MONGODB

a NoSQL, document-oriented database

DATABASES

organized collections of data

Database Models

NAVIGATIONAL

1960s

linked list of free-form records

hash on a primary key, linearly scan through a linked list

en.wikipedia.org/wiki/Database

RELATIONAL, SQL

1970s

split data into a series of **normalized** tables

use **joins** to combine data in different tables together

en.wikipedia.org/wiki/Database

2000s

Not only Sql $\xrightarrow{}$

NoSQL

fast key-value stores and document-oriented databases (JSON, XML)

do not require fixed table schemas, no support for joins

scale horizontally

en.wikipedia.org/wiki/Database

Mongo

Databases

Tables

Rows

MongoDB

Databases

Tables

Collections

Rows

Documents

MONGO DOCUMENTS

documents are JSON-like

stored as BSON

documents must be smaller than 16MB

Both of these documents can be stored in the same collection

```
{"type":"llama", height:1.8}
{"type":"camel", height:2.2, humps:2}
```

Why have separate collections?

developers aren’t confused

query efficiency

data locality

indexing (defined per collections)

Data Types

BASIC TYPES

JSON: null, boolean, number, string, array, and object

MongoDB: null, boolean, number, string, array, **date**, **regex**, **embedded document**, **object id**, **binary data**, **code**

EMBEDDED DOCUMENTS

```
{
    "type": "llama",
     "name": "Francesca",
    "height": 1.8,
    "farm": {
      "name": "Silver Lake",
       "owner": "Goldilocks"
    }
}
```

OBJECTIDS

Every document must have an **`"_id"`** key

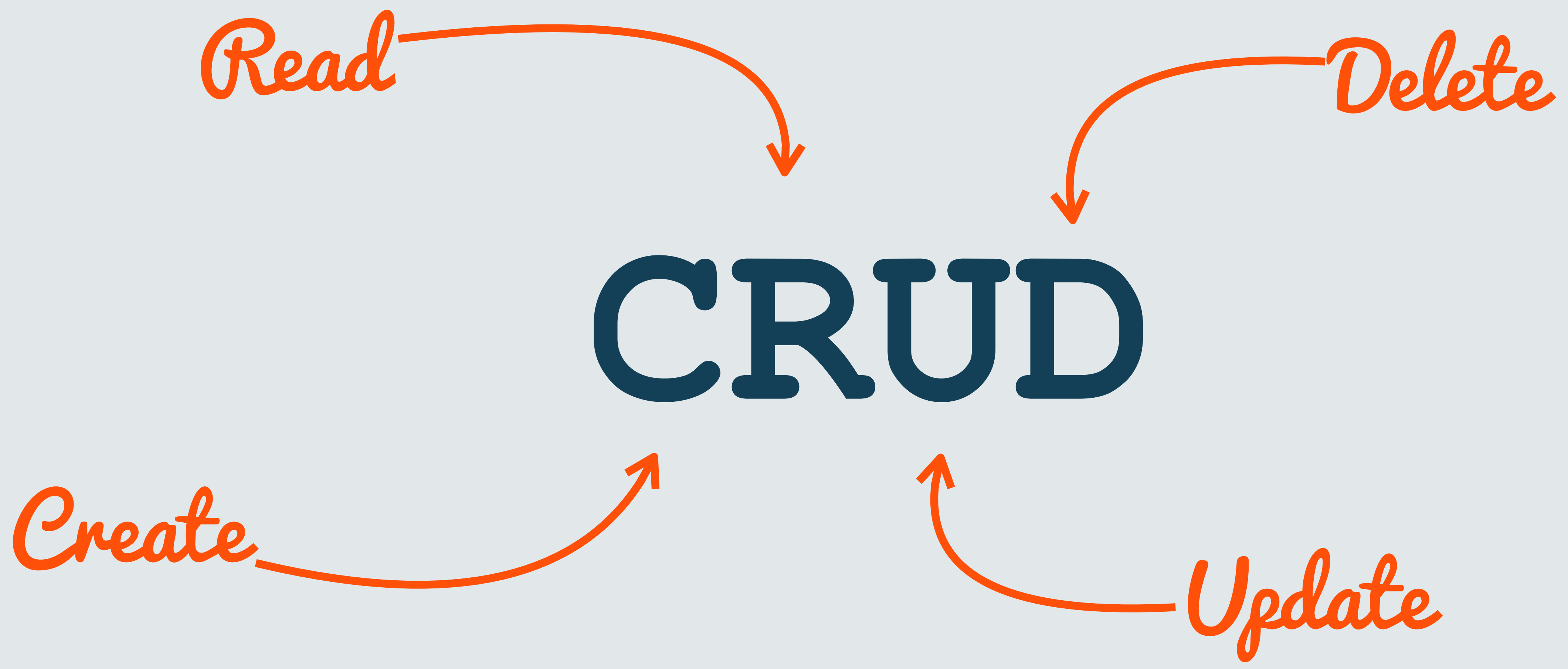
Every document in a collection must have a unique **`"_id"`** key

ObjectId is the default type for **`"_id"`**

OBJECTIDS

0-3	4-6	7-8	9-11
Timestamp	Machine	PID	Increment

~17M unique ObjectIds per process per second


Read
Delete
CRUD
Create
Update

Create

```
> llama = {
      "type": "llama",
      "name": "Francesca",
      "height": 1.8,
      "date" : new Date()
}

> db.camelids.insert(llama);
```

Read

```
> db.camelids.findOne()

{
  "_id" : ObjectId("54fda10dd452eebae749a0b8"),
  "type" : "llama",
  "name" : "Francesca",
  "height" : 1.8,
  "date" : ISODate("2015-03-09T13:32:43.737Z")
}
```

Update

```
> llama.diet = ["grass","hay"]

> db.camelids.update({"type" :
"llama"}, llama)
```

Update

```
> db.camelids.findOne()

{
   "_id" : ObjectId("54fda10dd452eebae749a0b8"),
   "type" : "llama",
   "name" : "Francesca",
   "height" : 1.8,
   "date" : ISODate("2015-03-09T13:32:43.737Z"),
   "diet" : [
      "grass",
      "hay"
   ]
}
```

Delete

```
> db.camelids.remove()
> db.camelids.remove({type : “llama"})
> db.camelids.drop()
```

Update Modifiers

Update

```
> llama.diet = ["grass","hay"]

> db.camelids.update({"type" : "llama"},
llama)

> db.camelids.update({"type" : "llama"},
{"name": "maria"})
```

What does this do?

Update

```
> db.camelids.findOne()

{ "_id" : ObjectId("54fda10dd452eebae749a0b8"),
"name" : "maria" }
```

Use update modifiers to update portions of a document

```
> db.camelids.update({"type" : "llama"},
{"$set": {"name": “maria”}})

> db.camelids.findOne()
{
   "_id" : ObjectId("54fda779d452eebae749a0ba"),
   "date" : ISODate("2015-03-09T14:00:22.530Z"),
   "height" : 1.8,
   "name" : "maria",
   "type" : "llama"
}
```

Use update modifiers to update portions of a document

```
> db.camelids.update({"type" : "llama"},
{"$inc": {"height": 0.2}})

> db.camelids.findOne()
{
   "_id" : ObjectId("54fda779d452eebae749a0ba"),
   "date" : ISODate("2015-03-09T14:00:22.530Z"),
   "height" : 2,
   "name" : "maria",
   "type" : "llama"
}
```

Array Modifiers

$push, $pop, $pull

$each

$sort, $slice

$ne/$push, $addToSet/$each

positional access

Queries and $-Conditionals

QUERYING IN MONGO

find() & findOne()

$-conditionals

queries return db cursor that lazily returns batches of documents

Basic Queries

```
> db.camelids.find()
> db.camelids.find({"type" : "llama"})
> db.camelids.find({"type" : "llama","name" :
"Francesca"})
{
   "_id" : ObjectId("54fda10dd452eebae749a0b8"),
   "type" : "llama",
   "name" : "Francesca",
   "height" : 1.8,
   "date" : ISODate("2015-03-09T13:32:43.737Z")
}
```

Specify which keys to return

```
> db.camelids.findOne({"type":"llama"},
{"_id":0,"name":1})

{ "name" : "maria" }
```

$-Conditionals

```
> db.camelids.findOne({"height":{"$lte"
: 1.5, "$gte" : 1.2}})

> db.camelids.findOne({"type" :
{"$in" : [“llama”,”alpaca"]}})

> db.camelids.find({"$or" : [{"type" :
"alpaca"},{"name" : "Francesca"}])
```

Schema Design

ONE-TO-FEW

```
> db.person.findOne()
{
  name: 'Kate Monster',
  ssn: '123-456-7890',
  addresses : [
     { street: '123 Sesame St', city: 'Anytown', cc: 'USA' },
     { street: '123 Avenue Q', city: 'New York', cc: 'USA' }
  ]
}
```

embedded document

blog.mongodb.org/post/87200945828/6-rules-of-thumb-for-mongodb-schema-design-part-1

ONE-TO-MANY

```
> db.parts.findOne()
{
    _id : ObjectID('AAAA'),
    partno : '123-aff-456',
    name : '#4 grommet',
    qty: 94,
    cost: 0.94,
    price: 3.99
}
```

each **`part`** has own document

blog.mongodb.org/post/87200945828/6-rules-of-thumb-for-mongodb-schema-design-part-1

ONE-TO-MANY

```
> db.products.findOne()
{
    name : 'left-handed smoke shifter',
    manufacturer : 'Acme Corp',
    catalog_number: 1234,
    parts : [
        ObjectID('AAAA'),
        ObjectID('F17C'),
        ObjectID('D2AA'),
        // etc
    ]
```

array of references to `part` documents

blog.mongodb.org/post/87200945828/6-rules-of-thumb-for-mongodb-schema-design-part-1

ONE-TO-MANY

```
> product =
db.products.findOne({catalog_number: 1234});

> product_parts = db.parts.find({_id:
{ $in : product.parts } } ).toArray() ;
```

application-level join

blog.mongodb.org/post/87200945828/6-rules-of-thumb-for-mongodb-schema-design-part-1

ONE-TO-GAZILLION

```
> db.hosts.findOne()
{
    _id : ObjectID('AAAB'),
    name : 'goofy.example.com',
    ipaddr : '127.66.66.66'
}

> db.logmsg.findOne()
{
    time : ISODate("2014-03-28T09:42:41.382Z"),
    message : 'cpu is on fire!',
    host: ObjectID('AAAB')
}
```

parent-referencing

blog.mongodb.org/post/87200945828/6-rules-of-thumb-for-mongodb-schema-design-part-1

ONE-TO-GAZILLION

```
> host = db.hosts.findOne({ipaddr :
'127.66.66.66'});

> last_5k_msg = db.logmsg.find({host:
host._id}).sort({time :
-1}).limit(5000).toArray()
```

application-level join

blog.mongodb.org/post/87200945828/6-rules-of-thumb-for-mongodb-schema-design-part-1

TWO-WAY REFERENCING

```
db.person.findOne()
{
    _id: ObjectID("AAF1"),
    name: "Kate Monster",
    tasks [
        ObjectID("ADF9"),
        ObjectID("AE02"),
        ObjectID("AE73")
        // etc
    ]
}
```

array of references to **`task`** documents

blog.mongodb.org/post/87892923503/6-rules-of-thumb-for-mongodb-schema-design-part-2

TWO-WAY REFERENCING

```
db.tasks.findOne()
{
    _id: ObjectID("ADF9"),
    description: "Write lesson plan",
    due_date:  ISODate("2014-04-01"),
    owner: ObjectID("AAF1")
}
```

reference to **`person`** document

blog.mongodb.org/post/87892923503/6-rules-of-thumb-for-mongodb-schema-design-part-2

DENORMALIZING MANY-TO-ONE

```
> db.products.findOne()
{
    name : 'left-handed smoke shifter',
    manufacturer : 'Acme Corp',
    catalog_number: 1234,
    parts : [
        { id : ObjectID('AAAA'), name : '#4 grommet' },
        { id: ObjectID('F17C'), name : 'fan blade assembly' },
        { id: ObjectID('D2AA'), name : 'power switch' },
        // etc
    ]
}
```

no join required to list `part` names

blog.mongodb.org/post/87892923503/6-rules-of-thumb-for-mongodb-schema-design-part-2

DENORMALIZING MANY-TO-ONE

```
> product = db.products.findOne({catalog_number:
1234});
```

```
> part_ids = product.parts.map( function(doc)
{ return doc.id } );
```

a little more work to application-level join

```
> product_parts = db.parts.find({_id: { $in :
part_ids } } ).toArray() ;
```

blog.mongodb.org/post/87892923503/6-rules-of-thumb-for-mongodb-schema-design-part-2

DENORMALIZING ONE-TO-MANY

```
> db.parts.findOne()
{
    _id : ObjectID('AAAA'),
    partno : '123-aff-456',
    name : '#4 grommet',
    product_name : 'left-handed smoke shifter',
    product_catalog_number: 1234,
    qty: 94,
    cost: 0.94,
    price: 3.99
}
```

blog.mongodb.org/post/87892923503/6-rules-of-thumb-for-mongodb-schema-design-part-2

STRUCTURING DATA

For “one-to-few”, you can use an array of embedded documents

For “one-to-many”, or on occasions when the “N” side must stand alone, you should use an array of references. You can also use a “parent-reference” on the “N” side if it optimizes your data access pattern

For “one-to-squillions”, you should use a “parent-reference” in the document storing the “N” side

blog.mongodb.org/post/88473035333/6-rules-of-thumb-for-mongodb-schema-design-part-3

CONSIDERATIONS

What is the cardinality of the relationship: is it “one-to-few”, “one-to-many”, or “one-to-squillions”?

Do you need to access the object on the “N” side separately, or only in the context of the parent object?

What is the ratio of updates to reads for a particular field?

blog.mongodb.org/post/88473035333/6-rules-of-thumb-for-mongodb-schema-design-part-3

RULES OF THUMB

favor embedding unless there is a compelling reason not to

needing to access an object on its own is a compelling reason not to embed it

high-cardinality arrays are a compelling reason not to embed

blog.mongodb.org/post/88473035333/6-rules-of-thumb-for-mongodb-schema-design-part-3

RULES OF THUMB

if you index correctly and use the projection specifier, application-level joins are barely more expensive than server-side joins in a relational database.

consider the write/read ratio when denormalizing

model your data according to application's data access patterns

blog.mongodb.org/post/88473035333/6-rules-of-thumb-for-mongodb-schema-design-part-3

NEXT CLASS: RESTFUL APIs

courses.engr.illinois.edu/cs498rk1/

AngularJS

CS498RK

October 9th, 2016

A Tribute To jQuery

“Write Less, Do More”

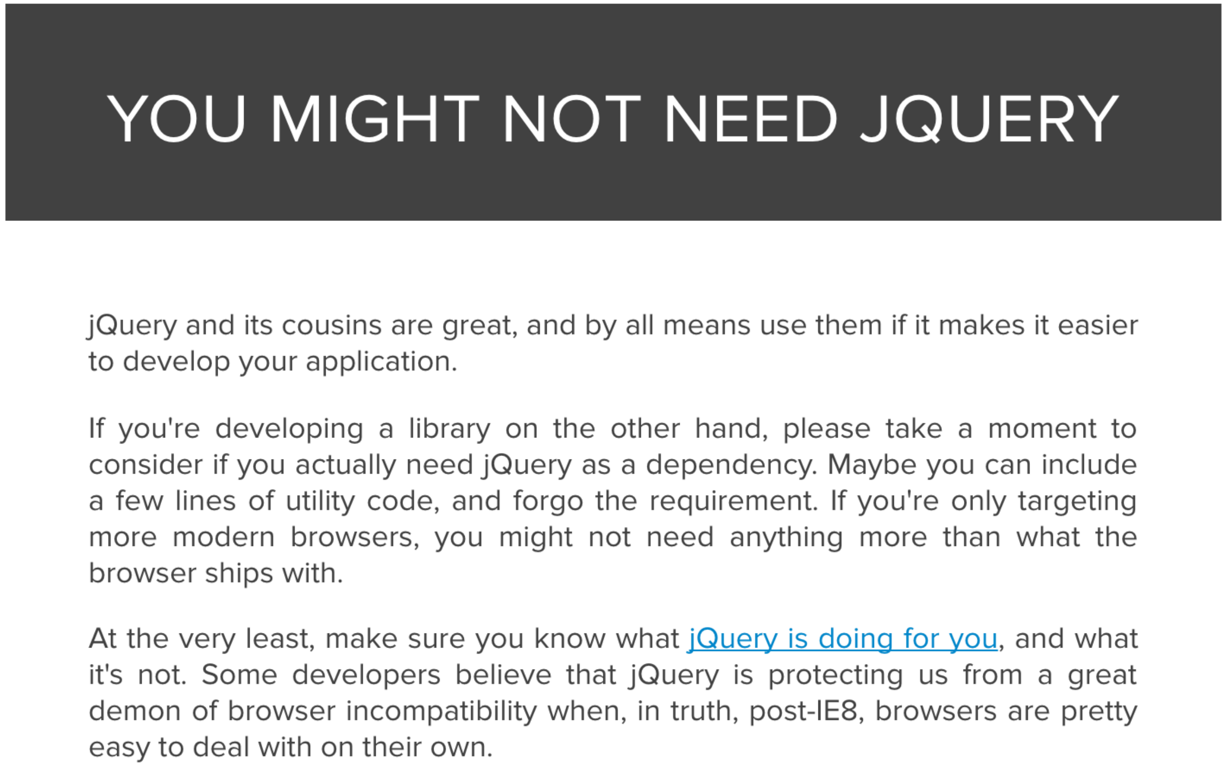
Works across a multitude of browsers.

Installation on more than 65% of top 10 million websites

Easy syntax

So what’s wrong with jQuery?

Nothing



YOU MIGHT NOT NEED JQUERY

jQuery and its cousins are great, and by all means use them if it makes it easier to develop your application.

If you're developing a library on the other hand, please take a moment to consider if you actually need jQuery as a dependency. Maybe you can include a few lines of utility code, and forgo the requirement. If you're only targeting more modern browsers, you might not need anything more than what the browser ships with.

At the very least, make sure you know what jQuery is doing for you, and what it's not. Some developers believe that jQuery is protecting us from a great demon of browser incompatibility when, in truth, post-IE8, browsers are pretty easy to deal with on their own.

http://youmightnotneedjquery.com/

DOM tree traversal is expensive compared to data binding

jQuery isn’t a framework, it’s a library

Code isn’t modularized in jQuery

So we need a framework!

Which one?

ember

BACKBONE.JS

React

METEOR

mocha

Flux

dōjō

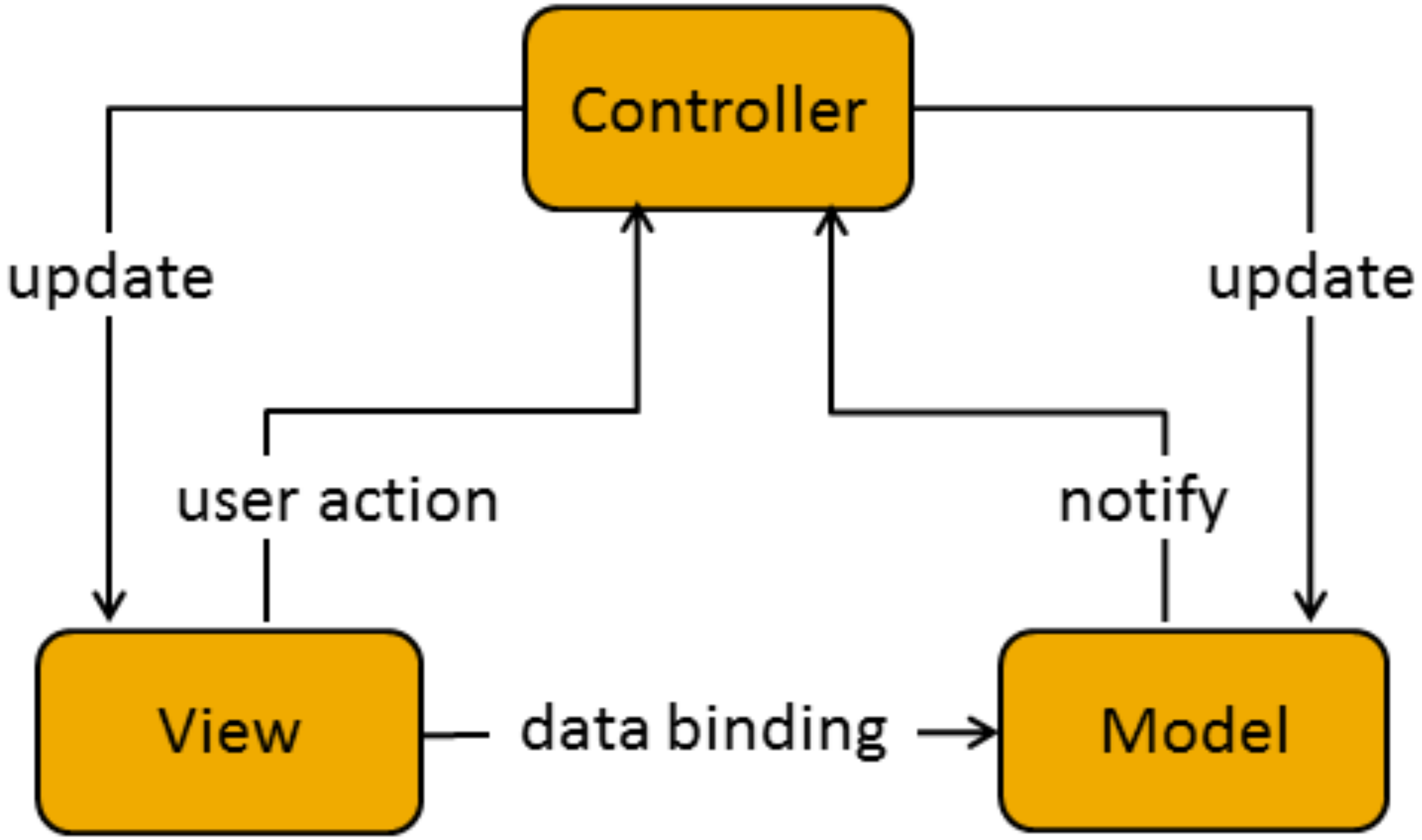
UNDERSCORE.JS

v1.3.13

Model-View-Controller Paradigm

Two Way Data Binding

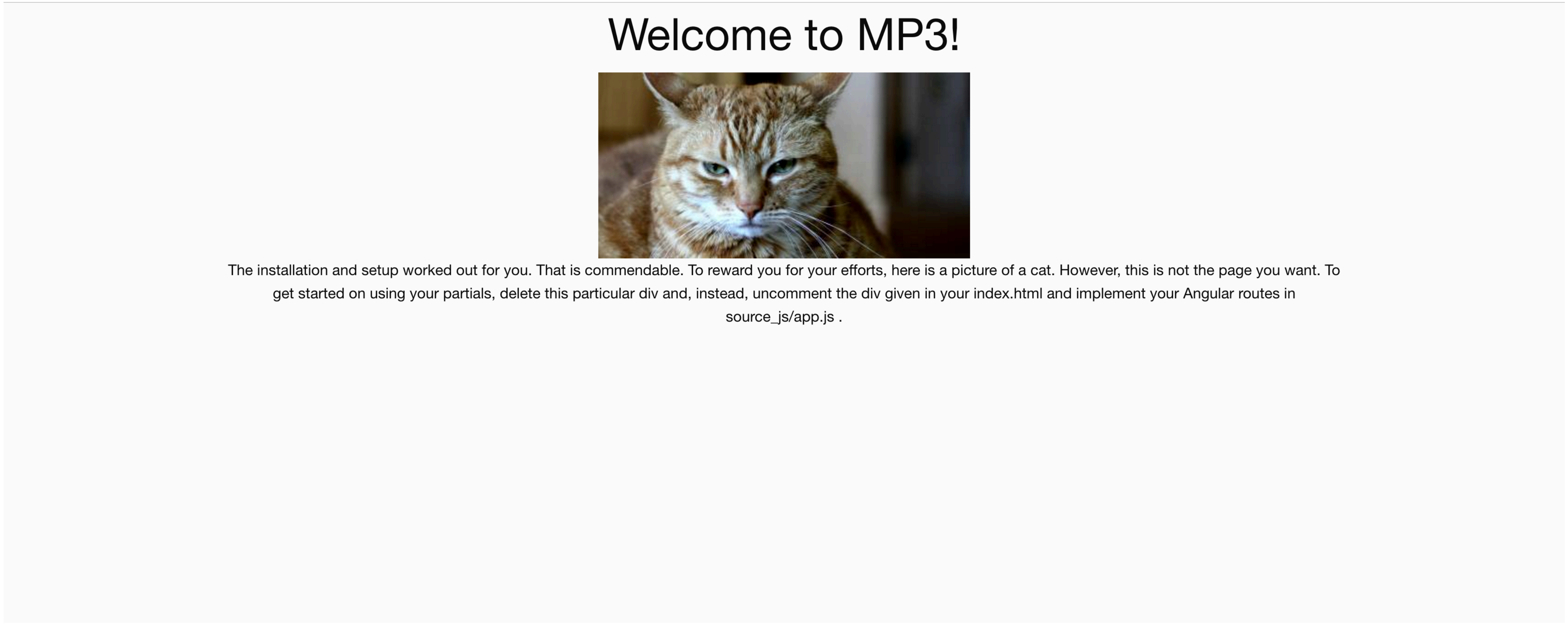
Services


Controller
update
update
user action
notify
View
data binding
Model

File Structure

```
mp3/
    source_js/
        app.js
        controllers.js
        script.js
    public/
        partials/
            details.html
            gallery.html
            list.html
        index.html
```

MP3

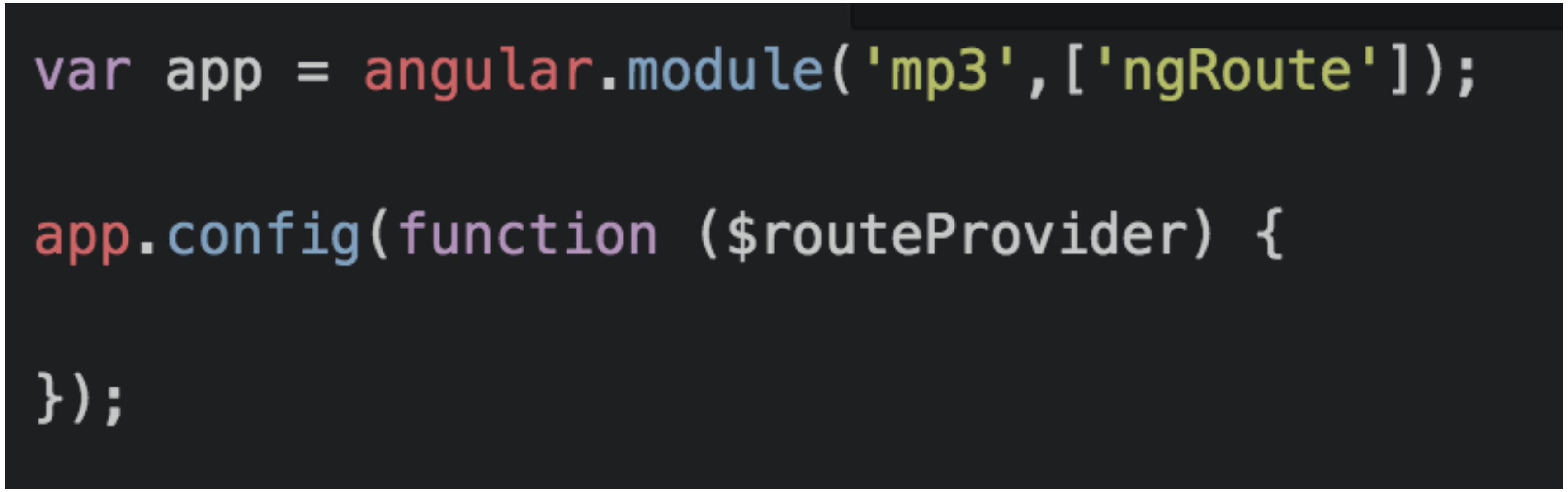


Welcome to MP3!

The installation and setup worked out for you. That is commendable. To reward you for your efforts, here is a picture of a cat. However, this is not the page you want. To get started on using your partials, delete this particular div and, instead, uncomment the div given in your index.html and implement your Angular routes in source_js/app.js .

Starting Screen at localhost:3000

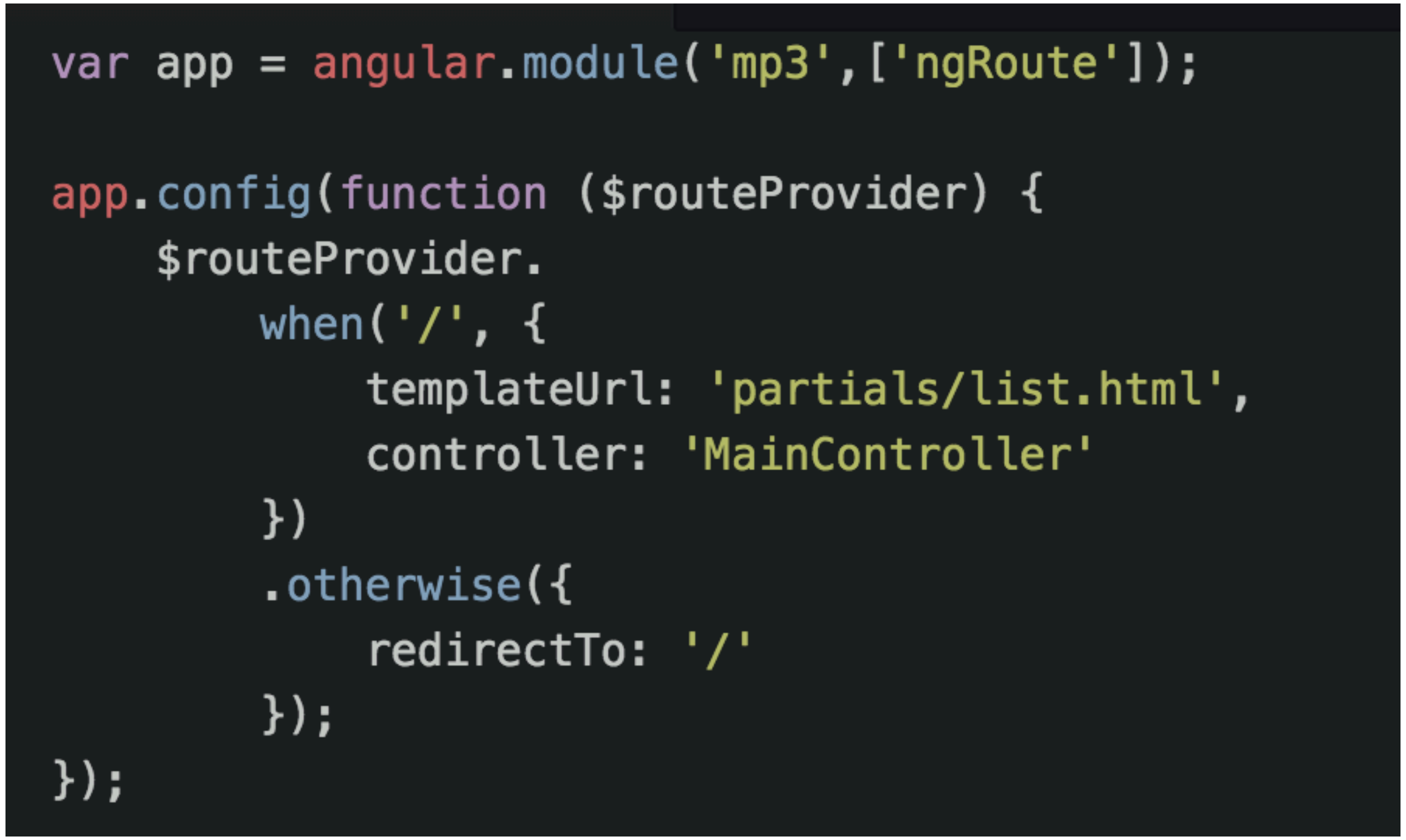
Routing



```
var app = angular.module('mp3',['ngRoute']);

app.config(function ($routeProvider) {

});
```

app.js

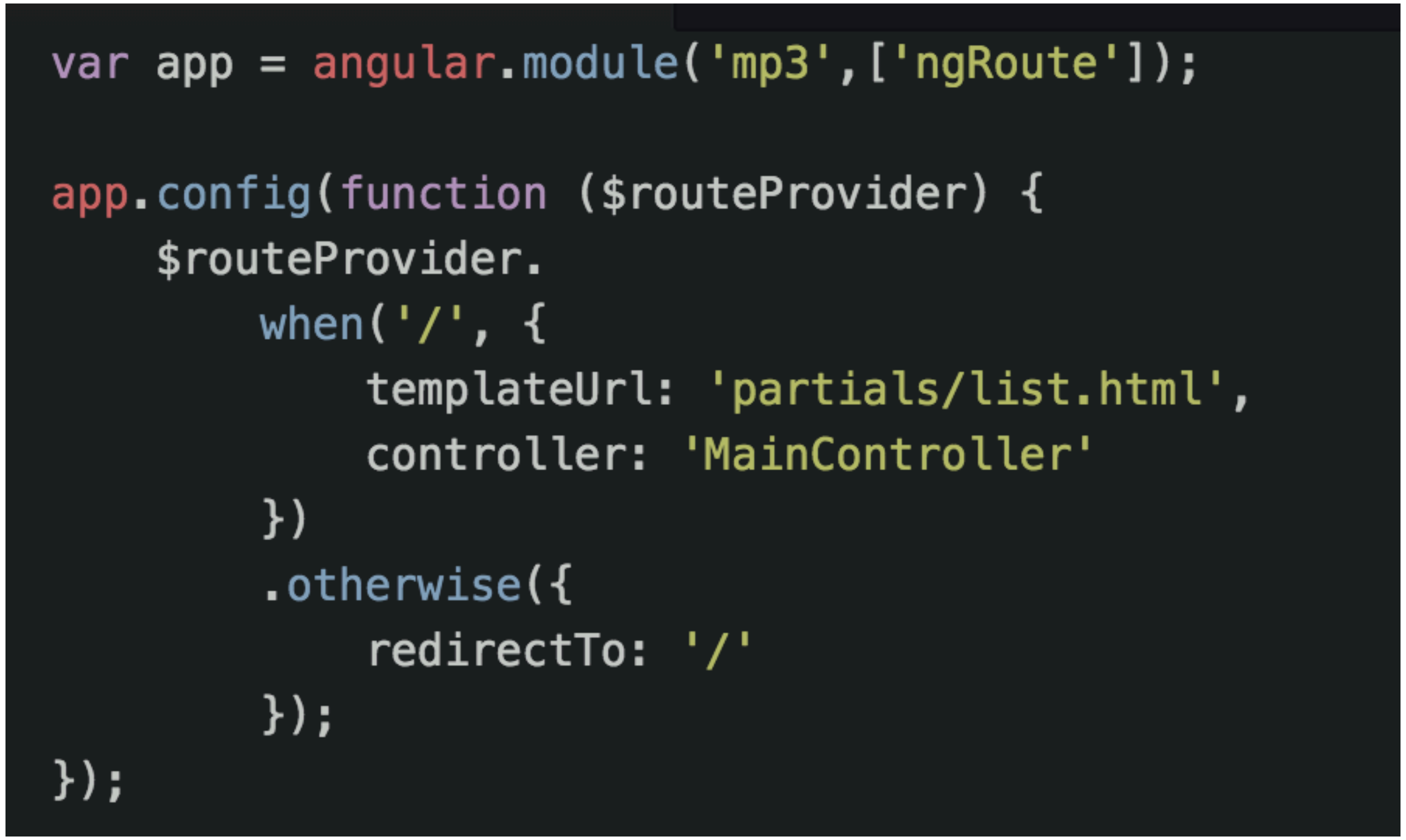
Routing



```
var app = angular.module('mp3',['ngRoute']);

app.config(function ($routeProvider) {
    $routeProvider.
        when('/', {
            templateUrl: 'partials/list.html',
            controller: 'MainController'
        })
        .otherwise({
            redirectTo: '/'
        });
});
```

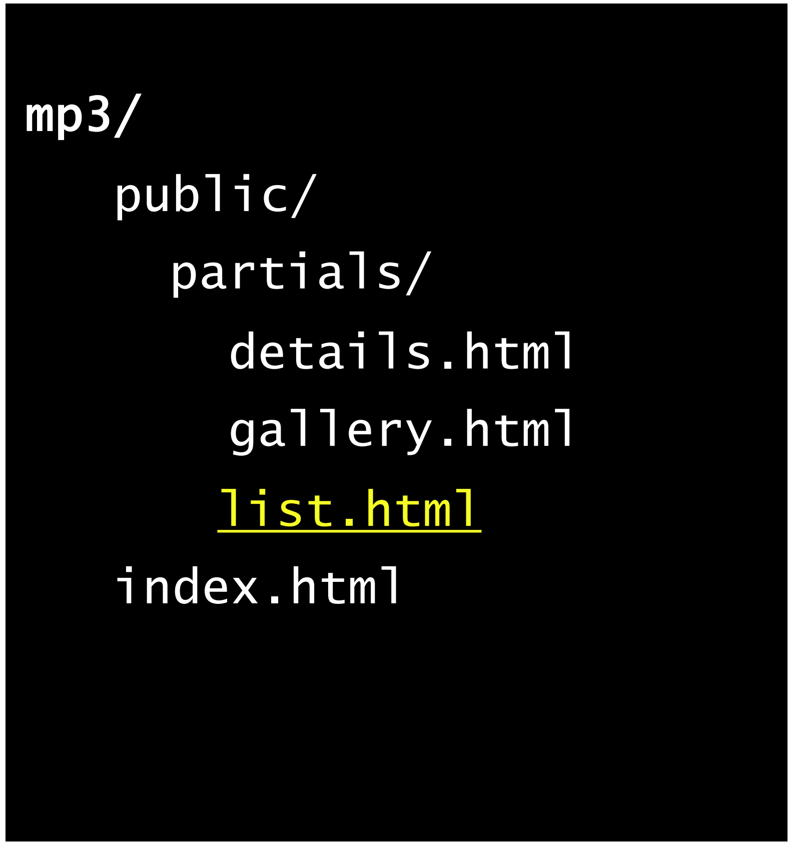
app.js

Partials



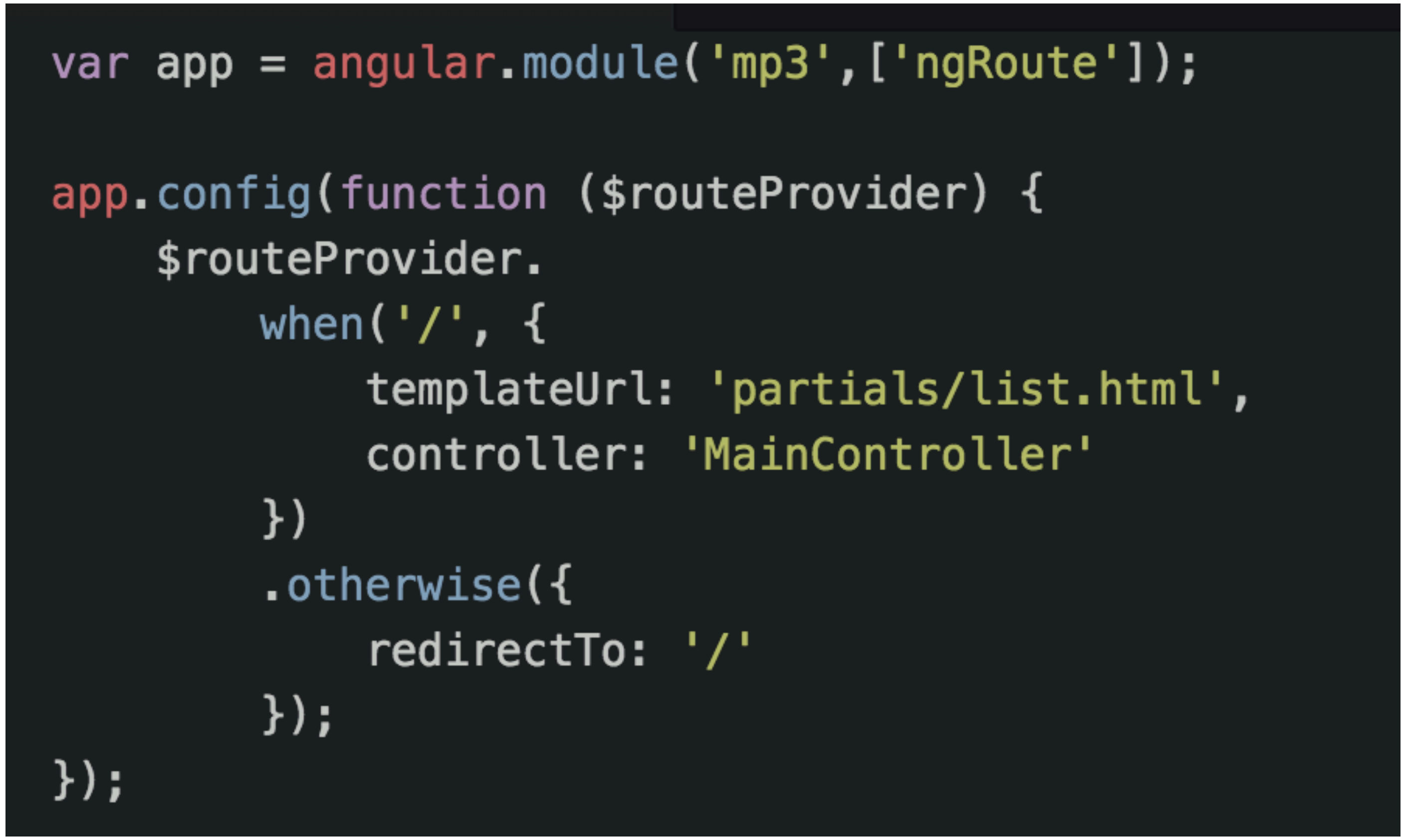
```javascript
var app = angular.module('mp3',['ngRoute']);

app.config(function ($routeProvider) {
    $routeProvider.
        when('/', {
            templateUrl: 'partials/list.html',
            controller: 'MainController'
        })
        .otherwise({
            redirectTo: '/'
        });
});
```

app.js



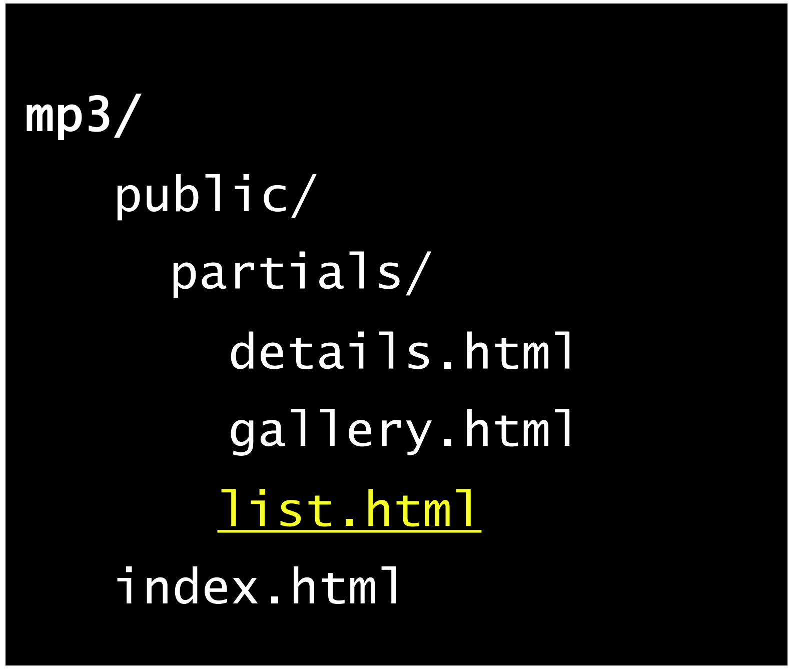
```
mp3/
    public/
      partials/
        details.html
        gallery.html
        list.html
    index.html
```

Partials

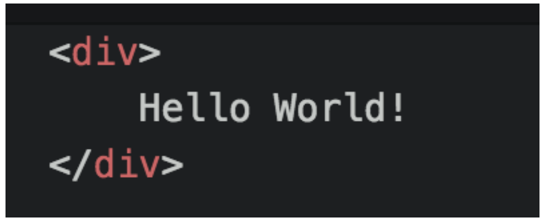


```
var app = angular.module('mp3',['ngRoute']);

app.config(function ($routeProvider) {
    $routeProvider.
        when('/', {
            templateUrl: 'partials/list.html',
            controller: 'MainController'
        })
        .otherwise({
            redirectTo: '/'
        });
});
```

app.js



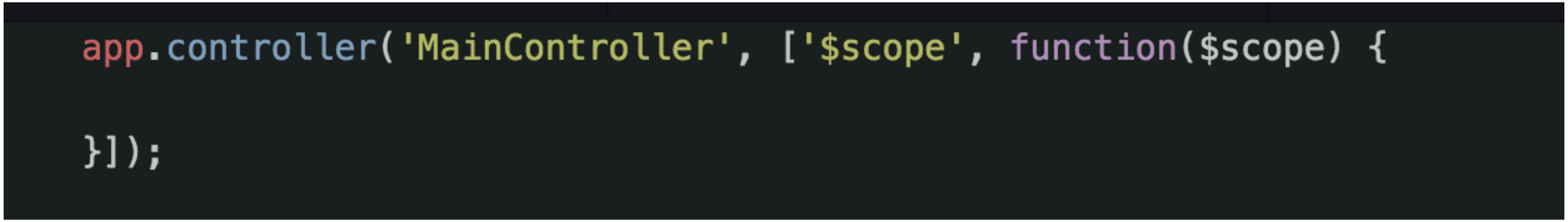
```
mp3/
    public/
        partials/
            details.html
            gallery.html
            list.html
    index.html
```



```
<div>
    Hello World!
</div>
```

list.html

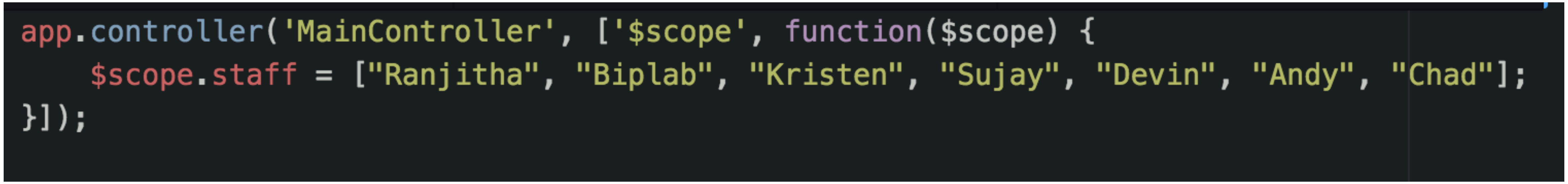
Controllers



```
app.controller('MainController', ['$scope', function($scope) {

}]);
```

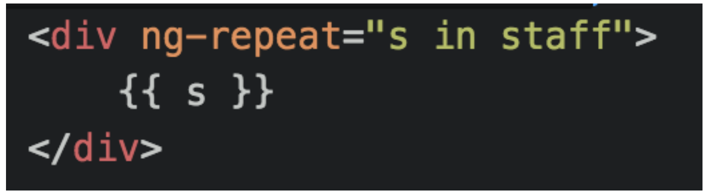
controllers.js

Controllers



```
app.controller('MainController', ['$scope', function($scope) {
    $scope.staff = ["Ranjitha", "Biplab", "Kristen", "Sujay", "Devin", "Andy", "Chad"];
}]);
```

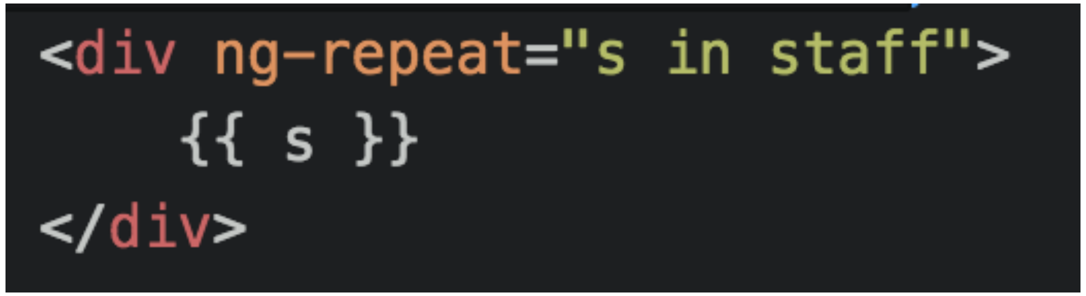
controllers.js



```
<div ng-repeat="s in staff">
    {{ s }}
</div>
```

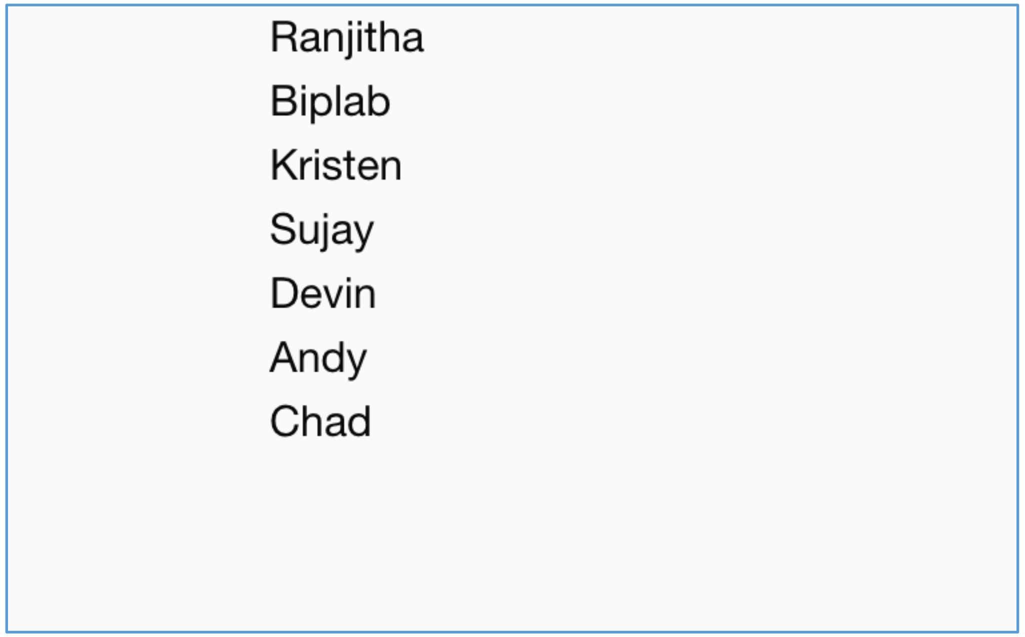
list.html

Controllers



```
<div ng-repeat="s in staff">
    {{ s }}
</div>
```

list.html

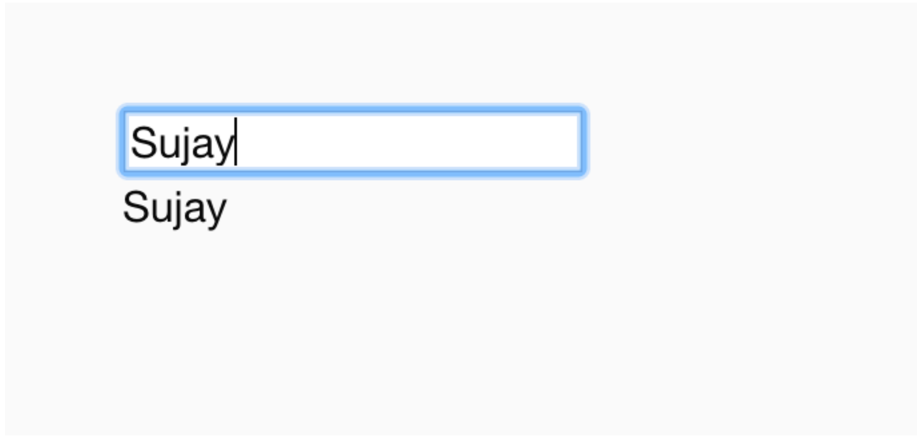


```
Ranjitha
Biplab
Kristen
Sujay
Devin
Andy
Chad
```

Result

ngModel

```html
<input ng-model="myName" />
<div>
    {{myName}}
</div>
```



```javascript
$scope.myName = "Sujay";
```

Angular Directives

ng-src

```html
<img ng-src="http://www.cs498rksite.com/avatar/{{staff[0]}}"/>
```

ng-show

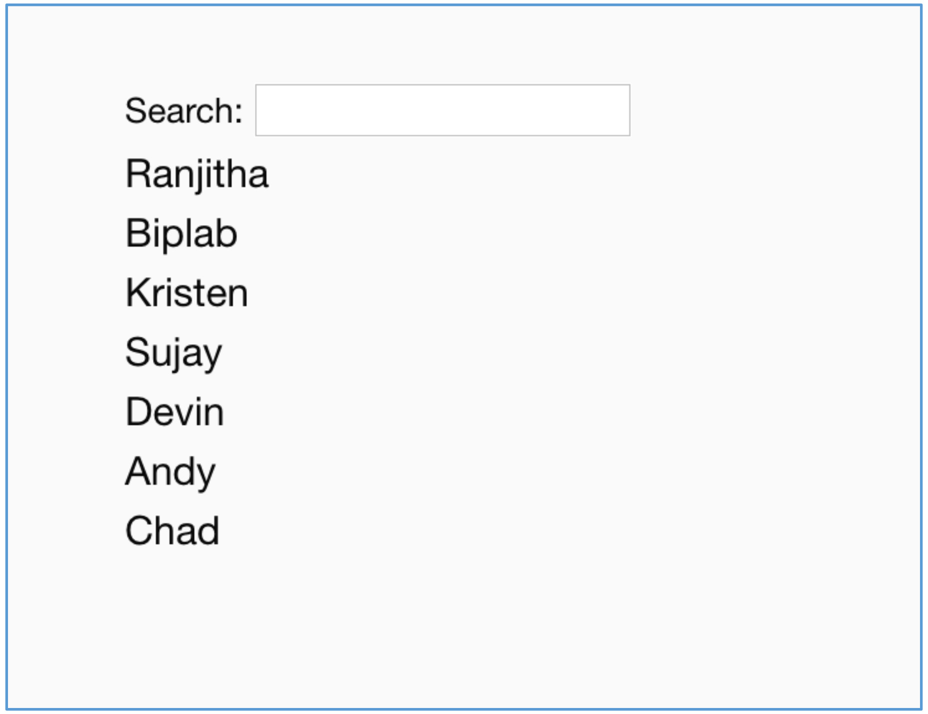
```html
<div ng-show="{{booleanValue}}">
    Hello World!
</div>
```

Filtering

```
<label>Search: <input ng-model="searchText"></label>
<div ng-repeat="s in staff | filter:searchText">
    {{ s}}
</div>
```

Filtering

```
<label>Search: <input ng-model="searchText"></label>
<div ng-repeat="s in staff | filter:searchText">
    {{ s}}
</div>
```

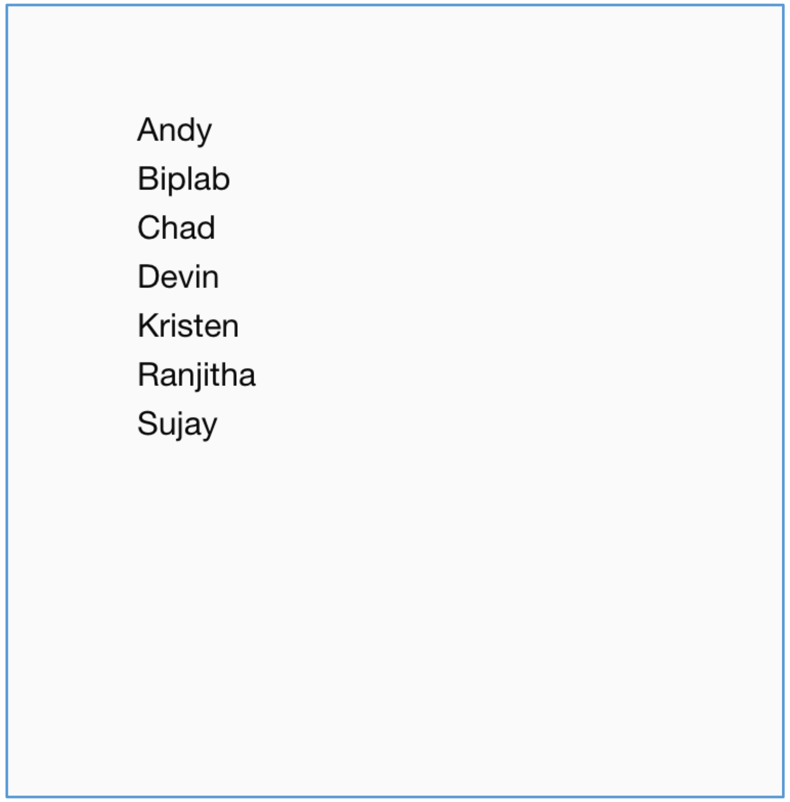


Search:

Ranjitha
Biplab
Kristen
Sujay
Devin
Andy
Chad

Ordering

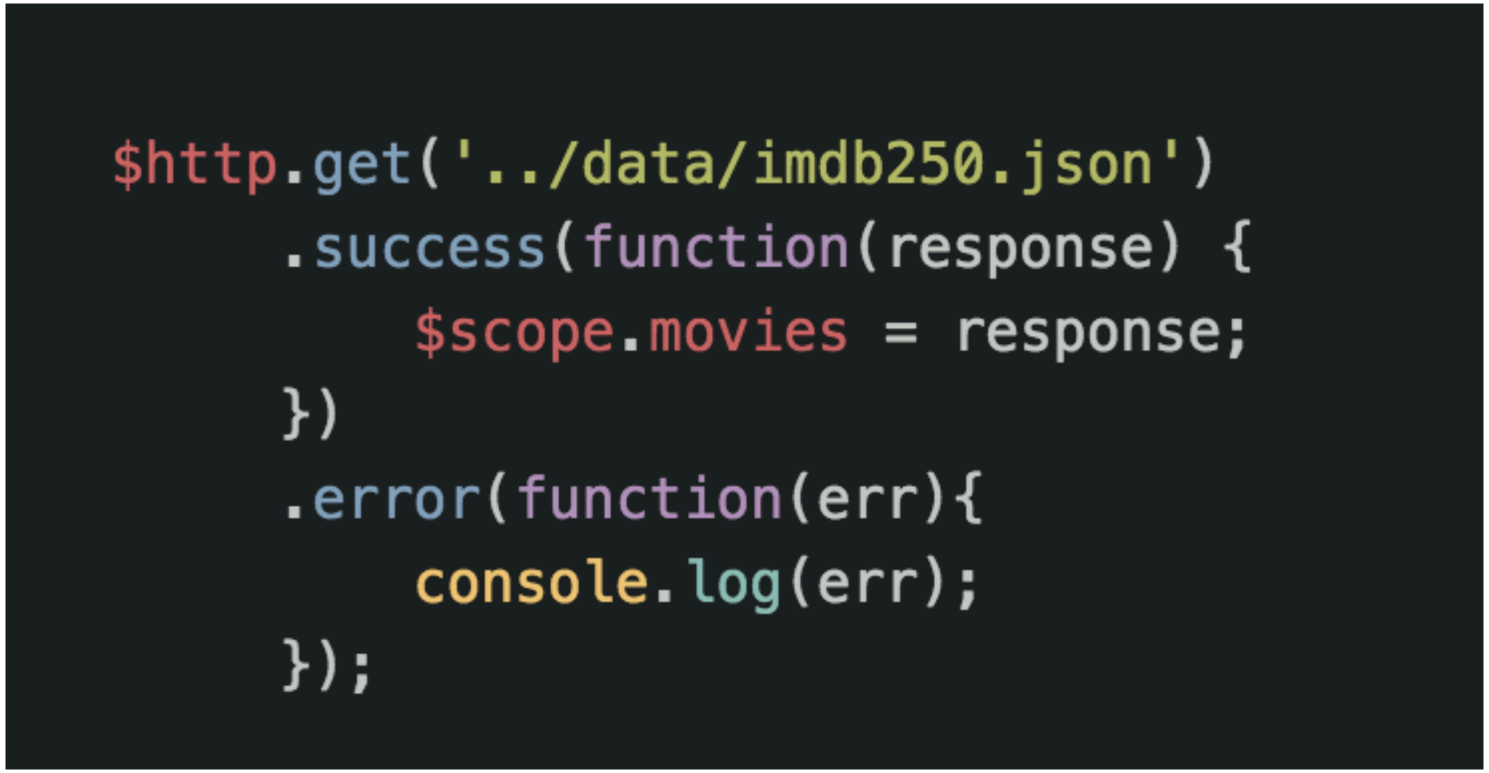
```
<div ng-repeat="s in staff | orderBy: 'toString()'">
    {{ s}}
</div>
```



```
Andy
Biplab
Chad
Devin
Kristen
Ranjitha
Sujay
```

Angular Built-in Services

$http



```
$http.get('../data/imdb250.json')
     .success(function(response) {
         $scope.movies = response;
     })
     .error(function(err){
         console.log(err);
     });
```