MongoDB and Cloud Storage

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Agenda

- Cloud Databases
- MongoDB
  - Querying
  - Integrating with Node.js
  - The Contacts API implementation

Databases in Enterprise Apps

- Most data driven enterprise applications need a database
- In traditional enterprise applications, this requires
  - Backups
  - Fail over
  - Maintenance
  - Capacity provisioning
- Usually handled by a Database Administrator.

Databases in the Cloud

- For some apps, a traditional database may not be the best fit
  - Does the app require transactional integrity
  - Do you need db schema definition
  - Do you know your scaling requirements, particularly if it’s a web app
- One approach is to use the **Cloud** for you DB
  - Designed for scale
  - Can be outsourced so you don’t have to deal with infrastructure requirements.

Cloud DB Advantages

- Removes Management costs
- Inherently scalable
- Latency is predictable and constant
- No need to define schemas etc.
- Lots of Cloud DB offerings out there
  - SQL based
  - NoSQL based
- If organisation policy/standards do not allow outsourcing:
  - Can host yourself, most NoSQL DBs are free.

Cloud Database Practices

- Drop Consistency
  - this makes distributed systems much easier to build
- Drop SQL and the relational model
  - simpler structures are easier to distribute:
    - key/value pairs
    - **structured documents**
    - **pseudo-tables**
    - tend to be schema-free,accepting data as-is
- Offer HTTP interfaces using XML or **JSON**
- Use in-memory storage aggressively

Designing Distributed Data

- App data is not homogeneous
  - some kinds of data will be much larger

- consider using different databases for different requirements:
- user details,billing - needs consistency
  - require traditional database
- user data,content - needs partition tolerance
  - replicate to keep safe
- analytics,sessions - needs availability
  - "eventually consistent" is good enough

MONGODB

Introduction

- Document-oriented database
  - but closer to traditional SQL databases than others
- Uses JSON natively - perfect fit for Node.js
- Query language with many SQL features
  - Uses JSON too, and has an easy learning curve
- Inbuilt sharding support means you can scale
  - Aggressively uses memory for high speed
- be careful:default configuration does not sync to disk
- Commercial support - 10gen.com product
  - cloud hosting providers - e.g.mongoLab.com
- Community support - popular choice

Mongo Terminology

- Each database contains a set of "Collections"
- Collections are analogous to SQL tables
- Collections contain a set of JSON documents
  - there is no schema (in the DB)
- the documents can all be different
  - means you have rapid development
  - adding a property is easy - just starting using in your code
- makes deployment easier and faster
  - roll-back and roll-forward are safe - unused properties are just ignored
- Collections can be indexed and queries
- Operations on individual documents are atomic

Getting Started (locally)

- For complete MongoDB installation instructions, see the manual.
- Starting MongoDB:

```
mongod
```

- This starts the process.
- Can add other parameters, for instance location of data.

Mongo Shell

- Interactive JavaScript interface to MongoDB.
- Query/update data and perform administrative operations.

```
C:\repos\webservicesdev-2017>mongo
MongoDB shell version v3.4.2
connecting to: mongodb://127.0.0.1:27017
MongoDB server version: 3.4.2
Server has startup warnings:
2017-03-20T13:49:38.768+0000 I CONTROL  [initandlisten]
2017-03-20T13:49:38.769+0000 I CONTROL  [initandlisten] ** WARNING: Access control is not enabled for the database.
2017-03-20T13:49:38.773+0000 I CONTROL  [initandlisten] **          Read and write access to data and configuration is u
nrestricted.
2017-03-20T13:49:38.775+0000 I CONTROL  [initandlisten]
>
```

- By default, Mongo shell will attempt to connect to the MongoDB instance running on the localhost interface on port 27017.

The MongoDB Query Language

- MongoDB provides a JavaScript API and JSON-based query language
- Use the MongoDB shell to execute queries
  - similar to usingMySQL console
- Example: list of contacts

```
C:\Windows\System32\cmd.exe - mongo
> db.contacts.find()
{ "_id" : ObjectId("58cff994420d7c3a44023cab"), "name" : "Contact 1", "address" :
"123 Test St", "phone_number" : "132-3212" }
{ "_id" : ObjectId("58cff994420d7c3a44023cac"), "name" : "Contact 2", "address" :
"23 Main St", "phone_number" : "934-4329" }
{ "_id" : ObjectId("58cff994420d7c3a44023cad"), "name" : "Contact 3", "address" :
"4 Lower St", "phone_number" : "432-5832" }
{ "_id" : ObjectId("58cff994420d7c3a44023cae"), "name" : "Contact 4", "address" :
"49 Upper Street", "phone_number" : "934-4290" }
>
```

- db - current database
- contacts - the contacts collection
- .find() - collectionAPI method (coorresponds to collection URL in last lecture…)
- The Result Set is a list of JavaScript objects, representing matched documents

MongoDB: Inserts

- Collections do not need to be created explicitly
  - just insert a document
- MongoDB automatically assigns a 12 byte unique identifier to any document
  - the **_id** property
  - Stored internally as binary

C:\Windows\System32\cmd.exe - mongo

```
>
> db.contacts.insert({"name":"Frank","address":"345 Soder St","phone_numb
er":"051-223344"})
WriteResult({ "nInserted" : 1 })
>
```

MongoDB:Queries

- Documents are retrieved by specifying a set of conditions to match against
- simplest case : query-by-example
- provide a subset of properties that must match

C:\Windows\System32\cmd.exe - mongo

```
> db.contacts.find({"name":"Frank"})
{ "_id" : ObjectId("58d00877182a3499b0e37fe6"), "name" : "Frank", "addres
s" : "345 Soder St", "phone_number" : "051-223344" }
>
```

- More complex queries use a convention of embedded meta- properties to specify conditions these are signified with a $ prefix Example:{name:{$exists:true}}

  returns documents that have a name property

MongoDB: Queries

- Common meta-properties used to query data are:
  - **$gt, $gte, $lt, $lte** meaning>, >=, <,<=

```
C:\Windows\System32\cmd.exe - mongo
> db.contacts.insert({"name":"Mary","age":21,"address":"345 Soder St","ph
one_number":"051-223344"})
WriteResult({ "nInserted" : 1 })
> db.contacts.insert({"name":"Jane","age":31,"address":"345 Keel St","pho
ne_number":"051-445566"})
WriteResult({ "nInserted" : 1 })
> db.contacts.find({"age":{$gte:21,$lt:31}})
{ "_id" : ObjectId("58d00909182a3499b0e37fe7"), "name" : "Mary", "age" :
21, "address" : "345 Soder St", "phone_number" : "051-223344" }
>
```

  - **$or, $in, $nin**

```
C:\Windows\System32\cmd.exe - mongo
> db.contacts.find({"name":{$in:["Jane", "Frank"]}})
{ "_id" : ObjectId("58d00877182a3499b0e37fe6"), "name" : "Frank", "addres
s" : "345 Soder St", "phone_number" : "051-223344" }
{ "_id" : ObjectId("58d00939182a3499b0e37fe8"), "name" : "Jane", "age" :
31, "address" : "345 Keel St", "phone_number" : "051-445566" }
>
```

MongoDB: Queries

- **regular expressions** {word: /th^/i }

```
C:\Windows\System32\cmd.exe - mongo
> db.contacts.find({"name":/^F/})
{ "_id" : ObjectId("58d00877182a3499b0e37fe6"), "name" : "Frank", "addres
s" : "345 Soder St", "phone_number" : "051-223344" }
>
```

- db.contacts.find().limit(5)
  - limits the number of documents in the result set.
- db.contacts.find().skip(5)
  - Set the Starting Point of the Result Set

MongoDB:Updates

- Documents are updated by providing:
  - a query to select the relevant subset of documents,
  - an update specification,which is either:
    - a complete replacement document
    - meta-properties that modify specific document properties
- example:
  $set changes specific properties
  Example:complete replacement:
  > db.city.insert({name:'dublin'})
  > db.city.update({name:'dublin'}, {name:'Dublin',county:'Dublin'})

- Example:modify specific properties:

```
> db.city.insert( {name:'Cork',county:'cork'} )
> db.city.update( {name:'Cork'}, {$set:{county:'Cork'}} )
```

- See http://www.mongodb.org/display/DOCS/Updating for more

MongoDB:Update Properties

- Common meta-properties used with the update command are:
  - **$set** - sets specified properties,but leaves others alone
    $set:{name:'New Name'}
- **$unset** - deletes specified properties
    $unset:{name:1}
- **$inc** - increments a numeric property
    inc:{ upvotes: 2 }
  adds 2 to the counter property, or if it does not exist, sets it to 2
- **$push, $pop** - add to or remove values from,an array
  - $push: { comments: {who:..., msg:...} }
  - $pop: {comments: -1 }

MongoDB:Upserts

- The MongoDB update command can optionally insert a document if it is not found. This is known as an 'upsert'
- This is useful when starting counters as it avoids corrupting the count when two independent updates try to initialize the counter.

```
db.counters.update( {name:'foo'}, {$inc:{value:1}}, true)
```

- The first update will create the counter: {name:'foo', value:1}
- The second update will increment the counter: {name:'foo', value:2}

MONGO DB NODE.JS DRIVER

MongoDB Node.jsDriver

- To connect Node.js to MongoDB you need a *database driver*
- A Node.js module that communicates over the wire to MongoDB,and presents an API over the database.
- The one we'll look at available with NPM:

http://docs.mongodb.org/ecosystem/drivers/node-js/

```
npm install mongodb
var mongodb = require('mongodb')
```

node-mongodb-native

- Provides low-level interface to MongoDB and replicates the MongoDB Console
  - suffers badly from callbacks !
- Used by higher level MongoDB modules:
  - mongoose:Object Relational Mapper
  - mongoskin:simplerAPI to reduce callbacks
- Sufficient for smaller apps

Connecting to MongoDB using Node

```
const mongo = require('mongodb');
const mongoClient = mongo.MongoClient;
const mongoDb;
const url = ‘mongodb://localhost:27017/myproject’
mongoClient.connect(url, (err, db)=> {    if(!err) {
            console.log("We are connected");
            mongoDb = db; }
      else
            {console.log("Unable to connect to
            the db");
      }
}
);
```

Inserting a Document

The following function that will insert a document:

```
if (mongoDb){
      const collection = mongoDb.collection('contacts');
      collection.insert(contact, {w:1},(err, result)=> {
            if (err) {
                console.log({'error':'An error has occurred'});
            } else {
                console.log('Success: ' + JSON.stringify(result[0]));}
        });
    }
  else
  {
    console.log('No database object!');
  }
```

- The insert function returns a result object that contains several fields that might be useful.
  - **result** Contains the result document from MongoDB
  - **ops** Contains the documents inserted with added **_id** fields
  - **connection** Contains the connection used to perform the insert

Updating a Document

- The following simple document update by adding a new field **b** to the document that has the field **a** set to **2**.

```
// Get the documents collection
  const collection = db.collection('documents');
  // Update document where a is 2, set b equal to 1
  collection.update({ a : 2 }, { $set: { b : 1 } },(err,
result)=>{
                    console.log("Updated the document with
the field a equal to 2");
  });
```

- The method will update the first document where the field **a** is equal to **2** by adding a new field **b** to the document set to **1**.

Deleting a Document

- This will remove the first document where the field **a** equals to **3**.

```
var collection = db.collection('documents');
  // Insert some documents
collection.remove({ a : 3 }, (err, result)=>{
       If (!err){
              console.log("Removed the document with the
field a              equal to 3");}
       }
       else{
              console.log("Did not remove document");}

       }
});
}
```

MONGOOSE

Mongoose Overview

- Mongoose is a object-document model module in Node.js for MongoDB
  - Wraps the functionality of the native MongoDB driver
  - Exposes models to control the records in a doc
  - Supports validation on save
  - Extends the native queries

Installing Mongoose

- Run the following from the CMD/Terminal

  $ npm install -save mongoose

- In node
  - Load the module

    import mongoose from ('mongoose');

- Connect to the database
  - mongoose.connect(mongoDbPath);

Mongoose Schemas and Models

- Mongoose supports models
  - i.e. fixed types of documents
  - Needs a mongoose.Schema
  - Each of the properties must have a type
    - Number, String, Boolean, array, object

```
1   const mongoose = require('mongoose'),
2   Schema = mongoose.Schema;
3
4   const ContactSchema = new Schema({
5     name: String,
6     address: String,
7     age: Number,
8     email: String,
9     updated: Date
10  });
11
12  const ContactModel = mongoose.model('contacts', ContactSchema);
```

Mongoose Schema - Validation

- Can define validation constraints on properties :

```
1   const mongoose = require('mongoose'),
2   Schema = mongoose.Schema;
3
4   const ContactSchema = new Schema({
5     name: String,
6     address: String,
7     age: { type: Number, min: 0, max: 120 },
8     email: String,
9     updated: { type: Date, default: Date.now }
10  });
11
12  const ContactModel = mongoose.model('contacts', ContactSchema);
```

Mongoose Schemas – Arrays

Comments property is an Array of CommentSchemas

```
1   const mongoose = require('mongoose'),
2   Schema = mongoose.Schema;
3
4   const CommentSchema = new Schema({
5     body: {type: String, required:true},
6     author: {type: String, required:true},
7     upvotes:Number
8     });
9
10   const PostSchema = new Schema({
11      title: {type: String, required:true},
12      link:  {type: String, optional:true},
13      username:  {type: String, required:true},
14      comments: [CommentSchema],
15    upvotes: { type: Number, min: 0, max: 100 }
16   });
17
18  export default mongoose.model('posts', PostSchema);
```

Mongoose Custom Validation

- Developers can define custom validation on their properties (e.g. validate length of comment when trying to save)

```
CommmentSchema.path('body').validate((v)=>{
    if (v.lenght>40 || v.length < 5){
        return false
    }
    return true
})
```

Data Manipulation Mongoose

- Mongoose supports all the CRUD operations:
  - Create –> model.create(callback)
  - Read –> Model.find().exec(callback)
  - Update –> modelObj.update(props, callback)–> Model.update(condition, props, cb)
  - Remove –> modelObj.remove(callback)–> Model.remove(condition, props, cb)

Create Contact with Mongoose

```
1   const mongoose = require('mongoose'),
2   Schema = mongoose.Schema;
3
4   const ContactSchema = new Schema({
5     name: String,
6     address: String,
7     age: { type: Number, min: 0, max: 120 },
8     email: String,
9     updated: { type: Date, default: Date.now }
10  });
11
12  const ContactModel = mongoose.model('contacts', ContactSchema);
```

```
1   router.post('/', (req, res) => {
2           let newContact = req.body;
3           if (newContact){
4              Contact.create(newContact, (err, contact) => {
5                 if(err) { return handleError(res, err); }
6                 return res.status(201).send({contact});
7              });
8        }else{
9           return handleError(res, err);
10       }
11  });
```

Update Contact with Mongoose

```
1   const mongoose = require('mongoose'),
2   Schema = mongoose.Schema;
3
4   const ContactSchema = new Schema({
5     name: String,
6     address: String,
7     age: { type: Number, min: 0, max: 120 },
8     email: String,
9     updated: { type: Date, default: Date.now }
10  });
11
12  const ContactModel = mongoose.model('contacts', ContactSchema);
```

```
1   router.put('/:id', (req, res) => {
2       let key = req.params.id;
3       let updateContact = req.body;
4
5       if(updateContact._id) {delete updateContact._id;}
6       ContactModel.findById(req.params.id,  (err, contact) => {
7         if (err) { return handleError(res, err); }
8           if(!contact) { return res.send(404); }
9               const updated = _.merge(contact, req.body);
10              updated.save((err) => {
11                    if (err) { return handleError(res, err); }
12                          return res.send(contact);
13              });
14        });
15  });
16
```

Mongoose Queries

- Mongoose provides a mode expressive version of the native MongoDB
  - Instead of:
    {$or: [{conditionOne: true}, {conditionTwo: true}]
  - Do:
    .where({conditionOne:true}).or({conditionTwo: true})

Mongoose Queries

- Mongoose supports many queries:
  - For equality/non-equality
  - Selection of some properties
  - Sorting
  - Limit & skip
- All queries are executed over the object returned by Model.find*()
  - Model.findOne() returns a single document, the first match
  - Model.find() returns all
  - Model.findById() queries on the _id field.

```
1
2   let id = "58cff994420d7c3a44023cb0"
3   ContactModel.findById(id,(err, contact) => {
4      if (err) { return handleError(res, err); }
5      console.log(contact)
6   });
7
```

Mongoose Queries

- Can build complex queries and execute them later

```
const query = ContactModel.where('age').gt(17).lt(66)
                          .where('county').in(['Waterford','Wexford','Kilkenny']);

query.exec((err,contacts)=>{...})
```

- The above finds all contacts where age >17 and <66 and living in either Waterford, Kilkenny or Wexford

Mongoose Sub-Docs

- Ex: Hacker News – Adding a comment to a post.

```
1   //add comment
2   router.post('/:id/comments', (req, res) => {
3       const id = req.params.id;
4       const comment = req.body;
5       PostModel.findById(id, (err, post)=>{
6           if(err) { return handleError(res, err); }
7           post.comments.push(comment);
8           post.save(err => {
9             if (err) {return handleError(res, err);}
10             return res.status(201).send({post});
11          });
12      });
13  });
```

Mongoose Sub-Docs

- Updating a Sub-Document(e.g. incrementing the upvotes for a comment)

```
1   router.post('/:postId/comments/:commentId/upvotes', (req, res) => {
2       const commentId = req.params.commentId;
3       const postId = req.params.postId;
4       Post.findById( postId, (err, post)=>{
5           if(err) { return handleError(res, err); }
6               post.comments.id(commentId).upvotes++;
7               post.save(err => {
8               if (err) {return handleError(res, err);}
9                   return res.status(201).send({post});
10              });
11    });
12  });
```

Each subdocument is assigned it's own _id from MongoDB. This is a special methog to access sub documents

Mongo Sub docs

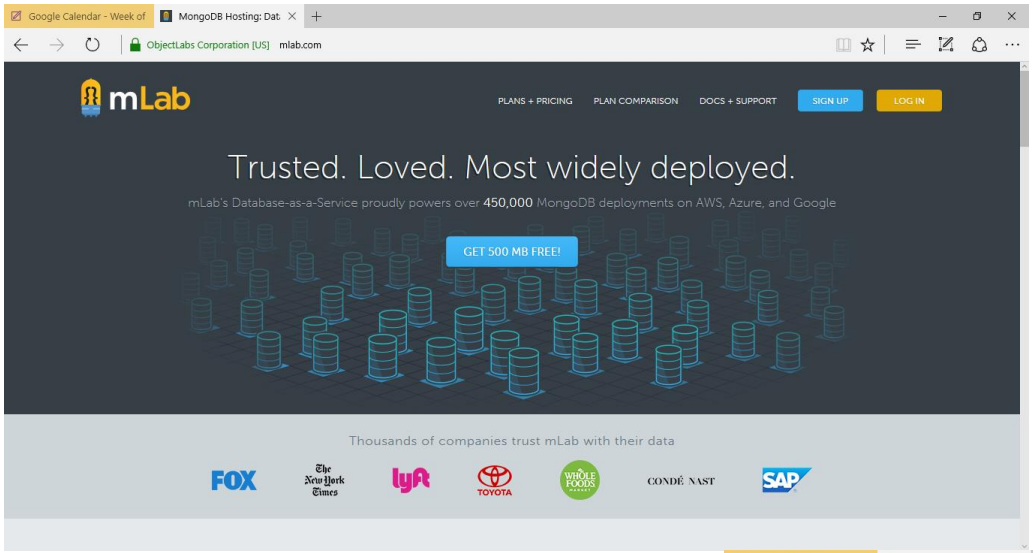
- Removing a sub document

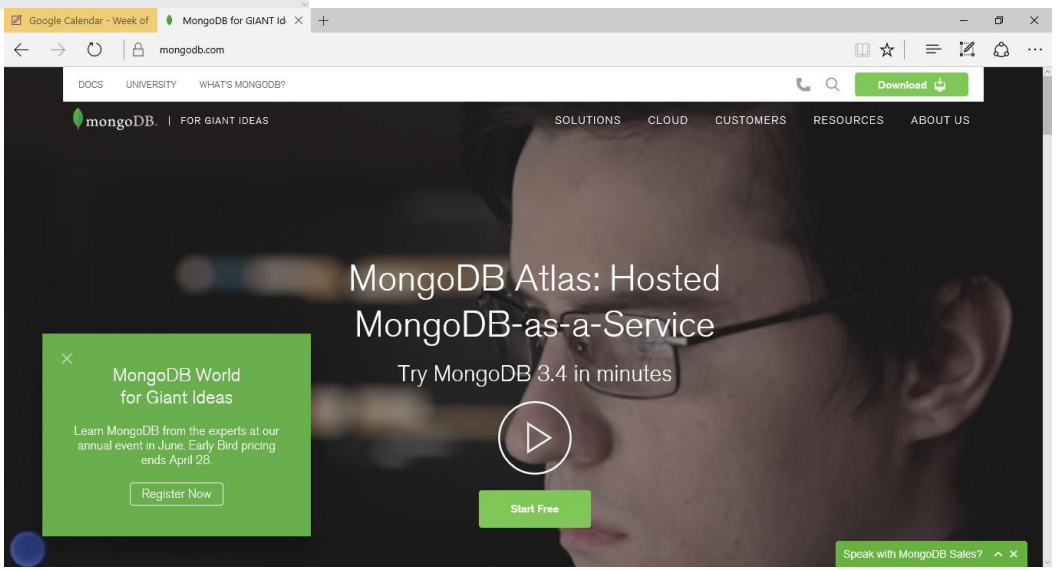
```
Post.findById('5510117c1a9f03cd1ed38a6c', function (err,p){
        p.comments.id('551020f317bf07692231caed').remove()
        p.save (function (err) {
            if (err) {
                console.log(p)
            } else {
                console.log('comment removed')
            }
            process.exit()
        })
} )
```

MongoDB as a Service

- Best practice for initial development is to host MongDB process on your development machine
- In production environments, Mongo will be hosted:
  - on it’s own instance or
  - provisioned as a service

MongoDB as a Service





MongoDB as a Service

- Most providers allow free access teir
- Provide user credentials wrapped in a URL
- All you need to do is update your config with the relevant URL
- Careful to ignore credentials when pushing to github/public repo