#codemash

MongoDB – Zero to Sharding:
Part 2.2 : Indexing

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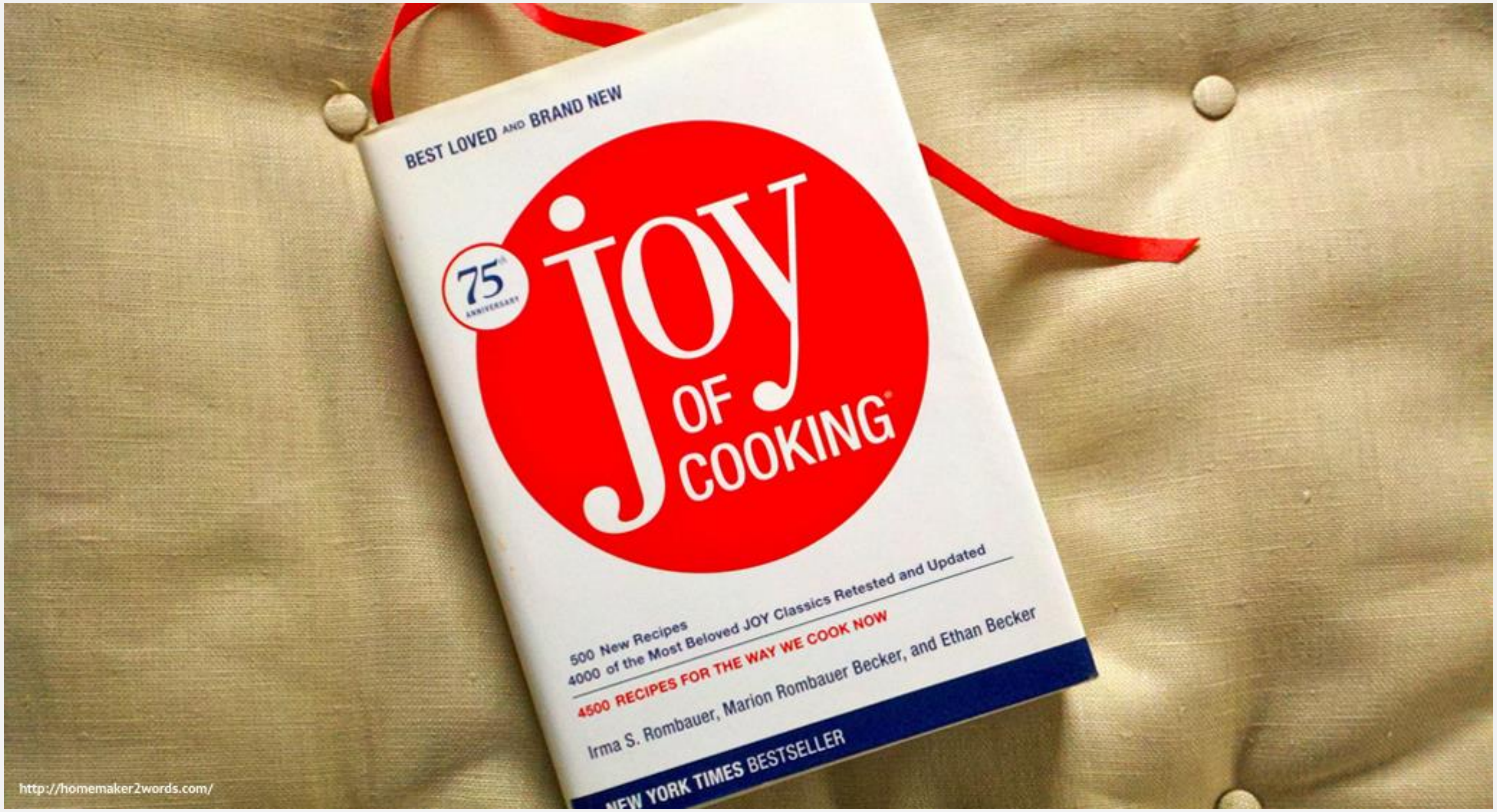
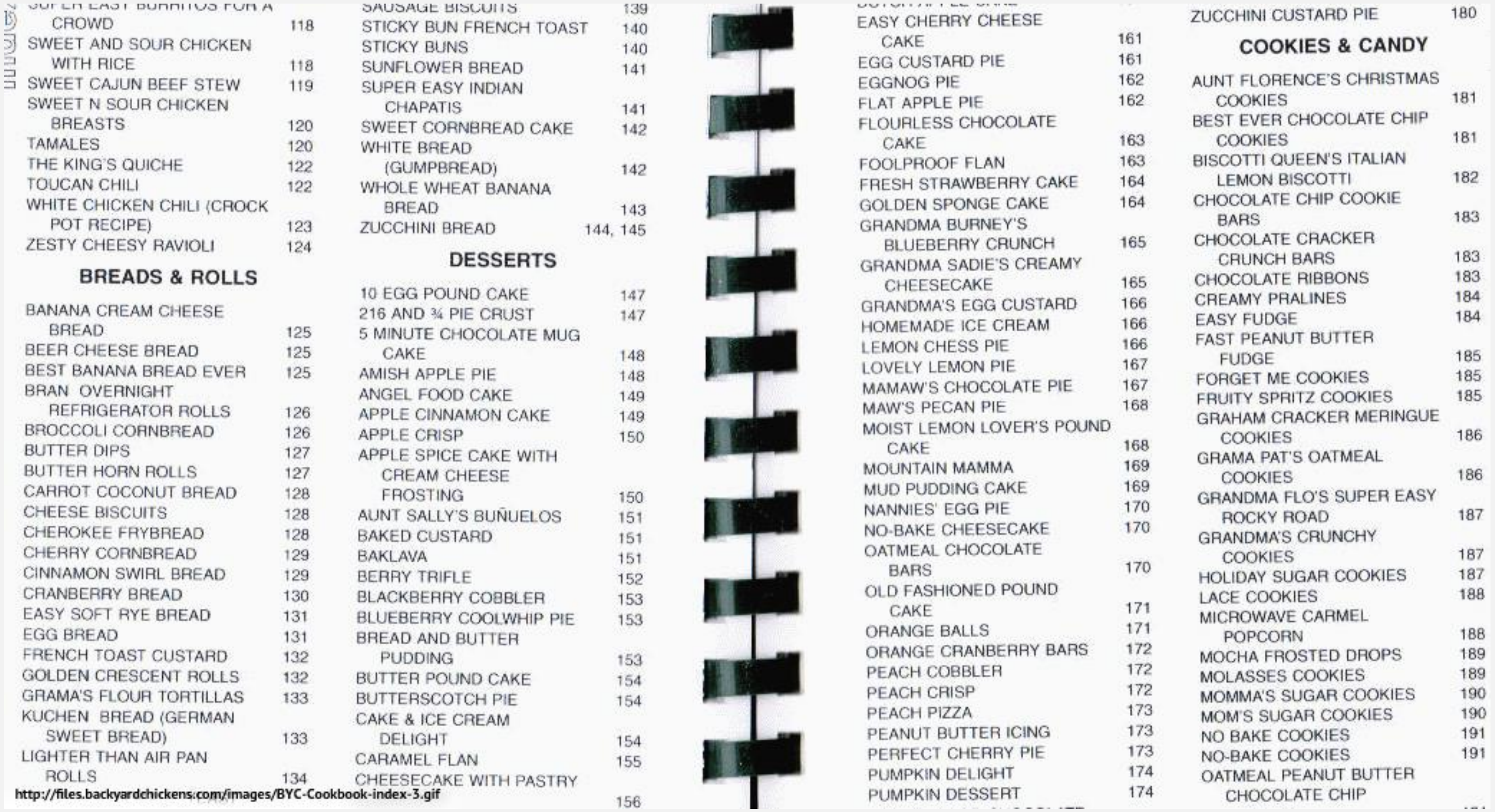
mongoDB

Agenda

- Working with indexes in MongoDB
- Optimize your queries
- Avoiding common mistakes

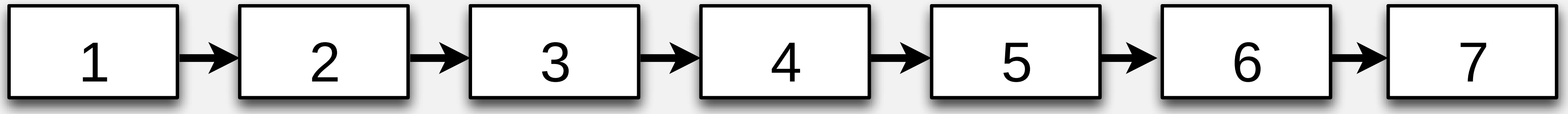

BEST LOVED AND BRAND NEW
75th ANNIVERSARY
joy OF COOKING®
500 New Recipes
4000 of the Most Beloved JOY Classics Retested and Updated
4500 RECIPES FOR THE WAY WE COOK NOW
Irma S. Rombauer, Marion Rombauer Becker, and Ethan Becker
NEW YORK TIMES BESTSELLER
http://homemaker2words.com/

What are indexes?

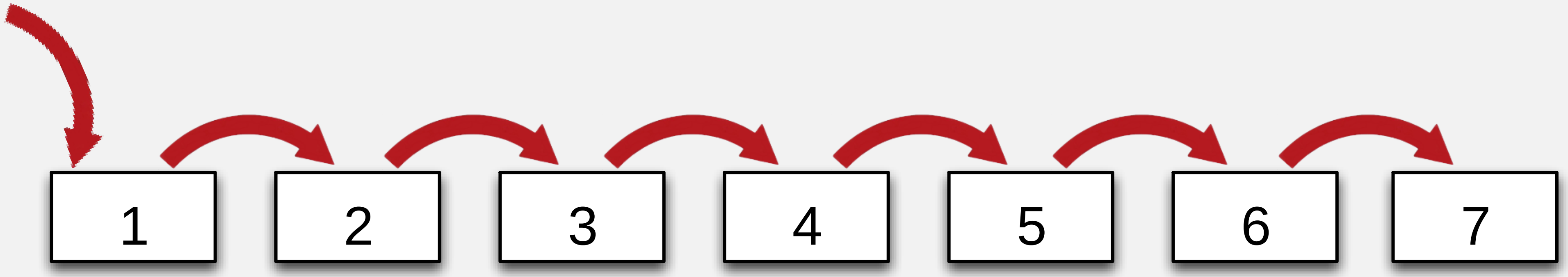


http://files.backyardchickens.com/images/BYC-Cookbook-index-3.gif

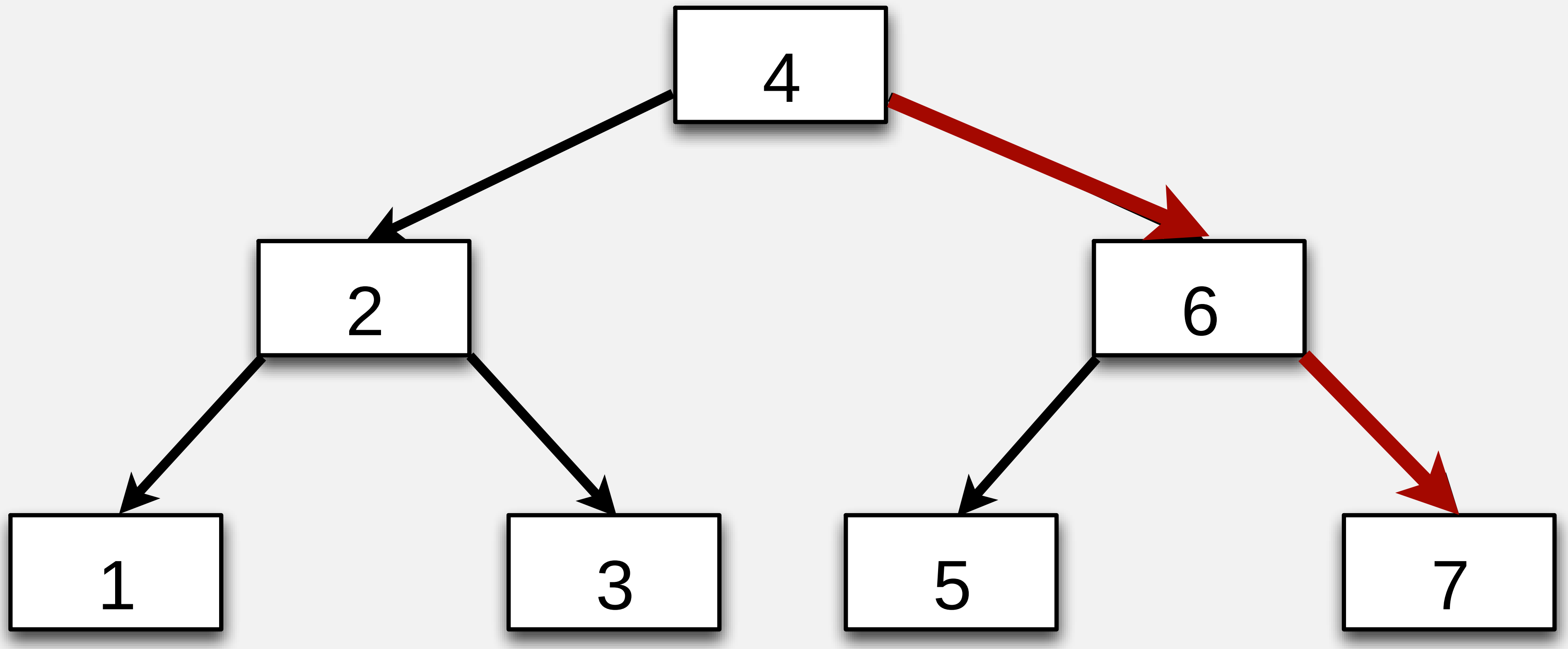
Consult the index!



Linked List

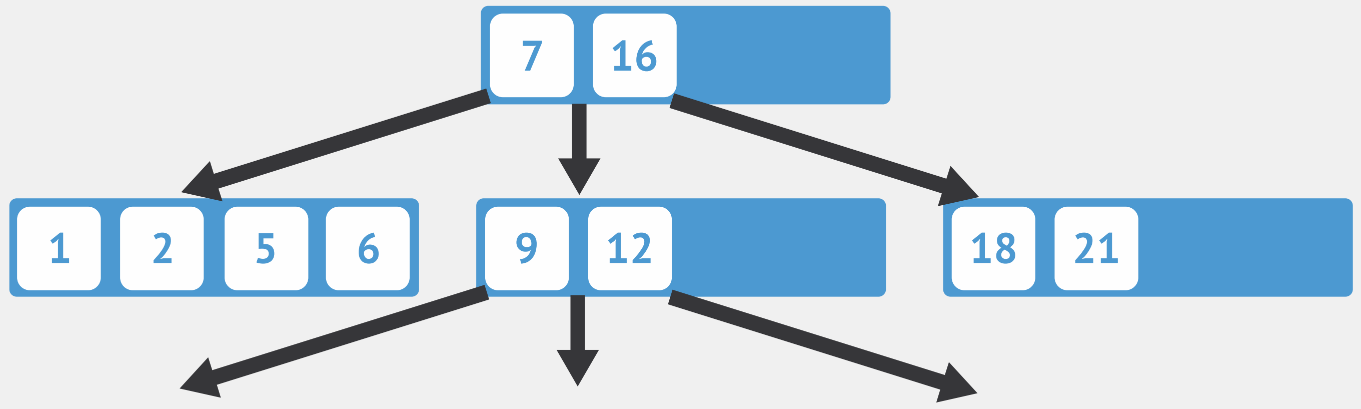


Finding 7 in Linked List



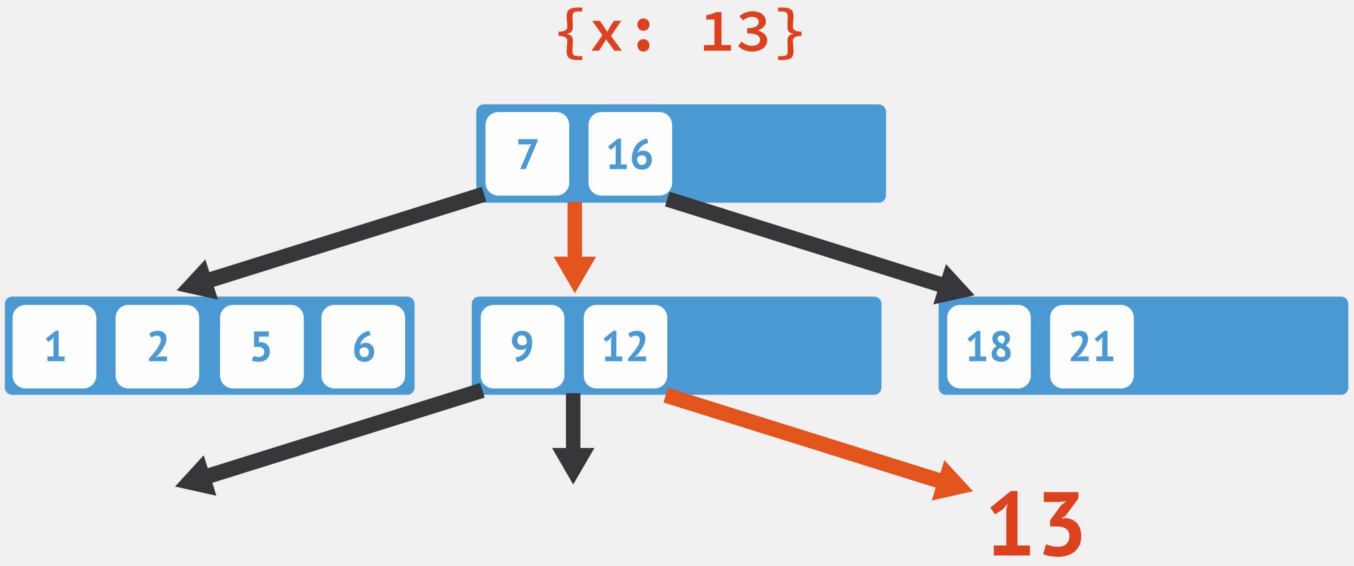
Finding 7 in Tree

B-Trees



Indexes in MongoDB are B-trees

B-Trees



Queries, inserts and deletes: O(log(n)) time

Indexes are the single biggest tunable performance factor in MongoDB

Working with Indexes in MongoDB

How do I create indexes?

```
// Create an index if one does not exist
// If an index exists throw an error
db.recipes.createIndex({ main_ingredient: 1 })



// Create an index if it does not exists
// Does not raise errors if index exists
db.recipes.ensureIndex({ main_ingredient: 1 })
```

* 1 means ascending, -1 descending

What can be indexed?

```
// Multiple fields (compound indexes)
db.recipes.ensureIndex({
    main_ingredient: 1,
    calories: -1
})

// Arrays of values (multikey indexes)
{
    name: 'Chicken Noodle Soup’,
    ingredients : ['chicken', 'noodles']
}

db.recipes.ensureIndex({ ingredients: 1 })
```

What can be indexed?

```
// Subdocuments
{
    name : 'Apple Pie',
    contributor: {
        name: 'Joe American',
        id: 'joea123'
    }
}

// Index field in a sub document
db.recipes.ensureIndex({ 'contributor.id': 1 })
```

How do I manage indexes?

```
// List a collection's indexes
db.recipes.getIndexes()
db.recipes.getIndexKeys()

// Drop a specific index
db.recipes.dropIndex({ ingredients: 1 })

// Drop all indexes and recreate them
db.recipes.reIndex()

// Default (unique) index on _id
```

Options

- Uniqueness constraints (unique, dropDups)
- Sparse Indexes
- Geospatial Indexes
  - 2d
  - 2dsphere (GeoJSON) 2.4+
- TTL Collections (expireAfterSeconds)

Limitations

- Collections can not have > 64 indexes.
- Index keys can not be > 1024 bytes (1K).
- The name of an index, including the namespace, must be < 128 characters.
- Queries can only use 1 index*
- Indexes have storage requirements, and impact the performance of writes.
- In memory sort (no-index) limited to 32mb of return data.

Optimize Your Queries

Profiling Slow Ops

db.setProfilingLevel(*n* , *slowms=100ms*)

n=0 profiler off

n=1 record operations longer than *slowms*

n=2 record all queries

db.system.profile.find()

* The profile collection is a capped collection

The Explain Plan (Pre Index)

```
db.recipes.find( { calories:
   { $lt : 40 } }
).explain( )
{
  "cursor" : "BasicCursor" ,
  "n" : 42,
  "nscannedObjects” : 12345
  "nscanned" : 12345,
   ...
  "millis" : 356,
   ...
}
```

Full Collection Scan

* Doesn’t use cached plans, re-evals and resets cache

The Explain Plan (Post Index)

```
db.recipes.find( { calories:
   { $lt : 40 } }
).explain( )
{
  "cursor" : "BtreeCursor calories_-1" ,
  "n" : 42,
  "nscannedObjects": 42
  "nscanned" : 42,
   ...
  "millis" : 0,
   ...
}
```

Indexed Query

* Doesn’t use cached plans, re-evals and resets cache

The Query Optimizer

- For each "type" of query, MongoDB periodically tries all useful indexes
- Aborts the rest as soon as one plan wins
- The winning plan is cached for each “type” of query
  - Up to 1000 writes
  - Change in indexes

Manually Select Index to Use

```
// Tell the database what index to use
db.recipes.find({
    calories: { $lt: 1000 } }
).hint({ _id: 1 })

// Tell the database to NOT use an index
db.recipes.find(
    { calories: { $lt: 1000 } }
).hint({ $natural: 1 })
```

Use Indexes to Sort Query Results

```
// Given the following index
db.collection.ensureIndex({ a:1, b:1 , c:1, d:1 })

// The following query and sort operations can use the index
db.collection.find( ).sort({ a:1 })
db.collection.find( ).sort({ a:1, b:1 })

db.collection.find({ a:4 }).sort({ a:1, b:1 })
db.collection.find({ b:5 }).sort({ a:1, b:1 })
```

Indexes that won’t work for sorting query results

```
// Given the following index
db.collection.ensureIndex({ a:1, b:1, c:1, d:1 })

// These can not sort using the index
db.collection.find( ).sort({ b: 1 })
db.collection.find({ b: 5 }).sort({ b: 1 })
```

Covered Index Queries

```
// MongoDB can return data from just the index
db.recipes.ensureIndex({ main_ingredient: 1, name: 1 })

// Return only the ingredients field
db.recipes.find(
    { main_ingredient: 'chicken’ },
    { _id: 0, name: 1 }
)

// indexOnly will be true in the explain plan
db.recipes.find(
    { main_ingredient: 'chicken' },
    { _id: 0, name: 1 }
).explain()
{
    "indexOnly": true,
}
```

Absent or suboptimal indexes are the most common avoidable MongoDB performance problem.

Avoiding Common Mistakes

Trying to Use Multiple Indexes

```
// MongoDB can only use one index for a query
db.collection.ensureIndex({ a: 1 })
db.collection.ensureIndex({ b: 1 })

// Only one of the above indexes is used
db.collection.find({ a: 3, b: 4 })
```

Compound Key Mistakes

```
// Compound key indexes are very effective
db.collection.ensureIndex({ a: 1, b: 1, c: 1 })

// But only if the query is a prefix of the index


// This query can't use the index
db.collection.find({ c: 2 })


// ...but this query can
db.collection.find({ a: 3, b: 5 })
```

Low Selectivity Indexes

```
db.collection.distinct('status’)
[ 'new', 'processed' ]

db.collection.ensureIndex({ status: 1 })

// Low selectivity indexes provide little benefit
db.collection.find({ status: 'new' })

// Better
db.collection.ensureIndex({ status: 1, created_at: -1 })
db.collection.find(
    { status: 'new' }
).sort({ created_at: -1 })
```

Regular Expressions

```
db.users.ensureIndex({ username: 1 })

// Left anchored regex queries can use the index
db.users.find({ username: /^joe smith/ })

// But not generic regexes
db.users.find({username: /smith/ })

// Or case insensitive queries
db.users.find({ username: /Joe/i })
```

Choosing the right indexes is one of the most important things you can do as a MongoDB developer so take the time to get your indexes right!

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Coming Next:
Part 3 : Replication and Sharding

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