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# MongoDB CRUD Operations

*Release 2.4.6*

## MongoDB Documentation Project

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MongoDB provides rich semantics for reading and manipulating data. CRUD stands for *create*, *read*, *update*, and *delete*. These terms are the foundation for all interactions with the database.

**MongoDB CRUD Introduction (page 3)** An introduction to the MongoDB data model as well as queries and data manipulations.

**MongoDB CRUD Concepts (page 6)** The core documentation of query and data manipulation.

**MongoDB CRUD Tutorials (page 33)** Examples of basic query and data modification operations.

**MongoDB CRUD Reference (page 57)** Reference material for the query and data manipulation interfaces.

## 1 MongoDB CRUD Introduction

MongoDB stores data in the form of *documents*, which are JSON-like field and value pairs. Documents are analogous to structures in programming languages that associate keys with values, where keys may hold other pairs of keys and values (e.g. dictionaries, hashes, maps, and associative arrays). Formally, MongoDB documents are *BSON* documents, which is a binary representation of *JSON* with additional type information. For more information, see <http://docs.mongodb.org/manualcore/document>.

```
{
  name: "sue",
  age: 26,
  status: "A",
  groups: [ "news", "sports" ]
}
```



field: value  
field: value  
field: value  
field: value

Figure 1: A MongoDB document.

MongoDB stores all documents in *collections*. A collection is a group of related documents that have a set of shared common indexes. Collections are analogous to a table in relational databases.

### 1.1 Database Operations

#### Query

In MongoDB a query targets a specific collection of documents. Queries specify criteria, or conditions, that identify the documents that MongoDB returns to the clients. A query may include a *projection* that specifies the fields from the matching documents to return. You can optionally modify queries to impose limits, skips, and sort orders.

In the following diagram, the query process specifies a query criteria and a sort modifier:

#### Data Modification

Data modification refers to operations that create, update, or delete data. In MongoDB, these operations modify the data of a single *collection*. For the update and delete operations, you can specify the criteria to select the documents to update or remove.

In the following diagram, the insert operation adds a new document to the `users` collection.



Figure 2: A collection of MongoDB documents.

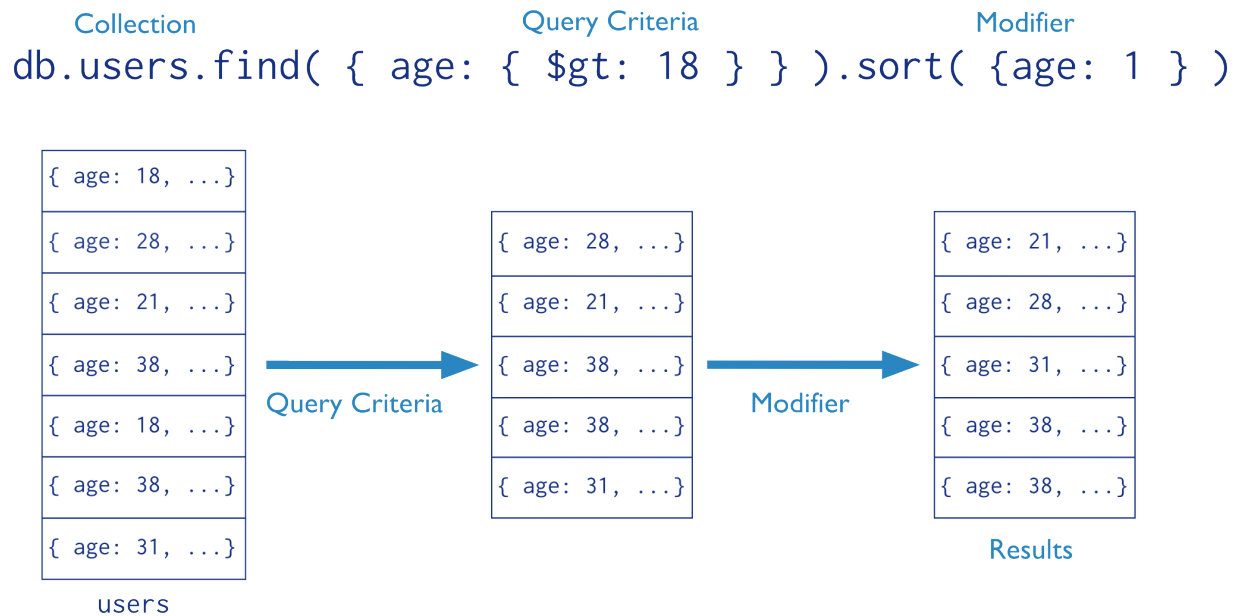


Figure 3: The stages of a MongoDB query with a query criteria and a sort modifier.

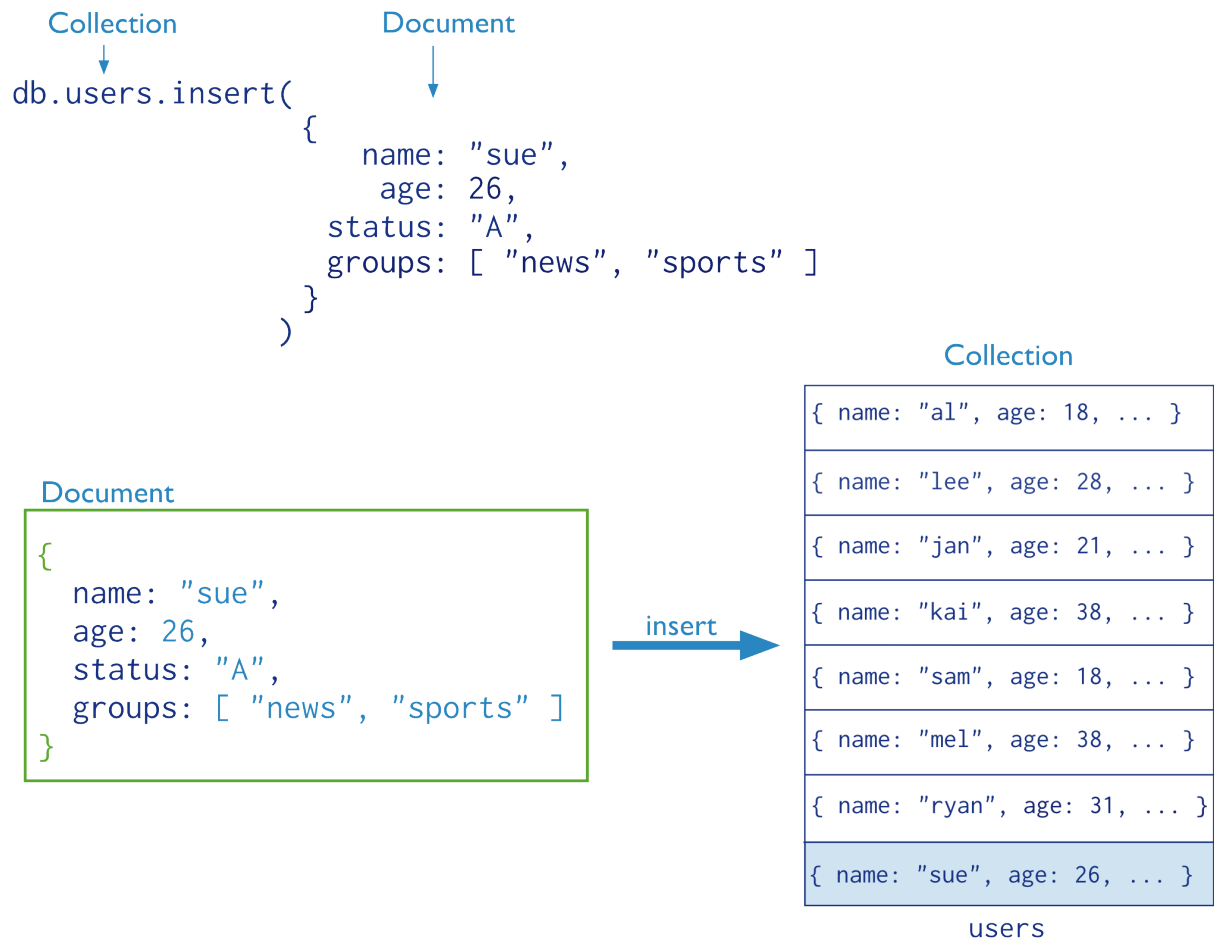


Figure 4: The stages of a MongoDB insert operation.

## 1.2 Related Features

### `/indexes`

To enhance the performance of common queries and updates, MongoDB has full support for secondary indexes. These indexes allow applications to store a *view* of a portion of the collection in an efficient data structure. Most indexes store an ordered representation of all values of a field or a group of fields. Indexes may also *enforce uniqueness*, store objects in a `geospatial` representation, and facilitate `text` search.

### `/core/read-preference`

For replica sets and sharded clusters with replica set components, applications specify *read preferences*. A read preference determines how the client directs read operations to the set.

### *Write Concern*

Applications can also control the behavior of write operations using *write concern* (page 21). Particularly useful for deployments with replica sets, the write concern semantics allow clients to specify the assurance that MongoDB provides when reporting on the success of a write operation.

### `/aggregation`

In addition to the basic queries, MongoDB provides several data aggregation features. For example, MongoDB can return counts of the number of documents that match a query, or return the number of distinct values for a field, or process a collection of documents using a versatile stage-based data processing pipeline or map-reduce operations.

## 2 MongoDB CRUD Concepts

The *Read Operations* (page 7) and *Write Operations* (page 17) documents introduce the behavior and operations of read and write operations for MongoDB deployments.

***Read Operations* (page 7)** Introduces all operations that select and return documents to clients, including the query specifications.

***Cursors* (page 10)** Queries return iterable objects, called cursors, that hold the full result set of the query request.

***Query Optimization* (page 12)** Analyze and improve query performance.

***Distributed Queries* (page 14)** Describes how *sharded clusters* and *replica sets* affect the performance of read operations.

***Write Operations* (page 17)** Introduces data create and modify operations, their behavior, and performances.

***Write Concern* (page 21)** Describes the kind of guarantee MongoDB provides when reporting on the success of a write operation.

***Distributed Write Operations* (page 24)** Describes how MongoDB directs write operations on *sharded clusters* and *replica sets* and the performance characteristics of these operations.

## 2.1 Read Operations

Read operations, or *queries*, retrieve data stored in the database. In MongoDB, queries select *documents* from a single *collection*.

Queries specify criteria, or conditions, that identify the documents that MongoDB returns to the clients. A query may include a *projection* that specifies the fields from the matching documents to return. The projection limits the amount of data that MongoDB returns to the client over the network.

### Query Interface

For query operations, MongoDB provide a `db.collection.find()` method. The method accepts both the query criteria and projections and returns a *cursor* (page 10) to the matching documents. You can optionally modify the query to impose limits, skips, and sort orders.

The following diagram highlights the components of a MongoDB query operation:



The diagram shows the MongoDB `find()` method call with four components highlighted by green arrows pointing to their respective parts in the code:

```
db.users.find(  
  { age: { $gt: 18 } },  
  { name: 1, address: 1 }  
) .limit(5)
```

- `collection` points to `db.users`
- `query criteria` points to `{ age: { $gt: 18 } }`
- `projection` points to `{ name: 1, address: 1 }`
- `cursor modifier` points to `.limit(5)`

Figure 5: The components of a MongoDB find operation.

The next diagram shows the same query in SQL:



The diagram shows the SQL `SELECT` statement with four components highlighted by green arrows pointing to their respective parts in the code:

```
SELECT _id, name, address  
FROM users  
WHERE age > 18  
LIMIT 5
```

- `projection` points to `_id, name, address`
- `table` points to `users`
- `select criteria` points to `age > 18`
- `cursor modifier` points to `LIMIT 5`

Figure 6: The components of a SQL SELECT statement.

---

### Example

```
db.users.find( { age: { $gt: 18 } }, { name: 1, address: 1 } ).limit(5)
```

This query selects the documents in the `users` collection that match the condition `age` is greater than 18. To specify the greater than condition, query criteria uses the greater than (i.e. `$gt`) *query selection operator*. The query returns at most 5 matching documents (or more precisely, a cursor to those documents). The matching documents will return with only the `_id`, `name` and `address` fields. See [Projections](#) (page 8) for details.

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### See

[SQL to MongoDB Mapping Chart](#) (page 59) for additional examples of MongoDB queries and the corresponding SQL statements.

---

## Query Behavior

MongoDB queries exhibit the following behavior:

- All queries in MongoDB address a *single* collection.
- You can modify the query to impose `limits`, `skips`, and `sort` orders.
- The order of documents returned by a query is not defined and is not necessarily consistent unless you specify a `sort()`.
- Operations that *modify existing documents* (page 42) (i.e. *updates*) use the same query syntax as queries to select documents to update.
- In aggregation pipeline, the `$match` pipeline stage provides access to MongoDB queries.

MongoDB provides a `db.collection.findOne()` method as a special case of `find()` that returns a single document.

## Query Statements

Consider the following diagram of the query process that specifies a query criteria and a sort modifier:

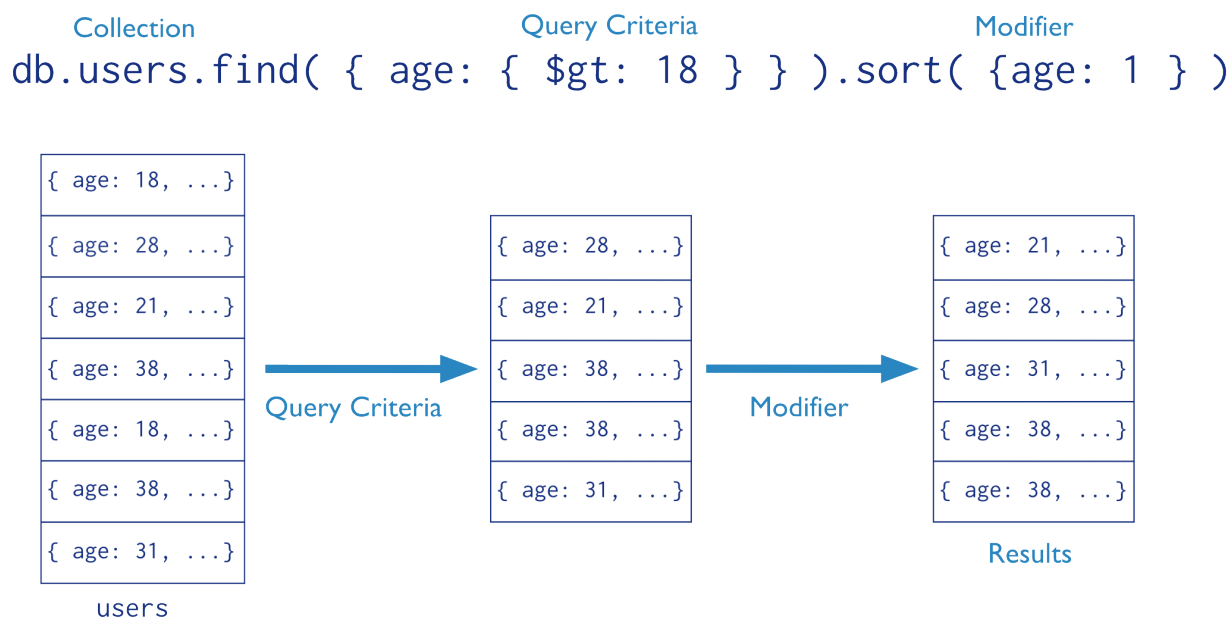


Figure 7: The stages of a MongoDB query with a query criteria and a sort modifier.

In the diagram, the query selects documents from the `users` collection. Using a query selection operator to define the conditions for matching documents, the query selects documents that have age greater than (i.e. `$gt`) 18. Then the `sort()` modifier sorts the results by age in ascending order.

For additional examples of queries, see [Query Documents](#) (page 34).

## Projections

Queries in MongoDB return all fields in all matching documents by default. To limit the amount of data that MongoDB sends to applications, include a *projection* in the queries. By projecting results with a subset of fields, applications



reduce their network overhead and processing requirements.

Projections, which are the the *second* argument to the `find()` method, may either specify a list of fields to return *or* list fields to exclude in the result documents.

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**Important:** Except for excluding the `_id` field in inclusive projections, you cannot mix exclusive and inclusive projections.

---

Consider the following diagram of the query process that specifies a query criteria and a projection:

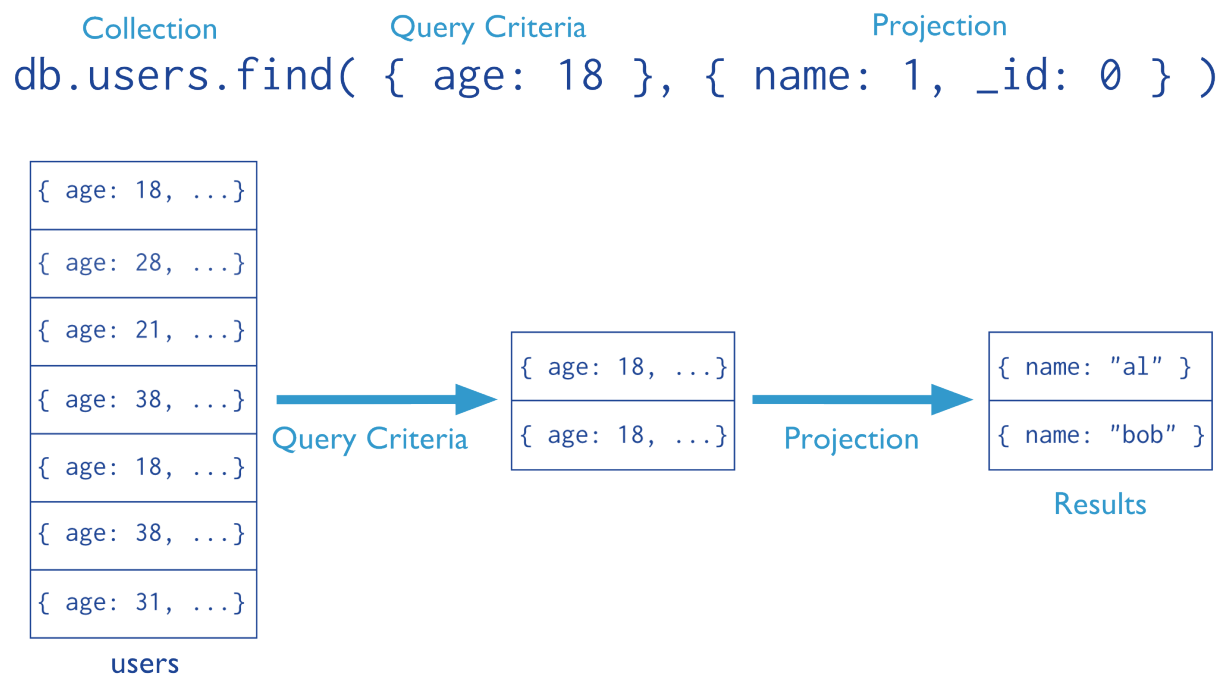


Figure 8: The stages of a MongoDB query with a query criteria and projection. MongoDB only transmits the projected data to the clients.

In the diagram, the query selects from the `users` collection. The criteria matches the documents that have `age` equal to 18. Then the projection specifies that only the `name` field should return in the matching documents.

## Projection Examples

### Exclude One Field From a Result Set

```
db.records.find( { "user_id": { $lt: 42 } }, { history: 0 } )
```

This query selects a number of documents in the `records` collection that match the query `{ "user_id": { $lt: 42 } }`, but excludes the `history` field.

### Return Two fields *and* the `_id` Field

```
db.records.find( { "user_id": { $lt: 42 } }, { "name": 1, "email": 1 } )
```

This query selects a number of documents in the `records` collection that match the query `{ "user_id": { $lt: 42 } }`, but returns documents that have the `_id` field (implicitly included) as well as the `name` and `email` fields.

## Return Two Fields and Exclude `_id`

```
db.records.find( { "user_id": { $lt: 42 } }, { "_id": 0, "name": 1 , "email": 1 } )
```

This query selects a number of documents in the `records` collection that match the query `{ "user_id": { $lt: 42 } }`, but only returns the `name` and `email` fields.

---

### See

[Limit Fields to Return from a Query](#) (page 38) for more examples of queries with projection statements.

---

## Projection Behavior

MongoDB projections have the following properties:

- In MongoDB, the `_id` field is always included in results unless explicitly excluded.
- For fields that contain arrays, MongoDB provides the following projection operators: `$elemMatch`, `$slice`, `$`.
- For related projection functionality in the aggregation framework pipeline, use the `$project` pipeline stage.

## Related Concepts

The following documents further describe read operations:

[Cursors](#) (page 10) Queries return iterable objects, called cursors, that hold the full result set of the query request.

[Query Optimization](#) (page 12) Analyze and improve query performance.

[Query Plans](#) (page 13) MongoDB processes and executes using plans developed to return results as efficiently as possible.

[Distributed Queries](#) (page 14) Describes how *sharded clusters* and *replica sets* affect the performance of read operations.

## Cursors

In the `mongo` shell, the primary method for the read operation is the `db.collection.find()` method. This method queries a collection and returns a *cursor* to the returning documents.

To access the documents, you need to iterate the cursor. However, in the `mongo` shell, if the returned cursor is not assigned to a variable using the `var` keyword, then the cursor is automatically iterated up to 20 times <sup>1</sup> to print up to the first 20 documents in the results.

For example, in the `mongo` shell, the following read operation queries the `inventory` collection for documents that have `type` equal to `'food'` and automatically print up to the first 20 matching documents:

```
db.inventory.find( { type: 'food' } );
```

To manually iterate the cursor to access the documents, see [Iterate a Cursor in the mongo Shell](#) (page 39).

## Cursor Behaviors

---

<sup>1</sup> You can use the `DBQuery.shellBatchSize` to change the number of iteration from the default value 20. See [mongo-shell-executing-queries](#) for more information.

**Closure of Inactive Cursors** By default, the server will automatically close the cursor after 10 minutes of inactivity or if client has exhausted the cursor. To override this behavior, you can specify the `noTimeout` [wire protocol flag](http://docs.mongodb.org/meta-driver/latest/legacy/mongodb-wire-protocol)<sup>2</sup> in your query; however, you should either close the cursor manually or exhaust the cursor. In the mongo shell, you can set the `noTimeout` flag:

```
var myCursor = db.inventory.find().addOption(DBQuery.Option.noTimeout);
```

See your driver documentation for information on setting the `noTimeout` flag. For the mongo shell, see `cursor.addOption()` for a complete list of available cursor flags.

**Cursor Isolation** Because the cursor is not isolated during its lifetime, intervening write operations on a document may result in a cursor that returns a document more than once if that document has changed. To handle this situation, see the information on *snapshot mode*.

**Cursor Batches** The MongoDB server returns the query results in batches. Batch size will not exceed the *maximum BSON document size*. For most queries, the *first* batch returns 101 documents or just enough documents to exceed 1 megabyte. Subsequent batch size is 4 megabytes. To override the default size of the batch, see `batchSize()` and `limit()`.

For queries that include a sort operation *without* an index, the server must load all the documents in memory to perform the sort and will return all documents in the first batch.

As you iterate through the cursor and reach the end of the returned batch, if there are more results, `cursor.next()` will perform a `getmore` operation to retrieve the next batch. To see how many documents remain in the batch as you iterate the cursor, you can use the `objsLeftInBatch()` method, as in the following example:

```
var myCursor = db.inventory.find();

var myFirstDocument = myCursor.hasNext() ? myCursor.next() : null;

myCursor.objsLeftInBatch();
```

**Cursor Information** You can use the command `cursorInfo` to retrieve the following information on cursors:

- total number of open cursors
- size of the client cursors in current use
- number of timed out cursors since the last server restart

Consider the following example:

```
db.runCommand( { cursorInfo: 1 } )
```

The result from the command returns the following document:

```
{
  "totalOpen" : <number>,
  "clientCursors_size" : <number>,
  "timedOut" : <number>,
  "ok" : 1
}
```

---

<sup>2</sup><http://docs.mongodb.org/meta-driver/latest/legacy/mongodb-wire-protocol>

## Query Optimization

Indexes improve the efficiency of read operations by reducing the amount of data that query operations need to process. This simplifies the work associated with fulfilling queries within MongoDB.

**Create an Index to Support Read Operations** If your application queries a collection on a particular field or fields, then an index on the queried field or fields can prevent the query from scanning the whole collection to find and return the query results. For more information about indexes, see the [complete documentation of indexes](#) in MongoDB.

---

### Example

An application queries the `inventory` collection on the `type` field. The value of the `type` field is user-driven.

```
var typeValue = <someUserInput>;
db.inventory.find( { type: typeValue } );
```

To improve the performance of this query, add an ascending, or a descending, index to the `inventory` collection on the `type` field.<sup>3</sup> In the mongo shell, you can create indexes using the `db.collection.ensureIndex()` method:

```
db.inventory.ensureIndex( { type: 1 } )
```

This index can prevent the above query on `type` from scanning the whole collection to return the results.

---

To analyze the performance of the query with an index, see [Analyze Query Performance](#) (page 41).

In addition to optimizing read operations, indexes can support sort operations and allow for a more efficient storage utilization. See `db.collection.ensureIndex()` and <http://docs.mongodb.org/manualadministration/indexes> for more information about index creation.

**Query Selectivity** Some query operations are not selective. These operations cannot use indexes effectively or cannot use indexes at all.

The inequality operators `$nin` and `$ne` are not very selective, as they often match a large portion of the index. As a result, in most cases, a `$nin` or `$ne` query with an index may perform no better than a `$nin` or `$ne` query that must scan all documents in a collection.

Queries that specify regular expressions, with inline JavaScript regular expressions or `$regex` operator expressions, cannot use an index with one exception. Queries that specify regular expression *with anchors* at the beginning of a string *can* use an index.

**Covering a Query** An index *covers* a query, a *covered query*, when:

- all the fields in the [query](#) (page 34) are part of that index, **and**
- all the fields returned in the documents that match the query are in the same index.

For these queries, MongoDB does not need to inspect documents outside of the index. This is often more efficient than inspecting entire documents.

---

### Example

Given a collection `inventory` with the following index on the `type` and `item` fields:

---

<sup>3</sup> For single-field indexes, the selection between ascending and descending order is immaterial. For compound indexes, the selection is important. See [indexing order](#) for more details.

```
{ type: 1, item: 1 }
```

This index will cover the following query on the `type` and `item` fields, which returns only the `item` field:

```
db.inventory.find( { type: "food", item:/^c/ },  
                  { item: 1, _id: 0 } )
```

However, the index will **not** cover the following query, which returns the `item` field **and** the `_id` field:

```
db.inventory.find( { type: "food", item:/^c/ },  
                  { item: 1 } )
```

---

See *indexes-covered-queries* for more information on the behavior and use of covered queries.

## Query Plans

The MongoDB query optimizer processes queries and chooses the most efficient query plan for a query given the available indexes. The query system then uses this query plan each time the query runs. The query optimizer occasionally reevaluates query plans as the content of the collection changes to ensure optimal query plans.

You can use the `explain()` method to view statistics about the query plan for a given query. This information can help as you develop indexing strategies.

**Query Optimization** To create a new query plan, the query optimizer:

1. runs the query against several candidate indexes in parallel.
2. records the matches in a common results buffer or buffers.
  - If the candidate plans include only *ordered query plans*, there is a single common results buffer.
  - If the candidate plans include only *unordered query plans*, there is a single common results buffer.
  - If the candidate plans include *both ordered query plans* and *unordered query plans*, there are two common results buffers, one for the ordered plans and the other for the unordered plans.

If an index returns a result already returned by another index, the optimizer skips the duplicate match. In the case of the two buffers, both buffers are de-duped.

3. stops the testing of candidate plans and selects an index when one of the following events occur:
  - An *unordered query plan* has returned all the matching results; *or*
  - An *ordered query plan* has returned all the matching results; *or*
  - An *ordered query plan* has returned a threshold number of matching results:
    - Version 2.0: Threshold is the query batch size. The default batch size is 101.
    - Version 2.2: Threshold is 101.

The selected index becomes the index specified in the query plan; future iterations of this query or queries with the same query pattern will use this index. Query pattern refers to query select conditions that differ only in the values, as in the following two queries with the same query pattern:

```
db.inventory.find( { type: 'food' } )  
db.inventory.find( { type: 'utensil' } )
```

**Query Plan Revision** As collections change over time, the query optimizer deletes the query plan and re-evaluates after any of the following events:

- The collection receives 1,000 write operations.
- The `reIndex` rebuilds the index.
- You add or drop an index.
- The `mongod` process restarts.

## Distributed Queries

**Read Operations to Sharded Clusters** *Sharded clusters* allow you to partition a data set among a cluster of `mongod` instances in a way that is nearly transparent to the application. For an overview of sharded clusters, see the <http://docs.mongodb.org/manual/sharding> section of this manual.

For a sharded cluster, applications issue operations to one of the `mongos` instances associated with the cluster.

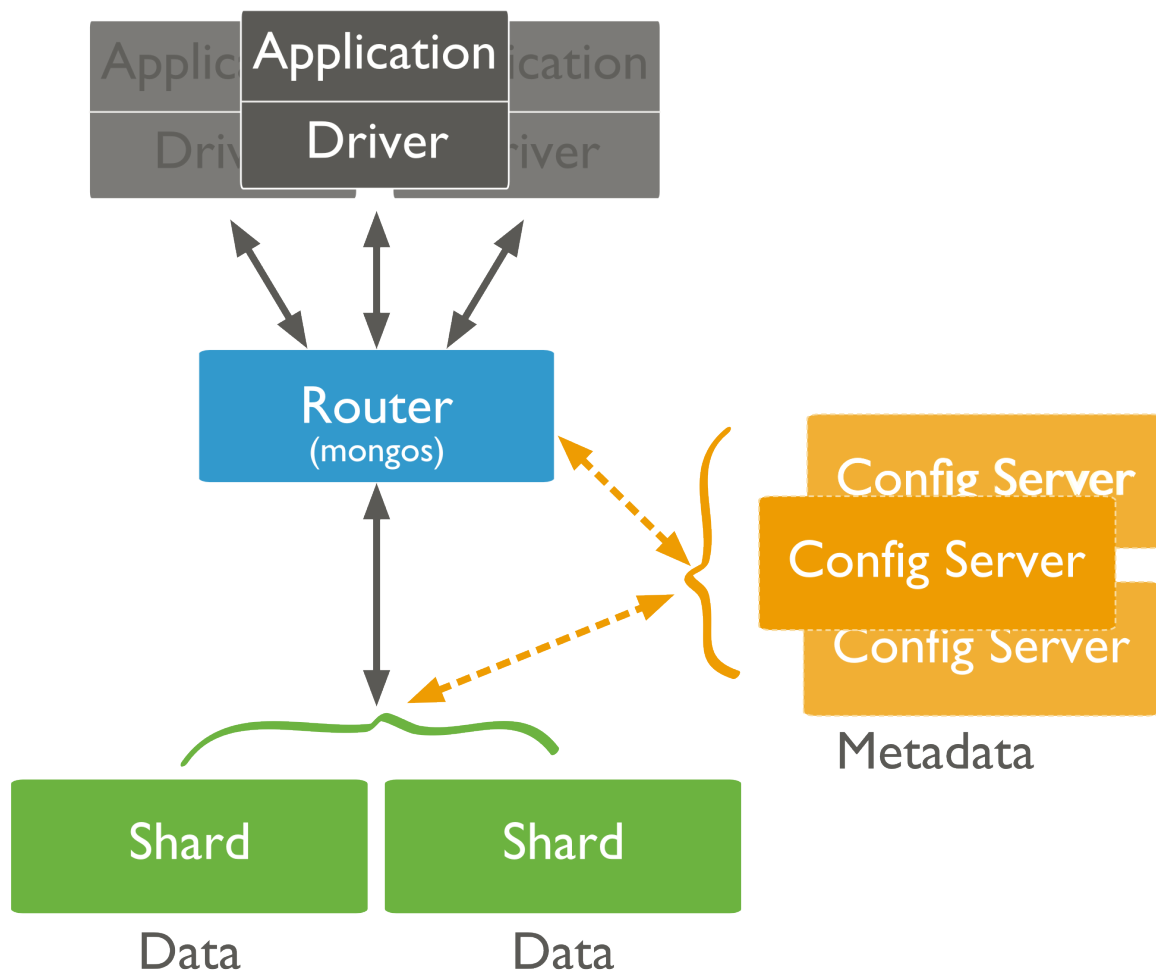


Figure 9: Diagram of a sharded cluster.

Read operations on sharded clusters are most efficient when directed to a specific shard. Queries to sharded collections should include the collection's *shard key*. When a query includes a shard key, the `mongos` can use cluster metadata

from the *config database* to route the queries to shards.

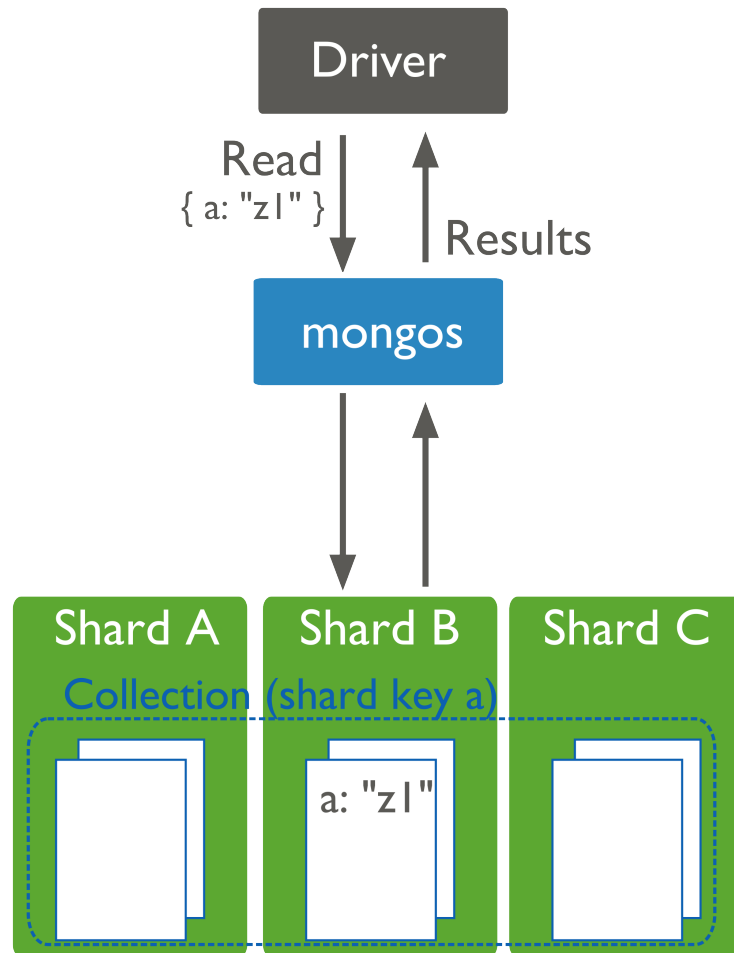


Figure 10: Read operations to a sharded cluster. Query criteria includes the shard key. The query router `mongos` can target the query to the appropriate shard or shards.

If a query does not include the shard key, the `mongos` must direct the query to *all* shards in the cluster. These *scatter gather* queries can be inefficient. On larger clusters, scatter gather queries are unfeasible for routine operations.

For more information on read operations in sharded clusters, see the <http://docs.mongodb.org/manualcore/sharded-clusters> and *sharding-shard-key* sections.

**Read Operations to Replica Sets** *Replica sets* use *read preferences* to determine where and how to route read operations to members of the replica set. By default, MongoDB always reads data from a replica set's *primary*. You can modify that behavior by changing the *read preference mode*.

You can configure the *read preference mode* on a per-connection or per-operation basis to allow reads from *secondaries* to:

- reduce latency in multi-data-center deployments,
- improve read throughput by distributing high read-volumes (relative to write volume),
- for backup operations, and/or

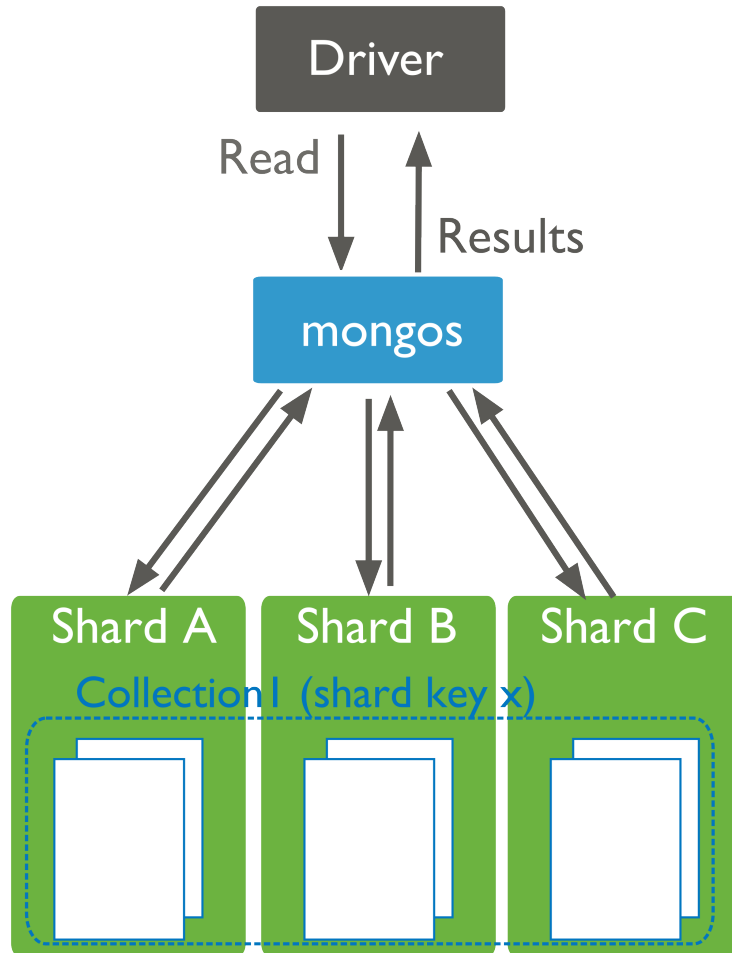


Figure 11: Read operations to a sharded cluster. Query criteria does not include the shard key. The query router `mongos` must broadcast query to all shards for the collection.



- to allow reads during *failover* situations.

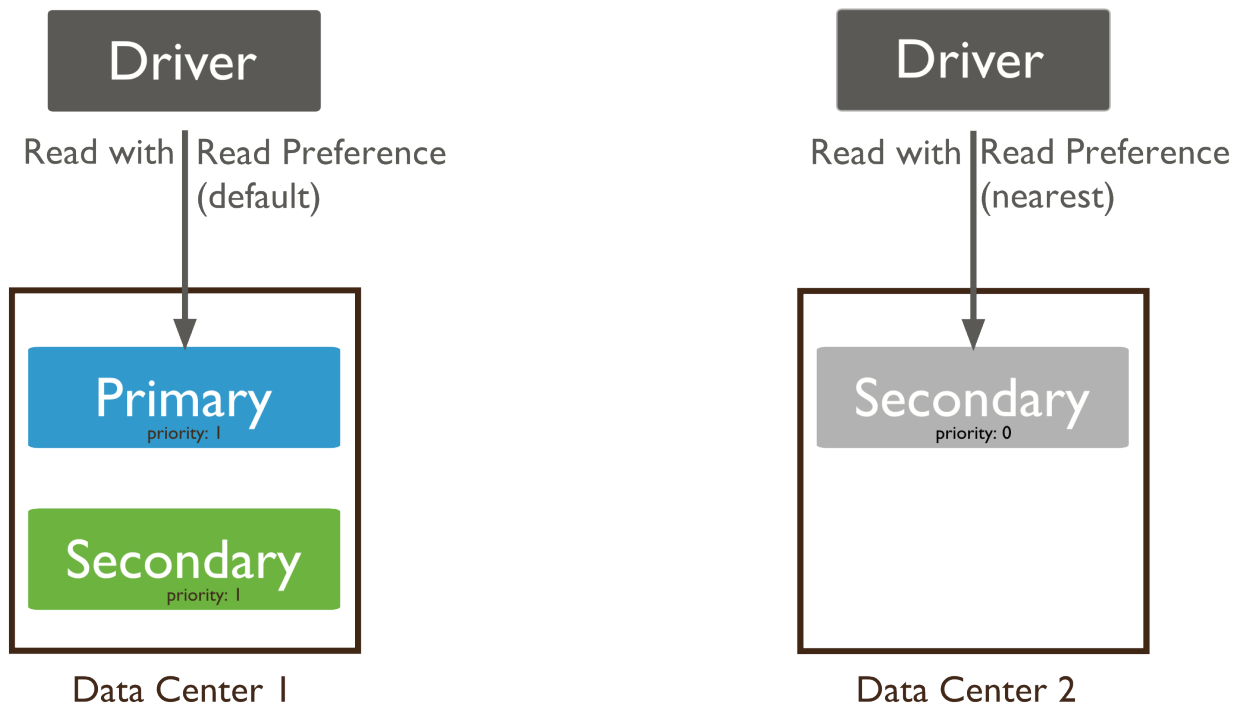


Figure 12: Read operations to a replica set. Default read preference routes the read to the primary. Read preference of `nearest` routes the read to the nearest member.

Read operations from secondary members of replica sets are not guaranteed to reflect the current state of the primary, and the state of secondaries will trail the primary by some amount of time. Often, applications don't rely on this kind of strict consistency, but application developers should always consider the needs of their application before setting read preference.

For more information on read preference or on the read preference modes, see <http://docs.mongodb.org/manualcore/read-preference> and *replica-set-read-preference-modes*.

## 2.2 Write Operations

A write operation is any operation that creates or modifies data in the MongoDB instance. In MongoDB, write operations target a single *collection*. All write operations in MongoDB are atomic on the level of a single *document*.

There are three classes of write operations in MongoDB: insert, update, and remove. Insert operations add new data to a collection. Update operations modify an existing data, and remove operations delete data from a collection. No insert, update, or remove can affect more than one document atomically.

For the update and remove operations, you can specify criteria, or conditions, that identify the documents to update or remove. These operations use the same query syntax to specify the criteria as *read operations* (page 7).

After issuing these modification operations, MongoDB allows applications to determine the level of acknowledgment returned from the database. See *Write Concern* (page 21).

## Create

Create operations add new *documents* to a collection. In MongoDB, the `db.collection.insert()` method perform create operations.

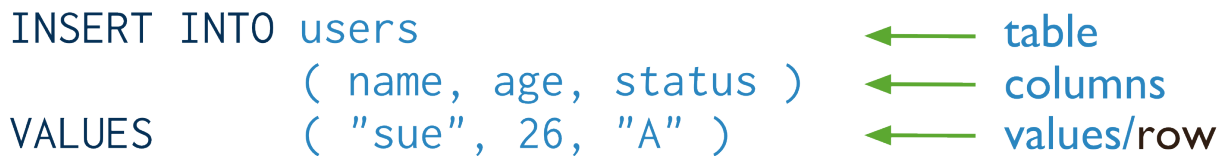
The following diagram highlights the components of a MongoDB insert operation:



The diagram illustrates the components of a MongoDB insert operation. It shows the code `db.users.insert ( { name: "sue", age: 26, status: "A" } )`. Annotations include: a green arrow pointing from the word `collection` to `db.users`; three green arrows pointing from the labels `field: value` to the pairs `name: "sue"`, `age: 26`, and `status: "A"`; and a large brown curly brace on the right grouping the entire document object `{ name: "sue", age: 26, status: "A" }` with the label `document`.

Figure 13: The components of a MongoDB insert operations.

The following diagram shows the same query in SQL:



The diagram illustrates the components of a SQL INSERT statement. It shows the code `INSERT INTO users ( name, age, status ) VALUES ( "sue", 26, "A" )`. Annotations include: a green arrow pointing from the word `table` to `users`; a green arrow pointing from the word `columns` to the parentheses containing `name, age, status`; and a green arrow pointing from the word `values/row` to the parentheses containing `"sue", 26, "A"`.

Figure 14: The components of a SQL INSERT statement.

---

### Example

```
db.users.insert (
  {
    name: "sue",
    age: 26,
    status: "A"
  }
)
```

This operation inserts a new documents into the `users` collection. The new document has four fields `name`, `age`, and `status`, and an `_id` field. MongoDB always adds the `_id` field to the new document if the field does not exist.

---

For more information, see `db.collection.insert()` and *Insert Documents* (page 33).

An upsert is an operation that performs either an update of an existing document or an insert of a new document if the document to modify does not exist. With an upsert, applications do not need to make two separate calls to the database in order to decide between performing an update or an insert operation. Both the `db.collection.update()` method and the `db.collection.save()` method can perform an upsert. See

`db.collection.update()` and `db.collection.save()` for details on performing an upsert with these methods.

---

## See

[SQL to MongoDB Mapping Chart](#) (page 59) for additional examples of MongoDB write operations and the corresponding SQL statements.

---

## Insert Behavior

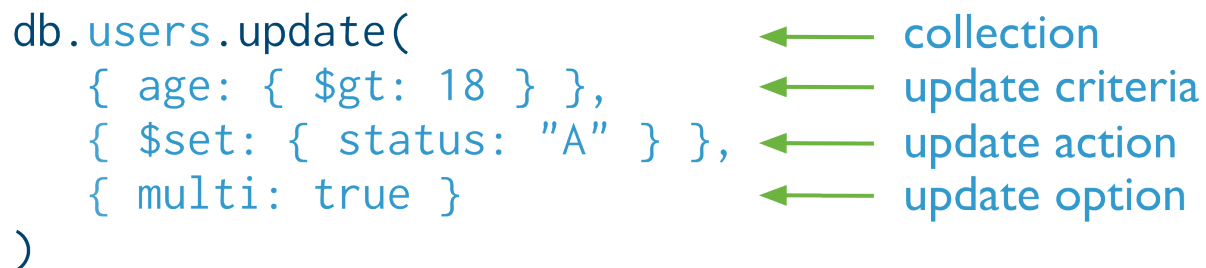
If you add a new document *without* the `_id` field, the client library or the `mongod` instance adds an `_id` field and populates the field with a unique *ObjectId*.

If you specify the `_id` field, the value must be unique within the collection. For operations with *write concern* (page 21), if you try to create a document with a duplicate `_id` value, `mongod` returns a duplicate key exception.

## Update

Update operations modify existing *documents* in a *collection*. In MongoDB, `db.collection.update()` and the `db.collection.save()` methods perform update operations. The `db.collection.update()` method can accept a query criteria to determine which documents to update as well as an option to update multiple rows. The method can also accept options that affect its behavior such as the `multi` option to update multiple documents.

The following diagram highlights the components of a MongoDB update operation:



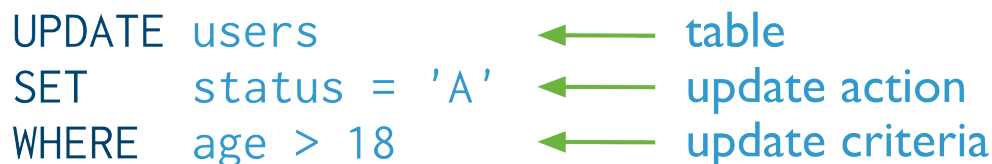
```
db.users.update(
  { age: { $gt: 18 } },
  { $set: { status: "A" } },
  { multi: true }
)
```

The diagram shows the components of the MongoDB update operation with green arrows pointing from labels to the corresponding parts of the code:

- `collection` points to `db.users`
- `update criteria` points to `{ age: { $gt: 18 } },`
- `update action` points to `{ $set: { status: "A" } },`
- `update option` points to `{ multi: true }`

Figure 15: The components of a MongoDB update operation.

The following diagram shows the same query in SQL:



```
UPDATE users
SET status = 'A'
WHERE age > 18
```

The diagram shows the components of the SQL UPDATE statement with green arrows pointing from labels to the corresponding parts of the code:

- `table` points to `users`
- `update action` points to `SET status = 'A'`
- `update criteria` points to `WHERE age > 18`

Figure 16: The components of a SQL UPDATE statement.

---

## Example

```

db.users.update(
  { age: { $gt: 18 } },
  { $set: { status: "A" } },
  { multi: true }
)

```

This update operation on the `users` collection sets the `status` field to `A` for the documents that match the criteria of age greater than 18.

---

For more information, see `db.collection.update()` and `db.collection.save()`, and [Modify Documents](#) (page 42) for examples.

## Update Behavior

By default, the `db.collection.update()` method updates a **single** document. However, with the `multi` option, `update()` can update all documents in a collection that match a query.

The `db.collection.update()` method either updates specific fields in the existing document or replaces the document. See `db.collection.update()` for details.

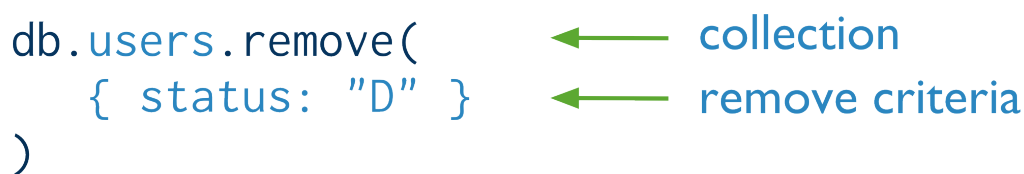
When performing update operations that increase the document size beyond the allocated space for that document, the update operation relocates the document on disk and may reorder the document fields depending on the type of update.

The `db.collection.save()` method replaces a document and can only update a single document. See `db.collection.save()` and [Insert Documents](#) (page 33) for more information.

## Delete

Delete operations remove documents from a collection. In MongoDB, `db.collection.remove()` method performs delete operations. The `db.collection.remove()` method can accept a query criteria to determine which documents to remove.

The following diagram highlights the components of a MongoDB remove operation:



```

db.users.remove(
  { status: "D" }
)

```

The diagram shows the components of the MongoDB `remove()` operation. The text `db.users.remove(` is on the first line, `{ status: "D" }` is on the second line, and `)` is on the third line. To the right of the first line, the word **collection** is written in blue, with a green arrow pointing left to `db.users`. To the right of the second line, the words **remove criteria** are written in blue, with a green arrow pointing left to `{ status: "D" }`.

Figure 17: The components of a MongoDB remove operation.

The following diagram shows the same query in SQL:



```

DELETE FROM users
WHERE status = 'D'

```

The diagram shows the components of the SQL `DELETE` statement. The text `DELETE FROM users` is on the first line, and `WHERE status = 'D'` is on the second line. To the right of the first line, the word **table** is written in blue, with a green arrow pointing left to `users`. To the right of the second line, the words **delete criteria** are written in blue, with a green arrow pointing left to `WHERE status = 'D'`.

Figure 18: The components of a SQL DELETE statement.

---

## Example

```
db.users.remove(  
    { status: "D" }  
)
```

This delete operation on the `users` collection removes all documents that match the criteria of `status` equal to `D`.

---

For more information, see `db.collection.remove()` method and [Remove Documents](#) (page 43).

## Remove Behavior

By default, `db.collection.remove()` method removes all documents that match its query. However, the method can accept a flag to limit the delete operation to a single document.

## Isolation of Write Operations

The modification of a single document is always atomic, even if the write operation modifies multiple sub-documents *within* that document. For write operations that modify multiple documents, the operation as a whole is not atomic, and other operations may interleave.

No other operations are atomic. You can, however, attempt to isolate a write operation that affects multiple documents using the `isolation` operator.

To isolate a sequence of write operations from other read and write operations, see [Perform Two Phase Commits](#) (page 43).

## Related Concepts

The following documents further describe write operations:

**[Write Concern](#) (page 21)** Describes the kind of guarantee MongoDB provides when reporting on the success of a write operation.

**[Distributed Write Operations](#) (page 24)** Describes how MongoDB directs write operations on *sharded clusters* and *replica sets* and the performance characteristics of these operations.

**[Write Operation Performance](#) (page 29)** Introduces the performance constraints and factors for writing data to MongoDB deployments.

**[Bulk Inserts in MongoDB](#) (page 30)** Describe behaviors associated with inserting an array of documents.

**[Record Padding](#) (page 31)** When storing documents on disk, MongoDB reserves space to allow documents to grow efficiently during subsequent updates.

## Write Concern

*Write concern* describes the guarantee that MongoDB provides when reporting on the success of a write operation. The strength of the write concerns determine the level of guarantee. When inserts, updates and deletes have a *weak* write concern, write operations return quickly. In some failure cases, write operations issued with weak write concerns may not persist. With *stronger* write concerns, clients wait after sending a write operation for MongoDB to confirm the write operations.

MongoDB provides different levels of write concern to better address the specific needs of applications. Clients may adjust write concern to ensure that the most important operations persist successfully to an entire MongoDB deployment. For other less critical operations, clients can adjust the write concern to ensure faster performance rather than ensure persistence to the entire deployment.

**See also:**

*Write Concern Reference* (page 58) for a reference of specific write concern configuration. Also consider *Write Operations* (page 17) for a general overview of write operations with MongoDB and <http://docs.mongodb.org/manualcore/replica-set-write-concern> for considerations specific to replica sets.

---

**Note:** The driver `write concern change` created a new connection class in all of the MongoDB drivers. The new class, called `MongoClient change` the default write concern. See the `release notes` for this change and the `release notes` for your driver.

---

**Write Concern Levels** Clients issue write operations with some level of *write concern*. MongoDB has the following levels of conceptual write concern, listed from weakest to strongest:

**Errors Ignored** With an *errors ignored* write concern, MongoDB does not acknowledge write operations. With this level of write concern, the client cannot detect failed write operations. These errors include connection errors and `mongod` exceptions such as duplicate key exceptions for *unique indexes*. Although the *errors ignored* write concern provides fast performance, this performance gain comes at the cost of significant risks for data persistence and durability.

To set *errors ignored* write concern, specify `w` values of `-1` to your driver.

**Warning:** Do not use *errors ignored* write concern in normal operation.

**Unacknowledged** With an *unacknowledged* write concern, MongoDB does not acknowledge the receipt of write operation. *Unacknowledged* is similar to *errors ignored*; however, drivers attempt receive and handle network errors when possible. The driver's ability to detect network errors depends on the system's networking configuration.

To set *unacknowledged* write concern, specify `w` values of `0` to your driver.

Before the releases outlined in *driver-write-concern-change*, this was the default write concern.

**Acknowledged** With a receipt *acknowledged* write concern, the `mongod` confirms the receipt of the write operation. *Acknowledged* write concern allows clients to catch network, duplicate key, and other errors.

To set *acknowledged* write concern, specify `w` values of `1` to your driver.

MongoDB uses *acknowledged* write concern by default, after the releases outlined in *driver-write-concern-change*.

Internally, the default write concern calls `getLastError` with no arguments. For replica sets, you can define the default write concern settings in the `getLastErrorDefaults`. When `getLastErrorDefaults` does not define a default write concern setting, `getLastError` defaults to basic receipt acknowledgment.

**Journalled** With a *journalled* write concern, the `mongod` confirms the write operation only after committing to the *journal*. A confirmed journal commit ensures *durability*, which guarantees that a write operation will survive a `mongod` shutdown. However, there is a window between journal commits when the write operation is not fully durable. See `journalCommitInterval` for more information on this window.

To set *journalled* write concern, specify `w` values of `1` and set the `journal` or `j` option to `true` to your driver.

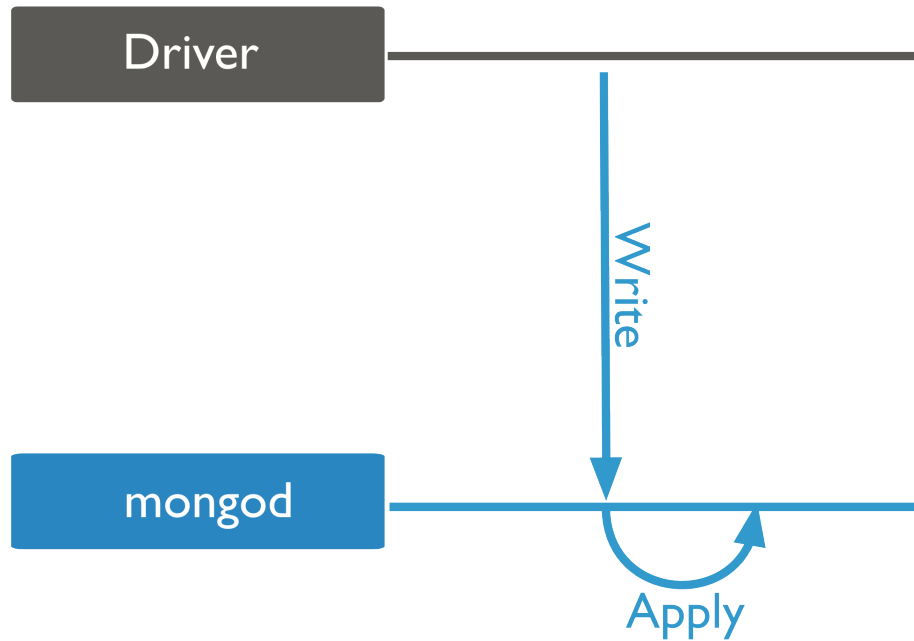


Figure 19: Write operation to a mongod instance with write concern of unacknowledged. The client does not wait for any acknowledgment.

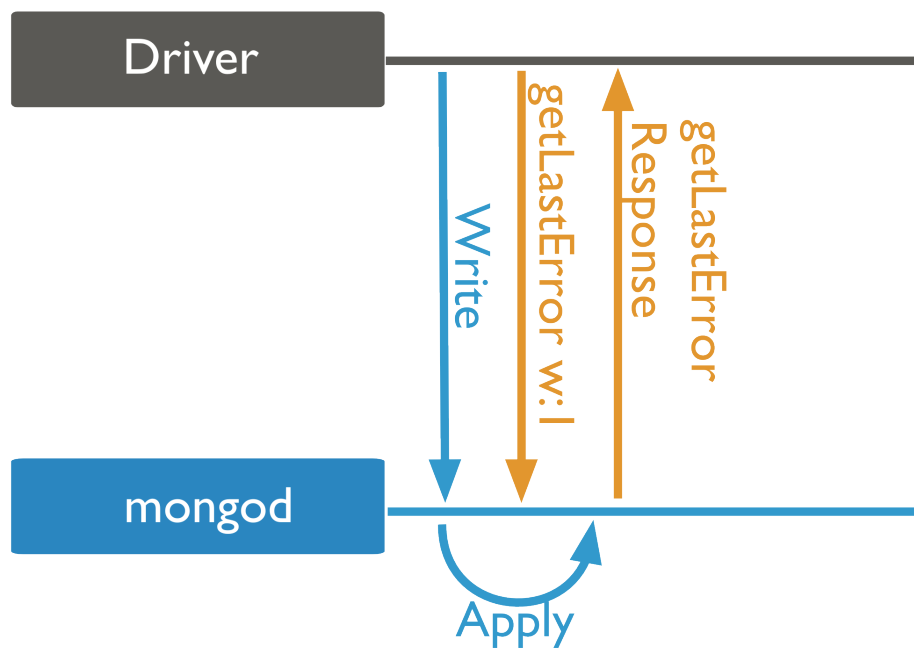


Figure 20: Write operation to a mongod instance with write concern of acknowledged. The client waits for acknowledgment of success or exception.

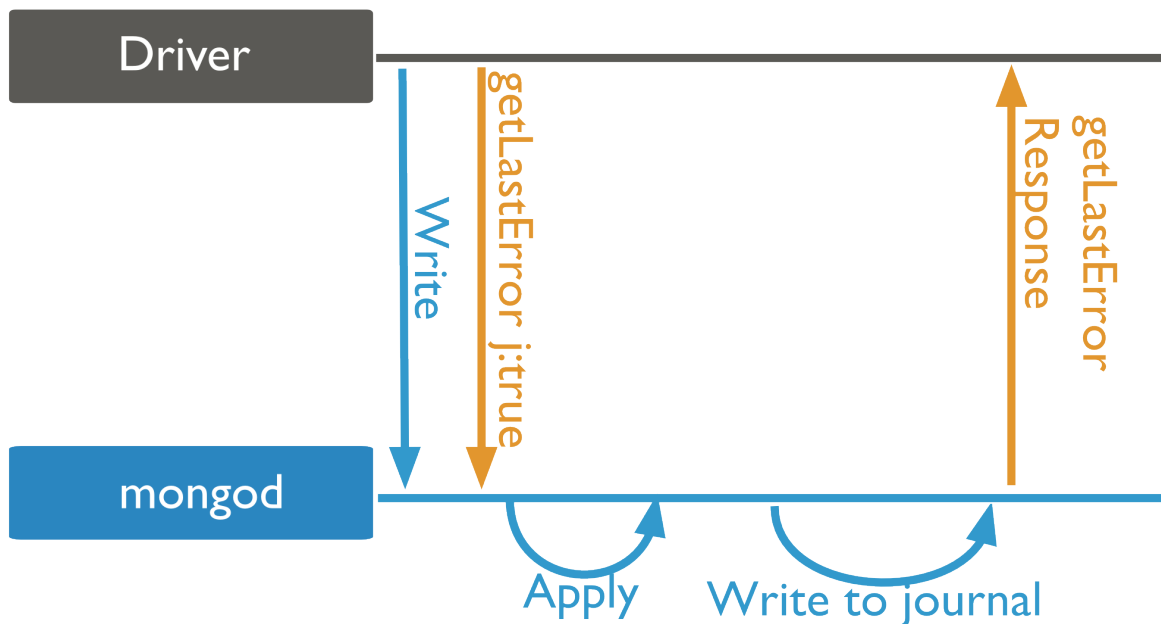


Figure 21: Write operation to a mongod instance with write concern of journaled. The mongod sends acknowledgment after it commits the write operation to the journal.

Receipt *acknowledged* without *journaled* provides the basis for write concern. Require *journaled* as part of the write concern to provide this durability guarantee. The mongod must have journaling enabled for the *journaled* write concern to have effect.

---

**Note:** Requiring *journaled* write concern in a replica set only requires a journal commit of the write operation to the *primary* of the set regardless of the level of *replica acknowledged* write concern.

---

**Replica Acknowledged** *Replica sets* add several considerations for write concern. Basic write concerns affect write operations on only one mongod instance. The *w* argument to `getLastError` provides *replica acknowledged* write concerns. With *replica acknowledged* you can guarantee that the write operation propagates to the members of a replica set. See [Write Concern Reference](#) (page 58) document for the values for *w* and Write Concern for Replica Sets for more information.

To set *replica acknowledged* write concern, specify *w* values greater than 1 to your driver.

---

**Note:** Requiring *journaled* write concern in a replica set only requires a journal commit of the write operation to the *primary* of the set regardless of the level of *replica acknowledged* write concern.

---

## Distributed Write Operations

**Write Operations on Sharded Clusters** For sharded collections in a *sharded cluster*, the mongos directs write operations from applications to the shards that are responsible for the specific *portion* of the data set. The mongos uses the cluster metadata from the *config database* to route the write operation to the appropriate shards.

MongoDB partitions data in a sharded collection into *ranges* based on the values of the *shard key*. Then, MongoDB distributes these chunks to shards. The shard key determines the distribution of chunks to shards. This can affect the performance of write operations in the cluster.



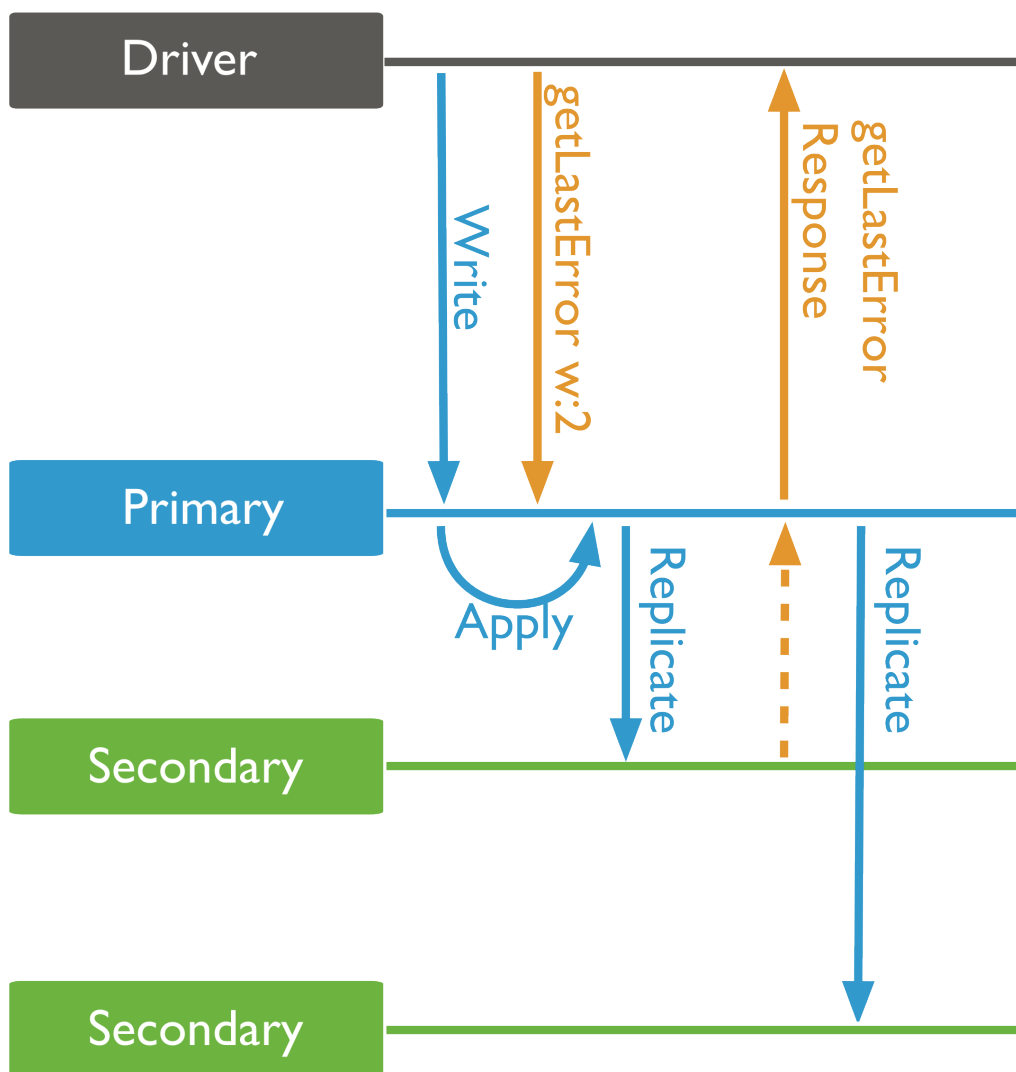


Figure 22: Write operation to a replica set with write concern level of  $w:2$  or write to the primary and at least one secondary.

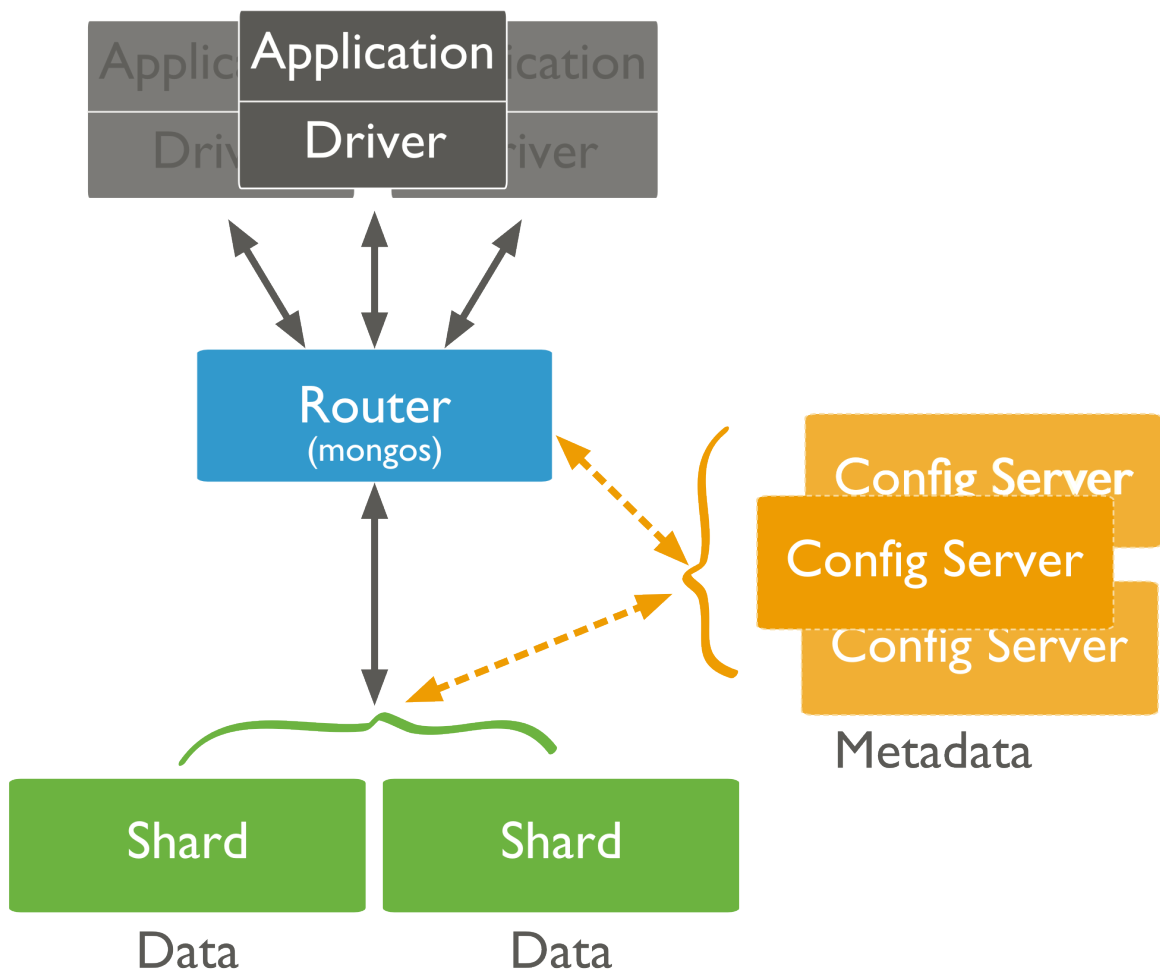


Figure 23: Diagram of a sharded cluster.

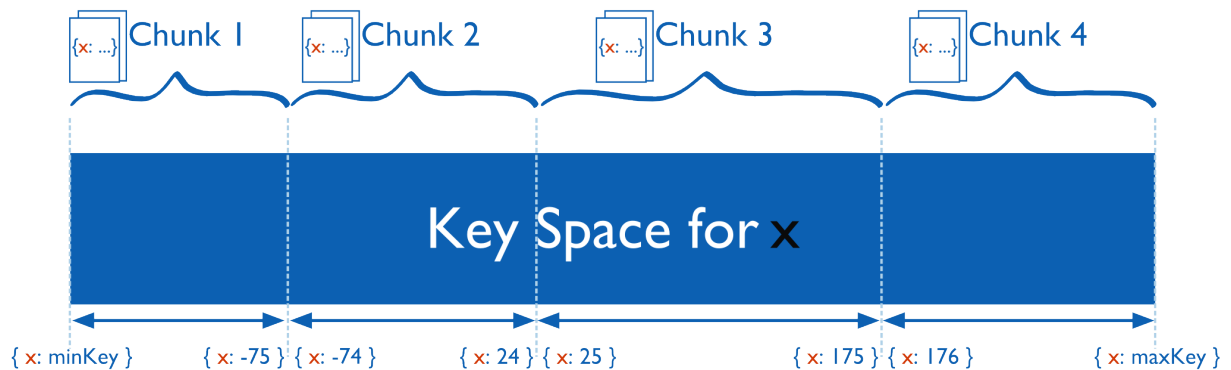


Figure 24: Diagram of the shard key value space segmented into smaller ranges or chunks.

---

**Important:** Update operations that affect a *single* document **must** include the *shard key* or the `_id` field. Updates that affect multiple documents are more efficient in some situations if they have the *shard key*, but can be broadcast to all shards.

---

If the value of the shard key increases or decreases with every insert, all insert operations target a single shard. As a result, the capacity of a single shard becomes the limit for the insert capacity of the sharded cluster.

For more information, see <http://docs.mongodb.org/manualadministration/sharded-clusters> and *Bulk Inserts in MongoDB* (page 30).

**Write Operations on Replica Sets** In *replica sets*, all write operations go to the set's *primary*, which applies the write operation then records the operations on the primary's operation log or *oplog*. The *oplog* is a reproducible sequence of operations to the data set. *Secondary* members of the set are continuously replicating the *oplog* and applying the operations to themselves in an asynchronous process.

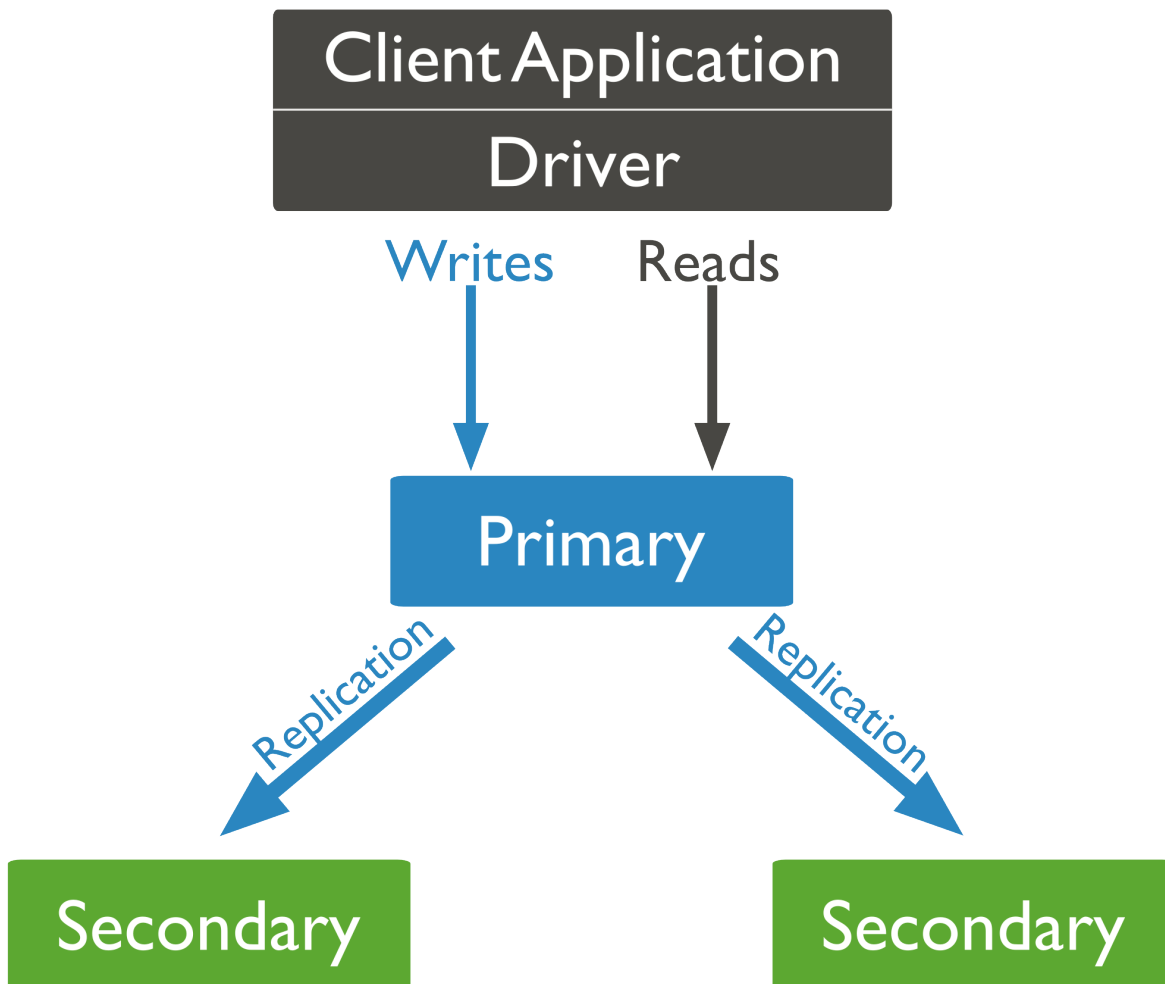


Figure 25: Diagram of default routing of reads and writes to the primary.

Large volumes of write operations, particularly bulk operations, may create situations where the secondary members have difficulty applying the replicating operations from the primary at a sufficient rate: this can cause the sec-

ondary's state to fall behind that of the primary. Secondaries that are significantly behind the primary present problems for normal operation of the replica set, particularly *failover* in the form of *rollbacks* as well as general read consistency.

To help avoid this issue, you can customize the *write concern* (page 21) to return confirmation of the write operation to another member<sup>4</sup> of the replica set every 100 or 1,000 operations. This provides an opportunity for secondaries to catch up with the primary. Write concern can slow the overall progress of write operations but ensure that the secondaries can maintain a largely current state with respect to the primary.

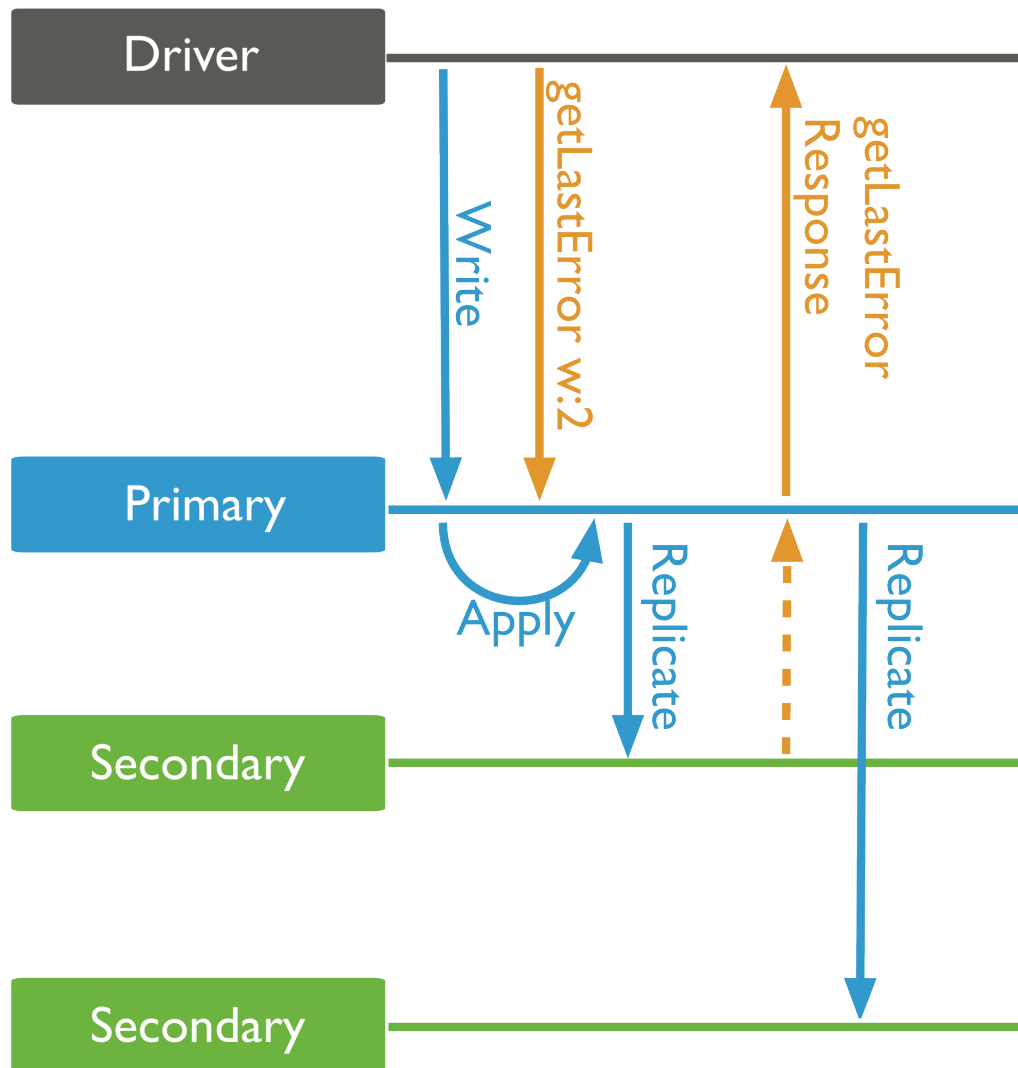


Figure 26: Write operation to a replica set with write concern level of `w:2` or write to the primary and at least one secondary.

For more information on replica sets and write operations, see *Replica Acknowledged* (page 24), *replica-set-oplog-sizing*, and <http://docs.mongodb.org/manual/tutorial/change-oplog-size>.

<sup>4</sup> Calling `getLastError` intermittently with a `w` value of 2 or `majority` will slow the throughput of write traffic; however, this practice will allow the secondaries to remain current with the state of the primary.

## Write Operation Performance

- [Indexes](#) (page 29)
- [Document Growth](#) (page 29)
- [Storage Performance](#) (page 29)
  - [Hardware](#) (page 29)
  - [Journaling](#) (page 30)

**Indexes** After every insert, update, or delete operation, MongoDB must update *every* index associated with the collection in addition to the data itself. Therefore, every index on a collection adds some amount of overhead for the performance of write operations.<sup>5</sup>

In general, the performance gains that indexes provide for *read operations* are worth the insertion penalty. However, in order to optimize write performance when possible, be careful when creating new indexes and evaluate the existing indexes to ensure that your queries actually use these indexes.

For indexes and queries, see [Query Optimization](#) (page 12). For more information on indexes, see <http://docs.mongodb.org/manualindexes> and <http://docs.mongodb.org/manualapplications/indexes>.

**Document Growth** If an update operation causes a document to exceed the currently allocated *record size*, MongoDB relocates the document on disk with enough contiguous space to hold the document. These relocations take longer than in-place updates, particularly if the collection has indexes. If a collection has indexes, MongoDB must update all index entries. Thus, for a collection with many indexes, the move will impact the write throughput.

Some update operations, such as the `$inc` operation, do not cause an increase in document size. For these update operations, MongoDB can apply the updates in-place. Other update operations, such as the `$push` operation, change the size of the document.

In-place-updates are significantly more efficient than updates that cause document growth. When possible, use `data models` that minimize the need for document growth.

See [Record Padding](#) (page 31) for more information.

## Storage Performance

**Hardware** The capability of the storage system creates some important physical limits for the performance of MongoDB's write operations. Many unique factors related to the storage system of the drive affect write performance, including random access patterns, disk caches, disk readahead and RAID configurations.

Solid state drives (SSDs) can outperform spinning hard disks (HDDs) by 100 times or more for random workloads.

---

### See

<http://docs.mongodb.org/manualadministration/production-notes> for recommendations regarding additional hardware and configuration options.

---

<sup>5</sup> For inserts and updates to un-indexed fields, the overhead for *sparse indexes* is less than for non-sparse indexes. Also for non-sparse indexes, updates that do not change the record size have less indexing overhead.

**Journaling** MongoDB uses *write ahead logging* to an on-disk *journal* to guarantee *write operation* (page 17) durability and to provide crash resiliency. Before applying a change to the data files, MongoDB writes the change operation to the journal.

While the durability assurance provided by the journal typically outweighs the performance costs of the additional write operations, consider the following interactions between the journal and performance:

- if the journal and the data file reside on the same block device, the data files and the journal may have to contend for a finite number of available write operations. Moving the journal to a separate device may increase the capacity for write operations.
- if applications specify *write concern* (page 21) that includes *journal* (page 22), `mongod` will decrease the duration between journal commits, which can increase the overall write load.
- the duration between journal commits is configurable using the `journalCommitInterval` run-time option. Decreasing the period between journal commits will increase the number of write operations, which can limit MongoDB's capacity for write operations. Increasing the amount of time between commits may decrease the total number of write operations, but also increases the chance that the journal will not record a write operation in the event of a failure.

For additional information on journaling, see <http://docs.mongodb.org/manualcore/journaling>.

## Bulk Inserts in MongoDB

- [Use the `insert\(\)` Method](#) (page 30)
- [Bulk Inserts on Sharded Clusters](#) (page 30)
  - [Pre-Split the Collection](#) (page 31)
  - [Insert to Multiple mongos](#) (page 31)
  - [Avoid Monotonic Throttling](#) (page 31)

In some situations you may need to insert or ingest a large amount of data into a MongoDB database. These *bulk inserts* have some special considerations that are different from other write operations.

**Use the `insert()` Method** The `insert()` method, when passed an array of documents, performs a bulk insert, and inserts each document atomically. Bulk inserts can significantly increase performance by amortizing *write concern* (page 21) costs.

New in version 2.2: `insert()` in the `mongo` shell gained support for bulk inserts in version 2.2.

In the `drivers`, you can configure write concern for batches rather than on a per-document level.

Drivers have a `ContinueOnError` option in their insert operation, so that the bulk operation will continue to insert remaining documents in a batch even if an insert fails.

---

**Note:** If multiple errors occur during a bulk insert, clients only receive the last error generated.

---

### See also:

Driver documentation for details on performing bulk inserts in your application. Also see <http://docs.mongodb.org/manualcore/import-export>.

**Bulk Inserts on Sharded Clusters** While `ContinueOnError` is optional on unsharded clusters, all bulk operations to a *sharded collection* run with `ContinueOnError`, which cannot be disabled.

Large bulk insert operations, including initial data inserts or routine data import, can affect *sharded cluster* performance. For bulk inserts, consider the following strategies:

**Pre-Split the Collection** If the sharded collection is empty, then the collection has only one initial *chunk*, which resides on a single shard. MongoDB must then take time to receive data, create splits, and distribute the split chunks to the available shards. To avoid this performance cost, you can pre-split the collection, as described in <http://docs.mongodb.org/manual/tutorial/split-chunks-in-sharded-cluster>.

**Insert to Multiple mongos** To parallelize import processes, send insert operations to more than one mongos instance. Pre-split empty collections first as described in <http://docs.mongodb.org/manual/tutorial/split-chunks-in-sharded-cluster>.

**Avoid Monotonic Throttling** If your shard key increases monotonically during an insert, then all inserted data goes to the last chunk in the collection, which will always end up on a single shard. Therefore, the insert capacity of the cluster will never exceed the insert capacity of that single shard.

If your insert volume is larger than what a single shard can process, and if you cannot avoid a monotonically increasing shard key, then consider the following modifications to your application:

- Reverse the binary bits of the shard key. This preserves the information and avoids correlating insertion order with increasing sequence of values.
- Swap the first and last 16-bit words to “shuffle” the inserts.

---

### Example

The following example, in C++, swaps the leading and trailing 16-bit word of *BSON ObjectIds* generated so that they are no longer monotonically increasing.

```
using namespace mongo;
OID make_an_id() {
    OID x = OID::gen();
    const unsigned char *p = x.getData();
    swap( (unsigned short&) p[0], (unsigned short&) p[10] );
    return x;
}

void foo() {
    // create an object
    BSONObj o = BSON( "_id" << make_an_id() << "x" << 3 << "name" << "jane" );
    // now we may insert o into a sharded collection
}
```

---

### See also:

*sharding-shard-key* for information on choosing a sharded key. Also see *Shard Key Internals* (in particular, *sharding-internals-operations-and-reliability*).

### Record Padding

Update operations can increase the size of the document<sup>6</sup>. If a document outgrows its current allocated *record space*, MongoDB must allocate a new space and move the document to this new location.

---

<sup>6</sup> Documents in MongoDB can grow up to the full maximum BSON document size.

To reduce the number of moves, MongoDB includes a small amount of extra space, or *padding*, when allocating the record space. This padding reduces the likelihood that a slight increase in document size will cause the document to exceed its allocated record size.

**See also:**

*Write Operation Performance* (page 29).

**Padding Factor** To minimize document movements and their impact, MongoDB employs padding. MongoDB adaptively adjusts the size of record allocations in a collection by adding a `paddingFactor` so that the documents have room to grow. The `paddingFactor` indicates the padding for new inserts and moves.

To check the current `paddingFactor` on a collection, you can run the `db.collection.stats()` operation in the mongo shell, as in the following example:

```
db.myCollection.stats()
```

Since MongoDB writes each document at a different point in time, the padding for each document will not be the same. You can calculate the padding size by subtracting 1 from the `paddingFactor`, for example:

```
padding size = (paddingFactor - 1) * <document size>.
```

For example, a `paddingFactor` of 1.0 specifies no padding whereas a `paddingFactor` of 1.5 specifies a padding size of 0.5 or 50 percent (50%) of the document size.

Because the `paddingFactor` is relative to the size of each document, you cannot calculate the exact amount of padding for a collection based on the average document size and padding factor.

If an update operation causes the document to *decrease* in size, for instance if you perform an `$unset` or a `$pop` update, the document remains in place and effectively has more padding. If the document remains this size, the space is not reclaimed until you perform a `compact` or a `repairDatabase` operation.

**Operations That Remove Padding** The following operations remove padding: `compact`, `repairDatabase`, and initial replica sync operations. However, with the `compact` command, you can run the command with a `paddingFactor` or a `paddingBytes` parameter. See `compact` command for details.

Padding is also removed if you use `mongoexport` a collection. If you use `mongoimport` into a new collection, `mongoimport` will not add padding. If you use `mongoimport` with an existing collection with padding, `mongoimport` will not affect the existing padding.

When a database operation removes padding from a collection, subsequent updates to the collection that increase the record size will have reduced throughput until the collection's padding factor grows. However, the collection will require less storage.

**Record Allocation Strategies** New in version 2.2: `collMod` and `usePowerOf2Sizes`.

To more efficiently reuse the space freed as a result of deletions or document relocations, you can specify that MongoDB allocates record sizes in powers of 2. To do so, use the `collMod` command with the `usePowerOf2Sizes` flag. See `collMod` command for more details. As with all padding, power of 2 size allocations minimizes, but does not eliminate, document movements.

See also *faq-developers-manual-padding*



## 3 MongoDB CRUD Tutorials

The following tutorials provide instructions for querying and modifying data. For a higher-level overview of these operations, see *MongoDB CRUD Operations* (page 2).

***Insert Documents* (page 33)** Insert new documents into a collection.

***Query Documents* (page 34)** Find documents in a collection using search criteria.

***Limit Fields to Return from a Query* (page 38)** Limit which fields are returned by a query.

***Iterate a Cursor in the mongo Shell* (page 39)** Access documents returned by a `find` query by iterating the cursor, either manually or using the iterator index.

***Analyze Query Performance* (page 41)** Analyze the efficiency of queries and determine how a query uses available indexes.

***Modify Documents* (page 42)** Modify documents in a collection

***Remove Documents* (page 43)** Remove documents from a collection.

***Perform Two Phase Commits* (page 43)** Use two-phase commits when writing data to multiple documents.

***Create Tailable Cursor* (page 49)** Create tailable cursors for use in capped collections with high numbers of write operations for which an index would be too expensive.

***Isolate Sequence of Operations* (page 51)** Use the `<isolation> isolated` operator to *isolate* a single write operation that affects multiple documents, preventing other operations from interrupting the sequence of write operations.

***Create an Auto-Incrementing Sequence Field* (page 52)** Describes how to create an incrementing sequence number for the `_id` field using a Counters Collection or an Optimistic Loop.

***Limit Number of Elements in an Array after an Update* (page 56)** Use `$push` with various modifiers to sort and maintain an array of fixed size after update

### 3.1 Insert Documents

In MongoDB, the `db.collection.insert()` method adds new documents into a collection. In addition, both the `db.collection.update()` method and the `db.collection.save()` method can also add new documents through an operation called an *upsert*. An *upsert* is an operation that performs either an update of an existing document or an insert of a new document if the document to modify does not exist.

This tutorial provides examples of insert operations using each of the three methods in the `mongo` shell.

#### Insert a Document with `insert()` Method

The following statement inserts a document with three fields into the collection `inventory`:

```
db.inventory.insert( { _id: 10, type: "misc", item: "card", qty: 15 } )
```

In the example, the document has a user-specified `_id` field value of 10. The value must be unique within the `inventory` collection.

For more examples, see `insert()`.

## Insert a Document with `update()` Method

Call the `update()` method with the `upsert` flag to create a new document if no document matches the update's query criteria.<sup>7</sup>

The following example creates a new document if no document in the `inventory` collection contains `{ type: "books", item: "journal" }`:

```
db.inventory.update(
  { type: "book", item: "journal" },
  { $set: { qty: 10 } },
  { upsert: true }
)
```

MongoDB adds the `_id` field and assigns as its value a unique `ObjectId`. The new document includes the `item` and `type` fields from the `<query>` criteria and the `qty` field from the `<update>` parameter.

```
{ "_id" : ObjectId("51e8636953dbe31d5f34a38a"), "item" : "journal", "qty" : 10, "type" : "book" }
```

For more examples, see `update()`.

## Insert a Document with `save()` Method

To insert a document with the `save()` method, pass the method a document that does not contain the `_id` field or a document that contains an `_id` field that does not exist in the collection.

The following example creates a new document in the `inventory` collection:

```
db.inventory.save( { type: "book", item: "notebook", qty: 40 } )
```

MongoDB adds the `_id` field and assigns as its value a unique `ObjectId`.

```
{ "_id" : ObjectId("51e866e48737f72b32ae4fbc"), "type" : "book", "item" : "notebook", "qty" : 40 }
```

For more examples, see `save()`.

## 3.2 Query Documents

In MongoDB, the `db.collection.find()` method retrieves documents from a collection.<sup>8</sup> The `db.collection.find()` method returns a *cursor* (page 10) to the retrieved documents.

This tutorial provides examples of read operations using the `db.collection.find()` method in the mongo shell. In these examples, the retrieved documents contain all their fields. To restrict the fields to return in the retrieved documents, see *Limit Fields to Return from a Query* (page 38).

### Select All Documents in a Collection

An empty query document (`{}`) selects all documents in the collection:

```
db.inventory.find( {} )
```

---

<sup>7</sup> Prior to version 2.2, in the mongo shell, you would specify the `upsert` and the `multi` options in the `update()` method as positional boolean options. See `update()` for details.

<sup>8</sup> The `db.collection.findOne()` method also performs a read operation to return a single document. Internally, the `db.collection.findOne()` method is the `db.collection.find()` method with a limit of 1.

Not specifying a query document to the `find()` is equivalent to specifying an empty query document. Therefore the following operation is equivalent to the previous operation:

```
db.inventory.find()
```

## Specify Equality Condition

To specify equality condition, use the query document `{ <field>: <value> }` to select all documents that contain the `<field>` with the specified `<value>`.

The following example retrieves from the `inventory` collection all documents where the `type` field has the value `snacks`:

```
db.inventory.find( { type: "snacks" } )
```

## Specify Conditions Using Query Operators

A query document can use the *query operators* to specify conditions in a MongoDB query.

The following example selects all documents in the `inventory` collection where the value of the `type` field is either `'food'` or `'snacks'`:

```
db.inventory.find( { type: { $in: [ 'food', 'snacks' ] } } )
```

Although you can express this query using the `$or` operator, use the `$in` operator rather than the `$or` operator when performing equality checks on the same field.

Refer to the <http://docs.mongodb.org/manualreference/operator> document for the complete list of query operators.

## Specify AND Conditions

A compound query can specify conditions for more than one field in the collection's documents. Implicitly, a logical AND conjunction connects the clauses of a compound query so that the query selects the documents in the collection that match all the conditions.

In the following example, the query document specifies an equality match on the field `food` **and** a less than (`$lt`) comparison match on the field `price`:

```
db.inventory.find( { type: 'food', price: { $lt: 9.95 } } )
```

This query selects all documents where the `type` field has the value `'food'` **and** the value of the `price` field is less than `9.95`. See *comparison operators* for other comparison operators.

## Specify OR Conditions

Using the `$or` operator, you can specify a compound query that joins each clause with a logical OR conjunction so that the query selects the documents in the collection that match at least one condition.

In the following example, the query document selects all documents in the collection where the field `qty` has a value greater than (`$gt`) `100` **or** the value of the `price` field is less than (`$lt`) `9.95`:

```
db.inventory.find(
  { $or: [
    { qty: { $gt: 100 } },
    { price: { $lt: 9.95 } }
  ]
}
```

## Specify AND as well as OR Conditions

With additional clauses, you can specify precise conditions for matching documents.

In the following example, the compound query document selects all documents in the collection where the value of the `type` field is `'food'` **and** *either* the `qty` has a value greater than (`$gt`) 100 *or* the value of the `price` field is less than (`$lt`) 9.95:

```
db.inventory.find( { type: 'food', $or: [ { qty: { $gt: 100 } },
                                          { price: { $lt: 9.95 } } ]
                  } )
```

## Subdocuments

When the field holds an embedded document (i.e. subdocument), you can either specify the entire subdocument as the value of a field, or “reach into” the subdocument using *dot notation*, to specify values for individual fields in the subdocument:

### Exact Match on Subdocument

To specify an equality match on the whole subdocument, use the query document `{ <field>: <value> }` where `<value>` is the subdocument to match. Equality matches on a subdocument require that the subdocument field match *exactly* the specified `<value>`, including the field order.

In the following example, the query matches all documents where the value of the field `producer` is a subdocument that contains *only* the field `company` with the value `'ABC123'` and the field `address` with the value `'123 Street'`, in the exact order:

```
db.inventory.find(
  {
    producer: {
      company: 'ABC123',
      address: '123 Street'
    }
  }
)
```

### Equality Match on Fields within Subdocument

Equality matches for specific fields within subdocuments select the documents in the collection when the field in the subdocument contains a field that matches the specified value.

In the following example, the query uses the *dot notation* to match all documents where the value of the field `producer` is a subdocument that contains a field `company` with the value `'ABC123'` and may contain other fields:

```
db.inventory.find( { 'producer.company': 'ABC123' } )
```

## Arrays

When the field holds an array, you can query for an exact array match or for specific values in the array. If the array holds sub-documents, you can query for specific fields within the sub-documents using *dot notation*:

### Exact Match on an Array

To specify equality match on an array, use the query document { <field>: <value> } where <value> is the array to match. Equality matches on the array require that the array field match *exactly* the specified <value>, including the element order.

In the following example, the query matches all documents where the value of the field `tags` is an array that holds exactly three elements, 'fruit', 'food', and 'citrus', in this order:

```
db.inventory.find( { tags: [ 'fruit', 'food', 'citrus' ] } )
```

### Match an Array Element

Equality matches can specify a single element in the array to match. These specifications match if the array contains at least *one* element with the specified value.

In the following example, the query matches all documents where the value of the field `tags` is an array that contains 'fruit' as one of its elements:

```
db.inventory.find( { tags: 'fruit' } )
```

### Match a Specific Element of an Array

Equality matches can specify equality matches for an element at a particular index or position of the array.

In the following example, the query uses the *dot notation* to match all documents where the value of the `tags` field is an array whose first element equals 'fruit':

```
db.inventory.find( { 'tags.0' : 'fruit' } )
```

## Array of Subdocuments

**Match a Field in the Subdocument Using the Array Index** If you know the array index of the subdocument, you can specify the document using the subdocument's position.

The following example selects all documents where the `memos` contains an array whose first element (i.e. index is 0) is a subdocument with the field `by` with the value 'shipping':

```
db.inventory.find( { 'memos.0.by': 'shipping' } )
```

**Match a Field Without Specifying Array Index** If you do not know the index position of the subdocument, concatenate the name of the field that contains the array, with a dot (.) and the name of the field in the subdocument.

The following example selects all documents where the `memos` field contains an array that contains at least one subdocument with the field `by` with the value `'shipping'`:

```
db.inventory.find( { 'memos.by': 'shipping' } )
```

**Match Multiple Fields** To match by multiple fields in the subdocument, you can use either dot notation or the `$elemMatch` operator:

The following example uses dot notation to query for documents where the value of the `memos` field is an array that has at least one subdocument that contains the field `memo` equal to `'on time'` and the field `by` equal to `'shipping'`:

```
db.inventory.find(
  {
    'memos.memo': 'on time',
    'memos.by': 'shipping'
  }
)
```

The following example uses `$elemMatch` to query for documents where the value of the `memos` field is an array that has at least one subdocument that contains the field `memo` equal to `'on time'` and the field `by` equal to `'shipping'`:

```
db.inventory.find( {
  memos: {
    $elemMatch: {
      memo : 'on time',
      by: 'shipping'
    }
  }
})
```

### 3.3 Limit Fields to Return from a Query

The *projection* specification limits the fields to return for all matching documents. The projection takes the form of a *document* with a list of fields for inclusion or exclusion from the result set. You can either specify the fields to include (e.g. { `field`: 1 }) or specify the fields to exclude (e.g. { `field`: 0 }).

---

**Important:** The `_id` field is, by default, included in the result set. To exclude the `_id` field from the result set, you need to specify in the projection document the exclusion of the `_id` field (i.e. { `_id`: 0 }).

---

You cannot combine inclusion and exclusion semantics in a single projection with the *exception* of the `_id` field.

This tutorial offers various query examples that limit the fields to return for all matching documents. The examples in this tutorial use a collection `inventory` and use the `db.collection.find()` method in the `mongo` shell. The `db.collection.find()` method returns a *cursor* (page 10) to the retrieved documents. For examples on query selection criteria, see [Query Documents](#) (page 34).

#### Return All Fields in Matching Documents

If you specify no projection, the `find()` method returns all fields of all documents that match the query.

```
db.inventory.find( { type: 'food' } )
```

This operation will return all documents in the `inventory` collection where the value of the `type` field is `'food'`. The returned documents contain all its fields.

### Return the Specified Fields and the `_id` Field Only

A projection can explicitly include several fields. In the following operation, `find()` method returns all documents that match the query. In the result set, only the `item` and `qty` fields and, by default, the `_id` field return in the matching documents.

```
db.inventory.find( { type: 'food' }, { item: 1, qty: 1 } )
```

### Return Specified Fields Only

You can remove the `_id` field from the results by specifying its exclusion in the projection, as in the following example:

```
db.inventory.find( { type: 'food' }, { item: 1, qty: 1, _id:0 } )
```

This operation returns all documents that match the query. In the result set, *only* the `item` and `qty` fields return in the matching documents.

### Return All But the Excluded Field

To exclude a single field or group of fields you can use a projection in the following form:

```
db.inventory.find( { type: 'food' }, { type:0 } )
```

This operation returns all documents where the value of the `type` field is `food`. In the result set, the `type` field does not return in the matching documents.

With the exception of the `_id` field you cannot combine inclusion and exclusion statements in projection documents.

### Projection for Array Fields

The `$elemMatch` and `$slice` projection operators provide more control when projecting only a portion of an array.

## 3.4 Iterate a Cursor in the mongo Shell

The `db.collection.find()` method returns a cursor. To access the documents, you need to iterate the cursor. However, in the mongo shell, if the returned cursor is not assigned to a variable using the `var` keyword, then the cursor is automatically iterated up to 20 times to print up to the first 20 documents in the results. The following describes ways to manually iterate the cursor to access the documents or to use the iterator index.

### Manually Iterate the Cursor

In the mongo shell, when you assign the cursor returned from the `find()` method to a variable using the `var` keyword, the cursor does not automatically iterate.

You can call the cursor variable in the shell to iterate up to 20 times <sup>9</sup> and print the matching documents, as in the following example:

```
var myCursor = db.inventory.find( { type: 'food' } );  
  
myCursor
```

You can also use the cursor method `next()` to access the documents, as in the following example:

```
var myCursor = db.inventory.find( { type: 'food' } );  
var myDocument = myCursor.hasNext() ? myCursor.next() : null;  
  
if (myDocument) {  
    var myItem = myDocument.item;  
    print(tojson(myItem));  
}
```

As an alternative print operation, consider the `printjson()` helper method to replace `print(tojson())`:

```
if (myDocument) {  
    var myItem = myDocument.item;  
    printjson(myItem);  
}
```

You can use the cursor method `forEach()` to iterate the cursor and access the documents, as in the following example:

```
var myCursor = db.inventory.find( { type: 'food' } );  
  
myCursor.forEach(printjson);
```

See *JavaScript cursor methods* and your driver documentation for more information on cursor methods.

## Iterator Index

In the mongo shell, you can use the `toArray()` method to iterate the cursor and return the documents in an array, as in the following:

```
var myCursor = db.inventory.find( { type: 'food' } );  
var documentArray = myCursor.toArray();  
var myDocument = documentArray[3];
```

The `toArray()` method loads into RAM all documents returned by the cursor; the `toArray()` method exhausts the cursor.

Additionally, some drivers provide access to the documents by using an index on the cursor (i.e. `cursor[index]`). This is a shortcut for first calling the `toArray()` method and then using an index on the resulting array.

Consider the following example:

```
var myCursor = db.inventory.find( { type: 'food' } );  
var myDocument = myCursor[3];
```

The `myCursor[3]` is equivalent to the following example:

---

<sup>9</sup> You can use the `DBQuery.shellBatchSize` to change the number of iteration from the default value 20. See *mongo-shell-executing-queries* for more information.



```
myCursor.toArray() [3];
```

## 3.5 Analyze Query Performance

The `explain()` cursor method allows you to inspect the operation of the query system. This method is useful for analyzing the efficiency of queries, and for determining how the query uses the index. The `explain()` method tests the query operation, and *not* the timing of query performance. Because `explain()` attempts multiple query plans, it does not reflect an accurate timing of query performance.

### Evaluate the Performance of a Query

To use the `explain()` method, call the method on a cursor returned by `find()`.

---

#### Example

Evaluate a query on the `type` field on the collection `inventory` that has an index on the `type` field.

```
db.inventory.find( { type: 'food' } ).explain()
```

Consider the results:

```
{
  "cursor" : "BtreeCursor type_1",
  "isMultiKey" : false,
  "n" : 5,
  "nscannedObjects" : 5,
  "nscanned" : 5,
  "nscannedObjectsAllPlans" : 5,
  "nscannedAllPlans" : 5,
  "scanAndOrder" : false,
  "indexOnly" : false,
  "nYields" : 0,
  "nChunkSkips" : 0,
  "millis" : 0,
  "indexBounds" : { "type" : [
    [ "food",
      "food" ]
  ] },
  "server" : "mongo0.example.net:27017" }
```

The `BtreeCursor` value of the `cursor` field indicates that the query used an index.

This query returned 5 documents, as indicated by the `n` field.

To return these 5 documents, the query scanned 5 documents from the index, as indicated by the `nscanned` field, and then read 5 full documents from the collection, as indicated by the `nscannedObjects` field.

Without the index, the query would have scanned the whole collection to return the 5 documents.

See *explain-results* method for full details on the output.

---

### Compare Performance of Indexes

To manually compare the performance of a query using more than one index, you can use the `hint()` and `explain()` methods in conjunction.

---

## Example

Evaluate a query using different indexes:

```
db.inventory.find( { type: 'food' } ).hint( { type: 1 } ).explain()
db.inventory.find( { type: 'food' } ).hint( { type: 1, name: 1 } ).explain()
```

These return the statistics regarding the execution of the query using the respective index.

---

**Note:** If you run `explain()` without including `hint()`, the query optimizer reevaluates the query and runs against multiple indexes before returning the query statistics.

---

For more detail on the explain output, see *explain-results*.

## 3.6 Modify Documents

In MongoDB, both `db.collection.update()` and `db.collection.save()` modify existing documents in a collection. `db.collection.update()` provides additional control over the modification. For example, you can modify existing data or modify a group of documents that match a query with `db.collection.update()`. Alternately, `db.collection.save()` replaces an existing document with the same `_id` field.

This document provides examples of the update operations using each of the two methods in the `mongo` shell.

### Modify Multiple Documents with `update()` Method

By default, the `update()` method updates a single document that matches its selection criteria. Call the method with the `multi` option set to `true` to update multiple documents.<sup>10</sup>

The following example finds all documents with `type` equal to "book" and modifies their `qty` field by -1. The example uses `$inc`, which is one of the *ref:update operators* <update-operators> available.

```
db.inventory.update(
  { type : "book" },
  { $inc : { qty : -1 } },
  { multi: true }
)
```

For more examples, see `update()`.

### Modify a Document with `save()` Method

The `save()` method can replace an existing document. To replace a document with the `save()` method, pass the method a document with an `_id` field that matches an existing document.

The following example completely replaces the document with the `_id` equal to 10 in the `inventory` collection:

```
db.inventory.save(
  {
    _id: 10,
    type: "misc",
    item: "placard"
  }
)
```

---

<sup>10</sup> This shows the syntax for MongoDB 2.2 and later. For syntax for versions prior to 2.2, see `update()`.

For further examples, see `save()`.

## 3.7 Remove Documents

In MongoDB, the `db.collection.remove()` method removes documents from a collection. You can remove all documents, specify which documents to remove, and limit the operation to a single document.

This tutorial provides examples of remove operations using the `db.collection.remove()` method in the mongo shell.

### Remove All Documents

If you do not specify a query, `remove()` removes all documents from a collection, but does not remove the indexes.<sup>11</sup>

The following example removes all documents from the `inventory` collection:

```
db.inventory.remove()
```

### Remove Documents that Matches a Condition

To remove the documents that match a deletion criteria, call the `remove()` method with the `<query>` parameter.

The following example removes all documents that have `type` equal to `food` from the `inventory` collection:

```
db.inventory.remove( { type : "food" } )
```

---

**Note:** For large deletion operations, it may be more efficient to copy the documents that you want to keep to a new collection and then use `drop()` on the original collection.

---

### Remove a Single Document that Matches a Condition

To remove a single document, call the `remove()` method with the `justOne` parameter set to `true` or `1`.

The following example removes one document that have `type` equal to `food` from the `inventory` collection:

```
db.inventory.remove( { type : "food" }, 1 )
```

## 3.8 Perform Two Phase Commits

### Synopsis

This document provides a pattern for doing multi-document updates or “transactions” using a two-phase commit approach for writing data to multiple documents. Additionally, you can extend this process to provide a *rollback* (page 47) like functionality.

---

<sup>11</sup> To remove all documents from a collection, it may be more efficient to use the `drop()` method to drop the entire collection, including the indexes, and then recreate the collection and rebuild the indexes.

## Background

Operations on a single *document* are always atomic with MongoDB databases; however, operations that involve multiple documents, which are often referred to as “transactions,” are not atomic. Since documents can be fairly complex and contain multiple “nested” documents, single-document atomicity provides necessary support for many practical use cases.

Thus, without precautions, success or failure of the database operation cannot be “all or nothing,” and without support for multi-document transactions it’s possible for an operation to succeed for some operations and fail with others. When executing a transaction composed of several sequential operations the following issues arise:

- Atomicity: if one operation fails, the previous operation within the transaction must “rollback” to the previous state (i.e. the “nothing,” in “all or nothing.”)
- Isolation: operations that run concurrently with the transaction operation set must “see” a consistent view of the data throughout the transaction process.
- Consistency: if a major failure (i.e. network, hardware) interrupts the transaction, the database must be able to recover a consistent state.

Despite the power of single-document atomic operations, there are cases that require multi-document transactions. For these situations, you can use a two-phase commit, to provide support for these kinds of multi-document updates.

Because documents can represent both pending data and states, you can use a two-phase commit to ensure that data is consistent, and that in the case of an error, the state that preceded the transaction is *recoverable* (page 47).

---

**Note:** Because only single-document operations are atomic with MongoDB, two-phase commits can only offer transaction-like semantics. It’s possible for applications to return intermediate data at intermediate points during the two-phase commit or rollback.

---

## Pattern

### Overview

The most common example of transaction is to transfer funds from account A to B in a reliable way, and this pattern uses this operation as an example. In a relational database system, this operation would encapsulate subtracting funds from the source (A) account and adding them to the destination (B) within a single atomic transaction. For MongoDB, you can use a two-phase commit in these situations to achieve a compatible response.

All of the examples in this document use the `mongo` shell to interact with the database, and assume that you have two collections: First, a collection named `accounts` that will store data about accounts with one account per document, and a collection named `transactions` which will store the transactions themselves.

Begin by creating two accounts named A and B, with the following command:

```
db.accounts.save({name: "A", balance: 1000, pendingTransactions: []})
db.accounts.save({name: "B", balance: 1000, pendingTransactions: []})
```

To verify that these operations succeeded, use `find()`:

```
db.accounts.find()
```

`mongo` will return two *documents* that resemble the following:

```
{ "_id" : ObjectId("4d7bc66cb8a04f512696151f"), "name" : "A", "balance" : 1000, "pendingTransactions" : [] }
{ "_id" : ObjectId("4d7bc67bb8a04f5126961520"), "name" : "B", "balance" : 1000, "pendingTransactions" : [] }
```

## Transaction Description

**Set Transaction State to Initial** Create the `transactions` collection by inserting the following document. The transaction document holds the `source` and `destination`, which refer to the `name` fields of the `accounts` collection, as well as the `value` field that represents the amount of data change to the `balance` field. Finally, the `state` field reflects the current state of the transaction.

```
db.transactions.save({source: "A", destination: "B", value: 100, state: "initial"})
```

To verify that these operations succeeded, use `find()`:

```
db.transactions.find()
```

This will return a document similar to the following:

```
{ "_id" : ObjectId("4d7bc7a8b8a04f5126961522"), "source" : "A", "destination" : "B", "value" : 100, "state" : "initial" }
```

**Switch Transaction State to Pending** Before modifying either records in the `accounts` collection, set the transaction state to pending from `initial`.

Set the local variable `t` in your shell session, to the transaction document using `findOne()`:

```
t = db.transactions.findOne({state: "initial"})
```

After assigning this variable `t`, the shell will return the value of `t`, you will see the following output:

```
{
  "_id" : ObjectId("4d7bc7a8b8a04f5126961522"),
  "source" : "A",
  "destination" : "B",
  "value" : 100,
  "state" : "initial"
}
```

Use `update()` to change the value of `state` to pending:

```
db.transactions.update({_id: t._id}, {$set: {state: "pending"}})
db.transactions.find()
```

The `find()` operation will return the contents of the `transactions` collection, which should resemble the following:

```
{ "_id" : ObjectId("4d7bc7a8b8a04f5126961522"), "source" : "A", "destination" : "B", "value" : 100, "state" : "pending" }
```

**Apply Transaction to Both Accounts** Continue by applying the transaction to both accounts. The `update()` query will prevent you from applying the transaction *if* the transaction is *not* already pending. Use the following `update()` operation:

```
db.accounts.update({name: t.source, pendingTransactions: {$ne: t._id}}, {$inc: {balance: -t.value}}, {multi: true})
db.accounts.update({name: t.destination, pendingTransactions: {$ne: t._id}}, {$inc: {balance: t.value}}, {multi: true})
db.accounts.find()
```

The `find()` operation will return the contents of the `accounts` collection, which should now resemble the following:

```
{ "_id" : ObjectId("4d7bc97fb8a04f5126961523"), "balance" : 900, "name" : "A", "pendingTransactions" : [ ObjectId("4d7bc7a8b8a04f5126961522") ] }
{ "_id" : ObjectId("4d7bc984b8a04f5126961524"), "balance" : 1100, "name" : "B", "pendingTransactions" : [ ObjectId("4d7bc7a8b8a04f5126961522") ] }
```

**Set Transaction State to Committed** Use the following `update()` operation to set the transaction's state to committed:

```
db.transactions.update({_id: t._id}, {$set: {state: "committed"}})
db.transactions.find()
```

The `find()` operation will return the contents of the `transactions` collection, which should now resemble the following:

```
{ "_id" : ObjectId("4d7bc7a8b8a04f5126961522"), "destination" : "B", "source" : "A", "state" : "comm
```

**Remove Pending Transaction** Use the following `update()` operation to set remove the pending transaction from the `documents` in the `accounts` collection:

```
db.accounts.update({name: t.source}, {$pull: {pendingTransactions: t._id}})
db.accounts.update({name: t.destination}, {$pull: {pendingTransactions: t._id}})
db.accounts.find()
```

The `find()` operation will return the contents of the `accounts` collection, which should now resemble the following:

```
{ "_id" : ObjectId("4d7bc97fb8a04f5126961523"), "balance" : 900, "name" : "A", "pendingTransactions"
{ "_id" : ObjectId("4d7bc984b8a04f5126961524"), "balance" : 1100, "name" : "B", "pendingTransactions"
```

**Set Transaction State to Done** Complete the transaction by setting the state of the transaction *document* to done:

```
db.transactions.update({_id: t._id}, {$set: {state: "done"}})
db.transactions.find()
```

The `find()` operation will return the contents of the `transactions` collection, which should now resemble the following:

```
{ "_id" : ObjectId("4d7bc7a8b8a04f5126961522"), "destination" : "B", "source" : "A", "state" : "done"
```

## Recovering from Failure Scenarios

The most important part of the transaction procedure is not, the prototypical example above, but rather the possibility for recovering from the various failure scenarios when transactions do not complete as intended. This section will provide an overview of possible failures and provide methods to recover from these kinds of events.

There are two classes of failures:

- all failures that occur after the first step (i.e. *setting the transaction set to initial* (page 45)) but before the third step (i.e. *applying the transaction to both accounts* (page 45).)

To recover, applications should get a list of transactions in the `pending` state and resume from the second step (i.e. *switching the transaction state to pending* (page 45).)

- all failures that occur after the third step (i.e. *applying the transaction to both accounts* (page 45)) but before the fifth step (i.e. *setting the transaction state to done* (page 46).)

To recover, application should get a list of transactions in the `committed` state and resume from the fourth step (i.e. *remove the pending transaction* (page 46).)

Thus, the application will always be able to resume the transaction and eventually arrive at a consistent state. Run the following recovery operations every time the application starts to catch any unfinished transactions. You may also wish run the recovery operation at regular intervals to ensure that your data remains consistent.

The time required to reach a consistent state depends, on how long the application needs to recover each transaction.

**Rollback** In some cases you may need to “rollback” or undo a transaction when the application needs to “cancel” the transaction, or because it can never recover as in cases where one of the accounts doesn’t exist, or stops existing during the transaction.

There are two possible rollback operations:

1. After you *apply the transaction* (page 45) (i.e. the third step,) you have fully committed the transaction and you should not roll back the transaction. Instead, create a new transaction and switch the values in the source and destination fields.
2. After you *create the transaction* (page 45) (i.e. the first step,) but before you *apply the transaction* (page 45) (i.e. the third step,) use the following process:

**Set Transaction State to Canceling** Begin by setting the transaction’s state to `canceling` using the following `update()` operation:

```
db.transactions.update({_id: t._id}, {$set: {state: "canceling"}})
```

**Undo the Transaction** Use the following sequence of operations to undo the transaction operation from both accounts:

```
db.accounts.update({name: t.source, pendingTransactions: t._id}, {$inc: {balance: t.value}, $pull: {pendingTransactions: t._id}})
db.accounts.update({name: t.destination, pendingTransactions: t._id}, {$inc: {balance: -t.value}, $pull: {pendingTransactions: t._id}})
db.accounts.find()
```

The `find()` operation will return the contents of the `accounts` collection, which should resemble the following:

```
{ "_id" : ObjectId("4d7bc97fb8a04f5126961523"), "balance" : 1000, "name" : "A", "pendingTransactions" : [] }
{ "_id" : ObjectId("4d7bc984b8a04f5126961524"), "balance" : 1000, "name" : "B", "pendingTransactions" : [] }
```

**Set Transaction State to Canceled** Finally, use the following `update()` operation to set the transaction’s state to `canceled`:

**Step 3:** set the transaction’s state to “canceled”:

```
db.transactions.update({_id: t._id}, {$set: {state: "canceled"}})
```

**Multiple Applications** Transactions exist, in part, so that several applications can create and run operations concurrently without causing data inconsistency or conflicts. As a result, it is crucial that only one application can handle a given transaction at any point in time.

Consider the following example, with a single transaction (i.e. T1) and two applications (i.e. A1 and A2). If both applications begin processing the transaction which is still in the `initial` state (i.e. *step 1* (page 45)), then:

- A1 can apply the entire whole transaction before A2 starts.
- A2 will then apply T1 for the second time, because the transaction does not appear as pending in the `accounts` documents.

To handle multiple applications, create a marker in the transaction document itself to identify the application that is handling the transaction. Use `findAndModify()` method to modify the transaction:

```
t = db.transactions.findAndModify({query: {state: "initial", application: {$exists: 0}},
                                   update: {$set: {state: "pending", application: "A1"}},
                                   new: true})
```

When you modify and reassign the local shell variable `t`, the mongo shell will return the `t` object, which should resemble the following:

```
{
  "_id" : ObjectId("4d7be8af2c10315c0847fc85"),
  "application" : "A1",
  "destination" : "B",
  "source" : "A",
  "state" : "pending",
  "value" : 150
}
```

Amend the transaction operations to ensure that only applications that match the identifier in the value of the `application` field before applying the transaction.

If the application `A1` fails during transaction execution, you can use the *recovery procedures* (page 46), but applications should ensure that they “owns” the transaction before applying the transaction. For example to resume pending jobs, use a query that resembles the following:

```
db.transactions.find({application: "A1", state: "pending"})
```

This will (or may) return a document from the `transactions` document that resembles the following:

```
{ "_id" : ObjectId("4d7be8af2c10315c0847fc85"), "application" : "A1", "destination" : "B", "source"
```

## Using Two-Phase Commits in Production Applications

The example transaction above is intentionally simple. For example, it assumes that:

- it is always possible roll back operations an account.
- account balances can hold negative values.

Production implementations would likely be more complex. Typically accounts need to information about current balance, pending credits, pending debits. Then:

- when your application *switches the transaction state to pending* (page 45) (i.e. step 2) it would also make sure that the accounts has sufficient funds for the transaction. During this update operation, the application would also modify the values of the credits and debits as well as adding the transaction as pending.
- when your application *removes the pending transaction* (page 46) (i.e. step 4) the application would apply the transaction on balance, modify the credits and debits as well as removing the transaction from the `pending` field., all in one update.

Because all of the changes in the above two operations occur within a single `update()` operation, these changes are all atomic.

Additionally, for most important transactions, ensure that:

- the database interface (i.e. client library or *driver*) has a reasonable *write concern* configured to ensure that operations return a response on the success or failure of a write operation.
- your `mongod` instance has *journaling* enabled to ensure that your data is always in a recoverable state, in the event of an unclean `mongod` shutdown.



## 3.9 Create Tailable Cursor

### Overview

By default, MongoDB will automatically close a cursor when the client has exhausted all results in the cursor. However, for capped collections you may use a *Tailable Cursor* that remains open after the client exhausts the results in the initial cursor. Tailable cursors are conceptually equivalent to the `tail` Unix command with the `-f` option (i.e. with “follow” mode.) After clients insert new additional documents into a capped collection, the tailable cursor will continue to retrieve documents.

Use tailable cursors on capped collections with high numbers of write operations for which an index would be too expensive. For instance, MongoDB replication uses tailable cursors to tail the primary’s *oplog*.

---

**Note:** If your query is on an indexed field, do not use tailable cursors, but instead, use a regular cursor. Keep track of the last value of the indexed field returned by the query. To retrieve the newly added documents, query the collection again using the last value of the indexed field in the query criteria, as in the following example:

```
db.<collection>.find( { indexedField: { $gt: <lastvalue> } } )
```

---

Consider the following behaviors related to tailable cursors:

- Tailable cursors do not use indexes and return documents in *natural order*.
- Because tailable cursors do not use indexes, the initial scan for the query may be expensive; but, after initially exhausting the cursor, subsequent retrievals of the newly added documents are inexpensive.
- Tailable cursors may become *dead*, or invalid, if either:
  - the query returns no match.
  - the cursor returns the document at the “end” of the collection and then the application deletes those document.

A *dead* cursor has an id of 0.

See your driver documentation for the driver-specific method to specify the tailable cursor. For more information on the details of specifying a tailable cursor, see [MongoDB wire protocol](http://docs.mongodb.org/meta-driver/latest/legacy/mongodb-wire-protocol)<sup>12</sup> documentation.

### C++ Example

The `tail` function uses a tailable cursor to output the results from a query to a capped collection:

- The function handles the case of the dead cursor by having the query be inside a loop.
- To periodically check for new data, the `cursor->more()` statement is also inside a loop.

```
#include "client/dbclient.h"

using namespace mongo;

/*
 * Example of a tailable cursor.
 * The function "tails" the capped collection (ns) and output elements as they are added.
 * The function also handles the possibility of a dead cursor by tracking the field 'insertDate'.
 * New documents are added with increasing values of 'insertDate'.
 */

void tail(DBClientBase& conn, const char *ns) {
```

---

<sup>12</sup><http://docs.mongodb.org/meta-driver/latest/legacy/mongodb-wire-protocol>

```

BSONElement lastValue = minKey.firstElement();

Query query = Query().hint( BSON( "$natural" << 1 ) );

while ( 1 ) {
    auto_ptr<DBClientCursor> c =
        conn.query(ns, query, 0, 0, 0,
            QueryOption_CursorTailable | QueryOption_AwaitData );

    while ( 1 ) {
        if ( !c->more() ) {

            if ( c->isDead() ) {
                break;
            }

            continue;
        }

        BSONObj o = c->next();
        lastValue = o["insertDate"];
        cout << o.toString() << endl;
    }

    query = QUERY( "insertDate" << GT << lastValue ).hint( BSON( "$natural" << 1 ) );
}
}

```

The tail function performs the following actions:

- Initialize the lastValue variable, which tracks the last accessed value. The function will use the lastValue if the cursor becomes *invalid* and tail needs to restart the query. Use hint() to ensure that the query uses the \$natural order.
- In an outer while(1) loop,
  - Query the capped collection and return a tailable cursor that blocks for several seconds waiting for new documents

```

auto_ptr<DBClientCursor> c =
    conn.query(ns, query, 0, 0, 0,
        QueryOption_CursorTailable | QueryOption_AwaitData );

```

- \* Specify the capped collection using ns as an argument to the function.
- \* Set the QueryOption\_CursorTailable option to create a tailable cursor.
- \* Set the QueryOption\_AwaitData option so that the returned cursor blocks for a few seconds to wait for data.
- In an inner while (1) loop, read the documents from the cursor:
  - \* If the cursor has no more documents and is not invalid, loop the inner while loop to recheck for more documents.
  - \* If the cursor has no more documents and is dead, break the inner while loop.
  - \* If the cursor has documents:
    - output the document,
    - update the lastValue value,

- and loop the inner `while (1)` loop to recheck for more documents.
- If the logic breaks out of the inner `while (1)` loop and the cursor is invalid:
  - \* Use the `lastValue` value to create a new query condition that matches documents added after the `lastValue`. Explicitly ensure `$natural` order with the `hint()` method:

```
query = QUERY( "insertDate" << GT << lastValue ).hint( BSON( "$natural" << 1 ) );
```

- \* Loop through the outer `while (1)` loop to re-query with the new query condition and repeat.

See also:

[Detailed blog post on tailable cursor](#)<sup>13</sup>

## 3.10 Isolate Sequence of Operations

### Overview

Write operations are atomic on the level of a single document: no single write operation can atomically affect more than one document or more than one collection.

When a single write operation modifies multiple documents, the operation as a whole is not atomic, and other operations may interleave. The modification of a single document, or record, is always atomic, even if the write operation modifies multiple sub-document *within* the single record.

No other operations are atomic; however, you can *isolate* a single write operation that affects multiple documents using the `isolation` operator.

This document describes one method of updating documents *only* if the local copy of the document reflects the current state of the document in the database. In addition the following methods provide a way to manage isolated sequences of operations:

- the `findAndModify()` provides an isolated query and modify operation.
- [Perform Two Phase Commits](#) (page 43)
- Create a *unique index*, to ensure that a key doesn't exist when you insert it.

### Update if Current

In this pattern, you will:

- query for a document,
- modify the fields in that document
- and update the fields of a document *only if* the fields have not changed in the collection since the query.

Consider the following example in JavaScript which attempts to update the `qty` field of a document in the `products` collection:

```
1 var myCollection = db.products;
2 var myDocument = myCollection.findOne( { sku: 'abc123' } );
3
4 if (myDocument) {
5
6     var oldQty = myDocument.qty;
```

---

<sup>13</sup><http://shtylman.com/post/the-tail-of-mongodb>

```

7
8   if (myDocument.qty < 10) {
9       myDocument.qty *= 4;
10  } else if ( myDocument.qty < 20 ) {
11       myDocument.qty *= 3;
12  } else {
13       myDocument.qty *= 2;
14  }
15
16  myCollection.update(
17      {
18          _id: myDocument._id,
19          qty: oldQty
20      },
21      {
22          $set: { qty: myDocument.qty }
23      }
24  )
25
26  var err = db.getLastErrorMessage();
27
28  if ( err && err.code ) {
29      print("unexpected error updating document: " + toJson( err ));
30  } else if ( err.n == 0 ) {
31      print("No update: no matching document for { _id: " + myDocument._id + ", qty: " + oldQty + "
32  }
33
34  }

```

Your application may require some modifications of this pattern, such as:

- Use the entire document as the query in lines 18 and 19, to generalize the operation and guarantee that the original document was not modified, rather than ensuring that a single field was not changed.
- Add a version variable to the document that applications increment upon each update operation to the documents. Use this version variable in the query expression. You must be able to ensure that *all* clients that connect to your database obey this constraint.
- Use `$set` in the update expression to modify only your fields and prevent overriding other fields.
- Use one of the methods described in [Create an Auto-Incrementing Sequence Field](#) (page 52).

## 3.11 Create an Auto-Incrementing Sequence Field

### Synopsis

MongoDB reserves the `_id` field in the top level of all documents as a primary key. `_id` must be unique, and always has an index with a *unique constraint*. However, except for the unique constraint you can use any value for the `_id` field in your collections. This tutorial describes two methods for creating an incrementing sequence number for the `_id` field using the following:

- [A Counters Collection](#) (page 53)
- [Optimistic Loop](#) (page 54)

**Warning:** Generally in MongoDB, you would not use an auto-increment pattern for the `_id` field, or any field, because it does not scale for databases with large numbers of documents. Typically the default value *ObjectId* is more ideal for the `_id`.

## A Counters Collection

Use a separate `counters` collection to track the *last* number sequence used. The `_id` field contains the sequence name and the `seq` field contains the last value of the sequence.

1. Insert into the `counters` collection, the initial value for the `userid`:

```
db.counters.insert(
  {
    _id: "userid",
    seq: 0
  }
)
```

2. Create a `getNextSequence` function that accepts a name of the sequence. The function uses the `findAndModify()` method to atomically increment the `seq` value and return this new value:

```
function getNextSequence(name) {
  var ret = db.counters.findAndModify(
    {
      query: { _id: name },
      update: { $inc: { seq: 1 } },
      new: true
    }
  );

  return ret.seq;
}
```

3. Use this `getNextSequence()` function during `insert()`.

```
db.users.insert(
  {
    _id: getNextSequence("userid"),
    name: "Sarah C."
  }
)

db.users.insert(
  {
    _id: getNextSequence("userid"),
    name: "Bob D."
  }
)
```

You can verify the results with `find()`:

```
db.users.find()
```

The `_id` fields contain incrementing sequence values:

```
{
  _id : 1,
  name : "Sarah C."
}
{
  _id : 2,
  name : "Bob D."
}
```

---

**Note:** When `findAndModify()` includes the `upsert: true` option **and** the query field(s) is not uniquely indexed, the method could insert a document multiple times in certain circumstances. For instance, if multiple clients each invoke the method with the same query condition and these methods complete the find phase before any of methods perform the modify phase, these methods could insert the same document.

In the `counters` collection example, the query field is the `_id` field, which always has a unique index. Consider that the `findAndModify()` includes the `upsert: true` option, as in the following modified example:

```
function getNextSequence(name) {
  var ret = db.counters.findAndModify(
    {
      query: { _id: name },
      update: { $inc: { seq: 1 } },
      new: true,
      upsert: true
    }
  );
  return ret.seq;
}
```

If multiple clients were to invoke the `getNextSequence()` method with the same `name` parameter, then the methods would observe one of the following behaviors:

- Exactly one `findAndModify()` would successfully insert a new document.
- Zero or more `findAndModify()` methods would update the newly inserted document.
- Zero or more `findAndModify()` methods would fail when they attempted to insert a duplicate.

If the method fails due to a unique index constraint violation, retry the method. Absent a delete of the document, the retry should not fail.

---

## Optimistic Loop

In this pattern, an *Optimistic Loop* calculates the incremented `_id` value and attempts to insert a document with the calculated `_id` value. If the insert is successful, the loop ends. Otherwise, the loop will iterate through possible `_id` values until the insert is successful.

1. Create a function named `insertDocument` that performs the “insert if not present” loop. The function wraps the `insert()` method and takes a `doc` and a `targetCollection` arguments.

```
function insertDocument(doc, targetCollection) {
  while (1) {
    var cursor = targetCollection.find( {}, { _id: 1 } ).sort( { _id: -1 } ).limit(1);
    var seq = cursor.hasNext() ? cursor.next()._id + 1 : 1;
    doc._id = seq;
    targetCollection.insert(doc);
    var err = db.getLastErrorMessage();
    if( err && err.code ) {
```

```

        if( err.code == 11000 /* dup key */ )
            continue;
        else
            print( "unexpected error inserting data: " + toJson( err ) );
    }

    break;
}
}

```

The while (1) loop performs the following actions:

- Queries the `targetCollection` for the document with the maximum `_id` value.
- Determines the next sequence value for `_id` by:
  - adding 1 to the returned `_id` value if the returned cursor points to a document.
  - otherwise: it sets the next sequence value to 1 if the returned cursor points to no document.
- For the doc to insert, set its `_id` field to the calculated sequence value `seq`.
- Insert the doc into the `targetCollection`.
- If the insert operation errors with duplicate key, repeat the loop. Otherwise, if the insert operation encounters some other error or if the operation succeeds, break out of the loop.

2. Use the `insertDocument()` function to perform an insert:

```

var myCollection = db.users2;

insertDocument(
    {
        name: "Grace H."
    },
    myCollection
);

insertDocument(
    {
        name: "Ted R."
    },
    myCollection
)

```

You can verify the results with `find()`:

```
db.users2.find()
```

The `_id` fields contain incrementing sequence values:

```

{
  _id: 1,
  name: "Grace H."
}
{
  _id : 2,
  "name" : "Ted R."
}

```

The while loop may iterate many times in collections with larger insert volumes.

## 3.12 Limit Number of Elements in an Array after an Update

New in version 2.4.

### Synopsis

Consider an application where users may submit many scores (e.g. for a test), but the application only needs to track the top three test scores.

This pattern uses the `$push` operator with the `$each`, `$sort`, and `$slice` modifiers to sort and maintain an array of fixed size.

---

**Important:** The array elements must be documents in order to use the `$sort` modifier.

---

### Pattern

Consider the following document in the collection `students`:

```
{
  _id: 1,
  scores: [
    { attempt: 1, score: 10 },
    { attempt: 2, score: 8 }
  ]
}
```

The following update uses the `$push` operator with:

- the `$each` modifier to append to the array 2 new elements,
- the `$sort` modifier to order the elements by ascending (1) score, and
- the `$slice` modifier to keep the last 3 elements of the ordered array.

```
db.students.update(
  { _id: 1 },
  { $push: { scores: { $each: [
    { attempt: 3, score: 7 },
    { attempt: 4, score: 4 }
  ],
    $sort: { score: 1 },
    $slice: -3
  } } }
)
```

---

**Note:** When using the `$sort` modifier on the array element, access the field in the subdocument element directly instead of using the *dot notation* on the array field.

---

After the operation, the document contains the only the top 3 scores in the `scores` array:

```
{
  "_id" : 1,
  "scores" : [
    { "attempt" : 3, "score" : 7 },
  ]
}
```



```

    { "attempt" : 2, "score" : 8 },
    { "attempt" : 1, "score" : 10 }
  ]
}

```

**See also:**

- `$push` operator,
- `$each` modifier,
- `$sort` modifier, and
- `$slice` modifier.

## 4 MongoDB CRUD Reference

### 4.1 Query Cursor Methods

Name	Description
<code>cursor.count()</code>	Returns a count of the documents in a cursor.
<code>cursor.explain()</code>	Reports on the query execution plan, including index use, for a cursor.
<code>cursor.hint()</code>	Forces MongoDB to use a specific index for a query.
<code>cursor.limit()</code>	Constrains the size of a cursor's result set.
<code>cursor.next()</code>	Returns the next document in a cursor.
<code>cursor.skip()</code>	Returns a cursor that begins returning results only after passing or skipping a number of documents.
<code>cursor.sort()</code>	Returns results ordered according to a sort specification.
<code>cursor.toArray()</code>	Returns an array that contains all documents returned by the cursor.

### 4.2 Query and Data Manipulation Collection Methods

Name	Description
<code>db.collection.count()</code>	Wraps <code>count</code> to return a count of the number of documents in a collection or matching a query.
<code>db.collection.distinct()</code>	Returns an array of documents that have distinct values for the specified field.
<code>db.collection.find()</code>	Performs a query on a collection and returns a cursor object.
<code>db.collection.findOne()</code>	Performs a query and returns a single document.
<code>db.collection.insert()</code>	Creates a new document in a collection.
<code>db.collection.remove()</code>	Deletes documents from a collection.
<code>db.collection.save()</code>	Provides a wrapper around an <code>insert()</code> and <code>update()</code> to insert new documents.
<code>db.collection.update()</code>	Modifies a document in a collection.

### 4.3 MongoDB CRUD Reference Documentation

***Write Concern Reference* (page 58)** Configuration options associated with the guarantee MongoDB provides when reporting on the success of a write operation.

***SQL to MongoDB Mapping Chart* (page 59)** An overview of common database operations showing both the MongoDB operations and SQL statements.

*The bios Example Collection* (page 64) Sample data for experimenting with MongoDB. `insert()`, `update()` and `find()` pages use the data for some of their examples.

## Write Concern Reference

### Overview

*Write concern* describes the guarantee that MongoDB provides when reporting on the success of a write operation. The strength of the write concerns determine the level of guarantee. When inserts, updates and deletes have a *weak* write concern, write operations return quickly. In some failure cases, write operations issued with weak write concerns may not persist. With *stronger* write concerns, clients wait after sending a write operation for MongoDB to confirm the write operations.

MongoDB provides different levels of write concern to better address the specific needs of applications. Clients may adjust write concern to ensure that the most important operations persist successfully to an entire MongoDB deployment. For other less critical operations, clients can adjust the write concern to ensure faster performance rather than ensure persistence to the entire deployment.

#### See also:

*Write Concern* (page 21) for an introduction to write concern in MongoDB.

### Available Write Concern

To provide write concern, drivers issue the `getLastError` command after a write operation and receive a document with information about the last operation. This document's `err` field contains either:

- `null`, which indicates the write operations have completed successfully, or
- a description of the last error encountered.

The definition of a “successful write” depends on the arguments specified to `getLastError`, or in replica sets, the configuration of `getLastErrorDefaults`. When deciding the level of write concern for your application, see the introduction to *Write Concern* (page 21).

The `getLastError` command has the following options to configure write concern requirements:

- `j` or “journal” option

This option confirms that the `mongod` instance has written the data to the on-disk journal and ensures data is not lost if the `mongod` instance shuts down unexpectedly. Set to `true` to enable, as shown in the following example:

```
db.runCommand( { getLastError: 1, j: "true" } )
```

If you set `journal` to `true`, and the `mongod` does not have journaling enabled, as with `nojournal`, then `getLastError` will provide basic receipt acknowledgment, and will include a `jnote` field in its return document.

- `w` option

This option provides the ability to disable write concern entirely *as well as* specifies the write concern operations for *replica sets*. See *Write Concern Considerations* (page 21) for an introduction to the fundamental concepts of write concern. By default, the `w` option is set to 1, which provides basic receipt acknowledgment on a single `mongod` instance or on the *primary* in a replica set.

The `w` option takes the following values:

- -1:  
Disables all acknowledgment of write operations, and suppresses all errors, including network and socket errors.
  - 0:  
Disables basic acknowledgment of write operations, but returns information about socket exceptions and networking errors to the application.
- 
- Note:** If you disable basic write operation acknowledgment but require journal commit acknowledgment, the journal commit prevails, and the driver will require that `mongod` will acknowledge the write operation.
- 
- 1:  
Provides acknowledgment of write operations on a standalone `mongod` or the *primary* in a replica set.
  - *A number greater than 1:*  
Guarantees that write operations have propagated successfully to the specified number of replica set members including the primary. If you set `w` to a number that is greater than the number of set members that hold data, MongoDB waits for the non-existent members to become available, which means MongoDB blocks indefinitely.
  - `majority`:  
Confirms that write operations have propagated to the majority of configured replica set: a majority of the set's configured members must acknowledge the write operation before it succeeds. This ensures that write operation will *never* be subject to a rollback in the course of normal operation, and furthermore allows you to avoid hard coding assumptions about the size of your replica set into your application.
  - *A tag set:*  
By specifying a *tag set* you can have fine-grained control over which replica set members must acknowledge a write operation to satisfy the required level of write concern.

`getLastError` also supports a `wtimeout` setting which allows clients to specify a timeout for the write concern: if you don't specify `wtimeout`, or if you give it a value of 0, and the `mongod` cannot fulfill the write concern the `getLastError` will block, potentially forever.

For more information on write concern and replica sets, see [Write Concern for Replica Sets](#) (page 24) for more information.

In sharded clusters, `mongos` instances will pass write concern on to the shard `mongod` instances.

## SQL to MongoDB Mapping Chart

In addition to the charts that follow, you might want to consider the <http://docs.mongodb.org/manual/faq> section for a selection of common questions about MongoDB.

## Terminology and Concepts

The following table presents the various SQL terminology and concepts and the corresponding MongoDB terminology and concepts.

SQL Terms/Concepts	MongoDB Terms/Concepts
database	<i>database</i>
table	<i>collection</i>
row	<i>document</i> or <i>BSON</i> document
column	<i>field</i>
index	<i>index</i>
table joins	embedded documents and linking
primary key Specify any unique column or column combination as primary key.	<i>primary key</i> In MongoDB, the primary key is automatically set to the <i>_id</i> field.
aggregation (e.g. group by)	aggregation pipeline See the <a href="http://docs.mongodb.org/manualreference/sql-aggregation-com">http://docs.mongodb.org/manualreference/sql-aggregation-com</a>

## Executables

The following table presents the MySQL/Oracle executables and the corresponding MongoDB executables.

	MySQL/Oracle	MongoDB
Database Server	mysqld/oracle	mongod
Database Client	mysql/sqlplus	mongo

## Examples

The following table presents the various SQL statements and the corresponding MongoDB statements. The examples in the table assume the following conditions:

- The SQL examples assume a table named `users`.
- The MongoDB examples assume a collection named `users` that contain documents of the following prototype:

```
{
  _id: ObjectID("509a8fb2f3f4948bd2f983a0"),
  user_id: "abc123",
  age: 55,
  status: 'A'
}
```

**Create and Alter** The following table presents the various SQL statements related to table-level actions and the corresponding MongoDB statements.

SQL Schema Statements	MongoDB Schema Statements	Reference
<pre>CREATE TABLE users (   id MEDIUMINT NOT NULL     AUTO_INCREMENT,   user_id Varchar(30),   age Number,   status char(1),   PRIMARY KEY (id) )</pre>	<p>Implicitly created on first insert() operation. The primary key _id is automatically added if _id field is not specified.</p> <pre>db.users.insert( {   user_id: "abc123",   age: 55,   status: "A" } )</pre> <p>However, you can also explicitly create a collection:</p> <pre>db.createCollection("users")</pre>	<p>See insert() and db.createCollection() for more information.</p>
<pre>ALTER TABLE users ADD join_date DATETIME</pre>	<p>Collections do not describe or enforce the structure of its documents; i.e. there is no structural alteration at the collection level. However, at the document level, update() operations can add fields to existing documents using the \$set operator.</p> <pre>db.users.update(   { },   { \$set: { join_date: new Date() } },   { multi: true } )</pre>	<p>See the <a href="http://docs.mongodb.org/manual/core/update/">http://docs.mongodb.org/manual/core/update/</a> for more information on changing the structure of documents in a collection.</p>
<pre>ALTER TABLE users DROP COLUMN join_date</pre>	<p>Collections do not describe or enforce the structure of its documents; i.e. there is no structural alteration at the collection level. However, at the document level, update() operations can remove fields from documents using the \$unset operator.</p> <pre>db.users.update(   { },   { \$unset: { join_date: "" } },   { multi: true } )</pre>	<p>See <a href="http://docs.mongodb.org/manual/core/update/">http://docs.mongodb.org/manual/core/update/</a> for more information on changing the structure of documents in a collection.</p>
<pre>CREATE INDEX idx_user_id_asc ON users(user_id)</pre>	<pre>db.users.ensureIndex( { user_id: 1 } )</pre>	<p>See ensureIndex() and indexes for more information.</p>
<pre>CREATE INDEX   idx_user_id_asc_age_desc ON users(user_id, age DESC)</pre>	<pre>db.users.ensureIndex( { user_id: 1, age: -1 } )</pre>	<p>See ensureIndex() and indexes for more information.</p>
<pre>DROP TABLE users</pre>	<pre>db.users.drop()</pre>	<p>See drop() for more information.</p>

**Insert** The following table presents the various SQL statements related to inserting records into tables and the corresponding MongoDB statements.

SQL INSERT Statements	MongoDB insert() Statements	Reference
<pre>INSERT INTO users (user_id,                     age,                     status) VALUES ("bcd001",        45,        "A")</pre>	<pre>db.users.insert( {     user_id: "bcd001",     age: 45,     status: "A" } )</pre>	See insert() for more information.

**Select** The following table presents the various SQL statements related to reading records from tables and the corresponding MongoDB statements.

SQL SELECT Statements	MongoDB find() Statements	Reference
<b>SELECT</b> * <b>FROM</b> users	db.users.find()	See find() for more information.
<b>SELECT</b> id, user_id, status <b>FROM</b> users	db.users.find( { }, { user_id: 1, status: 1 } )	See find() for more information.
<b>SELECT</b> user_id, status <b>FROM</b> users	db.users.find( { }, { user_id: 1, status: 1, _id: 0 } )	See find() for more information.
<b>SELECT</b> * <b>FROM</b> users <b>WHERE</b> status = "A"	db.users.find( { status: "A" } )	See find() for more information.
<b>SELECT</b> user_id, status <b>FROM</b> users <b>WHERE</b> status = "A"	db.users.find( { status: "A" }, { user_id: 1, status: 1, _id: 0 } )	See find() for more information.
<b>SELECT</b> * <b>FROM</b> users <b>WHERE</b> status != "A"	db.users.find( { status: { \$ne: "A" } } )	See find() and \$ne for more information.
<b>SELECT</b> * <b>FROM</b> users <b>WHERE</b> status = "A" <b>AND</b> age = 50	db.users.find( { status: "A", age: 50 } )	See find() and \$and for more information.
<b>SELECT</b> * <b>FROM</b> users <b>WHERE</b> status = "A" <b>OR</b> age = 50	db.users.find( { \$or: [ { status: "A" } { age: 50 } ] } )	See find() and \$or for more information.
<b>SELECT</b> * <b>FROM</b> users <b>WHERE</b> age > 25	db.users.find( { age: { \$gt: 25 } } )	See find() and \$gt for more information.
<b>SELECT</b> * <b>FROM</b> users <b>WHERE</b> age < 25	db.users.find( { age: { \$lt: 25 } } )	See find() and \$lt for more information.
<b>SELECT</b> * <b>FROM</b> users <b>WHERE</b> age > 25 <b>AND</b> age <= 50	db.users.find( { age: { \$gt: 25, \$lte: 50 } } )	See find(), \$gt, and \$lte for more information.
<b>SELECT</b> * <b>FROM</b> users <b>WHERE</b> user_id like "%bc%"	db.users.find( { user_id: /bc/ } )	See find() and \$regex for more information.

**Update Records** The following table presents the various SQL statements related to updating existing records in tables and the corresponding MongoDB statements.

SQL Update Statements	MongoDB update() Statements	Reference
<b>UPDATE</b> users <b>SET</b> status = "C" <b>WHERE</b> age > 25	db.users.update( { age: { \$gt: 25 } }, { \$set: { status: "C" } }, { multi: true } )	See update(), \$gt, and \$set for more information.
<b>UPDATE</b> users <b>SET</b> age = age + 3 <b>WHERE</b> status = "A"	db.users.update( { status: "A" }, { \$inc: { age: 3 } }, { multi: true } )	See update(), \$inc, and \$set for more information.

**Delete Records** The following table presents the various SQL statements related to deleting records from tables and the corresponding MongoDB statements.

SQL Delete Statements	MongoDB remove() Statements	Reference
<b>DELETE FROM</b> users <b>WHERE</b> status = "D"	db.users.remove( { status: "D" } )	See remove() for more information.
<b>DELETE FROM</b> users	db.users.remove( )	See remove() for more information.

## The bios Example Collection

The bios collection provides example data for experimenting with MongoDB. Many of this guide's examples on insert, update and read operations create or query data from the bios collection.

The following documents comprise the bios collection. In the examples, the data might be different, as the examples themselves make changes to the data.

```
{
  "_id" : 1,
  "name" : {
    "first" : "John",
    "last" : "Backus"
  },
  "birth" : ISODate("1924-12-03T05:00:00Z"),
  "death" : ISODate("2007-03-17T04:00:00Z"),
  "contribs" : [
    "Fortran",
    "ALGOL",
    "Backus-Naur Form",
    "FP"
  ],
  "awards" : [
    {
      "award" : "W.W. McDowell Award",
      "year" : 1967,
    }
  ]
}
```



```

        "by" : "IEEE Computer Society"
    },
    {
        "award" : "National Medal of Science",
        "year" : 1975,
        "by" : "National Science Foundation"
    },
    {
        "award" : "Turing Award",
        "year" : 1977,
        "by" : "ACM"
    },
    {
        "award" : "Draper Prize",
        "year" : 1993,
        "by" : "National Academy of Engineering"
    }
]
}

{
    "_id" : ObjectId("51df07b094c6acd67e492f41"),
    "name" : {
        "first" : "John",
        "last" : "McCarthy"
    },
    "birth" : ISODate("1927-09-04T04:00:00Z"),
    "death" : ISODate("2011-12-24T05:00:00Z"),
    "contribs" : [
        "Lisp",
        "Artificial Intelligence",
        "ALGOL"
    ],
    "awards" : [
        {
            "award" : "Turing Award",
            "year" : 1971,
            "by" : "ACM"
        },
        {
            "award" : "Kyoto Prize",
            "year" : 1988,
            "by" : "Inamori Foundation"
        },
        {
            "award" : "National Medal of Science",
            "year" : 1990,
            "by" : "National Science Foundation"
        }
    ]
}

{
    "_id" : 3,
    "name" : {
        "first" : "Grace",
        "last" : "Hopper"
    },

```

```

    "title" : "Rear Admiral",
    "birth" : ISODate("1906-12-09T05:00:00Z"),
    "death" : ISODate("1992-01-01T05:00:00Z"),
    "contribs" : [
        "UNIVAC",
        "compiler",
        "FLOW-MATIC",
        "COBOL"
    ],
    "awards" : [
        {
            "award" : "Computer Sciences Man of the Year",
            "year" : 1969,
            "by" : "Data Processing Management Association"
        },
        {
            "award" : "Distinguished Fellow",
            "year" : 1973,
            "by" : " British Computer Society"
        },
        {
            "award" : "W. W. McDowell Award",
            "year" : 1976,
            "by" : "IEEE Computer Society"
        },
        {
            "award" : "National Medal of Technology",
            "year" : 1991,
            "by" : "United States"
        }
    ]
}

{
    "_id" : 4,
    "name" : {
        "first" : "Kristen",
        "last" : "Nygaard"
    },
    "birth" : ISODate("1926-08-27T04:00:00Z"),
    "death" : ISODate("2002-08-10T04:00:00Z"),
    "contribs" : [
        "OOP",
        "Simula"
    ],
    "awards" : [
        {
            "award" : "Rosing Prize",
            "year" : 1999,
            "by" : "Norwegian Data Association"
        },
        {
            "award" : "Turing Award",
            "year" : 2001,
            "by" : "ACM"
        },
        {
            "award" : "IEEE John von Neumann Medal",

```

```

        "year" : 2001,
        "by" : "IEEE"
    }
]
}

{
    "_id" : 5,
    "name" : {
        "first" : "Ole-Johan",
        "last" : "Dahl"
    },
    "birth" : ISODate("1931-10-12T04:00:00Z"),
    "death" : ISODate("2002-06-29T04:00:00Z"),
    "contribs" : [
        "OOP",
        "Simula"
    ],
    "awards" : [
        {
            "award" : "Rosing Prize",
            "year" : 1999,
            "by" : "Norwegian Data Association"
        },
        {
            "award" : "Turing Award",
            "year" : 2001,
            "by" : "ACM"
        },
        {
            "award" : "IEEE John von Neumann Medal",
            "year" : 2001,
            "by" : "IEEE"
        }
    ]
}

{
    "_id" : 6,
    "name" : {
        "first" : "Guido",
        "last" : "van Rossum"
    },
    "birth" : ISODate("1956-01-31T05:00:00Z"),
    "contribs" : [
        "Python"
    ],
    "awards" : [
        {
            "award" : "Award for the Advancement of Free Software",
            "year" : 2001,
            "by" : "Free Software Foundation"
        },
        {
            "award" : "NLUUG Award",
            "year" : 2003,
            "by" : "NLUUG"
        }
    ]
}

```

```

    ]
  }

  {
    "_id" : ObjectId("51e062189c6ae665454e301d"),
    "name" : {
      "first" : "Dennis",
      "last" : "Ritchie"
    },
    "birth" : ISODate("1941-09-09T04:00:00Z"),
    "death" : ISODate("2011-10-12T04:00:00Z"),
    "contribs" : [
      "UNIX",
      "C"
    ],
    "awards" : [
      {
        "award" : "Turing Award",
        "year" : 1983,
        "by" : "ACM"
      },
      {
        "award" : "National Medal of Technology",
        "year" : 1998,
        "by" : "United States"
      },
      {
        "award" : "Japan Prize",
        "year" : 2011,
        "by" : "The Japan Prize Foundation"
      }
    ]
  }

  {
    "_id" : 8,
    "name" : {
      "first" : "Yukihiro",
      "aka" : "Matz",
      "last" : "Matsumoto"
    },
    "birth" : ISODate("1965-04-14T04:00:00Z"),
    "contribs" : [
      "Ruby"
    ],
    "awards" : [
      {
        "award" : "Award for the Advancement of Free Software",
        "year" : "2011",
        "by" : "Free Software Foundation"
      }
    ]
  }

  {
    "_id" : 9,
    "name" : {
      "first" : "James",

```

```

        "last" : "Gosling"
    },
    "birth" : ISODate("1955-05-19T04:00:00Z"),
    "contribs" : [
        "Java"
    ],
    "awards" : [
        {
            "award" : "The Economist Innovation Award",
            "year" : 2002,
            "by" : "The Economist"
        },
        {
            "award" : "Officer of the Order of Canada",
            "year" : 2007,
            "by" : "Canada"
        }
    ]
}

{
    "_id" : 10,
    "name" : {
        "first" : "Martin",
        "last" : "Odersky"
    },
    "contribs" : [
        "Scala"
    ],
}

```

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