Node.js: MVC Architecture MongoDB Introduction

Week 8 Lecture

Outline

- Implementing MVC basics
  - Application Folder Structure
  - CommonsJS modules
  - Controller and Routers
- Session Management
- Database layer

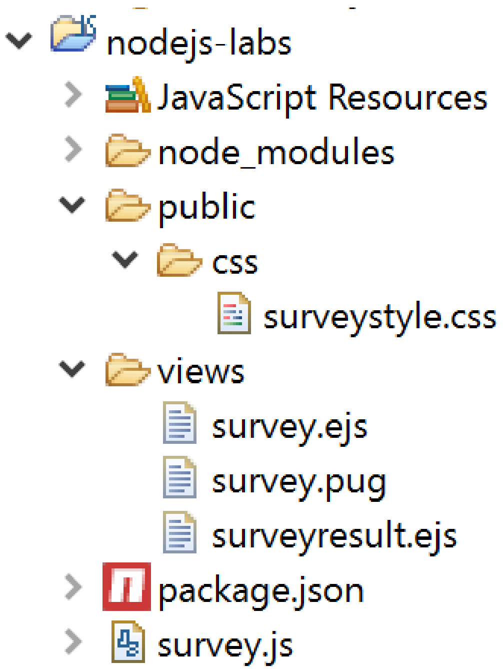
The small app in week 6 lab

```
var express = require('express')
var path = require('path')
var bodyParser = require('body-parser');

var app = express()
var products=['iphone 7', 'huawei p9', 'Pixel XL', 'Samsung S7']
var surveyresults = { fp:[0,0,0,0],mp:[0,0,0,0]}
app.use(express.static(path.join(__dirname, 'public')));
app.use(bodyParser.json())
app.use(bodyParser.urlencoded())
app.set('views', path.join(__dirname,'views'));

app.get('/', function(req,res){
    res.render('survey.pug',{products:products})
});

app.post('/survey', function(req,res){
    console.log(req.body);
    gender = req.body.gender
    …
    res.render('surveyresult.ejs', {products: products, surveyresults: surveyresults})
});
app.listen(3000, function () {
  console.log('survey app listening on port 3000!')
})
```

Application scope variables

Request scope variables

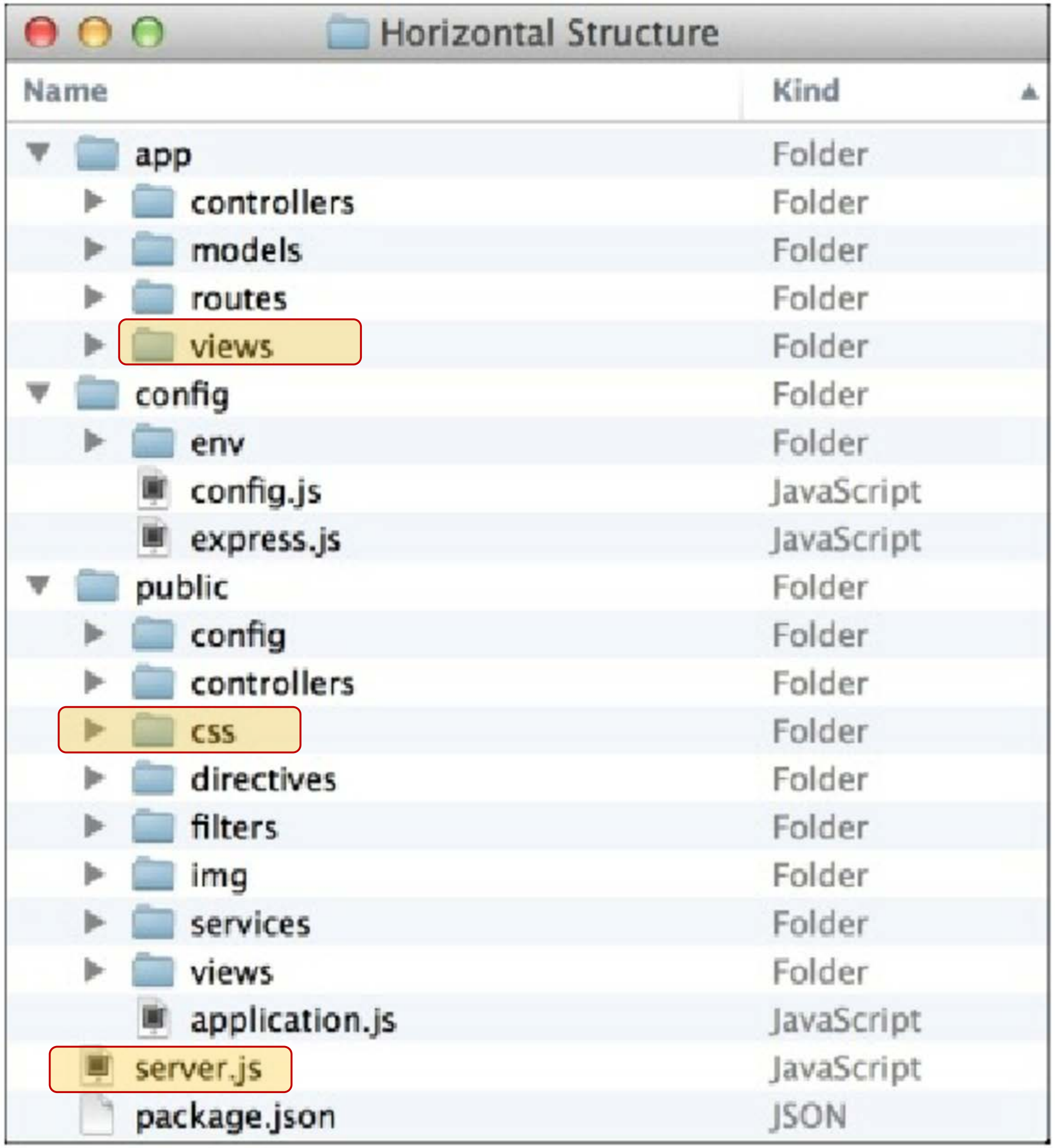
Several Issues



```
nodejs-labs
  JavaScript Resources
  node_modules
  public
    css
      surveystyle.css
  views
    survey.ejs
    survey.pug
    surveyresult.ejs
  package.json
  survey.js
```

- There is a *single* JS file with all settings and route methods
- Large application will have many route methods and some are related
  - Modular controller and route mappings
- Data sharing
  - Application scope variable
  - Request scope variable
  - Session scope variable
- We don’t have separated model yet!

Application folder structure



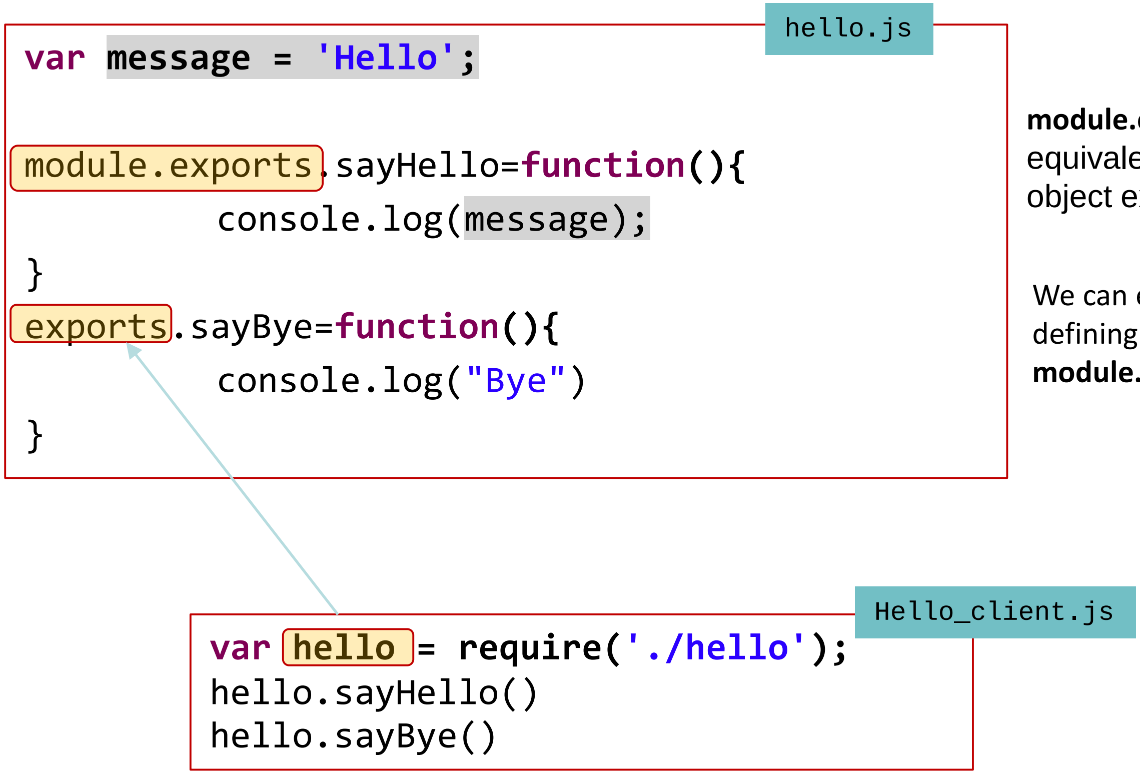
Horizontal Structure

Name	Kind
app	Folder
controllers	Folder
models	Folder
routes	Folder
views	Folder
config	Folder
env	Folder
config.js	JavaScript
express.js	JavaScript
public	Folder
config	Folder
controllers	Folder
css	Folder
directives	Folder
filters	Folder
img	Folder
services	Folder
views	Folder
application.js	JavaScript
server.js	JavaScript
package.json	JSON

CommonsJS module standard

- A file based module system to solve JavaScript single global namespace issue
  - Each file is its own module
- Three key components:
  - **requires():** this method is used to load the module into the current code
    - Eg: require(express)
  - **exports**: this object is contained in each module and allows you to expose piece of your code when the module is loaded.
  - **module**: refers to the current module definition (metadata).

Writing our own module



hello.js

```
var message = 'Hello';

module.exports.sayHello=function(){
        console.log(message);
}
exports.sayBye=function(){
        console.log("Bye")
}
```

Hello_client.js

```
var hello = require('./hello');
hello.sayHello()
hello.sayBye()
```

module.exports and **exports** are equivalent, both referring to the object exposed by the module

We can expose many methods by defining them as properties of the **module.exports** object.

Calling **require(…)** in the client code would return the **modules.exports** object. Our h which has exposed two methods

Writing Controller(s)

survey.server.controller.js

```
var express = require('express')

module.exports.showForm=function(req,res){
    products = req.app.locals.products
    res.render('survey.pug',{products:products})
}

module.exports.showResult=function(req,res){
    console.log(req.body);
    gender = req.body.gender
    productidx = req.body.vote;
    products = req.app.locals.products;
    surveyresults = req.app.locals.surveyresults;
    if (gender == 0)
        surveyresults.mp[productidx]++;
    else
        surveyresults.fp[productidx]++;
    res.render('surveyresult.pug', {products: products,
           surveyresults: surveyresults})
}
```

This controller module exposes two methods: **showForm** is used for displaying the form; **showReulsult** is used for showing the results

The methods are not mapped to URL yet

`req.app.locals` is used to share application scope variables

Each request object has a reference to the current running express application: **req.app**

`app.locals` is used to store properties that are local variables within the application (application scope data)

Mapping Controller to URL

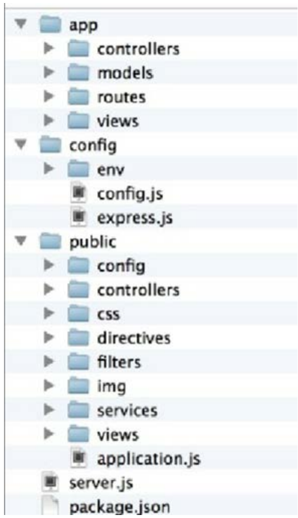
survey.server.routes.js

```
var express = require('express')
var controller = require('../controllers/survey.server.controller')
var router = express.Router()

router.get('/', controller.showForm)
router.post('/survey', controller.showResult)
module.exports = router
```

server.js

```
var express = require('express');
var path = require('path')
var bodyParser = require('body-parser');

var survey = require('../routes/survey.server.routes')

var app = express()
app.locals.products=['iphone 7', 'huawei p9', 'Pixel XL', 'Samsung S7']
app.locals.surveyresults = {
    fp:[0,0,0,0], mp:[0,0,0,0]
}

app.set('views', path.join(__dirname,'views'));
app.use(express.static(path.join(__dirname, 'public')));
app.use(bodyParser.json())
app.use(bodyParser.urlencoded())
app.use('/survey', survey)
app.listen(3000, function () {
  console.log('survey app listening on port 3000!')
})
```

Set the two application scope variables



```
▼ app
    ▶ controllers
    ▶ models
    ▶ routes
    ▶ views
▼ config
    ▶ env
      config.js
      express.js
▼ public
    ▶ config
    ▶ controllers
    ▶ css
    ▶ directives
    ▶ filters
    ▶ img
    ▶ services
    ▶ views
      application.js
  server.js
  package.json
```

Get request send to /survey will display the form

Post request send to /survey/survey will show the result

Outline

- Implementing MVC basics
  - Application Folder Structure
  - CommonsJS modules
  - Controller and Routers
- **Session Management**
- Database layer

Variable Scopes

- *Application scope* data is available through out the application
- *Request scope* data is available just to components handling the current request (controller, view, model)
- **Session scope** data is available across multiple related requestions
  - When a user logs in to web mail server, all subsequent requests are within a session until session expires or user logs out
  - Many websites, eg. Ecommerce web site creates default session for users that expires are a predefined period of inactivitiy.
  - Session management is implemented as middleware function in module **express-session**

Session

- Session is a mechanism to associate a series of requests coming from a client.
    - A conversational state between the client and the server
- HTTP is stateless
    - By default, each request is a session!
    - To maintain a conversational state
        - A server needs to remember what has been going on for EACH client
        - A client needs to send some data to identify self
        - Also a mechanism to control the start/end of a session

How does session work in general

- Client sends the first request
- The server creates an ID for the client and a session object to store session data, the ID is associated with the object
  - A server can maintain many sessions simultaneously hence multiple session objects, each with an ID to identify it
- The server executes predefined business logic for that request and sends back the response together with the ID to the client
- The client stores the ID and associates it with the server
  - A client may maintain many sessions with different servers simultaneously, hence it is important to remember which ID belongs to which server
- When the client sends a second request to this server, it attaches the ID with the request
- The server extracts the ID and use it to find the session data associated with this particular client and make it available to the current request

On the server side

- How can server remembers client state?
  - An object to hold conversational state across multiple requests from the same client identified by a key or ID.
  - It stays for an entire session with a specific client
  - We can use it to store everything about a particular client.
  - Stay in memory mostly but can be persisted in a database

Where does clients stores the ID?

- A cookie is a small piece of information stored on a client’s computer by the **browser**
- Each browser has its own way to store cookies either in a **text file** or in a **lightweight database**
- Each browser manages its own cookies.
- Since a browser stores cookies from various websites, it also needs a way to identify cookie for a particular site.
- Cookies are identified by {name, domain, path}
- The following are two cookies from different domain

cookie 1
name = **connect.id**
value = s%3AKTObttJqW0k6aVrHB
domain = **localhost**
path = ***/***

cookie 2
name = **name**
value = Joe
domain = **web.it.usyd.edu.au**
path = **/~comp5347/doc/**

Associate web sites/pages and Cookies

- Browser would associate/send all cookies in the URL scope:
  - cookie-domain is domain-suffix of URL-domain, and
  - cookie-path is prefix of URL-path
- An example
  - Page http://web.cs.usyd.edu.au/~comp5347/doc/cookie.html will have cookie 2 and 3, cookie 1 is not associated with this page

cookie 1
name = **name**
value = Paul
domain = web.it.usyd.edu.au
path = **/~info5010/comp5347/**

cookie 2
name = **name**
value = Joe
domain = web.cs.usyd.edu.au
path = /~comp5347/doc/

cookie 3
name = _utma
value = 223117855…
domain =.usyd.edu.au
path = **/**

express-session

- Express application’s session management is implemented as middleware function in module **express-session**
- Module **express-session** uses cookie based session management where a small cookie is created to store session id.
  - Cookies are managed by browsers, different browsers have different cookie store
    - If a user visits the same web site using two different browsers at the same time, the users’ requests would be put into two sessions

Session aware survey

- Requirements: to prevent abuse of the survey system, we want to ensure that a user cannot vote more than once in a certain period of time (session expire period) ‘using the same browser’.
- Simple solution:
  - add a session scope variable **vote** to store a user’s previous vote
  - Each time a user clicks the submit bottom, check if variable **vote** exists, if true, discard the current vote; else, set the variable to the current vote in session scope and update the results.
  - Session scope (object) is accessible to all request as: **req.session**

Session-aware survey

surveysession.server.controller.js

```
var express = require('express')

module.exports.showForm=function(req,res){
    products = req.app.locals.products
    res.render('surveysession.pug',{products:products})
}

module.exports.showResult=function(req,res){
    gender = req.body.gender
    productidx = req.body.vote;
    products = req.app.locals.products;
    surveyresults = req.app.locals.surveyresults;
    sess=req.session;
    if ("vote" in sess)
        res.render('surveysessionresult.pug', {products: products, surveyresults: surveyresults})
    else{
        sess.vote = productidx;
        gender = req.body.gender
        productidx = req.body.vote;
        if (gender == 0)
            surveyresults.mp[productidx]++;
        else
            surveyresults.fp[productidx]++;
        res.render('surveysessionresult.pug', {products: products, surveyresults: surveyresults})
    }
}
```

Routes and server.js

surveysession.server.routes.js

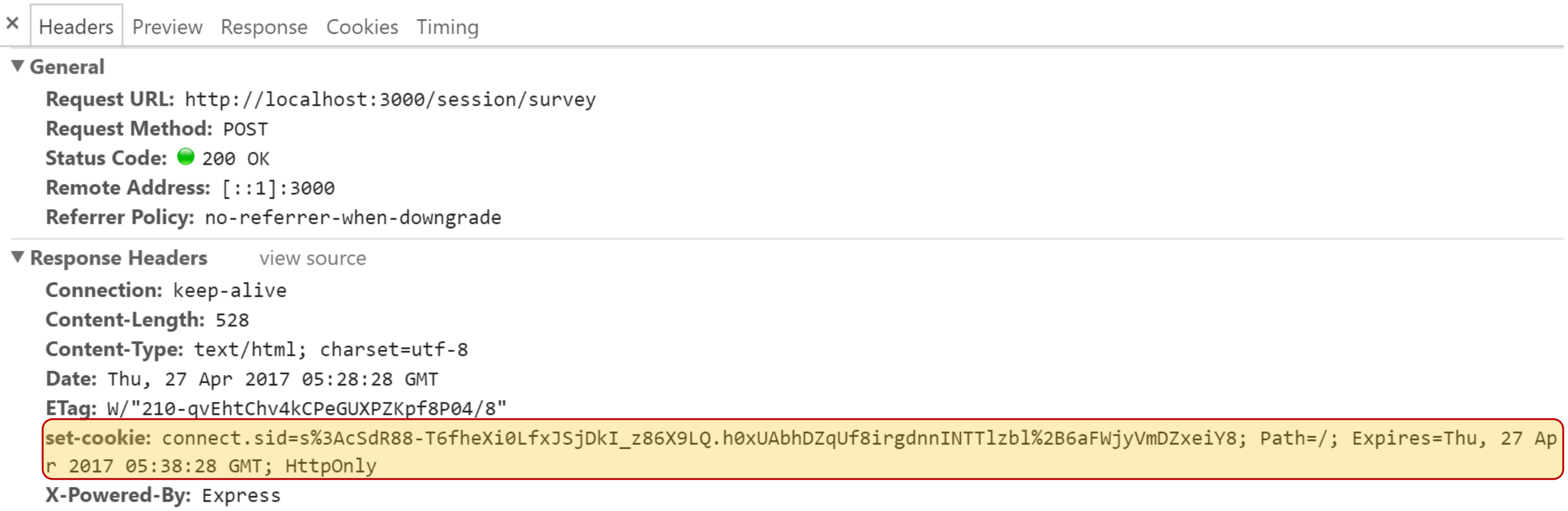
```
var express = require('express')
var router = express.Router()
var controller = require('../controllers/surveysession.server.controller')

router.get('/', controller.showForm)
router.post('/survey', controller.showResult)
module.exports = router
```

server.js

```
var express = require('express');
var path = require('path')
var bodyParser = require('body-parser');
var session = require('express-session');

var surveysession = require('./routes/surveysession.server.routes')

var app = express()
app.locals.products=['iphone 7', 'huawei p9', 'Pixel XL', 'Samsung S7']
app.locals.surveyresults = {fp:[0,0,0,0],mp:[0,0,0,0]}

app.set('views', path.join(__dirname,'views'));
app.use(express.static(path.join(__dirname, 'public')));
app.use(bodyParser.json())
app.use(bodyParser.urlencoded())
app.use(session({secret: 'ssshhhhh',cookie:{maxAge:600000}}));
app.use('/session',surveysession)
app.listen(3000, function () {
  console.log('survey app listening on port 3000!')
})
```

The session will expire in 30 minutes

Cookies sent by server

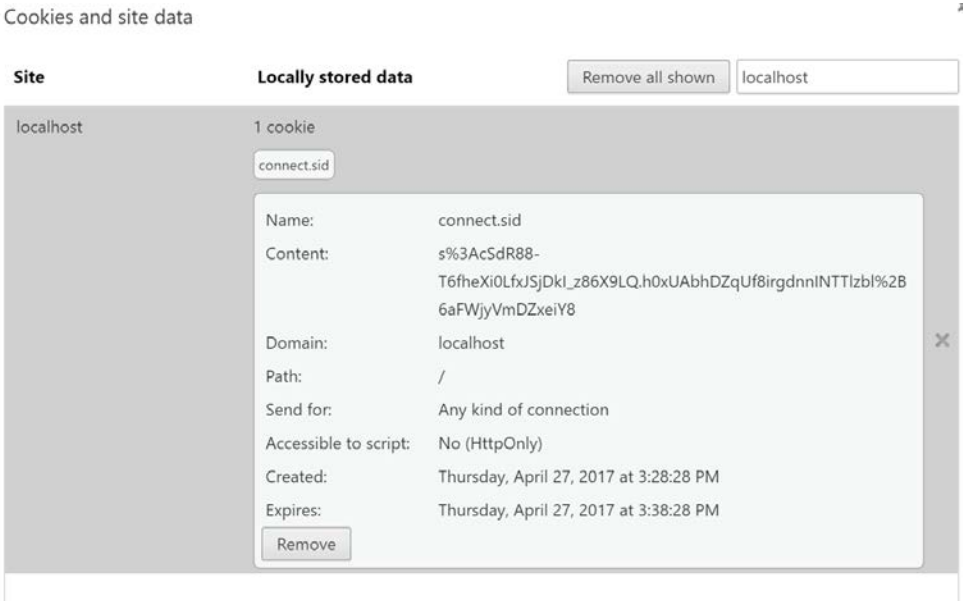


▼ **General**

Request URL: `http://localhost:3000/session/survey`
Request Method: `POST`
Status Code: ● `200 OK`
Remote Address: `[::1]:3000`
Referrer Policy: `no-referrer-when-downgrade`

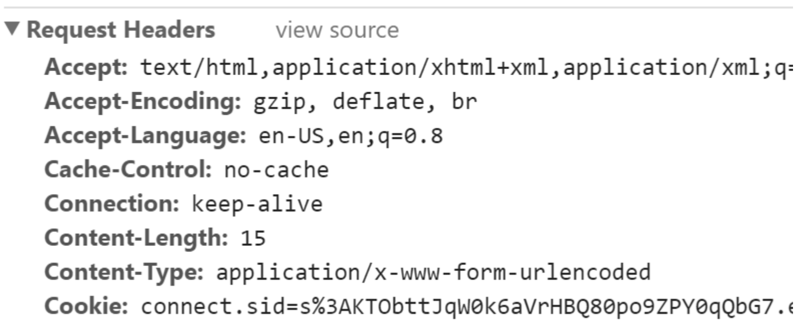
▼ **Response Headers** view source

Connection: `keep-alive`
Content-Length: `528`
Content-Type: `text/html; charset=utf-8`
Date: `Thu, 27 Apr 2017 05:28:28 GMT`
ETag: `W/"210-qvEhtChv4kCPeGUXPZKpf8P04/8"`
set-cookie: `connect.sid=s%3AcSdR88-T6fheXi0LfxJSjDkI_z86X9LQ.h0xUAbhDZqUf8irgdnnINTTlzbl%2B6aFWjyVmDZxeiY8; Path=/; Expires=Thu, 27 Apr 2017 05:38:28 GMT; HttpOnly`
X-Powered-By: `Express`


Cookies and site data

Site	Locally stored data
localhost	1 cookie connect.sid

Name:	connect.sid
Content:	s%3AcSdR88-T6fheXi0LfxJSjDkI_z86X9LQ.h0xUAbhDZqUf8irgdnnINTTlzbl%2B6aFWjyVmDZxeiY8
Domain:	localhost
Path:	/
Send for:	Any kind of connection
Accessible to script:	No (HttpOnly)
Created:	Thursday, April 27, 2017 at 3:28:28 PM
Expires:	Thursday, April 27, 2017 at 3:38:28 PM


▼ **Request Headers** view source

Accept: `text/html,application/xhtml+xml,application/xml;q=`
Accept-Encoding: `gzip, deflate, br`
Accept-Language: `en-US,en;q=0.8`
Cache-Control: `no-cache`
Connection: `keep-alive`
Content-Length: `15`
Content-Type: `application/x-www-form-urlencoded`
Cookie: `connect.sid=s%3AKTObttJqW0k6aVrHBQ80po9ZPY0qQbG7.`

Outline

- Implementing MVC basics
  - Application Folder Structure
  - CommonsJS modules
  - Controller and Routers
- Session Management
- **Database layer**

NoSQL Brief Introduction

- NoSQL (Not Only SQL) is a term used to encompass the general trend of a new generation of database servers.
  - These servers were created in response to challenges that were not being met by traditional SQL (Structured Query Language)
  - Scalability, flexible schema, object relational mismatch, etc
- Broad categories of NoSQL systems
  - Document Storage (e.g. MongoDB)
  - Key-Value Storage
  - Column based Storage
  - Graph database

Document Storage and MongoDB

- Document storage system is based on the concept of *self describing* documents.
  - Each entity is stored as a document as opposed to record(row) in typical SQL
  - Two dominant self-describing document formats
    - XML
    - JSON (JavaScript Object Notation)

```
Invoice _1= {   customer: {name: “John”, address: “Sydney”},
                product: { code: “123”, quantity: 2}
              }
```

```
Invoice _2= {   customer: {name: “Smith”, address: “Melbourne”},
                  product: { code: “xyz”, quantity: 20},
                  delivery: “express”
               }
```

JSON Data Format

- JSON (**J**ava**S**cript **O**bject **N**otation) is a simple way to represent JavaScript objects as strings.
- JSON was introduced in 1999 as an alternative to XML for data exchange.
  - It replaces XML for data storage as well
- Each JSON object is represented as a list of property names and values contained in curly braces, in the following format:

```
{ propertyName1 : value1, propertyName2 : value2 }
```

- Arrays are represented in JSON with square brackets in the following format:

```
[ value1, value2, value3 ]
```

Matching Terms in SQL and MongoDB

SQL	**MongoDB**
Database	Database
Table	Collection
Index	Index
Row	BSON document
Column	BSON field
Primary key	`_id` field
Join	Embedding and referencing $lookup in aggregation (since 3.2)

MongoDB Document Model

`users` table in RDBMS

Column name is part of schema

TFN	Name	Email	age
12345	Joe Smith	joe@gmail.com	30
54321	Mary Sharp	mary@gmail.com	27

two rows

```
{ _id: 12345,
  name: “Joe Smith”,
  email: “joe@gmail.com”,
  age: 30
}
```

```
{ _id: 54321,
  name: “Mary Sharp”,
  email: “mary@gmail.com”,
  age: 27
}
```

two documents

Field name is part of data

Native Support for Array

```
{ _id: 12345,
  name: “Joe Smith”,
  emails: [“joe@gmail.com”, “joe@ibm.com”],
  age: 30
}
```

```
{ _id: 54321,
  name: “Mary Sharp”,
  email: “mary@gmail.com”,
  age: 27
}
```

TFN	Name	Email	age
12345	Joe Smith	joe@gmail.com , joe@ibm.com ??	30
54321	Mary Sharp	mary@gmail.com	27

Native Support for Embedded Document

```
{ _id: 12345,
  name: “Joe Smith”,
  email: [“joe@gmail.com”, “joe@ibm.com”],
  age: 30
}
```

```
{ _id: 54321,
  name: “Mary Sharp”,
  email: “mary@gmail.com”,
  age: 27,
  address: { number: 1,
                  name: “cleveland street”,
                  suburb: “chippendale”,
                  zip: 2008
                }
}
```

TFN	Name	Email	age	address
12345	Joe Smith	joe@gmail.com	30	
54321	Mary Sharp	mary@gmail.com	27	1 cleveland street, chippendale, NSW 2008

MongoDB data types

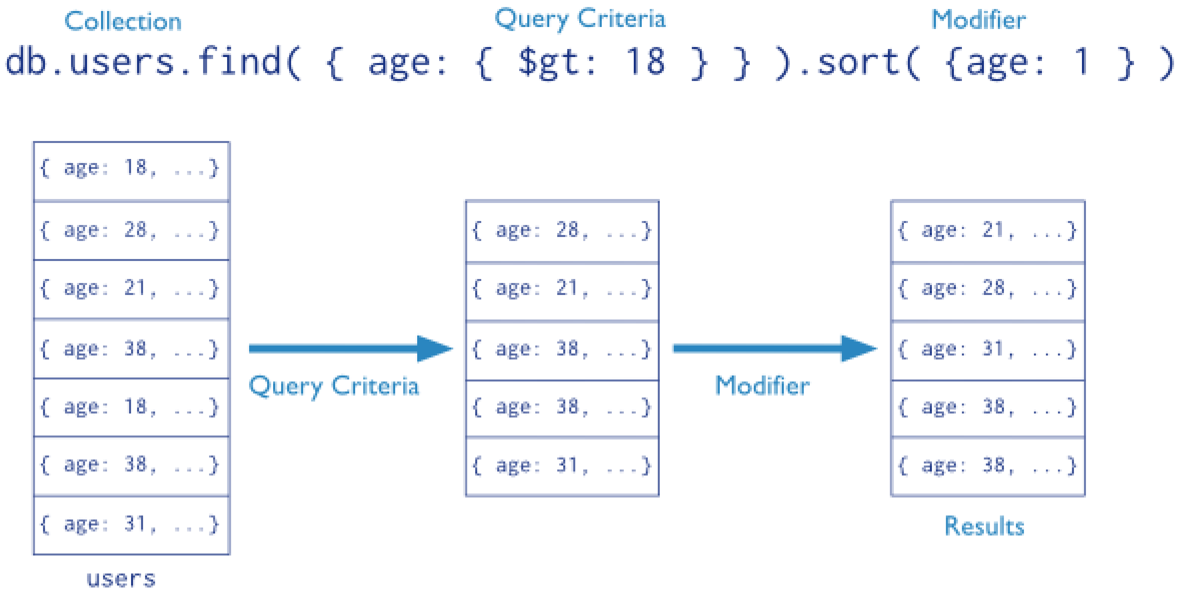
- Primitive types
  - String, integer, boolean (true/false), double, null
- Predefined special types
  - Date, object id, binary data, regular expression, timestamp, and a few more
  - DB Drivers implement them in language-specific way
  - The interactive shell provides constructors for all
    - ISODate(“2012-09-11 18:00:00”)
- Array and object
- Field name is of **string** type with certain restrictions
  - “_id” is reserved for primary key
  - cannot start with “$”, cannot contain “.” or null

MongoDB Queries

- In MongoDB, a ***read*** query targets a specific collection. It specifies **criteria**, and may include a **projection** to specify fields from the matching documents; it may include **modifier** to limit, skip, or sort the results.

- A ***write*** query may *create*, *update* or *delete* data. One query modifies the data of a single collection. Update and delete query can specify query **criteria**

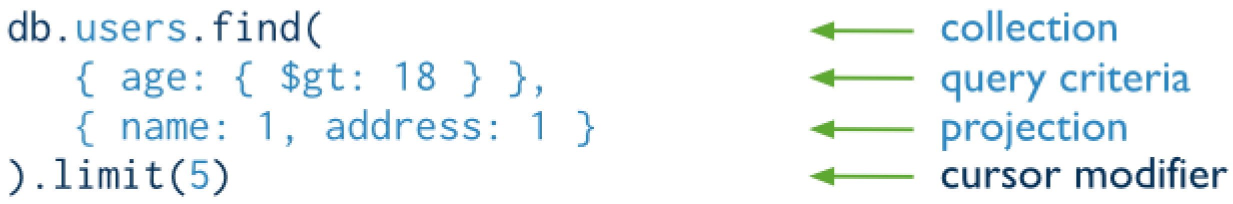
Read Query Example



Find documents in the **users** collection with **age** field greater than 18, sort the results in ascending order by **age**

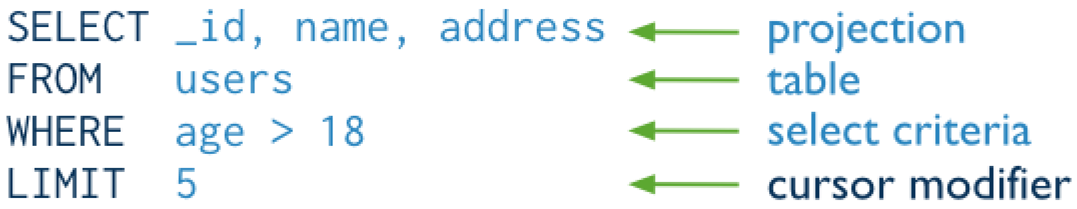
Read Query Interface

- db.collection.find()



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

Find at most 5 documents in the **users** collection with **age** field greater than 18, return only the name and address field of each document.



```
SELECT _id, name, address  ←  projection
FROM   users               ←  table
WHERE  age > 18            ←  select criteria
LIMIT  5                   ←  cursor modifier
```

Read Query Features

- Users can find data using any criteria in MongoDB
  - Does not require indexing
  - Indexing can improve performance (next week)
  - JOIN is not supported in read query!!
- Query **criteria** are expressed as BSON document (query object)
  - Individual is expressed using predefined selection operator, eg. **$lt** is the operator for “greater than”
- Query **projection** are expressed as BSON document as well

SQL	MongoDB Query in Shell
select * from user	db.user.find() or db.user.find({})
select name, age from user	db.user.find({},{name:1,age:1,_id:0})
select * from user where name = “Joe Smith”	db.user.find({name: “Joe Smith”})
select * from user where age < 30	db.user.find({age: {$lt:30}})

Querying Array field

- Querying array field is similar to querying simple type field
  - db.user.find({emails: “joe@gmail.com”})
    - Find a user whose email include “joe@gmail.com”.
  - db.user.find({“emails.0”: “joe@gmail.com”})
    - Find a user whose first email is “joe@gmail.com”.

```
{ _id: 12345,
  name: “Joe Smith”,
  emails: [“joe@gmail.com”, “joe@ibm.com”],
  age: 30}
```

```
{ _id: 54321,
  name: “Mary Sharp”,
  email: “mary@gmail.com”,
  age: 27}
```

http://docs.mongodb.org/manual/tutorial/query-documents/#arrays

Querying Embedded Document

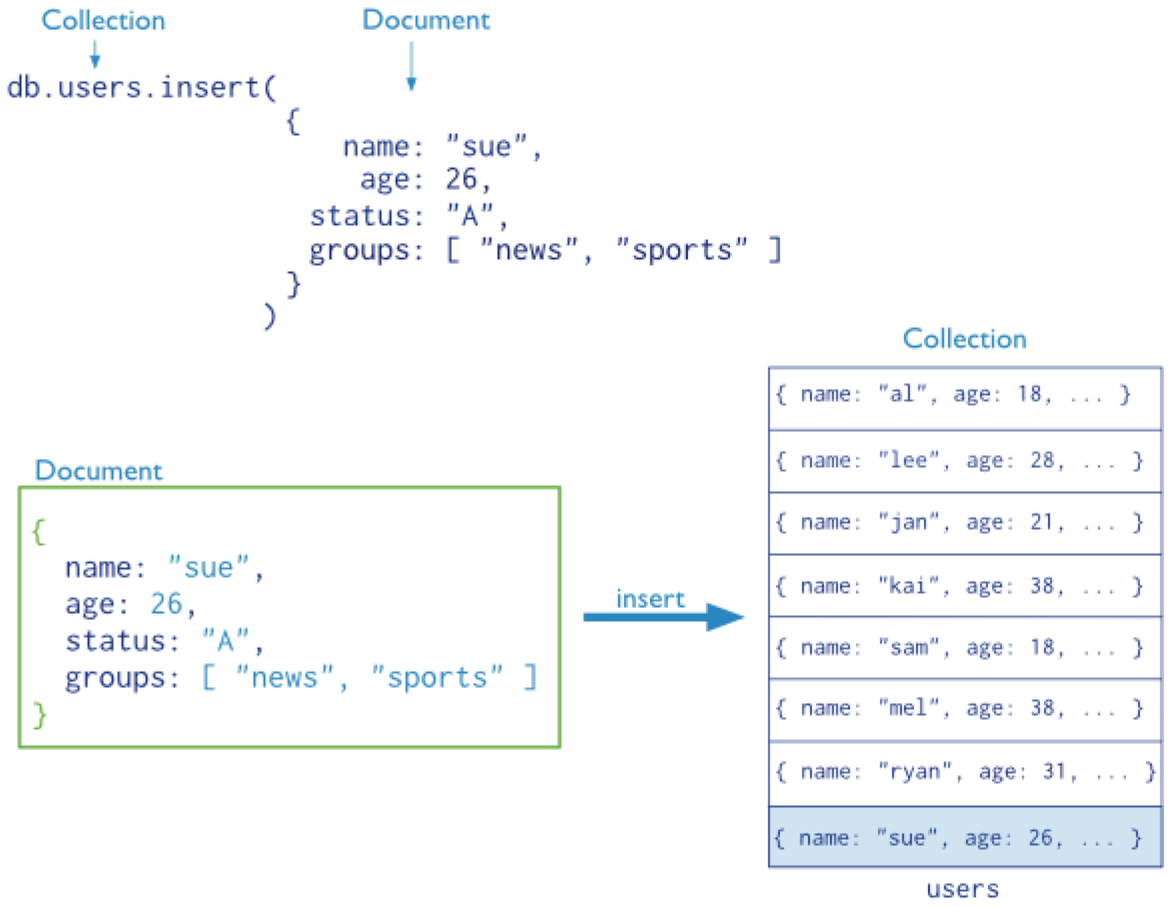
- Embedded Document can be queried as a **whole**, or by **individual field**, or by **combination of individual fields**
  - db.user.find({**address**: {number: 1, name: “pine street”, suburb: “chippendale”, zip: 2008}})
  - db.user.find({**“address.suburb”:** “chippendale”})
  - db.user.find({**address**: {**$elemMatch**: {name: “pine street”, suburb: “chippendale”}}})

```
{ _id: 12345,
  name: “Joe Smith”, email: [“joe@gmail.com”, “joe@ibm.com”], age: 30,
  address: {number: 1, name: “pine street”, suburb: “chippendale”, zip: 2008 }
}
```

```
{ _id: 54321,
  name: “Mary Sharp”, email: “mary@gmail.com”,age: 27,
  address: { number: 1, name: “cleveland street”,suburb: “chippendale”,zip: 2008 }
}
```

http://docs.mongodb.org/manual/tutorial/query-documents/#embedded-documents

Write Query- Insert



```
db.users.insert(
                 {
                    name: "sue",
                     age: 26,
                  status: "A",
                  groups: [ "news", "sports" ]
                 }
               )
```

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

```
{ name: "al", age: 18, ... }
{ name: "lee", age: 28, ... }
{ name: "jan", age: 21, ... }
{ name: "kai", age: 38, ... }
{ name: "sam", age: 18, ... }
{ name: "mel", age: 38, ... }
{ name: "ryan", age: 31, ... }
{ name: "sue", age: 26, ... }
```

Insert a new document in **users** collection.

Insert Example

- db.user.insert({**_id: 12345**, name: “Joe Smith”, emails: [“joe@gmail.com”, “joe@ibm.com”],age: 30})
- db.user.insert({ _id: 54321, name: “Mary Sharp”, email: “mary@gmail.com”, age: 27,
  address: { number: 1, name: “cleveland street”, suburb: “chippendale”, zip: 2008}})

user collection

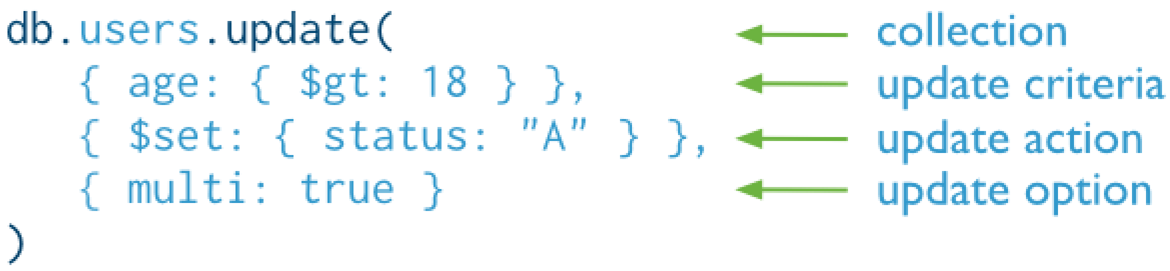
```
{ _id: 12345, name: “Joe Smith”,
  emails: [“joe@gmail.com”, “joe@ibm.com”],
age: 30
}
```

```
{ _id: 54321,
  name: “Mary Sharp”, email: “mary@gmail.com”, age: 27,
  address: { number: 1,
                  name: “cleveland street”,
                  suburb: “chippendale”,
                  zip: 2008
               }
}
```

Insert Behavior

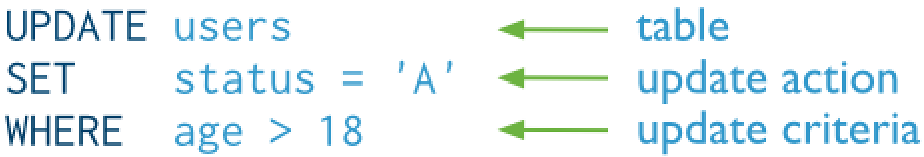
- If the new document does not contain an “**_id**” field, the system will adds an “**_id**” field and assign a unique value to it.
- If the new document does contain an “**_id**” field, it should have a unique value

Write Operation - Update



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

Has the same effect as the following SQL:



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

Updates operators

- Modifying simple field: $set, $unset
  - db.user.update({_id: 12345}, {$set: {age: 29}})
  - db.user.update({_id:54321}, {$unset: {email:1}}) // remove the field
- Modifying array elements: $push, $pushAll, $pull, $pullAll
  - db.user.update({_id: 12345}, {$push: {emails: “joe@hotmail.com”}})
  - db.user.update({_id: 54321},

    {$pushAll: {emails: [“mary@gmail.com”, “mary@microsoft.com”]}})
  - db.user.update({_id: 12345}, {$pull: {emails: “joe@ibm.com”}})

{ **_id: 12345**, name: “Joe Smith”, emails: [“joe@gmail.com”, “joe@ibm.com”], age: 30}	{ **_id: 12345**, name: “Joe Smith”, emails: [“joe@gmail.com”, “joe@hotmail.com”], age: 29}
{ **_id: 54321**, name: “Mary Sharp”, email: “mary@gmail.com”, age: 27}	{ **_id: 54321**, name: “Mary Sharp”, emails: [“mary@gmail.com”, “mary@microsoft.com”] age: 27}

http://www.mongodb.org/display/DOCS/Updating

Write Operation - Delete

- db.user.remove();
  - Remove all documents in user collection
- db.user.remove({_id: 12345})
  - Remove document with a particular id from user collection

Aggregation

- Simple and relatively standard data analytics can be achieved through **aggregation**
  - Grouping, summing up value, counting, sorting, etc
  - Running on the DB engine instead of application layer

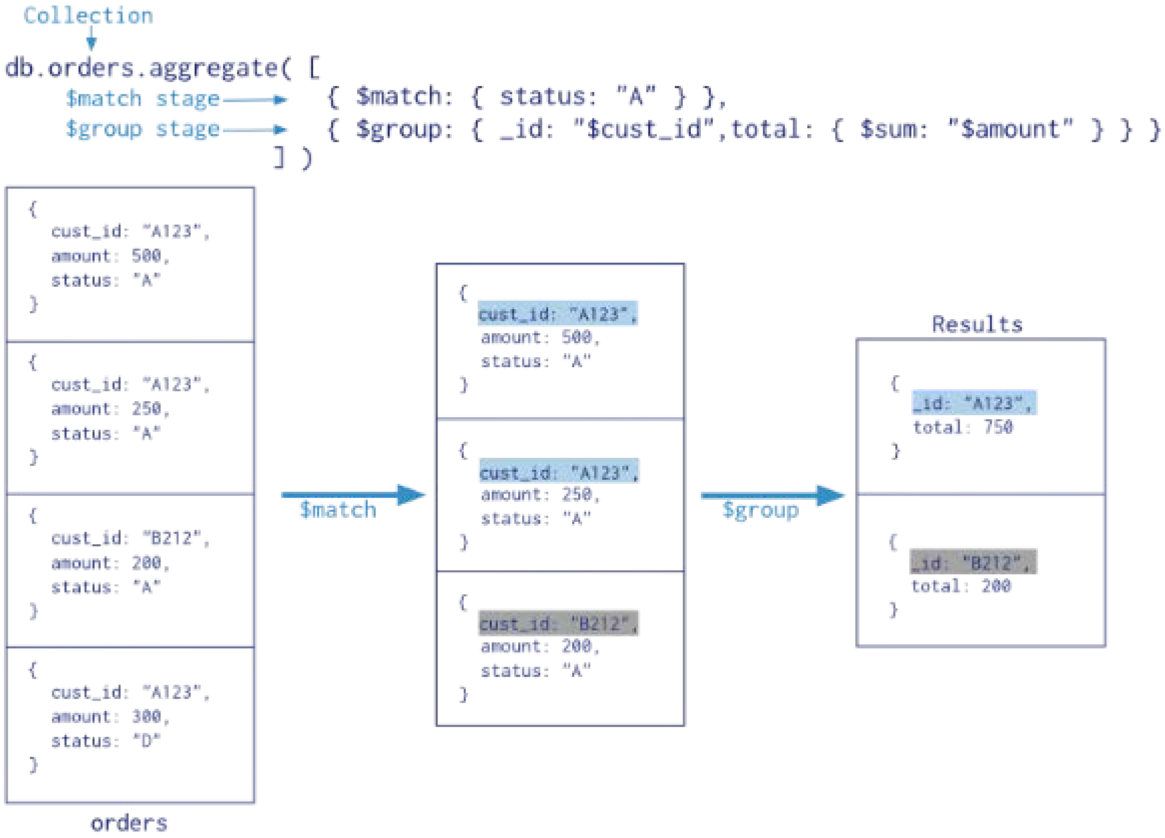
- Several options
  - Aggregation Pipeline
  - MapReduce
    - Through JavaScript Functions
    - Performance is not as good as aggregation pipeline for simple aggregation tasks
    - Is able to do customized aggregations

Aggregation Pipeline

- Aggregation pipeline consists of multiple stages
  - Stages are specified using **pipeline operators** such as **$match, $group, $sort** and so on
    - This is similar to SQL’s WHERE, GROUP BY, SORT BY etc
    - Each stage is expressed as an object enclosed by curly bracket
  - Various **expressions** can be specified in each stage
    - To filter documents or to perform simple calculation on an document
      - $substr, $size, etc, …
  - **$group** stage can specify **accumulators** to perform calculation on documents with the same group key

```
db.collection.aggregate( [
          { pipeline operator: {expression/accumulator,…, expression/accumulator} },
          { pipeline operator: {expression/accumulator,…, expression/accumulator} },
          ...
          ] )
```

Aggregation Example



```
db.orders.aggregate( [
    { $match: { status: "A" } },
    { $group: { _id: "$cust_id",total: { $sum: "$amount" } } }
] )
```

```
{
  cust_id: "A123",
  amount: 500,
  status: "A"
}
{
  cust_id: "A123",
  amount: 250,
  status: "A"
}
{
  cust_id: "B212",
  amount: 200,
  status: "A"
}
{
  cust_id: "A123",
  amount: 300,
  status: "D"
}
```

```
{
  cust_id: "A123",
  amount: 500,
  status: "A"
}
{
  cust_id: "A123",
  amount: 250,
  status: "A"
}
{
  cust_id: "B212",
  amount: 200,
  status: "A"
}
```

```
{
  _id: "A123",
  total: 750
}
{
  _id: "B212",
  total: 200
}
```

```
select  cust_id as _id, SUM(amount) as total
        from orders
        where  status = “A”
        group by cust_id
```

Aggregation Behaviour

- It operates on a single collection (before 3.2)
  - Join can be performed using a particular operator **$lookup**
- It logically passes the *entire* collection into the pipeline
- Early filtering can improve the performance
- **$match** and **$sort** operator are able to use index if placed at the beginning of the pipeline

Admin

- Assignment 2
  - Group of up to 3 students
  - Form groups in Elearning
- Week 9
  - We are running one hour lecture + two hours supervised lab on week 9
    - Tuesday labs will be from 7-9pm
    - Wednesday labs will be changed to Thursday 4-6pm in SIT lab 457
      - We cannot find any lab with two hour block before 6pm next Wednesday!

Resources

- Haviv, Amos Q, MEAN Web Development
  - E-book, accessible from USYD library
  - Chapter 4 and 5
- MongoDB online documents:
  - MongoDB CRUD Operations
    - http://docs.mongodb.org/manual/core/crud-introduction/
  - MongoDB Aggregation
    - http://docs.mongodb.org/manual/core/aggregation-introduction/
- COM5338@2016 slides by Ying