

Comp 424 - Client-side Web Design

Fall Semester 2016 - Week 12

Dr Nick Hayward

Contents

- Complementary Server-side considerations
 - *Node.js*
- Data storage
 - *Redis*
 - *MongoDB - Part I*

Server-side considerations - Node.js

install Node.js

- a number of different ways to install **Node.js**, **npm**, and the lightweight, customisable web server **Express**
- run and test Node.js on a local Mac OS X or Windows machine
- download and install a package from the following URL
 - *Node.js - download*
- install the Node module, **Express**
- Express is a framework for web applications built upon Node.js
 - *minimal, flexible, & easily customised server*
- use *npm* to install the Express module

```
npm install -g express
```

- *-g* option sets a global flag for Express instead of limited local install
- installs Express command line tool
 - *allows us to start building our basic web application*
- now also necessary to install Express application generator

```
npm install -g express-generator
```

Server-side considerations - Node.js

NPM - intro

- **npm** is a package manager for Node.js
- Developers can use **npm** to share and reuse modules in Node.js applications
- **npm** can also be used to share complete Node.js applications
- example modules might include
 - *Markup, YAML etc parsers*
 - *database connectors*
 - *Express server*
 - ...
- **npm** is included with the default installers available at the Node.js website
- test whether **npm** is installed, simply issue the following command

```
npm
```

- should output some helpful information if **npm** is currently installed
- **NB:** on a Unix system, such as OS X or Linux
 - *best to avoid installing **npm** modules with `sudo` privileges*

Server-side considerations - Node.js

NPM - installing modules

- install existing **npm** modules, use the following type of command

```
npm install express
```

- this command installs module named `express` in the current directory
- it will act as a local installation within the current directory
- installing in a folder called `node_modules`
 - *this is the default behaviour for current installs*
- we can also specify a global install for modules
 - eg: we may wish to install the **express** module with global scope

```
npm install -g express
```

- again, the `-g` flag specifies the required global install

Server-side considerations - Node.js

NPM - importing modules

- import, or effectively add, modules in our Node.js code
 - *use the following declaration*

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

- when we run this application
 - *Node.js looks for the required module library and its source code*

Server-side considerations - Node.js

NPM - finding modules

- official online search tool for **npm** can be found at
 - *npmjs*
- top packages include options such as
 - *browserify*
 - *express*
 - *grunt*
 - *bower*
 - *karma*
 - ...
- also search for Node modules directly
 - *search from the command line using the following command*

```
npm search express
```

- returns results for module names and descriptions

Server-side considerations - Node.js

NPM - specifying dependencies

- ease Node.js app installation
 - *specify any required dependencies in an associated `package.json` file*
- allows us as developers to specify modules to install for our application
 - *which can then be run using the following command*

```
npm install
```

- helps reduce the need to install each module individually
- helps other users install an application as quickly as possible
- our application's dependencies are stored in one place
- example `package.json`

```
{
  "name": "app",
  "version": "0.0.1",
  "dependencies": {
    "express": "4.2.x",
    "underscore": "-1.2.1"
  }
}
```


Server-side considerations - Node.js

initial Express usage

- now use Express to start building our initial basic web application
- Express creates a basic shell for our web application
 - *cd to working directory and use the following command*

```
express /node/test-project
```

- command makes a new directory
 - *populates with required basic web application directories and files*
- cd to this directory and install any required dependencies,

```
npm install
```

- then run our new app,

```
npm start
```

- or run and monitor our app,

```
nodemon start
```

Server-side considerations - Node.js

initial Express server - setup

- we've now tested **npm**, and installed our first module with **Express**
- test **Express**, and build our first, simple server
- initial directory structure

```
| - .  
  | - 424-node  
    | - node_modules
```

- need to do is create a JS file to store our server code, so we'll add `server.js`

```
| - .  
  | - 424-node  
    | - node_modules  
    | - server.js
```

- start adding our Node.js code to create a simple server

Server-side considerations - Node.js

initial Express server - server.js - part I

- add some initial code to get our server up and running

```
/* a simple Express server for Node.js*/  
  
var express = require("express"),  
    http = require("http"),  
    appTest;  
  
// create our server - listen on port 3030  
appTest = express();  
http.createServer(appTest).listen(3030);  
  
// set up routes  
appTest.get("/test", function(req, res) {  
    res.send("welcome to the 424 test app.");  
});
```

- then start and test this server as follows at the command line

```
node server.js
```

Server-side considerations - Node.js

initial Express server - server.js - part 2

- open our web browser, and use the following URL

```
http://localhost:3030
```

- this is the route of our new server
 - *to get our newly created route use the following URL*

```
http://localhost:3030/test
```

- this will now return our specified route, and output message
- update our `server.js` file to support root directory level routes

```
appTest.get("/", function(req, res) {  
  res.send("Welcome to the 424 server.")  
});
```

- now load our server at the root URL

```
http://localhost:3030
```

- stop server from command line using CTRL and c

Server-side considerations - Node.js

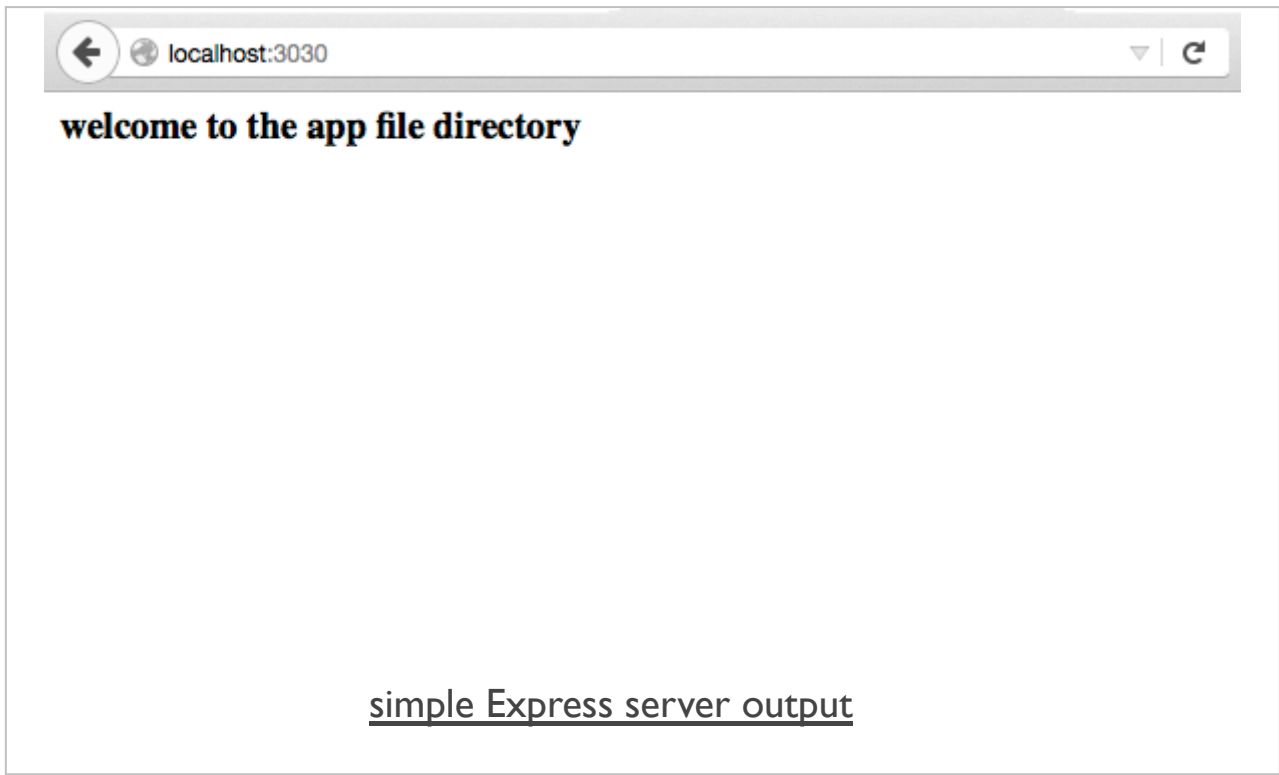
initial Express server - server.js - part 3

- currently, initial Express server is managing some static routes for loading content
 - *we simply tell the server how to react when a given route is requested*
- what if we now want to serve some HTML pages?
 - *Express allows us to set up routes for static files*

```
//set up static file directory - default route for server  
appTest.use(express.static(__dirname + "/app"));
```

- now defining Express as a static file server
 - *enabling us to publish our HTML, CSS, and JS files*
 - *published from our default directory, /app*
- if requested file not available
 - *server will check other available routes*
 - *or report error to browser if nothing found*
- DEMO - 424-node

Image - Client-side and server-side computing



Server-side considerations - Node.js

working with data - JSON

- let us now work our way through a basic Node.js app
- serve our JSON, then read and load from a standard web app
- create our initial `server.js` file

```
var express = require('express'),
    http = require("http"),
    jsonApp = express(),
    notes = {
      "travelNotes": [{
        "created": "2015-10-12T00:00:00Z",
        "note": "Curral das Freiras..."
      }]
    };

jsonApp.use(express.static(__dirname + "/app"));

http.createServer(jsonApp).listen(3030);

//json route
jsonApp.get("notes.json", function(req, res) {
  res.json(notes);
});
```

Image - Client-side and server-side computing



Server-side considerations - Node.js

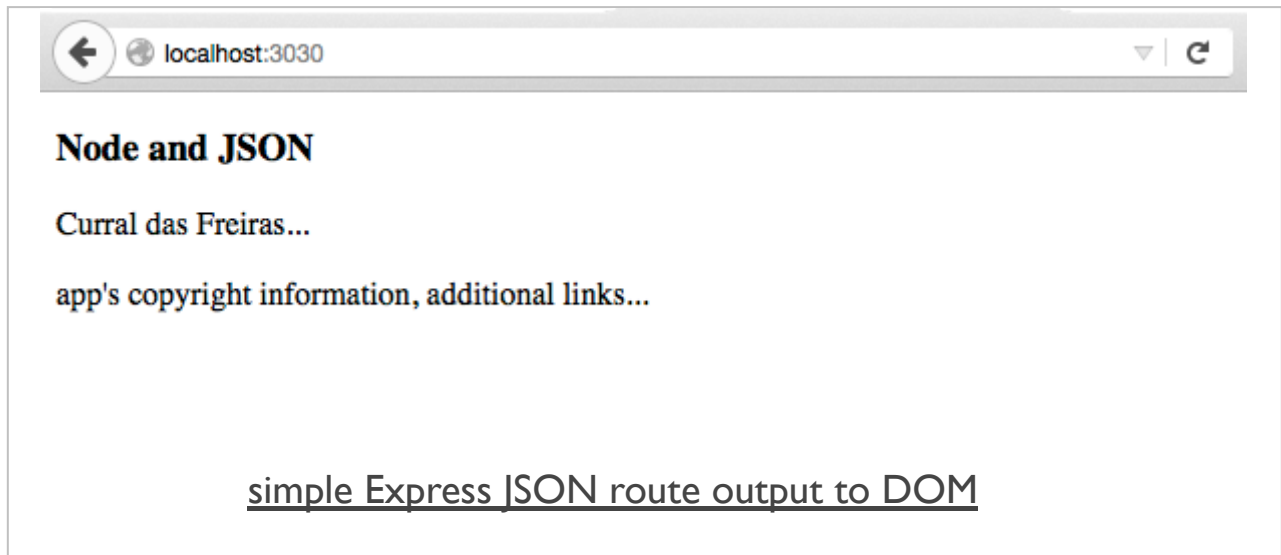
working with data - JSON

- now have our get routes setup for JSON
- now add some client-side logic to read that route
- render to the browser
- same basic patterns we've seen before
 - using jQuery's `.getJSON()` function

```
...  
$.getJSON("notes.json", function (response) {  
    console.log("response = "+response.toSource());  
    buildNote(response);  
})  
...
```

- response object from our JSON
 - *this time from the server and not a file or API*
- use our familiar functions to create and render each note
 - *call our normal `buildNote()` function*
- DEMO - 424-node-json1

Image - Client-side and server-side computing



Server-side considerations - Node.js

working with data - post data

- we've seen examples that load JSON data
 - using jQuery's `.getJSON()` function
- now consider jQuery's `post` function
 - allow us to easily send JSON data to the server
 - simply called *post*
- begin our updates by creating a new route in our Express server
 - one that will handle the *post* route

```
jsonApp.post("/notes", function(req, res) {  
  //return simple JSON object  
  res.json({  
    "message": "post complete to server"  
  });  
});
```

Server-side considerations - Node.js

working with data - post data

- may look similar to our earlier `get` routes
 - *difference due to browser restrictions*
 - *can't simply request direct route using our browser*
 - *as we did with `get` routes*
- need to change JS we use for the client-side
 - *allows us to post new route*
 - *then enables view of the returned message*
- update our test app to store data on the server
 - *then initialise our client with this stored data*

Server-side considerations - Node.js

working with data - post data

- start with a simple check that the post route is working correctly
 - *add a button, submit a request to the post route, and then wait for the response*
 - *add event handler for a button*

```
$("#post").on("click", function() {  
  $.post("notes", {}, function (response) {  
    console.log("server post response returned..." + response.toSource());  
  })  
});
```

- submit a post request
 - *specify the route for the post to the Node.js server*
 - *then specify the data to post - an empty object in this example*
 - *the specify a callback for the server's response*
- test returns the following output to the browser's console,

```
server post response returned...({message:"post complete to server"})
```

Server-side considerations - Node.js

working with data - post data

- now send some data to the server
 - *add new note to our object*
- update the server to handle this incoming object
 - *process the submitted jQuery JSON into a JavaScript object*
 - *ready for use with the server*
- use the **Express** module's body-parser plugin
- update `server.js` as follows

```
//add body-parser for JSON parsing etc...
var bodyParser = require("body-parser");
...
//Express will parse incoming JSON objects
jsonApp.use(bodyParser.urlencoded({ extended: false }));
...
```

- as server receives new JSON object
 - *it will now parse, or process, this object*
 - *ensures it can be stored on the server for future use*

Server-side considerations - Node.js

working with data - post data

- now update our test button's event handler
 - *send a new note as a JSON object*
- note will retrieve its new content from the input field
 - *gets the current time from the node server*

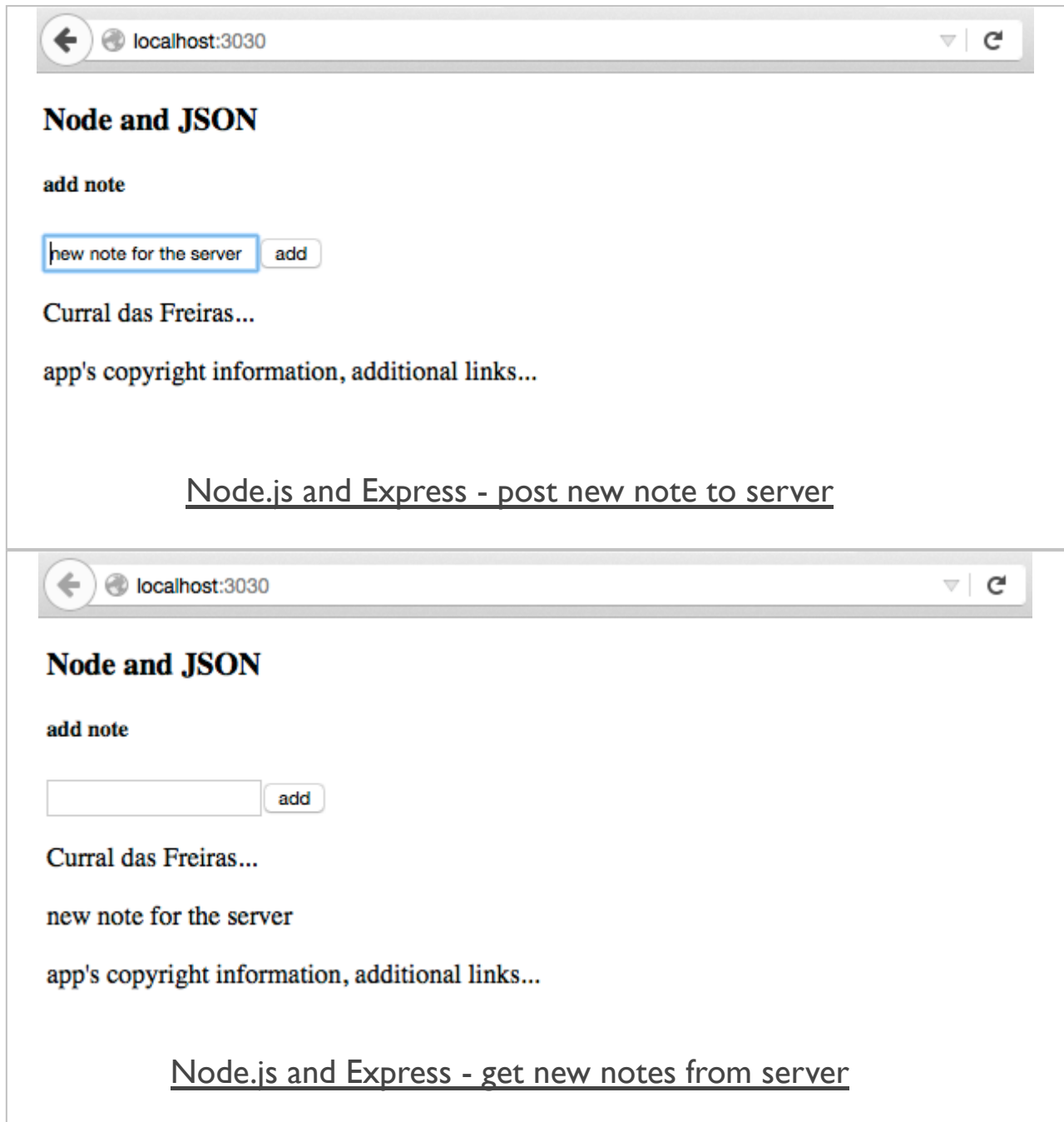
```
$(".note-input button").on("click", function() {  
    //get values for new note  
    var note_text = $(".note-input input").val();  
    var created = new Date();  
    //create new note  
    var newNote = {"created":created, "note":note_text};  
    //post new note to server  
    $.post("notes", newNote, function (response) {  
        console.log("server post response returned..." + response.toSource());  
    })  
});
```

- input field and button follow the same pattern as previous examples

```
<!-- note input -->  
<section class="note-input col-6">  
    <h5>add note</h5>  
    <input><button>add</button>  
</section>
```

- DEMO - 424-node-json2

Image - Client-side and server-side computing



Server-side considerations - data storage

intro

- tested Node.js, created a server for hosting our files and routes with ExpressJS
 - *read JSON from the server*
 - *updated our JSON on the server-side*
- works well as long as we do not need to restart, repair, update etc our server
- data lost with restart etc...
- need to consider a persistent data storage
 - *independent from the application*
- NoSQL options such as Redis and MongoDB
- integration with Node.js

Server-side considerations - data storage

SQL or NoSQL

- common database usage and storage
 - *often thought solely in terms of SQL, or structured query language*
- SQL used to query data in a relational format
- relational databases, for example MySQL or PostgreSQL, store their data in tables
 - *provides a semblance of structure through rows and cells*
 - *easily cross-reference, or relate, rows across tables*
- a relational structure to map authors to books, players to teams...
 - *thereby dramatically reducing redundancy, required storage space...*
- improvement in storage capacities, access...
 - *led to shift in thinking, and database design in general*
- started to see introduction of non-relational databases
 - *often referred to simply as **NoSQL***
- with NoSQL DBs
 - *redundant data may be stored*
 - *such designs often provide increased ease of use for developers*
- some NoSQL examples for specific use cases
 - *eg: fast reading of data more efficient than writing*
 - *specialised DB designs*

Server-side considerations - data storage

Redis - intro

- Redis provides an excellent example of NoSQL based data storage
- designed for fast access to frequently requested data
- improvement in performance often due to a reduction in perceived reliability
 - *due to in-memory storage instead of writing to a disk*
- able to flush data to disk
 - *performs this task at given points during uptime*
 - *for majority of cases considered an in-memory data store*
- stores this data in a **key-value** format
 - *similar in nature to standard object properties in JavaScript*
- Redis often a natural extension of conventional data structures
- Redis is a good option for quick access to data
 - *optionally caching temporary data for frequent access*

Server-side considerations - data storage

Redis - installation

- On OS X, use the Homebrew package manager to install Redis

```
brew install redis
```

- Windows port maintained by the Microsoft Open Tech Group - Redis
 - or use Windows package manager - <https://chocolatey.org/>
- for Linux - download, extract, and compile Redis

```
$ wget http://download.redis.io/releases/redis-3.0.5.tar.gz
$ tar xzf redis-3.0.5.tar.gz
$ cd redis-3.0.5
$ make
```

Server-side considerations - data storage

Redis - server and CLI

- start the Redis server with the following command,

```
redis-server
```

- interact with our new server directly using the CLI tool,

```
redis-cli
```

- store some data in Redis using the set command
 - create a new key for *notes*, and then set its value to *0*
 - if value is set, Redis returns *OK*

```
set notes 0
```

- retrieve a value using the get command
 - returns our set value of *0*

```
get notes
```

Image - Client-side and server-side computing

```
Drs-MacBook-Air-2:~ ancientlives$ redis-cli
127.0.0.1:6379> set notes 0
OK
127.0.0.1:6379> get notes
"0"
127.0.0.1:6379> █
```

Redis CLI - set and get

Server-side considerations - data storage

Redis - server and CLI

- also manipulate existing values for a given key
 - eg: *increment and decrement a value, or simply delete a key*
- increment key notes value by 1

```
incr notes
```

- decrement key notes value by 1

```
decr notes
```

- we can then increment or decrement by a specified amount

```
// increment by 10
incrby notes 10
// decrement by 5
decrby notes 5
```

- delete our key

```
// single key deletion
del notes
// multiple keys deletion
del notes notes2 notes3
```

Image - Client-side and server-side computing

```
Drs-MacBook-Air-2:~ ancientlives$ redis-cli
127.0.0.1:6379> set notes 0
OK
127.0.0.1:6379> get notes
"0"
127.0.0.1:6379> incr notes
(integer) 1
127.0.0.1:6379> incr notes
(integer) 2
127.0.0.1:6379> get notes
"2"
127.0.0.1:6379> decr notes
(integer) 1
127.0.0.1:6379> get notes
"1"
127.0.0.1:6379> incrby notes 10
(integer) 11
127.0.0.1:6379> get notes
"11"
127.0.0.1:6379> decrby notes 5
(integer) 6
127.0.0.1:6379> get notes
"6"
```

Redis CLI - increment and decrement

Server-side considerations - data storage

Redis and Node.js setup

- test Redis with our Node.js app
- new test app called 424-node-redis1

```
| - 424-node-redis1  
  | - app  
    | - assets  
  | - node_modules  
  | - package.json  
  | - server.js
```

- create new file, `package.json` to track project
 - eg: *dependencies, name, description, version...*

Server-side considerations - data storage

Redis and Node.js - package.json

```
{
  "name": "424-node-redis1",
  "version": "1.0.0",
  "description": "test app for node and redis",
  "main": "server.js",
  "dependencies": {
    "body-parser": "^1.14.1",
    "express": "^4.13.3",
    "redis": "^2.3.0"
  },
  "author": "ancientlives",
  "license": "ISC"
}
```

- we can write the `package.json` file ourselves or use the interactive option

```
npm init
```

- then add extra dependencies, eg: Redis, using

```
npm install redis --save
```

- use `package.json` to help with app management and abstraction...

Server-side considerations - data storage

Redis and Node.js - set notes value

- add Redis to our earlier test app
- import and use Redis in the `server.js` file

```
...  
var express = require("express"),  
    http = require("http"),  
    bodyParser = require("body-parser"),  
    jsonApp = express(),  
    redis = require("redis");  
...
```

- create client to connect to Redis from Node.js

```
//create client to connect to Redis  
redisConnect = redis.createClient();
```

- then use Redis, for example, to store access total for notes on server

```
redisConnect.incr("notes");
```

- check Redis command line for change in notes value

```
get notes
```

Server-side considerations - data storage

Redis and Node.js - get notes value

- now set the counter value for our notes
 - *add our counter to the application to record access count for notes*
- use the get command with Redis to retrieve the incremented values for the notes key

```
redisConnect.get("notes", function(error, notesCounter) {  
    //set counter to int of value in Redis or start at 0  
    notesTotal.notes = parseInt(notesCounter,10) || 0;  
});
```

- get accepts two parameters - error and return value
- Redis stores values and strings
 - *convert string to integer using `parseInt()`*
 - *two parameters - return value and `base-10` value of the specified number*
- value is now being stored in a global variable `notesTotal`
 - *declared in `server.js`*

```
var express = require("express"),  
    http = require("http"),  
    bodyParser = require("body-parser"),  
    jsonApp = express(),  
    redis = require("redis"),  
    notesTotal = {};
```

Server-side considerations - data storage

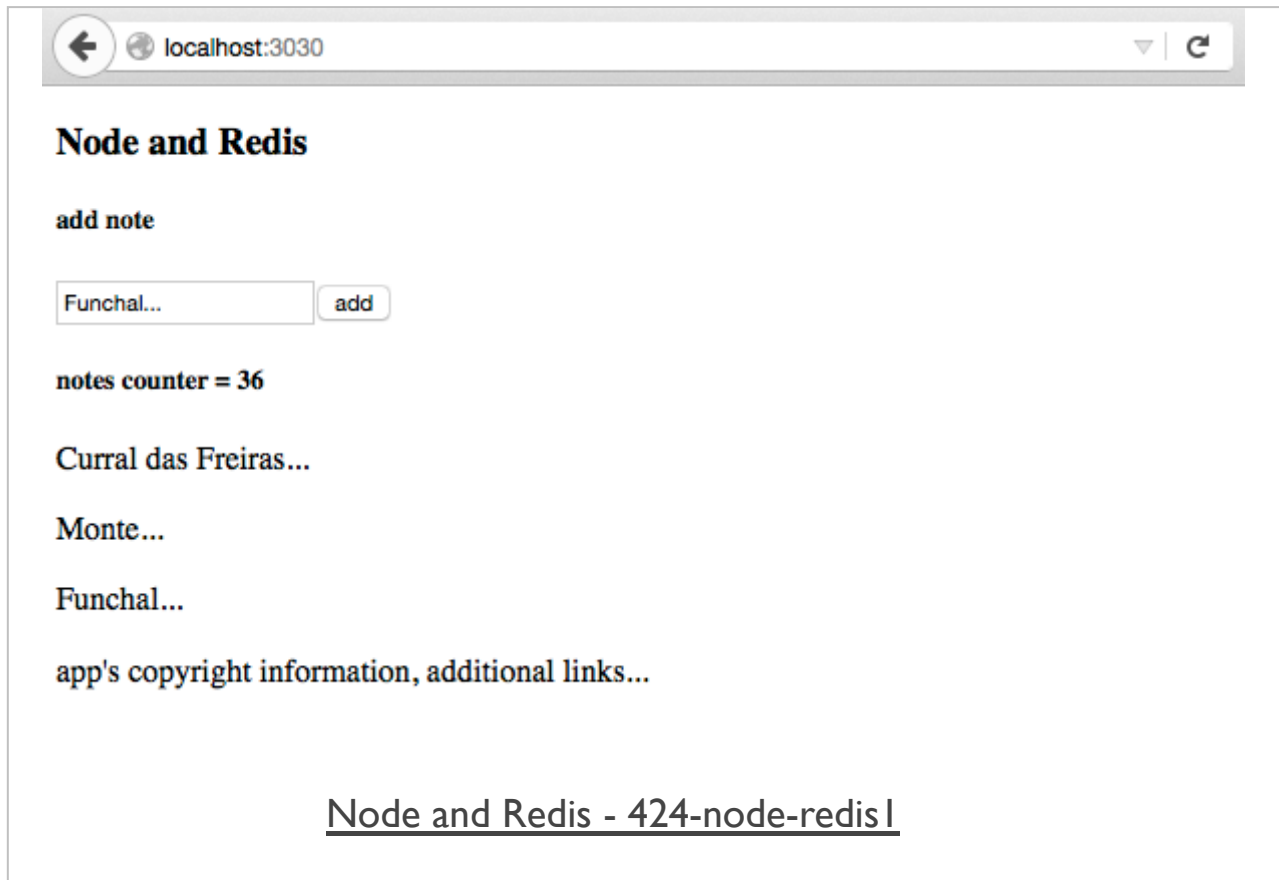
Redis and Node.js - get notes value

- store notes counter value in Redis
- create new route in `server.js`
 - *monitor the returned JSON for the counter*

```
//json get route
jsonApp.get("/notesTotal.json", function(req, res) {
  res.json(notesTotal);
});
```

- start using it with our application
 - *load by default, within event handler...*
- render to DOM
- store as a internal log record
- link to create note event handler...
- DEMO - 424-node-redis I

Image - Client-side and server-side computing



Server-side considerations - data storage

MongoDB - intro

- MongoDB is another example of a NoSQL based data store
 - *a database that enables us to store our data on disk*
- unlike MySQL, for example, it is not in a relational format
- MongoDB is best characterised as a **document-oriented** database
- conceptually may be considered as storing objects in collections
- stores its data using the BSON format
 - *consider similar to JSON*
 - *use JavaScript for working with MongoDB*

Server-side considerations - data storage

MongoDB - document oriented

- SQL database, data is stored in tables and rows
- MongoDB, by contrast, uses **collections** and **documents**
- comparison often made between a collection and a table
- **NB:** a document is quite different from a table
- a document can contain a lot more data than a table
- a noted concern with this document approach is duplication of data
- one of the trade-offs between NoSQL (MongoDB) and SQL
- SQL - goal of data structuring is to normalise as much as possible
- thereby avoiding duplicated information
- NoSQL (MongoDB) - provision a data store, as easy as possible for the application to use

Server-side considerations - data storage

MongoDB - BSON

- BSON is the format used by MongoDB to store its data
- effectively, JSON stored as binary with a few notable differences
 - eg: *ObjectId* values - data type used in MongoDB to uniquely identify documents
 - created automatically on each document in the database
 - often considered as analogous to a primary key in a SQL database
- *ObjectId* is a large pseudo-random number
- for nearly all practical occurrences, assume number will be unique
- might cease to be unique if server can't keep pace with number generation...
- other interesting aspect of *ObjectId*
 - they are partially based on a timestamp
 - helps us determine when they were created

Server-side considerations - data storage

MongoDB - general hierarchy of data

- in general, MongoDB has a three tiered data hierarchy

1. database

- *normally one database per app*
- *possible to have multiple per server*
- *same basic role as DB in SQL*

2. collection

- *a grouping of similar pieces of data*
- *documents in a collection*
- *name is usually a noun*
- *resembles in concept a table in SQL*
- *documents do not require the same schema*

3. document

- *a single item in the database*
- *data structure of field and value pairs*
- *similar to objects in JSON*
- *eg: an individual user record*

Server-side considerations - data storage

MongoDB - install and setup

- install on Linux
- install on Mac OS X
 - again, we can use **Homebrew** to install MongoDB

```
// update brew packages  
brew update  
  
// install MongoDB  
brew install mongodb
```

- then follow the above OS X install instructions to set paths...
- install on Windows

Server-side considerations - data storage

MongoDB - a few shell commands

- issue following commands at command line to get started - OS X etc

```
// start MongoDB server - terminal window 1
mongod

// connect to MongoDB - terminal window 2
mongo
```

- switch to, create a new DB (if not available), and drop a current DB as follows

```
// list available databases
show dbs

// switch to specified db
use 424db1

// show current database
db

// drop current database
db.dropDatabase();
```

- DB is not created permanently until data is created and saved
 - *insert a record and save to current DB*
- only permanent DB is the local test DB, until new DBs created...

Server-side considerations - data storage

MongoDB - a few shell commands

- add an initial record to a new 424db1 database.

```
// select/create db
use 424db1

// insert data to collection in current db
db.notes.insert({
...   "travelNotes": [{
...     "created": "2015-10-12T00:00:00Z",
...     "note": "Curral das Freiras..."
...   }]
... })
```

- our new DB 424db1 will now be saved in Mongo
- we've created a new collection, notes

```
// show databases
show dbs

// show collections
show collections
```

Server-side considerations - data storage

MongoDB - test app

- now create a new test app for use with MongoDB
- create and setup app as before
 - *eg: same setup pattern as Redis test app*
- add **Mongoose** to our app
 - *use to connect to MongoDB*
 - *helps us create a schema for working with DB*
- update our `package.json` file
 - *add dependency for Mongoose*

```
// add mongoose to app and save dependency to package.json  
npm install mongoose --save
```

- test server and app as usual from app's working directory

```
node server.js
```

Server-side considerations - data storage

MongoDB - Mongoose schema

- use **Mongoose** as a type of bridge between Node.js and MongoDB
- works as a client for MongoDB from Node.js applications
- serves as a useful data modeling tool
 - *represent our documents as objects in the application*
- a data model
 - *object representation of a document collection within data store*
 - *helps specify required fields for each collection's document*
 - *known as a schema in Mongoose, eg: `NoteSchema`*

```
var NoteSchema = mongoose.Schema({  
  "created": Date,  
  "note": String  
});
```

- using schema, build a model
 - *by convention, use first letter uppercase for name of data model object*

```
var Note = mongoose.model("Note", NoteSchema);
```

- now start creating objects of this model type using JavaScript

```
var funchalNote = new Note({  
  "created": "2015-10-12T00:00:00Z",  
  "note": "Curral das Freiras..."  
});
```

- then use the Mongoose object to interact with the MongoDB
 - *using functions such as `save` and `find`*

Source code - demos

Node.js

- [424-node](#)
- [424-node-json1](#)
- [424-node-json2](#)

Redis

- [424-node-redis1](#)

MongoDB

- [424-node-mongo1](#)

References

- Chocolatey for Windows
 - *Chocolatey package manager for Windows*
- Homebrew for OS X
 - *Homebrew - the missing package manager for OS X*
- MongoDB
 - *MongoDB - For Giant Ideas*
 - *MongoDB - Getting Started (Node.js driver edition)*
 - *MongoDB - Getting Started (shell edition)*
- Mongoose
 - *MongooseJS Docs*
- Node.js
 - *Node.js home*
 - *Node.js - download*
 - *ExpressJS*
 - *ExpressJS body-parser*
- Redis
 - *redis.io*
 - *redis commands*
 - *redis - npm*
 - *try redis*
 - *Windows support*