**OP_UPDATE**

The OP_UPDATE message is used to update a document in a collection. The format of a OP_UPDATE message is:

```c
struct {
    MsgHeader header;       // standard message header
    int32    ZERO;          // 0 - reserved for future use
    cstring  fullCollectionName; // "dbname.collectionname"
    int32    flags;         // bit vector. see below
    document selector;      // the query to select the document
    document update;        // specification of the update to perform
}
```

**fullCollectionName**: The full collection name. The full collection name is the concatenation of the database name with the collection name, using a "." for the concatenation. For example, for the database "foo" and the collection "bar", the full collection name is "foo.bar".

**flags**:

<table>
<thead>
<tr>
<th>bit num</th>
<th>name</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Upsert</td>
<td>If set, the database will insert the supplied object into the collection if no matching document is found.</td>
</tr>
<tr>
<td>1</td>
<td>MultiUpdate</td>
<td>If set, the database will update all matching objects in the collection. Otherwise only updates first matching doc.</td>
</tr>
<tr>
<td>2-31</td>
<td>Reserved</td>
<td>Must be set to 0.</td>
</tr>
</tbody>
</table>

**selector**: BSON document that specifies the query for selection of the document to update.

**update**: BSON document that specifies the update to be performed. For information on specifying updates see the documentation on Updating.

There is no response to an OP_UPDATE message.

**OP_INSERT**

The OP_INSERT message is used to insert one or more documents into a collection. The format of the OP_INSERT message is:

```c
struct {
    MsgHeader header;       // standard message header
    int32    ZERO;          // 0 - reserved for future use
    cstring  fullCollectionName; // "dbname.collectionname"
    document* documents;    // one or more documents to insert into the collection
}
```

**fullCollectionName**: The full collection name. The full collection name is the concatenation of the database name with the collection name, using a "." for the concatenation. For example, for the database "foo" and the collection "bar", the full collection name is "foo.bar".

**documents**: One or more documents to insert into the collection. If there are more than one, they are written to the socket in sequence, one after another.

There is no response to an OP_UPDATE message.

**OP_QUERY**

The OP_QUERY message is used to query the database for documents in a collection. The format of the OP_QUERY message is:
struct {
    MsgHeader header;       // standard message header
    int32     opts;         // query options. See below for details.
    cstring   fullCollectionName;  // "dbname.collectionname"
    int32     numberToSkip;   // number of documents to skip when returning results
    int32     numberToReturn; // number of documents to return in the first OP_REPLY
    document  query;         // query object. See below for details.
    [ document  returnFieldSelector; ] // OPTIONAL : selector indicating the fields to return. See below for details.
} 

opts : query options
- None: 0
- Tailable cursor: 2
- Slave OK: 4
- Oplog replay: 8 (internal replication use only - drivers should not implement)
- No cursor timeout : 16

fullCollectionName : The full collection name. The full collection name is the concatenation of the database name with the collection name, using a "." for the concatenation. For example, for the database "foo" and the collection "bar", the full collection name is "foo.bar".

countToSkip : Sets the number of documents to omit - starting from the first document in the resulting dataset - when returning the result of the query.

countToReturn : Limits the number of documents in the first CONTRIB:OP_REPLY message to the query. However, the database will still establish a cursor and return the cursorID to the client if there are more results than numberToReturn. If the client driver supports the 'limit' functionality (like the SQL LIMIT keyword), then it is up to the client driver to ensure that no more than the specified number of documents are returned to the calling application. If numberToReturn is 0, the db will use the default return size. If the number is negative, then the database will return that number and close the cursor. No further results for that query can be fetched. If numberToReturn is 1, the server will treat it as -1 (closing the cursor automatically).

query : BSON document that represents the query. The query will contain one or more elements, all of which must match for a document to be included in the result set. Please see $$$ TODO QUERY for more information.

returnFieldsSelector : OPTIONAL BSON document that limits the fields in the returned documents. The returnFieldsSelector contains one or more elements, each of which is the name of a field that should be returned, and the integer value 1. In JSON notation, a returnFieldsSelector to limit to the fields "a", "b" and "c" would be:

```
{ a : 1, b : 1, c : 1 }
```

The database will respond to an OP_QUERY message with an CONTRIB:OP_REPLY message.

OP_GETMORE

The OP_GETMORE message is used to query the database for documents in a collection. The format of the OP_GETMORE message is:

```
struct {
    MsgHeader header;       // standard message header
    int32     ZERO;         // 0 - reserved for future use
    cstring   fullCollectionName;  // "dbname.collectionname"
    int32     numberToReturn; // number of documents to return
    int64     cursorID;      // cursorID from the OP_REPLY
} 
```

fullCollectionName : The full collection name. The full collection name is the concatenation of the database name with the collection name, using a "." for the concatenation. For example, for the database "foo" and the collection "bar", the full collection name is "foo.bar".

countToReturn : Limits the number of documents in the first CONTRIB:OP_REPLY message to the query. However, the database will still establish a cursor and return the cursorID to the client if there are more results than numberToReturn. If the client driver supports the 'limit' functionality (like the SQL LIMIT keyword), then it is up to the client driver to ensure that no more than the specified number of documents are returned to the calling application. If numberToReturn is 0, the db will use the default return size.

cursorID : Cursor identifier that came in the CONTRIB:OP_REPLY. This must be the value that came from the database.

The database will respond to an OP_GETMORE message with a CONTRIB:OP_REPLY message.
The OP_DELETE message is used to remove one or more messages from a collection. The format of the OP_DELETE message is:

```c
struct {
    MsgHeader header; // standard message header
    int32     ZERO;   // 0 - reserved for future use
    cstring   fullCollectionName; // "dbname.collectionname"
    int32     flags;     // bit vector - see below for details.
    document selector;  // query object. See below for details.
} fullCollectionName:
    The full collection name. The full collection name is the concatenation of the database name with the collection name, using a "." for the concatenation. For example, for the database "foo" and the collection "bar", the full collection name is "foo.bar".

flags:

<table>
<thead>
<tr>
<th>bit num</th>
<th>name</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>SingleRemove</td>
<td>If set, the database will remove only the first matching document in the collection. Otherwise all matching documents will be removed.</td>
</tr>
<tr>
<td>1-31</td>
<td>Reserved</td>
<td>Must be set to 0.</td>
</tr>
</tbody>
</table>

document selector: BSON document that represent the query used to select the documents to be removed. The selector will contain one or more elements, all of which must match for a document to be removed from the collection. Please see $$$ TODO QUERY for more information.

There is no response to an OP_DELETE message.

**OP_KILL_CURSORS**

The OP_KILL_CURSORS message is used to close an active cursor in the database. This is necessary to ensure that database resources are reclaimed at the end of the query. The format of the OP_KILL_CURSORS message is:

```c
struct {
    MsgHeader header; // standard message header
    int32     numberOfCursorIDs; // number of cursorIDs in message
    int64*    cursorIDs;         // sequence of cursorIDs to close
} numberOfCursorIDs:
    The number of cursors that are in the message.

cursorIDs: "array" of cursor IDs to be closed. If there are more than one, they are written to the socket in sequence, one after another.

Note that if a cursor is read until exhausted (read until OP_QUERY or OP_GETMORE returns zero for the cursor id), there is no need to kill the cursor.

**OP_MSG**

Deprecated. OP_MSG sends a diagnostic message to the database. The database sends back a fixed response. The format is:

```c
struct {
    MsgHeader header; // standard message header
    cstring message; // message for the database
} Drivers do not need to implement OP_MSG.

**Database Response Messages**

**TableOfContents**

**OP_REPLY**

The OP_REPLY message is sent by the database in response to an CONTRIBUTION:OP_QUERY or CONTRIBUTION:OP_GET_MORE message. The format
of an OP_REPLY message is:

```c
struct {
    MsgHeader header;       // standard message header
    int32     responseFlag; // normally zero, non-zero on query failure
    int64     cursorID;     // id of the cursor created for this query response
    int32     startingFrom; // indicates where in the cursor this reply is starting
    int32     numberReturned; // number of documents in the reply
    document* documents;    // documents
}]
```

**responseFlag**: Flag that indicates status of the query. Normally 0, a non-zero value is used to indicate a failed query or information about the cursor generated.

**cursorID**: The cursorID that this OP_REPLY is a part of. In the event that the result set of the query fits into one OP_REPLY message, `cursorID` will be 0. This `cursorID` must be used in any `CONTRIB:OP_GET_MORE` messages used to get more data, and also must be closed by the client when no longer needed via a `CONTRIB:OP_KILL_CURSORS` message.

**BSON**

- [bsonspec.org](http://bsonspec.org)
- **BSON and MongoDB**
- **Language-Specific Examples**
  - C
  - C++
  - Java
  - PHP
  - Python
  - Ruby
- **MongoDB Document Types**

**bsonspec.org**

BSON is a binary-en-coded serial-ization of JSON-like doc-u-ments. BSON is designed to be lightweight, traversable, and efficient. BSON, like JSON, supports the embedding of objects and arrays within other objects and arrays. See [bsonspec.org](http://bsonspec.org) for the spec and more information in general.

**BSON and MongoDB**

MongoDB uses **BSON** as the data storage and network transfer format for "documents".

BSON at first seems BLOB-like, but there exists an important difference: the Mongo database understands BSON internals. This means that MongoDB can "reach inside" BSON objects, even nested ones. Among other things, this allows MongoDB to build indexes and match objects against query expressions on both top-level and nested BSON keys.

See also: the [BSON blog post](http://example.com).

**Language-Specific Examples**

We often map from a language's "dictionary" type – which may be its native objects – to BSON. The mapping is particularly natural in dynamically typed languages:

JavaScript: `{"foo": "bar"}`
Perl: `{"foo" => "bar"}`
PHP: `array("foo" => "bar")`
Python: `{"foo": "bar"}`
Ruby: `{"foo" => "bar"}`
Java: `DBObject obj = new BasicDBObject("foo", "bar");`

C


C++
BSONObj p = BSON("name" << "Joe" << "age" << 33);
cout << p.toString() << endl;
cout << p["age"].number() << endl;

See the BSON section of the C++ Tutorial for more information.

Java

BasicDBObject doc = new BasicDBObject();
doc.put("name", "MongoDB");
doc.put("type", "database");
doc.put("count", 1);
BasicDBObject info = new BasicDBObject();
info.put("x", 203);
info.put("y", 102);
doc.put("info", info);
coll.insert(doc);

PHP

The PHP driver includes `bson_encode` and `bson_decode` functions. `bson_encode` takes any PHP type and serializes it, returning a string of bytes:

```php
$bson = bson_encode(null);
$bson = bson_encode(true);
$bson = bson_encode(4);
$bson = bson_encode("hello, world");
$bson = bson_encode(array("foo" => "bar"));
$bson = bson_encode(new MongoDate());
```

Mongo-specific objects (MongoId, MongoDate, MongoRegex,MongoCode) will be encoded in their respective BSON formats. For other objects, it will create a BSON representation with the key/value pairs you would get by running for ($object as $key => $value).

`bson_decode` takes a string representing a BSON object and parses it into an associative array.

Python

```python
>>> from pymongo.bson import BSON
>>> bson_string = BSON.from_dict({"hello": "world"})
>>> bson_string
'\x16\x00\x00\x00\x02hello\x00\x06\x00\x00\x00world\x00\x00'
>>> bson_string.to_dict()
{'hello': 'world'}
```

PyMongo also supports "ordered dictionaries" through the `pymongo.son` module. The `BSON` class can handle SON instances using the same methods you would use for regular dictionaries.

Ruby

There are now two gems that handle BSON-encoding: bson and bson_ext. These gems can be used to work with BSON independently of the MongoDB Ruby driver.
The BSON class also supports ordered hashes. Simply construct your documents using the OrderedHash class, also found in the MongoDB Ruby Driver.

**MongoDB Document Types**

MongoDB uses BSON documents for three things:

1. Data storage (user documents). These are the regular JSON-like objects that the database stores for us. These BSON documents are sent to the database via the INSERT operation. User documents have limitations on the "element name" space due to the usage of special characters in the JSON-like query language.
   a. A user document element name cannot begin with "$".
   b. A user document element name cannot have a "." in the name.
   c. The element name ".id" is reserved for use as a primary key id, but you can store anything that is unique in that field.
   The database expects that drivers will prevent users from creating documents that violate these constraints.
2. Query "Selector" Documents: Query documents (or selectors) are BSON documents that are used in QUERY, DELETE and UPDATE operations. They are used by these operations to match against documents. Selector objects have no limitations on the "element name" space, as they must be able to supply special "marker" elements, like "$where" and the special "command" operations.
3. "Modifier" Documents: Documents that contain 'modifier actions' that modify user documents in the case of an update (see Updating).

**Mongo Extended JSON**

Mongo's REST interface supports storage and retrieval of JSON documents. Special representations are used for BSON types that do not have obvious JSON mappings, and multiple representations are allowed for some such types. The REST interface supports three different modes for document output { Strict, JS, TenGen }, which serve to control the representations used. Mongo can of course understand all of these representations in REST input.

- **Strict** mode produces output conforming to the JSON spec [http://www.json.org](http://www.json.org).
- **JS** mode uses some Javascript types to represent certain BSON types.
- **TenGen** mode uses some Javascript types and some 10gen specific types to represent certain BSON types.

The following BSON types are represented using special conventions:

<table>
<thead>
<tr>
<th>Type</th>
<th>Strict</th>
<th>JS</th>
<th>TenGen</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>data_binary</td>
<td></td>
<td>{ &quot;$binary&quot; :</td>
<td>{ &quot;$binary&quot; :</td>
<td>{ &quot;$binary&quot; :</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&quot;$bindata&quot; :</td>
<td>&quot;$bindata&quot; :</td>
<td>&quot;$bindata&quot; :</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&quot;$type&quot; : &quot;$&quot;</td>
<td>&quot;$type&quot; : &quot;$&quot;</td>
<td>&quot;$type&quot; : &quot;$&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&quot;$&quot; }</td>
<td>&quot;$&quot; )</td>
<td>&quot;$&quot; )</td>
</tr>
<tr>
<td>data_date</td>
<td></td>
<td>{ &quot;$date&quot; :</td>
<td>Date( &lt;date&gt; )</td>
<td>Date( &lt;date&gt; )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;date&gt; }</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;bindata&gt; is the base64 representation of a binary string. &lt;t&gt; is the hexadecimal representation of a single byte indicating the data type. &lt;date&gt; is the JSON representation of a 64 bit unsigned integer for milliseconds since epoch.</td>
</tr>
</tbody>
</table>
### GridFS Specification

- **Introduction**
- Specification
  - Storage Collections
    - files
    - chunks
  - Indexes

**Introduction**
GridFS is a storage specification for large objects in MongoDB. It works by splitting large objects into small chunks, usually 256k in size. Each chunk is stored as a separate document in a `chunks` collection. Metadata about the file, including the filename, content type, and any optional information needed by the developer, is stored as a document in a `files` collection.

So for any given file stored using GridFS, there will exist one document in the `files` collection and one or more documents in the `chunks` collection.

If you’re just interested in using GridFS, see the docs on **storing files**. If you’d like to understand the GridFS implementation, read on.

### Specification

#### Storage Collections

GridFS uses two collections to store data:

- `files` contains the object metadata
- `chunks` contains the binary chunks with some additional accounting information

In order to make more than one GridFS namespace possible for a single database, the files and chunks collections are named with a prefix. By default the prefix is `fs`, so any default GridFS store will consist of collections named `fs.files` and `fs.chunks`. The drivers make it possible to change this prefix, so you might, for instance, have another GridFS namespace specifically for photos where the collections would be `photos.files` and `photos.chunks`.

Here’s an example of the standard GridFS interface in Java:

```java
/*
* default root collection usage - must be supported
*/
GridFS myFS = new GridFS(myDatabase);  // returns a default GridFS (e.g. "fs" root collection)
myFS.storeFile(new File("/tmp/largething.mpg"));  // saves the file into the "fs" GridFS store

/*
* specified root collection usage - optional
*/
GridFS myContracts = new GridFS(myDatabase, "contracts");  // returns a GridFS where "contracts" is root
myFS.retrieveFile("smithco", new File("/tmp/smithco_20090105.pdf"));  // retrieves object whose filename is "smithco"
```

Note that the above API is for demonstration purposes only - this spec does not (at this time) recommend any API. See individual driver documentation for API specifics.

**files**

Documents in the `files` collection require the following fields:

```json
{
  "_id" : <unspecified>,  // unique ID for this file
  "length" : data_number,  // size of the file in bytes
  "chunkSize" : data_number,  // size of each of the chunks. Default is 256k
  "uploadDate" : data_date,  // date when object first stored
  "md5" : data_string  // result of running the "filemd5" command on this file's chunks
}
```

Any other desired fields may be added to the `files` document; common ones include the following:
Note that the _id field can be of any type, per the discretion of the spec implementor.

chunks

The structure of documents from the chunks collection is as follows:

```json
{
  "_id": <unspecified>, // object id of the chunk in the _chunks collection
  "files_id": <unspecified>, // _id of the corresponding files collection entry
  "n": chunk_number, // chunks are numbered in order, starting with 0
  "data": data_binary, // the chunk’s payload as a BSON binary type
}
```

Notes:

- The _id is whatever type you choose. As with any MongoDB document, the default will be a BSON object id.
- The files_id is a foreign key containing the _id field for the relevant files collection entry

Indexes

GridFS implementations should create a unique, compound index in the chunks collection for files_id and n. Here’s how you’d do that from the shell:

```bash
db.fs.chunks.ensureIndex({files_id:1, n:1}, {unique: true});
```

This way, chunks can be retrieved efficiently and in order:

```bash
db.fs.chunks.find({file_id: myFileID}).orderby({n:1});
```

Implementing Authentication in a Driver

The current version of Mongo supports only very basic authentication. One authenticates a username and password in the context of a particular database. Once authenticated, the user has full read and write access to the database in question.

The admin database is special. In addition to several commands that are administrative being possible only on admin, authentication on admin gives one read and write access to all databases on the server. Effectively, admin access means root access to the db.

Note on a single socket we may authenticate for any number of databases, and as different users. This authentication persists for the life of the database connection (barring a logout command).

The Authentication Process

Authentication is a two step process. First the driver runs a getnonce command to get a nonce for use in the subsequent authentication. We can view a sample getnonce invocation from dbshell:

```bash
> db.$cmd.findOne({getnonce:1})
{ "nonce": "7268c504683936e1", "ok": 1
```

The nonce returned is a hex String.

The next step is to run an authenticate command for the database on which to authenticate. The authenticate command has the form:
authenticate: 1, user: username, nonce: nonce, key: digest

where

- *username* is a username in the database’s system.users collection;
- *nonce* is the nonce returned from a previous getnonce command;
- *digest* is the hex encoding of a MD5 message digest which is the MD5 hash of the concatenation of (nonce, username, password_digest), where password_digest is the user’s password value in the pwd field of the associated user object in the database’s system.users collection. pwd is the hex encoding of MD5(username + ”:mongo:” + password_text).

Authenticate will return an object containing

{ ok: 1 }

when successful.

Details of why an authentication command failed may be found in the Mongo server’s log files.

The following code from the Mongo Javascript driver provides an example implementation:

```javascript
DB.prototype.addUser = function( username, pass ){
    var c = this.getCollection( "system.users" );
    var u = c.findOne( { user : username } ) || { user : username };
    u.pwd = hex_md5( username + pass );
    print( tojson( u ) );
    c.save( u );
}

DB.prototype.auth = function( username, pass ){  
    n = this.runCommand( { getnonce : 1 } );
    var a = this.runCommand(
        { 
            authenticate : 1,
            user : username,
            nonce : n.nonce,
            key : hex_md5( n.nonce + username + hex_md5( username + ”:mongo:” + pass ) )
        }
    );
    return a.ok;
}
```

**Logout**

Drivers may optionally implement the logout command which deauthorizes usage for the specified database for this connection. Note other databases may still be authorized.

Alternatively, close the socket to deauthorize.

```
> db.$cmd.findOne({logout:1})
{ "ok" : 1.0 }
```

**Replica Pairs and Authentication**

For drivers that support replica pairs, extra care with replication is required.

When switching from one server in a pair to another (on a failover situation), you must reauthenticate. Clients will likely want to cache authentication from the user so that the client can reauthenticate with the new server when appropriate.
Be careful also with operations such as Logout - if you log out from only half a pair, that could be an issue.

Authenticating with a server in slave mode is allowed.

**See Also**

- Security and Authentication

**Notes on Pooling for Mongo Drivers**

Note that with the db write operations can be sent asynchronously or synchronously (the latter indicating a getlasterror request after the write).

When asynchronous, one must be careful to continue using the same connection (socket). This ensures that the next operation will not begin until after the write completes.

**Pooling and Authentication**

An individual socket connection to the database has associated authentication state. Thus, if you pool connections, you probably want a separate pool for each authentication case (db + username).

**Pseudo-code**

The following pseudo-code illustrates our recommended approach to implementing connection pooling in a driver's connection class. This handles authentication, grouping operations from a single "request" onto the same socket, and a couple of other gotchas:

```python
class Connection:
    init(pool_size, addresses, auto_start_requests):
        this.pool_size = pool_size
        this.addresses = addresses
        this.auto_start_requests = auto_start_requests
        this.thread_map = {}
        this.locks = Lock[pool_size]
        thissockets = Socket[pool_size]
        this.socket_auth = String[pool_size][]
        this.auth = {}
        this.find_master()

    find_master():
        for address in this.addresses:
            if address.is_master():
                this.master = address

    pick_and_acquire_socket():
        choices = random permutation of [0, ..., this.pool_size - 1]
        choices.sort(order: ascending,
                      value: size of preimage of choice under this.thread_map)

        for choice in choices:
            if this.locks[choice].non_blocking_acquire():
                return choice

        sock = choices[0]
        this.locks[sock].blocking_acquire()
        return sock

    get_socket():
        if this.thread_map[current_thread] >= 0:
            sock number = this.thread_map[current_thread]
            this.locks[sock_number].blocking_acquire()
        else:
            sock_number = this.pick_and_lock_socket()
            if this.auto_start_requests or current_thread in this.thread_map:
                this.thread_map[current_thread] = sock_number
```

if not this.sockets[sock_number]:
    this.sockets[sock_number] = Socket(this.master)
    return sock_number

send_message_without_response(message):
    sock_number = this.get_socket()
    this.check_auth()
    this.sockets[sock_number].send(message)
    this.locks[sock_number].release()

send_message_with_response(message):
    sock_number = this.get_socket()
    this.check_auth()
    this.sockets[sock_number].send(message)
    result = this.sockets[sock_number].receive()
    this.locks[sock_number].release()
    return result

# start_request is only needed if auto_start_requests is False
start_request():
    this.thread_map[current_thread] = -1

end_request():
    delete this.thread_map[current_thread]

authenticate(database, username, password):
    # TODO should probably make sure that these credentials are valid,
    # otherwise errors are going to be delayed until first op.
    this.auth[database] = (username, password)

logout(database):
    delete this.auth[database]

check_auth(sock_number):
    for db in this.socket_auth[sock_number]:
        if db not in this.auth.keys():
            this.sockets[sock_number].send(logout_message)
            this.socket_auth[sock_number].remove(db)
        for db in this.auth.keys():
            if db not in this.socket_auth[sock_number]:
                this.sockets[sock_number].send(authenticate_message)
                this.socket_auth[sock_number].append(db)

# somewhere we need to do error checking - if you get not master then everything
# in this.sockets gets closed and set to null and we call find_master() again.
See Also

- The Driver and Integration Center for information about the latest drivers
- The [top page] for this section
- The main Database Internals page
- The starting point for all Home

Driver and Integration Center

Error Handling in Mongo Drivers

If an error occurs on a query (or getMore operation), Mongo returns an error object instead of user data.

The error object has a first field guaranteed to have the reserved key $err. For example:

```javascript
{ $err : "some error message" }
```

The $err value can be of any type but is usually a string.

Drivers typically check for this return code explicitly and take action rather than returning the object to the user. The query results flags include a set bit when $err is returned.

```c
/* db response format

Query or GetMore: // see struct QueryResult
int resultFlags;
    int64 cursorID;
    int startingFrom;
    int nReturned;
    list of marshalled JSObjects;
*/

struct QueryResult : public MsgData {
    enum {
        ResultFlag_CursorNotFound = 1, /* returned, with zero results, when getMore is called but the
cursor id is not valid at the server. */
        ResultFlag_ErrSet = 2          /* { $err : ... } is being returned */
    };
    ...
};
```

See Also

- The Driver and Integration Center for information about the latest drivers
- The [top page] for this section
- The main Database Internals page
- The starting point for all Home

Developer Zone

- Tutorial
- Shell
- Manual
- Databases
- Collections
- Indexes
- Data Types and Conventions
- GridFS
Introduction

MongoDB is a collection-oriented, schema-free document database.

By **collection-oriented**, we mean that data is grouped into sets that are called 'collections'. Each collection has a unique name in the database, and can contain an unlimited number of documents. Collections are analogous to tables in a RDBMS, except that they don't have any defined schema.

By **schema-free**, we mean that the database doesn't need to know anything about the structure of the documents that you store in a collection. In fact, you can store documents with different structure in the same collection if you so choose.

By **document**, we mean that we store data that is a structured collection of key-value pairs, where keys are strings, and values are any of a rich set of data types, including arrays and documents. We call this data format "**BSON**" for "Binary Serialized dOcument Notation."

MongoDB Operational Overview

MongoDB is a server process that runs on Linux, Windows and OS X. It can be run both as a 32 or 64-bit application. We recommend running in 64-bit mode, since Mongo is limited to a total data size of about 2GB for all databases in 32-bit mode.

The MongoDB process listens on port 27017 by default (note that this can be set at start time - please see Command Line Parameters for more information).

Clients connect to the MongoDB process, optionally authenticate themselves if security is turned on, and perform a sequence of actions, such as inserts, queries and updates.

MongoDB stores its data in files (default location is `/data/db/`), and uses memory mapped files for data management for efficiency.

MongoDB can also be configured for **automatic data replication**, as well as **automatic fail-over**.

For more information on MongoDB administration, please see Mongo Administration Guide.

MongoDB Functionality

As a developer, MongoDB drivers offer a rich range of operations:

- Queries: Search for documents based on either query objects or SQL-like "where predicates". Queries can be sorted, have limited return sizes, can skip parts of the return document set, and can also return partial documents.
- Inserts and Updates: Insert new documents, update existing documents.
- Index Management: Create indexes on one or more keys in a document, including substructure, deleted indexes, etc
- General commands: Any MongoDB operation can be managed via DB Commands over the regular socket.

Tutorial

- Getting the Database
- Getting A Database Connection
- Inserting Data into A Collection
- Accessing Data From a Query
- Specifying What the Query Returns
- `findOne()` - Syntactic Sugar
- Limiting the Result Set via `limit()`
- More Help
- What Next

Getting the Database

Download the database, unpack it, and start the mongod process:

```bash
$ bin/mongod
```
By default MongoDB will store data files in /data/db/ (or c:\data\db) on all systems. This convention is used throughout the documentation. You can use a different directory by specifying the --dbpath argument:

```
$ bin/mongod --dbpath /path/to/my/data/dir
```

Getting A Database Connection

Let's now try manipulating the database with the database shell. (We could perform similar operations from any programming language using an appropriate driver. The shell is convenient for interactive and administrative use.)

Start the MongoDB JavaScript shell with:

```
$ bin/mongo
```

By default the shell connects to database "test" on localhost. You then see:

```
MongoDB shell version: 0.9.8
url: test
connecting to: test
type "help" for help
>
```

"connecting to:" tells you the name of the database the shell is using. To switch databases, type:

```
> use mydb
```

To see a list of handy commands, type help.

### Tip for Developers with Experience in Other Databases

You may notice, in the examples below, that we never create a database or collection. MongoDB does not require that you do so. As soon as you insert something, MongoDB creates the underlying collection and database. If you query a collection that does not exist, MongoDB treats it as an empty collection.

Switching to a database with the use command won't immediately create the database - the database is created lazily the first time data is inserted. This means that if you use a database for the first time it won't show up in the list provided by `show dbs` until data is inserted.

Inserting Data into A Collection

Let's create a test collection and insert some data into it. We will create two objects, `j` and `t`, and then save them in the collection `things`.

In the following examples, `>` indicates commands typed at the shell prompt.

```
> j = { name : "mongo" };
"name" : "mongo"
> t = { x : 3 };
"x" : 3
> db.things.save(j);
> db.things.save(t);
> db.things.find();
```

A few things to note:

- We did not predefine the collection. The database creates it automatically on the first insert.
- The documents we store can have any "structure" - in fact in this example, the documents have no common data elements at all. In practice, one usually stores documents of the same structure within collections. However, this flexibility means that schema migration and augmentation are very easy in practice - rarely will you need to write scripts which perform "alter table" type operations.
Upon being inserted into the database, objects are assigned an object ID (if they do not already have one) in the field `_id`.

When you run the above example, your ObjectID values will be different.

Let's add some more records to this collection:

```javascript
> for( var i = 1; i < 10; i++ ) db.things.save( { x:4, j:i } );
> db.things.find();
```

Note that not all documents were shown - the shell limits the number to 10 when automatically iterating a cursor. Since we already had 2 documents in the collection, we only see the first 8 of the newly-inserted documents.

If we want to return the next set of results, there's the `it` shortcut. Continuing from the code above:

```javascript
> it
```

Technically, `find()` returns a cursor object. But in the cases above, we haven't assigned that cursor to a variable. So, the shell automatically iterates over the cursor, giving us an initial result set, and allowing us to continue iterating with the `it` command.

But we can also work with the cursor directly; just how that's done is discussed in the next section.

### Accessing Data From a Query

Before we discuss queries in any depth, let's talk about how to work with the results of a query - a cursor object. We'll use the simple `find()` method, which returns everything in a collection, and talk about how to create specific queries later on.

In order to see all the elements in the collection when using the `mongo shell`, we need to explicitly use the cursor returned from the `find()` operation.

Let's repeat the same query, but this time use the cursor that `find()` returns, and iterate over it in a while loop:

```javascript
> var cursor = db.things.find();
> while (cursor.hasNext()) { print(tojson(cursor.next())); }
```

The above example shows cursor-style iteration. The `hasNext()` function tells if there are any more documents to return, and the `next()` function returns the next document. We also used the built-in `tojson()` method to render the document in a pretty JSON-style format.

When working in the JavaScript shell, we can also use the functional features of the language, and just call `forEach` on the cursor. Repeating the example above, but using `forEach()` directly on the cursor rather than the while loop:
In the case of a forEach() we must define a function that is called for each document in the cursor.

In the mongo shell, you can also treat cursors like an array:

```javascript
> var cursor = db.things.find();
> print (tojson(cursor[4]));
```

When using a cursor this way, note that all values up to the highest accessed (cursor[4] above) are loaded into RAM at the same time. This is inappropriate for large result sets, as you will run out of memory. Cursors should be used as an iterator with any query which returns a large number of elements.

In addition to array-style access to a cursor, you may also convert the cursor to a true array:

```javascript
> var arr = db.things.find().toArray();
> arr[5];
```

Please note that these array features are specific to mongo - The Interactive Shell, and not offered by all drivers.

MongoDB cursors are not snapshots - operations performed by you or other users on the collection being queried between the first and last call to next() of your cursor may or may not be returned by the cursor. Use explicit locking to perform a snapshotted query.

### Specifying What the Query Returns

Now that we know how to work with the cursor objects that are returned from queries, lets now focus on how to tailor queries to return specific things.

In general, the way to do this is to create "query documents", which are documents that indicate the pattern of keys and values that are to be matched.

These are easier to demonstrate than explain. In the following examples, we'll give example SQL queries, and demonstrate how to represent the same query using MongoDB via the mongo shell. This way of specifying queries is fundamental to MongoDB, so you'll find the same general facility in any driver or language.

```sql
SELECT * FROM things WHERE name="mongo"
```
The query expression is a document itself. A query document of the form `{ a:A, b:B, ... }` means "where a==A and b==B and ...". More information on query capabilities may be found in the `Queries and Cursors` section of the `Mongo Developers' Guide`.

MongoDB also lets you return "partial documents" - documents that have only a subset of the elements of the document stored in the database. To do this, you add a second argument to the `find()` query, supplying a document that lists the elements to be returned.

To illustrate, let's repeat the last example `find({x:4})` with an additional argument that limits the returned document to just the "j" elements:

```
SELECT j FROM things WHERE x=4
```

```javascript
> db.things.find({x:4}, {j:true}).forEach(function(x) { print(tojson(x));});
true
```

Note that the "_id" field is always returned.

**findOne() - Syntactic Sugar**

For convenience, the `mongo shell` (and other drivers) lets you avoid the programming overhead of dealing with the cursor, and just lets you retrieve one document via the `findOne()` function. `findOne()` takes all the same parameters of the `find()` function, but instead of returning a cursor, it will return either the first document returned from the database, or `null` if no document is found that matches the specified query.

As an example, let's retrieve the one document with `name='mongo'`. There are many ways to do it, including just calling `next()` on the cursor (after checking for `null`, of course), or treating the cursor as an array and accessing the 0th element.

However, the `findOne()` method is both convenient and efficient:

```javascript
> var mongo = db.things.findOne({name:"mongo"});
> print(tojson(mongo));
{
    "name" : "mongo" , 
    "_id" : ObjectId("497cf60751712cf7758fbdbb")
}
```

This is more efficient because the client requests a single object from the database, so less work is done by the database and the network. This is the equivalent of `find({name:"mongo"}).limit(1)`.

**Limiting the Result Set via `limit()`**

You may limit the size of a query's result set by specifying a maximum number of results to be returned via the `limit()` method.

This is highly recommended for performance reasons, as it limits the work the database does, and limits the amount of data returned over the network. For example:
More Help

In addition to the general "help" command, you can call help on db and db.whatever to see a summary of methods available.

If you are curious about what a function is doing, you can type it without the {{()}}s and the shell will print the source, for example:

```javascript
> db.foo.insert
function (obj, _allow_dot) {
  if (!obj) {
    throw "no object passed to insert!";
  }
  if (!_allow_dot) {
    this._validateForStorage(obj);
  }
  return this._mongo.insert(this._fullName, obj);
}
```

mongo is a full JavaScript shell, so any JavaScript function, syntax, or class can be used in the shell. In addition, MongoDB defines some of its own classes and globals (e.g., db). You can see the full API at http://api.mongodb.org/js/.

What Next

After completing this tutorial the next step to learning MongoDB is to dive into the manual for more details.

Manual

This is the MongoDB manual. Except where otherwise noted, all examples are in JavaScript for use with the mongo shell. There is a table available giving the equivalent syntax for each of the drivers.

- Connections
- Databases
  - Commands
    - Clone Database
    - fsync Command
    - Index-Related Commands
    - Last Error Commands
    - Viewing and Terminating Current Operation
    - Validate Command
    - getLastError
    - List of Database Commands
  - Mongo Metadata
- Collections
  - Capped Collections
  - Using a Large Number of Collections
- Data Types and Conventions
  - Internationalized Strings
  - Object IDs
  - Database References
- GridFS
- Indexes
  - Geospatial Indexing
  - Indexing as a Background Operation
  - Multikeys
  - Indexing Advice and FAQ
- Inserting
  - Legal Key Names
  - Schema Design
  - Trees in MongoDB
- Optimization
Connections

MongoDB is a database server: it runs in the foreground or background and waits for connections from the user. Thus, when you start MongoDB, you will see something like:

```
~/$ ./mongod

# some logging output

Tue Mar  9 11:15:43 waiting for connections on port 27017
Tue Mar  9 11:15:43 web admin interface listening on port 28017
```

It will stop printing output at this point but it hasn't frozen, it is merely waiting for connections on port 27017. Once you connect and start sending commands, it will continue to log what it's doing. You can use any of the MongoDB drivers or Mongo shell to connect to the database.

You cannot connect to MongoDB by going to http://localhost:27017 in your web browser. The database cannot be accessed via HTTP on port 27017.

**Standard Connection Format**

The uri scheme described on this page is not yet supported by all of the drivers. Refer to a specific driver's documentation to see how much (if any) of the standard connection uri is supported. All drivers support an alternative method of specifying connections if this format is not supported.

```
mongodb://[username:password@]host1[:port1][,host2[:port2],...[,hostN[:portN]]][/database]
```

- `mongodb://` is a required prefix to identify that this is a string in the standard connection format.
- `username:password@` are optional. If given, the driver will attempt to login to a database after connecting to a database server.
- `host1` is the only required part of the URI. It identifies a server address to connect to.
- `:portX` is optional and defaults to :27017 if not provided.
- `/database` is the name of the database to login to and thus is only relevant if the `username:password@` syntax is used. If not specified the "admin" database will be used by default.

As many hosts as necessary may be specified (for connecting to replica pairs/sets).

**Examples**

Connect to a database server running locally on the default port:
Connect and login to the admin database as user "fred" with password "foobar":

```
mongodb://fred:foobar@localhost
```

Connect and login to the "baz" database as user "fred" with password "foobar":

```
mongodb://fred:foobar@localhost/baz
```

Connect to a replica pair, with one server on example1.com and another server on example2.com:

```
mongodb://example1.com:27017,example2.com:27017
```

Connect to a replica set with three servers running on localhost (on ports 27017, 27018, and 27019):

```
mongodb://localhost,localhost:27018,localhost:27019
```

Databases

Each MongoDB server can support multiple databases. Each database is independent, and the data for each database is stored separately, for security and ease of management.

A database consists of one or more collections, the documents (objects) in those collections, and an optional set of security credentials for controlling access.

- Commands
  - Clone Database
  - fsync Command
  - Index-Related Commands
  - Last Error Commands
  - Viewing and Terminating Current Operation
  - Validate Command
  - getLastError
  - List of Database Commands
- Mongo Metadata

Commands

Introduction

The Mongo database has a concept of a database command. Database commands are ways to ask the database to perform special operations, or to request information about its current operational status.

- Introduction
- Privileged Commands
- Getting Help Info for a Command
- More Command Documentation
- List of Database Commands

A command is sent to the database as a query to a special collection namespace called $cmd. The database will return a single document with the command results - use `findOne()` for that if your driver has it.

The general command syntax is:
The shell provides a helper function for this:

```javascript
db.runCommand( { <commandname>: <value> [, options] } );
```

For example, to check our database's current profile level setting, we can invoke:

```javascript
> db.runCommand({profile:-1});
{  
"was": 0.0 ,  
"ok": 1.0 
}
```

For many db commands, some drivers implement wrapper methods are implemented to make usage easier. For example, the mongo shell offers

```javascript
> db.getProfilingLevel()
0.0
```

Let's look at what this method is doing:

```javascript
> print( db.getProfilingLevel )
function () {
  res = this._dbCommand({profile:-1});
  return res ? res.was : null;
}
> print( db._dbCommand )
function (cmdObj) {
  return this.$cmd.findOne(cmdObj);
}
```

Many commands have helper functions - see your driver's documentation for more information.

**Privileged Commands**

Certain operations are for the database administrator only. These privileged operations may only be performed on the special database named `admin`.

```javascript
> use admin;
> db.runCommand("shutdown"); // shut down the database
```

If the `db` variable is not set to 'admin', you can use `_adminCommand` to switch to the right database automatically (and just for that operation):

```javascript
> db._adminCommand("shutdown");
```

(For this particular command there is also a shell helper function, `db.shutdownServer`.)

**Getting Help Info for a Command**

Use `commandHelp` in shell to get help info for a command:

```javascript
> db.commandHelp("datasize")
help for: datasize  example: { datasize:"blog.posts", keyPattern:{x:1}, min:{x:10}, max:{x:55} }
NOTE: This command may take awhile to run
```

(Help is not yet available for some commands.)
More Command Documentation

- Clone Database
- fsync Command
- Index-Related Commands
- Last Error Commands
- Viewing and Terminating Current Operation
- Validate Command
- getLastError
- List of Database Commands

Clone Database

MongoDB includes commands for copying a database from one server to another.

```javascript
// copy an entire database from one name on one server to another
// name on another server. omit <from_hostname> to copy from one
// name to another on the same server.
db.copyDatabase(<from_dbname>, <to_dbname>, <from_hostname>);

// if you must authenticate with the source database

// db.copyDatabase(<from_dbname>, <to_dbname>, <from_hostname>, <username>, <password>);  
// in "command" syntax (runnable from any driver):

db.runCommand( { copydb : 1, fromdb : ..., todb : ..., fromhost : ... });

// command syntax for authenticating with the source:

n = db.runCommand( { copydbgetnonce : 1, fromhost: ... });

// clone the current database (implied by 'db') from another host
var fromhost = ...

// in "command" syntax (runnable from any driver):

// var fromhost = ...
print("about to get a copy of database " + db + " from " + fromhost);

db.runCommand( { clone : fromhost });
```

fsync Command

- Basics
- Lock, Snapshot and Unlock
- See Also

⚠️ Version 1.3.1 and higher

The fsync command allows us to flush all pending writes to datafiles. More importantly, it also provides a lock option that makes backups easier.

**Basics**

The fsync command forces the database to flush all datafiles:

```javascript
> use admin
> db.runCommand({fsync:1});
```

By default the command returns after synchronizing. To return immediately use:

```javascript
> db.runCommand({fsync:1,async:true});
```

To fsync on a regular basis, use the --syncdelay command line option (see mongod --help output). By default a full flush is forced every 60 seconds.

**Lock, Snapshot and Unlock**

The fsync command supports a lock option that allows one to safely snapshot the database's datafiles. While locked, all write operations are blocked, although read operations are still allowed. After snapshotting, use the unlock command to unlock the database and allow locks again.
Example:

```javascript
> use admin
switched to db admin
> db.runCommand({fsync:1,lock:1})
{  
  "info" : "now locked against writes",
  "ok" : 1
}
> db.currentOp()
{  
  "inprog" : [
  ],
  "fsyncLock" : 1
}
> // do some work here: for example, snapshot datafiles...
> db.$cmd.sys.unlock.findOne();
{  
  : 1,
  : }
"ok"
"info"
"unlock requested"
> db.currentOp()
{  
  "inprog" : [ ]
}
```

See Also

- Backups

Index-Related Commands

Create Index

`ensureIndex()` is the helper function for this. Its implementation creates an index by adding its info to the `system.indexes` table.

```javascript
> db.myCollection.ensureIndex(<keypattern>);
> // same as:
> db.system.indexes.insert({ name: "name", ns: "namespaceToIndex",
key: <keypattern> });
```

Note: Once you've inserted the index, all subsequent document inserts for the given collection will be indexed, as will all pre-existing documents in the collection. If you have a large collection, this can take a significant amount of time and will block other operations. However, beginning with version 1.3.2, you can specify that indexing happen in the background. See the background indexing docs for details.

You can query `system.indexes` to see all indexes for a table `foo`:

```javascript
> db.system.indexes.find( { ns: "foo" } );
```

In some drivers, `ensureIndex()` remembers if it has recently been called, and foregoes the insert operation in that case. Even if this is not the case, `ensureIndex()` is a cheap operation, so it may be invoked often to ensure that an index exists.

Dropping an Index

From the shell:

```javascript
db.mycollection.dropIndex(<name_or_pattern>)
db.mycollection.dropIndexes()
// example:
t.dropIndex( { name : 1 } );
```

From a driver (raw command object form; many drivers have helpers):

```javascript
db.myCollection.dropIndex(<keypattern>);
```
Index Namespace

Each index has a namespace of its own for the btree buckets. The namespace is:

```
<collectionnamespace>$<indexname>
```

This is an internal namespace that cannot be queried directly.

LastError Commands

Since MongoDB doesn't wait for a response by default when writing to the database, a couple commands exist for ensuring that these operations have succeeded. These commands can be invoked automatically with many of the drivers when saving and updating in "safe" mode. But what's really happening is that a special command called `getLastError` is being invoked. Here, we explain how this works.

- `getLastError`
- `Drivers`
- `Use Cases`
- `Mongo Shell Behavior`
- `fsync option`
- `With Replication`
- `getPrevError`

`getLastError`

The `getLastError` command checks for an error on the last database operation for this connection. Since it's a command, there are a few ways to invoke it:

```
> db.$cmd.findOne({getLastError:1})
```

Or

```
> db.runCommand("getLastError")
```

Or you can use the helper:

```
> db.getLastLError()
```

For more about commands, see the command documentation.

Drivers

The drivers support `getLastError` in the command form and many also offer a "safe" mode for operations. If you're using Python, for example, you automatically call `getLastError` on insert as follows:

```
collection.save({"name": "MongoDB"}, safe=True)
```

If the save doesn't succeed, an exception will be raised. For more on "safe" mode, see your driver's documentation.

Use Cases

getLastError is primarily useful for write operations (although it is set after a command or query too). Write operations by default do not have a return code: this saves the client from waiting for client/server turnarounds during write operations. One can always call `getLastError` if one wants a return code.

If you're writing data to MongoDB on multiple connections, then it can sometimes be important to call `getLastError` on one connection to be certain that the data has been committed to the database. For instance, if you're writing to connection #1 and want those writes to be reflected in reads from connection #2, you can assure this by calling `getLastError` after writing to connection #1.
Note: The special mongo wire protocol killCursors operation does not support getLastError. (This is really only of significant to driver developers.)

**Mongo Shell Behavior**

The database shell performs a `resetError()` before each read/eval/print loop command evaluation - and automatically prints the error, if one occurred, after each evaluation. Thus, after an error, at the shell prompt `db.getLastError()` will return null. However, if called before returning to the prompt, the result is as one would expect:

```plaintext
> try { db.foo.findOne() } catch(e) { print("preverr:" + toJSON(db.getPrevError())); print("lasterr:" + toJSON(db.getLastError()));}
preverr:{"err" : "unauthorized", "nPrev" : 1, "ok" : 1}
lasterr:"unauthorized"
```

**fsync option**

Include the fsync option to force the database to fsync all files before returning (v1.3+):

```plaintext
> db.runCommand({getlasterror:1,fsync:true})
{ "err" : null, "n" : 0, "fsyncFiles" : 2, "ok" : 1 }
```

**With Replication**

See blocking for replication.

**getPrevError**

Note: `getPrevError` may be deprecated in the future.

When performing bulk write operations, `resetError()` and `getPrevError()` can be an efficient way to check for success of the operation. For example if we are inserting 1,000 objects in a collection, checking the return code 1,000 times over the network is slow. Instead one might do something like this:

```plaintext
db.resetError();
for( loop 1000 times... )
  db.foo.save(something...);
if{ db.getPrevError().err }
  print("didn't work!");
```

**Viewing and Terminating Current Operation**

- **View Current Operation(s) in Progress**
- **Terminate (Kill) an Operation in Progress**

**View Current Operation(s) in Progress**

```plaintext
> db.currentOp();
// same as: db.$cmd.sys.inprog.findOne()
{ inprog: [ { "opid" : 18 , "op" : "query" , "ns" : "mydb.votes" ,
  "query" : "{ score : 1.0 }" , "inLock" : 1 } ]
  }
```

Fields:

- **opid** - an incrementing operation number. Use with `killOp()`.
- **op** - the operation type (query, update, etc.)
- **ns** - namespace for the operation (database + collection name)
- **query** - the query spec, if operation is a query

**NOTE:** currentOp's output format varies from version 1.0 and version 1.1 of MongoDB. The format above is for 1.1 and higher.

You can also do
Terminate (Kill) an Operation in Progress

```javascript
// <= v1.2
> db.killOp()
> // same as: db.$cmd.sys.killop.findOne()
{
    "info": "no op in progress/not locked"
}
// v>= 1.3
> db.killOp(1234/*opid*/)
> // same as: db.$cmd.sys.killop.findOne({op:1234})
```

Validate Command

Use this command to check that a collection is valid (not corrupt) and to get various statistics.

This command scans the entire collection and its indexes and will be very slow on large datasets.

From the shell:

```javascript
> db.foo.validate()
{
    "ns": "test.foo", "result": "
    validate
    details: 08D03C9C ofs:963c9c
    firstExtent:0:156800 ns:test.foo
    lastExtent:0:156800 ns:test.foo
    # extents:1
    datasize?:144 nrecords?:3 lastExtentSize:2816
    padding:1
    first extent:
        loc:0:156800 xnext:null xprev:null
        ns:test.foo
        size:2816 firstRecord:0:1568b0 lastRecord:0:156930
    3 objects found, nobj:3
    192 bytes data w/headers
    144 bytes data w/out/headers
    deletedList: 00000001000000000000 deleted: n: 1 size: 2448
    nIndexes:1
    test.foo.$x_1 keys:3
    ", "ok": 1, "valid": true, "lastExtentSize": 2816}
```

From a driver one might invoke the driver's equivalent of:

```javascript
> db.$cmd.findOne({validate: "foo"});
```

`validate` takes an optional `scandata` parameter which skips the scan of the base collection (but still scans indexes).

```javascript
> db.$cmd.findOne({validate: "foo", scandata: true});
```

getLastError
Most drivers, and the db shell, support a getlasterror capability. This lets one check the error code on the last operation.

Database commands, as well as queries, have a direct return code.

getlasterror is primarily useful for write operations (although it is set after a command or query too). Write operations by default do not have a return code: this saves the client from waiting for client/server turnarounds during write operations. One can always call getLastError if one wants a return code.

```javascript
> db.runCommand("getlasterror")
> db.getLastError()
```

Note: The special mongo wire protocol killCursors operation does not support getlasterror. (This is really only of significant to driver developers.)

getPrevError

Note: getPrevError may be deprecated in the future.

When performing bulk write operations, resetError() and getPrevError() can be an efficient way to check for success of the operation. For example if we are inserting 1,000 objects in a collection, checking the return code 1,000 times over the network is slow. Instead one might do something like this:

```javascript
db.resetError();
for( loop 1000 times... )
  db.foo.save(something...);
if( db.getPrevError().err )
  print("didn't work!");
```

Last Error in the Shell

The database shell performs a resetError() before each read/eval/print loop command evaluation - and automatically prints the error, if one occurred, after each evaluation. Thus, after an error, at the shell prompt db.getLastError() will return null. However, if called before returning to the prompt, the result is as one would expect:

```javascript
> try { db.foo.findOne() } catch(e) { print("preverr:" + tojson(db.getPrevError())); print("lasterr:" + tojson(db.getLastError())); preverr:{"err" : "unauthorized", "nPrev" : 1, "ok" : 1} lasterr:"unauthorized"
```

FSync with GetLastError

Include the fsync option to force the database to fsync all files before returning (v1.3+):

```javascript
> db.runCommand({getlasterror:1,fsync:true})
{ "err" : null, "n" : 0, "fsyncFiles" : 2, "ok" : 1 }
```

List of Database Commands

See the Commands page for details on how to invoke a command.

- Requires Auth - requires authentication
- Admin Only - if "Yes" this command is privileged - must be run against the admin database
- Slave Okay - can be run on a replication slave db server

<table>
<thead>
<tr>
<th>Command</th>
<th>Requires Auth</th>
<th>Admin Only</th>
<th>Slave Okay</th>
<th>Description</th>
</tr>
</thead>
</table>

Redirection Notice
This page should redirect to Last Error Commands in about 3 seconds.
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>{assertinfo : 1}</code></td>
<td>Info on any assertions thrown:</td>
</tr>
<tr>
<td></td>
<td>📌 <code>asserted : boolean</code>, <code>assert : string</code>, <code>assertw : string</code>, <code>assertmsg : string</code>, <code>assertuser : string</code>, <code>ok : 1</code></td>
</tr>
<tr>
<td><code>{buildinfo : 1}</code></td>
<td>Returns:</td>
</tr>
<tr>
<td></td>
<td>📌 <code>{version : dbVersion, gitVersion : gitCommitId, sysInfo : osInfo, ok : 1}</code></td>
</tr>
<tr>
<td><code>{ clone : from_host }</code></td>
<td>Copy the current database from another host to here. <a href="#">DocPage</a></td>
</tr>
<tr>
<td><code>{collstats : collection_name}</code></td>
<td>Gets statistics about a collection.</td>
</tr>
<tr>
<td><code>{convertToCapped : collection_name, size : size_in_bytes}</code></td>
<td>Convert a collection to capped. This command is rarely used and is not currently supported with sharding.</td>
</tr>
<tr>
<td><code>{ copydb : l, fromdb : ..., todb : ..., fromhost : ..., username: ..., nonce: ..., key: ... }</code></td>
<td>Copy a database, potentially from another host. The username, nonce, and key arguments are only required if the source database needs authentication. <a href="#">DocPage</a></td>
</tr>
<tr>
<td><code>{ copydbgetnonce : l, fromhost : ... }</code></td>
<td>Get a nonce for a subsequent call to copydb using a secure source database. <a href="#">DocPage</a></td>
</tr>
<tr>
<td><code>{ count : collection_name, query : query_spec, fields : [field1, field2] }</code></td>
<td>Returns a count for the specified query.</td>
</tr>
<tr>
<td><code>{ create : name, capped : boolean, size : N[, max : N] }</code></td>
<td>Creates a collection</td>
</tr>
<tr>
<td>Command</td>
<td>No</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>----</td>
</tr>
<tr>
<td>{dbstats:1}</td>
<td></td>
</tr>
<tr>
<td>{deleteIndexes : coll_name,</td>
<td></td>
</tr>
<tr>
<td>index : index_name}</td>
<td></td>
</tr>
<tr>
<td>{distinct : collection_name,</td>
<td></td>
</tr>
<tr>
<td>key : key_name [, query : a_query ]}</td>
<td></td>
</tr>
<tr>
<td>{drop : collection_name}</td>
<td></td>
</tr>
<tr>
<td>{dropDatabase : 1}</td>
<td></td>
</tr>
<tr>
<td>{filemd5 : object_id, root :</td>
<td></td>
</tr>
<tr>
<td>file_root}</td>
<td></td>
</tr>
<tr>
<td>{findAndModify : collection_name,</td>
<td></td>
</tr>
<tr>
<td>query: query_filter, update:</td>
<td></td>
</tr>
<tr>
<td>update_modifier_object, sort:</td>
<td></td>
</tr>
<tr>
<td>sort_order, remove: boolean, new: boolean}</td>
<td></td>
</tr>
<tr>
<td>{forceerror : 1}</td>
<td></td>
</tr>
<tr>
<td>{fsync : 1[, async : true]}</td>
<td></td>
</tr>
<tr>
<td>{getlasterror : 1}</td>
<td></td>
</tr>
<tr>
<td>Method</td>
<td>No</td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>----</td>
</tr>
<tr>
<td><code>getoptime</code></td>
<td>No</td>
</tr>
<tr>
<td><code>getpreverror</code></td>
<td>No</td>
</tr>
<tr>
<td><code>nIndexesWas : N</code></td>
<td>No</td>
</tr>
<tr>
<td><code>ismaster</code></td>
<td>No</td>
</tr>
<tr>
<td><code>listDatabases</code></td>
<td>No</td>
</tr>
<tr>
<td><code>diagLogging : &lt;n&gt;</code></td>
<td>No</td>
</tr>
<tr>
<td><code>profile : integer</code></td>
<td>No</td>
</tr>
<tr>
<td><code>queryTraceLevel : N</code></td>
<td>No</td>
</tr>
<tr>
<td><code>renameCollection : &lt;collectionToRename&gt;, to: &lt;new collection name&gt;, dropTarget: &lt;boolean&gt;</code></td>
<td>No</td>
</tr>
<tr>
<td><code>repairDatabase : 1, preserveClonedFilesOnFailure : boolean, backupOriginalFiles : boolean</code></td>
<td>No</td>
</tr>
</tbody>
</table>
Mongo Metadata

The <dbname>-system.* namespaces in MongoDB are special and contain database system information. System collections include:

- `system.namespaces` lists all namespaces.
- `system.indexes` lists all indexes.
- Additional namespace/index metadata exists in the database.ns files, and is opaque.
- `system.profile` stores database profiling information.
- `system.users` lists users who may access the database.
- `local.sources` stores replica slave configuration data and state.
- Information on the structure of a stored object is stored within the object itself. See BSON.

There are several restrictions on manipulation of objects in the system collections. Inserting in `system.indexes` adds an index, but otherwise that table is immutable (the special drop index command updates it for you). `system.users` is modifiable. `system.profile` is droppable.

Note: `$_` is a reserved character. Do not use it in namespace names or within field names. Internal collections for indexes use the `$_` character in their names. These collection store b-tree bucket data and are not in BSON format (thus direct querying is not possible).

Collections

MongoDB collections are essentially named groupings of documents. You can think of them as roughly equivalent to relational database tables.

Details

A MongoDB collection is a collection of BSON documents. These documents are usually have the same structure, but this is not a requirement since MongoDB is a schema-free database. You may store a heterogeneous set of documents within a collection, as you do not need predefine the collection's "columns" or fields.

A collection is created when the first document is inserted.

Collection names should begin with letters or an underscore and may include numbers; `$_` is reserved. Collections can be organized in namespaces; these are named groups of collections defined using a dot notation. For example, you could define collections `blog.posts` and `blog.authors`, both reside under "blog". Note that this is simply an organizational mechanism for the user -- the collection namespace is flat from the database's perspective.

Programmatically, we access these collections using the dot notation. For example, using the mongo shell:

```javascript
if( db.blog.posts.findOne() )
    print("blog.posts exists and is not empty.");
```

See also:
Capped Collections

Capped collections are fixed sized collections that have a very high performance auto-LRU age-out feature (age out is based on insertion order).

In addition, capped collections automatically, with high performance, maintain insertion order for the objects in the collection; this is very powerful for certain use cases such as logging.

Creating a Fixed Size (capped) Collection

Unlike a standard collection, you must explicitly create a capped collection, specifying a collection size in bytes. The collection's data space is then preallocated. Note that the size specified includes database headers.

```javascript
db.createCollection("mycoll", {capped:true, size:100000})
```

Usage and Restrictions

- You may insert new objects in the capped collection.
- You may update the existing objects in the collection. However, the objects must not grow in size. If they do, the update will fail. (There are some possible workarounds which involve pre-padding objects; contact us in the support forums for more information, if help is needed.)
- The database does not allow deleting objects from a capped collection. Use the `drop()` method to remove all rows from the collection.
- Maximum size for a capped collection is currently 1e9 bytes on a thirty-two bit machine. The maximum size of a capped collection on a sixty-four bit machine is constrained only by system resources.

Behavior

- Once the space is fully utilized, newly added objects will replace the oldest objects in the collection.
- If you perform a `find()` on the collection with no ordering specified, the objects will always be returned in insertion order. Reverse order is always retrievable with `find().sort({$natural:-1})`.

Applications

- **Logging.** Capped collections are the preferred logging mechanism for Mongo. Mongo does not use log "files." Rather, log events are stored in the database. Capped collections provide a high-performance means for storing these objects in the database. Inserting objects in an unindexed capped collection will be close to the speed of logging to a filesystem. Additionally, with the built-in LRU mechanism, you are not at risk of using excessive disk space for the logging.
- **Caching.** If you wish to cache a small number of objects in the database, perhaps cached computations of information, the capped tables provide a convenient mechanism for this. Note that for this application you will likely use an index on the capped table as there will be more reads than writes.
- **Auto Archiving.** If you know you want data to automatically "roll out" over time as it ages, a capped collection can be an easier way to support than writing manual archival cron scripts.

Recommendations

- For maximum performance, do not create indexes on a capped collection. If the collection will be written to much more than it is read from, it is better to have no indexes. Note that you may create indexes on a capped collection; however, you are then moving from "log speed" inserts to "database speed" inserts – that is, it will still be quite fast by database standards.
- Use natural ordering to retrieve the most recently inserted elements from the collection efficiently. This is (somewhat) analogous to tail on a log file.

Capping the Number of Objects

You may also cap the number of objects in the collection. Once the limit is reached, items roll out on a least recently inserted basis.

To cap on number of objects, specify a `max` parameter on the `createCollection()` call.

```javascript
db.createCollection("mycoll", {capped:true, size:100000, max:100});
db.mycoll.validate();
```
Tip: When programming, a handy way to store the most recently generated version of an object can be a collection capped with max=1.

**Preallocating space for a normal collection**

The `createCollection` command may be used for non capped collections as well. For example:

```javascript
db.createCollection("mycoll", {size:10000000});
db.createCollection("mycoll", {size:10000000, autoIndexId:false});
```

Explicitly creating a non capped collection via `createCollection` allows parameters of the new collection to be specified. For example, specification of a collection size causes the corresponding amount of disk space to be preallocated for use by the collection. The `autoIndexId` field may be set to true or false to explicitly enable or disable automatic creation of a unique key index on the `_id` object field. By default, such an index is created for non capped collections but is not created for capped collections.

---

An index is not automatically created on `_id` for capped collections by default

**See Also**

- The Sorting and Natural Order section of this Guide

**Using a Large Number of Collections**

A technique one can use with MongoDB in certain situations is to have several collections to store information instead of a single collection. By doing this, certain repeating data no longer needs to be stored in every object, and an index on that key may be eliminated. More importantly for performance (depending on the problem), the data is then clustered by the grouping specified.

For example, suppose we are logging objects/documents to the database, and want to have M logs: perhaps a dev log, a debug log, an ops log, etc. We could store them all in one collection 'logs' containing objects like:

```javascript
{ log : 'dev', ts : ..., info : ... }
```

However, if the number of logs is not too high, it might be better to have a collection per log. We could have a 'logs.dev' collection, a 'logs.debug' collection, 'logs.ops', etc.:

```javascript
// logs.dev:
{ ts : ..., info : ... }
```

Of course, this only makes sense if we do not need to query for items from multiple logs at the same time.

Generally, having a large number of collections has no significant performance penalty, and results in very good performance.

**Limits**

By default MongoDB has a limit of approximately 24,000 *namespaces* per database. Each collection counts as a namespace, as does each index. Thus if every collection had one index, we can create up to 12,000 collections. Use the `--nssize` parameter to set a higher limit.

Be aware that there is a certain minimum overhead per collection -- a few KB. Further, any index will require at least 8KB of data space as the b-tree page size is 8KB.

`--nssize`

If more collections are required, run `mongod` with the `--nssize` parameter specified. This will make the `<database>.ns` file larger and support more collections. Note that `--nssize` sets the size used for newly created `.ns` files -- if you have an existing database and wish to resize, after running the `db` with `--nssize`, run the `db.repairDatabase()` command from the shell to adjust the size.

Maximum `.ns` file size is 2GB.

**Data Types and Conventions**

**MongoDB (BSON) Data Types**

Mongo uses special data types in addition to the basic JSON types of string, integer, boolean, double, null, array, and object. These types include...
date, object id, binary data, regular expression, and code. Each driver implements these types in language-specific ways, see your driver's documentation for details.

See BSON for a full list of database types.

Internationalization

- See Internationalized strings

Database References

- See Database References and Schema Design

Internationalized Strings

MongoDB supports UTF-8 for strings in stored objects and queries. (Specifically, BSON strings are UTF-8.)

Generally, drivers for each programming language convert from the language's string format of choice to UTF-8 when serializing and deserializing BSON. For example, the Java driver converts Java Unicode strings to UTF-8 on serialization.

In most cases this means you can effectively store most international characters in MongoDB strings. A few notes:

- MongoDB regex queries support UTF-8 in the regex string.
- Currently, sort() on a string uses strcmp: sort order will be reasonable but not fully international correct. Future versions of MongoDB may support full UTF-8 sort ordering.

Object IDs

Documents in MongoDB are required to have a key, _id, which uniquely identifies them.

- Document IDs: _id
- The BSON ObjectID Datatype
  - BSON ObjectID Specification
  - Document Timestamps
- Sequence Numbers

Document IDs: _id

Every MongoDB document has an _id field as its first attribute. This value usually a BSON ObjectID. Such an id must be unique for each member of a collection; this is enforced if the collection has an index on _id, which is the case by default.

If a user tries to insert a document without providing an id, the database will automatically generate an _object id and store it the _id field.

Users are welcome to use their own conventions for creating ids; the _id value may be of any type so long as it is a unique.

The BSON ObjectID Datatype

Although _id values can be of any type, a special BSON datatype is provided for object ids. This type is a 12-byte binary value designed to have a reasonably high probability of being unique when allocated. All of the officially-supported MongoDB drivers use this type by default for _id values. Also, the Mongo database itself uses this type when assigning _id values on inserts where no _id value is present.

In the MongoDB shell, ObjectId() may be used to create ObjectIds. ObjectId(string) creates an object ID from the specified hex string.

```javascript
> x={ name: "joe" }
{ name: "joe" }
> db.people.save(x)
{ name: "joe", _id: ObjectId( "47cc67093475061e3d95369d" ) }
> x
{ name: "joe", _id: ObjectId( "47cc67093475061e3d95369d" ) }
> db.people.findOne( { _id: ObjectId( "47cc67093475061e3d95369d" ) } )
{ _id: ObjectId( "47cc67093475061e3d95369d" ), name: "joe" }
> db.people.findOne( { _id: new ObjectId( "47cc67093475061e3d95369d" ) } )
{ _id: ObjectId( "47cc67093475061e3d95369d" ), name: "joe" }
```

BSON ObjectID Specification

A BSON ObjectID is a 12-byte value consisting of a 4-byte timestamp (seconds since epoch), a 3-byte machine id, a 2-byte process id, and a
3-byte counter. Note that the timestamp and counter fields must be stored big endian unlike the rest of BSON. This is because they are compared byte-by-byte and we want to ensure a mostly increasing order. Here’s the schema:

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>time</td>
<td>machine</td>
<td>pid</td>
<td>inc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Document Timestamps**

One useful consequence of this specification is that it provides documents with a creation timestamp for free. All of the drivers implement methods for extracting these timestamps; see the relevant api docs for details.

**Sequence Numbers**

Traditional databases often use monotonically increasing sequence numbers for primary keys. In MongoDB, the preferred approach is to use Object IDs instead. Object IDs are more synergistic with sharding and distribution.

However, sometimes you may want a sequence number. The Insert if Not Present section of the Atomic Operations page shows an example of how to do this.

**Database References**

- Simple Manual References
- DBRef
  - DBRef in Different Languages / Drivers
    - C#
    - C++
    - Java
    - Javascript (mongo shell)
    - PHP
    - Python
    - Ruby
- See Also

As MongoDB is non-relational (no joins), references ("foreign keys") between documents are generally resolved client-side by additional queries to the server. Two conventions are common for references in MongoDB: first simple manual references, and second, the DBRef standard, which many drivers support explicitly.

Note: Often embedding of objects eliminates the need for references, but sometimes references are still appropriate.

**Simple Manual References**

Generally, manually coded references work just fine. We simply store the value that is present in _id in some other document in the database. For example:

```javascript
> p = db.postings.findOne();
{ "_id" : ObjectId("4b866f08234ae01d21d89604"),
  "author" : "jim",
  "title" : "Brewing Methods"
}
> // get more info on author
> db.users.findOne( { _id : p.author } )
{ "_id" : "jim", "email" : "jim@gmail.com" }
```

**DBRef**

DBRef is a more formal specification for creating references between documents. DBRefs (generally) include a collection name as well as an object id. Most developers only use DBRefs if the collection can change from one document to the next. If your referenced collection will always be the same, the manual references outlined above are more efficient.

A DBRef is a reference from one document (object) to another within a database. A database reference is a standard embedded (JSON/BSON) object: we are defining a convention, not a special type. By having a standard way to represent, drivers and data frameworks can add helper methods which manipulate the references in standard ways.

DBRefs have the advantage of allowing optional automatic **client-side** dereferencing with some drivers, although more features may be added later. In many cases, you can just get away with storing the _id as a reference then dereferencing manually as detailed in the “Simple Manual References” section above.
Syntax for a DBRef reference value is

\[
\{ \text{ \$ref : <collname>, \$id : <idvalue>\[, \$db : <dbname>\]} \}
\]

where \(<\text{collname}>\) is the collection name referenced (without the database name), and \(<\text{idvalue}>\) is the value of the \(_\text{id}\) field for the object referenced. \(<\text{dbname}>\) is optional (currently unsupported by many of the drivers) and allows for references to documents in other databases (specified by \(<\text{dbname}>\)).

> The ordering for DBRefs does matter, fields must be in the order specified above.

The old BSON DBRef datatype is deprecated.

**DBRef in Different Languages / Drivers**

**C#**
Use the DBRef class. It takes the collection name and \(_\text{id}\) as parameters to the constructor. Then you can use the FollowReference method on the Database class to get the referenced document.

**C++**
The C++ driver does not yet provide a facility for automatically traversing DBRefs. However one can do it manually of course.

**Java**
Java supports DB references using the **DBRef class**.

**Javascript (mongo shell)**
Example:

```javascript
> x = { name : 'Biology' }
  "name" : "Biology"
> db.courses.save(x)
> x
  "name" : "Biology", "_id" : ObjectId("4b0552b0f0da7d1eb6f126a1")
> stu = { name : 'Joe', classes : [ new DBRef('courses', x._id) ] }
// or we could write:
// stu = { name : 'Joe', classes : [ {\$ref:'courses',\$id:x._id} ] } 
> db.students.save(stu)
> stu
  "name" : "Joe",
  "classes" : 
  [
    { "\$ref" : "courses",
      "$id" : ObjectId("4b0552b0f0da7d1eb6f126a1")
    }
  ],
  "_id" : ObjectId("4b0552e4f0da7d1eb6f126a2")
> stu.classes[0]
  { "\$ref" : "courses", "$id" : ObjectId("4b0552b0f0da7d1eb6f126a1") }
> stu.classes[0].fetch() 
  { "_id" : ObjectId("4b0552b0f0da7d1eb6f126a1"), "name" : "Biology" }
```

**PHP**
PHP supports DB references with the **MongoDBRef class**, as well as creation and deferencing methods at the database (**MongoDB::createDBRef** and **MongoDB::getDBRef**) and collection (**MongoCollection::createDBRef** and **MongoCollection::getDBRef**) levels.

**Python**
To create a DB reference in Python use the `pymongo.dbref.DBRef` class. You can also use the `dereference` method on Database instances to make dereferencing easier.

Python also supports auto-ref and auto-deref - check out the auto_reference example.

Ruby

Ruby also supports DB references using the `DBRef` class and a `dereference` method on DB instances. For example:

```ruby
@db   = Connection.new.db("blog")
@user = @db["users"].save({:name => "Smith"})
@post = @db["posts"].save({:title => "Hello World", :user_id => @user.id})
@ref  = DBRef.new("users", @post.user_id)
assert_equal @user, @db.dereference(@ref)
```

See Also

- Schema Design

GridFS

GridFS is a specification for storing large files in MongoDB. All of the officially supported driver implement the GridFS spec.

- Rationale
- Implementation
- Language Support
- Command Line Tools
- See also

Rationale

The database supports native storage of binary data within BSON objects. However, BSON objects in MongoDB are limited to 4MB in size. The GridFS spec provides a mechanism for transparently dividing a large file among multiple documents. This allows us to efficiently store large objects, and in the case of especially large files, such as videos, permits range operations (e.g., fetching only the first N bytes of a file).

Implementation

To facilitate this, a standard is specified for the chunking of files. Each file has a metadata object in a files collection, and one or more chunk objects in a chunks collection. Details of how this is stored can be found in the GridFS Specification; however, you do not really need to read that, instead, just look at the GridFS API in each language's client driver or `mongofiles` tool.

Language Support

Most drivers include GridFS implementations; for languages not listed below, check the driver's API documentation. (If a language does not include support, see the GridFS specification -- implementing a handler is usually quite easy.)

Command Line Tools

Command line tools are available to write and read GridFS files from and to the local filesystem.

See also

- C++
- A PHP GridFS Blog Article

Indexes

Indexes enhance query performance, often dramatically. It's important to think about the kinds of queries your application will need so that you can define relevant indexes. Once that's done, actually creating the indexes in MongoDB is relatively easy.

Indexes in MongoDB are conceptually similar to those in RDBMSes like MySQL. You will want an index in MongoDB in the same sort of situations where you would have wanted an index in MySQL.

- Basics
  - Default Indexes
An index is a data structure that collects information about the values of the specified fields in the documents of a collection. This data structure is used by Mongo's query optimizer to quickly sort through and order the documents in a collection. Formally speaking, these indexes are implemented as "B-Tree" indexes.

In the shell, you can create an index by calling the `ensureIndex()` function, and providing a document that specifies one or more keys to index. Referring back to our `examples` database from Mongo Usage Basics, we can index on the `j` field as follows:

```javascript
db.things.ensureIndex({j:1});
```

The `ensureIndex()` function only creates the index if it does not exist.

Once a collection is indexed on a key, random access on query expressions which match the specified key are fast. Without the index, MongoDB has to go through each document checking the value of specified key in the query:

```javascript
db.things.find({j : 2}); // fast - uses index
db.things.find({x : 3}); // slow - has to check all because 'x' isn't indexed
```

You can run `db.things.getIndexes();` to see the existing indexes on the collection.

### Default Indexes

An index is always created on `_id`. This index is special and cannot be deleted. The `_id` index enforces uniqueness for its keys.

### Embedded Keys

With MongoDB you can even index on a key inside of an embedded document. For example:

```javascript
db.things.ensureIndex({"address.city": 1})
```

### Documents as Keys

Indexed fields may be of any type, including documents:

```javascript
db.factories.insert( { name: "xyz", metro: { city: "New York", state: "NY" } } );
db.factories.ensureIndex({ metro : 1 });
// this query can use the above index:
db.factories.find( { metro: { city: "New York", state: "NY" } } );
```

An alternative to documents as keys it to create a compound index such as:
There are pros and cons to the two approaches. When using the entire (sub-)document as a key, compare order is predefined and is ascending key order in the order the keys occur in the BSON document. With compound indexes reaching in, you can mix ascending and descending keys, and the query optimizer will then be able to use the index for queries on solely the first key(s) in the index too.

Arrays

When a document's stored value for a index key field is an array, MongoDB indexes each element of the array. See the Multikeys page for more information.

Compound Keys Indexes

In addition to single-key basic indexes, MongoDB also supports multi-key "compound" indexes. Just like basic indexes, you use the ensureIndex() function in the shell to create the index, but instead of specifying only a single key, you can specify several:

```
db.things.ensureIndex({j:1, name:-1});
```

When creating an index, the number associated with a key specifies the direction of the index, so it should always be 1 (ascending) or -1 (descending). Direction doesn’t matter for single key indexes or for random access retrieval but is important if you are doing sorts or range queries on compound indexes.

If you have a compound index on multiple fields, you can use it to query on the beginning subset of fields. So if you have an index on

```
a,b,c
```

you can use it query on

```
a
```
```
a,b
```
```
a,b,c
```

Unique Indexes

MongoDB supports unique indexes, which guarantee that no documents are inserted whose values for the indexed keys match those of an existing document. To create an index that guarantees that no two documents have the same values for both firstname and lastname you would do:

```
db.things.ensureIndex({firstname: 1, lastname: 1}, {unique: true});
```

Missing Keys

When a document is saved to a collection with unique indexes, any missing indexed keys will be inserted with null values. Thus, it won't be possible to insert multiple documents missing the same indexed key.

```
db.things.ensureIndex({firstname: 1}, {unique: true});
db.things.save({lastname: "Smith"});
```
```
// Next operation will fail because of the unique index on firstname.
db.things.save({lastname: "Jones"});
```
**Duplicate Values**

A unique index cannot be created on a key that has duplicate values. If you would like to create the index anyway, keeping the first document the database indexes and deleting all subsequent documents that have duplicate values, add the `dropDups` option.

```javascript
db.things.ensureIndex({firstname : 1}, {unique : true, dropDups : true})
```

**Background Index Building**

By default, building an index blocks other database operations. v1.3.2 and higher has a **background index build option**.

**Dropping Indexes**

To delete all indexes on the specified collection:

```javascript
db.collection.dropIndexes();
```

To delete a single index:

```javascript
db.collection.dropIndex({x: 1, y: -1})
```

Running directly as a command without helper:

```javascript
// note: command was "deleteIndexes", not "dropIndexes", before MongoDB v1.3.2
// remove index with key pattern {y:1} from collection foo
db.runCommand({dropIndexes:'foo', index : {y:1}})
// remove all indexes:
db.runCommand({dropIndexes:'foo', index : '*'});
```

**ReIndex**

The `reIndex` command will rebuild all indexes for a collection.

```javascript
db.myCollection.reIndex()
// same as:
db.runCommand( { reIndex : 'myCollection' } )
```

Usually this is unnecessary. You may wish to do this if the size of your collection has changed dramatically or the disk space used by indexes seems oddly large.

Repair database recreates all indexes in the database.

**Additional Notes on Indexes**

- MongoDB indexes (and string equality tests in general) are case sensitive.
- When you update an object, if the object fits in its previous allocation area, only those indexes whose keys have changed are updated. This improves performance. Note that if the object has grown and must move, all index keys must then update, which is slower.
- Index information is kept in the `system.indexes` collection, run `db.system.indexes.find()` to see example data.

**Index Performance**

Indexes make retrieval by a key, including ordered sequential retrieval, very fast. Updates by key are faster too as MongoDB can find the document to update very quickly.

However, keep in mind that each index created adds a certain amount of overhead for inserts and deletes. In addition to writing data to the base collection, keys must then be added to the B-Tree indexes. Thus, indexes are best for collections where the number of reads is much greater than the number of writes. For collections which are write-intensive, indexes, in some cases, may be counterproductive. Most collections are read-intensive, so indexes are a good thing in most situations.

**Using `sort()` without an Index**

You may use `sort()` to return data in order without an index if the data set to be returned is small (less than four megabytes). For these cases it
is best to use `limit()` and `sort()` together.

**Geospatial**

- See Geospatial Indexing page.

**Webinar**


**Geospatial Indexing**

- Creating the Index
- Querying
- Compound Indexes
- geoNear Command
- Bounds Queries
- The Earth is Round but Maps are Flat
- Sharded Environments
- Implementation

---

MongoDB supports two-dimensional geospatial indexes. It is designed with location-based queries in mind, such as "find me the closest N items to my location." It can also efficiently filter on additional criteria, such as "find me the closest N museums to my location."

In order to use the index, you need to have a field in your object that is either a sub-object or array where the first 2 elements are x,y coordinates (or y,x - just be consistent). Some examples:

```json
{ loc : [ 50 , 30 ] }
{ loc : { x : 50 , y : 30 } }
{ loc : { foo : 50 , y : 30 } }
{ loc : { lat : 40.739037, long: 73.992964 } }
```

**Creating the Index**

```javascript
db.places.ensureIndex( { loc : "2d" } )
```

By default, the index assumes you are indexing latitude/longitude and is thus configured for a [-180..180] value range.

If you are indexing something else, you can specify some options:

```javascript
db.places.ensureIndex( { loc : "2d" }, { min : -500 , max : 500 } )
```

that will scale the index to store values between -500 and 500. Currently geo indexing is limited to indexing squares with no "wrapping" at the outer boundaries. You cannot insert values on the boundaries, for example, using the code above, the point (-500, -500) could not to be inserted.

**Querying**

The index can be used for exact matches:

```javascript
db.places.find( { loc : [50,50] } )
```

Of course, that is not very interesting. More important is a query to find points near another point, but not necessarily matching exactly:

```javascript
db.places.find( { loc : { $near : [50,50] } } )
```

The above query finds the closest points to (50,50) and returns them sorted by distance (there is no need for an additional sort parameter). Use `limit()` to specify a maximum number of points to return (a default limit of 100 applies if unspecified):
Compound Indexes

MongoDB geospatial indexes optionally support specification of secondary key values. If you are commonly going to be querying on both a location and other attributes at the same time, add the other attributes to the index. The other attributes are annotated within the index to make filtering faster. For example:

```javascript
db.places.ensureIndex( { location : "2d", category : 1 } );
db.places.find( { location : { $near : [50,50] }, category : 'coffee' } );
```

geoNear Command

While the find() syntax above is typically preferred, MongoDB also has a geoNear command which performs a similar function. The geoNear command has the added benefit of returning the distance of each item from the specified point in the results, as well as some diagnostics for troubleshooting.

```javascript
> db.runCommand( { geoNear : "places", near : [50,50], num : 10 } );
> db.runCommand({geoNear:"asdf", near:[50,50]})

{ "results" : [ { "dis" : 69.29646421910687, "obj" : { "_id" : ObjectId("4b8bd6b93b83c574d8760280"), "y" : [ 1, 1 ], "category" : "Coffee" } }, { "dis" : 69.29646421910687, "obj" : { "_id" : ObjectId("4b8bd6b03b83c574d876027f"), "y" : [ 1, 1 ] } } ], "stats" : { "time" : 0, "btreelocs" : 1, "btreelocs" : 1, "nsnanned" : 2, "nsnanned" : 2, "objectsLoaded" : 2, "objectsLoaded" : 2, "avgDistance" : 69.29646421910687 }, "ok" : 1 }
```

The above command will return the 10 closest items to (50,50). (The loc field is automatically determined by checking for a 2d index on the collection.)

If you want to add an additional filter, you can do so:
query can be any regular mongo query.

Bounds Queries

$vwithin$ can be used instead of $snear$ to find items within a shape. At the moment, $sbox$ (rectangles) and $scenter$ (circles) are supported.

To query for all points within a rectangle, you must specify the lower-left and upper-right corners:

```javascript
> box = [[40, 40], [60, 60]]
> db.places.find({"loc" : {
    "$within" : {
        "$box" : box
    }
}})
```

A circle is specified by a center point and radius:

```javascript
> center = [50, 50]
> radius = 10
> db.places.find({"loc" : {
    "$within" : {
        "$center" : [center, radius]
    }
}})
```

The Earth is Round but Maps are Flat

The current implementation assumes an idealized model of a flat earth, meaning that an arcdegree of latitude (y) and longitude (x) represent the same distance everywhere. This is only true at the equator where they are both about equal to 69 miles or 111km. However, at the 10gen offices at \( \{ x : -74 , y : 40.74 \} \) one arcdegree of longitude is about 52 miles or 83 km (latitude is unchanged). This means that something 1 mile to the north would seem closer than something 1 mile to the east.

Sharded Environments

Support for geospatial in sharded collections is coming; please watch this ticket: [http://jira.mongodb.org/browse/SHARDING-83](http://jira.mongodb.org/browse/SHARDING-83).

In the meantime sharded clusters can use geospatial indexes for unsharded collections within the cluster.

Implementation

The current implementation encodes geographic hash codes atop standard MongoDB b-trees. Results of $snear$ queries are exact. The problem with geohashing is that prefix lookups don't give you exact results, especially around bit flip areas. MongoDB solves this by doing a grid by grid search after the initial prefix scan. This guarantees performance remains very high while providing correct results.

Indexing as a Background Operation

By default the `ensureIndex()` operation is blocking, and will stop other operations on the database from proceeding until completed. However, in v1.3.2+, a background indexing option is available.

To build an index in the background, add `background: true` to your index options. Examples:

```javascript
> db.things.ensureIndex({x:1}, {background: true});
> db.things.ensureIndex({name:1}, {background: true, unique: true, ... dropDups: true});
```

With background mode enabled, other operations, including writes, will not be obstructed during index creation. The index is not used for queries until the build is complete.

Although the operation is 'background' in the sense that other operations may run concurrently, the command will not return to the shell prompt until completely finished. To do other operations at the same time, open a separate mongo shell instance.
Please note that background mode building uses an incremental approach to building the index which is slower than the default foreground mode: time to build the index will be greater.

While the build progresses, it is possible to see that the operation is still in progress with the `db.currentOp()` command (will be shown as an insert to `system.indexes`). You may also use `db.killOp()` to terminate the build process.

While the build progresses, the index is visible in `system.indexes`, but it is not used for queries until building completes.

**Notes**

- Only one index build at a time is permitted per collection.
- Some administrative operations, such as `repairDatabase`, are disallowed while a background indexing job is in progress.
- v1.3.2 : alpha (of this feature)
- v1.3.3 : beta
- v1.4 : production

**Multikeys**

MongoDB provides an interesting “multikey” feature that can automatically index arrays of an object's values. A good example is tagging. Suppose you have an article tagged with some category names:

```bash
$ dbshell
> db.articles.save( { name: "Warm Weather", author: "Steve",
tags: ['weather', 'hot', 'record', 'april'] } )
> db.articles.find()
{"name": "Warm Weather", "author": "Steve",
"tags": ["weather","hot","record","april"], 
"_id": "497ce4051ca9ca6d3efca323"
}
```

We can easily perform a query looking for a particular value in the `tags` array:

```bash
> db.articles.find({ tags: 'april' })
{"name": "Warm Weather", "author": "Steve",
"tags": ["weather","hot","record","april"], 
"_id": "497ce4051ca9ca6d3efca323"
}
```

Further, we can index on the `tags` array. Creating an index on an array element indexes results in the database indexing each element of the array:

```bash
> db.articles.ensureIndex({ tags : 1 })
true
> db.articles.find({ tags: 'april' })
{"name": "Warm Weather", "author": "Steve",
"tags": ["weather","hot","record","april"], 
"_id": "497ce4051ca9ca6d3efca323"
}
```

```bash
> db.articles.find({ tags: 'april' }).explain()
{"cursor": "BtreeCursor tags_1", "startKey": {"tags": "april"},
"endKey": {"tags": "april"}, nscanned: 1, n: 1, millis: 0
}
```

**Embedded object fields in an array**

Additionally the same technique can be used for fields in embedded objects:

```bash
> db.posts.find({ "comments.author": "julie" })
{"title": "How the west was won",
"comments": [{"text": "great!", "author": "sam"},
{"text": "ok", "author": "julie"}], 
"_id": "497ce79f1ca9ca6d3efca325"
}
```

**Querying on all values in a given set**

By using the `$all` query option, a set of values may be supplied each of which must be present in a matching object field. For example:
See Also

- The Multikeys section of the Full Text Search in Mongo document for information about this feature.

Indexing Advice and FAQ

We get a lot of questions about indexing. Here we provide answers to a number of these. There are a couple of points to keep in mind, though. First, indexes in MongoDB work quite similarly to indexes in MySQL, and thus many of the techniques for building efficient indexes in MySQL apply to MongoDB.

Second, and even more importantly, know that advice on indexing can only take you so far. The best indexes for your application should always be based on a number of important factors, including the kinds of queries you expect, the ratio of reads to writes, and even the amount of free memory on your system. This means that the best strategy for designing indexes will always be to profile a variety of index configurations with data sets similar to the ones you’ll be running in production, and see which perform best. There’s no substitute for good empirical analyses.

Indexing Strategies

- Create indexes to match your queries.
- One index per query.
- Make sure your indexes can fit in RAM.
- Be careful about single-key indexes with low selectivity.
- Use explain.
  - Understanding explain's output.
- Pay attention to the read/write ratio of your application.

Indexing Properties

1. The sort column must be the last column used in the index.
2. The range query must also be the last column in an index. This is an axiom of 1 above.
3. Only use a range query or sort on one column.
4. Conserve indexes by re-ordering columns used on equality (non-range) queries.
5. MongoDB's $ne or $nin operator's aren't efficient with indexes.

FAQ

- I've started building an index, and the database has stopped responding. What's going on? What do I do?
- I'm using $ne or $nin in a query, and while it uses the index, it's still slow. What's happening?

Indexing Strategies

Here are some general principles for building smart indexes.

Create indexes to match your queries.

If you only query on a single key, then a single-key index will do. For instance, maybe you're searching for a blog post's slug:

```javascript
db.posts.find({ slug: 'state-of-mongodb-2010' })
```

In this case, a unique index on a single key is best:

```javascript
db.ensureIndex({ slug: 1 }, {unique: true});
```

However, it's common to query on multiple keys and to sort the results. For these situations, compound indexes are best. Here's an example for querying the latest comments with a 'mongodb' tag:

```javascript
db.comments.find({ tags: 'mongodb' }).sort({ created_at: -1 });
```

And here's the proper index:

```javascript
db.comments.ensureIndex({ tags: 1, created_at: -1 });
```
Note that if we wanted to sort by `created_at` ascending, this index would be less effective.

One index per query.

It's sometimes thought that queries on multiple keys can use multiple indexes; this is not the case with MongoDB. If you have a query that selects on multiple keys, and you want that query to use an index efficiently, then a compound-key index is necessary.

Make sure your indexes can fit in RAM.

The shell provides a command for returning the total index size on a given collection:

```javascript
db.comments.totalIndexSize();
65443
```

If your queries seem sluggish, you should verify that your indexes are small enough to fit in RAM. For instance, if you're running on 4GB RAM and you have 3GB of indexes, then your indexes probably aren't fitting in RAM. You may need to add RAM and/or verify that all the indexes you've created are actually being used.

Be careful about single-key indexes with low selectivity.

Suppose you have a field called 'status' where the possible values are 'new' and 'processed'. If you add an index on 'status' then you've created a low-selectivity index, meaning that the index isn't going to be very helpful in locating records and might just be be taking up space.

A better strategy, depending on your queries, of course, would be to create a compound index that includes the low-selectivity field. For instance, you could have a compound-key index on 'status' and 'created_at'.

Another option, again depending on your use case, might be to use separate collections, one for each status. As with all the advice here, experimentation and benchmarks will help you choose the best approach.

Use `explain`.

MongoDB includes an `explain` command for determining how your queries are being processed and, in particular, whether they're using an index. `explain` can be used from the drivers and also from the shell:

```javascript
db.comments.find({ tags : 'mongodb'}).sort({ created_at : -1 }).explain();
```

This will return lots of useful information, including the number of items scanned, the time the query takes to process in milliseconds, which indexes the query optimizer tried, and the index ultimately used.

If you've never used `explain`, now's the time to start.

Understanding `explain`'s output.

There are three main fields to look for when examining the `explain` command's output:

- `cursor`: the value for `cursor` can be either `BasicCursor` or `BtreeCursor`. The second of these indicates that the given query is using an index.
- `nscanned`: the number of documents scanned.
- `n`: the number of documents returned by the query. You want the value of `n` to be close to the value of `nscanned`. What you want to avoid is doing a collection scan, that is, where every document in the collection is accessed. This is the case when `nscanned` is equal to the number of documents in the collection.
- `millis`: the number of milliseconds require to complete the query. This value is useful for comparing indexing strategies, indexed vs. non-indexed queries, etc.

Pay attention to the read/write ratio of your application.

This is important because, whenever you add an index, you add overhead to all insert, update, and delete operations on the given collection. If your application is read-heavy, as are most web applications, the additional indexes are usually a good thing. But if your application is write-heavy, then be careful when creating new indexes, since each additional index with impose a small write-performance penalty.

In general, don't be cavalier about adding indexes. Indexes should be added to complement your queries. Always have a good reason for adding a new index, and make sure you've benchmarked alternative strategies.

Indexing Properties

Here are a few properties of compound indexes worth keeping in mind (Thanks to Doug Green and Karoly Negyesi for their help on this).

These examples assume a compound index of three fields: `a`, `b`, `c`. So our index creation would look like this:
Here’s some advice on using an index like this:

1. The sort column must be the last column used in the index.

   Good:
   - find(a=1).sort(a)
   - find(a=1).sort(b)
   - find(a=1, b=2).sort(c)

   Bad:
   - find(a=1).sort(c)
   - even though c is the last column in the index, a is that last column used, so you can only sort on a or b.

2. The range query must also be the last column in an index. This is an axiom of 1 above.

   Good:
   - find(a=1,b>2)
   - find(a=1 and a<10)
   - find(a>1 and a<10).sort(a)

   Bad:
   - find(a>1, b=2)

3. Only use a range query or sort on one column.

   Good:
   - find(a=1,b>2).sort(c)
   - find(a=1,b=2)
   - find(a=1,b>2 and b<4)
   - find(a=1,b>2).sort(b)

   Bad:
   - find(a>1,b>2)
   - find(a=1,b>2).sort(c)

4. Conserve indexes by re-ordering columns used on equality (non-range) queries.

   Imagine you have the following two queries:
   - find(a=1,b=1,d=1)
   - find(a=1,b=1,c=1,d=1)

   A single index defined on a, b, c, and d can be used for both queries.
   If, however, you need to sort on the final value, you might need two indexes.

5. MongoDB’s $ne or $nin operator’s aren’t efficient with indexes.

   - When excluding just a few documents, it’s better to retrieve extra rows from MongoDB and do the exclusion on the client side.

**FAQ**

I’ve started building an index, and the database has stopped responding. What’s going on? What do I do?

Building an index can be an IO-intensive operation, especially you have a large collection. This is true on any database system that supports secondary indexes, including MySQL. If you’ll need to build an index on a large collection in the future, you’ll probably want to consider building the index in the background, a feature available beginning with 1.3.2. See the docs on background indexing for more info.

As for the long-building index, you only have a few options. You can either wait for the index to finish building or kill the current operation (see killOp()). If you choose the latter, the partial index will be deleted.

I’m using $ne or $nin in a query, and while it uses the index, it’s still slow. What’s happening?

The problem with $ne and $nin is that much of an index will match queries like these. If you need to use $nin, it’s often best to make sure that an additional, more selective criterion is part of the query.
Inserting

When we insert data into MongoDB, that data will always be in document-form. Documents are data structure analogous to JSON, Python dictionaries, and Ruby hashes, to take just a few examples. Here, we discuss more about document-orientation and describe how to insert data into MongoDB.

- Document-Orientation
- JSON
- Mongo-Friendly Schema
- Store Example

Document-Orientation

When we describe MongoDB as "document-oriented", we mean it's in the class of databases for which the primary storage unit is a collection - possibly structured - of data, most likely as key/value pairs.

Some examples of document formats are JSON, XML, and simple sets of key/value pairs.

The documents stored in MongoDB are JSON-like. To be efficient, the database uses a format called BSON which is a binary representation of this data. The goal is a format that is both compact and reasonably fast to scan.

Client drivers serialize data to BSON, then transmit the data over the wire to the db. Data is stored on disk in BSON format. Thus, on a retrieval, the database does very little translation to send an object out, allowing high efficiency. The client driver unserialized a received BSON object to its native language format.

JSON

For example the following "document" can be stored in MongoDB:

```json
{ author: 'joe',
  created: new Date('03-28-2009'),
  title: 'Yet another blog post',
  text: 'Here is the text...',
  tags: [ 'example', 'joe' ],
  comments: [
    { author: 'jim', comment: 'I disagree' },
    { author: 'nancy', comment: 'Good post' }
  ]
}
```

This document is a blog post, so we can store in a "posts" collection using the shell:

```javascript
> doc = { author: 'joe', created: new Date('03-28-2009'), ... }
> db.posts.insert(doc);
```

MongoDB understands the internals of BSON objects -- not only can it store them, it can query on internal fields and index keys based upon them. For example the query

```javascript
> db.posts.find( { "comments.author" : "jim" } )
```

is possible and means "find any blog post where at least one comment subobject has author == 'jim'".

Mongo-Friendly Schema

Mongo can be used in many ways, and one's first instincts when using it are probably going to be similar to how one would write an application with a relational database. While this work pretty well, it doesn't harness the real power of Mongo. Mongo is designed for and works best with a rich object model.

Store Example

If you're building a simple online store that sells products with a relation database, you might have a schema like:
You would probably normalize it like this because different items would have different features, and you wouldn't want a table with all possible features. You could model this the same way in mongo, but it would be much more efficient to do:

```
item : {
    "title" : <title> ,
    "price" : <price> ,
    "sku" : <sku> ,
    "features" : {
        "optical zoom" : <value> ,
        ...
    }
}
```

This does a few nice things:

- you can load an entire item with 1 dbquery
- all the data for an item is on the same place on disk, so its only 1 seek to load it all

Now, at first glance there might seem to be some issues, but we've got them covered:

- you might want to insert or update a single feature. mongo lets you operate on embedded files like:

  ```
  db.items.update( { sku : 123 } , { "$set" : { "features.zoom" : "5" } } )
  ```

- Does adding a feature requires moving the entire object on disk? No. mongo has a padding heuristic that adapts to your data so it will leave some empty space for the object to grow. This will prevent indexes from being changed, etc.

**Legal Key Names**

Key names in inserted documents are limited as follows:

- The "$" character must not be the first character in the key name.
- The "." character must not appear anywhere in the key name.

**Schema Design**

- Introduction
- Embed vs. Reference
- Use Cases
- Index Selection
- How Many Collections?
- See Also

**Introduction**

With Mongo, you do less "normalization" than you would perform designing a relational schema because there are no server-side "joins". Generally, you will want one database collection for each of your top level objects.

You do not want a collection for every "class" - instead, embed objects. For example, in the diagram below, we have two collections, students and courses. The student documents embed address documents and the "score" documents, which have references to the courses.
Embed vs. Reference

The key question in Mongo schema design is "does this object merit its own collection, or rather should it embed in objects in other collections?" In relational databases, each sub-item of interest typically becomes a separate table (unless denormalizing for performance). In Mongo, this is not recommended - embedding objects is much more efficient. Data is then colocated on disk; client-server turnarounds to the database are eliminated. So in general the question to ask is, "why would I not want to embed this object?"

So why are references slow? Let’s consider our students example. If we have a student object and perform:

```javascript
print( student.address.city );
```

This operation will always be fast as address is an embedded object, and is always in RAM if student is in RAM. However for

```javascript
print( student.scores[0].for_course.name );
```

if this is the first access to `scores[0]`, the shell or your driver must execute the query

```javascript
// pseudocode for driver or framework, not user code
student.scores[0].for_course = db.courses.findOne({_id:_course_id_to_find_});
```

Thus, each reference traversal is a query to the database. Typically, the collection in question is indexed on `_id`. The query will then be reasonably fast. However, even if all data is in RAM, there is a certain latency given the client/server communication from appserver to database. In general, expect 1ms of time for such a query on a ram cache hit. Thus if we were iterating 1,000 students, looking up one reference per student would be quite slow - over 1 second to perform even if cached. However, if we only need to look up a single item, the time is on the order of 1ms, and completely acceptable for a web page load. (Note that if already in db cache, pulling the 1,000 students might actually take much less than 1 second, as the results return from the database in large batches.)

Some general rules on when to embed, and when to reference:

- "First class" objects, that are at top level, typically have their own collection.
- Line item detail objects typically are embedded.
- Objects which follow an object modelling "contains" relationship should generally be embedded.
- Many to many relationships are generally by reference.
- Collections with only a few objects may safely exist as separate collections, as the whole collection is quickly cached in application server memory.
- Embedded objects are harder to reference than "top level" objects in collections, as you cannot have a DBRef to an embedded object (at least not yet).
- It is more difficult to get a system-level view for embedded objects. For example, it would be easier to query the top 100 scores across all collections.
students if Scores were not embedded.

- If the amount of data to embed is huge (many megabytes), you may reach the limit on size of a single object.
- If performance is an issue, embed.

Use Cases

Let's consider a few use cases now.

1. Customer / Order / Order Line-Item

   - orders should be a collection, customers a collection, line-items should be an array of line-items embedded in the order object.

1. Blogging system.

   - posts should be a collection, post author might be a separate collection, or simply a field within posts if only an email address.
   - comments should be embedded objects within a post for performance.

Index Selection

A second aspect of schema design is index selection. As a general rule, where you want an index in a relational database, you want an index in Mongo.

- The _id field is automatically indexed.
- Fields upon which keys are looked up should be indexed.
- Sort fields generally should be indexed.

The MongoDB profiling facility provides useful information for where an index should be added that is missing.

Note that adding an index slows writes to a collection, but not reads. Use lots of indexes for collections with a high read : write ratio (assuming one does not mind the storage overage). For collections with more writes than reads, indexes are very expensive.

How Many Collections?

As Mongo collections are polymorphic, one could have a collection objects and put everything in it! This approach is taken by some object databases. For performance reasons, we do not recommend this approach. Data within a Mongo collection tends to be contiguous on disk. Thus, table scans of the collection are possible, and efficient. Collections are very important for high throughput batch processing.

See Also

- DBRef
- Trees in MongoDB
- MongoDB Data Modeling and Rails

Next: Advanced Queries

Trees in MongoDB

- Patterns
  - Full Tree in Single Document
  - Parent Links
  - Child Links
  - Array of Ancestors
  - Materialized Paths (Full Path in Each Node)
  - acts_as_nested_set

See Also

The best way to store a tree usually depends on the operations you want to perform; see below for some different options. In practice, most developers find that one of the "Full Tree in Single Document", "Parent Links", and "Array of Ancestors" patterns works best.

Patterns

Full Tree in Single Document
Pros:

- Single document to fetch per page
- One location on disk for whole tree
- You can see full structure easily

Cons:

- Hard to search
- Hard to get back partial results
- Can get unwieldy if you need a huge tree (there is a 4MB per doc limit)

Parent Links

Storing all nodes in a single collection, with each node having the id of its parent, is a simple solution. The biggest problem with this approach is getting an entire subtree requires several query turnarounds to the database (or use of `db.eval`).

```javascript
> t = db.tree1;
> t.find()
{ "_id" : 1 } 
{ "_id" : 2, "parent" : 1 } 
{ "_id" : 3, "parent" : 1 } 
{ "_id" : 4, "parent" : 2 } 
{ "_id" : 5, "parent" : 4 } 
{ "_id" : 6, "parent" : 4 } 

> // find children of node 4
> t.ensureIndex({parent:1})
> t.find( {parent : 4 } )
{ "_id" : 5, "parent" : 4 } 
{ "_id" : 6, "parent" : 4 } 

Child Links

Another option is storing the ids of all of a node's children within each node's document. This approach is fairly limiting, although ok if no operations on entire subtrees are necessary. It may also be good for storing graphs where a node has multiple parents.

```javascript
> t = db.tree2
> t.find()
{ "_id" : 1, "children" : [ 2, 3 ] } 
{ "_id" : 2 } 
{ "_id" : 3, "children" : [ 4 ] } 
{ "_id" : 4 } 

> // find immediate children of node 3
> t.findOne({_id:3}).children
[ 4 ] 

> // find immediate parent of node 3
> t.ensureIndex({children:1})
> t.find({children:3})
{ "_id" : 1, "children" : [ 2, 3 ] } 

Array of Ancestors
Here we store all the ancestors of a node in an array. This makes a query like "get all descendents of x" fast and easy.

```javascript
> t = db.mytree;
> t.find()
{  
  "_id": "a"
}
{  
  "_id": "b", "ancestors": [  "a" ], "parent": "a"
}
{  
  "_id": "c", "ancestors": [  "a", "b" ], "parent": "b"
}
{  
  "_id": "d", "ancestors": [  "a", "b" ], "parent": "b"
}
{  
  "_id": "e", "ancestors": [  "a" ], "parent": "a"
}
{  
  "_id": "f", "ancestors": [  "a", "e" ], "parent": "e"
}
{  
  "_id": "g", "ancestors": [  "a", "b", "d" ], "parent": "d"
}
> t.ensureIndex( { ancestors : 1 } )
> // find all descendents of b:
> t.find( { ancestors : 'b' } )
{  
  "_id": "c",
  "ancestors": [  "a", "b" ],
  "parent": "b"
}
{  
  "_id": "d",
  "ancestors": [  "a", "b" ],
  "parent": "b"
}
{  
  "_id": "g",
  "ancestors": [  "a", "b", "d" ],
  "parent": "d"
}
> // get all ancestors of f:
> anc = db.mytree.findOne({_id:'f'}).ancestors
[  "a", "e" ]
> db.mytree.find( { _id : { $in : anc } } )
{  
  "_id": "a"
}
{  
  "_id": "e",
  "ancestors": [  "a" ],
  "parent": "a"
}
```

EnsureIndex and MongoDB’s multikey feature makes the above queries efficient.

In addition to the ancestors array, we also stored the direct parent in the node to make it easy to find the node’s immediate parent when that is necessary.

**Materialized Paths (Full Path in Each Node)**

Materialized paths make certain query options on trees easy. We store the full path to the location of a document in the tree within each node. Usually the “array of ancestors” approach above works just as well, and is easier as one doesn’t have to deal with string building, regular expressions, and escaping of characters. (Theoretically, materialized paths will be slightly faster.)

The best way to do this with MongoDB is to store the path as a string and then use regex queries. Simple regex expressions beginning with "^" can be efficiently executed. As the path is a string, you will need to pick a delimiter character -- we use "," below. For example:
Ruby example: http://github.com/banker/newsmonger/blob/master/app/models/comment.rb

acts_as_nested_set

See http://api.rubyonrails.org/classes/ActiveRecord/Acts/NestedSet/ClassMethods.html

This pattern is best for datasets that rarely change as modifications can require changes to many documents.

See Also

- Sean Cribbs blog post (source of several ideas on this page).

Optimization

- Optimizing A Simple Example
  - Optimization #1: Create an index
  - Optimization #2: Limit results
  - Optimization #3: Select only relevant fields
- Using the Profiler
- Optimizing Statements that Use count()
- Increment Operations
- Circular Fixed Size Collections
- Server Side Code Execution
- Explain
- Hint
- See Also

Optimizing A Simple Example

This section describes proper techniques for optimizing database performance.

Let's consider an example. Suppose our task is to display the front page of a blog - we wish to display headlines of the 10 most recent posts. Let's assume the posts have a timestamp field $ts$.

The simplest thing we could write might be:
articles = db.posts.find().sort({ts:-1}); // get blog posts in reverse time order

for (var i=0; i< 10; i++) {
  print(articles[i].getSummary());
}

**Optimization #1: Create an index**

Our first optimization should be to create an index on the key that is being used for the sorting:

```
db.posts.ensureIndex({ts:1});
```

With an index, the database is able to sort based on index information, rather than having to check each document in the collection directly. This is much faster.

**Optimization #2: Limit results**

MongoDB cursors return results in groups of documents that we'll call “chunks”. The chunk returned might contain more than 10 objects - in some cases, much more. These extra objects are a waste of network transmission and resources both on the app server and the database.

As we know how many results we want, and that we do not want all the results, we can use the `limit()` method for our second optimization.

```
articles = db.posts.find().sort({ts:-1}).limit(10); // 10 results maximum
```

Now, we'll only get 10 results returned to client.

**Optimization #3: Select only relevant fields**

The blog post object may be very large, with the post text and comments embedded. Much better performance will be achieved by selecting only the fields we need:

```
articles = db.posts.find({}, {ts:1,title:1,author:1,abstract:1}).sort({ts:-1}).limit(10);
articles.forEach( function(post) { print(post.getSummary()); } );
```

The above code assumes that the `getSummary()` method only references the fields listed in the `find()` method.

Note if you fetch only select fields, you have a partial object. An object in that form cannot be updated back to the database:

```
a_post = db.posts.findOne({}, Post.summaryFields);
a_post.x = 3;
db.posts.save(a_post); // error, exception thrown
```

**Using the Profiler**

MongoDB includes a database profiler which shows performance characteristics of each operation against the database. Using the profiler you can find queries (and write operations) which are slower than they should be; use this information, for example, to determine when an index is needed. See the [Performance Tuning] section of the [Mongo Developers' Guide](#) for more information.

**Optimizing Statements that Use count()**

To speed operations that rely on `count()`, create an index on the field involved in the count query expression.

```
db.posts.ensureIndex({author:1});
db.posts.find({author:"george"}).count();
```

**Increment Operations**

MongoDB supports simple object field increment operations; basically, this is an operation indicating “increment this field in this document at the server”. This can be much faster than fetching the document, updating the field, and then saving it back to the server and are particularly useful for implementing real time counters. See the [Updates] section of the [Mongo Developers' Guide](#) for more information.
Circular Fixed Size Collections

MongoDB provides a special circular collection type that is pre-allocated at a specific size. These collections keep the items within well-ordered even without an index, and provide very high-speed writes and reads to the collection. Originally designed for keeping log files - log events are stored in the database in a circular fixed size collection - there are many uses for this feature. See the Capped Collections section of the Mongo Developers’ Guide for more information.

Server Side Code Execution

Occasionally, for maximal performance, you may wish to perform an operation in process on the database server to eliminate client/server network turnarounds. These operations are covered in the Server-Side Processing section of the Mongo Developers’ Guide.

Explain

A great way to get more information on the performance of your database queries is to use the \$explain feature. This will display "explain plan" type info about a query from the database.

When using the mongo - The Interactive Shell, you can find out this "explain plan" via the explain() function called on a cursor. The result will be a document that contains the "explain plan".

```javascript
db.collection.find(query).explain();
```

provides information such as the following:

```json
{
   "cursor" : "BasicCursor",
   "nscanned" : 57594.0,
   "n" : 3.0,
   "millis" : 108.0
}
```

This will tell you the type of cursor used (BtreeCursor is another type), the number of records the DB had to examine as part of this query, the number of records returned by the query, and the time in milliseconds the query took to execute.

Hint

While the mongo query optimizer often performs very well, explicit "hints" can be used to force mongo to use a specified index, potentially improving performance in some situations. When you have a collection indexed and are querying on multiple fields (and some of those fields are indexed), pass the index as a hint to the query. You can do this in two different ways. You may either set it per query, or set it for the entire collection.

To set the hint for a particular query, call the hint() function on the cursor before accessing any data, and specify a document with the key to be used in the query:

```javascript
db.collection.find({user:u, foo:d}).hint({user:1});
```

Be sure to Index

For the above hints to work, you need to have run ensureIndex() to index the collection on the user field.

To force the query optimizer to not use indexes (do a table scan), use:

```javascript
> db.collection.find().hint({$natural:1})
```

See Also

- Optimizing Storage of Small Objects
- Query Optimizer
- currentOp()
Optimizing Storage of Small Objects

MongoDB records have a certain amount of overhead per object (BSON document) in a collection. This overhead is normally insignificant, but if your objects are tiny (just a few bytes, maybe one or two fields) it would not be. Below are some suggestions on how to optimize storage efficiently in such situations.

Using the _id Field Explicitly

Mongo automatically adds an object ID to each document and sets it to a unique value. Additionally this field is indexed. For tiny objects this takes up significant space.

The best way to optimize for this is to use _id explicitly. Take one of your fields which is unique for the collection and store its values in _id. By doing so, you have explicitly provided IDs. This will effectively eliminate the creation of a separate _id field. If your previously separate field was indexed, this eliminates an extra index too.

Using Small Field Names

Consider a record

```javascript
{ last_name : "Smith", best_score: 3.9 }
```

The strings "last_name" and "best_score" will be stored in each object's BSON. Using shorter strings would save space:

```javascript
{ lname : "Smith", score : 3.9 }
```

Would save 9 bytes per document. This of course reduces expressiveness to the programmer and is not recommended unless you have a collection where this is of significant concern.

Field names are not stored in indexes as indexes have a predefined structure. Thus, shortening field names will not help the size of indexes. In general it is not necessary to use short field names.

Combining Objects

Fundamentally, there is a certain amount of overhead per document in MongoDB. One technique is combining objects. In some cases you may be able to embed objects in other objects, perhaps as arrays of objects. If your objects are tiny this may work well, but will only make sense for certain use cases.

Query Optimizer

The MongoDB query optimizer generates query plans for each query submitted by a client. These plans are executed to return results. Thus, MongoDB supports ad hoc queries much like say, MySQL.

The database uses an interesting approach to query optimization though. Traditional approaches (which tend to be cost-based and statistical) are not used, as these approaches have a couple of problems.

First, the optimizer might consistently pick a bad query plan. For example, there might be correlations in the data of which the optimizer is unaware. In a situation like this, the developer might use a query hint.

Also with the traditional approach, query plans can change in production with negative results. No one thinks rolling out new code without testing is a good idea. Yet often in a production system a query plan can change as the statistics in the database change on the underlying data. The query plan in effect may be a plan that never was invoked in QA. If it is slower than it should be, the application could experience an outage.

The Mongo query optimizer is different. It is not cost based -- it does not model the cost of various queries. Instead, the optimizer simply tries different query plans and learn which ones work well. Of course, when the system tries a really bad plan, it may take an extremely long time to run. To solve this, when testing new plans, MongoDB executes multiple query plans in parallel. As soon as one finishes, it terminates the other executions, and the system has learned which plan is good. This works particularly well given the system is non-relational, which makes the space of possible query plans much smaller (as there are no joins).

Sometimes a plan which was working well can work poorly -- for example if the data in the database has changed, or if the parameter values to the query are different. In this case, if the query seems to be taking longer than usual, the database will once again run the query in parallel to try different plans.

This approach adds a little overhead, but has the advantage of being much better at worst-case performance.

See Also

- MongoDB hint() and explain() operators
Querying

One of MongoDB's best capabilities is its support for dynamic (ad hoc) queries. Systems that support dynamic queries don't require any special indexing to find data; users can find data using any criteria. For relational databases, dynamic queries are the norm. If you're moving to MongoDB from a relational databases, you'll find that many SQL queries translate easily to MongoDB's document-based query language.

- Query Expression Objects
- Query Options
  - Field Selection
  - Sorting
  - Skip and Limit
- Cursors
- See Also

Query Expression Objects

MongoDB supports a number of query objects for fetching data. Queries are expressed as BSON documents which indicate a query pattern. For example, suppose we're using the MongoDB shell and want to return every document in the users collection. Our query would look like this:

```javascript
db.users.find({})
```

In this case, our selector is an empty document, which matches every document in the collection. Here's a more selective example:

```javascript
db.users.find({'last_name': 'Smith'})
```

Here our selector will match every document where the last_name attribute is 'Smith.'

MongoDB support a wide array of possible document selectors. For more examples, see the MongoDB Tutorial or the section on Advanced Queries. If you're working with MongoDB from a language driver, see the driver docs:

Query Options

Field Selection

In addition to the query expression, MongoDB queries can take some additional arguments. For example, it's possible to request only certain fields be returned. If we just wanted the social security numbers of users with the last name of 'Smith,' then from the shell we could issue this query:

```javascript
// retrieve ssn field for documents where last_name == 'Smith':
db.users.find({last_name: 'Smith'}, {ssn: 1});
```

```javascript
// retrieve all fields *except* the thumbnail field, for all documents:
db.users.find({}, {thumbnail:0});
```

Note the _id field is always returned even when not explicitly requested.

Sorting

MongoDB queries can return sorted results. To return all documents and sort by last name in ascending order, we'd query like so:

```javascript
db.users.find({}).sort({last_name: 1});
```

Skip and Limit

MongoDB also supports skip and limit for easy paging. Here we skip the first 20 last names, and limit our result set to 10:

```javascript
db.users.find({}, {}, 10, 20);
```

Cursors
Database queries, performed with the find() method, technically work by returning a cursor. Cursors are then used to iteratively retrieve all the
documents returned by the query. For example, we can iterate over a cursor in the mongo shell like this:
> var cur = db.example.find();
> cur.forEach( function(x) { print(tojson(x))});
{"n" : 1 , "_id" : "497ce96f395f2f052a494fd4"}
{"n" : 2 , "_id" : "497ce971395f2f052a494fd5"}
{"n" : 3 , "_id" : "497ce973395f2f052a494fd6"}
>

See Also
Queries and Cursors
Advanced Queries
Query Optimizer

Advanced Queries
Introduction
Retrieving a Subset of Fields
$slice operator
Conditional Operators : <, <=, >, >=
Conditional Operator : $ne
Conditional Operator : $in
Conditional Operator : $nin
Conditional Operator : $mod
Conditional Operator: $all
Conditional Operator : $size
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Conditional Operator : $type
Regular Expressions
Value in an Array
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Meta operator: $not
Javascript Expressions and $where
sort()
limit()
skip()
snapshot()
count()
group()
See Also
Introduction

MongoDB offers a rich query environment with lots of features. This page lists some of those features.
Queries in MongoDB are represented as JSON-style objects, very much like the documents we actually store in the database. For example:
// i.e., select * from things where x=3 and y="foo"
db.things.find( { x : 3, y : "foo" } );

Note that any of the operators on this page can be combined in the same query document. For example, to find all document where j is not equal
to 3 and k is greater than 10, you'd query like so:
db.things.find({j: {$ne: 3}, k: {$gt: 10} });

Retrieving a Subset of Fields

By default on a find operation, the entire document/object is returned. However we may also request that only certain fields are returned. Note
that the _id field is always returned automatically.


// select z from things where x=3
db.things.find( { x: 3 }, { z: 1 } );

You can also remove specific fields that you know will be large:

// get all posts about mongodb without comments
db.posts.find( { tags: 'mongodb' }, { comments: 0 } );

$slice operator

New in MongoDB 1.5.1

You can use the $slice operator to retrieve a subset of elements in an array.

db.posts.find({}, {comments:{$slice: 5}}) // first 5 comments

db.posts.find({}, {comments:{$slice: -5}}) // last 5 comments

db.posts.find({}, {comments:{$slice: [20, 10]}}) // skip 20, limit 10

More examples at example slice1

Conditional Operators : <, <=, >, >=

Use these special forms for greater than and less than comparisons in queries, since they have to be represented in the query document:

db.collection.find({ "field": { $gt: value } }); // greater than : field > value

db.collection.find({ "field": { $lt: value } }); // less than : field < value

db.collection.find({ "field": { $gte: value } }); // greater than or equal to : field >= value

db.collection.find({ "field": { $lte: value } }); // less than or equal to : field <= value

For example:

db.things.find({j: {$lt: 3}});
db.things.find({j: {$gte: 4}});

You can also combine these operators to specify ranges:

db.collection.find({ "field": { $gt: value1, $lt: value2 } }); // value1 < field < value

Conditional Operator : $ne

Use $ne for "not equals".

db.things.find( { x: { $ne: 3 } } );

Conditional Operator : $in

The $in operator is analogous to the SQL IN modifier, allowing you to specify an array of possible matches.

db.collection.find( { "field": { $in: array } } );

Let's consider a couple of examples. From our things collection, we could choose to get a subset of documents based upon the value of the 'j' key:
db.things.find({j:{$in: [2,4,6]}});

Suppose the collection updates is a list of social network style news items; we want to see the 10 most recent updates from our friends. We might invoke:

db.updates.ensureIndex( { ts : 1 } ); // ts == timestamp
var myFriends = myUserObject.friends; // let's assume this gives us an array of DBRef's of my friends
var latestUpdatesForMe = db.updates.find( { user : { $in : myFriends } } ).sort( { ts : -1 } ).limit(10);

Conditional Operator : $nin

The $nin operator is similar to $in except that it selects objects for which the specified field does not have any value in the specified array. For example

db.things.find({j:{$nin: [2,4,6]}});

would match \{j:1,b:2\} but not \{j:2,c:9\}.

Conditional Operator : $mod

The $mod operator allows you to do fast modulo queries to replace a common case for where clauses. For example, the following $where query:

db.things.find( "this.a % 10 == 1"

can be replaced by:

db.things.find( { a : { $mod : [ 10 , 1 ] } } )

Conditional Operator: $all

The $all operator is similar to $in, but instead of matching any value in the specified array all values in the array must be matched. For example, the object

\{ a: [ 1, 2, 3 ] \}

would be matched by

db.things.find( { a: { $all: [ 2, 3 ] } } );

but not

db.things.find( { a: { $all: [ 2, 3, 4 ] } } );

Conditional Operator : $size

The $size operator matches any array with the specified number of elements. The following example would match the object \{a:"foo"\}, since that array has just one element:

db.things.find( { a : { $size: 1 } } );

You cannot use $size to find a range of sizes (for example: arrays with more than 1 element). If you need to query for a range, create an extra size field that you increment when you add elements.

Conditional Operator : $exists
Check for existence (or lack thereof) of a field.

```javascript
db.things.find( { a : { $exists : true } } ); // return object if a is present
db.things.find( { a : { $exists : false } } ); // return if a is missing
```

Currently `$exists` is not able to use an index. Indexes on other fields are still used.

**Conditional Operator: $type**

The `$type` operator matches values based on their `bson` type.

```javascript
db.things.find( { a : { $type : 2 } } ); // matches if a is a string
db.things.find( { a : { $type : 16 } } ); // matches if a is an int
```

**Regular Expressions**

You may use regexes in database query expressions:

```javascript
db.customers.find( { name : /acme.*corp/i } );
```

For simple prefix queries (also called rooted regexps) like `/^prefix/`, the database will use an index when available and appropriate (much like most SQL databases that use indexes for a `LIKE 'prefix%'` expression). This only works if you don’t have `i` (case-insensitivity) in the flags.

![Warning: While `/^a/`, `/^a.*$/`, and `/^a.*$/` are equivalent and will all use an index in the same way, the latter two require scanning the whole string so they will be slower. The first format can stop scanning after the prefix is matched.](image)

**Value in an Array**

To look for the value "red" in an array field `colors`:

```javascript
db.things.find( { colors : "red" } );
```

That is, when "colors" is inspected, if it is an array, each value in the array is checked. This technique may be mixed with the embedded object technique below.

**Conditional Operator: $elemMatch**

Version 1.3.1 and higher.

Use `$elemMatch` to check if an element in an array matches the specified match expression.

```javascript
> t.find( { x : { $elemMatch : { a : 1, b : { $gt : 1 } } } })
{ "_id" : ObjectId("4b5783303343000000000aa9"),
  "x" : [ { "a" : 1, "b" : 3 }, 7, { "b" : 99 }, { "a" : 11 } ] }
```

Note that a single array element must match all the criteria specified; thus, the following query is semantically different in that each criteria can match a different element in the `x` array:

```javascript
> t.find( { "x.a" : 1, "x.b" : { $gt : 1 } } )
```

See the [dot notation](page) page for more.

**Value in an Embedded Object**

For example, to look `author.name=="joe"` in a postings collection with embedded author objects:
db.postings.find( { "author.name": "joe" } );

See the dot notation page for more.

**Meta operator: $not**

Version 1.3.3 and higher.

The $not meta operator can be used to negate the check performed by a standard operator. For example:

```javascript
db.customers.find( { name: { $not: /acme.*corp/i } } );
dx.things.find( { a: { $not: { $mod: [10, 1] } } } );
```

**Javascript Expressions and $where**

In addition to the structured query syntax shown so far, you may specify query expressions as Javascript. To do so, pass a string containing a Javascript expression to `find()`, or assign such a string to the query object member $where. The database will evaluate this expression for each object scanned. When the result is true, the object is returned in the query results.

For example, the following statements all do the same thing:

```javascript
db.myCollection.find( { a: { $gt: 3 } } );
db.myCollection.find( { $where: "this.a > 3" } );
f = function() { return this.a > 3; } db.myCollection.find(f);
```

Javascript executes more slowly than the native operators listed on this page, but is very flexible. See the server-side processing page for more information.

**sort()**

`sort()` is analogous to the ORDER BY statement in SQL - it requests that items be returned in a particular order. We pass `sort()` a key pattern which indicates the desired order for the result.

```javascript
db.myCollection.find().sort( { ts: -1 } ); // sort by ts, descending order
```

`sort()` may be combined with the `limit()` function. In fact, if you do not have a relevant index for the specified key pattern, `limit()` is recommended as there is a limit on the size of sorted results when an index is not used.

**limit()**

`limit()` is analogous to the LIMIT statement in MySQL: it specifies a maximum number of results to return. For best performance, use `limit()` whenever possible. Otherwise, the database may return more objects than are required for processing.

```javascript
db.students.find().limit(10).forEach( function(student) { print(student.name + "<p>"); } );
```

**skip()**

The `skip()` expression allows one to specify at which object the database should begin returning results. This is often useful for implementing "paging". Here's an example of how it might be used in a JavaScript application:

```javascript
function printStudents(pageNumber, nPerPage) {
    print("Page: " + pageNumber);
    db.students.find().skip((pageNumber-1)*nPerPage).limit(nPerPage).forEach( function(student) {
        print(student.name + "<p>");
    });
}
```
snapshot()

Indicates use of snapshot mode for the query. Snapshot mode assures no duplicates are returned, or objects missed, which were present at both the start and end of the query's execution (even if the object were updated). If an object is new during the query, or deleted during the query, it may or may not be returned, even with snapshot mode.

Note that short query responses (less than 1MB) are always effectively snapshotted.

Currently, snapshot mode may not be used with sorting or explicit hints.

count()

The count() method returns the number of objects matching the query specified. It is specially optimized to perform the count in the MongoDB server, rather than on the client side for speed and efficiency:

```javascript
nstudents = db.students.find({ 'address.state' : 'CA' }).count();
```

Note that you can achieve the same result with the following, but the following is slow and inefficient as it requires all documents to be put into memory on the client, and then counted. Don’t do this:

```javascript
nstudents = db.students.find({ 'address.state' : 'CA' }).toArray().length; // VERY BAD: slow and uses excess memor
```

On a query using skip() and limit(), count ignores these parameters by default. Use count(true) to have it consider the skip and limit values in the calculation.

```javascript
n = db.students.find().skip(20).limit(10).count(true);
```

group()

The group() method is analogous to GROUP BY in SQL. group() is more flexible, actually, allowing the specification of arbitrary reduction operations. See the Aggregation section of the Mongo Developers’ Guide for more information.

See Also

* Optimizing Queries (including explain() and hint())

Dot Notation (Reaching into Objects)

- Dot Notation vs. Subobjects
- Array Element by Position
- Matching with $elemMatch

MongoDB is designed for store JSON-style objects. The database understands the structure of these objects and can reach into them to evaluate query expressions.

Let's suppose we have some objects of the form:

```javascript
> db.persons.findOne()
{ name: "Joe", address: { city: "San Francisco", state: "CA" }, likes: [ 'scuba', 'math', 'literature' ] }
```

Querying on a top-level field is straightforward enough using Mongo's JSON-style query objects:

```javascript
> db.persons.find( { name: "Joe" } )
```

But what about when we need to reach into embedded objects and arrays? This involves a bit different way of thinking about queries than one would do in a traditional relational DBMS. To reach into embedded objects, we use a "dot notation":

```javascript
> db.persons.find( { "address.state" : "CA" } )
```
Reaching into arrays is implicit: if the field being queried is an array, the database automatically assumes the caller intends to look for a value within the array:

```javascript
> db.persons.find( { likes : "math" } )
```

We can mix these styles too, as in this more complex example:

```javascript
> db.blogposts.findOne()
{ title : "My First Post", author: "Jane",
  comments : [{ by: "Abe", text: "First" },
               { by : "Ada", text : "Good post" } ]
}
> db.blogposts.find( { "comments.by" : "Ada" } )
```

We can also create indexes of keys on these fields:

```javascript
db.persons.ensureIndex( { "address.state" : 1 } );
db.blogposts.ensureIndex( { "comments.by" : 1 } );
```

### Dot Notation vs. Subobjects

Suppose there is an author id, as well as name. To store the author field, we can use an object:

```javascript
> db.blog.save({ title : "My First Post", author: {name : "Jane", id : 1}})
```

If we want to find any authors named Jane, we use the notation above:

```javascript
> db.blog.findOne({"author.name" : "Jane"})
```

To match only objects with these exact keys and values, we use an object:

```javascript
db.blog.findOne({"author" : {"name" : "Jane", "id" : 1}})
```

Note that

```javascript
db.blog.findOne({"author" : {"name" : "Jane"}})
```

will not match, as subobjects have to match exactly (it would match an object with one field: {"name" : "Jane"}).

### Array Element by Position

Array elements also may be accessed by specific array position:

```javascript
// i.e. comments[0].by == "Abe"
> db.blogposts.find( { "comments.0.by" : "Abe" } )
```

(The above examples use the mongo shell's Javascript syntax. The same operations can be done in any language for which Mongo has a driver available.)

### Matching with $elemMatch

Using the $elemMatch query operator (mongod >= 1.3.1), you can match an entire document within an array. This is best illustrated with an example. Suppose you have the following two documents in your collection:
// Document 1
// { "foo" : [ 
// { "shape" : "square", "color" : "purple", "thick" : false }, 
// { "shape" : "circle", "color" : "red", "thick" : true } 
// ] } 

// Document 2
// { "foo" : [ 
// { "shape" : "square", "color" : "red", "thick" : true }, 
// { "shape" : "circle", "color" : "blue", "thick" : false } 
// ] } 

You want to query for a red square, and so you write the following:

db.foo.find({"foo.shape": "square", "foo.color": "red"})

The problem with this query is that it will match the first document. In other words, the standard query syntax won’t restrict itself to a single document within the foo array. As mentioned above subobjects have to match exactly, so

db.foo.find({foo: {"shape": "square", "color": "red"} })

won’t help either (you’d need to define whether you want a thick red square or not).

To match an entire document within the foo array, you need to use $elemMatch. To properly query for a purple square, you’d use $elemMatch like so:

db.foo.find({foo: {"$elemMatch": {shape: "square", color: "purple"}}})

The query will return the first document, which contains the purple square you’re looking for.

**Full Text Search in Mongo**

- Introduction
- Multikeys (Indexing Values in an Array)
- Text Search
- Comparison to Full Text Search Engines
- Real World Examples

**Introduction**

Mongo provides some functionality that is useful for text search and tagging.
Multikeys (Indexing Values in an Array)

The Mongo multikey feature can automatically index arrays of values. Tagging is a good example of where this feature is useful. Suppose you have an article object/document which is tagged with some category names:

```json
obj = {
    name: "Apollo",
    text: "Some text about Apollo moon landings",
    tags: [ "moon", "apollo", "spaceflight" ]
}
```

and that this object is stored in `db.articles`. The command

```javascript
db.articles.ensureIndex( { tags: 1 } );
```

will index all the tags on the document, and create index entries for "moon", "apollo" and "spaceflight" for that document.

You may then query on these items in the usual way:

```javascript
> print(db.articles.findOne( { tags: "apollo" } ).name);
Apollo
```

The database creates an index entry for each item in the array. Note an array with many elements (hundreds or thousands) can make inserts very expensive. (Although for the example above, alternate implementations are equally expensive.)

Text Search

It is fairly easy to implement basic full text search using multikeys. What we recommend is having a field that has all of the keywords in it, something like:

```json
{ title : "this is fun",
  _keywords : [ "this", "is", "fun" ]
}
```

Your code must split the title above into the keywords before saving. Note that this code (which is not part of Mongo DB) could do stemming, etc. too. (Perhaps someone in the community would like to write a standard module that does this...)

Comparison to Full Text Search Engines

MongoDB has interesting functionality that makes certain search functions easy. That said, it is not a dedicated full text search engine. For example, dedicated engines provide the following capabilities:

- built-in text stemming
- ranking of queries matching various numbers of terms (can be done with MongoDB, but requires user supplied code to do so)
- bulk index building

Bulk index building makes building indexes fast, but has the downside of not being realtime. MongoDB is particularly well suited for problems where the search should be done in realtime. Traditional tools are often not good for this use case.

Real World Examples

The Business Insider web site uses MongoDB for its blog search function in production.

Mark Watson’s opinions on Java, Ruby, Lisp, AI, and the Semantic Web - A recipe example in Ruby.

**min and max Query Specifiers**

The `min()` and `max()` functions may be used in conjunction with an index to constrain query matches to those having index keys between the min and max keys specified. The `min()` and `max()` functions may be used individually or in conjunction. The index to be used may be specified with a `hint()` or one may be inferred from pattern of the keys passed to `min()` and/or `max()`. 
If you're using the standard query syntax, you must distinguish between the $min and $max keys and the query selector itself. See here:

```
db.f.find({$min: {name: "barry"}, $max: {name: "larry"}, $query:{}});
```

The min() value is included in the range and the max() value is excluded.

Normally, it is much preferred to use $gte and $lt rather than to use min and max, as min and max require a corresponding index. Min and max are primarily useful for compound keys: it is difficult to express the last_name/first_name example above without this feature (it can be done using $where).

min and max exist primarily to support the mongos (sharding) process.

### OR operations in query expressions

Query objects in Mongo by default AND expressions together. Mongo currently does not include an OR operator for such queries, however there are ways to express such queries.

http://jira.mongodb.org/browse/SERVER-205

#### $in

The $in operator indicates a "where value in ..." expression. For expressions of the form \( x = a \) OR \( x = b \), this can be represented as

```
{x: { $in: [a, b] }}
```

#### $where

We can provide arbitrary Javascript expressions to the server via the $where operator. This provides a means to perform OR operations. For example in the mongo shell one might invoke:

```
db.mycollection.find( { $where : function() { return this.a == 3 || this.b == 4; } } );
```

The following syntax is briefer and also works; however, if additional structured query components are present, you will need the $where form:

```
db.mycollection.find( function() { return this.a == 3 || this.b == 4; } );
```

See Also

Advanced Queries

Queries and Cursors

Queries to MongoDB return a cursor, which can be iterated to retrieve results. The exact way to query will vary with language driver. Details below focus on queries from the MongoDB shell (i.e. the mongo process).

The shell \texttt{find()} method returns a cursor object which we can then iterate to retrieve specific documents from the result. We use \texttt{hasNext()} and \texttt{next()} methods for this purpose.

```
for( var c = db.parts.find(); c.hasNext(); ) {
    print( c.next());
}
```

Additionally in the shell, \texttt{forEach()} may be used with a cursor:
Array Mode in the Shell

Note that in some languages, like JavaScript, the driver supports an "array mode". Please check your driver documentation for specifics.

In the db shell, to use the cursor in array mode, use array index [] operations and the `length` property.

Array mode will load all data into RAM up to the highest index requested. Thus it should **not** be used for any query which can return very large amounts of data: you will run out of memory on the client.

You may also call `toArray()` on a cursor. `toArray()` will load all objects queries into RAM.

Getting a Single Item

The shell `findOne()` method fetches a single item. Null is returned if no item is found.

`findOne()` is equivalent in functionality to:

```
function findOne(coll, query) {
    var cursor = coll.find(query).limit(1);
    return cursor.hasNext() ? cursor.next() : null;
}
```

**Tip:** If you only need one row back and multiple match, `findOne()` is efficient, as it performs the `limit()` operation, which limits the objects returned from the database to one.

Querying Embedded Objects

To find an exact match of an entire embedded object, simply query for that object:

```
db.order.find( { shipping: { carrier: "usps" } } );
```

The above query will work if `{ carrier: "usps" }` is an exact match for the entire contained shipping object. If you wish to match any sub-object with `shipping.carrier == "usps"`, use this syntax:

```
db.order.find( { "shipping.carrier" : "usps" } );
```

See the **dot notation** docs for more information.

Greater Than / Less Than

```
db.myCollection.find( { a : { $gt : 3 } } );
db.myCollection.find( { a : { $gte :3 } } );
db.myCollection.find( { a : { $lt :3 } } );
db.myCollection.find( { a : { $lte :3 } } ); // a <= 3
```

Latent Cursors and Snapshotting

A latent cursor has (in addition to an initial access) a latent access that occurs after an intervening write operation on the database collection (i.e., an insert, update, or delete). Under most circumstances, the database supports these operations.

Conceptually, a cursor has a current position. If you delete the item at the current position, the cursor automatically skips its current position forward to the next item.

Mongo DB cursors do not provide a snapshot: if other write operations occur during the life of your cursor, it is unspecified if your application will see the results of those operations or not. See the **snapshot** docs for more information.

Auditing allocated cursors

Information on allocated cursors may be obtained using the `{cursorInfo:1}` command.
Tailable Cursors

MongoDB has a feature known as tailable cursors which are similar to the Unix "tail -f" command.

Tailable means the cursor is not closed once all data is retrieved. Rather, the cursor marks the last known object's position and you can resume using the cursor later, from where that object was located, provided more data is available.

Like all "latent cursors", the cursor may become invalid at any point -- for example if the last object returned is deleted. Thus, you should be prepared to requery if the cursor is dead. You can determine if a cursor is dead by checking its id. An id of zero indicates a dead cursor.

In addition, the cursor may be dead upon creation if the initial query returns no matches. In this case a requery is required to create a persistent tailable cursor.

Tailable cursors are only allowed on capped collections and can only return objects in natural order.

Mongo replication uses this feature to follow the end of the master server's replication op log collection -- the tailable feature eliminates the need to create an index for the oplog at the master, which would slow log writes.

C++ example:

```c++
#include "client/dbclient.h"
#include "util/goodies.h"

using namespace mongo;

/* "tail" the namespace, outputting elements as they are added.
   For this to work _id values should be increasing when items are added.
*/
void tail(DBClientBase& conn, const char *ns) {
    BSONElement lastId = minKey.firstElement();
    Query query = Query().sort("_id");
    while (1) {
        auto_ptr<DBClientCursor> c =
            conn.query(ns, query, 0, 0, 0, Option_CursorTailable);
        while (1) {
            if ( !c->more() ) {
                // we need to requery
                break;
            }
            BSONObj o = c->next();
            lastId = o["_id"];
            cout << o.toString() << endl;
        }
        // prepare to requery
        query = QUERY("_id" << GT << lastId).sort("_id");
    }
}
```

Server-side Code Execution
Introduction

Mongo supports the execution of code inside the database process.

### $where Clauses and Functions in Queries

In addition to the regular document-style query specification for `find()` operations, you can also express the query either as a string containing a SQL-style WHERE predicate clause, or a full JavaScript function.

When using this mode of query, the database will call your function, or evaluate your predicate clause, for each object in the collection.

In the case of the string, you must represent the object as "this" (see example below). In the case of a full JavaScript function, you use the normal JavaScript function syntax.

The following four statements in `mongo - The Interactive Shell` are equivalent:

```javascript
db.myCollection.find( { a : { $gt: 3 } } );
db.myCollection.find( { $where: "this.a > 3" } );
db.myCollection.find( "this.a > 3" );
db.myCollection.find( { $where: function() { return this.a > 3; } } );
```

The first statement is the preferred form. It will be at least slightly faster to execute because the query optimizer can easily interpret that query and choose an index to use.

You may mix data-style find conditions and a function. This can be advantageous for performance because the data-style expression will be evaluated first, and if not matched, no further evaluation is required. Additionally, the database can then consider using an index for that condition's field. To mix forms, pass your evaluation function as the $where field of the query object. For example:

```javascript
db.myCollection.find( { active: true, $where: function() { return obj.credits - obj.debits < 0; } } );
```

You may mix data-style find conditions and a function. This can be advantageous for performance because the data-style expression will be evaluated first, and if not matched, no further evaluation is required. Additionally, the database can then consider using an index for that condition's field. For example:

```javascript
db.myCollection.find( { active: true, $where: "this.credits - this.debits < 0" } );
```

### Restrictions

Do not write to the collection being inspected from the $where expression.

### Using db.eval()

`db.eval()` is used to evaluate a function (written in JavaScript) at the database server. This is useful if you need to touch a lot of data lightly. In that scenario, network transfer of the data could be a bottleneck.

`db.eval()` returns the return value of the function that was invoked at the server. If invocation fails an exception is thrown.

For a trivial example, we can get the server to add 3 to 3:

```javascript
> db.eval( function() { return 3+3; } );
6
>
```

Let's consider an example where we wish to erase a given field, `foo`, in every single document in a collection. A naive client-side approach would be something like:
function my_erase() {
db.things.find().forEach( function(obj) {
delete obj.foo;
db.things.save(obj);
} );
}
my_erase();

Calling my_erase() on the client will require the entire contents of the collection to be transmitted from server to client and back again.

Instead, we can pass the function to eval(), and it will be called in the runtime environment of the server. On the server, the db variable is set to the current database:

db.eval(my_erase);

Examples

```javascript
> myfunc = function(x){ return x; };
> db.eval( myfunc, {k:"asdf"} );
{ k : "asdf" }
> db.eval( myfunc, "asdf" );
"asdf"
> db.eval( function(x){ return x; }, 2 );
2.0
```

If an error occurs on the evaluation (say, a null pointer exception at the server), an exception will be thrown of the form:

```javascript
{ dbEvalException: { errno : -3.0 , errmsg : "invoke failed", ok : 0.0 } }
```

Example of using eval() to do equivalent of the Mongo count() function:

```javascript
function mycount(collection) {
 return db.eval( function(){
 db[collection].find({},{'_id':ObjId()}).length();
 } );
}
```

Example of using db.eval() for doing an atomic increment, plus some calculations:

```javascript
function inc( name , howMuch ){
 return db.eval(
 function(){
 var t = db.things.findOne( { name : name } );
t = t || { name : name , num : 0 , total : 0 , avg : 0 };
t.num++;
t.total += howMuch;
t.avg = t.total / t.num;
db.things.save( t );
return t;
}
);
}
db.things.remove( {});
print( tojson( inc( "eliot" , 2 ) ) );
print( tojson( inc( "eliot" , 3 ) ) );
```

Storing functions server-side
There is a special system collection called `system.js` that can store JavaScript function to be re-used. To store a function, you would do:

```javascript
db.system.js.save( { _id : "foo", value : function( x , y ){ return x + y; } } );
```

_id is the name of the function, and is unique per database.

Once you do that, you can use `foo` from any JavaScript context (db.eval, $where, map/reduce)

See [http://github.com/mongodb/mongo/tree/master/jstests/storefunc.js](http://github.com/mongodb/mongo/tree/master/jstests/storefunc.js) for a full example

### Map/Reduce

MongoDB supports Javascript-based map/reduce operations on the server. See the [map/reduce documentation](https://docs.mongodb.com/manual/reference/map-reduce/) for more information.

### Notes on Concurrency

eval() blocks the entire mongod process while running. Thus, its operations are atomic but prevent other operations from processing.

When more concurrency is needed consider using map/reduce instead of eval().

### Sorting and Natural Order

"Natural order" is defined as the database’s native ordering of objects in a collection.

When executing a `find()` with no parameters, the database returns objects in forward natural order.

For standard tables, natural order is not particularly useful because, although the order is often close to insertion order, it is not guaranteed to be. However, for Capped Collections, natural order is guaranteed to be the insertion order. This can be very useful.

In general, the natural order feature is a very efficient way to store and retrieve data in insertion order (much faster than say, indexing on a timestamp field). But remember, the collection must be capped for this to work.

In addition to forward natural order, items may be retrieved in reverse natural order. For example, to return the 50 most recently inserted items (ordered most recent to less recent) from a capped collection, you would invoke:

```javascript
> c=db.cappedCollection.find().sort({$natural:-1}).limit(50)
```

Sorting can also be done on arbitrary keys in any collection. For example, this sorts by ‘name’ ascending, then ‘age’ descending:

```javascript
> c=db.collection.find().sort({name : 1, age : -1})
```

### See Also

- The [Capped Collections](https://docs.mongodb.com/manual/core/capped-collections/) section of this Guide
- Advanced Queries
- The starting point for all [Home](https://docs.mongodb.com/manual/

### Aggregation

Mongo includes utility functions which provide server-side [count](https://docs.mongodb.com/manual/reference/operator/aggregation/count/), [distinct](https://docs.mongodb.com/manual/reference/operator/aggregation/distinct/), and [group](https://docs.mongodb.com/manual/reference/operator/aggregation/group/) by operations. More advanced aggregate functions can be crafted using [MapReduce](https://docs.mongodb.com/manual/reference/operator/aggregation/map-reduce/).

- Count
- Distinct
- Group
  - Examples
  - Using Group from Various Languages
- Map/Reduce
- See Also

### Count
count() returns the number of objects in a collection or matching a query. If a document selector is provided, only the number of matching documents will be returned.

size() is like count() but takes into consideration any limit() or skip() specified for the query.

```javascript
db.collection.count(selector);
```

For example:

```javascript
print("# of objects: " + db.mycollection.count() );
print( db.mycollection.count( {active: true} ) );
```

count is faster if an index exists for the condition in the selector. For example, to make the count on active fast, invoke

```javascript
db.mycollection.ensureIndex( {active:1} );
```

Distinct

The distinct command returns a list of distinct values for the given key across a collection.

Command is of the form:

```javascript
{ distinct : <collection_name>, key : <key>, query : <query> }
```

although many drivers have a helper function for distinct.

```javascript
> db.addresses.insert({"zip-code": 10010})
> db.addresses.insert({"zip-code": 10010})
> db.addresses.insert({"zip-code": 99701})

> // shell helper:
> db.addresses.distinct("zip-code");
[ 10010, 99701 ]

> // running as a command manually:
> db.runCommand( { distinct: 'addresses', key: 'zip-code' } )
{ "values" : [ 10010, 99701 ], "ok" : 1 }
```

distinct may also reference a nested key:

```javascript
> db.comments.save("user": {"points": 25})
> db.comments.save("user": {"points": 31})
> db.comments.save("user": {"points": 25})

> db.comments.distinct("user.points");
[ 25, 31 ]
```

You can add an optional query parameter to distinct as well

```javascript
> db.address.distinct( "zip-code", { age : 30 } )
```

Note: the distinct command results are returned as a single BSON object. If the results could be large (> 4 megabytes), use map/reduce instead.

Group

Note: currently one must use map/reduce instead of group() in sharded MongoDB configurations.

group returns an array of grouped items. The command is similar to SQL’s group by. The SQL statement
```
select a, b, sum(c) csum from coll where active=1 group by a, b
```
corresponds to the following in MongoDB:
```
db.coll.group(
    { key: { a: true, b: true },
      cond: { active: 1 },
      reduce: function(obj, prev) { prev.csum += obj.c; },
      initial: { csum: 0 }
    });
```

Note: the result is returned as a single BSON object and for this reason must be fairly small – less than 10,000 keys, else you will get an exception. For larger grouping operations without limits, please use `map/reduce`.

group takes a single object parameter containing the following fields:

- **key**: Fields to group by.
- **reduce**: The reduce function aggregates (reduces) the objects iterated. Typical operations of a reduce function include summing and counting. `reduce` takes two arguments: the current document being iterated over and the aggregation counter object. In the example above, these arguments are named `obj` and `prev`.
- **initial**: Initial value of the aggregation counter object.
- **keyf**: An optional function returning a "key object" to be used as the grouping key. Use this instead of `key` to specify a key that is not an existing member of the object (or, to access embedded members). Set in lieu of `key`.
- **cond**: An optional condition that must be true for a row to be considered. This is essentially a `find()` query expression object. If null, the reduce function will run against all rows in the collection.
- **finalize**: An optional function to be run on each item in the result set just before the item is returned. Can either modify the item (e.g., add an average field given a count and a total) or return a replacement object (returning a new object with just `_id` and average fields). See `jstests/group3.js` for examples.

To order the grouped data, simply sort it client-side upon return. The following example is an implementation of `count()` using `group()`.
```
function gcount(collection, condition) {
    var res =
        db[collection].group(
            { key: {},
              initial: { count: 0 },
              reduce: function(obj, prev) { prev.count++; },
              cond: condition }
        );
    // group() returns an array of grouped items. here, there will be a single
    // item, as key is {}.
    return res[0] ? res[0].count : 0;
}
```

Examples

The examples assume data like this:
```
{ domain: "www.mongodb.org",
  invoked_at: { d: "2009-11-03", t: "17:14:05" },
  response_time: 0.05,
  http_action: "GET /display/DOCS/Aggregation"
}
```

Show me stats for each `http_action` in November 2009:
Show me stats for each domain for each day in November 2009:

```javascript
db.test.group(
  key: {domain: true, invoked_at: true},
  initial: {count: 0, total_time: 0},
  reduce: function(doc, out){ out.count++; out.total_time+=doc.response_time },
  finalize: function(out){ out.avg_time = out.total_time / out.count }
});
```

```javascript
Show me stats for each domain for each day in November 2009:

```javascript
db.test.group(
  key: {domain: true, invoked_at: true},
  initial: {count: 0, total_time: 0},
  reduce: function(doc, out){ out.count++; out.total_time+=doc.response_time },
  finalize: function(out){ out.avg_time = out.total_time / out.count }
});
```

```javascript
Using Group from Various Languages

Some language drivers provide a group helper function. For those that don't, one can manually issue the db command for group. Here's an example using the Mongo shell syntax:

```javascript
> db.$cmd.findOne({group : {
  ... ns : "foo",
  ... cond : {}},
  ... key : {x : 1},
  ... initial : {count : 0},
  ... $reduce : function(obj,prev){prev.count++;}})
{'retval' : [{"x" : 1 }, "count" : 1},{"x" : 3 }, "count" : 3 , "keys" : 2 , "ok" : 1}
```

If you use the database command with keyf (instead of key) it must be prefixed with a $. For example:

```javascript
db.$cmd.findOne({group : {
  ... ns : "foo",
  ... $keyf : function(doc) { return {"x" : doc.x}; },
  ... initial : {count : 0},
  ... $reduce : function(obj,prev) { prev.count++; }})
```

Map/Reduce
MongoDB provides a MapReduce facility for more advanced aggregation needs. CouchDB users: please note that basic queries in MongoDB do not use map/reduce.

**See Also**

- jstests/eval2.js for an example of group() usage
- Advanced Queries

## Removing

### Removing Objects from a Collection

To remove objects from a collection, use the `remove()` function in the mongo shell. (Other drivers offer a similar function, but may call the function "delete". Please check your driver's documentation).

`remove()` is like `find()` in that it takes a JSON-style query document as an argument to select which documents are removed. If you call `remove()` without a document argument, or with an empty document `{}`, it will remove all documents in the collection. Some examples:

```javascript
db.things.remove({}); // removes all
db.things.remove({n:1}); // removes all where n == 1
```

If you have a document in memory and wish to delete it, the most efficient method is to specify the item's document `_id` value as a criteria:

```javascript
db.things.remove({ _id: myobject._id });
```

You may be tempted to simply pass the document you wish to delete as the selector, and this will work, but it's inefficient.

### References

If a document is deleted, any existing references to the document will still exist in the database. These references will return null when evaluated.

### Concurrency and Remove

v1.3+ supports concurrent operations while a remove runs. If a simultaneous update (on the same collection) grows an object which matched the remove criteria, the updated object may not be removed (as the operations are happening at approximately the same time, this may not even be surprising). In situations where this is undesireable, pass `{atomic : true}` in your filter expression:

```javascript
db.videos.remove( { rating : { $lt : 3.0 }, atomic : true } )
```

The remove operation is then completely atomic – however, it will also block other operations while executing.

## Updating

MongoDB supports atomic, in-place updates as well as more traditional updates for replacing an entire document.

- `update()`
- `save()` in the mongo shell
- Modifier Operations
  - `$inc`
  - `$set`
  - `$unset`
  - `$push`
  - `$pushAll`
  - `$addToSet`
  - `$pop`
  - `$pull`
  - `$pullAll`
- The `$ positional operator`
- Upserts with Modifiers
- Pushing a Unique Value
Checking the Outcome of an Update Request

Notes

- Object Padding
- Blocking
- See Also

**update()**

Here's the MongoDB shell syntax for update():

```javascript
db.collection.update( criteria, objNew, upsert, multi )
```

**Arguments:**

- `criteria` - query which selects the record to update;
- `objNew` - updated object or $ operators (e.g., $inc) which manipulate the object
- `upsert` - if this should be an "upsert"; that is, if the record does not exist, insert it
- `multi` - if all documents matching criteria should be updated (the default is to only update the first document found)

**save() in the mongo shell**

The save() command in the mongo shell provides a shorthand syntax to perform a single object update with upsert:

```javascript
// x is some JSON style object
db.mycollection.save(x); // updates if exists; inserts if new
```

**save()** does an upsert if `x` has an `_id` field and an insert if it does not. Thus, normally, you will not need to explicitly request upserts, just use **save()**.

Upset means "update if present; insert if missing."

```javascript
myColl.update( { name: "Joe" }, { name: "Joe", age: 20 }, true );
```

**Modifier Operations**

Modifier operations are highly-efficient and useful when updating existing values; for instance, they're great for incrementing a number.

So, while a conventional implementation does work:

```javascript
var j=myColl.findOne( { name: "Joe" } );
j.n++;
myColl.save(j);
```

A modifier update has the advantages of avoiding the latency involved in querying and returning the object. The modifier update also features operation **atomicity** and very little network data transfer.

To perform an atomic update, simply specify any of the special update operators (which always start with a '$' character) with a relevant update document:

```javascript
db.people.update( { name:"Joe" }, { $inc: { n : 1 } } );
```

The preceding example says, "Find the first document where 'name' is 'Joe' and then increment 'n' by one."

While not shown in the examples, most modifier operators will accept multiple field/value pairs when one wishes to modify multiple fields. For example, the following operation would set `x` to 1 and `y` to 2:

```javascript
{ $set : { x : 1 , y : 2 } }
```

**$inc**
increments field by the number value if field is present in the object, otherwise sets field to the number value.

$set

sets field to value. All datatypes are supported with $set.

$unset

Deletes a given field. v1.3+

$push

appends value to field, if field is an existing array, otherwise sets field to the array [value] if field is not present. If field is present but is not an array, an error condition is raised.

$pushAll

appends each value in value_array to field, if field is an existing array, otherwise sets field to the array value_array if field is not present. If field is present but is not an array, an error condition is raised.

$addToSet

Adds value to the array only if its not in the array already.

To add many values use update

$pop

removes the last element in an array (ADDED in 1.1)

$pull

removes the first element in an array (ADDED in 1.1)
removes all occurrences of value from field, if field is an array. If field is present but is not an array, an error condition is raised.

```javascript
$pullAll
{
$pullAll : { field : value_array }
}
```

removes all occurrences of each value in value_array from field, if field is an array. If field is present but is not an array, an error condition is raised.

**The $ positional operator**

Version 1.3.4+ only.

The $ operator (by itself) means “position of the matched array item in the query”. Use this to find an array member and then manipulate it. For example:

```javascript
> t.find()
{ "_id" : ObjectId("4b97e62bf1d8c71529c9c9cb74"), "title" : "ABC",
  "comments" : [ { "by" : "joe", "votes" : 3 }, { "by" : "jane", "votes" : 7 } ] }
> t.update( { 'comments.by' : 'joe' }, { $inc : { 'comments.$votes' : 1 } }, false, true )
> t.find()
{ "_id" : ObjectId("4b97e62bf1d8c71529c9c9cb74"), "title" : "ABC",
  "comments" : [ { "by" : "joe", "votes" : 4 }, { "by" : "jane", "votes" : 7 } ] }
```

Currently the $ operator only applies to the first matched item in the query. For example:

```javascript
> t.find();
{ "_id" : ObjectId("4b9e4a1fc583fa1c76198319"), "x" : [ 1, 2, 3, 2 ] }
> t.update( { x: 2 }, { $inc : { "x.$" : 1 } }, false, true );
> t.find();
{ "_id" : ObjectId("4b9e4a1fc583fa1c76198319"), "x" : [ 1, 3, 3, 2 ] }
```

**Upserts with Modifiers**

You may use upsert with a modifier operation. In such a case, the modifiers will be applied to the update criteria member and the resulting object will be inserted. The following upsert example may insert the object {name:"Joe",x:1,y:1}.

```javascript
db.people.update( { name: "Joe" }, { $inc: { x: 1, y: 1 } }, true );
```

There are some restrictions. A modifier may not reference the _id field, and two modifiers within an update may not reference the same field, for example the following is not allowed:

```javascript
db.people.update( { name: "Joe" }, { $inc: { x: 1 }, $set: { x: 5 } } );
```

**Pushing a Unique Value**

To add a value to an array only if not already present:

Starting in 1.3.3, you can do

```javascript
update( { _id: 'joe' }, { "$addToSet": { tags : "baseball" } } );
```

For older versions, add $ne : <value> to your query expression:

```javascript
update( { _id: 'joe', tags: { "$ne": "baseball" } }, { "$push": { tags : "baseball" } } );
```
Checking the Outcome of an Update Request

As described above, a non-upsert update may or may not modify an existing object. An upsert will either modify an existing object or insert a new object. The client may determine if its most recent message on a connection updated an existing object by subsequently issuing a `db.runCommand( "getlasterror" )`. If the result of the `getlasterror` command contains an `updatedExisting` field, the last message on the connection was an update request. If the `updatedExisting` field's value is true, that update request caused an existing object to be updated; if `updatedExisting` is false, no existing object was updated.

Notes

**Object Padding**

When you update an object in MongoDB, the update occurs in-place if the object has not grown in size. This is good for insert performance if the collection has many indexes.

Mongo adaptively learns if objects in a collection tend to grow, and if they do, it adds some padding to prevent excessive movements. This statistic is tracked separately for each collection.

**Blocking**

The update command blocks - this is particularly important to keep in mind on multi updates. This will be improved soon, see SERVER-516.

See Also

- `findandmodify Command`
- Atomic Operations

Atomic Operations

- Modifier operations
  - "Update if Current"
    - The ABA Nuance
  - "Insert if Not Present"
  - Find and Modify (or Remove)
  - Updating Multiple Objects Atomically

MongoDB supports atomic operations on single documents. MongoDB does not support traditional locking and complex transactions for a number of reasons:

- First, in sharded environments, distributed locks could be expensive and slow. MongoDB's goal is to be lightweight and fast.
- We dislike the concept of deadlocks. We want the system to be simple and predictable without these sort of surprises.
- We want MongoDB to work well for realtime problems. If an operation may execute which locks large amounts of data, it might stop some small light queries for an extended period of time. (We don't claim MongoDB is perfect yet in regards to being "real-time", but we certainly think locking would make it even harder.)

MongoDB does support several methods of manipulating single documents atomically, which are detailed below.

Modifier operations

The MongoDB update command supports several modifiers, all of which atomically update an element in a document. They include:

- `$set` - set a particular value
- `$unset` - set a particular value (since 1.3.0)
- `$inc` - increment a particular value by a certain amount
- `$push` - append a value to an array
- `$pushAll` - append several values to an array
- `$pull` - remove a value(s) from an existing array
- `$pullAll` - remove several value(s) from an existing array

These modifiers are convenient ways to perform certain operations atomically.

"Update if Current"

Another strategy for atomic updates is "Update if Current". This is what an OS person would call Compare and Swap. For this we

1. Fetch the object.
2. Modify the object locally.
3. Send an update request that says "update the object to this new value if it still matches its old value".

Should the operation fail, we might then want to try again from step 1.
For example, suppose we wish to fetch one object from inventory. We want to see that an object is available, and if it is, deduct it from the inventory. The following code demonstrates this using mongo shell syntax (similar functions may be done in any language):

```javascript
> t=db.inventory
> s = t.findOne({sku:'abc'})
{ "_id" : "4d4f4d3c9664d32c73ea865a" , "sku" : "abc" , "qty" : 30}
> qty_old = s.qty;
> --s.qty;
> t.update({_id:s._id, qty:qty_old}, s); db.$cmd.findOne({getlasterror:1});
{ "err" : , "updatedExisting" : true , "n" : 1 , "ok" : 1 } // it worked
```

For the above example, we likely don't care the exact sku quantity as long as it is as least as great as the number to deduct. Thus the following code is better, although less general -- we can get away with this as we are using a predefined modifier operation ($inc). For more general updates, the “update if current” approach shown above is recommended.

```javascript
> t.update({sku:}, qty:{$gt:0}}, { $inc : { qty : -1 } } ) ;
db.$cmd.findOne({getlasterror:1})
{ "err" : , "updatedExisting" : false , "n" : 0 , "ok" : 1 } // did not work
```

**The ABA Nuance**

In the first of the examples above, we basically did “update object if qty is unchanged”. However, what if since our read, sku had been modified? We would then overwrite that change and lose it!

There are several ways to avoid this problem: it's mainly just a matter of being aware of the nuance.

1. Use the entire object in the update's query expression, instead of just the _id and qty field.
2. Use $set to set the field we care about. If other fields have changed, they won’t be effected then.
3. Put a version variable in the object, and increment it on each update.
4. When possible, use a $ operator instead of an update-if-current sequence of operations.

"Insert if Not Present"

Another optimistic concurrency scenario involves inserting a value when not already there. When we have a unique index constraint for the criteria, we can do this. The following example shows how to insert monotonically increasing _id values into a collection using optimistic concurrency:

```javascript
function insertObject(o) {
    x = db.myCollection;
    while (1) {
        // determine next _id value to try
        var c = x.find({},{ _id:1 }).sort({ _id:-1 }).limit(1);
        var i = c.hasNext() ? c.next()._id + 1 : 1;
        o._id = i;
        x.insert(o);
        var err = db.getLastErrorObj();
        if (err && err.code) {
            if (err.code == 11000 /* dup key */) {
                continue;
            } else {
                print("unexpected error inserting data: " + tojson(err));
            }
        }
        break;
    }
}
```

**Find and Modify (or Remove)**

See the [findandmodify Command documentation](#) for more information.

**Updating Multiple Objects Atomically**

Generally, Mongo DB does not support updating several documents atomically in one operation. However, you can nest objects making them effectively one document for atomicity purposes. The `db.eval()` statement provides a way to atomically perform several operations at once; however, its use for this is not recommended as this eval() atomicity will not be supported for certain cases in sharded environments.
findandmodify Command

Find and Modify (or Remove)

MongoDB 1.3+ supports a "find, modify, and return" command. This command can be used to atomically modify a document (at most one) and return it. Note that the document returned will not include the modifications made on the update. The command includes sort option which is useful when storing queue-like data.

The general form is

```javascript
db.runCommand( { findandmodify : <collection>,
                 <options> } )
```

The MongoDB shell includes a helper method, findAndModify(), for executing the command. Some drivers provide helpers also.

Let's take the example of fetching the highest priority job that hasn't been grabbed yet and atomically marking it as grabbed:

```javascript
job = db.jobs.findAndModify({
    query: {inprogress: false},
    sort:{priority:-1},
    update: {$set: {inprogress: true, started: new Date()}}
});
```

You could also simply remove the object to be returned, but be careful. If the client crashes before processing the job, the document will be lost forever.

```javascript
job = db.jobs.findAndModify({sort:{priority:-1}, remove:true});
```

See the tests for more examples.

At least one of the update or remove parameters is required; the other arguments are optional.

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>query</td>
<td>a filter for the query</td>
<td>{}</td>
</tr>
<tr>
<td>sort</td>
<td>if multiple docs match, choose the first one in the specified sort order as the object to manipulate</td>
<td>{}</td>
</tr>
<tr>
<td>remove</td>
<td>set to a true to remove the object before returning</td>
<td>N/A</td>
</tr>
<tr>
<td>update</td>
<td>a modifier object</td>
<td>N/A</td>
</tr>
<tr>
<td>new</td>
<td>set to true if you want to return the modified object rather than the original. Ignored for remove.</td>
<td>false</td>
</tr>
</tbody>
</table>

If your driver doesn’t yet provide a helper function for this command, run the command directly with something like this:

```javascript
job = db.runCommand({ findandmodify : "jobs",
                      sort : { priority : -1 },
                      remove : true
}).value;
```

See Also

- Atomic Operations

Updating Data in Mongo

- Updating a Document in the mongo Shell with .save()
- Embedding Documents Directly in Documents
• Database References

Updating a Document in the mongo Shell with `save()`

As shown in the previous section, the `save()` method may be used to save a new document to a collection. We can also use `save()` to update an existing document in a collection.

Continuing with the `example` database from the last section, let's add new information to the document `{name: "mongo"}` that already is in the collection.

```javascript
> var mongo = db.things.findOne({name: "mongo"});
> print(tojson(mongo));
{
  "_id": "497dab624ee47b3a675d2d9c",
  "name": "mongo"
}
> mongo.type = "database";
database
> db.things.save(mongo);
> db.things.findOne({name: "mongo"});
{
  "_id": "497dab624ee47b3a675d2d9c",
  "name": "mongo",
  "type": "database"
}
```

This was a simple example, adding a string valued element to the existing document. When we called `save()`, the method saw that the document already had an "_id" field, so it simply performed an update on the document.

In the next two sections, we'll show how to embed documents within documents (there are actually two different ways), as well as show how to query for documents based on values of embedded documents.

Embedding Documents Directly in Documents

As another example of updating an existing document, let's embed a document within an existing document in the collection. We'll keep working with the original `{name: "mongo"}` document for simplicity.

```javascript
> var mongo = db.things.findOne({name: "mongo"});
> print(tojson(mongo));
{
  "_id": "497da93d4ee47b3a675d2d9b",
  "name": "mongo",
  "type": "database"
}
> mongo.data = { a:1, b:2};
{
  "a": 1,
  "b": 2
}
> db.things.save(mongo);
> db.things.findOne({name: "mongo"});
{
  "_id": "497da93d4ee47b3a675d2d9b",
  "name": "mongo",
  "type": "database",
  "data": {"a": 1, "b": 2}
}
```

As you can see, we added new data to the mongo document, adding `{a:1, b:2}` under the key "data".

Note that the value of "data" is a document itself - it is embedded in the parent mongo document. With BSON, you may nest and embed documents to any level. You can also query on embedded document fields, as shown here:

```javascript
> db.things.findOne({ "data.a": 1});
{
  "_id": "497da93d4ee47b3a675d2d9b",
  "name": "mongo",
  "data": {"a": 1, "b": 2}
}
> db.things.findOne({ "data.a": 2});
```

Note that the second `findOne()` doesn't return anything, because there are no documents that match.

Database References

Alternatively, a document can reference other documents which are not embedded via a database reference, which is analogous to a foreign key in a relational database. A database reference (or "DBRef" for short), is a reference implemented according to the Database References. Most drivers support helpers for creating DBRefs. Some also support additional functionality, like dereference helpers and auto-referencing. See specific driver documentation for examples / more information

In the previous section we saw that the statement

```javascript
obj_a.x = obj_b;
```
Let's repeat the above example, but create a document and place it in a different collection, say `otherthings`, and embed that as a reference in our favorite "mongo" object under the key "otherdata":

```javascript
// first, save a new doc in the 'otherthings' collection

> var other = { s : "other thing", n : 1};
> db.otherthings.save(other);
> db.otherthings.find();
{ "_id" : "497dbcb36b27d59a708e89a4", "s" : "other thing", "n" : 1 }

// now get our mongo object, and add the 'other' doc as 'otherthings'

> var mongo = db.things.findOne();
> print(tojson(mongo));
{ "_id" : "497dab624ee47b3a675d2d9c", "name" : "mongo", "type" : "database", "data" : { "a" : 1, "b" : 2 } }
> mongo.otherthings = new DBRef( 'otherthings', other._id );
> db.things.save(mongo);
> db.things.findOne().otherthings.fetch();
{ "_id" : "497dab624ee47b3a675d2d9c", "name" : "mongo", "type" : "database", "data" : { "a" : 1, "b" : 2 }, "otherthings" : { "_id" : "497dbcb36b27d59a708e89a4", "s" : "other thing", "n" : 1 } }

// now, let's modify our 'other' document, save it again, and see that when the dbshell
// gets our mongo object and prints it, if follows the dbref and we have the new value

> other.n = 2;
2
> db.otherthings.save(other);
> db.otherthings.find();
{ "_id" : "497dbcb36b27d59a708e89a4", "s" : "other thing", "n" : 2 }
> db.things.findOne().otherthings.fetch();
{ "_id" : "497dab624ee47b3a675d2d9c", "name" : "mongo", "type" : "database", "data" : { "a" : 1, "b" : 2 }, "otherthings" : { "_id" : "497dbcb36b27d59a708e89a4", "s" : "other thing", "n" : 2 } }
```

## MapReduce

Map/Reduce in MongoDB is useful for batch manipulation of data and aggregation operations. It is similar in spirit to using something like Hadoop with all input coming from a collection and output going to a collection. Often, in a situation where you would have used GROUP BY in SQL, map/reduce is the right tool in MongoDB.

### Indexing and standard queries in MongoDB are separate from map/reduce.

If you have used CouchDB in the past, note this is a big difference: MongoDB is more like MySQL for basic querying and indexing. See the [queries](#) and [indexing](#) documentation for those operations.

### Overview

- Map Function
- Reduce Function
- Finalize Function
- Sharded Environments
- Examples
- Shell Example 1
- Shell Example 2
- More Examples
- Note on Permanent Collections
- Parallelism
- See Also

**Version 1.1.1 and above**
map/reduce is invoked via a database command. The database creates a temporary collection to hold output of the operation. The collection is cleaned up when the client connection closes, or when explicitly dropped. Alternatively, one can specify a permanent output collection name. map and reduce functions are written in JavaScript and execute on the server.

Command syntax:

```javascript
db.runCommand(
    { mapreduce : <collection>,
      map : <mapfunction>,
      reduce : <reducefunction>
        [, query : <query filter object>]
        [, sort : <sort the query. useful for optimization>]
        [, limit : <number of objects to return from collection>]
        [, out : <output-collection name>]  
        [, keeptemp : <true|false>]
        [, finalize : <finalizelfunction>]
        [, scope : <object where fields go into javascript global scope >]}
    [, verbose : true]
) ;
```

- `keeptemp`: if true, the generated collection is not treated as temporary. Defaults to false. When `out` is specified, the collection is automatically made permanent.
- `finalize`: function to apply to all the results when finished
- `verbose`: provide statistics on job execution time
- `scope`: can pass in variables that can be access from map/reduce/finalize example `mr5`

Result:

```javascript
( result : <collection_name>,
  counts : { 
    input : <number of objects scanned>,
    emit : <number of times emit was called>,
    output : <number of items in output collection>
  },
  timeMillis : <job_time>,
  ok : <1_if_ok>,
  [, err : <errmsg_if_error>]
)
```

A command helper is available in the MongoDB shell:

```javascript
db.collection.mapReduce(mapfunction,reducefunction[,options]);
```

map, reduce, and finalize functions are written in JavaScript.

**Map Function**

The map function references the variable `this` to inspect the current object under consideration. A map function must call `emit(key,value)` at least once, but may be invoked any number of times, as may be appropriate.

```javascript
function map(void) -> void
```

**Reduce Function**

The reduce function receives a key and an array of values. To use, reduce the received values, and return a result.

```javascript
function reduce(key, value_array) -> value
```

The MapReduce engine may invoke reduce functions iteratively; thus, these functions must be idempotent. That is, the following must hold for your reduce function:
for all k, vals : reduce( k, [reduce(k, vals)] ) == reduce(k, vals)

If you need to perform an operation only once, use a finalize function.

Note: The output of emit (the 2nd param) and reduce should be the same format to make iterative reduce possible. If not, there will be weird bug that are hard to debug.

Note: Currently, the return value from a reduce function cannot be an array (it's typically an object or a number).

**Finalize Function**

A finalize function may be run after reduction. Such a function is optional and is not necessary for many map/reduce cases. The finalize function takes a key and a value, and returns a finalized value.

```javascript
function finalize(key, value) -> final_value
```

**Sharded Environments**

In sharded environments, data processing of map/reduce operations runs in parallel on all shards.

**Examples**

**Shell Example 1**

The following example assumes we have an events collection with objects of the form:

```javascript
{ time : <time>, user_id : <userid>, type : <type>, ... }
```

We then use MapReduce to extract all users who have had at least one event of type "sale":

```javascript
> m = function() { emit(this.user_id, 1); }
> r = function(k, vals) {
... return 1;
}  
> res = db.events.mapReduce(m, r, { query : {type:'sale'} });
> db[res.result].find().limit(2)
{ "_id" : 8321073716060 , "value" : 1 }
{ "_id" : 7921232311289 , "value" : 1 }
```

If we also wanted to output the number of times the user had experienced the event in question, we could modify the reduce function like so:

```javascript
> r = function(k, vals) {
... var sum=0;
... for(var i in vals) sum += vals[i];
... return sum;
}
```

Note, here, that we cannot simply return vals.length, as the reduce may be called multiple times.

**Shell Example 2**
More Examples

- example mr1
- Finalize example: example mr2

Note on Permanent Collections

Even when a permanent collection name is specified, a temporary collection name will be used during processing. At map/reduce completion, the temporary collection will be renamed to the permanent name atomically. Thus, one can perform a map/reduce job periodically with the same target collection name without worrying about a temporary state of incomplete data. This is very useful when generating statistical output collections on a regular basis.

Parallelism

As of right now, MapReduce jobs on a single mongod process are single threaded. This is due to a design limitation in current JavaScript engines. We are looking into alternatives to solve this issue, but for now if you want to parallelize your MapReduce jobs, you will need to either use sharding or do the aggregation client-side in your code.

See Also

- Aggregation

Data Processing Manual

DRAFT - TO BE COMPLETED.

This guide provides instructions for using MongoDB batch data processing oriented features including map/reduce.

By "data processing", we generally mean operations performed on large sets of data, rather than small interactive operations.

Import
One can always write a program to load data of course, but the `mongoimport` utility also works for some situations. `mongoimport` supports importing from json, csv, and tsv formats.

A common usage pattern would be to use `mongoimport` to load data in a relatively raw format and then use a server-side script (`db.eval()` or `map/reduce`) to reduce the data to a more clean format.

See Also
- Import/Export Tools
- Server-Side Code Execution
- Map/Reduce

**mongo - The Interactive Shell**

*MongoDB Interactive Shell*

The MongoDB distribution includes `bin/mongo`, the MongoDB interactive shell. This utility is a JavaScript shell that allows you to issue commands to MongoDB from the command line.

The shell is useful for:
- inspecting a database's contents
- testing queries
- creating indices
- other administrative functions.

When you see sample code in this wiki and it looks like JavaScript, assume it is a shell example. See the driver syntax table for a chart that can be used to convert those examples to any language.

**Datatypes**
- Numbers
  The shell treats all numbers as floating-point values. If you have long/integer data you may see something like this:

```
"bytes" : {
   "floatApprox" : 575175
}
```

or something like this for larger numbers

```
"bytes" : {
   "floatApprox" : 5284376243087482000,
   "top" : 1230364721,
   "bottom" : 4240317554
}
```

**More Information**
- Shell Overview
- Shell Reference
- Shell API

**Overview - The MongoDB Interactive Shell**

**Starting the Shell**

The interactive shell is included in the standard MongoDB distribution. To start the shell, go into the root directory of the distribution and type

`./bin/mongo`
It might be useful to add `mongo_distribution_root/bin` to your `PATH` so you can just type `mongo` from anywhere.

If you start with no parameters, it connects to a database named "test" running on your local machine on the default port (27017). You can see the `db` to which you are connecting by typing `db:

```
./mongo
  type "help" for help
  > db
test
```

You can pass `mongo` an optional argument specifying the address, port and even the database to initially connect to:

<table>
<thead>
<tr>
<th>Command</th>
<th>Connection Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>./mongo foo</code></td>
<td>connects to the <code>foo</code> database on your local machine</td>
</tr>
<tr>
<td><code>./mongo 192.168.13.7/foo</code></td>
<td>connects to the <code>foo</code> database on 192.168.13.7</td>
</tr>
<tr>
<td><code>./mongo dbserver.mydomain.com/foo</code></td>
<td>connects to the <code>foo</code> database on dbserver.mydomain.com</td>
</tr>
<tr>
<td><code>./mongo 192.168.13.7:9999/foo</code></td>
<td>connects to the <code>foo</code> database on 192.168.13.7 on port 9999</td>
</tr>
</tbody>
</table>

**Connecting**

If you have not connected via the command line, you can use the following commands:

```javascript
conn = new Mongo(host);
db = conn.getDB(dbname);
db.auth(username,password);
```

where `host` is a string that contains either the name or address of the machine you want to connect to (e.g. "192.168.13.7") or the machine and port (e.g. "192.168.13.7:9999"). Note that `host` in an optional argument, and can be omitted if you want to connect to the database instance running on your local machine. (e.g. `conn = new Mongo();`

**Basics Commands**

The following are three basic commands that provide information about the available databases, and collections in a given database.

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>show dbs</code></td>
<td>displays all the databases on the server you are connected to</td>
</tr>
<tr>
<td><code>use db_name</code></td>
<td>switches to <code>db_name</code> on the same server</td>
</tr>
<tr>
<td><code>show collections</code></td>
<td>displays a list of all the collections in the current database</td>
</tr>
</tbody>
</table>

**Querying**

`mongo` uses a JavaScript API to interact with the database. Because `mongo` is also a complete JavaScript shell, `db` is the variable that is the current database connection.

To query a collection, you simply specify the collection name as a property of the `db` object, and then call the `find()` method. For example:

```
  db.foo.find();
```

This will display the first 10 objects from the `foo` collection.

**Inserting Data**

In order to insert data into the database, you can simply create a JavaScript object, and call the `save()` method. For example, to save an object `{ name: "sara" }` in a collection called `foo`, type:

```
  db.foo.save({ name: "sara" });
```

Note that MongoDB will implicitly create any collection that doesn't already exist.

**Modifying Data**
Let's say you want to change someone's address. You can do this using the following `mongo` commands:

```javascript
person = db.people.findOne( { name : "sara" } );
person.city = "New York";
db.people.save( person );
```

## Deleting Data

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>db.foo.drop()</code></td>
<td>drop the entire <code>foo</code> collection</td>
</tr>
<tr>
<td><code>db.foo.remove()</code></td>
<td>remove all objects from the collection</td>
</tr>
<tr>
<td><code>db.foo.remove( { name : &quot;sara&quot; } )</code></td>
<td>remove objects from the collection where name is sara</td>
</tr>
</tbody>
</table>

## Indexes

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>db.foo.getIndexKeys()</code></td>
<td>get all fields that have indexes on them</td>
</tr>
<tr>
<td><code>db.foo.ensureIndex({ _field_ : 1 })</code></td>
<td>create an index on <code>field</code> if it doesn't exist</td>
</tr>
</tbody>
</table>

## Line Continuation

If a line contains open '(' or '{' characters, the shell will request more input before evaluating:

```javascript
> function f() {
... x = 1;
... }
> 
```

You can press Ctrl-C to escape from "..." mode and terminate line entry.

## See Also

- [MongoDB Shell Reference](#)
- [dbshell Reference](#)

## dbshell Reference

### Special Command Helpers

Non-javascript convenience macros:

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>show dbs</code></td>
<td>Print a list of all databases on this server</td>
</tr>
<tr>
<td><code>use dbname</code></td>
<td>Set the <code>db</code> variable to represent usage of <code>dbname</code> on the server</td>
</tr>
<tr>
<td><code>show collections</code></td>
<td>Print a list of all collections for current database</td>
</tr>
<tr>
<td><code>show users</code></td>
<td>Print a list of users for current database</td>
</tr>
<tr>
<td><code>show profile</code></td>
<td>Print most recent profiling operations that took &gt;= 1ms</td>
</tr>
</tbody>
</table>

### Basic Shell Javascript Operations

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>db</code></td>
<td>The variable that references the current database object / connection. Already defined for you in your instance.</td>
</tr>
<tr>
<td><code>db.auth(user,pass)</code></td>
<td>Authenticate with the database (if running in secure mode).</td>
</tr>
<tr>
<td><code>coll = db.collection</code></td>
<td>Access a specific <code>collection</code> within the database.</td>
</tr>
<tr>
<td><code>cursor = coll.find();</code></td>
<td>Find all objects in the collection. See queries.</td>
</tr>
</tbody>
</table>
### Remove Matching Objects from the Collection

**coll.remove(objpattern)**

Remove matching objects from the collection. **objpattern** is an object specifying fields to match. E.g.: `coll.remove( { name: "Joe" } );`

### Save an Object in the Collection

**coll.save(object);**

Save an object in the collection, or update if already there. If your object has a presave method, that method will be called before the object is saved to the db (before both updates and inserts).

### Insert an Object in the Collection

**coll.insert(object);**

Insert object in collection. No check is made (i.e., no upsert) that the object is not already present in the collection.

### Update an Object in a Collection

**coll.update(...)**

Update an object in a collection. See the **Updating** documentation; update() has many options.

### Ensure Index

**coll.ensureIndex( { name : 1 } )**

Creates an index on tab.name. Does nothing if index already exists.

### Drop the Collection

**coll.drop()**

Drops the collection coll.

### Get a Reference to Another Database

**db.getSisterDB(name)**

Return a reference to another database using this same connection. Usage example: `db.getSisterDB('production').getCollectionNames()`

---

### Queries

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>coll.find()</strong></td>
<td>Find all.</td>
</tr>
<tr>
<td><strong>coll.find( criteria );</strong></td>
<td>Find objects matching <strong>criteria</strong> in the collection. E.g.: <code>coll.find( { name: &quot;Joe&quot; } );</code></td>
</tr>
<tr>
<td><strong>coll.findOne( criteria );</strong></td>
<td>Find and return a single object. Returns null if not found. If you want only one object returned, this is more efficient than just <code>find()</code> as <code>limit(1)</code> is implied. You may use regular expressions if the element type is a string, number, or date: <code>coll.find( { name: /joe/i } );</code></td>
</tr>
<tr>
<td><strong>coll.find( criteria, fields );</strong></td>
<td>Get just specific fields from the object. E.g.: <code>coll.find( {}, {name:true} );</code></td>
</tr>
<tr>
<td><strong>coll.find().sort( { field:1[, field :1] } );</strong></td>
<td>Return results in the specified order (field ASC). Use -1 for DESC.</td>
</tr>
<tr>
<td><strong>coll.find( criteria ).sort( { field : 1 } )</strong></td>
<td>Return the objects matching <strong>criteria</strong>, sorted by <strong>field</strong>.</td>
</tr>
<tr>
<td><strong>coll.find( ... ).limit(n)</strong></td>
<td>Limit result to n rows. Highly recommended if you need only a certain number of rows for best performance.</td>
</tr>
<tr>
<td><strong>coll.find( ... ).skip(n)</strong></td>
<td>Skip n results.</td>
</tr>
<tr>
<td><strong>coll.count()</strong></td>
<td>Returns total number of objects in the collection.</td>
</tr>
<tr>
<td><strong>coll.find( ... ).count()</strong></td>
<td>Returns the total number of objects that match the query. Note that the number ignores limit and skip; for example if 100 records match but the limit is 10, <code>count()</code> will return 100. This will be faster than iterating yourself, but still take time.</td>
</tr>
</tbody>
</table>

More information: see [queries](#).

---

### Error Checking

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>db.getLastError()</strong></td>
<td>Returns error from the last operation.</td>
</tr>
<tr>
<td><strong>db.getPrevError()</strong></td>
<td>Returns error from previous operations.</td>
</tr>
<tr>
<td><strong>db.resetError()</strong></td>
<td>Clear error memory.</td>
</tr>
</tbody>
</table>

---

### Administrative Command Helpers

---
<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>db.cloneDatabase(fromhost)</code></td>
<td>Clone the current database from the other host specified. fromhost database must be in noauth mode.</td>
</tr>
<tr>
<td><code>db.copyDatabase(fromdb, todb, fromhost)</code></td>
<td>Copy fromhost/fromdb to todb on this server. fromhost must be in noauth mode.</td>
</tr>
<tr>
<td><code>db.repairDatabase()</code></td>
<td>Repair and compact the current database. This operation can be very slow on large databases.</td>
</tr>
<tr>
<td><code>db.addUser(user, pwd)</code></td>
<td>Add user to current database.</td>
</tr>
<tr>
<td><code>db.getCollectionNames()</code></td>
<td>get list of all collections.</td>
</tr>
<tr>
<td><code>db.dropDatabase()</code></td>
<td>Drops the current database.</td>
</tr>
</tbody>
</table>

**Miscellaneous**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>c = connect(&quot;&lt;host&gt;:&lt;port&gt;/&lt;dbname&gt;&quot;)</code></td>
<td>Open a new database connection. One may have multiple connections within a single shell, however, automatic getLastError reporting by the shell is done for the 'db' variable only. See here for an example of connect().</td>
</tr>
<tr>
<td><code>Object.bsonsize(db.foo.findOne())</code></td>
<td>prints the bson size of a db object (mongo version 1.3 and greater)</td>
</tr>
<tr>
<td><code>db.foo.findOne().bsonsize()</code></td>
<td>prints the bson size of a db object (mongo versions predating 1.3)</td>
</tr>
</tbody>
</table>

For a full list of functions, see the shell API.

**Developer FAQ**

- What's a "namespace"?
- How do I copy all objects from one database collection to another?
- If you remove an object attribute is it deleted from the store?
- Are null values allowed?
- Does an update fsync to disk immediately?
- How do I do transactions/locking?
- How do I do equivalent of SELECT count * and GROUP BY?
- What are so many "Connection Accepted" messages logged?
- Why are my data files so large?
  - Preallocation
  - Deleted Space
  - Checking Size of a Collection
- Do I have to Worry About SQL Injection?
- How does concurrency work?
- What is the Compare Order for BSON Types?

**What's a "namespace"?**

MongoDB stores BSON objects in collections. The concatenation of the database name and the collection name (with a period in between) is called a namespace.

For example, `acme.users` is a namespace, where `acme` is the database name, and `users` is the collection name. Note that periods can occur in collection names, so a name such as `acme.blog.posts` is legal too (in that case `blog.posts` is the collection name).

**How do I copy all objects from one database collection to another?**

See below. The code below may be ran server-side for high performance with the eval() method.

```javascript
db.myoriginal.find().forEach( function(x){db.mycopy.save(x)} );
```

**If you remove an object attribute is it deleted from the store?**

Yes, you remove the attribute and then re-save() the object.

**Are null values allowed?**

For members of an object, yes. You cannot add null to a database collection though as null isn’t an object. You can add {}, though.
Does an update fsync to disk immediately?

No, writes to disk are lazy. A write may hit disk a couple of seconds later. For example, if the database receives a thousand increments to an object within one second, it will only be flushed to disk once.

How do I do transactions/locking?

MongoDB does not use traditional locking or complex transactions with rollback, as it is designed to be lightweight and fast and predictable in its performance. It can be thought of as analogous to the MySQL MyISAM autocommit model. By keeping transaction support extremely simple, performance is enhanced, especially in a system that may run across many servers.

The system provides alternative models for atomically making updates that are sufficient for many common use cases. See the wiki page Atomics Operations for detailed information.

How do I do equivalent of SELECT count * and GROUP BY?

See aggregation.

What are so many "Connection Accepted" messages logged?

If you see a tremendous number of connection accepted messages in the mongod log, that means clients are repeatedly connecting and disconnected. This works, but is inefficient.

With CGI this is normal. If you find the speed acceptable for your purposes, run mongod with --quiet to suppress these messages in the log. If you need better performance, which to a solution where connections are pooled -- such as an Apache module.

Why are my data files so large?

You may notice that for a given set of data the MongoDB datafiles in /data/db are larger than the data set inserted into the database. There are several reasons for this.

Preallocation

Each datafile is preallocated to a given size. (This is done to prevent file system fragmentation, among other reasons.) The first file for a database is <dbname>.0, then <dbname>.1, etc. <dbname>.0 will be 64MB, <dbname>.1 128MB, etc., up to 2GB. Once the files reach 2GB in size, each successive file is also 2GB.

Thus if the last datafile present is say, 1GB, that file might be 90% empty if it was recently reached.

Additionally, on Unix, mongod will preallocate an additional datafile in the background and do background initialization of this file. These files are prefilled with zero bytes. This initialization can take up to a minute (less on a fast disk subsystem) for larger datafiles; without prefilling in the background this could result in significant delays when a new file must be prepopulated.

You can disable preallocation with the --noprealloc option to the server. This flag is nice for tests with small datasets where you drop the db after each test. It shouldn't be used on production servers.

For large databases (hundreds of GB or more) this is of no significant consequence as the unallocated space is small.

Deleted Space

MongoDB maintains deleted lists of space within the datafiles when objects or collections are deleted. This space is reused but never freed to the operating system.

To compact this space, run db.repairDatabase() from the mongo shell (note this operation will block and is slow).

When testing and investigating the size of datafiles, if your data is just test data, use db.dropDatabase() to clear all datafiles and start fresh.

Checking Size of a Collection

Use the validate command to check the size of a collection -- that is from the shell run:

> db.<collectionname>.validate();
> // these are faster:
> db.<collectionname>.dataSize(); // just data size for collection
> db.<collectionname>.storageSize(); // allocation size including unused space
> db.<collectionname>.totalSize(); // data + index
> db.<collectionname>.totalIndexSize(); // index data size

This command returns info on the collection data but note there is also data allocated for associated indexes. These can be checked with validate
too, if one looks up the index's namespace name in the system.namespaces collection. For example:

```javascript
> db.system.namespaces.find()
{"name" : "test.foo"
{"name" : "test.system.indexes"
{"name" : "test.foo.$_id_
> > db.foo.$_id_.validate()
{"ns" : "test.foo.$_id_", "result" : "
validate
details: 0xb3590b68 ofs:83fb68
firstExtent:0:8100 ns:test.foo.$_id_
lastExtent:0:8100 ns:test.foo.$_id_
# extents:1
datasize?:8192 nrecords?:1 lastExtentSize:131072
padding:1
first extent:
loc:0:8100 xnext:null xprev:null
ns:test.foo.$_id_
sizel31072 firstRecord:0:81b0 lastRecord:0:81b0
1 objects found, nobj:1
8208 bytes data w/headers
8192 bytes data w/out/headers
deletedList: 000000000000000000000000
deleted: n: 1 size: 122688
nIndexes:0
", "ok" : 1 , "valid" : true , "lastExtentSize" : 131072}
```

Do I Have to Worry About SQL Injection?

Generally, with MongoDB we are not building queries from strings, so traditional SQL Injection attacks are not a problem. More details and some nuances are covered below.

MongoDB queries are represented as BSON objects. Typically the programming language gives a convenient way to build these objects that is injection free. For example in C++ one would write:

```c++
BSONObj my_query = BSON( "name" << a_name );
auto_ptr<DBClientCursor> cursor = c.query("tutorial.persons", my_query);
```

my_query then will have a value such as { name : "Joe" }. If my_query contained special characters such as *, ;, {, etc., nothing bad happens, they are just part of the string.

Javascript

Some care is appropriate when using server-side Javascript. For example when using the $where statement in a query, do not concatenate user supplied data to build Javascript code; this would be analogous to a SQL injection vulnerability. Fortunately, most queries in MongoDB can be expressed without Javascript. Also, we can mix the two modes. It's a good idea to make all the user-supplied fields go straight to a BSON field, and have your Javascript code be static and passed in the $where field.

If you need to pass user-supplied values into a $where clause, a good approach is to escape them using the CodeWScope mechanism. By setting the user values as variables in the scope document you will avoid the need to have them eval'ed on the server-side.

If you need to use db.eval() with user supplied values, you can either use a CodeWScope or you can supply extra arguments to your function. Something like: db.eval(function(userVal){...}, user_value); This will ensure that user_value gets sent as data rather than code.

User-Generated Keys

Sometimes it is useful to build a BSON object where the key is user-provided. In these situations, keys will need to have substitutions for the reserved $ and . characters. If you are unsure what characters to use, the Unicode full width equivalents aren't a bad choice: U+FF04 () and U+FF0E ()

For example:

```javascript
BSONObj my_object = BSON( a_key << a_name );
```

The user may have supplied a $ value within a_key. my_object could be { $where : "things" }. Here we can look at a few cases:
• Inserting. Inserting into the database will do no harm. We are not executing this object as a query, we are inserting the data in the database.
  Note: properly written MongoDB client drivers check for reserved characters in keys on inserts.
• Update. update(query, obj) allows $ operators in the obj field. $where is not supported in update. Some operators are possible that manipulate the single document only -- thus, the keys should be escaped as mentioned above if reserved characters are possible.
• Querying. Generally this is not a problem as for { x : user_obj }, dollar signs are not top level and have no effect. In theory one might let the user build a query completely themself and provide it to the database. In that case checking for $ characters in keynames is important. That however would be a highly unusual case.

One way to handle user-generated keys is to always put them in sub-objects. Then they are never at top level (where $operators live) anyway.

See Also
• http://groups.google.com/group/mongodb-user/browse_thread/thread/b4ef57912cbbf09d7

How does concurrency work?

• mongos
• mongod
  • v1.0-v1.2 Concurrency
  • Viewing Operations in Progress
  • Read/Write Lock
  • Operations
  • On Javascript
  • Multicore

mongos

For sharded environments, mongos can perform any number of operations concurrently. This results in downstream operations to mongod instances. Execution of operations at each mongod is independent; that is, one mongod does not block another.

mongod

The original mongod architecture is concurrency friendly; however, some work with respect to granular locking and latching is not yet done. This means that some operations can block others. This is particular true in versions < 1.3. Version 1.3+ has improvements to concurrency, although future work will make things even better.

v1.0-v1.2 Concurrency

In these versions of mongod, most operations prevent concurrent execution of other operations. In many circumstances, this worked reasonably as most operations can be executed very quickly.

The following operations do have concurrent support in v1.2 and below:

  1. db.currentOp() and db.killOp() commands
  2. map/reduce
  3. queries returning large amounts of data do interleave with other operations (but does block when scanning data that is not returned)

The rest of this document focuses on concurrency for v1.3+.

Viewing Operations in Progress

Use db.currentOp() to view operations in progress, and db.killOp() to terminate an operation.

You can also see operations in progress from the adminstrative Http Interface.

Read/Write Lock

mongod uses a read/write lock for many operations. Any number of concurrent read operations are allowed, but typically only one write operation (although some write operations yield and in the future more concurrency will be added). The write lock acquisition is greedy: a pending write lock acquisition will prevent further read lock acquisitions until fulfilled.

Operations

<table>
<thead>
<tr>
<th>Operation</th>
<th>Lock type</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>OP_QUERY (query)</td>
<td>Acquires read lock</td>
<td>see also: SERVER-517</td>
</tr>
</tbody>
</table>
OP_GETMORE (get more from cursor)  |  Acquires read lock
---|---
OP_INSERT (insert)  |  Acquires write lock  |  Inserts are normally fast and short-lived operations
OP_DELETE (remove)  |  Acquires write lock  |  Yields while running to allow other operations to interleave.
OP_UPDATE (update)  |  Acquires write lock  |  Will yield for interleave in the future: SERVER-516
map/reduce  |  At times locked  |  Allows substantial concurrent operation.
create index  |  See notes  |  Batch build acquires write lock. But a background build option is available.
db.eval()  |  Acquires write lock
getLastError command  |  Non-blocking
ismaster command  |  Non-blocking
serverStatus command  |  Non-blocking

On Javascript

Only one thread in the mongod process executes Javascript at a time (other database operations are often possible concurrent with this).

Multicore

With read operations, it is easy for mongod 1.3+ to saturate all cores. However, because of the read/write lock above, write operations will not yet fully utilize all cores. This will be improved in the future.

What is the Compare Order for BSON Types?

MongoDB allows objects in the same collection which have values which may differ in type. When comparing values from different types, a convention is utilized as to which value is less than the other. This (somewhat arbitrary but well defined) ordering is listed below.

Note that some types are treated as equivalent for comparison purposes -- specifically numeric types which undergo conversion before comparison.

See also the [BSON specification](#).

Example (using the mongo shell):

```javascript
> t = db.mycoll;
> t.insert({x:3});
> t.insert({x : 2.9 });
> t.insert({x : new Date()});
> t.insert({x : true})
> t.find().sort({x:1})
{ "_id" : ObjectId("4b03155dce8de6586fb002c7"), "x" : 2.9 }  
{ "_id" : ObjectId("4b03154c8de6586fb002c6"), "x" : 3 }  
{ "_id" : ObjectId("4b031566ce8de6586fb002c9"), "x" : true }  
{ "_id" : ObjectId("4b031563ce8de6586fb002c8"), "x" : "Tue Nov 17 2009 16:28:03 GMT-0500 (EST)" }  
```

MinKey and MaxKey

In addition to the above types MongoDB internally uses a special type for MinKey and MaxKey which are less than, and greater than all other
possible BSON element values, respectively.

From the mongo Javascript Shell

For example we can continue our example from above adding two objects which have x key values of MinKey and MaxKey respectively:

```
> t.insert( { x : MaxKey } )
> t.insert( { x : MinKey } )
> t.find().sort({x:1})
{
   "_id" : ObjectId("4b03155dce8de6586fb002c7"), "x" : 2.9 }
   "_id" : ObjectId("4b03154cce8de6586fb002c6"), "x" : 3 }
   "_id" : ObjectId("4b031566ce8de6586fb002c9"), "x" : true }
   "_id" : ObjectId("4b031563ce8de6586fb002c8"), "x" : "Tue Nov 17 2009 16:28:03 GMT-0500 (EST)" }
   "_id" : ObjectId("4b0409487c65b846e2090111"), "x" : { $maxKey : 1 } }
```

From C++

See also the Tailable Cursors page for an example of using MinKey from C++. See also minKey and maxKey definitions in jsobj.h.

Admin Zone

- Admin UIs
- Starting and Stopping Mongo
- Hosting Center
- Import Export Tools
- GridFS Tools
- Monitoring and Diagnostics
- DBA Operations from the Shell
- Database Profiler
- Sharding
- Replication
- Production Notes
- Security and Authentication
- Architecture and Components
- Backups
- Troubleshooting
- Durability and Repair

Community Admin-Related Articles

- boxedice.com - notes from a production deployment
- Survey of Admin UIs for MongoDB
- MongoDB Nagios Check
- MongoDB Cacti Graphs

See Also

- Commands in Developer Zone

Admin UIs

Several administrative user interfaces are available for MongoDB. Tim Gourley's blog has a good summary of the tools.

- Fang of Mongo
- Futon4Mongo
- Mongo3
- MongoHub for OS X
- Myngo
- Opricot
- PHPMoAdmin
Details
(more to come)

Fang of Mongo

A web based user interface for MongoDB build with django and jquery.

It will allow you to explore content of mongodb with simple but (hopefully) pleasant user interface.

Features:

- field name autocompletion in query builder
- data loading indicator
- human friendly collection stats
- disabling collection windows when there is no collection selected
- twitter stream plugin
- many more minor usability fixes
- works well on recent chrome and firefox

see it in action at: http://blueone.pl:8001/fangofmongo/
get it from github: http://github.com/Fiedzia/Fang-of-Mongo
or track progress on twitter: @fangofmongo

Starting and Stopping Mongo

- Starting Mongo
  - Default Data Directory, Default Port
  - Alternate Data Directory, Default Port
  - Alternate Port
  - Running as a Daemon
- Stopping Mongo
  - Control-C
  - Sending shutdownServer() message from the mongo shell
  - Sending a Unix INT or TERM signal
- Memory Usage

Mongo is run as a standard program from the command line. Please see Command Line Parameters for more information on those options.

Here are some common use cases for starting mongo

The following examples assume that you are in the directory where the Mongo executable is, and the Mongo executable is called mongod.

Starting Mongo

Default Data Directory, Default Port
To start Mongo in default mode, where data will be stored in the /data/db directory (or c:\data\db on Windows), and listening on port 27017, just type

```
$ ./mongod
```

**Alternate Data Directory, Default Port**

To specify a directory for Mongo to store files, use the `--dbpath` option:

```
$ ./mongod --dbpath /var/lib/mongodb/
```

Note that you must create the directory and set its permissions appropriately ahead of time -- Mongo will not create the directory if it doesn't exist.

**Alternate Port**

You can specify a different port for Mongo to listen on for connections from clients using the `--port` option

```
$ ./mongod --port 12345
```

This is useful if you want to run more than one instance of Mongo on a machine (e.g., for running a master-slave pair).

**Running as a Daemon**

Note: these options are only available in MongoDB version 1.1 and later.

This will fork the Mongo server and redirect its output to a logfile. As with `--dbpath`, you must create the log path yourself, Mongo will not create parent directories for you.

```
$ ./mongod --fork --logpath /var/log/mongodb.log --logappend
```

**Stopping Mongo**

**Control-C**

If you have Mongo running in the foreground in a terminal, you can simply "Ctrl-C" the process. This will cause Mongo to do a clean exit, flushing and closing it's data files. Note that it will wait until all ongoing operations are complete.

**Sending shutdownServer() message from the mongo shell**

The shell can request that the server terminate.

```
$ ./mongo
> db.shutdownServer()
```

This command only works from localhost, or, if one is authenticated.

From a driver (where the helper function may not exist), one can run the command

```
{ "shutdown" : 1 }
```

**Sending a Unix INT or TERM signal**

You can cleanly stop mongod using a SIGINT or SIGTERM signal on Unix-like systems. Either `^C`, "kill -2 PID," or `kill -15 PID` will work.

Please note that sending a KILL signal `kill -9` will probably cause damage as mongod will not be able to cleanly exit. (In such a scenario, run the repairDatabase command.)

**Memory Usage**

Mongo uses memory mapped files to access data, which results in large numbers being displayed in tools like top for the mongod process. This is
not a concern, and is normal when using memory-mapped files. Basically, the size of mapped data is shown in the virtual size parameter, and resident bytes shows how much data is being cached in RAM.

You can get a feel for the "inherent" memory footprint of Mongo by starting it fresh, with no connections, with an empty /data/db directory and looking at the resident bytes. (Running with --nojni option will result in even lower core memory usage.)

Logging

MongoDB outputs some important information to stdout while its running. There are a number of things you can do to control this

**Command Line Options**

- `--quiet` - less verbose output
- `--verbose` - more verbose output
- `--logpath <file>` - output to file instead of stdout
  - if you use logpath, you can rotate the logs by either running the logRotate command (1.3.4+) or sending SIGUSR1

```
> db.runCommand("logRotate");
```

**Command Line Parameters**

MongoDB can be configured via command line parameters in addition to File Based Configuration. You can see the currently supported set of command line options by running the database with `-h [ --help ]` as a single parameter:

```
$ ./mongod -h
```

Information on usage of these parameters can be found in Starting and Stopping Mongo.

The following list of options is not complete; for the complete list see the usage information as described above.

**Basic Options**

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-h</td>
<td>--help</td>
</tr>
<tr>
<td>-f</td>
<td>--config &lt;file&gt;</td>
</tr>
<tr>
<td>--port &lt;portno&gt;</td>
<td>Specifies the port number on which Mongo will listen for client connections. Default is 27017</td>
</tr>
<tr>
<td>--bind_ip &lt;ip&gt;</td>
<td>Specifies a single IP that the database server will listen for</td>
</tr>
<tr>
<td>--dbpath &lt;path&gt;</td>
<td>Specifies the directory for datafiles. Default is /data/db or c:\data\db</td>
</tr>
<tr>
<td>--directoryperdb</td>
<td>Specify use of an alternative directory structure, in which files for each database are kept in a unique directory. (since 1.3.2)</td>
</tr>
<tr>
<td>--quiet</td>
<td>Reduces amount of log output</td>
</tr>
<tr>
<td>--logpath &lt;file&gt;</td>
<td>File to write logs to (instead of stdout). You can rotate the logs by sending SIGUSR1 to the server.</td>
</tr>
<tr>
<td>--logappend</td>
<td>Append to existing log file, instead of overwriting</td>
</tr>
<tr>
<td>--repairpath &lt;path&gt;</td>
<td>Root path for temporary files created during database repair. Default is dbpath value.</td>
</tr>
<tr>
<td>--fork</td>
<td>Fork the server process</td>
</tr>
<tr>
<td>--cpu</td>
<td>Enables periodic logging of CPU utilization and I/O wait</td>
</tr>
<tr>
<td>--noauth</td>
<td>Turns off security. This is currently the default</td>
</tr>
<tr>
<td>--auth</td>
<td>Turn on security</td>
</tr>
<tr>
<td>-v[v[v[v[v]]]]</td>
<td>Verbese logging output (-vvvvv is most verbose, -v == --verbose)</td>
</tr>
<tr>
<td>--verbose</td>
<td></td>
</tr>
<tr>
<td>--objcheck</td>
<td>Inspect all client data for validity on receipt (useful for developing drivers)</td>
</tr>
<tr>
<td>--quota</td>
<td>Enable db quota management</td>
</tr>
<tr>
<td>Option</td>
<td>Description</td>
</tr>
<tr>
<td>---------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>--dialog &lt;n&gt;</td>
<td>Set oplogging level where n is 0=off (default) 1=W 2=R 3=both 7=W+some reads</td>
</tr>
<tr>
<td>--nocursors</td>
<td>Diagnostic/debugging option</td>
</tr>
<tr>
<td>--nohints</td>
<td>Ignore query hints</td>
</tr>
<tr>
<td>--nohttpinterface</td>
<td>Disable the HTTP interface (localhost:27018)</td>
</tr>
<tr>
<td>--noscripting</td>
<td>Turns off server-side scripting. This will result in greatly limited functionality</td>
</tr>
<tr>
<td>--notablescan</td>
<td>Turns off table scans. Any query that would do a table scan fails</td>
</tr>
<tr>
<td>--noprealloc</td>
<td>Disable data file preallocation</td>
</tr>
<tr>
<td>--nssize &lt;MB&gt;</td>
<td>Specifies .ns file size for new databases</td>
</tr>
<tr>
<td>--sysinfo</td>
<td>Print system info as detected by Mongo and exit</td>
</tr>
<tr>
<td>--upgrade</td>
<td>Upgrade database files to new format if necessary</td>
</tr>
<tr>
<td></td>
<td>(required when upgrading from &lt;= 1.0 to 1.1+)</td>
</tr>
</tbody>
</table>

**Replication Options**

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>--master</td>
<td>Designate this server as a master in a master-slave setup</td>
</tr>
<tr>
<td>--slave</td>
<td>Designate this server as a slave in a master-slave setup</td>
</tr>
<tr>
<td>--source <a href="">server:port</a></td>
<td>Specify the source (master) for a slave instance</td>
</tr>
<tr>
<td>--only &lt;db&gt;</td>
<td>Slave only: specify a single database to replicate</td>
</tr>
<tr>
<td>--pairwith <a href="">server:port</a></td>
<td>Address of a server to pair with</td>
</tr>
<tr>
<td>--arbiter <a href="">server:port</a></td>
<td>Address of arbiter server</td>
</tr>
<tr>
<td>--autoresync</td>
<td>Automatically resync if slave data is stale</td>
</tr>
<tr>
<td>--oplogSize &lt;MB&gt;</td>
<td>Custom size for replication operation log</td>
</tr>
<tr>
<td>--opIdMem &lt;bytes&gt;</td>
<td>Size limit for in-memory storage of op ids</td>
</tr>
</tbody>
</table>

**File Based Configuration**

In addition to accepting Command Line Parameters, MongoDB can also be configured using a configuration file. A configuration file to use can be specified using the --config command line options. The following example configuration file demonstrates the syntax to use:

```
# This is an example config file for MongoDB.

dbpath = /var/lib/mongodb
bind_ip = 127.0.0.1
noauth = true # use 'true' for options that don't take an argument
```

**Notes**

- Lines starting with octothorpes (#) are comments
- Options are case sensitive
- The syntax is assignment of a value to an option name
- All command line options are accepted

**Hosting Center**

**Setup Instructions**

- Amazon EC2
- Joyent
- Linode
Hosted MongoDB

- MongoHQ provides cloud-style hosted MongoDB instances
- Mongo Machine is currently in private beta.

One-Click Installation

- Dreamhost offers instant configuration and deployment of MongoDB

Other

- EngineYard supports MongoDB on its private cloud.
- LOCUM Hosting House is a project-oriented shared hosting and VDS. MongoDB is available for all customers as a part of their subscription plan.

Amazon EC2

- Instance Types
- Linux
- EC2 TCP Port Management
- EBS Snapshotting

MongoDB runs well on Amazon EC2. This page includes some notes in this regard.

**Instance Types**

MongoDB works on most EC2 types including Linux and Windows. We recommend you use a 64 bit instance as this is required for all databases of significant size.

**Linux**

One can download a binary or build from source. Generally it is easier to download a binary. We can download and run the binary without being root. For example on 64 bit Linux:

```
[-]$: curl -O http://downloads.mongodb.org/linux/mongodb-linux-x86_64-1.0.1.tgz
[-]$: tar -xzf mongodb-linux-x86_64-1.0.1.tgz
[-]$: cd mongodb-linux-x86_64-1.0.1/bin
[bin]$: ./mongod --version
```

Before running the database one should decide where to put datafiles. Run `df -h` to see volumes. On some images `/mnt` will be the many locally attached storage volume. Alternatively you may want to use Elastic Block Store which will have a different mount point. Regardless, create a directory in the desired location and then run the database:

```
mkdir /mnt/db
./mongod --fork --logpath ~/mongod.log --dbpath /mnt/db/
```

**EC2 TCP Port Management**

By default the database will now be listening on port 27017. The web administrative UI will be on port 28017.

**EBS Snapshotting**

If your datafiles are on an EBS volume, you can snapshot them for backups. Use the `fsync` lock command to lock the database to prevent writes. Then, snapshot the volume. Then use the `unlock` command to allow writes to the database again. See the `fsync` documentation for more information.

This method may also be used with slave databases.
The prebuilt MongoDB Solaris 64 binaries work with Joyent accelerators.

Some newer gcc libraries are required to run -- see sample setup session below.

```bash
$ # assuming a 64 bit accelerator
$ /usr/bin/isainfo -kv
64-bit amd64 kernel modules

$ # get mongodb
$ # note this is 'latest' you may want a different version
$ gzip -d mongodb-sunos5-x86_64-latest.tgz
$ mv "mongodb-sunos5-x86_64-2009-10-26" mongo

$ cd mongo

$ # get extra libraries we need (else you will get a libstdc++.so.6 dependency issue)
$ tar -xf mongo-extra-64.tar

$ # just as an example - you will really probably want to put these somewhere better:
$ export LD_LIBRARY_PATH=mongo-extra-64
$ bin/mongod --help
```

Import Export Tools

- **mongoimport**
- **mongoexport**
- **mongodump**
- **mongorestore**

### mongoimport

This utility takes a single file that contains 1 JSON/CSV/TSV string per line and inserts it. You have to specify a database and a collection.

```bash
options:
   --help      produce help message
   -v [ --verbose ] be more verbose (include multiple times for more
                   verbosity e.g. -vvvv)
   -h [ --host ] arg   mongo host to connect to (*left,right* for pairs)
   -d [ --db ] arg database to use
   -c [ --collection ] arg collection to use (some commands)
   -u [ --username ] arg username
   -p [ --password ] arg password
   --dbpath arg directly access mongod data files in the given path,
                   instead of connecting to a mongod instance - needs to
                   lock the data directory, so cannot be used if a
                   mongod is currently accessing the same path
   --directoryperdb if dbpath specified, each db is in a separate
                   directory
   -f [ --fields ] arg comma seperated list of field names e.g. -f name,age
   --fieldFile arg file with fields names - 1 per line
   --ignoreBlanks if given, empty fields in csv and tsv will be ignored
   --type arg type of file to import. default: json (json,csv,tsv)
   --file arg file to import from; if not specified stdin is used
   --drop drop collection first
   --headerline CSV,TSV only - use first line as headers
```

### mongoexport

This utility takes a collection and exports to either JSON or CSV. You can specify a filter for the query, or a list of fields to output.
If you want to output CSV, you have to specify the fields in the order you want them.

Example

<table>
<thead>
<tr>
<th>options:</th>
<th>produce help message</th>
</tr>
</thead>
<tbody>
<tr>
<td>--help</td>
<td>produce help message</td>
</tr>
<tr>
<td>-v [ --verbose ]</td>
<td>be more verbose (include multiple times for more verbosity e.g. -vvvvv)</td>
</tr>
<tr>
<td>-h [ --host ] arg</td>
<td>mongo host to connect to (&quot;left,right&quot; for pairs)</td>
</tr>
<tr>
<td>-d [ --db ] arg</td>
<td>database to use</td>
</tr>
<tr>
<td>-c [ --collection ] arg</td>
<td>collection to use (some commands)</td>
</tr>
<tr>
<td>-u [ --username ] arg</td>
<td>username</td>
</tr>
<tr>
<td>-p [ --password ] arg</td>
<td>password</td>
</tr>
<tr>
<td>--dbpath arg</td>
<td>directly access mongod data files in the given path, instead of connecting to a mongod instance - needs to lock the data directory, so cannot be used if a mongod is currently accessing the same path</td>
</tr>
<tr>
<td>--directoryperdb</td>
<td>if dbpath specified, each db is in a separate directory</td>
</tr>
<tr>
<td>-q [ --query ] arg</td>
<td>query filter, as a JSON string</td>
</tr>
<tr>
<td>-f [ --fields ] arg</td>
<td>comma separated list of field names e.g. -f name,age</td>
</tr>
<tr>
<td>--csv</td>
<td>export to csv instead of json</td>
</tr>
<tr>
<td>-o [ --out ] arg</td>
<td>output file; if not specified, stdout is used</td>
</tr>
</tbody>
</table>

**mongodump**

This takes a database and outputs it in a binary representation. This is mostly used for doing hot backups of a database.

<table>
<thead>
<tr>
<th>options:</th>
<th>produce help message</th>
</tr>
</thead>
<tbody>
<tr>
<td>--help</td>
<td>produce help message</td>
</tr>
<tr>
<td>-v [ --verbose ]</td>
<td>be more verbose (include multiple times for more verbosity e.g. -vvvvv)</td>
</tr>
<tr>
<td>-h [ --host ] arg</td>
<td>mongo host to connect to (&quot;left,right&quot; for pairs)</td>
</tr>
<tr>
<td>-d [ --db ] arg</td>
<td>database to use</td>
</tr>
<tr>
<td>-c [ --collection ] arg</td>
<td>collection to use (some commands)</td>
</tr>
<tr>
<td>-u [ --username ] arg</td>
<td>username</td>
</tr>
<tr>
<td>-p [ --password ] arg</td>
<td>password</td>
</tr>
<tr>
<td>--dbpath arg</td>
<td>directly access mongod data files in the given path, instead of connecting to a mongod instance - needs to lock the data directory, so cannot be used if a mongod is currently accessing the same path</td>
</tr>
<tr>
<td>--directoryperdb</td>
<td>if dbpath specified, each db is in a separate directory</td>
</tr>
<tr>
<td>-q [ --query ] arg</td>
<td>query filter, as a JSON string</td>
</tr>
<tr>
<td>-f [ --fields ] arg</td>
<td>comma separated list of field names e.g. -f name,age</td>
</tr>
<tr>
<td>--csv</td>
<td>export to csv instead of json</td>
</tr>
<tr>
<td>-o [ --out ] arg (=dump)</td>
<td>output directory</td>
</tr>
</tbody>
</table>

**mongorestore**

This takes the output from mongodump and restores it.
usage: ./mongorestore [options] [directory or filename to restore from]

options:
--help             produce help message
-v [ --verbose ]    be more verbose (include multiple times for more
                   verbosity e.g. -vvvvv)
-h [ --host ] arg   mongo host to connect to ("left,right" for pairs)
-d [ --db ] arg     database to use
-c [ --collection ] arg collection to use (some commands)
-u [ --username ] arg username
-p [ --password ] arg password
--dbpath arg        directly access mongod data files in the given path,
                   instead of connecting to a mongod instance - needs to
                   lock the data directory, so cannot be used if a
                   mongod is currently accessing the same path
--directoryperdb    if dbpath specified, each db is in a separate
directory
--drop             drop each collection before import
--objcheck         validate object before inserting

GridFS Tools

File Tools

mongo files is a tool for manipulating GridFS from the command line.

Example:

$ ./mongo files list
connected to: 127.0.0.1

$ ./mongo files put libmongoclient.a
connected to: 127.0.0.1
done!

$ ./mongo files list
connected to: 127.0.0.1
libmongoclient.a 1200964

$ cd /tmp/

$ ~/work/mon/mongo files get libmongoclient.a

$ ~/work/mon/mongo files get libmongoclient.a
connected to: 127.0.0.1
done write to: libmongoclient.a

$ md5 libmongoclient.a
MD5 (libmongoclient.a) = 23a52d361cfa7bad98099c5bad50dc41

$ md5 ~/work/erh/work/mon/mongo/libmongoclient.a = 23a52d361cfa7bad98099c5bad50dc41

Monitoring and Diagnostics

- Query Profiler
- Http Console
- mongostat Utility
- db.serverStatus() from mongo shell
- Trending/Monitoring Adaptors
- Database Record/Replay
Query Profiler

Use the Database Profiler to analyze slow queries.

Http Console

The mongod process includes a simple diagnostic screen at http://localhost:28017/. See the Http Interface docs for more information.

mongostat Utility

- mongostat

**db.serverStatus() from mongo shell**

```javascript
> db.stats()
> db.serverStatus()
> db.foo.find().explain()
> help
> db.help()
> db.foo.help()
```

Server Status Fields

- globalLock - totalTime & lockTime are total ms since startup that there has been a write lock
- mem - current usage in megabytes
- indexCounters - counters since startup, may rollover
- opcounters - operation counters since startup
- asserts - assert counters since startup

Trending/Monitoring Adaptors

- munin
- ganglia
- scout app slow queries
- cacti

Database Record/Replay

Recording database operations, and replaying them later, is sometimes a good way to reproduce certain problems in a controlled environment.

To enable logging:

```
db._adminCommand( { diagLogging : 1 } )
```

To disable:

```
db._adminCommand( { diagLogging : 0 } )
```

Values for diagLogging:

- 0 off. Also flushes any pending data to the file.
- 1 log writes
- 2 log reads
- 3 log both

Note: if you log reads, it will record the findOnes above and if you replay them, that will have an effect!

Output is written to diaglog.bin_ in the /data/db/ directory (unless --dbpath is specified).

To replay the logged events:

```
nc '"database_server_ip"' 27017 < '"somelog.bin"' | hexdump -c
```
mongosniff Utility

- mongosniff

Http Interface

- REST - Sleepy Mongoose
- HTTP Console Page
- HTTP Console Security
- Simple REST Interface
  - JSON in the simple REST interface
  - See Also

REST - Sleepy Mongoose

Sleepy Mongoose is a full featured REST interface for MongoDB which is available as a separate project.

The remainder of this page describes the very basic HTTP interface built into the mongod process.

HTTP Console Page

MongoDB provides a simple http interface listing information of interest to administrators. This interface may be accessed at the port with numeric value 1000 more than the configured mongod port; the default port for the http interface is 28017. To access the http interface an administrator may, for example, point a browser to http://localhost:28017 if mongod is running with the default port on the local machine.

Here is a description of the informational elements of the http interface:

<table>
<thead>
<tr>
<th>element</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>db version</td>
<td>database version information</td>
</tr>
<tr>
<td>git hash</td>
<td>database version developer tag</td>
</tr>
</tbody>
</table>
### sys info
- mongod compilation environment

### dblocked
- indicates whether the primary mongod mutex is held

### uptime
- time since this mongod instance was started

### assertions
- any software assertions that have been raised by this mongod instance

### replInfo
- information about replication configuration

### currentOp
- most recent client request

### # databases
- number of databases that have been accessed by this mongod instance

### curclient
- last database accessed by this mongod instance

### Cursors
- describes outstanding client cursors

### master
- whether this mongod instance has been designated a master

### slave
- whether this mongod instance has been designated a slave

### initialSyncCompleted
- whether this slave or repl pair node has completed an initial clone of the mongod instance it is replicating

### DBTOP
- Displays the total time the mongod instance has devoted to each listed collection, as well as the percentage of available time devoted to each listed collection recently and the number of reads, writes, and total calls made recently

### dt
- Timing information about the primary mongod mutex

### HTTP Console Security

If security is configured for a mongod instance, authentication is required for a client to access the http interface from another machine.

### Simple REST Interface

The mongod process includes a simple read-only REST interface for convenience. For full REST capabilities we recommend using an external tool such as Sleepy.Mongoose.

Note: in v1.3.4+ of MongoDB, this interface is disabled by default. Use `--rest` on the command line to enable.

To get the contents of a collection (note the trailing slash):

```
http://127.0.0.1:28017/databaseName/collectionName/
```

To add a limit:

```
http://127.0.0.1:28017/databaseName/collectionName/?limit=-10
```

To skip:

```
http://127.0.0.1:28017/databaseName/collectionName/?skip=5
```

To query for `{a : 1}`:

```
http://127.0.0.1:28017/databaseName/collectionName/?filter_a=1
```

Separate conditions with an `&`:

```
http://127.0.0.1:28017/databaseName/collectionName/?filter_a=1&limit=-10
```

### JSON in the simple REST interface

The simple ReST interface uses strict JSON (as opposed to the shell, which uses Dates, regular expressions, etc.). To display non-JSON types, the web interface wraps them in objects and uses the key for the type. For example:
The code type has not been implemented yet and causes the DB to crash if you try to display it in the browser. See Mongo Extended JSON for details.

See Also

- Diagnostic Tools

**mongostat**

Use the mongostat utility to quickly view statistics on a running mongod instance.

```
Starting in 1.3.3
```

```
$ ./mongostat --help
Options:
  --help       produce help message
  -v [ --verbose ]   be more verbose (include multiple times for more
                    verbosity e.g. -vvvvv)
  -h [ --host ] arg  mongo host to connect to ("left,right" for pairs)
  -d [ --db ] arg    database to use
  -c [ --collection ] arg collection to use (some commands)
  -u [ --username ] arg  username
  -p [ --password ] arg  password
```

**mongosniff**

Unix releases of MongoDB include a utility called mongosniff. This utility is to MongoDB what tcpdump is to TCP/IP; that is, fairly low level and for complex situations. The tool is quite useful for authors of driver tools.
Building

mongosniff is including in the binaries for Unix distributions. The MongoDB SConstruct only builds mongosniff if libpcap is installed.

```
sudo yum install libpcap-devel
scons mongosniff
```

DBA Operations from the Shell

This page lists common DBA-class operations that one might perform from the MongoDB shell.

Note one may also create .js scripts to run in the shell for administrative purposes.

```
help                         show help
show dbs                     show database names
show collections             show collections in current database
show users                   show users in current database
show profile                 show most recent system.profile entries with time >= 1ms
use <db name>                set curent database to <db name>
```

```
db.addUser (username, password)
db.removeUser(username)
db.cloneDatabase(fromhost)
db.copyDatabase(fromdb, todb, fromhost)
db.createCollection(name, { size : ..., capped : ..., max : ... } )
db.getName()
db.dropDatabase()
db.printCollectionStats()
```

```
db.currentOp() displays the current operation in the db
db.killOp() kills the current operation in the db
db.getProfilingLevel()
db.setProfilingLevel(level) 0=off 1=slow 2=all
```

```
db.getReplicationInfo()
db.printReplicationInfo()
db.printSlaveReplicationInfo()
db.repairDatabase()
db.version() current version of the server
db.shutdownServer()
```

Commands for manipulating and inspecting a collection:
db.foo.drop() drop the collection
db.foo.dropIndex(name)
db.foo.dropIndexes()
db.foo.getIndexes()
db.foo.ensureIndex(keypattern,options) - options object has these possible fields: name, unique, dropDups

db.foo.find([query], [fields]) - first parameter is an optional query filter. second parameter is optional set of fields to return. e.g. db.foo.find{
  x : 77 ,
  name : 1 , x : 1 }

db.foo.find(...).count()
db.foo.find(...).limit(n)
db.foo.find(...).skip(n)
db.foo.find(...).sort(...)
db.foo.findOne([query])

db.foo.getDB() get DB object associated with collection
db.foo.count()
db.foo.group({ key : ..., initial: ... , reduce : ...[, cond: ...] })

db.foo.renameCollection(newName) renames the collection
db.foo.stats()
db.foo.dataSize()
db.foo.storageSize() - includes free space allocated to this collection
db.foo.totalIndexSize() - size in bytes of all the indexes
db.foo.totalSize() - storage allocated for all data and indexes
db.foo.validate() (slow)

db.foo.insert(obj)
db.foo.update(query, object[, upsert_bool])
db.foo.save(obj)
db.foo.remove(query) - remove objects matching query remove({}) will remove all

### Database Profiler

Mongo includes a profiling tool to analyze the performance of database operations.

See also the `currentOp` command.

#### Enabling Profiling

To enable profiling, from the `mongo` shell invoke:

```shell
> db.setProfilingLevel(2);
{ "was" : 0 , "ok" : 1 }
> db.getProfilingLevel() 2
```

Profiling levels are:

- 0 - off
- 1 - log slow operations (>100ms)
- 2 - log all operations

Starting in 1.3.0, you can also enable on the command line, --profile=1

#### Viewing
Profiling data is recorded in the database’s `system.profile` collection. Query that collection to see the results.

```
> db.system.profile.find()
{"ts": "Thu Jan 29 2009 15:19:32 GMT-0500 (EST)" , "info": "query test.$cmd ntoreturn:1 reslen:66 nscanned:0 <br>query: { profile: 2 } nreturned:1 bytes:50" , "millis": 0}
```

To see output without `$cmd` (command) operations, invoke:

```
db.system.profile.find( function() { return this.info.indexOf('$cmd')<0; } )
```

To view operations for a particular collection:

```
> db.system.profile.find( { info: /test.foo/ } )
{"ts": "Thu Jan 29 2009 15:19:40 GMT-0500 (EST)" , "info": "insert test.foo" , "millis": 0}
{"ts": "Thu Jan 29 2009 15:19:42 GMT-0500 (EST)" , "info": "insert test.foo" , "millis": 0}
{"ts": "Thu Jan 29 2009 15:19:45 GMT-0500 (EST)" , "info": "query test.foo ntoreturn:0 reslen:102 nscanned:2 <br>query: {} nreturned:2 bytes:86" , "millis": 0}
{"ts": "Thu Jan 29 2009 15:21:17 GMT-0500 (EST)" , "info": "query test.foo ntoreturn:0 reslen:36 nscanned:2 <br>query: { $not: { x: 2 } } nreturned:0 bytes:20" , "millis": 0}
{"ts": "Thu Jan 29 2009 15:21:27 GMT-0500 (EST)" , "info": "query test.foo ntoreturn:0 exception bytes:53" , "millis": 88}
```

To view operations slower than a certain number of milliseconds:

```
> db.system.profile.find( { millis : { $gt : 5 } } )
{"ts": "Thu Jan 29 2009 15:21:27 GMT-0500 (EST)" , "info": "query test.foo ntoreturn:0 exception bytes:53" , "millis": 88}
```

To see newest information first:

```
db.system.profile.find().sort({$natural:-1})
```

The mongo shell includes a helper to see the most recent 5 profiled events that took at least 1ms to execute. Type `show profile` at the command prompt to use this feature.

**Understanding the Output**

The output reports the following values:

- **ts** Timestamp of the profiled operation.
- **millis** Time, in milliseconds, to perform the operation.
- **info** Details on the operation.
  - **query** A database query operation. The query info field includes several additional terms:
    - **ntoreturn** Number of objects the client requested for return from a query. For example, `<code>findOne()</code>` sets `ntoreturn` to 1. `<code>limit()</code>` sets the appropriate limit. Zero indicates no limit.
    - **query** Details of the query spec.
    - **nscanned** Number of objects scanned in executing the operation.
    - **reslen** Query result length in bytes.
    - **nreturned** Number of objects returned from query.
  - **update** A database update operation. `<code>save()</code>` calls generate either an update or insert operation.
    - **fastmod** Indicates a fast modify operation. See Updates. These operations are normally quite fast.
    - **fastmodinsert** indicates a fast modify operation that performed an upsert.
    - **upsert** Indicates on upsert performed.
    - **moved** Indicates the update moved the object on disk (not updated in place). This is slower than an in place update, and normally occurs when an object grows.
  - **insert** A database insert.
  - **getmore** For large queries, the database initially returns partial information. `getmore` indicates a call to retrieve further information.

**Optimizing Query Performance**

- If `nscanned` is much higher than `nreturned`, the database is scanning many objects to find the target objects. Consider creating an
index to improve this.

- reslen A large number of bytes returned (hundreds of kilobytes or more) causes slow performance. Consider passing `<code>find()</code>` a second parameter of the member names you require.

**Note:** There is a cost for each index you create. The index causes disk writes on each insert and some updates to the collection. If a rare query, it may be better to let the query be "slow" and not create an index. When a query is common relative to the number of saves to the collection, you will want to create the index.

**Optimizing Update Performance**

- Examine the `nscanned` info field. If it is a very large value, the database is scanning a large number of objects to find the object to update. Consider creating an index if updates are a high-frequency operation.
- Use fast modify operations when possible (and usually with these, an index). See Updates.

**Profiler Performance**

When enabled, profiling affects performance, although not severely.

Profile data is stored in the database's `system.profile` collection, which is a Capped Collection. By default it is set to a very small size and thus only includes recent operations.

**Configuring "Slow"**

Since 1.3.0 there are 2 ways to configure "slow"

- `--slowms` on the command line when starting mongod (or file config)
- `db.setProfilingLevel( level , slowms )`

```javascript
  db.setProfilingLevel( 1 , 10 );
```

will log all queries over 10ms to system.profile

**See Also**

- Optimization
- `explain()`
- Viewing and Terminating Current Operation

**Sharding**

**Introduction**

MongoDB has been designed to scale horizontally via an auto-sharding architecture. Auto-sharding permits the development of large-scale data clusters that incorporate additional machines dynamically, automatically accomodate changes in load and data distribution, and ensure automated failover.

Sharding will be production-ready in MongoDB v1.6, estimated to be released in July, 2010. In the meantime, an alpha version of sharding is available in the 1.5.x development branch. Please see the limitations page for progress updates and current restrictions.

**Docs**

1. **Introduction and Overview**
   Here we provide an introduction to MongoDB's auto-sharding, highlighting its philosophy, use cases, and its core components.

2. **Configuration and Management**
   How to set up a sharding cluster and manage it.
   - Configuration
   - Administration
   - Failover

3. **Sharding Internals**
   Auto-Sharding implementation details.

4. **Restrictions and Limitations**
   Sharding in the 1.5.x development branch is not yet production-ready. Here you can find out the current limitations and keep track of progress
towards the 1.6 production release.

5. FAQ
Common questions.

Sharding Introduction

MongoDB supports an automated sharding architecture, enabling horizontal scaling across multiple nodes. For applications that outgrow the resources of a single database server, MongoDB can convert to a sharded cluster, automatically managing failover and balancing of nodes, with few or no changes to the original application code.

This document explains MongoDB's auto-sharding approach to scalability in detail and provides an architectural overview of the various components that enable it.

Since auto-sharding as of the 1.5.x branch is still alpha, be sure to acquaint yourself with the current limitations.

- MongoDB's Auto-Sharding
- Sharding in a Nutshell
- Balancing and Failover
- Scaling Model
- Architectural Overview
  - Shards
    - Shard Keys
    - Chunks
  - Config Servers
  - Routing Processes
  - Operation Types
  - Server Layout
  - Configuration

MongoDB's Auto-Sharding

*Sharding in a Nutshell*

Sharding is the partitioning of data among multiple machines in an order-preserving manner. To take an example, let's imagine sharding a collection of users by their state of residence. If we designate three machines as our shard servers, the first of those machines might contain users from Alaska to Kansas, the second from Kentucky to New York, and the third from North Carolina to Wyoming.

Our application connects to the sharded cluster through a *mongos* process, which routes operations to the appropriate shard(s). In this way, the sharded MongoDB cluster continues to look like a single-node database system to our application. But the system's capacity is greatly enhanced. If our *users* collection receives heavy writes, those writes are now distributed across three shard servers. Queries continue to be efficient, as well, because they too are distributed. And since the documents are organized in an order-preserving manner, any operations specifying the state of residence will be routed only to those nodes containing that state.

Sharding occurs on a per-collection basis, not on the database as a whole. This makes sense since, as our application grows, certain collections will grow much larger than others. For instance, if we were building a service like Twitter, our collection of tweets would likely be several orders of magnitude larger than the next biggest collection. The size and throughput demands of such a collection would be prime for sharding, whereas smaller collections would still live on a single server. In the context on MongoDB's sharded architecture, non-sharded collections will reside on just one of the sharded nodes.

*Balancing and Failover*

A sharded architecture needs to handle balancing and failover. Balancing is necessary when the load on any one shard node grows out of proportion with the remaining nodes. In this situation, the data must be redistributed to equalize load across shards. A good portion of the work being applied to the 1.5.x branch is devoted to auto-balancing.

Automated failover is also quite important since proper system functioning requires that each shard node be always online. In practice, this means that each shard consists of more than one machine in a configuration known as a *replica set*. A replica set is a set of *n* servers, frequently three or more, each of which contains a replica of the entire data set for the given shard. One of the *n* servers in a replica set will always be master. If the master replica fails, the remaining replicas are capable of electing a new master. Thus is automated failover provided for the individual shard.

Replica sets are another focus of development in 1.5.x. See the documentation on replica sets for more details.

*Scaling Model*

MongoDB's auto-sharding scaling model shares many similarities with Yahoo's PNUTS and Google's BigTable. Readers interested in detailed discussions of distributed databases using order-preserving partitioning are encouraged to look at the PNUTS and BigTable white papers.

*Architectural Overview*

A MongoDB shard cluster consists of two or more shards, one or more config servers, and any number of routing processes to which the
application servers connect. Each of these components is described below in detail.

**Shards**

Each shard consists of one or more servers and stores data using *mongod* processes (*mongod* being the core MongoDB database process). In a production situation, each shard will consist of multiple replicated servers per shard to ensure availability and automated failover. The set of servers/*mongod* process within the shard comprise a *replica set*.

*Replica sets*, as discussed earlier, represent an improved version of MongoDB's replication (SERVER-557).

For testing, you can use sharding with a single *mongod* instance per shard. If you need redundancy, use one or more slaves for each shard's *mongod* master. This configuration will require manual failover until replica sets become available.

**Shard Keys**

To partition a collection, we specify a shard key pattern. This pattern is similar to the key pattern used to define an index; it names one or more fields to define the key upon which we distribute data. Some example shard key patterns include the following:

```json
{ state : 1 }
{ name : 1 }
{ _id : 1 }
{ lastname : 1, firstname : 1 }
{ tag : 1, timestamp : -1 }
```

MongoDB's sharding is order-preserving; adjacent data by shard key tends to be on the same server. The config database stores all the metadata indicating the location of data by range:

<table>
<thead>
<tr>
<th>collection</th>
<th>minKey</th>
<th>maxKey</th>
<th>location</th>
</tr>
</thead>
<tbody>
<tr>
<td>users</td>
<td>{ name : 'Miller' }</td>
<td>{ name : 'Nessman' }</td>
<td>shard2</td>
</tr>
<tr>
<td>users</td>
<td>{ name : 'Nessman' }</td>
<td>{ name : 'Ogden' }</td>
<td>shard4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>...</td>
</tr>
</tbody>
</table>

**Chunks**

A chunk is a contiguous range of data from a particular collection. Chunks are described as a triple of *collection, minKey, and maxKey*. Thus, the shard key K of a given document assigns that document to the chunk where minKey <= K < maxKey.
Chunks grow to a maximum size, usually 200MB. Once a chunk has reached that approximate size, the chunk splits into two new chunks. When a particular shard has excess data, chunks will then migrate to other shards in the system. The addition of a new shard will also influence the migration of chunks.

When choosing a shard key, keep in mind that these values should be granular enough to ensure an even distribution of data. For instance, in the above example, where we’re sharding on name, we have to be careful that we don’t have a disproportionate number of users with the same name. In that case, the individual chunk can become too large and find itself unable to split, e.g., where the entire range comprises just a single key.

Thus, if it’s possible that a single value within the shard key range might grow exceptionally large, it’s best to use a compound shard key instead so that further discrimination of the values will be possible.

**Config Servers**

The config servers store the cluster's metadata, which includes basic information on each shard server and the chunks contained therein.

Chunk information is the main data stored by the config servers. Each config server has a complete copy of all chunk information. A two-phase commit is used to ensure the consistency of the configuration data among the config servers.

If any of the config servers is down, the cluster's meta-data goes read only. However, even in such a failure state, the MongoDB cluster can still be read from and written to.

**Routing Processes**

The mongos process can be thought of as a routing and coordination process that makes the various components of the cluster look like a single system. When receiving client requests, the mongos process routes the request to the appropriate server(s) and merges any results to be sent back to the client.

mongos processes have no persistent state; rather, they pull their state from the config server on startup. Any changes that occur on the config servers are propagated to each mongos process.

mongos processes can run on any server desired. They may be run on the shard servers themselves, but are lightweight enough to exist on each application server. There are no limits on the number of mongos processes that can be run simultaneously since these processes do not coordinate between one another.

**Operation Types**

Operations on a sharded system fall into one of two categories: global and targeted.

For targeted operations, mongos communicates with a very small number of shards -- often a single shard. Such targeted operations are quite efficient.

Global operations involve the mongos process reaching out to all (or most) shards in the system.

The following table shows various operations and their type. For the examples below, assume a shard key of \{ x : 1 \}.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Type</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>db.foo.find( { x : 300 } )</td>
<td>Targeted</td>
<td>Queries a single shard.</td>
</tr>
<tr>
<td>db.foo.find( { x : 300, age : 40 } )</td>
<td>Targeted</td>
<td>Queries a single shard.</td>
</tr>
<tr>
<td>db.foo.find( { age : 40 } )</td>
<td>Global</td>
<td>Queries all shards.</td>
</tr>
<tr>
<td>db.foo.find()</td>
<td>Global</td>
<td>sequential</td>
</tr>
<tr>
<td>db.foo.find(...).count()</td>
<td>Variable</td>
<td>Same as the corresponding find() operation</td>
</tr>
<tr>
<td>db.foo.find(...).sort( { age : 1 } )</td>
<td>Global</td>
<td>parallel</td>
</tr>
<tr>
<td>db.foo.find(...).sort( { x : 1 } )</td>
<td>Global</td>
<td>sequential</td>
</tr>
<tr>
<td>db.foo.count()</td>
<td>Global</td>
<td>parallel</td>
</tr>
<tr>
<td>db.foo.insert( &lt;object&gt;\ )</td>
<td>Targeted</td>
<td></td>
</tr>
<tr>
<td>db.foo.update( { x : 100 }, &lt;object&gt;\ )</td>
<td>Targeted</td>
<td></td>
</tr>
<tr>
<td>db.foo.remove( { x : 100 } )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>db.foo.update( { age : 40 }, &lt;object&gt;\ )</td>
<td>Global</td>
<td></td>
</tr>
<tr>
<td>db.foo.remove( { age : 40 } )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Server Layout

Machines may be organized in a variety of fashions. For instance, it's possible to have separate machines for each config server process, mongos process, and mongod process. However, this can be overkill since the load is almost certainly low on the config servers. Here, then, is an example where some sharing of physical machines is used to lay out a cluster.

Yet more configurations are imaginable, especially when it comes to mongos. For example, it's possible to run mongos processes on all of servers 1-6. Alternatively, as suggested earlier, the mongos processes can exists on each application server (server 7). There is some potential benefit to this configuration, as the communications between app server and mongos then can occur over the localhost interface.

Configuration

Sharding becomes a bit easier to understand one you've set it up. It's even possible to set up a sharded cluster on a single machine. To try it for yourself, see the configuration docs:

Configuring Sharding

Configuring Sharding

Introduction

This document describes the steps involved in setting up a basic sharding cluster. A sharding cluster requires, at minimum, three components:

1. Two or more shards.
2. At least one config server.
3. A mongos routing process.

For testing purposes, it's possible to start all the processes involved on a single server, whereas in a production situation, a number of server configurations are possible.
Once the shards, config servers, and mongos processes are running, configuration is simply a matter of issuing a series of commands to establish the various shards as being part of the cluster. Once the cluster has been established, you can begin sharding individual collections.

This document is fairly detailed; if you're the kind of person who prefers a terse, code-only explanation, see the sample shard configuration.

- **Introduction**
- **1. Sharding Components**
  - Shard Servers
  - Config Servers
  - mongos Router
- **2. Configuring the Shard Cluster**
  - Adding shards
  - Optional Parameters
  - Listing shards
  - Enabling Sharding on a Database
  - 3. Sharding a Collection
  - Relevant Examples and Docs

### 1. Sharding Components

First, start the individual shards, config servers, and mongos processes.

#### Shard Servers

Run mongod on the shard servers. Use the --shardsvr command line parameter to indicate this mongod is a shard. For limited failover support, a replica pairs may be used as the individual shards --pairwith; however, the [replica set] will soon be the preferred failover configuration.

To get started with a simple test, we recommend running a single mongod process per shard, as a test configuration doesn't demand automated failover.

#### Config Servers

Run mongod on the config server(s) with the --configsvr command line parameter. If the config servers are running on a shared machine, be sure to provide a separate dbpath for the config data (--dbpath command line parameter).

#### mongos Router

Run mongos on the servers of your choice. Specify the --configdb parameter to indicate location of the config database(s).

### 2. Configuring the Shard Cluster

Once the shard components are running, issue the sharding commands. You may want to automate or record your steps below in a .js file for replay in the shell when needed.

Connect to one of the mongos processes started above, and switch to the admin database before issuing any commands.

Keep in mind that once these commands are run, the configuration data will be persisted to the config servers. So, regardless of the number of processes you've launched, you'll only need run these commands on one of those processes.

You can connect to the admin database via mongos like so:

```
./mongo <mongos-hostname>:<mongos-port>/admin
> db
admin
```

#### Adding shards

Each shard can consist of more than one server (see replica sets); however, for testing, only a single server with one mongod instance need be used.

You must explicitly add each shard to the cluster's configuration using the addshard command:

```
> db.runCommand({ addshard: "<serverhostname>[::<port>]", ok: 1, added: ... })
```

Run this command once for each shard in the cluster.

If the individual shards consist of pairs or sets of servers, their hosts and ports can be specified by comma-separating the server[port] names in the addshard command (alpha 3 and beyond).
Optional Parameters

**name**
Each shard has a name, which can be specified using the `name` option. If no name is given, one will be assigned automatically.

**maxSize**
The `addshard` command accepts an optional `maxSize` parameter. This parameter lets you tell the system a maximum amount of disk space in megabytes to use on the specified shard. If unspecified, the system will use the entire disk. `maxSize` is useful when you have machines with different disk capacities or when you want to prevent storage of too much data on a particular shard.

As an example:

```plaintext
> db.runCommand( { addshard : "sf103", maxSize:100000 } );
```

**Listing shards**
To see current set of configured shards, run the `listshards` command:

```plaintext
> db.runCommand( { listshards : 1 } );
```

This way, you can verify that all the shard have been committed to the system.

**Enabling Sharding on a Database**
Once you've added the various shards, you can enable sharding on a database. This is an important step; without it, all collection in the database will be stored on the same shard.

```plaintext
> db.runCommand( { enablesharding : "<dbname>" } );
```

Once enabled, mongos will place different collections for the database on different shards, with the caveat that each collection will still exists on one shard only. To enable real partitioning of date, we have to shard an individual collection.

3. Sharding a Collection
Use the `shardcollection` command to shard a collection. When you shard a collection, you must specify the shard key, for which an index will be automatically created.

```plaintext
> db.runCommand( { shardcollection : "<namespace>",
    key : <shardkeypatternobject> });
```

For example, let's assume we want to shard a GridFS `chunks` collection stored in the `test` database. We'd want to shard on the `files_id` keys, so we'd invoke the `shardcollection` command like so:

```plaintext
> db.runCommand( { shardcollection : "test.fs.chunks", key : { _id : 1 } } )
{ "ok" : 1 }
```

One note: a sharded collection can only have a single unique indexes, on the shard key. No other unique indexes can exist on the collection.

Here's how to make a shard key unique:

```plaintext
db.runCommand( { shardcollection : "test.users", key : { email : 1 }, unique : true } );
```

**Relevant Examples and Docs**

**Examples**
- Sample configuration session
- The following example shows how to run a simple shard setup on a single machine for testing purposes: Sharding JS Test.

**Docs**
A Sample Configuration Session

The following example uses two shards (one server each), one config db, and one mongos process, all running on a single test server.

```
$ mkdir /data/db/a
$ mkdir /data/db/b
$ mkdir /data/db/config
$ ./mongod --shardsvr --dbpath /data/db/a --port 10000 > /tmp/sharda.log &
$ cat /tmp/sharda.log
$ ./mongod --shardsvr --dbpath /data/db/b --port 10001 > /tmp/shardb.log &
$ cat /tmp/shardb.log
$ ./mongod --configsvr --dbpath /data/db/config --port 20000 > /tmp/configdb.log &
$ cat /tmp/configdb.log
$ ./mongos --configdb localhost:20000 > /tmp/mongos.log &
$ cat /tmp/mongos.log

$ # we connect to mongos process
$ ./mongo
MongoDB shell version: 1.1.0-
url: test
connecting to: test
type "help" for help
> use admin
switched to db admin
> db.runCommand( { addshard : "localhost:10000", allowLocal : true } )
{"ok" : 1, "added" : "localhost:10000"}
> db.runCommand( { addshard : "localhost:10001", allowLocal : true } )
{"ok" : 1, "added" : "localhost:10001"}
> config = connect("localhost:20000")
> config = config.getSisterDB("config")
> test = db.getSisterDB("test")
test
> db.runCommand( { enablesharding : "test" } )
{"ok" : 1}
> db.runCommand( { shardcollection : "test.people", key : {name : 1} } )
{"ok" : 1}
> db.runCommand({listshards:1})
{"servers": [{"_id": ObjectId("4a9d40c981ba1487ccfaa634"), "host": "localhost:10000"},
              {"_id": ObjectId("4a9d40df81ba1487ccfaa635"), "host": "localhost:10001"}],
"ok" : 1}>
```

Sharding Administration

See also Configuring.

```
> // test if we are speaking to a mongos process or
> // straight to a mongod process
> db.$cmd.findOne({isdbgrid:1});
> // mongos returns { ismaster: 0.0, msg: "isdbgrid" }
> db.$cmd.findOne({ismaster:1});
```

List Existing Shards
List Which Databases are Sharded

Here we query the config database (through mongos – your shell connection is connected to a mongos and it connects to the config database automatically).

```bash
> config = db.getSisterDB("config")
> config.system.namespaces.find()
```

See full sharding setup

```bash
> printShardingStatus( db.getSisterDB( "config" ) );
```

Moving a chunk manually

has to be run on admin db

```bash
db.runCommand( { movechunk : <full ns> , find : <something in the chunk> , to : <shard name> } )
```

example:

```bash
db.runCommand( { movechunk : "test.blog.posts" , find : { title : "The Cool Post" } , to : "192.168.1.2" } )
```

More

```bash
> db.runCommand({netstat:1})
implementation pending...
```

Sharding and Failover

**Failure of a mongod process within a shard (PLANNED)**

If a member of a replica set in a shard is down, read and write operations are still permitted. Replica sets functionality is pending: SERVER-557.

**Failure of all mongod processes within a shard**

If all replicas within a shard are down, the data within that shard is (at least temporarily) unavailable. Queries which can be resolved at other shards continue to work properly. Queries that require the down shard will return an error.

**Failure of a config server**

When one of the config servers is down, split and migrate operations do not happen. Other aspects of the system including conventional reads and writes continue properly. It is important that the down config server be repaired by the administrator in a reasonable period of time (say, 1 day) so that shards do not become unbalanced due to lack of migrates (which may or may not happen in practice). Note if repairing the down config server will be difficult, it could simply be retired and removed from the cluster; another can be added back later.
Sharding Limits

Sharding Alpha 2 (MongoDB v1.1)

- Work is still underway on replication/failover. For Alpha 2, please use a single mongod master per shard (and manual slaves if desired). Replica sets, which are intended for use with sharding, are coming: SERVER-557.
- `group()` is not supported in alpha 2. In generally, we recommend using the `map/reduce facility` in sharded environments.
- Sharding must be ran in trusted security mode, without explicit `security`.

Shard Keys

- Shard keys are immutable in the current version.
- Compound shard keys are not yet supported, but will be in the future.

Differences from Unsharded Configurations

Sharded databases behave differently in certain circumstances from a standalone, single-server mongod instance.

$where

$where works with sharding. However do not reference the `db` object from the `$where` function (one normally does not do this anyway).

db.eval

db.eval() may not be used with sharded collections. However, you may use `db.eval()` if the evaluation function accesses unsharded collections within your database. Use `map/reduce` in sharded environments.

getPrevError

getPrevError is unsupported for sharded databases, and may remain so in future releases (TBD).

Unique Indexes

For a sharded collection, you may only (optionally) specify a unique constraint on the shard key. Other secondary indexes work (via a `global` operation) as long as no unique constraint is specified.

Counts

Count is supported with sharding; however, a "count all in collection" will not be instantaneous for a sharded collection as it is for an unsharded collection.

Scale Limits

Goal is support of systems of up to 1,000 shards. Testing for Alpha 2 will be limited to clusters with a modest number of shards (e.g., 20). More information will be reported here later on any scaling limitations which are encountered.

MongoDB sharding supports two `styles of operations` -- targeted and global. On giant systems, global operations will be of less applicability.

Sharding Internals

This section includes internal implementation details for MongoDB auto sharding. See also the `main sharding documentation`.

Note: some internals docs could be out of date -- if you see that let us know so we can fix.

Internals

- Moving Chunks
- Sharding Config Schema
- Sharding Design
- Sharding Use Cases
- Shard Ownership
- Splitting Shards

Unit Tests

```
./mongo --nodb jstests/sharding/*js
```
Moving Chunks

- inc version
- try to set on from
- if set is successful, have it "locked"
- start transfer
- finish transfer
- commit result

max version for a shard is $\text{MAX}(\text{chunks on shard})$
this poses slight problem when moving last chunk off of a shard, so add a special marker

Sharding Config Schema

Sharding configuration schema. This lives in the config servers.

Collections
version

This is a singleton that contains the current meta-data version number.

```javascript
> db.getCollection("version").findOne()
{ "_id": 1, "version": 2 }
```

settings

Key/Value table for configurable options (chunkSize)

```javascript
> db.settings.find()
{ "_id": "chunksize", "value": 200 } 
{ "_id": "balancer", "who": "ubuntu:27017", "x": ObjectId("4bd0cb39503139ae28630ee9") }
```

shards

Stores information about the shards.

```javascript
> db.shards.findOne()
{ "_id": "shard0", "host": "localhost:30001" }
```

databases

```javascript
{ 
  "_id": "admin",
  "partitioned": false,
  "primary": "localhost:20001"
}
```

chunks
mongos

Record of all mongos affiliated with this cluster. mongos will ping every 30 seconds so we know who is alive.

```javascript
> db.mongos.findOne()
{
  "_id" : "erh-wd1:27017",
  "ping" : "Fri Apr 23 2010 11:08:39 GMT-0400 (EST)",
  "up" : 30
}
```

changelog

Human readable log of all meta-data changes. Capped collection that defaults to 10mb.
> db.changelog.findOne()
{
  
  
  "_id": "erah-wd1-2010-3-21-17-24-0",
  "server": "erah-wd1",
  "time": "Wed Apr 21 2010 13:24:24 GMT-0400 (EST)",
  "what": "split",
  "ns": "test.foo",
  "details": {
    "before": {
      "min": { $minKey: 1 }
    },
    "max": {
      "max": { $maxKey: 1 }
    }
  },
  "left": {
    "min": {
      
      "min": { $minKey: 1 }
    },
    "max": {
      "max": 5
    }
  },
  "right": {
    "min": {
      "$x": 5
    },
    "max": {
      "$x": { $maxKey: 1 }
    }
  }
}
collection lists where to find particular chunks; that is, it maps chunk->shard.

- mongos process
  - "routes" request to proper db's, and performs merges. can have a couple per system, or can have 1 per client server.
  - gets chunk locations from the client db's home shard. load lazily to avoid using too much mem.
  - chunk information is cached by mongos. This information can be stale at a mongos (it is always up to date at the owning shard; you cannot migrate an item if the owning shard is down). If so, the shard contacted will tell us so and we can then retry to the proper location.

db operations

- moveprimary - move a database's primary server
- migrate - migrate a chunk from one machine to another.
  - lock and migrate
  - shard db's coordinate with home shard to atomically pass over ownership of the chunk (two phase commit)
  - split - split a chunk that is growing too large into pieces. as the two new chunks are on the same machine after the split, this is really just a metadata update and very fast.
  - reconfiguration operations
  - add shard - dbgrid processes should lazy load information on a new (unknown) shard when encountered.
  - retire shard - in background gradually migrate all chunks off

minimizing lock time

If a chunk is migrating and is 50MB, that might take 5-10 seconds which is too long for the chunk to be locked.

We could perform the migrate much like Cloner works, where we copy the objects and then apply all operations that happened during copying. This way lock time is minimal.

Sharding Use Cases

What specific use cases do we want to address with db partitioning (and other techniques) that are challenging to scale? List here for discussion.

- video site (e.g., youtube) (also, GridFS scale-up)
  - seems straightforward: partition by video
  - for related videos feature, see search below
- social networking (e.g., facebook)
  - this can be quite hard to partition, because it is difficult to cluster people.
  - very high RPS sites with small datasets
    - N replicas, instead of partitioning, might help here
    - replicas only work if the dataset is really small as we are using/wasting the same RAM on each replica. thus, partitioning might help us with ram cache efficiency even if entire data set fits on one or two drives.
- twitter
- search & tagging

Log Processing

Use cases related to map-reduce like things.

- massive sort
- top N queries per day
- compare data from two nonadjacent time periods

Shard Ownership

By shard ownership we mean which server owns a particular key range.

Early draft/thoughts will change:

Contract

- the master copy of the ownership information is in the config database
- mongos instances have cached info on which server owns a shard. this information may be stale.
- mongod instances have definitive information on who owns a shard (atomic with the config db) when they know about a shards ownership

mongod

The mongod processes maintain a cache of shards the mongod instance owns:
State values are as follows:

- missing - no element in the map means no information available. In such a situation we should query the config database to get the state.
- 1 - this instance owns the shard
- 0 - this instance does not own the shard (indicates we queried the config database and found another owner, and remembered that fact)

Initial Assignment of a Region to a Node

This is trivial: add the configuration to the config db. As the ShardKey is new, no nodes have any cached information.

Splitting a Key Range

The mongod instance A which owns the range R breaks it into R1,R2 which are still owned by it. It updates the config db. We take care to handle the config db crashing or being unreachable on the split:

```
lock(R) on A
update the config db -- ideally atomically perhaps with eval(). await return code.
ownership[R].erase
unlock(R) on A
```

After the above the cache has no information on the R,R1,R2 ownerships, and will requery configdb on the next request. If the config db crashed and failed to apply the operation, we are still consistent.

Migrate ownership of keyrange R from server A->B. We assume here that B is the coordinator of the job:

```
B copies range from A
lock(R) on A and B
    B copies any additional operations from A (fast)
    clear ownership maps for R on A and B. B waits for a response from A on this operation.
    B then updates the ownership data in the config db. (Perhaps even fsyncing.) await return code.
    unlock(R) on B
    delete R on A (cleanup)
    unlock (R) on A
```

We clear the ownership maps first. That way, if the config db update fails, nothing bad happens, IF mongos filters data upon receipt for being in the correct ranges (or in its query parameters).

R stays locked on A for the cleanup work, but as that shard no longer owns the range, this is not an issue even if slow. It stays locked for that operation in case the shard were to quickly migrate back.

Migrating Empty Shards

Typically we migrate a shard after a split. After certain split scenarios, a shard may be empty but we want to migrate it.

Splitting Shards

For chunk [lowbound,highbound)->shard, there are two types of splits we can perform. In one case, we split the range s.t. both new chunks have about the same number of values, in another, we split the range but one of the new chunk is empty.

When at least one bound is MinKey or MaxKey, we choose a split strategy s.t. all existing values remain in one chunk. For example:
chunk \((\text{MinKey}, \text{MaxKey})\) values \{ 1,5,9,12 \}
becomes
chunk \((\text{MinKey}, 13)\) values \{ 1,5,9,12 \}
chunk \([13, \text{MaxKey})\) values \{ \}

whereas

chunk \([0, 15)\) values \{ 1,5,9,12 \}
becomes
chunk \([0, 9)\) values \{ 1,5 \}
chunk \([9, 15)\) values \{ 9,12 \}

This approach is more efficient when items are added in key order.

### Sharding FAQ

- Where do unsharded collections go if sharding is enabled for a database?
- When will data be on more than one shard?
- What happens if I try to update a document on a chunk that is being migrated?
- What if a shard is down or slow and I do a query?
- How do queries distribute across shards?

Where do unsharded collections go if sharding is enabled for a database?

In alpha 2 unsharded data goes to the “primary” for the database specified (query `config.databases` to see details). Future versions will parcel out unsharded collections to different shards (that is, a collection could be on any shard, but will be on only a single shard if unsharded).

When will data be on more than one shard?

MongoDB sharding is range based. So all the objects in a collection get put into a chunk. Only when there is more than 1 chunk is there an option for multiple shards to get data. Right now, the chunk size is 50mb, so you need at least 50mb for a migration to occur.

What happens if I try to update a document on a chunk that is being migrated?

The update will go through immediately on the old shard, and then the change will be replicated to the new shard before ownership transfers.

What if a shard is down or slow and I do a query?

If a shard is down, the query will return an error. If a shard is responding slowly, mongos will wait for it. You won’t get partial results.

How do queries distribute across shards?

There are a few different cases to consider, depending on the query keys and the sort keys. Suppose 3 distinct attributes, X, Y, and Z, where X is the shard key. A query that keys on X and sorts on X will translate straightforwardly to a series of queries against successive shards in X-order. A query that keys on X and sorts on Y will execute in parallel on the appropriate shards, and perform a merge sort keyed on Y of the documents found. A query that keys on Y must run on all shards: if the query sorts by X, the query will serialize over shards in X-order; if the query sorts by Z, the query will parallelize over shards and perform a merge sort keyed on Z of the documents found.

### Replication

- Configuration Types
- Security
- Replication Acknowledgement via getlasterror
- Diagnostics
  - From the shell
  - Http Interface
- Command Line Options
  - Master Options
  - Slave Options
  - --slavedelay
- See Also

MongoDB supports replication of data between servers for failover and redundancy.

MongoDB replication is an enhanced form of master-slave configuration: that is, only one server is active for writes (the master) at a given time. With a single active master at any point in time, we can achieve strong consistency semantics. One can also optionally run queries on the slaves when eventually consistent read behavior is acceptable.
Configuration Types

- Master-Slave Replication
- Replica Pairs
- Replica Sets
- Limited Master-Master Replication

All else being equal, master/slave is recommended for MongoDB version 1.4.

Security

When security is enabled, one must configure a user account for the local database that exists on both servers.

The slave-side of a replication connection first looks for a user `repl in local.system.users`. If present, that user is used to authenticate against the local database on the source side of the connection. If `repl user` does not exist, the first user object in `local.system.users` is tried.

The `local` database works like the `admin` database: an account for `local` has access to the entire server.

Replication Acknowledgement via `getlasterror`

A new feature in 1.5.0 is the ability for a client to block until a write operation has been replicated to N servers. The way you do this is to use the `getlasterror` command with a new parameter "w"

```javascript
db.runCommand( { getlasterror : 1 , w : 2 } )
```

If w is not set, or <= 1, the command returns immediately, implying the data is on 1 server (itself). If w is 2, then the data is on the current server and 1 other slave.

The higher w is, the longer this might take. A recommended way of using this feature in a web context is to do all the write operations for a page, then call this once if needed. That way you’re only paying the cost once. Also in 1.5.0, replication is more real time, so on average, the added latency is very low.

There is an optional `wtimeout` parameter that allows you to timeout after a certain number of milliseconds and perhaps return an error to a user. For example, the following will wait for 3 seconds before giving up:

```javascript
> db.runCommand((getlasterror : 1, w : 40, wtimeout : 3000))
{    
  "err" : null,    
  "n" : 0,    
  "wtimeout" : true,    
  "waited" : 3006,    
  "errmsg" : "timed out waiting for slaves",    
  "ok" : 0
}
```

Note: the current implementation returns when the data has been delivered to w servers. Future versions will provide more options for delivery vs. say, physical fsync at the server.

Diagnostics

From the shell

Check master status from the `mongo` shell with:

```javascript
// inspects contents of local.oplog.$main on master and reports status:
db.printReplicationInfo()
```

Check slave status from the `mongo` shell with:

```javascript
// inspects contents of local.sources on the slave and reports status:
db.printSlaveReplicationInfo()
```
As of 1.3.2, you can do this on the slave

```
 db._adminCommand( { serverStatus : 1 , repl : N } )
```

N is the level of diagnostic information and can have the following values:

- 0 - none
- 1 - local (doesn't have to connect to other server)
- 2 - remote (has to check with the master)

**Http Interface**

The administrative [Http Interface](at port 28017) provides some basic status information on either a master or slave mongod process.

```
replInfo:  repl: sleep 2sec before next pass
replication
master:  0
slave:  1
initialSyncCompleted: 1
```

**Command Line Options**

**Master Options**

```
--master              master mode
--oplogSize arg       size limit (in MB) for op log
```

**Slave Options**

```
--slave               slave mode
--source arg          arg specifies master as <server:port>
--only arg            arg specifies a single database to replicate
--slavedelay arg      arg specifies delay (in seconds) to be used
                       when applying master ops to slave
--autoresync          automatically resync if slave data is stale
```

**--slavedelay**

Sometimes it's beneficial to have a slave that is purposefully many hours behind to prevent human error. In MongoDB 1.3.3+, you can specify this with the `--slavedelay` mongod command line option. Specify the delay in seconds to be used when applying master operations to the slave.

Specify this option at the slave. Example command line:

```
mongod --slave --source mymaster.foo.com --slavedelay 7200
```

**See Also**

- [Production Notes on Halted Replication](#)

**Replica Sets**

Replica sets are NOT ready to use as of the current 1.5.x release. Please watch this jira for more information: [http://jira.mongodb.org/browse/SERVER-557](http://jira.mongodb.org/browse/SERVER-557).
Replica Sets is "Replica Pairs version 2" and will be available in version 1.6.

- Supports more than two servers in the cluster
- Better failover and recovery between nodes
- Data center and rack aware
- Can have passive set members (slaves) that are never primary

**Docs**

- Replica Set Commands
- Replica Set Configuration
- Replica Set Internals

**Replica Set Commands**

```json
{ isMaster : 1 }
```

Checks if the node to which we are connecting is currently primary. Most drivers do this check automatically and then send requires to the current primary.

```json
{ replSetGetStatus : 1 }
```

Status information on the replica set from this node's point of view.

Can also be accesses through the [http interface](http://localhost:28017/replSetGetStatus) as

- http://localhost:28017/replSetGetStatus

```json
{ replSetInitiate : <config> }
```

Initiate a replica set. Run this command at one node only, to initiate the set. Whatever data is on the initiating node becomes the initial data for the set. This is a one time operation done at cluster creation. See also Configuration.

```json
{ replSetFreeze : <bool> }
```

Freezing a replica set prevents failovers from occurring. This can be useful during maintenance.

**Replica Set Configuration**

- Initial Setup
- `local.system.replset`
- Shell Example

**Initial Setup**

We use the initiate command for initial configuration of a replica set. Send the initiate command to a single server with the set.

```javascript
> db.runCommand( { replSetInitiate : <config_object> } )
```

`local.system.replset`

This collection holds a singleton object which contains the replica set configuration. The config object automatically propagates among members of the set. The object is not directly manipulated, but rather changed via commands (such as replSetInitiate).

The config object has the form:
priority - priority a server has for potential election as primary. The highest priority member which is up will become primary. Default 1.0. Priority zero means server can never be primary.

arbiterOnly - participates in consensus, but receives no data.

votes - number of votes this set member gets in elections. Default 1.

Heartbeat params are optional as reasonable settings are predefined.

- heartbeatSleep how frequently nodes should send a heartbeat to each other.
- heartbeatTimeout indicates how long a node needs to fail to send data before we note a problem.
- heartbeatConnRetries is how many times after heartbeatTimeout to try connecting again and getting a new heartbeat.

getLastErrorDefaults specifies defaults for the getlasterror command.

**Shell Example**

```bash
> cfg = {
... _id : "acme_a",
... members : [
... { _id : 0, host : "sf1.acme.com" },
... { _id : 1, host : "sf2.acme.com" },
... { _id : 2, host : "sf3.acme.com" } ] }
> use admin
> db.runCommand({replSetInitiate:cfg})
```

**Replica Set Internals**

- Design Concepts
- Configuration
  - Command Line
  - Node Types
  - local.system.replset
  - Set Initiation (Initial Setup)
- Design
  - Server States
  - Applying Operations
  - OpOrdinal
  - Picking Primary
  - Heartbeat Monitoring
  - Assumption of Primary
  - Failover
  - Resync (Connecting to a New Primary)
  - Consensus
  - Increasing Durability
  - Reading from Secondaries and Staleness
- Example

---

**DRAFT - subject to change.**
Design Concepts

- A write is only truly committed once it has replicated to a majority of servers in the set. (We can wait for confirmation for this though, with getlasterror.)
- Writes which are committed at the master of the set may be visible before the true cluster-wide commit has occurred. This property, which is more relaxed than some traditional products, makes theoretically achievable performance and availability higher.

Configuration

Command Line

We specify --replSet set_name/seed_hostname_list on the command line. seed_hostname_list is a (partial) list of some members of the set. The system then fetches full configuration information from collection admin.system.replset. set_name is specified to help the system catch misconfigurations.

Node Types

Conceptually, we have some different types of nodes:

- Standard - a standard node as described above. Can transition to and from being a primary or a secondary over time. There is only one primary (master) server at any point in time.
- Passive - a server can participate as if it were a member of the replica set, but be specified to never be Primary.
- Arbiter - member of the cluster for consensus purposes, but receives no data. Arbiters cannot be seed hosts.

Each node in the set has a priority setting. On a resync (see below), the rule is: choose as master the node with highest priority that is healthy. If multiple nodes have the same priority, pick the node with the freshest data. For example, we might use 1.0 priority for Normal members, 0.0 for passive (0 indicates cannot be primary no matter what), and 0.5 for a server in a less desirable data center.

local.system.replset

This collection has one object per server in the set. See the configuration page for details.

Set Initiation (Initial Setup)

For a new cluster, on negotiation the max op ordinal is zero everywhere. We then know we have a new replica set with no data yet. A special command

```json
{replSetInitiate:1}
```

is sent to a (single) server to begin things.

Design

Server States

- Primary - Can be thought of as "master" although which server is primary can vary over time. Only 1 server is primary at a given point in time.
- Secondary - Can be thought of as a slave in the cluster; varies over time.
- Recovering - getting back in sync before entering Secondary mode.

Applying Operations

Secondaries apply operations from the Primary. Each applied operation is also written to the secondary's local oplog. We need only apply from the current primary (and be prepared to switch if that changes).

OpOrdinal

We use a monotonically increasing ordinal to represent each operation.

These values appear in the oplog (local.oplog.$main). maxLocalOpOrdinal() returns the largest value logged. This value represents how up-to-date we are. The first operation is logged with ordinal 1.

Note two servers in the set could in theory generate different operations with the same ordinal under some race conditions. Thus for full uniqueness one must look at the combination of server id and op ordinal.

Picking Primary
We use a consensus protocol to pick a primary. Exact details will be spared here but that basic process is:

1. Get maxLocalOpOrdinal from each server.
2. If a majority of servers are not up (from this server's POV), remain in Secondary mode and stop.
3. If the last op time seems very old, consider stopping and awaiting human intervention.
4. Else, using a consensus protocol, pick the server with the highest maxLocalOpOrdinal the Primary.

Any server in the replica set, when it fails to reach master, will attempt a new election process.

**Heartbeat Monitoring**

All nodes will monitor all other nodes in the set via heartbeats. If the current primary cannot see half of the nodes in the set (including itself), it will fall back to secondary mode. This monitoring is a way to check for network partitions. Otherwise in a network partition, a server might think it is still primary when it is not.

An alternative way to deal with network partitions is proper configuration of the maxLag parameter (see below).

**Assumption of Primary**

When we become primary, we assume we have the latest data. Any data newer than the new primary's will be discarded.

**Failover**

We renegotiate when the primary is unavailable.

**Resync (Connecting to a New Primary)**

When a secondary connects to a new primary, it must resynchronize its position. It is possible the secondary has operations that were never committed at the primary. In this case, we roll those operations back. Additionally we may have new operations from a previous primary that never replicated elsewhere. The method is basically:

- For each operation in our oplog that DNE at the primary, (1) remove from oplog and (2) resync the document in question by a query to the primary for that object. Update the object, deleting if it does not exist at the primary.

We can work our way back in time until we find a few operations that are consistent with the new primary, and then stop.

One approach would be to include in the oplog entries a hash of (hash(prev_entry), ordinal, fromserver). Then if the hash does not match, we are out of sync and must work our way back in time.

**Consensus**

Fancier methods would converge faster but this would get us started. Typically only ~2 nodes will be jockeying for primary status at any given time so there shouldn't be much contention:

- Query all others for their maxappliedoptime
- Try to elect self if we have the highest time and can see a majority of nodes
  - If a tie on highest time, delay a short random amount amount first
  - Elect (selfid, maxoptime) msg -> others
- If we get a msg and our time is higher, we send back NO
- We must get back a majority of YES
- If a YES is sent, we respond NO to all others for 1 minute. Electing ourself counts as a YES.
- Repeat as necessary after a random sleep

**Increasing Durability**

We can trade off durability versus availability in a replica set. When a primary fails, a secondary will assume primary status with whatever data it has. Thus, we have some desire to see that things replicate quickly. Durability is guaranteed once a majority of servers in the replica set have an operation.

Several different techniques could improve durability:

1. The heartbeat monitoring described above would assure that (after a short delay) writes never happen when a majority of servers are offline. However servers could still in theory lag.
2. MaxLag: We could have the Primary block if the slaves are too far behind. We can set a max-lag value <LAG,N>. We then require that at least N secondaries are within LAG time of being current. If this criteria is not met, the primary could block on writes, or return an error on writes, as the data is apt to be lost. max-lag would also be a way to prevent oplog rollover.
3. GetLastError: Clients can call getLasterror and wait for acknowledgement until replication of an operation has occurred. The client can then selectively call for a blocking, somewhat more synchronous operation.

**Reading from Secondaries and Staleness**

Secondaries could report via a command how far behind the primary they are. Then, a read-only client can decide if the server's data is too stale
or close enough for usage.

Example

server-a: secondary oplog: ()
server-b: secondary oplog: ()
server-c: secondary oplog: ()
...
server-a: primary oplog: (a1,a2,a3,a4,a5)
server-b: secondary oplog: ()
server-c: secondary oplog: ()
...
server-a: primary oplog: (a1,a2,a3,a4,a5)
server-b: secondary oplog: (a1)
server-c: secondary oplog: (a1,a2,a3)
...

// server-a goes down
...
server-b: secondary oplog: (a1)
server-c: secondary oplog: (a1,a2,a3)
...
server-b: secondary oplog: (a1)
server-c: primary oplog: (a1,a2,a3)
...
server-a resumes
...
server-a: recovering oplog: (a1,a2,a3,a4,a5)
server-b: secondary oplog: (a1,a2,a3)
server-c: primary oplog: (a1,a2,a3,c4)
...
server-a: secondary oplog: (a1,a2,a3,c4)
server-b: secondary oplog: (a1,a2,a3,c4)
server-c: primary oplog: (a1,a2,a3,c4,c5,c6,c7,c8)
...
server-a: secondary oplog: (a1,a2,a3,c4,c5,c6,c7,c8)
server-b: secondary oplog: (a1,a2,a3,c4,c5,c6,c7,c8)
server-c: primary oplog: (a1,a2,a3,c4,c5,c6,c7,c8)

In the above example, server-c becomes primary after server-a fails. Operations (a4,a5) are lost. c4 and c5 are new operations with the same ordinals.

Administration

See the Replica Set Commands page for full info.

Commands:

- `{ replSetFreeze : <bool> } "freeze" or unfreeze a set. When frozen, new nodes cannot be elected master. Used when doing administration. Details TBD.
- `{ replSetGetStatus : 1 } get status of the set, from this node's POV
- `{ replSetInitiate : 1 }
- `{ ismaster : 1 } check if this node is master

Future Versions

- add support for replication trees / hierarchies
- replicating to a slave that is not a member of the set (perhaps we do not need this given we have the Passive set member type)

Master Slave

Setup of a Manual Master/Slave Configuration

To configure an instance of Mongo to be a master database in a master-slave configuration, you'll need to start two instances of the database, one in master mode, and the other in slave mode.
Data Storage
The following examples explicitly specify the location of the data files on the command line. This is unnecessary if you are running the master and slave on separate machines, but in the interest of the readers who are going try this setup on a single node, they are supplied in the interest of safety.

```bash
$ bin/mongod --master [--dbpath /data/masterdb/]
```

As a result, the master server process will create a `local.oplog.$main` collection. This is the "transaction log" which queues operations which will be applied at the slave.

To configure an instance of Mongo to be a slave database in a master-slave configuration:

```bash
$ bin/mongod --slave --source <masterhostname>[:<port>] [--dbpath /data/slavedb/]
```

Details of the source server are then stored in the slave's `local.sources` collection. Instead of specifying the `--source` parameter, one can add an object to `local.sources` which specifies information about the master server:

```bash
$ bin/mongo <slavehostname>/local
> db.sources.find(); // confirms the collection is empty. then:
> db.sources.insert({ host: <masterhostname> });
```

- `host: masterhostname` is the IP address or FQDN of the master database machine. Append `:port` to the server hostname if you wish to run on a nonstandard port number.
- `only: databasename` (optional) if specified, indicates that only the specified database should replicate. NOTE: A bug with only is fixed in v1.2.4+

A slave can pull from multiple upstream masters. In such a situation add multiple configuration objects to the `local.sources` collection. See the One Slave Two Masters doc page.

A server can be slave and a master at same time.

A slave may become out of sync with a master if it falls far behind the data updates available from that master, or if the slave is terminated and then restarted some time later when relevant updates are no longer available from the master. If a slave becomes out of sync, replication will terminate and operator intervention is required by default if replication is to be restarted. An operator may restart replication using the `{resync:1}` command. Alternatively, the command line option `--autoresync` causes a slave to restart replication automatically (after ten second pause) if it becomes out of sync. If the `--autoresync` option is specified, the slave will not attempt an automatic resync more than once in a ten minute period.

The `--oplogSize` command line option may be specified (along with `--master`) to configure the amount of disk space in megabytes which will be allocated for storing updates to be made available to slave nodes. If the `--oplogSize` option is not specified, the amount of disk space for storing updates will be 5% of available disk space (with a minimum of 1GB) for 64bit machines, or 50MB for 32bit machines.

Security

Example security configuration when security is enabled:

```bash
$ dbshell <slavehostname>/admin -u <existingadminusername> -p<adminpassword>
> use local
> db.addUser('repl', <replpassword>);
^c
$ dbshell <masterhostname>/admin -u <existingadminusername> -p<adminpassword>
> use local
> db.addUser('repl', <replpassword>);
```

One Slave Two Masters
This document shows an example session with one slave pulling data from two different masters. A couple notes:

- Each master host has a different hostname (hostname:port).
- Pulling the same database from two different databases can have unexpected results. This can be done in certainly limited ways, as the data will tend to be merged, but there are some edge cases: for example the two masters should have exactly the same set of collections or else some may not show up. Generally, this is not recommended.
- Slaving a replica pair is unfortunately not currently supported – see SERVER-30.

$ mkdir /data/1
$ mkdir /data/2
$ mkdir /data/3
$ ./mongod --port 27020 --dbpath /data/1 --master &
$ ./mongod --port 27021 --dbpath /data/2 --master &
$ ./mongod --port 27022 --dbpath /data/3 --slave &

$ # add some data to masters
$ ./mongo localhost:27020
  > use db1
  > db.foo.insert({x:1})
  > db.foo.insert({x:2})
  ^C
$ # master 2
$ ./mongo localhost:27021
  > use db2
  > db.foo.insert({x:999, note:"in db2"})
  ^C

$ # configure slave
$ ./mongo localhost:27022
  > use local
  > db.sources.insert({host:"localhost:27020"})
  > db.sources.insert({host:"localhost:27021"})
  > db.sources.find()
  
  { "_id" : ObjectId("4b8ed00a1d42d47b3afa3c47"), "host" : "localhost:27020" }
  { "_id" : ObjectId("4b8ecfc30cb095ca52b6294a"), "host" : "localhost:27021" }

  > // wait a little, still connected to slave
  > use db1
  > db.foo.count()
  2
  > use db2
  > db.foo.find()
  
  { "_id" : ObjectId("4b8ed00a1d42d47b3afa3c47"), "x" : 999, "note" : "in db2" }
  > db.printSlaveReplicationInfo()
  
  source: localhost:27020
  syncedTo: Wed Mar 03 2010 16:04:35 GMT-0500 (EST)
    = 2717 secs ago (0.75 hrs)
  source: localhost:27021
  syncedTo: Wed Mar 03 2010 16:09:31 GMT-0500 (EST)
    = 2421 secs ago (0.67 hrs)
  >
Replica Pairs

- Setup of Replica Pairs
- Consistency
- Security
- Replacing a Replica Pair Server
- Querying the slave
- What is and when should you use an arbiter?
- Working with an existing (non-paired) database
- See Also

Setup of Replica Pairs

⚠️ Replica Sets will soon replace replica pairs. If you are just now setting up an instance, you may want to wait for that and use master/slave replication in the meantime.

Mongo supports a concept of **replica pairs**. These databases automatically coordinate which is the master and which is the slave at a given point in time.

At startup, the databases will negotiate which is master and which is slave. Upon an outage of one database server, the other will automatically take over and become master from that point on. In the event of another failure in the future, master status would transfer back to the other server. The databases manage this themselves internally.

**Note:** Generally, start with empty /data/db directories for each pair member when creating and running the pair for the first time. See section on Existing Databases below for more information.

To start a pair of databases in this mode, run each as follows:

```
$ ./mongod --pairwith <remoteserver> --arbiter <arbiterserver>
```

where

- **remoteserver** is the hostname of the other server in the pair. Append :port to the server hostname if you wish to run on a nonstandard port number.
- **arbiterserver** is the hostname (and optional port number) of an arbiter. An arbiter is a Mongo database server that helps negotiate which member of the pair is master at a given point in time. Run the arbiter on a third machine; it is a "tie-breaker" effectively in determining which server is master when the members of the pair cannot contact each other. You may also run with no arbiter by not including the --arbiter option. In that case, both servers will assume master status if the network partitions.

One can manually check which database is currently the master:

```
$ ./mongo
> db.$cmd.findOne({ismaster:1});
{ "ismaster" : 0.0 , "remote" : "192.168.58.1:30001" , "ok" : 1.0 }
```

(Note: When security is on, remote is only returned if the connection is authenticated for the admin database.)

However, Mongo drivers with replica pair support normally manage this process for you.

Consistency

Members of a pair are only eventually consistent on a failover. If machine L of the pair was master and fails, its last couple seconds of operations may not have made it to R - R will not have those operations applied to its dataset until L recovers later.

Security

Example security configuration when security is enabled:
Replacing a Replica Pair Server

When one of the servers in a Mongo replica pair set fails, should it come back online, the system recovers automatically. However, should a machine completely fail, it will need to be replaced, and its replacement will begin with no data. The following procedure explains how to replace one of the machines in a pair.

Let's assume nodes (n1, n2) is the old pair and that n2 dies. We want to switch to (n1, n3).

1. If possible, assure the dead n2 is offline and will not come back online; otherwise it may try communicating with its old pair partner.
2. We need to tell n1 to pair with n3 instead of n2. We do this with a replacepeer command. Be sure to check for a successful return value from this operation.

   n1> ./mongo n1/admin
     > db.$cmd.findOne({replacepeer:1});
     { "info" : "adjust local.sources hostname; db restart now required", "ok" : 1.0 }  

At this point, n1 is still running but is reset to not be confused when it begins talking to n3 in the future. The server is still up although replication is now disabled.

3. Restart n1 with the right command line to talk to n3

   n1> ./mongod --pairwith n3 --arbiter <arbiterserver>

4. Start n3 paired with n1.

   n3> ./mongod --pairwith n1 --arbiter <arbiterserver>

Note that n3 will not accept any operations as "master" until fully synced with n1, and that this may take some time if there is a substantial amount of data on n1.

Querying the slave

You can query the slave if you set the slave ok flag. In the shell:

   db.getMongo().setSlaveOk()

What is and when should you use an arbiter?

The arbiter is used in some situations to determine which side of a pair is master. In the event of a network partition (left and right are both up, but can't communicate) whoever can talk to the arbiter becomes master.

If your left and right server are on the same switch, an arbiter isn't necessary. If you're running on the same ec2 availability zone, probably not needed as well. But if you've got left and right on different ec2 availability zones, then an arbiter should be used.

Working with an existing (non-paired) database

Care must be taken when enabling a pair for the first time if you have existing datafiles you wish to use that were created from a singleton database. Follow the following procedure to start the pair. Below, we call the two servers "left" and "right".

- assure no mongod processes are running on both servers
- we assume the data files to be kept are on server left. Check that there is no local.* datafiles in left's /data/db (--dbpath) directory. If there
are, remove them.
• check that there are no datafiles at all on right’s /data/db directory
• start the left process with the appropriate command line including --pairwith argument
• start the right process with the appropriate paired command line

If both left and right servers have datafiles in their dbpath directories at pair initiation, errors will occur. Further, you do not want a local database (which contains replication metadata) during initiation of a new pair.

See Also
• Replica Pairs in Ruby

Master Master Replication

Mongo does not support full master-master replication. However, for certain restricted use cases master-master can be used. Generally, we recommend one does not use the database in a master-master mode.

Master-master usages is eventually consistent.

To configure master-master, simply run both databases with both the --master and --slave parameters. For example, to set up this configuration on a single machine as a test one might run:

```
$ nohup mongod --dbpath /data1/db --port 27017 --master --slave --source localhost:27018 > /tmp/dblog1
&
$ nohup mongod --dbpath /data2/db --port 27018 --master --slave --source localhost:27017 > /tmp/dblog2
&
```

This mode is safe for:
• insert operations
• delete operations by _id;
• any query

Master-master should not be used if:
• concurrent updates of single object may occur (including $inc and other updates)

A sample test session on a single computer follows:
$ # terminal 1, we run a mongod on default db port (27017)
$ ./mongod --slave --master --source localhost:10000

$ # terminal 2, we run a mongod on port 10000
$ ./mongod --slave --master --dbpath /data/slave --port 10000 --source localhost

$ # terminal 3, we run the shell here
$ ./mongo

> // 'db' is now connected to localhost:27017/test
> z = connect("localhost:10000/test")
> // 'z' is now connected to localhost:10000/test db

> db.foo.insert({x:7});
> z.foo.find()
("_id" : ObjectId( "4ab917d7c50e4c10591ce3b6"), "x" : 7)
> db.foo.find()
("_id" : ObjectId( "4ab917d7c50e4c10591ce3b6"), "x" : 7)

> db.foo.insert({x:8})
> db.foo.find()
("_id" : ObjectId( "4ab917d7c50e4c10591ce3b6"), "x" : 7)
("_id" : ObjectId( "4ab9182a938798896fd8a906"), "x" : 8)
> z.foo.find()
("_id" : ObjectId( "4ab917d7c50e4c10591ce3b6"), "x" : 7)
("_id" : ObjectId( "4ab9182a938798896fd8a906"), "x" : 8)

> z.foo.save({x:9})
> z.foo.find()
("_id" : ObjectId( "4ab917d7c50e4c10591ce3b6"), "x" : 7)
("_id" : ObjectId( "4ab9182a938798896fd8a906"), "x" : 8)
("_id" : ObjectId( "4ab9188ac50e4c10591ce3b7"), "x" : 9)

> z.foo.remove({x:8})
> db.foo.find()
("_id" : ObjectId( "4ab917d7c50e4c10591ce3b6"), "x" : 7)
("_id" : ObjectId( "4ab9188ac50e4c10591ce3b7"), "x" : 9)
> z.foo.find()
("_id" : ObjectId( "4ab917d7c50e4c10591ce3b6"), "x" : 7)
("_id" : ObjectId( "4ab9188ac50e4c10591ce3b7"), "x" : 9)

> db.foo.drop()
> indexesWas : 1, "msg" : "all indexes deleted for collection", "ns" : "test.foo", "ck" : 1
> db.foo.find()
> z.foo.find()
1 master, N slaves - have to handle failover manually

- **Replica Pairs**
  - 2 servers, 1 is always master, auto-failover

**Backups**
- **Import Export Tools**

**Recommended System Settings**
- turn off atime
- set file descriptor limit to 4+k

**TCP Port Numbers**

Default TCP port numbers for MongoDB processes:
- standalone mongod – 27017
- mongos – 27017
- shard server (mongod --shardsvr) – 27018
- config server (mongod --configsvr) – 27019
- web stats page for mongod – add 1000 to port number

**Tips**
- **Handling Halted Replication**

**See Also**
- **Starting and Stopping the Database**

**Halted Replication**

If you're running mongod with master-slave replication, there are certain scenarios where the slave will halt replication because it hasn't kept up with the master's oplog.

The first is when a slave is prevented from replicating for an extended period of time, due perhaps to a network partition or the killing of the slave process itself. The best solution in this case is to resync the slave. To do this, open the mongo shell and point it at the slave:

```
$ mongo <slave_host_and_port>
```

Then run the resync command:

```
> use admin
> db.runCommand({resync: 1})
```

**Increasing the OpLog Size**

Since the oplog is a capped collection, it's allocated to a fixed size; this means that as more data is entered, the collection will loop around and overwrite itself instead of growing beyond its pre-allocated size. If the slave can't keep up with this process, then replication will be halted. The solution is to increase the size of the master's oplog. There are a couple of ways to do this, depending on how big your oplog will be and how much downtime you can stand. But first you need to figure out how big an oplog you need.

**Figuring out the OpLog size**

If the current oplog size is wrong, how do you figure out what's right? The goal is not to let the oplog age out in the time it takes to clone the database. The first step is to print the replication info. On the master node, run this command:

```
> db.printReplicationInfo();
```
configured oplog size: 1048.576MB
log length start to end: 7200secs (2hrs)
oplog first event time: Wed Mar 03 2010 16:20:39 GMT-0500 (EST)
oplog last event time: Wed Mar 03 2010 18:20:39 GMT-0500 (EST)
now: Wed Mar 03 2010 18:40:34 GMT-0500 (EST)

This indicates that you're adding data to the database at a rate of 524MB/hr. If an initial clone takes 10 hours, then the oplog should be at least 5240MB, so something closer to 8GB would make for a safe bet.

Changing the Oplog Size

The standard way of changing the oplog size involves stopping the mongod master, deleting the local.* oplog datafiles, and then restarting with the oplog size you need, measured in MB:

$ # Stop mongod - killall mongod or kill -2 or ctrl-c) - then:
$ rm /data/db/local.*
$ mongod --oplog=8038 --master

This works, but might be a problem if you need a large oplog (say, > 10GB), since the time it takes mongod to pre-allocate the oplog files may mean too much downtime. If this is the case, read on.

Manually Allocating OpLog Files

An alternative approach is to create the oplog files manually before shutting down mongod. Suppose you need an 20GB oplog; here's how you'd go about creating the files:

1. Create a temporary directory, /tmp/local.
2. You'll be creating ten 2GB datafiles. Here's a shell script for doing just that:

   cd /tmp/local
   for i in {0..9}
   do
     echo $i
     head -c 2146435072 /dev/zero > local.$i
   done

Note that the datafiles aren't exactly 2GB due MongoDB's max int size.

3. Shut down the mongod master (kill -2) and then replace the oplog files:

   $ mv /data/db/local.* /safe/place
   $ mv /tmp/local/* /data/db/

4. Restart the master with the new oplog size:

   $ mongod --master --oplogSize=20000

5. Finally, resync the slave. This can be done by shutting down the slave, deleting all its datafiles, and restarting it.

See Also

- Replication

Security and Authentication
Running Without Security (Trusted Environment)

One valid way to run the Mongo database is in a trusted environment, with no security and authentication. This is the default option and is recommended. Of course, in such a configuration, one must be sure only trusted machines can access database TCP ports.

The current revision of sharding requires trusted (nonsecure) mode.

Mongo Security

The current version of Mongo supports only very basic security. One authenticates a username and password in the context of a particular database. Once authenticated, a normal user has full read and write access to the database in question while a read only user only has read access.

The admin database is special. In addition to several commands that are administrative being possible only on admin, authentication on admin gives one read and write access to all databases on the server. Effectively, admin access means root access to the server process.

Run the database (mongodb process) with the --auth option to enable security. You must have added a user to the admin db before starting the server with --auth.

Configuring Authentication and Security

Authentication is stored in each database's system.users collection. For example, on a database projectx, projectx.system.users will contain user information.

We should first configure an administrator user for the entire db server process. This user is stored under the special admin database.

If no users are configured in admin.system.users, one may access the database from the localhost interface without authenticating. Thus, from the server running the database (and thus on localhost), run the database shell and configure an administrative user:

```
$ ./mongo
> use admin
> db.addUser("theadmin", "anadminpassword")
```

We now have a user created for database admin. Note that if we have not previously authenticated, we now must if we wish to perform further operations, as there is a user in admin.system.users.

```
> db.auth("theadmin", "anadminpassword")
```

We can view existing users for the database with the command:

```
> db.system.users.find()
```

Now, let's configure a "regular" user for another database.

```
> use projectx
> db.addUser("joe", "passwordForJoe")
```

Finally, let's add a readonly user. (only supported in 1.3.2+)

```
> use projectx
> db.addUser("guest", "passwordForGuest", true)
```

Changing Passwords

The shell addUser command may also be used to update a password: if the user already exists, the password simply updates.

Many Mongo drivers provide a helper function equivalent to the db shell's addUser method.

Deleting Users

To delete a user:
db.system.users.remove( { user: username } )

Architecture and Components

MongoDB has two primary components to the database server. The first is the mongod process which is the core database server. In many cases, mongod may be used as a self-contained system similar to how one would use mysqld on a server. Separate mongod instances on different machines (and data centers) can replicate from one to another.

Another MongoDB process, mongos, facilitates auto-sharding. mongos can be thought of as a "database router" to make a cluster of mongod processes appear as a single database. See the sharding documentation for more information.

Database Caching

With relational databases, object caching is usually a separate facility (such as memcached), which makes sense as even a RAM page cache hit is a fairly expensive operation with a relational database (joins may be required, and the data must be transformed into an object representation). Further, memcached type solutions are more scaleable than a relational database.

Mongo eliminates the need (in some cases) for a separate object caching layer. Queries that result in file system RAM cache hits are very fast as the object's representation in the database is very close to its representation in application memory. Also, the MongoDB can scale to any level and provides an object cache and database integrated together, which is very helpful as there is no risk of retrieving stale data from the cache. In addition, the complex queries a full DBMS provides are also possible.

Backups

- Fsync, Write Lock and Backup
- Shutdown and Backup
- Exports
- Slave Backup

Several strategies exist for backing up MongoDB databases. A word of warning: it's not safe to back up the mongod data files (by default in /data/db/) while the database is running and writes are occurring; such a backup may turn out to be corrupt. See the fsync option below for a way around that.

Fsync, Write Lock and Backup

MongoDB v1.3.1 and higher supports an fsync and lock command with which we can flush writes, lock the database to prevent writing, and then backup the datafiles.

While in this locked mode, all writes will block. If this is a problem consider one of the other methods below.

Shutdown and Backup

A simple approach is just to stop the database, back up the data files, and resume. This is safe but of course requires downtime.

Exports

The mongodump utility may be used to dump an entire database, even when the database is running and active. The dump can then be restored later if needed.

Slave Backup

Another good technique for backups is replication to a slave database. The slave polls master continuously and thus always has a nearly-up-to-date copy of master.

We then have several options for backing up the slave:

1. Fsync, write lock, and backup the slave.
2. Shut it down, backup, and restart.
3. Export from the slave.

For methods 1 and 2, after the backup the slave will resume replication, applying any changes made to master in the meantime.

Using a slave is advantageous because we then always have backup database machine ready in case master fails (failover). But a slave also gives us the chance to back up the full data set without affecting the performance of the master database.
How to do Snapshotted Queries in the Mongo Database

For performance reasons, MongoDB does not currently support true point-in-time snapshotting of collections. (This may change in the future.) However, some functionality is available which is detailed below.

Cursors

A MongoDB query returns data as well as a cursor ID for additional lookups, should more data exist. Drivers lazily perform a "getMore" operation as needed on the cursor to get more data. Cursors may have latent getMore accesses that occurs after an intervening write operation on the database collection (i.e., an insert, update, or delete).

Conceptually, a cursor has a current position. If you delete the item at the current position, the cursor automatically skips its current position forward to the next item.

MongoDB cursors do not provide a snapshot: if other write operations occur during the life of your cursor, it is unspecified if your application will see the results of those operations. In fact, it is even possible (although unlikely) to see the same object returned twice if the object were updated and grew in size (and thus moved in the datafile). To assure no update duplications, use snapshot() mode (see below).

Snapshot Mode

snapshot() mode assures that objects which update during the lifetime of a query are returned once and only once. This is most important when doing a find-and-update loop that changes the size of documents that are returned ($inc does not change size).

```javascript
> // mongo shell example
> var cursor = db.myCollection.find({country:'uk'}).snapshot();
```

Even with snapshot mode, items inserted or deleted during the query may or may not be returned; that is, this mode is not a true point-in-time snapshot (currently).

Note that a true point-in-time snapshot occurs for short query responses (less than 1MB).

Because snapshot mode traverses the _id index, it may not be used with sorting or explicit hints. It also cannot use any other index for the query. You can get the same effect as snapshot by using any unique index on a field(s) that will not be modified (probably best to use explicit hint() too). If you want to use a non-unique index (such as creation time), you can make it unique by appending _id to the index at creation time.

See Also

- The Advanced Queries section of MongoDB - A Developer's Tour

Troubleshooting

- Too Many Open Files
- mongod process "disappeared"
- See Also

mongod process "disappeared"

Scenario here is the log ending suddenly with no error or shutdown messages logged.

On Unix, check /var/log/messages:

```
$ grep mongod /var/log/messages
$ grep score /var/log/messages
```

See Also

- Diagnostic Tools
Too Many Open Files

If you receive the error too many open files in the mongod log, there are a couple of possible reasons for this.

First, to check what file descriptors are in use, run lsof (some variations shown below):

```
lsconf | grep mongod
lsconf | grep mongod | grep TCP
lsconf | grep mongod | grep data | wc
```

If most lines include “TCP”, there are many open connections from client sockets. If most lines include the name of your data directory, the open files are mostly datafiles.

**ulimit**

If the numbers from lsof look reasonable, check your ulimit settings. The default for file handles (often 1024) might be too low for production usage. Run ulimit -a (or limit -a depending on shell) to check.

Use ulimit -n X to change the max number of file handles to X. If your OS is configured to not allow modifications to that setting you might need to reconfigure first. On ubuntu you'll need to edit /etc/security/limits.conf and add a line something like the following (where user is the username and X is the desired limit):

```
user hard nofile X
```

**High TCP Connection Count**

If lsof shows a large number of open TCP sockets, it could be that one or more clients is opening too many connections to the database. Check that your client apps are using connection pooling.

**Durability and Repair**

- Repairing a Database
- Thoughts on Durability
  - Tradeoffs
- See Also

See also: [http://jira.mongodb.org/browse/SERVER-980](http://jira.mongodb.org/browse/SERVER-980)

Relational database systems achieve durability, in part, by writing all updates to a transaction log. However, transaction logging incurs a performance penalty, so MongoDB takes an alternate approach to durability: replication.

Because MongoDB forgoes transaction logging, it's possible to lose data on a hardware or process crash (or kill -9). Data can be lost when writes have occurred recently and haven't yet been synced to disk. If a database file becomes corrupted, it will be necessary to repair the database.

Since 1.1.4, the --syncdelay option controls how often changes are flushed to disk (the default is 60 seconds). If replication is not being used, it may be desirable to reduce this default.

**Repairing a Database**

In the event of a crash, we recommend running a repair - analogous to running fsck. If a slave crashes, one option is just to re-slave and start from scratch which will likely be just as fast.

From the command line `mongod --repair`

From the shell:

```
> db.repairDatabase();
```

Analogous to running fsck on the file system, this command will repair the database.

To check the condition of any particular collection, there's a validation command that returns a lot of useful information. For example, here we
validate the `users` collection:

```javascript
> db.users.validate();
{
  "ns" : "test.users",
  "result" : " validate
details: 0x1243dbbd 0x0 0x0 0x0 740bdc
firstExtent:0:178b00 ns:test.users
lastExtent:0:178b00 ns:test.users
# extents:1
datasize?:44 nrecords?:1 lastExtentSize:8192
padding:1
first extent:
  loc:0:178b00 xnext:0x0 xprev:0x0 nsdiag:0x0
s:8192 firstRecord:0:178bb0 lastRecord:0:178bb0
1 objects found, nobj:1
60 bytes data w/headers
44 bytes data wout/headers
deletedList: 0000000000000000000
deleted: n: 1 size: 7956
nIndexes:2
test.users.$_id_ keys:1
test.users.$username_1 keys:1 ",
"ok" : 1,
"valid" : true,
"lastExtentSize" : 8192
}
```

During a repair operation, mongod must store temporary files to disk. By default, mongod creates temporary directories under the dbpath for this purpose. Alternatively, the `--repairpath` command line option can be used to specify a base directory for temporary repair files.

**Thoughts on Durability**

If you question the idea of forgoing transaction logging, keep in mind that this idea is not unique to MongoDB. For example, MySQL's MyISAM storage engine also dispenses with transaction logging.

The philosophy behind MongoDB is that different styles of databases should be used for different problems. MongoDB attempts to provide high performance at some reduction of features. Of course, some problems require greater durability: we would not recommend using it for a bond trading system. However, for many problems, particularly with scaling web site infrastructure, MongoDB works quite well in practice (see our growing list of production deployments).

**Tradeoffs**

Full durability comes at a significant cost to write performance. For this reason, modern hard drives have hardware buffering of writes turned on by default. What's more, many traditional RDBMS solutions simply perform an fsync-style flush when flushing the transaction log. This is reasonably fast but incomplete -- on Linux for example, fsync() may return before the data is permanently stored when the drive has write caching enabled. (Disabling the write cache on the drive could result in a huge drops in performance).

What all this means is that even the most durable systems are susceptible to corruption and data loss in certain situations. Some research is underway with MongoDB on durability schemes that maintain very high performance. Those desiring greater durability are free to configure the `--syncdelay` option mentioned above and are encouraged to employ some forms of replication.

**See Also**

- fsync Command

**Contributors**

- C++ Coding Style
- Project Ideas
- UI
- Source Code
- Building
- Database Internals
• Contributing to the Documentation

10gen Contributor Agreement

C++ Coding Style

not totally obeyed yet

camelCase

brackets

```cpp
if ( 0 ) {
}
```

class members

```cpp
class Foo {
    int _bar;
};
```

templates

```cpp
set<int> s;
```

namespaces

```cpp
namespace foo {
    int foo;
    namespace bar {
        int bar;
    }
}
```

start of file

```cpp
// <filename>
```

assertions

There are several different types of assertions used in the MongoDB code. In brief:

- `assert` should be used for internal assertions.
- `massert` is an internal assertion with a message.
- `uassert` is used for a user error

Both `massert` and `uassert` take error codes, so that all errors have codes associated with them. These error codes are assigned randomly, so there aren’t segments that have meaning. Scons checks for duplicates, but if you want the next available code you can run:

```bash
python buildscripts/errorcodes.py
```

Project Ideas
If you're interested in getting involved in the MongoDB community (or the open source community in general) a great way to do so is by starting or contributing to a MongoDB related project. Here we've listed some project ideas for you to get started on. For some of these ideas projects are already underway, and for others nothing (that we know of) has been started yet.

**A GUI**

One feature that is often requested for MongoDB is a GUI, much like CouchDB's futon or phpMyAdmin. There are a couple of projects working on this sort of thing that are worth checking out:

http://github.com/sbellity/futon4mongo
http://www.mongodb.org/display/DOCS/Http+Interface
http://www.mongodb.com

We've also started to spec out the features that a tool like this should provide.

**Try Mongo!**

It would be neat to have a web version of the MongoDB Shell that allowed users to interact with a real MongoDB instance (for doing the tutorial, etc). A project that does something similar (using a basic MongoDB emulator) is here:

http://github.com/banker/mongulator

**Real-time Full Text Search Integration**

It would be interesting to try to nicely integrate a search backend like Xapian, Lucene or Sphinx with MongoDB. One idea would be to use MongoDB's oplog (which is used for master-slave replication) to keep the search engine up to date.

**GridFS FUSE**

There is a project working towards creating a FUSE filesystem on top of GridFS - something like this would create a bunch of interesting potential uses for MongoDB and GridFS:

http://github.com/mikejs/gridfs-fuse

**GridFS Web Server Modules**

There are a couple of modules for different web servers designed to allow serving content directly from GridFS:

Nginx: http://github.com/mdiroll/nginx-gridfs
Lighttpd: http://bitbucket.org/bwmcadams/lighttpd-gridfs

**Framework Adaptors**

Working towards adding MongoDB support to major web frameworks is a great project, and work has been started on this for a variety of different frameworks (please use google to find out if work has already been started for your favorite framework).

**Logging and Session Adaptors**

MongoDB works great for storing logs and session information. There are a couple of projects working on supporting this use case directly.

Logging:
Python: http://github.com/andreisavu/mongodb-log
Rails: http://github.com/peburrows/mongo_db_logger

Sessions:
web.py: http://github.com/whilefalse/webpy-mongodb-sessions
Beaker: http://pypi.python.org/pypi/mongodb_beaker

**Package Managers**

Add support for installing MongoDB with your favorite package manager and let us know!

**Locale-aware collation / sorting**

MongoDB doesn't yet know how to sort query results in a locale-sensitive way. If you can think up a good way to do it and implement it, we'd like to know!

**Drivers**
If you use an esoteric/new/awesome programming language write a driver to support MongoDB! Again, check google to see what people have started for various languages.

Some that might be nice:

- Scheme (probably starting with PLT)
- GNU R
- Visual Basic
- lua
- Lisp (e.g., Common Lisp)
- Delphi
- Falcon

Write a killer app that uses MongoDB as the persistence layer!

UI

Spec/requirements for a future MongoDB admin UI.

- list databases
  - repair, drop, clone?
- collections
  - validate(), datasize, indexsize, clone/copy
- indexes
- queries - explain() output
- security: view users, adjust
- see replication status of slave and master
- sharding
- system.profile viewer ; enable disable profiling
- curop / killop support

Source Code

All source for MongoDB, it's drivers, and tools is open source and hosted at Github.

- **Mongo Database** (includes C++ driver)
- **Python Driver**
- **PHP Driver**
- **Ruby Driver**
- **Java Driver**
- **Perl Driver**

(Additionally, community drivers and tools also exist and will be found in other places.)

See Also

- Building

Building

This section provides instructions on setting up your environment to write Mongo drivers or other infrastructure code. For specific instructions, go to the document that corresponds to your setup.

Note: see the Downloads page for prebuilt binaries!

Sub-sections of this section:

- **Building for FreeBSD**
- **Building for Linux**
- **Building for OS X**
- **Building for Solaris**
- **Building for Windows**
  - **Boost 1.41.0 Visual Studio 2010 Binary**
- **Building SpiderMonkey**

See Also
Building for FreeBSD

On FreeBSD 8.0 and later, there is a mongodb port you can use.

For FreeBSD <= 7.2:

2. Update your ports tree:

   ```
   $ sudo portsnaps -f && portsnap extract
   ```

   The packages that come by default on 7.2 and older are too old, you’ll get weird errors when you try to run the database
3. Install SpiderMonkey:

   ```
   $ cd /usr/ports/lang/spidermonkey && make && make install
   ```

4. Install scons:

   ```
   $ cd /usr/ports/devel/scons && make && make install
   ```

5. Install boost: (it will pop up an X "GUI", select PYTHON)

   ```
   $ cd /usr/ports/devel/boost-all && make && make install
   ```

6. Install libexecinfo:

   ```
   $ cd /usr/ports/devel/libexecinfo && make && make install
   ```

7. Change to the database source directory
8. scons .

See Also

- Building for Linux - many of the details there including how to clone from git apply here too.

Building for Linux

- General Instructions
- Special Notes about Spider Monkey
- Package Requirements
  - Fedora
    - Fedora 8 or 10
    - Ubuntu
      - Ubuntu 8.04
      - Ubuntu 9.04 and 9.10
  - See Also

General Instructions

1. Install Dependencies - see platform specific below
2. get source
3. build

    scons all

4. install

    scons --prefix=/opt/mongo install

Special Notes about Spider Monkey

Most pre-built spider monkey binaries don't have UTF8 compiled in. Additionally, ubuntu has a weird version of spider monkey that doesn't support everything we use. If you get any warnings during compile time or runtime, we highly recommend building spider monkey from source. See Building Spider Monkey for more information.

We currently support spider monkey 1.6 and 1.7, although there is some degradation with 1.6, so we recommend using 1.7. We have not yet tested 1.8, but will once it is officially released.

Package Requirements

Fedora

Fedora 8 or 10

    sudo yum -y install git tcsh scons gcc-c++ glibc-devel
    sudo yum -y install boost-devel pcre-devel js-devel readline-devel
    # for release builds:
    sudo yum -y install boost-devel-static readline-static ncurses-static

Ubuntu

See spider monkey note above.

Ubuntu 8.04

    apt-get -y install tcsh git-core scons g++
    apt-get -y install libpcre++-dev libboost-dev libreadline-dev xulrunner-1.9-dev
    apt-get -y install libboost-program-options-dev libboost-thread-dev libboost-filesystem-dev
    libboost-date-time-dev

Ubuntu 9.04 and 9.10

    apt-get -y install tcsh git-core scons g++
    apt-get -y install libpcre++-dev libboost-dev libreadline-dev xulrunner-1.9.1-dev

See Also

- The Building page for setup information for other operating systems
- The main Database Internals page
Building for OS X

- Upgrading to Snow Leopard
- Setup
  - Package Manager Setup (32bit)
    - Manual Setup
      - Install Apple developer tools
      - Install libraries (32bit option)
      - Install libraries (64bit option)
- Compiling
- XCode
- See Also

To set up your OS X computer for MongoDB development:

**Upgrading to Snow Leopard**

If you have installed Snow Leopard, the builds will be 64 bit -- so if moving from a previous OS release, a bit more setup may be required than one might first expect.

1. Install XCode tools for Snow Leopard.
2. Install MacPorts (snow leopard version). If you have MacPorts installed previously, we've had the most success by running `rm -rf /opt/local` first.
4. Update/install SpiderMonkey with `sudo port install spidermonkey`. (If this fails, see the note on #2 above.)

**Setup**

1. Install git. If not already installed, download the source and run `.configure; make; sudo make install`
   - Then: git clone git://github.com/mongodb/mongo.git (more info)
   - Then: git tag -l to see tagged version numbers
   - Switch to a stable branch (unless doing development) -- an even second number indicates "stable". (Although with stharding you will want the latest if the latest is less than 1.6.0.) For example:
     - `git checkout r1.4.1`
     - If you do not wish to install git you can instead get the source code from the Downloads page.

1. Install gcc.
   gcc version 4.0.1 (from XCode Tools install) works, but you will receive compiler warnings. The easiest way to upgrade gcc is to install the iPhone SDK.

**Package Manager Setup (32bit)**

1. Install libraries (using macports)

```
port install boost pcre++ spidermonkey
```

**Manual Setup**

Install Apple developer tools

Install libraries (32bit option)

1. Download boost ([boost 1.37.0](http://downloads.sourceforge.net/boost/boost_1_37_0.tar.gz)) Apply the following patch:
diff -u -r a/configure b/configure
--- a/configure 2009-01-26 14:10:42.000000000 -0500
+++ b/configure 2009-01-26 10:21:29.000000000 -0500
@@ -9,9 +9,9 @@
BJAM=""
TOOLSET=""
+BJAM_CONFIG="--layout=system"
BUILD=""
PREFIX=/usr/local
EPREFIX=
diff -u -r a/tools/build/v2/tools/darwin.jam b/tools/build/v2/tools/darwin.jam
@@ -367,5 +367,5 @@
  actions link.dll bind LIBRARIES
  |
    - "$(CONFIG_COMMAND)" -dynamiclib -Wl,-single_module -install_name "$<:B>$(<:S)" -L
+BJAM_CONFIG="--layout=system"
BUILD=""
PREFIX=/usr/local
EPREFIX=
diff -u -r a/tools/build/v2/tools/darwin.jam b/tools/build/v2/tools/darwin.jam
@@ -367,5 +367,5 @@
  actions link.dll bind LIBRARIES
  |
    - "$<:B>$(<:S)" "$(LINKPATH)" -o "$<" "$<" "$<" "$(LIBRARIES)" "$<:B>$(<:S)" "$<:B>$(<:S)" "$<:B>$(<:S)" "$<:B>$(<:S)" "$<:B>$(<:S)"

then,

```
./configure; make; sudo make install
```


```
./configure --enable-utf8 --enable-unicode-properties --with-match-limit=200000
--with-match-limit-recursion=4000; make; sudo make install
```


```
./configure; make; sudo make install
```

**Install libraries (64bit option)**

(The 64bit libraries will be installed in /usr/64/{include,lib}.)

1. Download SpiderMonkey: [ftp.mozilla.org/pub.mozilla.org/js/js-1.7.0.tar.gz](ftp.mozilla.org/pub.mozilla.org/js/js-1.7.0.tar.gz)

Apply the following patch:
diff -u -r js/src/config/Darwin.mk js-1.7.0/src/config/Darwin.mk
--- js/src/config/Darwin.mk 2007-02-05 11:24:49.000000000 -0500
+++ js-1.7.0/src/config/Darwin.mk 2009-05-11 10:18:37.000000000 -0400
@@ -43,7 +43,7 @@
 # Just ripped from Linux config
 #
-CC = cc
+CC = cc -m64
 CCC = g++
 CFLAGS += -Wall -Wno-format
 OS_CFLAGS = -DXP_UNIX -DSVR4 -DSYSV -D_BSD_SOURCE -DPOSIX_SOURCE -DDARWIN
@@ -56,9 +56,9 @@
#.c.o:
 # $(CC) -c -MD *.d $(CFLAGS) $<

-CPU_ARCH = $(shell uname -m)
+CPU_ARCH = "X86_64"
 ifeq (86,$(findstring 86,$(CPU_ARCH)))
 -CPU_ARCH = x86
+CPU_ARCH = x86_64
 OS_CFLAGS+= -DX86_LINUX
 endif
 GFX_ARCH = x
@@ -81,3 +81,14 @@
 # Don't allow Makefile.ref to use libmth
 NO_LIBM = 1
+ifeq ($(CPU_ARCH),x86_64)
+  +# Use VA_COPY() standard macro on x86-64
+  +# FIXME: better use it everywhere
+  +OS_CFLAGS += -DHAVE_VA_COPY -DVA_COPY=va_copy
+endif
+  +ifeq ($(CPU_ARCH),x86_64)
+  +# We need PIC code for shared libraries
+  +# FIXME: better patch rules.mk & fdlibm/Makefile*
+  +OS_CFLAGS += -DPIC -fPIC
+endif

compile and install

    cd src
    make -f Makefile.ref
    sudo JS_DIST=/usr/64 make -f Makefile.ref export

remove the dynamic library

    sudo rm /usr/64/lib64/libjs.dylib

# Download boost {{boost 1.37.0 http://downloads.sourceforge.net/boost/boost_1_37_0.tar.gz}}Apply the following patch:
diff --u -r a/configure b/configure
--- a/configure 2009-01-26 14:10:42.000000000 -0500
+++ b/configure 2009-01-26 10:21:29.000000000 -0500
@@ -9,9 +9,9 @@
BJAM=""
TOOLSET=""
-BJAM_CONFIG=""
+BJAM_CONFIG="architecture=x86 address-model=64 --layout=system"
BUILD=""
-PREFIX=/usr/local
+PREFIX=/usr/64
EPREFIX=
LIBDIR=
INCLUDEDIR=

diff --u -r a/tools/build/v2/tools/darwin.jam b/tools/build/v2/tools/darwin.jam
@@ -367,5 +367,5 @@
actions link.dll bind LIBRARIES
{
-    "$\{\text{CONFIG\_COMMAND}\}\" -dynamiclib -Wl,-single_module -install_name "$\{\langle B\}\$\{\langle S\}\" -L"$\{\text{LINKPATH}\]\" -o "$\{\langle C\}\" "$\{\langle R\}\" "$\{\text{LIBRARIES}\}\" -I$\{\text{FINDLIBS\_SA}\} -I$\{\text{FINDLIBS\_ST}\} $\{\text{FRAMEWORK\_PATH}\} -framework\$\{\langle D\}\$\{\langle S\}\} $\{\text{OPTIONS}\} $\{\text{USER\_OPTIONS}\} +
-    "$\{\text{CONFIG\_COMMAND}\}\" -dynamiclib -Wl,-single_module -install_name "/usr/64/lib/$\{\langle B\}\$\{\langle S\}\" -L"$\{\text{LINKPATH}\]\" -o "$\{\langle C\}\" "$\{\langle R\}\" "$\{\text{LIBRARIES}\}\" -I$\{\text{FINDLIBS\_SA}\} -I$\{\text{FINDLIBS\_ST}\} $\{\text{FRAMEWORK\_PATH}\} -framework\$\{\langle D\}\$\{\langle S\}\} $\{\text{OPTIONS}\} $\{\text{USER\_OPTIONS}\} 
}

then,

./configure; make; sudo make install

# Install pcre http://www.pcre.org/ (must enable UTF8)

CFLAGS="-m64" CXXFLAGS="-m64" LDFLAGS="-m64" ./configure --enable-utf8 --with-match-limit=200000 --with-match-limit-recursion=4000 --enable-unicode-properties --prefix /usr/64; make; sudo make install

# Install unit test framework http://unittest.red-bean.com/ (optional)

CFLAGS="-m64" CXXFLAGS="-m64" LDFLAGS="-m64" ./configure --prefix /usr/64; make; sudo make install

Compiling

To compile 32bit, just run

scons

To compile 64bit on 10.5 (64 is default on 10.6), run

scons --64

XCode

You can open the project with:
You need to add an executable target:

1. In the mongo project window, go to the Executables, right click and choose Add->NewCustomExecutable.
2. Name it db. Path is ./db/db.
   It will appear under Executables*.
3. Double-click on it.
4. Under general, set the working directory to the project directory.
5. Under arguments, add run.
6. Go to general prefs (cmd ,), go to debugging and turn off lazy load.
   (Seems to be an issue that prevents breakpoints from working in debugger?)

See Also

- The Building page for setup information for other environments
- The main Database Internals page
- The starting point for all Home

Building for Solaris

MongoDB server currently supports little endian Solaris operation. (Although most drivers – not the database server – work on both.)

Community: Help us make this rough page better please! (And help us add support for big endian please...)

Prerequisites:

- g++ 4.x (SUNWgcc)
- scons (need to install from source)
- spider monkey Building Spider Monkey
- pcre (SUNWpcre)
- boost (need to install from source)

See Also

- Joyent
- Building for Linux - many of the details there including how to clone from git apply here too

Building for Windows

- Prerequisites and Setup
  - Get the Source Code
  - SCons
  - Visual C++
  - Boost
  - SpiderMonkey
- Building with SCons
- Building in the Visual Studio IDE
  - Visual Studio 2010
- Build Troubleshooting

MongoDB can be compiled for Windows (32 and 64 bit) using Visual C++. SCons is the make mechanism, although a .vcproj/.sln is also included in the project for convenience when using the Visual Studio IDE.

There are several dependencies exist which are listed below; you may find it easier to simply download a pre-built binary.

Prerequisites and Setup

Get the Source Code

Download the source code from Downloads.

Or install Git. Then:

- git clone git://github.com/mongodb/mongo.git (more info)
- git tag -l to see tagged version numbers
• Switch to a stable branch (unless doing development) -- an even second number indicates "stable". (Although with sharding you will want the latest if the latest is less than 1.6.0.) For example:
  • git checkout r1.4.1

**SCons**

If building with scons, install SCons:

• First install Python: http://www.python.org/download/releases/2.6.4/.
• Then SCons itself: http://sourceforge.net/projects/scons/files/scons/1.2.0/scons-1.2.0.win32.exe/download.
• Add the python scripts directory (e.g., C:\Python26\Scripts) to your PATH.

**Visual C++**

• Install Visual C++ Express or Visual Studio 2008. Building has been tested with Visual Studio 2008 only. We have not tried 2005. There are reports of success building with 2010 (see notes below).

**Boost**

Install Boost.

• 32-bit: At http://www.boostpro.com/products/free, install the prebuilt libraries for Boost version 1.35.0 (or higher - generally newer is better). During installation, for release builds choose static multithread libraries for installation. The Debug version of the project uses the DLL libraries; choose all multithread libraries if you plan to do development. From the BoostPro installer, be sure to select all relevant libraries that mongodb uses -- for example, you need Filesystem, Regex, Threads, and ProgramOptions (and perhaps others).
• 64-bit: you must use boost 1.39 or higher. compile boost: {{ bjam variant=debug,release link=static threading=multi address-model=64 runtime-link=static}}

After installing boost, move your boost files to C:\Program Files\boost\latest. This is the default location checked by the SConstruct and vcproj. If there is no latest directory, SCons (but not the vcproj) will then look for other relevant directories under {{C:\Program Files\boost\boost_1_39}}. Alternatively, in VS2008, if you want boost to be located elsewhere, add the boost home location in Tools.Options.Projects&Solutions.VC++ Directories.Include, and add the boost lib location (\...\lib\subdirectory) in Tools.Options.Projects&Solutions.VC++ Directories.Libraries.

**SpiderMonkey**

Build a SpiderMonkey js engine library (js.lib) – details here.

**Building with SCons**

The SConstruct file from the MongoDB project is the preferred way to perform production builds. Run scons in the mongo project directory to build.

When using SCons you may want the Visual C++ files to be on your path; one way to do that is use Tools...Visual Studio Command Prompt to get a prompt from Visual Studio.

To build mongod:

```
scons
```

To build the C++ client driver library:

```
scons mongoclient.lib
```

To build all end user components:

```
scons all
```

To build all components including components including unit tests:

```
scons .
```

**Building in the Visual Studio IDE**
**Note:** building with scons should be considered the "base port" -- 10gen runs all buildbots and regression tests are ran against scons builds. However, the project file is convenient for IDE based development and debugging. Note also that some utilities including the mongo shell are not configured in the project file (use scons or download the binary version).

Note: After installing Visual Studio, you may want to go to Control Panel->Services and disable SQL Server Express, as we won't be using that.

Open the db/db.sln solution file to build MongoDB.

**Visual Studio 2010**

Open the db.sln VS2008 solution file. Let VS2010 update the project.

Boost 1.41.0 compiles with Visual Studio 2010 -- you will want that version of boost (or newer).

**Build Troubleshooting**

- **Can't find jstypes.h when compiling.** This file is generated when building SpiderMonkey. See the Building SpiderMonkey page for more info.
- **Can't find / run cl.exe when building with scons.** See troubleshooting note on the Building SpiderMonkey page.

**Boost 1.41.0 Visual Studio 2010 Binary**

The following is a prebuilt boost binary (libraries) for Visual Studio 2010 beta 2.

The MongoDB vcxproj files assume this package is unzipped under c:\Program Files\boost\boost_1_41_0\.

- http://downloads.mongodb.org/misc/boost_1_41_0_binary_vs10beta2.zip

Note: we're not boost build gurus please let us know if there are things wrong with the build.

See also the prebuilt boost binaries at http://www.boostpro.com/download.

**Building Spider Monkey**

- **Building js.lib - Unix**
  - Download
  - Build
  - Install
- **Building js.lib - Windows**
  - Prebuilt
  - Download
  - Build
  - Troubleshooting scons

**See Also**

MongoDB uses SpiderMonkey for server-side Javascript execution. The mongod project requires a file js.lib when linking. This page details how to build js.lib.

**Building js.lib - Unix**

**Download**

```
curl -O ftp://ftp.mozilla.org/pub/mozilla.org/js/js-1.7.0.tar.gz
tar zxvf js-1.7.0.tar.gz
```

**Build**

```
cd js/src
export CFLAGS="-DJS_C_STRINGS_ARE_UTF8"
make -f Makefile.ref
```

SpiderMonkey does not use UTF-8 by default, so we enable before building.
An experimental SConstruct build file is available here.

Install

```
JS_DIST=/usr make -f Makefile.ref export
```

By default, the mongo scons project expects spidermonkey to be located at ../js/.

Building js.lib - Windows

Prebuilt

For convenience when compiling MongoDB on Windows, a prebuilt SpiderMonkey library and headers for Win32 is attached to this document (this file may or may not work depending on your compile settings and compiler version). Alternatively, follow the steps below.

Download

From an msysgit or cygwin shell, run:

```
curl -O ftp://ftp.mozilla.org/pub/mozilla.org/js/js-1.7.0.tar.gz
tar zxvf js-1.7.0.tar.gz
```

Build

```
cd js/src
export CFLAGS="-DJS_C_STRINGS_ARE_UTF8"
make -f Makefile.ref
```

If cl.exe is not found, launch Tools...Visual Studio Command Prompt from inside Visual Studio -- your path should then be correct for make.

If you do not have a suitable make utility installed, you may prefer to build using scons. An experimental SConstruct file to build the js.lib is available in the mongodb/snippets project. For example:

```
cd
git clone git://github.com/mongodb/mongo-snippets.git
cp mongo-snippets/jslib-sconstruct js/src/SConstruct
cd js/src
scons
```

Troubleshooting scons

Note that scons does not use your PATH to find Visual Studio. If you get an error running cl.exe, try changing the following line in the msvc.py scons source file from:

```
MVSdir = os.getenv('ProgramFiles') + r'\Microsoft Visual Studio 8'
```

to

```
MVSdir = os.getenv('ProgramFiles') + r'\Microsoft Visual Studio ' + version
```

See Also

- [Building MongoDB](#)

Database Internals

This section provides information for developers who want to write drivers or tools for MongoDB, contribute code to the MongoDB codebase itself, and for those who are just curious how it works internally.
Sub-sections of this section:

- Caching
- Cursors
- Error Codes
- Internal Commands
- Replication Internals
- Smoke Tests
- Pairing Internals

Caching

**MongoMemMapped_RecStore Storage Engine**

This is the current default storage engine for MongoDB, and it uses memory-mapped files for all disk I/O. Using this strategy, the operating system's virtual memory manager is in charge of caching. This has several implications:

- There is no redundancy between file system cache and database cache: they are one and the same.
- MongoDB can use all free memory on the server for cache space automatically without any configuration of a cache size.
- Virtual memory size and resident size will appear to be very large for the mongod process. This is benign: virtual memory space will just larger than the size of the datafiles open and mapped; resident size will vary depending on the amount of memory not used by other processes on the machine.
- Caching behavior (such as LRU'ing out of pages, and laziness of page writes) is controlled by the operating system: quality of the VMM implementation will vary by OS.

**CachedBasicRecStore (alternative) Storage Engine**

An alternative storage engine (CachedBasicRecStore), which does not use memory-mapped files, is under development. This engine is more traditional in design with its own page cache. With this store the database has more control over the exact timing of reads and writes, and of the cache LRU strategy.

Generally, the memory-mapped store works quite well. The alternative store will be useful in cases where an operating system's virtual memory manager is behaving suboptimally.

Cursors

⚠️ **Redirection Notice**
This page should redirect to Internals.

Error Codes

<table>
<thead>
<tr>
<th>Error Code</th>
<th>Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>E10003</td>
<td>failing update: objects in a capped ns cannot grow</td>
<td></td>
</tr>
<tr>
<td>E11000</td>
<td>duplicate key error</td>
<td>_id values must be unique in a collection</td>
</tr>
<tr>
<td>E11001</td>
<td>duplicate key on update</td>
<td></td>
</tr>
<tr>
<td>E12000</td>
<td>idxNo fails</td>
<td>an internal error</td>
</tr>
<tr>
<td>E12001</td>
<td>can't sort with $snapshot</td>
<td>the $snapshot feature does not support sorting yet</td>
</tr>
<tr>
<td>E12010 - E12012</td>
<td>can't $inc/$set an indexed field</td>
<td></td>
</tr>
</tbody>
</table>

Internal Commands

Most commands have helper functions and do not require the `$cmd.findOne()` syntax. These are primarily internal and administrative.
Replication Internals

On the master mongod instance, the local database will contain a collection, oplog.$main, which stores a high-level transaction log. The transaction log essentially describes all actions performed by the user, such as “insert this object into this collection.” Note that the oplog is not a low-level redo log, so it does not record operations on the byte/disk level.

The slave mongod instance polls the oplog.$main collection from master. The actual query looks like this:

```
local.oplog.$main.find({ ts: { $gte: '$last_op_processed_time' } }).sort({$natural:1});
```

where ‘local’ is the master instance’s local database. oplog.$main collection is a capped collection, allowing the oldest data to be aged out automatically.

See the Replication section of the Mongo Developers’ Guide for more information.

OpTime

An OpTime is a 64-bit timestamp that we use to timestamp operations. These are stored as Javascript Date datatypes but are not JavaScript Date objects. Implementation details can be found in the OpTime class in repl.h.

Applying OpTime Operations

Operations from the oplog are applied on the slave by reexecuting the operation. Naturally, the log includes write operations only.

Note that inserts are transformed into upserts to ensure consistency on repeated operations. For example, if the slave crashes, we won't know
exactly which operations have been applied. So if we're left with operations 1, 2, 3, 4, and 5, and if we then apply 1, 2, 3, 2, 3, 4, 5, we should achieve the same results. This repeatability property is also used for the initial cloning of the replica.

**Tailing**

After applying operations, we want to wait a moment and then poll again for new data with our `gte` operation. We want this operation to be fast, quickly skipping past old data we have already processed. However, we do not want to build an index on `ts`, as indexing can be somewhat expensive, and the oplog is write-heavy. Instead, we use a table scan in [natural] order, but use a tailable cursor to "remember" our position. Thus, we only scan once, and then when we poll again, we know where to begin.

**Initiation**

To create a new replica, we do the following:

```plaintext
t = now();
cloneDatabase();
end = now();
applyOperations(t..end);
```

cloneDatabase effectively exports/imports all the data in the database. Note the actual "image" we will get may or may not include data modifications in the time range `(t..end)`. Thus, we apply all logged operations from that range when the cloning is complete. Because of our repeatability property, this is safe.

See class Cloner for more information.

**Smoke Tests**

```plaintext
// run basic c++ unit tests:
scons smoke

// run all unit tests (slow)
// NOTE This scons target starts a mongod instance needed by some tests.
scons smokeAll

// to run basic jstests
// first start mongod, then:
scons smokeJs
```

Full list of scons targets for running smoke tests: 
smoke, smokePerf, smokeClient, mongoTest, smokeJs, smokeClone, smokeRepl, smokeDisk, smokeSharding, smokeJsPerf, smokeQuota, smokeTool

Note that before running smokeClient, smokeJs, smokeJsPerf, or smokeQuota a mongod instance must first be started.

**Pairing Internals**

*Policy for reconciling divergent oplogs*

In a paired environment, a situation may arise in which each member of a pair has logged operations as master that have not been applied to the other server. In such a situation, the following procedure will be used to ensure consistency between the two servers:

1. The new master will scan through its own oplog from the point at which it last applied an operation from it's peer's oplog to the end. It will create a set C of object ids for which changes were made. It will create a set M of object ids for which only modifier changes were made. The values of C and M will be updated as client operations are applied to the new master.
2. The new master will iterate through its peer's oplog, applying only operations that will not affect an object having an id in C.
3. For any operation in the peer's oplog that may not be applied due to the constraint in the previous step, if the id of the of the object in question is in M, the value of the whole object on the new master is logged to the new master's oplog.
4. The new slave applies all operations from the new master's oplog.

**Contributing to the Documentation**

Qualified volunteers are welcome to assist in editing the wiki documentation. Contact us for more information.
Editing Confluence From Emacs

You can edit Confluence directly from Emacs:

First, follow the basic instructions on [http://code.google.com/p/confluence-el/](http://code.google.com/p/confluence-el/)

Change the confluence-url in their sample setup to [http://mongodb.onconfluence.com/rpc/xmlrpc](http://mongodb.onconfluence.com/rpc/xmlrpc)

Might also want to change the default space to DOCS or DOCS-ES or whatever space you edit the most.

Mongo Documentation Style Guide

This page provides information for everyone adding to the Mongo documentation on Confluence. It covers:

- General Notes on Writing Style
- Guide to Confluence markup for specific situations
- Some general notes about doc production

General Notes on Writing Style

**Voice**

Active voice is almost always preferred to passive voice.

To make this work, however, you may find yourself anthropomorphizing components of the system - that is, treating the driver or the database as an agent that actually does something. ("The dbms writes the new record to the collection" is better than "the new record is written to the database", but some purists may argue that the dbms doesn't do anything - it's just code that directs the actions of the processor - but then someone else says "yes, but does the processor really do anything?" and so on and on.) It is simpler and more economical to write as if these components are actually doing things, although you as the infrastructure developers might have to stop and think about which component is actually performing the action you are describing.

**Tense**

Technical writers in general prefer to keep descriptions of processes in the present tense: "The dbms writes the new collection to disk" rather than "the dbms will write the new collection to disk." You save a few words that way.

MongoDB Terminology

It would be good to spell out precise definitions of technical words and phrases you are likely to use often, like the following:

- **Mongo**
- database (do you want "a Mongo database"? Or a Mongo database instance?)
- dbms (I haven't seen this term often - is it correct to talk about "the Mongo DBMS"?)
- Document
- Record
- Transaction (I stopped myself from using this term because my understanding is the Mongo doesn't support "transactions" in the sense of operations that are logged and can be rolled back - is this right?)

These are just a few I noted while I was editing. More should be added. It would be good to define these terms clearly among yourselves, and then post the definitions for outsiders.

Markup for terms

It's important to be consistent in the way you treat words that refer to certain types of objects. The following table lists the types you will deal with most often, describes how they should look, and (to cut to the chase) gives you the Confluence markup that will achieve that appearance.

<table>
<thead>
<tr>
<th>Type</th>
<th>Appearance</th>
<th>Markup</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object name (the type of &quot;object&quot; that &quot;object-oriented programming&quot; deals with)</td>
<td>monospace</td>
<td>{{ term }}</td>
</tr>
<tr>
<td>short code fragment inline</td>
<td>monospace</td>
<td>{{ term }}</td>
</tr>
<tr>
<td>file path/name, extension</td>
<td>italic</td>
<td><em>term</em></td>
</tr>
<tr>
<td>programming command, statement or expression</td>
<td>monospace</td>
<td>{{ term }}</td>
</tr>
<tr>
<td>variable or &quot;replaceable item&quot;</td>
<td>monospace italic</td>
<td><em>term</em></td>
</tr>
<tr>
<td>Placeholders in paths, directories, or other text that would be italic anyway</td>
<td>angle brackets around &lt;item&gt;</td>
<td>&lt;item&gt;</td>
</tr>
</tbody>
</table>
GUI element (menus menu items, buttons) | bold | “term”
--- | --- | ---
First instance of a technical term | italic | _term_
Tag (in HTML or XML, for example) | monospace | {{ term }}
Extended code sample | code block | {code}

In specifying these, I have relied on the O'Reilly Style Guide, which is at:

http://oreilly.com/oreilly/author/stylesheet.html

This guide is a good reference for situations not covered here.

I should mention that for the names of GUI objects I followed the specification in the Microsoft Guide to Technical Publications.

**Other Confluence markup**

If you are editing a page using Confluence's RTF editor, you don't have to worry about markup. Even if you are editing markup directly, Confluence displays a guide on the right that shows you most of the markup you will need.

**References and Links**

Confluence also provides you with a nice little utility that allows you to insert a link to another Confluence page by searching for the page by title or by text and choosing it from a list. Confluence handles the linking markup. You can even use it for external URLs.

The one thing this mechanism does NOT handle is links to specific locations within a wiki page. Here is what you have to know if you want to insert these kinds of links:

- Every heading you put in a Confluence page ("h2.Title", "h3.OtherTitle", etc.) becomes an accessible "anchor" for linking.
- You can also insert an anchor anywhere else in the page by inserting "[anchor:\_anchorname\] where _anchorname_ is the unique name you will use in the link.
- To insert a link to one of these anchors, you must go into wiki markup and add the anchor name preceded by a "#". Example: if the page MyPage contains a heading or an ad-hoc anchor named GoHere, the link to that anchor from within the same page would look like [#GoHere], and a link to that anchor from a different page would look like [MyPage#GoHere]. (See the sidebar for information about adding other text to the body of the link.)

**Special Characters**

- You will often need to insert code samples that contain curly braces. As Dwight has pointed out, Confluence gets confused by this unless you "escape" them by preceding them with a backslash, thusly:

  ```
  \\
  ```

  You must do the same for ":[", "]", ", - and some others.

  Within a {code} block you don't have to worry about this. If you are inserting code fragments inline using {{ and }}, however, you still need to escape these characters. Further notes about this:

  - If you are enclosing a complex code expression with {{ and }}, do NOT leave a space between the last character of the expression and the }}. This confuses Confluence.
  - Confluence also gets confused (at least sometimes) if you use {{ and }}, to enclose a code sample that includes escaped curly brackets.

**About MongoDB's Confluence wiki**

Confluence has this idea of "spaces". Each person has a private space, and there are also group spaces as well.

The MongoDB Confluence wiki has three group spaces defined currently:

- **Mongo Documentation** - The publicly accessible area for most Mongo documentation
- **Contributor** - Looks like, the publicly accessible space for information for "Contributors"
- **Private** - a space open to MongoDB developers, but not to the public at large.

As I said in my email on Friday, all of the (relevant) info from the old wiki now lives in the "Mongo Documentation"

**Standard elements of Wiki pages**

You shouldn't have to spend a lot of time worrying about this kind of thing, but I do have just a few suggestions:
Since these wiki pages are (or can be) arranged hierarchically, you may have "landing pages" that do little more than list their child pages. I think Confluence actually adds a list of children automatically, but it only goes down to the next hierarchical level. To insert a hierarchical list of a page's children, all you have to do is insert the following Confluence "macro":

```
{children:all=true}
```

See the Confluence documentation for more options and switches for this macro.

For pages with actual text, I tried to follow these guidelines:
- For top-level headings, I used "h2" not "h1"
- I never began a page with a heading. I figured the title of the page served as one.
- I always tried to include a "See Also" section that listed links to other Mongo docs.
- I usually tried to include a link to the "Talk to us about Mongo" page.

## Community

### General Community Resources

**User Mailing List**

The user list is for general questions about using, configuring, and running MongoDB and the associated tools and drivers. The list is open to everyone

**IRC chat**

irc://irc.freenode.net/#mongodb

**Blog**

http://blog.mongodb.org/

**Bugtracker**

File, track, and vote on bugs and feature requests. There is issue tracking for MongoDB and all supported drivers

**Announcement Mailing List**

http://groups.google.com/group/mongodb-announce - for release announcement and important bug fixes.

**Store**

Visit our Cafepress store for Mongo-related swag.

### Resources for Driver and Database Developers

**Developer List**

This mongodb-dev mailing list is for people developing drivers and tools, or who are contributing to the MongoDB codebase itself.

**Source**

The source code for the database and drivers is available at the http://github.com/mongodb.

### MongoDB Commercial Services Providers

Note: if you provide consultative or support services for MongoDB and wish to be listed here, just let us know.

- Support
- Training
- Hosting
- Consulting
  - Hashrocket
Support
10gen offers commercial MongoDB support services.

Training
10gen offers MongoDB training, with upcoming sessions in San Francisco and New York City. Custom training programs are available as well.

Hosting
See the MongoDB Hosting Center.

Consulting

Hashrocket
Hashrocket is a full-service design and development firm that builds successful web businesses. Hashrocket continually creates and follows best practices and surround themselves with passionate and talented craftsmen to ensure the best results for you and your business.

LightCube Solutions
LightCube Solutions provides PHP development and consulting services, as well as a lightweight PHP framework designed for MongoDB called ‘photon’

Squeejee
Squeejee builds web applications on top of MongoDB with multiple sites already in production.

10gen
10gen offers consulting services for MongoDB application design, development, and production operation. These services are typically advisory in nature with the goal of building higher in-house expertise on MongoDB for the client.

User Feedback
"I just have to get my head around that mongodb is really _this_ good"
-muckster, #mongodb

"Guys at Redmond should get a long course from you about what is the software development and support 😎"
-kunthar@gmail.com, mongodb-user list

"#mongodb keep me up all night. I think I have found the 'perfect' storage for my app 😊"
-elpargo, Twitter

"Maybe we can relax with couchdb but with mongodb we are completely in dreams"
-namlook, #mongodb

"Dude, you guys are legends!"
-Stii, mongodb-user list

"Times I've been wowed using MongoDB this week: 7:"
-tpitale, Twitter

Community Blog Posts
Why I Think Mongo is to Databases what Rails was to Frameworks
- John Nunemaker

MongoDB a Light in the Darkness...
- EngineYard
Introducing MongoDB
- Linux Magazine

NoSQL in the Real World
- CNET

Boxed Ice - Choosing a non-relational database; why we migrated from MySQL to MongoDB
- Tom Smith

The Other Blog - The Holy Grail of the Funky Data Model
- Samuel

GIS Solved - Populating a MongoDb with POIs
- Samuel

Community Presentations

How Python, TurboGears, and MongoDB are Transforming SourceForge.net
Rick Copeland at PyCon 2010

MongoDB
Adrian Madrid at Mountain West Ruby Conference 2009, video

MongoDB - Ruby friendly document storage that doesn't rhyme with ouch
Wynn Netherland at Dallas.rb Ruby Group, slides

MongoDB
jnunemaker at Grand Rapids RUG, slides

Developing Joomla! 1.5 Extensions, Explained (slide 37)
Mitch Pirtle at Joomla!Day New England 2009, slides

Drop Acid (slide 31) (video)
Bob Ippolito at Pycon 2009

Python and Non-SQL Databases (in French, slide 21)
Benoit Chesneau at Pycon France 2009, slides

Massimiliano Dessì at the Spring Framework Italian User Group
  - MongoDB (in Italian)
  - MongoDB and Scala (in Italian)

Presentations and Screencasts at Learnivore
Frequently-updated set of presentations and screencasts on MongoDB.

Benchmarking

We keep track of user benchmarks on the Benchmarks page.

About

- Philosophy
- Use Cases
- Production Deployments
- Mongo-Based Applications
- Events
- Roadmap
- Articles
- Benchmarks
- FAQ
- Product Comparisons
- Licensing
- Books

Philosophy

Design Philosophy
Databases are specializing - the "one size fits all" approach no longer applies.
By reducing transactional semantics the db provides, one can still solve an interesting set of problems where performance is very important, and horizontal scaling then becomes easier.
The (JSON) document data model is easy to code to, easy to manage (schemaless), and yields excellent performance by grouping relevant data together internally.
A non-relational approach is the best path to database solutions which scale horizontally to many machines.
While there is an opportunity to relax certain capabilities for better performance, there is also a need for deeper functionality than that provided by pure key/value stores.
Database technology should run anywhere, being available both for running on your own servers or VMs, and also as a cloud pay-for-what-you-use service.

Use Cases
See also the Production Deployments page for a discussion of how companies like Disqus, EA, Github, SourceForge, etc. use MongoDB.

Use Case Articles
- Using MongoDB for Real-time Analytics
- Using MongoDB for Logging
- Full Text Search in Mongo

Well Suited
- Operational data store of a web site. MongoDB is very good at real-time inserts, updates, and queries. Scalability and replication are provided which are necessary functions for large web sites' real-time data stores. Specific web use case examples:
  - content management
  - comment storage, management, voting
  - real time page view counters
  - user registration, profile, session data
- Caching. With its potential for high performance, MongoDB works well as a caching tier in an information infrastructure. The persistent backing of Mongo's cache ensures that on a system restart the downstream data tier is not overwhelmed with cache population activity.
  - "High volume, low value data". Problems where a traditional DBMS might be too expensive for the data in question. In many cases developers would traditionally write custom code to a filesystem instead using flat files or other methodologies.
- Problems requiring high scalability. Mongo is well suited to problems where the database must comprise tens or hundreds of servers. Map/Reduce engine integration is planned in the Mongo roadmap.
- Storage of program objects and JSON data (and equivalent). Mongo's BSON data format makes it very easy to store and retrieve data in a document-style / "schemaless" format. Addition of new properties to existing objects is easy and does not require blocking "ALTER TABLE" style operations.

Less Well Suited
- Highly transactional systems, such as banking systems and accounting. MongoDB, like most "NOSQL" solutions, provides lightweight transactionality: atomicity around single documents only. Applications with highly complex transactions are more suited to a traditional RDBMS.
- Traditional Business Intelligence. Data warehouses are more suited to new, problem-specific BI databases. However note that MongoDB can work very well for several reporting and analytics problems where data is predistilled or aggregated in runtime -- but classic, business intelligence is not a sweet spot.
- Problems requiring SQL.

Use Case - Session Objects
MongoDB is a good tool for storing HTTP session objects.

One implementation model is to have a sessions collection, and store the session object's _id value in a browser cookie.

With its update-in-place design and general optimization to make updates fast, the database is efficient at receiving an update to the session object on every single app server page view.

Aging Out Old Sessions
The best way to age out old sessions is to use the auto-LRU facility of capped collections. The one complication is that objects in capped collections may not grow beyond their initial allocation size. To handle this, we can "pre-pad" the objects to some maximum size on initial addition, and then on further updates we are fine if we do not go above the limit. The following mongo shell javascript example demonstrates
Production Deployments

If you're using MongoDB in production, we'd love to list you here! Email meghan@10gen.com.

<table>
<thead>
<tr>
<th>Company</th>
<th>Use Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>SourceForge</td>
<td>MongoDB is used for back-end storage on the SourceForge front pages, project pages, and download pages for all projects. See Compound Thinking, the SourceForge blog, and the PyCon 2010 website for details.</td>
</tr>
<tr>
<td>Foursquare</td>
<td>Foursquare is a location based social network that incorporates gaming elements.</td>
</tr>
<tr>
<td>Etsy</td>
<td>Etsy is a website that allows users to buy and sell handmade items.</td>
</tr>
<tr>
<td>GitHub</td>
<td>GitHub, the social coding site, is using MongoDB for an internal reporting application.</td>
</tr>
<tr>
<td>The New York Times</td>
<td>The New York Times is using MongoDB in a form-building application for photo submissions. Mongo's lack of schema gives producers the ability to define any combination of custom form fields. For example, submit a food photo. The entire interactive application is powered by MongoDB.</td>
</tr>
<tr>
<td>Disqus</td>
<td>Disqus is an innovative blog-commenting system.</td>
</tr>
<tr>
<td>Company</td>
<td>Description</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Boxedice</td>
<td>BoxedIce's server monitoring solution - <em>Server Density</em> - stores 600 million+ documents in MongoDB. BoxedIce blog posts:</td>
</tr>
<tr>
<td></td>
<td>- Why we migrated from mysql to mongodb</td>
</tr>
<tr>
<td></td>
<td>- Notes from a production deployment</td>
</tr>
<tr>
<td>CollegeHumor</td>
<td>CollegeHumor is a comedy website. MongoDB is used in CollegeHumor for internal analytics and link exchange application.</td>
</tr>
<tr>
<td>MongoHQ</td>
<td>MongoHQ provides a hosting platform for MongoDB and also uses MongoDB as the back-end for its service. Our hosting centers page provides more information about MongoDB and other MongoDB hosting options.</td>
</tr>
<tr>
<td>Justin.tv</td>
<td>Justin.tv is the easy, fun, and fast way to share live video online. MongoDB powers Justin.tv's internal analytics tools for virality, user retention, and general usage stats that out-of-the-box solutions can't provide. Read more about Justin.tv's broadcasting architecture.</td>
</tr>
<tr>
<td>The Business Insider</td>
<td>The Business Insider has been using MongoDB since the beginning of 2008. All of the site's data, including posts, comments, and even the images, are stored on MongoDB. Read more...</td>
</tr>
<tr>
<td>Chartbeat</td>
<td>Chartbeat is a revolutionary real-time analytics service that enables people to understand emergent behaviour in real-time and exploit or mitigate it. Chartbeat stores all historical analytics data in MongoDB. Read The Secret Weapons Behind Chartbeat for more information.</td>
</tr>
<tr>
<td>Hot Potato</td>
<td>Hot Potato is a social tool that organizes conversations around events. See Hot Potato's presentation about using Scala and MongoDB at the New York Tech Talks Meetup.</td>
</tr>
<tr>
<td>PhoneTag</td>
<td>PhoneTag is a service that automatically transcribes voicemail to text and delivers it in real-time via e-mail and SMS. PhoneTag stores the metadata and transcriptions for every voicemail it process in MongoDB.</td>
</tr>
<tr>
<td>Hashrocket</td>
<td>Hashrocket is an expert web design and development group. Hashrocket built PharmMD, a fully-featured Medication Management application in Ruby on Rails. The system contains functionality for identifying and resolving drug-related problems for millions of patients.</td>
</tr>
<tr>
<td>The Mozilla open-source Ubiquity Herd project</td>
<td>The Mozilla open-source Ubiquity Herd project uses MongoDB for back-end storage. Source code is available on bitbucket.</td>
</tr>
<tr>
<td>Gilt Groupe</td>
<td>Gilt Groupe is an invitation only luxury shopping site.</td>
</tr>
<tr>
<td>Codaset</td>
<td>Codaset is an open system where you can browse and search through open source projects, and check out what your friends are coding. Read the Codaset blog: The awesomeness that is MongoDB and NoSQL, is taking over Codaset</td>
</tr>
<tr>
<td>Wordnik</td>
<td>Wordnik stores its entire text corpus in MongoDB - 1.2TB of data in over 5 billion records. The speed to query the corpus was cut to 1/4 the time it took prior to migrating to MongoDB. Read more about MongoDB at Wordnik on their blog.</td>
</tr>
<tr>
<td><strong>Shopwiki</strong></td>
<td>Shopwiki uses Mongo as a data store for its shopping search engine, where they commit all the data generated, such as custom analytics. Mongo’s performance is such that ShopWiki uses it in cases where MySQL would just not be practical. ShopWiki is also using it as a storage engine for all R&amp;D and data-mining efforts where MongoDB's document oriented architecture offers maximum flexibility. Read more on the ShopWiki Dev Blog.</td>
</tr>
<tr>
<td><strong>MyPunchbowl.com</strong></td>
<td>MyPunchbowl.com is a start to finish party planning site that uses MongoDB for tracking user behavior and datamining. Read Ryan Angilly on Replacing MySQL with MongoDB (Zero to Mongo) on The Bitsource for more information.</td>
</tr>
<tr>
<td><strong>Stickybits</strong></td>
<td>Stickybits is a fun and social way to attach digital content to real world objects.</td>
</tr>
<tr>
<td><strong>EA</strong></td>
<td>MongoDB is being used for the game feeds component. It caches game data from different sources which gets served to ea.com, rupture.com and the EA download manager.</td>
</tr>
<tr>
<td><strong>Struq</strong></td>
<td>Struq develops technology that personalises the contents and design of online display advertising in real time.</td>
</tr>
<tr>
<td><strong>Pitchfork</strong></td>
<td>Pitchfork is using MongoDB for their year-end readers survey and internal analytics.</td>
</tr>
<tr>
<td><strong>Floxee</strong></td>
<td>Floxee, a web toolkit for creating Twitter directories, leverages MongoDB for back-end storage. The award-winning TweetCongress is powered by Floxee.</td>
</tr>
<tr>
<td><strong>Sailthru</strong></td>
<td>Sailthru is an email service provider that uses MongoDB for click-stream analysis and reporting.</td>
</tr>
<tr>
<td><strong>Silentale</strong></td>
<td>Silentale keeps track of your contacts and conversations from multiple platforms and allows you to search and access them from anywhere. Silentale is using MongoDB as the back-end for indexing and searching on millions of stored messages of different types. More details on Silentale can be found in this TechCrunch article.</td>
</tr>
<tr>
<td><strong>Defensio</strong></td>
<td>Defensio is a comment-spam blocker that uses MongoDB for back-end storage.</td>
</tr>
<tr>
<td><strong>TweetSaver</strong></td>
<td>TweetSaver is a web service for backing up, searching, and tagging your tweets. TweetSaver uses MongoDB for back-end storage.</td>
</tr>
<tr>
<td><strong>Bloom Digital</strong></td>
<td>Bloom Digital's AdGear platform is a next-generation ad platform. MongoDB is used for back-end reporting storage for AdGear.</td>
</tr>
<tr>
<td><strong>KLATU Networks</strong></td>
<td>KLATU Networks designs, develops and markets asset monitoring solutions which helps companies manage risk, reduce operating costs and streamline operations through proactive management of the status, condition, and location of cold storage assets and other mission critical equipment. KLATU uses MongoDB to store temperature, location, and other measurement data for large wireless sensor networks. KLATU chose MongoDB over competitors for scalability and query capabilities.</td>
</tr>
<tr>
<td><strong>MusicNation</strong></td>
<td>Almost all data for MusicNation, including user information, images, and music videos, are stored in MongoDB.</td>
</tr>
<tr>
<td><strong>songkick</strong></td>
<td>songkick lets you track your favorite artists so you never miss a gig again.</td>
</tr>
<tr>
<td><strong>Detexify</strong></td>
<td>Detexify is a cool application to find LaTeX symbols easily. It uses MongoDB for back-end storage. Check out the blog post for more on why Detexify is using MongoDB.</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
</tr>
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</tr>
<tr>
<td><strong>Sluggy Freelance</strong></td>
<td><a href="http://sluggy.com/">http://sluggy.com/</a> is built on MongoDB, mongodb_beaker, and MongoKit.</td>
</tr>
<tr>
<td><strong>Stylesignal</strong></td>
<td>Stylesignal is using MongoDB to store opinions from social media, blogs, forums and other sources to use in their sentiment analysis system, Zeitgeist.</td>
</tr>
<tr>
<td><strong>@trackmeet</strong></td>
<td>@trackmeet helps you take notes with twitter, and is built on MongoDB.</td>
</tr>
<tr>
<td><strong>eFlyover</strong></td>
<td>eFlyover leverages the Google Earth Browser Plugin and MongoDB to provide interactive flyover tours of over two thousand golf courses worldwide.</td>
</tr>
<tr>
<td><strong>Shapado</strong></td>
<td>Shapado is a multi-topic question and answer site in the style of Stack Overflow. Shapado is written in Rails and uses MongoDB for back-end storage.</td>
</tr>
<tr>
<td><strong>Sifino</strong></td>
<td>Sifino enables students to help each other with their studies. Students can share notes, course summaries, and old exams, and can also ask and respond to questions about particular courses.</td>
</tr>
<tr>
<td><strong>GameChanger</strong></td>
<td>GameChanger provides mobile apps that replace pencil-and-paper scorekeeping and online tools that distribute real-time game updates for amateur sports.</td>
</tr>
<tr>
<td><strong>soliMAP</strong></td>
<td>soliMAP is a map-based ad listings site that uses MongoDB for storage.</td>
</tr>
<tr>
<td><strong>MyBankTracker iPhone App</strong></td>
<td>MyBankTracker iPhone App uses MongoDB for the iPhone app's back-end server.</td>
</tr>
<tr>
<td><strong>BillMonitor</strong></td>
<td>BillMonitor uses MongoDB to store all user data, including large amounts of billing information. This is used by the live site and also by BillMonitor's internal data analysis tools.</td>
</tr>
<tr>
<td><strong>Tubricator</strong></td>
<td>Tubricator allows you to create easy to remember links to YouTube videos. It's built on MongoDB and Django.</td>
</tr>
<tr>
<td><strong>Mu.ly</strong></td>
<td>Mu.ly uses MongoDB for user registration and as a backend server for its iPhone Push notification service. MongoDB is mu.ly's Main backend database and absolute mission critical for mu.ly.</td>
</tr>
<tr>
<td><strong>Avinu</strong></td>
<td>Avinu is a Content Management System (CMS) built on the Vork enterprise framework and powered by MongoDB.</td>
</tr>
<tr>
<td><strong>edelight</strong></td>
<td>edelight is a social shopping portal for product recommendations.</td>
</tr>
<tr>
<td><strong>Topsy</strong></td>
<td>Topsy is a search engine powered by Tweets that uses Mongo for realtime log processing and analysis.</td>
</tr>
<tr>
<td><strong>Codepeek</strong></td>
<td>Codepeek is using MongoDB and GridFS for storing pastes.</td>
</tr>
<tr>
<td>Company</td>
<td>Information</td>
</tr>
<tr>
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</tr>
<tr>
<td>Similaria.pl</td>
<td>is an online platform, created to connect users with people and products that match them.</td>
</tr>
<tr>
<td>ToTuTam</td>
<td>uses Mongo to store information about events in its portal and also to store and organise information about users preferences.</td>
</tr>
<tr>
<td>themoviedb.org</td>
<td>is a free, user driven movie database that uses MongoDB as its primary database.</td>
</tr>
<tr>
<td>OCW Search</td>
<td>is a search engine for OpenCourseWare. It stores all the course materials in MongoDB and uses Sphinx to index these courses.</td>
</tr>
<tr>
<td>Mixero</td>
<td>is the new generation Twitter client for people who value their time and are tired of information noise. Mixero uses Mongo to store users' preferences and data.</td>
</tr>
<tr>
<td>Biggo</td>
<td>is an advanced site constructor with e-commerce modules. Biggo uses MongoDB for stats collection.</td>
</tr>
<tr>
<td>Kabisa</td>
<td>is a web development firm specializing in Ruby on Rails and Java / J2EE. Kabisa uses MongoDB for many of its client projects, including a mobile news application for iPhone and Android.</td>
</tr>
<tr>
<td>DokDok</td>
<td>makes it easy and automatic for users to find, work on and share the latest version of any document - right from their inbox. DokDok migrated to a Mongo backend in August 2009. See Bruno Morency's presentation Migrating to MongoDB for more information.</td>
</tr>
</tbody>
</table>

See also
- MongoDB Apps
- Use Cases
- User Feedback

Mongo-Based Applications

Please list applications that leverage MongoDB here. If you're using MongoDB for your application, we'd love to list you here! Email meghan@10gen.com.

See Also
- Production Deployments - Companies and Sites using MongoDB
- Hosting Center

Applications Using MongoDB

CMS
Harmony App

Harmony is a powerful web-based platform for creating and managing websites. It helps connect developers with content editors, for unprecedented flexibility and simplicity.

c5t

Content-management using TurboGears and Mongo

Events

- MongoNYC May 21
- MongoDB Training
- 10gen Weekly "Office Hours"
- Conferences and Meetups
- Video & Slides from Recent Events and Presentations

MongoNYC May 21

Friday May 21
New York, NY
Register

MongoNYC is a full-day, in-depth, multi-track conference exploring development with the non-relational, document-oriented database MongoDB. The conference features sessions on database internals, schema design, geospatial indexing, map/reduce, replication, sharding, and more.

In addition to these topics, attendees can learn about MongoDB in the real world through a series of presentations about production deployments at foursquare, Gilt Groupe, Hot Potato, and more.

MongoDB Training

Practical MongoDB Training
Kyle Banker, Software Engineer, 10gen
New York, NY
Thursday, April 22

MongoDB Workshop at NoSQL EU
Mathias Stearn, Software Engineer, 10gen
Seth Edwards, mytrade.com
London, UK
Thursday, April 22

MongoDB Workshop at Frozen Rails
Mike Dirolf, Software Engineer, 10gen
Helsinki, Finland
May 6, 2010

Gettin' Tough with MongoDB
Kyle Banker and John Nunemaker
CityFlats Hotel, Holland, Michigan
May 24-25, 2010

Practical MongoDB Training
Kyle Banker, Software Engineer, 10gen
New York, NY
Thursday, June 17

10gen Weekly "Office Hours"

10gen holds weekly open "office hours" with whiteboarding, hack sessions, etc., in NYC. Come over to 10gen headquarters to meet the MongoDB team.

Wednesdays, 4pm - 6:30pm ET
17 West 18th Street - 8th Floor
Between 5th & 6th Ave
New York, NY

On the west coast? Stop by the Epicenter Cafe in San Francisco on Mondays to meet 10gen Software Engineer Aaron Staple. Ask questions, hack, have some coffee. Look for a laptop with a "Powered by MongoDB" sticker.
Mondays 4pm - 6pm PT  
**Epicenter Cafe**  
764 Harrison St  
Between 4th St & Lapu St  
San Francisco, CA

**Conferences and Meetups**

**New York MongoDB User Group**  
**San Francisco MongoDB User Group**

They’re called databases, not dataacids  
Richard Kreuter, Software Engineer, 10gen  
New York Linux Users Group (NYLUG)  
New York, NY  
Wednesday, April 21

**NoSQL: The Shift to a Non-relational World**  
Nosh Petigara, Director of Product Strategy, 10gen  
Great Indian Developer Summit  
Bangalore, India  
April 20-23

**NoSQL EU**  
Mathias Stearn, Software Engineer, 10gen  
London, UK  
April 20-21

**Big Data Workshop**  
Aaron Staple, Software Engineer, 10gen  
Friday, April 23  
Mountain View, CA

**Sharding with MongoDB**  
Eliot Horowitz, CTO & Co-Founder, 10gen  
New York MongoDB User Group  
Monday April 26

**Schema Design with MongoDB**  
Kyle Banker, Software Engineer, 10gen  
Webinar  
Tuesday April 27

**Mongo!**  
Mathias Stearn, Software Engineer, 10gen  
New York Technology Meetup  
New York, NY  
Tuesday, May 4

**Data Driven Applications with Ruby and MongoDB**  
Kyle Banker & John Taber  
Red Dirt Ruby Conference  
Oklahoma City, OK  
You can obtain a 10% discount on registration by using the discount code rdrc10gen10  
Thursday, May 6

**Introduction to MongoDB**  
Mike Dirolf, Software Engineer, 10gen  
Frozen Rails  
Helsinki, Finland  
Friday, May 7

**MongoDB: Another approach to data**  
Daniel Wehner  
Drupal Dev Days  
Munich, Germany  
May 7-8

**Introduction to MongoDB**  
Mike Dirolf, Software Engineer, 10gen  
New York NoSQL Meetup  
New York, NY  
May 12
Chartbeat and MongoDB - a perfect marriage
Kushal Dave, CTO, Chartbeat & Mike Dirolf, Software Engineer, 10gen
New York City Cloud Computing Meetup
New York, NY
May 18

Converting Your MySQL App to NoSQL with MongoDB?
MongoDB for Mobile Applications
Kristina Chodorow, Software Engineer, 10gen
Tek-X
Chicago, IL
May 18-21

The Future of Content Technologies
Scaling Web Applications with NonSQL Databases: Business Insider Case Study
Ian White, Lead Developer, Business Insider
Gilbane Conference
San Francisco, CA
Thursday, May 20

NoSQL-Channeling the Data Explosion
Dwight Merriman, CEO, 10gen
Inside MongoDB: the Internals of an Open-Source Database
Mike Dirolf, Software Engineer, 10gen
Gluecon
Denver, CO
Wednesday May 26 & Thursday May 27
Use the discount code "10gendisc" when registering to receive 10% off!

Joomla and MongoDB
Mitch Pirtle, Spacemonkey Labs
J and Beyond, the International Joomla Conference
May 30 - June 1
Weisbaden, Germany

Dropping ACID with MongoDB
Kristina Chodorow, Software Engineer, 10gen
Yet Another Perl Conference
June 21 - 23

MongoDB Inside and Outside
Kyle Banker, Software Engineer, 10gen
WindyCityDB
June 28
Chicago, IL

Introduction to NoSQL with MongoDB
Erick Camacho, Software Engineer, TidySlice
GULEV 2010
June 26 - 28
Veracruz, Mexico

Practical Ruby Projects with MongoDB
Alex Sharp, Lead Developer, OptimisCorp
Ruby Midwest
Kansas City, MO
July 16-17

Introduction to MongoDB
Kristina Chodorow, Software Engineer, 10gen
Scaling SourceForge with MongoDB
Nosh Petigara (10gen) and Mark Ramm (SourceForge)
OSCON
July 19-23
Portland, OR

Video & Slides from Recent Events and Presentations

MongoDB
Richard Kreuter, Software Engineer, 10gen
Southern CT Open Source Users Group
New Haven, CT
Sunday April 18
MongoDB
Seth Edwards
London Ruby Users Group
London, UK
Wednesday April 14
Video & Slides

NoSQL Meetup at Blue Box Group
Grant Goodale, Zendorse
Seattle, WA
Wednesday April 14

Dropping ACID with MongoDB
Kristina Chodorow, Software Engineer, 10gen
San Francisco MySQL Meetup
San Francisco, CA
Monday, April 12
Video

MongoDB: The New "M" in your LAMP Stack
Richard Kreuter, Software Engineer, 10gen
Texas Linux Fest
Austin, TX
Saturday, April 10

MongoDB: The Way and its Power
Kyle Banker, Software Engineer, 10gen
RubyNation
Friday April 9 & Saturday April 10
Reston, VA
Slides

Introduction to MongoDB
Mike Dirolf, Software Engineer, 10gen
Emerging Technologies for the Enterprise Conference
Philadelphia, PA
Friday, April 9
Slides

Indexing with MongoDB
Aaron Staple, Software Engineer, 10gen
Webinar
Tuesday April 6, 2010
Video | Slides

TechZing Interview with Mike Dirolf, Software Engineer, 10gen
Monday, April 5
Podcast

Hot Potato and MongoDB
New York Tech Talks Meetup
Justin Shaffer and Lincoln Hochberg
New York, NY
Tuesday March 30
Video

MongoDB Day
Geek Austin Data Series
Austin, TX
Saturday March 27
Photo

Mongo Scale!
Kristina Chodorow, Software Engineer, 10gen
Webcast
Friday March 26
Webcast

Yahoo! Open Hack Day Brasil 2010
Cesar Rodas
Saturday March 20

NoSQL, no Join, noRDBMS: Understanding Cloud Data
Dwight Merriman, CEO, 10gen
Cloud Connect
Santa Clara, CA
Monday March 15

MongoDB Rules
Kyle Banker, Software Engineer, 10gen
Mountain West Ruby Conference
Salt Lake City, UT
Thursday March 11 & Friday March 12
Slides

MongoDB: huMONGOus Data at SourceForge
Mark Ramm, Web Developer, SourceForge
QCon London
Thursday March 11
Slides

NoSQL Live Boston
Boston, MA
Thursday March 11
Recap with slides and MP3

Migrating to MongoDB
Bruno Morency, DokDok
Confoo.ca
March 10 - 12
Slides

MongoDB: How it Works
Mike Dirolf, Software Engineer, 10gen
Monday March 8, 12:30 PM Eastern Time
Slides

MongoDB & Mongoid
Durran Jordan, Hashrocket
RubyJax
February 23, 2010
Video

Intro to MongoDB
Alex Sharp, Founder / Lead Software Architect, FrothLogic
LA WebDev Meetup
February 23, 2010
Slides

How Python, TurboGears, and MongoDB are Transforming SourceForge.net
Rick Copeland, SourceForge.net
PyCon - Atlanta, GA
February 21, 2010
Slides

Introduction to MongoDB
Kristina Chodorow, Software Engineer, 10gen
FOSDEM - Brussels, Belgium
February 7, 2010
Video | Slides | Photos

MongoDB Isn't Water
Kyle Banker, Software Engineer, 10gen
Chicago Ruby
February 2, 2010
Video | Slides | Photos

If you're interested in having someone present MongoDB at your conference or meetup, or if you would like to list your MongoDB event on this page, contact meghan at 10gen dot com.

Roadmap

1.4 - 2010 Q1

<table>
<thead>
<tr>
<th>Type</th>
<th>Key</th>
<th>Summary</th>
<th>Assignee</th>
<th>Reporter</th>
<th>Priority</th>
<th>Status</th>
<th>Resolution</th>
<th>Created</th>
<th>Updated</th>
<th>Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Key</td>
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<tr>
<td>SERVER-1044</td>
<td>more quiet logging</td>
<td>Allow user to choose whether to wrap MapReduce results inside &quot;value&quot;-attribute of result</td>
<td>Eliot Horowitz</td>
<td>Tobias O.</td>
<td></td>
<td>Open</td>
<td>Unresolved</td>
<td>Apr 23, 2010</td>
<td>Apr 24, 2010</td>
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<tr>
<td>SERVER-813</td>
<td>Add radius to $near</td>
<td>Add radius to $near</td>
<td>Eliot Horowitz</td>
<td>pitchfork media, inc</td>
<td></td>
<td>Closed</td>
<td>Fixed</td>
<td>Mar 23, 2010</td>
<td>Apr 26, 2010</td>
<td></td>
</tr>
<tr>
<td>SERVER-775</td>
<td>What if create something like CouchDB views with low cost of developing?</td>
<td>What if create something like CouchDB views with low cost of developing?</td>
<td>Eliot Horowitz</td>
<td>Kostyantin Voz</td>
<td></td>
<td>Open</td>
<td>Unresolved</td>
<td>Mar 17, 2010</td>
<td>Apr 06, 2010</td>
<td></td>
</tr>
<tr>
<td>SERVER-656</td>
<td>ismaster command should be readonly</td>
<td>ismaster command should be readonly</td>
<td>aaron</td>
<td>Dwight Merriman</td>
<td></td>
<td>Closed</td>
<td>Fixed</td>
<td>Feb 23, 2010</td>
<td>Mar 02, 2010</td>
<td></td>
</tr>
<tr>
<td>SERVER-648</td>
<td>access control</td>
<td>access control</td>
<td>Eliot Horowitz</td>
<td>Mark Waschkowski</td>
<td></td>
<td>Open</td>
<td>Unresolved</td>
<td>Feb 19, 2010</td>
<td>Feb 19, 2010</td>
<td></td>
</tr>
<tr>
<td>SERVER-631</td>
<td>add $ tilde operator for dynamic index entry</td>
<td>add $ tilde operator for dynamic index entry</td>
<td>Eliot Horowitz</td>
<td>Dwight Merriman</td>
<td></td>
<td>Closed</td>
<td>Fixed</td>
<td>Feb 12, 2010</td>
<td>Mar 22, 2010</td>
<td></td>
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<tr>
<td>SERVER-534</td>
<td>Official RPMs</td>
<td>Official RPMs</td>
<td>Richard Kreuter</td>
<td>Gregg Lind</td>
<td></td>
<td>Open</td>
<td>Unresolved</td>
<td>Jan 12, 2010</td>
<td>Apr 15, 2010</td>
<td></td>
</tr>
<tr>
<td>SERVER-479</td>
<td>global read/write lock</td>
<td>global read/write lock</td>
<td>Dwight Merriman</td>
<td>Eliot Horowitz</td>
<td></td>
<td>Closed</td>
<td>Fixed</td>
<td>Dec 12, 2009</td>
<td>Jan 05, 2010</td>
<td></td>
</tr>
<tr>
<td>SERVER-467</td>
<td>getLastError option to wait/block until N slaves have pulled a write</td>
<td>getLastError option to wait/block until N slaves have pulled a write</td>
<td>Eliot Horowitz</td>
<td>Mathias Stearn</td>
<td></td>
<td>Closed</td>
<td>Fixed</td>
<td>Dec 09, 2009</td>
<td>Apr 26, 2010</td>
<td></td>
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<tr>
<td>SERVER-464</td>
<td>background index creation</td>
<td>background index creation</td>
<td>Dwight Merriman</td>
<td>Eliot Horowitz</td>
<td></td>
<td>Closed</td>
<td>Fixed</td>
<td>Dec 09, 2009</td>
<td>Mar 09, 2010</td>
<td></td>
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<tr>
<td>SERVER-459</td>
<td>Find and Modify command</td>
<td>Find and Modify command</td>
<td>Mathias Stearn</td>
<td>Mathias Stearn</td>
<td></td>
<td>Closed</td>
<td>Fixed</td>
<td>Dec 04, 2009</td>
<td>Jan 05, 2010</td>
<td></td>
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<tr>
<td>SERVER-446</td>
<td>finish v8 command</td>
<td>finish v8 command</td>
<td>aaron</td>
<td>Eliot Horowitz</td>
<td></td>
<td>Closed</td>
<td>Fixed</td>
<td>Nov 29, 2009</td>
<td>Feb 12, 2010</td>
<td></td>
</tr>
<tr>
<td>SERVER-134</td>
<td>$unset (was: $unset and $rename)</td>
<td>$unset (was: $unset and $rename)</td>
<td>Mathias Stearn</td>
<td>Kristina Chodorow</td>
<td></td>
<td>Closed</td>
<td>Fixed</td>
<td>Jul 08, 2009</td>
<td>Jan 05, 2010</td>
<td></td>
</tr>
<tr>
<td>SERVER-91</td>
<td>2d spatial indexing</td>
<td>2d spatial indexing</td>
<td>Eliot Horowitz</td>
<td>Eliot Horowitz</td>
<td></td>
<td>Closed</td>
<td>Fixed</td>
<td>Jun 03, 2009</td>
<td>Mar 02, 2010</td>
<td></td>
</tr>
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</table>

### 1.6 - 2010 Q2

<table>
<thead>
<tr>
<th>(5 issues)</th>
<th>Type</th>
<th>Key</th>
<th>Summary</th>
<th>Assignee</th>
<th>Reporter</th>
<th>Priority</th>
<th>Status</th>
<th>Resolution</th>
<th>Created</th>
<th>Updated</th>
<th>Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>SERVER-1031</td>
<td></td>
<td>SERVER-1031</td>
<td>Allow user to choose whether to wrap MapReduce results inside &quot;value&quot;-attribute of result</td>
<td>Eliot Horowitz</td>
<td>Tommy V</td>
<td></td>
<td>Open</td>
<td>Unresolved</td>
<td>Apr 20, 2010</td>
<td>Apr 20, 2010</td>
<td></td>
</tr>
<tr>
<td>SERVER-1001</td>
<td></td>
<td>SERVER-1001</td>
<td>errors should be returned when ns hashmap is almost full, not when completely full</td>
<td>Eliot Horowitz</td>
<td>Dwight Merriman</td>
<td></td>
<td>Open</td>
<td>Unresolved</td>
<td>Apr 12, 2010</td>
<td>Apr 12, 2010</td>
<td></td>
</tr>
</tbody>
</table>

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**1.6 - 2010 Q2**

(5 issues)
Articles

See also the User Feedback page for community presentations, blog posts, and more.

Best of the MongoDB Blog

- What is the Right Data Model? - (for non-relational databases)
- Why Schemaless is Good
- The Importance of Predictability of Performance
- Capped Collections - one of MongoDB's coolest features
- Using MongoDB for Real-time Analytics
- Using MongoDB for Logging
- http://blog.mongodb.org/tagged/best-of

Articles / Key Doc Pages

- On Atomic Operations
- Reaching into Objects - how to do sophisticated query operations on nested JSON-style objects
- Schema Design
- Full Text Search in Mongo
- MongoDB Production Deployments

Videos

- MongoDB for Rubyists (February 2010 Chicago Ruby Meetup)
- Introduction to MongoDB (FOSDEM February 2010)
- NY MySQL Meetup - NoSQL, Scaling, MongoDB
- Teach Me To Code - Introduction to MongoDB
- DGVIE

Benchmarks

If you've done a benchmark, we'd love to hear about it! Let us know at kristina at 10gen dot com.

March 9, 2010 - Speed test between django_mongokit and postgresql_psycopg2 benchmarks creating, editing, and deleting.

February 15, 2010 - Benchmarking Tornado's Sessions flatfile, Memcached, MySQL, Redis, and MongoDB compared.

January 23, 2010 - Inserts and queries against MySQL, CouchDB, and Memcached.

May 10, 2009 - MongoDB vs. CouchDB vs. Tokyo Cabinet

July 2, 2009 - MongoDB vs. MySQL

September 25, 2009 - MongoDB inserts using Java.

August 11, 2009 - MySQL vs. MongoDB vs. Tokyo Tyrant vs. CouchDB inserts and queries using PHP.

August 23, 2009 - MySQL vs. MongoDB in PHP: Part 1 (inserts), Part 2 (queries), aginst InnoDB with and without the query log and MyISAM.

November 9, 2009 - MySQL vs. MongoDB in PHP and Ruby inserts (original Russian, English translation)

Disclaimer: these benchmarks were created by third parties not affiliated with MongoDB. MongoDB does not guarantee in any way the correctness, thoroughness, or repeatability of these benchmarks.

FAQ

See also the Developer FAQ for deeper / more minute techie FAQ's.

- What kind of database is the Mongo database?
- What languages can I use to work with the Mongo database?
- Does it support SQL?
- Is caching handled by the database?
- What language is MongoDB written in?
- What are the 32-bit limitations?

What kind of database is the Mongo database?

MongoDB is an document-oriented DBMS. Think of it as MySQL but JSON (actually, BSON ) as the data model, not relational. There are no
joins. If you have used object-relational mapping layers before in your programs, you will find the Mongo interface similar to use, but faster, more powerful, and less work to set up.

**What languages can I use to work with the Mongo database?**

Lots! See the [drivers page](#).

**Does it support SQL?**

No, but MongoDB does support ad hoc queries via a JSON-style query language. See the [Tour](#) and [Advanced Queries](#) pages for more information on how one performs operations.

**Is caching handled by the database?**

For simple queries (with an index) Mongo should be fast enough that you can query the database directly without needing the equivalent of memcached. The goal is for Mongo to be an alternative to an ORM/memcached/mysql stack. Some MongoDB users do like to mix it with memcached though.

**What language is MongoDB written in?**

The database is written in C++. Drivers are usually written in their respective languages, although some use C extensions for speed.

**What are the 32-bit limitations?**

MongoDB uses memory-mapped files. When running on a 32-bit operating system, the total storage size for the server (data, indexes, everything) is 2gb. If you are running on a 64-bit os, there is virtually no limit to storage size. See the blog post for more information.

## Product Comparisons

### Interop Demo (Product Comparisons)

**Interop 2009 MongoDB Demo**


### MongoDB, CouchDB, MySQL Compare Grid

<table>
<thead>
<tr>
<th></th>
<th>CouchDB</th>
<th>MongoDB</th>
<th>MySQL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Model</td>
<td>Document-Oriented (JSON)</td>
<td>Document-Oriented (BSON)</td>
<td>Relational</td>
</tr>
<tr>
<td>Data Types</td>
<td>string, number, boolean, array, object</td>
<td>string, int, double, boolean, date, bytearray, object, array, others</td>
<td>link</td>
</tr>
<tr>
<td>Large Objects (Files)</td>
<td>Yes (attachments)</td>
<td>Yes (GridFS)</td>
<td>blobs?</td>
</tr>
<tr>
<td>Replication</td>
<td>Master-master (with developer supplied conflict resolution)</td>
<td>Master-slave</td>
<td>Master-slave</td>
</tr>
<tr>
<td>Object(row) Storage</td>
<td>One large repository</td>
<td>Collection based</td>
<td>Table based</td>
</tr>
<tr>
<td>Query Method</td>
<td>Map/reduce of javascript functions to lazily build an index per query</td>
<td>Dynamic; object-based query language</td>
<td>Dynamic; SQL</td>
</tr>
<tr>
<td>Secondary Indexes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Interface</td>
<td>REST</td>
<td>Native drivers</td>
<td>Native drivers</td>
</tr>
</tbody>
</table>
We are getting a lot of questions "how are mongo db and couch different?" It's a good question: both are document-oriented databases with schemaless JSON-style object data storage. Both products have their place -- we are big believers that databases are specializing and "one size fits all" no longer applies.

We are not CouchDB gurus so please let us know in the forums if we have something wrong.

**MVCC**

One big difference is that CouchDB is MVCC based, and MongoDB is more of a traditional update-in-place store. MVCC is very good for certain classes of problems: problems which need intense versioning; problems with offline databases that resync later; problems where you want a large amount of master-master replication happening. Along with MVCC comes some work too: first, the database must be compacted periodically, if there are many updates. Second, when conflicts occur on transactions, they must be handled by the programmer manually (unless the db also does conventional locking -- although then master-master replication is likely lost).

MongoDB updates an object in-place when possible. Problems require high update rates of objects are a great fit; compaction is not necessary. MongoDB's replication works great but, without the MVCC model, it is more oriented towards master/slave and auto failover configurations than to complex master-master setups. With MongoDB you should see high write performance, especially for updates.

**Horizontal Scalability**

One fundamental difference is that a number of Couch users use replication as a way to scale. With Mongo, we tend to think of replication as a way to gain reliability/failover rather than scalability. MongoDB takes a different approach to scalability (sharding is in alpha). In this sense MongoDB is more like Google BigTable. (We hear that Couch might one day add partitioning too.)

**Query Expression**

Couch uses a clever index building scheme to generate indexes which support particular queries. There is an elegance to the approach, although one must predeclare these structures for each query one wants to execute. One can think of them as materialized views.

Mongo uses traditional dynamic queries. As with, say, MySQL, we can do queries where an index does not exist, or where an index is helpful but only partially so. MongoDB includes a query optimizer which makes these determinations. We find this is very nice for inspecting the data administratively, and this method is also good when we don't want an index: such as insert-intensive collections. When an index corresponds perfectly to the query, the Couch and Mongo approaches are then conceptually similar. We find expressing queries as JSON-style objects in MongoDB to be quick and painless though

**Atomicity**

Both MongoDB and CouchDB support **concurrent modifications of single documents**. Both forego complex transactions involving large numbers of objects.

**Durability**

The products take different approaches to durability. CouchDB is a "crash-only" design where the db can terminate at any time and remain consistent. MongoDB take a different approach to durability. On a machine crash, one then would run a repairDatabase() operation when starting up again (similar to MyISAM). MongoDB recommends using replication -- either LAN or WAN -- for true durability as a given server could permanently be dead. To summarize: CouchDB is better at durability when using a single server with no replication.

**Map Reduce**

Both CouchDB and MongoDB support map/reduce operations. For CouchDB map/reduce is inherent to the building of all views. With MongoDB, map/reduce is only for data processing jobs but not for traditional queries.

**Javascript**

Both CouchDB and MongoDB make use of Javascript. CouchDB uses Javascript extensively including in the building of views.
MongoDB supports the use of Javascript but more as an adjunct. In MongoDB, query expressions are typically expressed as JSON-style query objects; however one may also specify a javascript expression as part of the query. MongoDB also supports running arbitrary javascript functions server-side and uses javascript for map/reduce operations.

**REST**

Couch uses REST as its interface to the database. With its focus on performance, MongoDB relies on language-specific database drivers for access to the database over a proprietary binary protocol. Of course, one could add a REST interface atop an existing MongoDB driver at any time -- that would be a very nice community project. Some early stage REST implementations exist for MongoDB.

**Performance**

Philosophically, Mongo is very oriented toward performance, at the expense of features that would impede performance. We see MongoDB being useful for many problems where databases have not been used in the past because databases are too “heavy”. Features that give MongoDB good performance are:

- client driver per language: native socket protocol for client/server interface (not REST)
- use of memory mapped files for data storage
- collection-oriented storage (objects from the same collection are stored contiguously)
- update-in-place (not MVCC)
- written in C++

**Use Cases**

It may be helpful to look at some particular problems and consider how we could solve them.

- if we were building Lotus Notes, we would use Couch as its programmer versioning reconciliation/MVCC model fits perfectly. Any problem where data is offline for hours then back online would fit this. In general, if we need several eventually consistent master-master replica databases, geographically distributed, often offline, we would use Couch.
- if we had very high performance requirements we would use Mongo. For example, web site user profile object storage and caching of data from other sources.
- if we were building a system with very critical transactions, such as bond trading, we would not use MongoDB for those transactions -- although we might in hybrid for other data elements of the system. For something like this we would likely choose a traditional RDBMS.
- for a problem with very high update rates, we would use Mongo as it is good at that. For example, updating real time analytics counters for a web site (pages views, visits, etc.)

Generally, we find MongoDB to be a very good fit for building web infrastructure.

**Licensing**

If you are using a vanilla MongoDB server from either source or binary packages you have **NO** obligations. You can ignore the rest of this page.

All of the MongoDB software is open source, under a variety of licenses. The following is a list of components and licenses:

- MongoDB : GNU AGPL v3.0
- mongodb.org Supported Drivers : Apache License v2.0 (third parties have created drivers too; licenses will vary there)
- Documentation : Creative Commons

From our blog post on the AGPL:

*Our goal with using AGPL is to preserve the concept of copyleft with MongoDB. With traditional GPL, copyleft was associated with the concept of distribution of software. The problem is that nowadays, distribution of software is rare: things tend to run in the cloud. AGPL fixes this “loophole” in GPL by saying that if you use the software over a network, you are bound by the copyleft. Other than that, the license is virtually the same as GPL v3.*

*Note however that it is never required that applications using mongo be published. The copyleft applies only to the mongod and mongos database programs. This is why MongoDB drivers are all licensed under an Apache license. Your application, even though it talks to the database, is a separate program and “work”.*

If you intend to modify the server and distribute or provide access to your modified version you are required to release the full source code for the modified MongoDB server. To reiterate, you **only** need to provide the source for the MongoDB server and not your application (assuming you use the provided interfaces rather than linking directly against the server).

A few example cases of when you’d be required to provide your changes to MongoDB to external users:
<table>
<thead>
<tr>
<th>Case</th>
<th>Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hosting company providing access MongoDB servers</td>
<td>yes</td>
</tr>
<tr>
<td>Public-facing website using MongoDB for content</td>
<td>yes</td>
</tr>
<tr>
<td>Internal use website using MongoDB</td>
<td>no</td>
</tr>
<tr>
<td>Internal analysis of log files from a web site</td>
<td>no</td>
</tr>
</tbody>
</table>

Regardless of whether you are required to release your changes we request that you do. The preferred way to do this is via a [github](https://github) fork. Then we are likely to include your changes so everyone can benefit.

### Books

Several MongoDB books are scheduled for release in 2010 and available to pre-order. Please check this page for updates.

**The Definitive Guide to MongoDB: The NoSQL Database for Cloud and Desktop Computing**  
Peter Membrey  
Apress  
Pre-Order  
First four chapters now available through Apress’ [Alpha Program](https://github.com/mongodb).

**MongoDB for Web Development**  
Mitch Pirtle  
Addison-Wesley  
Pre-Order

**MongoDB: The Definitive Guide**  
Kristina Chodorow and Mike Dirolf  
O'Reilly  
Rough Cut version now available online  
Pre-Order

### International Documentation

Most documentation for MongoDB is currently written in English. We are looking for volunteers to contribute documentation in other languages. If you're interested in contributing to documentation in another language please email [mike at 10gen dot com](mailto:mike@10gen.com).

### Language Homepages

- Deutsch [Deutsche](#)  
- Español [Español](#)  
- Français [Français](#)  
- Italiano [Italiano](#)  
- Português [Português](#)

### Documentation Index

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<td>S ... 26</td>
<td>T ... 7</td>
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<td></td>
<td>V ... 8</td>
</tr>
</tbody>
</table>
1.0 Changelist

Wrote MongoDB. See documentation

1.1 Development Cycle

1.2.x Release Notes

New Features: More indexes per collection, Faster index creation, Map/Reduce, Stored JavaScript functions, Configurable fsync time.

Several small features and fixes.

DB Upgrade Required: There are some changes that will require doing an upgrade ...

1.4 Release Notes

We're pleased to announce the 1.4 release of MongoDB. 1.4 is a drop in replacement for 1.2. To upgrade you just need to shutdown mongod, then restart with the new binaries. (Users upgrading from release 1.0 should review the 1.2 release notes. 1.2.x ...
Building SpiderMonkey

section provides instructions on setting up your environment to write Mongo drivers or other infrastructure code. For specific instructions, go to the document that corresponds to your setup. Note: see the Downloads DOCS:Downloads page for prebuilt binaries! Subsections of this section ...

Building for FreeBSD

FreeBSD 8.0 and later, there is a mongodb port you can use. For FreeBSD <= 7.2: # Get the database source: http://www.github.com/mongodb/mongo. # Update your ports tree: $ sudo portsnap fetch & & portsnap extract The packages that come by default on 7.2 ...

Building for Linux

General Instructions # Install Dependencies see platform specific below # get source git clone git://github.com/mongodb/mongo.git # pick a stable version unless doing true dev git tag ! # Switch to a stable branch (unless ...

Building for OS X

set up your OS X computer for MongoDB development: Upgrading to Snow Leopard If you have installed Snow Leopard, the builds will be 64 bit \ \ so if moving from a previous OS release, a bit more setup may be required ...

Building for Solaris

MongoDB server currently supports little endian Solaris operation. (Although most drivers not the database server work on both.) Community: Help us make this rough page better please!&nbsp; (And help us add support for big ...

Building for Windows

MongoDB can be compiled for Windows (32 and 64 bit) using Visual C.&nbsp; SCons http://www.scons.org/ is the make mechanism, although a .vcproj/.sln is also included in the project for convenience when using the Visual Studio IDE. There are several ...

Building SpiderMonkey

MongoDB uses SpiderMonkey http://www.mozilla.org/js/spidermonkey/ for serverside Javascript execution. The mongod project requires a file js.lib when linking. This page details how to build js.lib. Note: V8 http://code.google.com/p/v8/ Javascript support is under ...

Building SpiderMonkey

Data Processing Manual

DRAFT TO BE COMPLETED. This guide provides instructions for using MongoDB batch data processing oriented features including map/reduce DOC:MapReduce. By “data processing”, we generally mean operations performed on large sets of data, rather than small ...

Data Types and Conventions

MongoDB (BSON) Data Types Mongo uses special data types in addition to the basic JSON types of string, integer, boolean, double, null, array, and object. These types include date, object id Object IDs, binary data, regular ...

Database Internals

section provides information for developers who want to write drivers or tools for MongoDB, contribute code to the MongoDB codebase itself, and for those who are just curious how it works internally. Subsections of this section

Database Profiler

Mongo includes a profiling tool to analyze the performance of database operations. See also the currentOp DOCS:Viewing and Terminating Current Operation command. Enabling Profiling To enable profiling, from the {{mongo}} shell invoke: > db.setProfilingLevel(2); > db.getProfilingLevel() 2 Profiling ...

Database References

MongoDB is nonrelational (no joins), references (“foreign keys”) between documents are generally resolved clientside by additional queries to the server. Two conventions are common for references in MongoDB: first simple manual references, and second, the DBRef standard, which many drivers support ...

Databases

Each MongoDB server can support multiple databases. Each database is independent, and the data for each database is stored separately, for security and ease of management. A database consists of one or more collections, the documents (objects) in those collections, and an optional set ...

DBA Operations from the Shell

page lists common DBAclass operations that one might perform from the MongoDB shell DOCS:mongo The Interactive Shell. Note one may also create .js scripts to run in the shell for administrative purposes. help show help show ...

dbshell Reference

Special Command Helpers Nonjavascript convenience macros: {{show dbs}} Print a list of all databases on this server {{use dbname[]}} Set the db variable to represent usage of dbname on the server {{show collections}} Print a list of all collections for current database ...

Design Overview

Developer FAQ

What’s a “namespace”? MongoDB stores BSON objects in collections. The concatenation of the database name and the collection name (with a period in between) is called a namespace. For example, {{acme.users}} is a namespace, where {{acme}} is the database name, and {{users}} is the collection name. Note that periods can occur ...

Developer Zone

Tutorial Shell mongo The Interactive Shell Manual Databases Collections Indexes Data Types and Conventions GridFS Inserting Updating Querying Removing Optimization Developer FAQ
Do I Have to Worry About SQL Injection?

Generally, with MongoDB we are not building queries from strings, so traditional SQL injection attacks are not a problem. More details and some nuances are covered below. MongoDB queries are represented as BSON objects. Typically the programming ...

FAQ

See also the Developer FAQ for deeper / more minute techie FAQ's. What kind of database is the Mongo database? MongoDB is an document oriented DBMS. Think of it as MySQL but JSON (actually, BSON DOCS:BSON) as the data model, not relational. There are no joins.&nbsp ...

Feature Checklist for Mongo Drivers

Functionality Checklist This section lists tasks the driver author might handle. Essential BSON serialization/deserialization Basic operations: {{query}}, {{save}}, {{update}}, {{remove}}, {{ensureIndex}}, {{findOne}}, {{limit}}, {{sort}} Fetch more data from a cursor when necessary ...

File Based Configuration

addition to accepting command line parameters, MongoDB can also be configured using a configuration file to use can be specified using the {{[]} or {{[config]}} command line options. The following example configuration file demonstrates the syntax to use ...

findandmodify Command

Find and Modify (or Remove) v1.3.0 and higher MongoDB 1.3\ supports a "find, modify, and return" command.&nbsp; This command can be used to atomically modify a document (at most one) and return it. Note that the document returned will not include the modifications made on the update. The command ...

Frequently Asked Questions - Ruby

list of frequently asked questions about using Ruby with MongoDB. If you have a question you'd like to have answered here, please add it in the comments. Can I run \insert command name here\ from the Ruby driver? Yes ...
Full Text Search in Mongo

Introduction

Mongo provides some functionality that is useful for text search and tagging.

Multikeys (Indexing Values in an Array)

The Mongo multikey feature can automatically index arrays of values. Tagging is a good example of where this feature is useful. Suppose you ...

How does concurrency work?

Execution of operations at each mongod is independent; that is, one mongod does not block operations concurrently. This results in downstream operations to mongod instances. (This may change in the future.)

Execution of operations at each mongod is independent; that is, one mongod does not block another. mongod The original mongod ...

How to do Snapshotted Queries in the Mongo Database

Document refers to query snapshots. For backup snapshots of the database’s datafiles, see the fsync lock page fsync Command. For performance reasons, MongoDB does not currently support true point-in-time snapshotting of collections.&nbsp; (This may change in the future.)

However ...

HowTo

Http Interface

REST Sleepy Mongoose Sleepy Mongoose

http://www.snailnutturtlebeck.com/blog/2010/02/22/sleepymongooseamongodbrestinterface/ is a full featured REST interface for MongoDB which is available as a separate project. The remainder of this page describes the very basic HTTP interface built into the mongod process. HTTP Console Page ...

GridFS Specification

Introduction

GridFS is a storage works by splitting large object into chunk is stored as a separate document about the file, including the file meta information such as the filename, content type ...

GridFS Tools

File Tools {mongofiles} is a tool from the command line. Example: mongofiles.put libmongoclient.a list connected to: 127.0.0.1 libmongoclient ...

Implementing Authentication in a Directory

Current version of MongoDB support authenticates a username and password for a MongoDB database. Once authenticated, the database in question. The {username:...</div>
Java - Saving Objects Using DBObject

Java driver provides a DBObject interface to save custom objects to the database. For example, suppose one had a class called Tweet that they wanted to save: public class Tweet implements DBObject Then you can say: Tweet myTweet = new Tweet ...

Java Driver Concurrency

Java MongoDB driver is thread safe. If you are using in a web serving environment, for example, you should create a single Mongo instance, and you can use it in every request.&nbsp; The Mongo object maintains an internal pool of connections ...

Java Language Center

Tutorial Java Tutorial API Documentation http://api.mongodb.org/java/index.html Downloads http://github.com/mongodb/mongojavadrive/downloads Specific Topics Concurrency Java Driver Concurrency Saving Objects Java Saving Objects Using DBObject Data Types ...

Java Tutorial

Introduction This page is a brief overview of working with the MongoDB Java Driver. For more information about the Java API, please refer to the online API Documentation for Java Driver http://api.mongodb.org/java/index.html A Quick Tour Using the Java driver is very ...

Java Types

ObjectId (com.mongodb.ObjectId)

http://api.mongodb.org/java/0.11/com/mongodb/ObjectId.html is used to autogenerate unique ids. ObjectId id = new ObjectId(); ObjectId copy = new ObjectId(id); Regular Expressions The Java driver uses ([java.util.regex.Pattern]) http://java.sun.com ...

Javascript Language Center

MongoDB can be Used by clients written in Javascript; Uses Javascript internally serverside for certain options such as map/reduce; Has a shell that is based on Javascript for administrative purposes. SpiderMonkey The MongoDB shell extends SpiderMonkey.&nbsp; See the MongoDB shell documentation ...

Joyent

prebuilt DOCS:Downloads MongoDB Solaris 64 binaries work with Joyent accelerators.&nbsp; Some newer gcc libraries are required to run \ make sample setup session below. # assuming a 64 bit accelerator $ /usr/bin/isainfo kv ...

JVM Languages


Language Support

Last Error Commands

Since MongoDB doesn't wait for a response by default when writing to the database, a couple commands exist for ensuring that these operations have succeeded. These commands can be invoked automatically with many of the drivers when saving and updating in "safe" mode. But what's really happening ...

Legal Key Names

Key names in inserted documents are limited as follows: The "$" character must not be the first character in the key name. The ':' character must not appear anywhere in the key name

Licensing

you are using a vanilla MongoDB server from either source or binary packages you have NO obligations. You can ignore the rest of this page. All of the MongoDB software is open source, under a variety of licenses. The following is a list of components and licenses ...

List of Database Commands

See the Commands page for details on how to invoke a command. Requires Auth requires authentication Admin Only if "Yes" this command is privileged Commands#Privileged Commands \ must be run against the admin database Slave Okay can be run on a replication slave ...
Locking

Logging

MongoDB outputs some important information to stdout while its running. There are a number of things you can do to control this Command Line Options \

*quiet* less verbose output \\n
*\v* more verbose output \\n
*logpath <file>* output to file ...

---

**Locking in Mongo**

**Logging**

MongoDB outputs some important information to stdout while its running. There are a number of things you can do to control this Command Line Options 'quiet less verbose output \v more verbose output logpath <file> output to file ...
Notes on Pooling for Mongo Drivers

Note that with the db write operations can be sent asynchronously or synchronously (the latter indicating a getlasterror request after the write). When asynchronous, one must be careful to continue using the same connection (socket). This ensures that the next operation will not begin until after ...

Object IDs

Documents in MongoDB are required to have a key, _id, which uniquely identifies them. Document IDs: _id Every MongoDB document has an _id field as its first attribute. This value usually a BSON ObjectId. Such an ...

Object Mappers for Ruby and MongoDB

Although it's possible to use the Ruby driver by itself, sometimes you want validations, associations, and many of the other conveniences provided by ActiveRecord. Here, then, is a list for working with Ruby and MongoDB 10gen ...

Optimizing Mongo Performance

Optimizing Storage of Small Objects

MongoDB records have a certain amount of overhead per object (BSON document) in a collection. This overhead is normally insignificant, but if your objects are tiny (just a few bytes, maybe one or two fields) it would not be. Below ...

OR operations in query expressions

Query objects in Mongo by default AND expressions together. Mongo currently does not include an OR operator for such queries, however there are ways to express such queries. http://jira.mongodb.org/browse/SERVER205

http://blog.mongodb.org/post/114440717/bson

Relational Data Types

string, number, boolean, array, object ...

mongosniff

Unix releases of MongoDB include a utility called mongosniff. This utility is to MongoDB what tcpdump is to TCP situations. The tool is quite useful. Usage: mongosniff help forward.

mongostat

Use the mongostat utility to quick instance. Starting in 1.3.3

Monitoring

Monitoring and Diagnostics

Query Profiler Use the Database Monitor Utility mongostat db.serverStatus() from ...

Moving Chunks

inc version try to set on from if se finish transfer commit result max this poses slight problem when π Multikeys

MongoDB provides an interesting feature that can automatically index arrays of an object's values. A good example is tagging. Suppose you have an article tagged with some category names: $ dbshell > db.articles.save( ) > db.articles.find() We can ...

Notes on Pooling for Mongo Drivers

Note that with the db write operations can be sent asynchronously or synchronously (the latter indicating a getlasterror request after the write). When asynchronous, one must be careful to continue using the same connection (socket). This ensures that the next operation will not begin until after ...

Object IDs

Documents in MongoDB are required to have a key, _id, which uniquely identifies them. Document IDs: _id Every MongoDB document has an _id field as its first attribute. This value usually a BSON ObjectId. Such an ...

Object Mappers for Ruby and MongoDB

Although it's possible to use the Ruby driver by itself, sometimes you want validations, associations, and many of the other conveniences provided by ActiveRecord. Here, then, is a list for working with Ruby and MongoDB 10gen ...

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Removing Objects from a Collection To remove objects from a collection, use the `{{remove()}}` function in the mongo shell. The `mongo` process uses `{{mongo}}` as the command. Some tests may be skipped if you are not running a recent version of the database (>= 1.1.3).

Installing CPAN: $ sudo cpan MongoDB The Perl driver is available through CPAN.

Perl Tutorial

Philosophy

Design Philosophy.png align=right! Databases are specializing the "one size fits all" approach no longer applies. By reducing transactional semantics the db provides, one can still solve an interesting set of problems where performance is very...
but may call the function "delete". Please check your driver's documentation ...

**Replica Pairs**
Setup of Replica Pairs
Replica Sets will soon replace replica pairs.&nbsp; If you are just now setting up an instance, you may want to wait for that and use master/slave replication in the meantime. MongoDB supports a concept of replica ...

**Replica Pairs in Ruby**
Here follow a few considerations for those using the Ruby driver Ruby Tutorial with MongoDB and replica pairing. Setup First, make sure that you've correctly paired two {{mongod}} instances. If you want to do this on the same machine for testing, make ...

**Replica Set Commands**
Checks if the node to which we are connecting is currently primary. Most drivers do this check automatically and then send requires to the current primary. \ Status information on the replica set from this node's point of view. Can also be accesses thorough the http interface ...

**Replica Set Configuration**
Initial Setup We use the initiate command for initial configuration of a replica set. Send the initiate command to a single server with the set. > db.runCommand( ) local.system.replset This collection holds a singleton object which contains the replica set configuration. The config object automatically ...

**Replica Set Internals**
DRAFT \ subject to change. Design Concepts A write is only truly committed once it has replicated to a majority of servers in the set.&nbsp; (We can wait for confirmation for this though, with getlasterror.) Writes are committed at the master of the set may be visible before ...

**Replica Sets**
Replica sets are NOT ready to use as of the current 1.5.x release. Please watch this jira for more information: http://jira.mongodb.org/browse/SERVER557. Replica Sets is "Replica Pairs version 2" and will be available in version 1.6. Supports more than two servers in the cluster ...

**Replication**
MongoDB supports replication of data between servers for failover and redundancy. MongoDB replication is an enhanced form of masterslave configuration: that is, only one server is active for writes (the master) at a given time. With a single active master at any point in time, we ...

**Replication Internals**
master mongod instance, the {{local}} database will contain a collection, {{oplog.$main}}, which stores a highlevel transaction log. The transaction log essentially describes all actions performed by the user, such as "insert this object into this collection." Note that the oplog is not a lowlevel redo log ...

**Roadmap**
1.4 2010 Q1 1.6 2010 Q2

**Ruby External Resources**
number of good resources appearing all over the web for learning about MongoDB and Ruby. A useful selection is listed below. If you know of others, do let us know. Screencasts Introduction to MongoDB Part I http://www.teachmetocode.com/screencasts ...

**Ruby Language Center**
an overview of the available tools and suggested practices for using Ruby with MongoDB. Those wishing to skip to more detailed discussion should check out the Ruby Driver Tutorial Ruby Tutorial, Getting started with Rails Rails Getting StartedRails ...

**Ruby Tutorial**
tutorial gives many common examples of using MongoDB with the Ruby driver. If you're looking for information on data modeling, see MongoDB Data Modeling and Rails. Links to the various object mappers are listed on our object mappers page http://www.mongodb.org ...
Troubleshooting

Too Many Open Files

you receive the error too many open files in the mongod log, there are a couple of possible reasons for this. First, to check what file descriptors are in use, run lsof (some variations shown below): lsof grep mongod lsof grep mongod ...

Troubleshooting the PHP Driver

Getting the Database Download Downloads the database, unpack it, and start the mongod process: $ bin/mongod By default MongoDB will store data files in {{/data/db/}} (or {{c:\data\db\}}) on all systems. This convention is used throughout the documentation. You can use ...

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Tailable Cursors

MongoDB has a feature known as tailable cursors which are similar to the Unix "tail " command. Tailable means the cursor is not closed once all data is retrieved. Rather, the cursor marks the last known object's position and you can resume ...

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Trouble in MongoDB

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Ubuntu and Debian packages

Please read the notes on the Doc pages. Packages are updated daily, and try updating your apt package list 10gen ...

Spec, Notes and Suggestions for Mc

Assume that the BSON DOCS:BSON objects returned from the database may be up to 4MB. This size may change over time but for now the limit is 4MB per ...
Using a Large Number of Collections

One technique one can use with MongoDB in certain situations is to have several collections to store information instead of a single collection. By doing this, certain repeating data no longer needs to be stored in every object, and an index on that key may be eliminated.

V

v0.8 Details
Existing Core Functionality
Basic Mongo database functionality: inserts, deletes, queries, indexing. Master / Slave Replication
Replica Pairs
Serverside javascript code execution
New to v0.8
Drivers for Java, C, Python, Ruby.
db shell utility ...

v0.9 Details
v0.9 adds stability and bug fixes over v0.8. The biggest addition to v0.9 is a completely new and improved query optimizer.

v1.0 Details
v1.5 Details
v2.0 Details

Validate Command
Use this command to check that a collection is valid (not corrupt) and to get various statistics. This command scans the entire collection and its indexes and will be very slow on large datasets. From the {{mongo}} shell: &gt; db.foo.validate() From a driver one might invoke the driver's equivalent ...

Version Numbers
MongoDB uses the Oddnumbered versions for development releases

There are 3 numbers in a MongoDB version: A.B.C
A is the major version. This will rarely change and signify very large changes
B is the release number. This will include many changes ...

Viewing and Terminating Current Operation
View Current Operation(s) in Progress &gt; db.currentOp(); &gt; // same as:
db.$cmd.sys.inprog.findOne() { inprog: { “opid” : 18 , “op” : “query” , “ns” : “mydb.votes” , “query” : “” , “inLock” : 1 } } Fields: opid an incrementing operation number.&nbsp; Use with killOp(). op the operation type ...

W

What is the Compare Order for BSON Types?
MongoDB allows objects in the same collection which have values which may differ in type. When comparing values from different types, a convention is utilized as to which value is less than the other. This (somewhat arbitrary but well ...

Why are my datafiles so large?
Why so many "Connection Accepted" messages logged?

Working with Mongo Objects and Classes in Ruby

Writing Drivers and Tools
mongosniff