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Database Systems

Lecture 11: MongoDB

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What Is It?

- A document-oriented database
  - documents encapsulate and encode data (or information) in some standard formats or encodings
- NoSQL database
  - non-adherence to the widely used relational database
  - highly optimized for retrieve and append operations
- uses BSON format
- schema-less
  - No more configuring database columns with types
- No transactions
- No joins

The Basics

- A MongoDB instance may have zero or more databases
- A database may have zero or more collections.
  - Can be thought of as the relation (table) in DBMS, but with many differences.
- A collection may have zero or more documents.
  - Docs in the same collection don't even need to have the same fields
  - Docs are the records in RDBMS
  - Docs can embed other documents
  - Documents are addressed in the database via a unique key
- A document may have one or more fields.
- MongoDB Indexes is much like their RDBMS counterparts.

The Basics

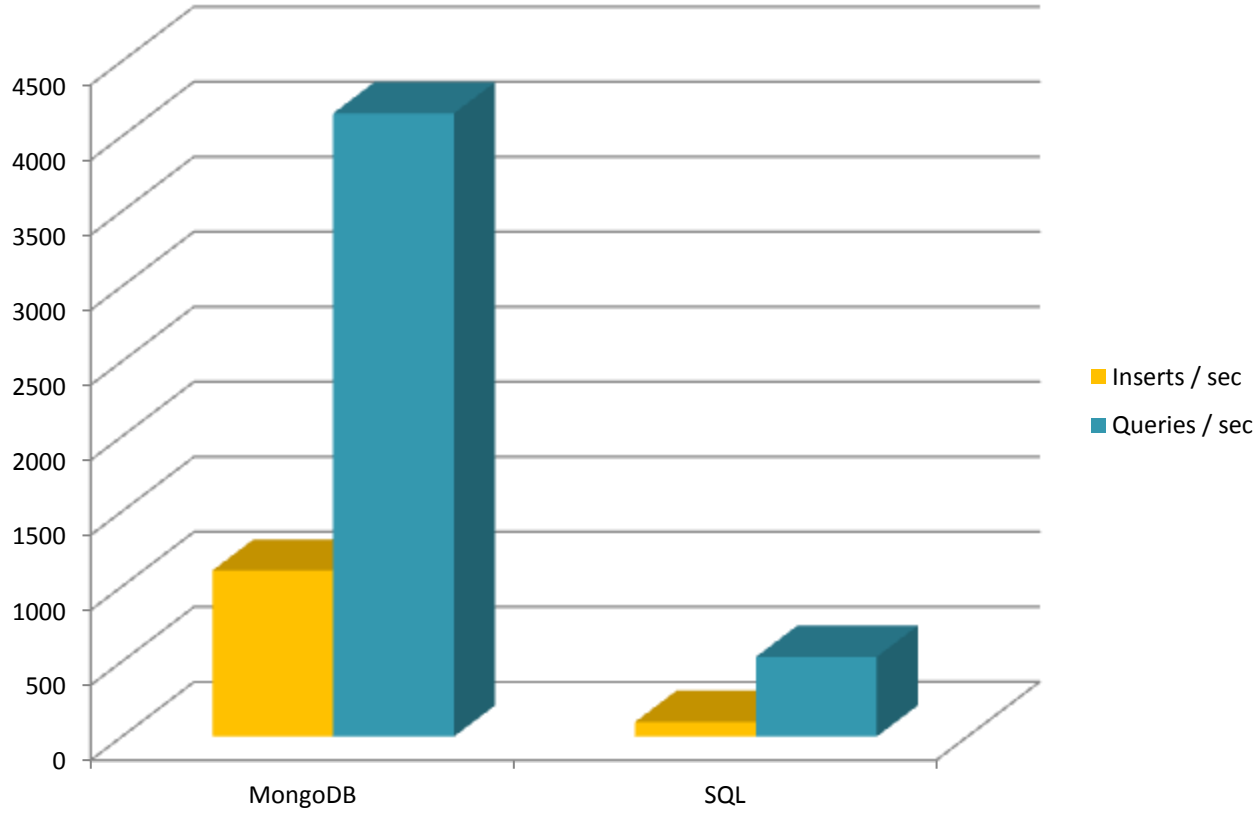
+ Simple queries
+ Makes sense with most web applications
+ Easier and faster integration of data
- Not well suited for heavy and complex transactions systems.

MongoDB Vs Relational DBMS

- Collection vs table
- Document vs row
- Field vs column
- schema-less vs schema-oriented

It Is Fast!

- Anywhere from 2 to 10 times faster than MySQL



Example: Mongo Document

```
user = {
          name: “Z",
          occupation: "A scientist",
          location: “New York"
        }
```

Example: Mongo Document

```
{
  name: 'Brad Steve',
  address:
    {
      street: 'Oak Terrace',
      city: 'Denton'
    }
}
```

Example: Mongo Collection

```
{ "_id": ObjectId("4efa8d2b7d284dad101e4bc9"),
  "Last Name": "DUMONT",
   "First Name": "Jean",
   "Date of Birth": "01-22-1963" },

  { "_id": ObjectId("4efa8d2b7d284dad101e4bc7"),
    "Last Name": "PELLERIN",
    "First Name": "Franck",
    "Date of Birth": "09-19-1983",
    "Address": "1 chemin des Loges",
    "City": "VERSAILLES" }
```

Obligatory, and automatically generated by MongoDB

Example: A Blog

- A blog post has an author, some text, and many comments
- The comments are unique per post, but one author has many posts
- How would you design this in SQL?

Example: A Blog: Bad Design

- Collections for posts, authors, and comments
- References by manually created ID

```
post = {
  id: 150,
  author: 100,
  text: 'This is a pretty awesome post.',
  comments: [100, 105, 112]
}
author = {
  id: 100,
  name: 'Michael Arrington'
  posts: [150]
}
comment = {
  id: 105,
  text: 'Whatever this sux.'
}
```

Example: A Blog: Better Design

- Collection for posts
- Embed comments, author name

```
post = {
  author: 'Michael Arrington',
  text: 'This is a pretty awesome post.',
  comments: [
              'Whatever this post sux.',
              'I agree, lame!'
            ]
}
```

Why is this one better?

Benefits

- Embedded objects brought back in the same query as parent object
  - Only 1 trip to the DB server required
- Objects in the same collection are generally stored contiguously on disk
  - Spatial locality = faster
- If the document model matches your domain well, it can be much easier to comprehend than nasty joins

Queries in MongoDB

- Query expression objects indicate a pattern to match
  - `db.users.find( {last_name: 'Smith'} )`
- Several query objects for advanced queries
  - `db.users.find( {age: {$gte: 23} } )`
  - `db.users.find( {age: {$in: [23,25]} } )`
- Exact match an entire embedded object
  - `db.users.find( {address: {street: 'Oak Terrace', city: 'Denton'}} )`
- Dot-notation for a partial match
  - `db.users.find( {"address.city": 'Denton'} )`

Indexing

- Indexes in MongoDB are similar to indexes in RDBMS.
- MongoDB supports indexes on any field or sub-field contained in documents
- MongoDB defines indexes on a per-collection level.
- All MongoDB indexes use a B-tree data structure.

Building An Application

- Want to build an app where users can check in to a location
- Leave notes or comments about that location
- Requirements
  - Need to store locations (Offices, Restaurants etc)
    - Want to be able to store name, address and tags
    - Maybe User Generated Content, i.e. tips / small notes ?
  - Want to be able to find other locations nearby
  - User should be able to 'check in' to a location
  - Want to be able to generate statistics

Building An Application

loc1, loc2, loc3

Locations

User1, User2

Users

Places

```
location1 = {
        name: "10gen HQ”,
        address: "17 West 18th Street 8th Floor”,
        city: "New York”,
        zip: "10011”,
        latlong: [40.0,72.0],
        tags: [“business”, “cool place”],
        tips: [
                {user:"nosh", time:6/26/2010, tip:"stop by for office hours on
                Wednesdays from 4-6pm"},
                 {.....},
                ]
}
```

Example queries:

- db.locations.find({latlong:{$near:[40,70]}})
- db.locations.find({zip:”10011”, tags:”business”})
- db.locations.find({zip:”10011”}).limit(10)

Inserting and updating locations

Initial data load:

```
db.locations.insert(place1)
```

Using update to Add tips:

```
db.locations.update({name:"10gen HQ"},
        {$push :{tips:
                        {user:"nosh", time:6/26/2010,
                         tip:"stop by for office hours on
                         Wednesdays from 4-6"}}}}
```

Users

```
user1 = {
        name: “nosh”
        email: “nosh@10gen.com”,
        .
        .
        .
        checkins: [{ location: “10gen HQ”,
            ts: 9/20/2010 10:12:00,
            …},
            …
         ]
}
```

Simple Stats

```
db.users.find({‘checkins.location’: “10gen HQ”)

db.checkins.find({‘checkins.location’: “10gen HQ”})
                                        .sort({ts:-1}).limit(10)

db.checkins.find({‘checkins.location’: “10gen HQ”,
                                        ts: {$gt: midnight}}).count()
```

Limitations of MongoDB

- No referential integrity
- High degree of denormalization means updating something in many places instead of one
- Lack of predefined schema is a double-edged sword
  - You must have a model in your app
  - Objects within a collection can be completely inconsistent in their fields

Conclusions

- MongoDB is fast
  - Very little CPU overhead
  - MongoDB is Implemented in C++ for best performance
- Very rapid development, open source
- useful when working with a huge quantity of data when the data's nature does not require a relational model
- used when what really matters is the ability to store and retrieve great quantities of data, not the relationships between the elements.
- Works on many platforms and there are many language drivers

http://www.mongodb.org/