

Comp 324/424 - Client-side Web Design

Fall Semester 2019 - Week 12

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JavaScript - ES Modules

extra material

- extra notes on ES Modules
 - *general usage*
 - *custom design and structure*
 - *custom library*
 - *technical overview of module design*
- extra source code examples available
 - *general usage*
 - *custom modules*
 - *custom library example*

JS Server-side considerations - save data

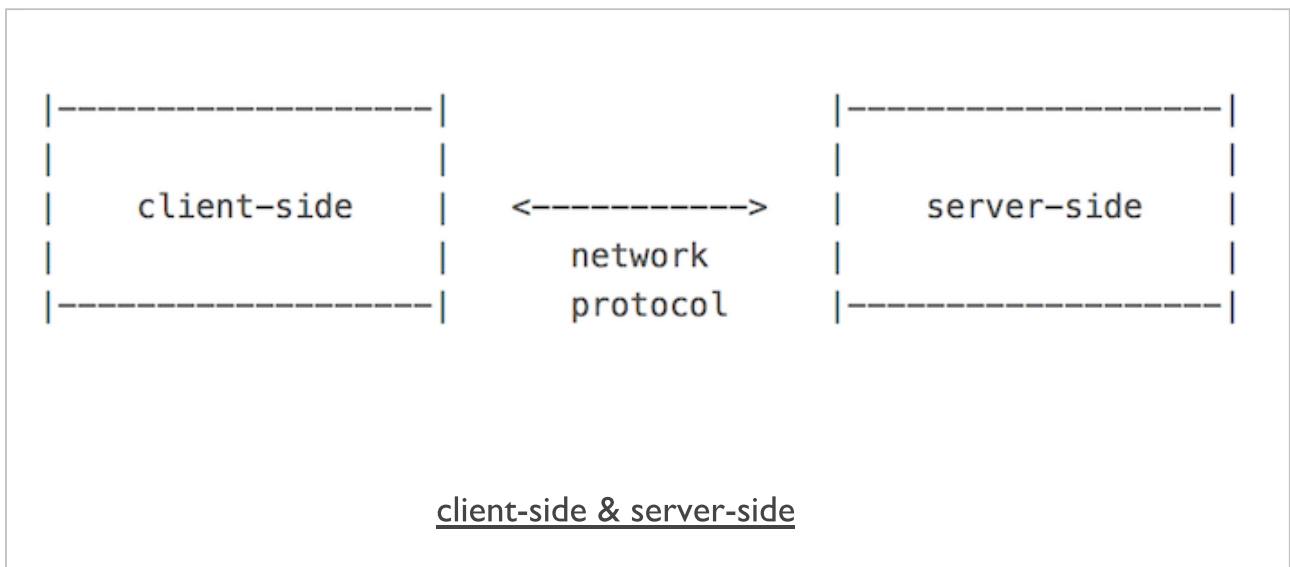
save JSON in travel notes app

- need to be able to save our simple notes
- now load from a JSON file as the app starts
 - *also we can add new notes, delete existing notes...*
- not as simple as writing to our existing JSON file direct from JS
 - *security implications if that was permitted directly from the browser*
- need to consider a few server-side options
- could use a combination of PHP on the server-side
 - *with AJAX jQuery on the client-side*
 - *traditional option with a simple ajax post to a PHP file on the server-side*
- consider JavaScript options on the client and server-side
- brief overview of working with **Node.js**

Server-side considerations - intro

- normally define computer programs as either client-side or server-side programs
- server-side programs normally abstract a resource over a network
 - *enabling many client-side programs to access at the same time*
 - *a common example is file requests and transfers*
- we can think of the client as the web browser
- a web server as the remote machine abstracting resources
- abstracts them via **hypertext transfer protocol**
 - *HTTP for short*
- designed to help with the transfer of HTML documents
 - *HTTP now used as an abstracted wrapper for many different types of resources*
 - *may include documents, media, databases...*

Image - Client-side and server-side computing



Server-side considerations - Node.js

intro - what is Node.js?

- Node.js is, in essence, a JavaScript runtime environment
 - *designed to be run outside of the browser*
- designed as a general purpose utility
- can be used for many different tasks including
 - *asset compilation*
 - *monitoring*
 - *scripting*
 - *web servers*
- with Node.js, role of JS is changing
 - *moving from client-side to a support role in back-end development*

Server-side considerations - Node.js

intro - speed of Node.js

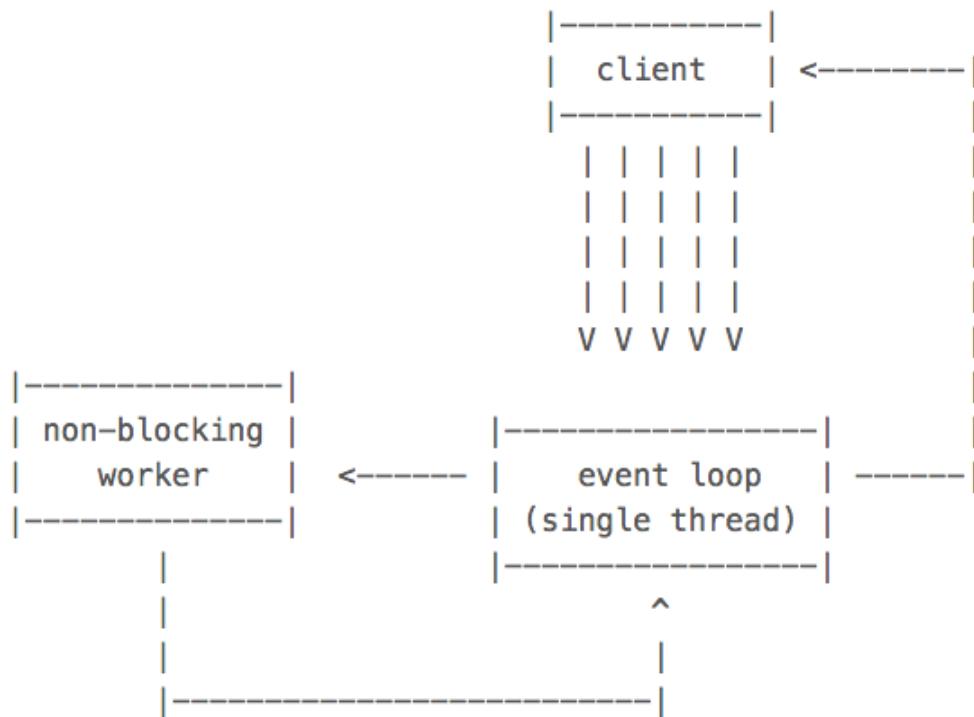
- a key advantage touted for Node.js is its speed
- many companies have noted the performance benefits of implementing Node.js
 - *including PayPal, Walmart, LinkedIn...*
- a primary reason for this speed boost is the underlying architecture of Node.js
- Node.js uses an **event-based** architecture
- instead of a threading model popular in compiled languages
- Node.js uses a single event thread by default
- all I/O is asynchronous

Server-side considerations - Node.js

intro - conceptual model for processing in Node.js

- how does Node.js, and its underlying processing model, actually work?
- client sends a hypertext transfer protocol, HTTP, request
 - *request or requests sent to Node.js server*
- event loop is then informed by the host OS
 - *passes applicable request and response objects as JavaScript closures*
 - *passed to associated worker functions with callbacks*
- long running jobs continue to run on various assigned worker threads
- responses are sent from the non-blocking workers back to the main event loop
 - *returned via a callback*
- event loop returns any results back to the client
 - *effectively when they're ready*

Image - Client-side and server-side computing



Node.js - conceptual model for processing

Server-side considerations - Node.js

intro - threaded architecture

- concurrency allows multiple things to happen at the same time
- common practice on servers due to the nature of multiple user queries
- Java, for example, will create a new thread on each connection
 - *threading is inherently resource expensive*
- size of a thread is normally around 4MB of memory
- naturally limits the number of threads that can run at the same time
- also inherently more complicated to develop platforms that are thread-safe
 - *thereby allowing for such functionality*
- due to this complexity
 - *many languages, eg: Ruby, Python, and PHP, do not have threads that allow for real concurrency*
 - *without custom binaries*
- JavaScript is similarly single-threaded
 - *able to run multiple code paths in parallel due to **events***

Server-side considerations - Node.js

intro - event-driven architecture

- JavaScript originally designed to work within the confines of the web browser
- had to handle restrictive nature of a single thread and single process for the whole page
- synchronous blocking in code would lock up a web page from all actions
 - *JavaScript was built with this in mind*
- due to this style of I/O handling
 - *Node.js is able to handle millions of concurrent requests on a single process*
- added, using libraries, to many other existing languages
 - *Akka for Java*
 - *EventMachine for Ruby*
 - *Twisted for Python*
 - ...
- JavaScript syntax already assumes events through its use of callbacks
- **NB:** if a query etc is CPU intensive instead of I/O intensive
 - *thread will be tied up*
 - *everything will be blocked as it waits for it to finish*

Server-side considerations - Node.js

intro - callbacks

- in most languages
 - *send an I/O query & wait until result is returned*
 - *wait before you can continue your code procedure*
- for example, submit a query to a database for a user ID
 - *server will pause that thread/process until database returns result for ID query*
- in JS, this concept is rarely implemented as standard
- in JS, more common to pass the I/O call a **callback**
- in JS, this **callback** will need to run when task is completed
 - *eg: find a user ID and then do something, such as output to a HTML element*
- biggest difference in these approaches
 - *whilst the database is fetching the user ID query*
 - *thread is free to do whatever else might be useful*
 - *eg: accept another web request, listen to a different event...*
- this is one of the reasons that Node.js returns good benchmarks and is easily scaled
- **NB:** makes Node.js well suited for I/O heavy and intensive scenarios

Server-side considerations - Node.js

install Node.js

- a number of different ways to install **Node.js**, **npm**, and the lightweight, customisable web framework **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*
- example 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

CommonJS modules - custom design and usage

- extra notes available on CommonJS module usage
 - *custom design and usage*
 - *library structure and development*
- extra source code examples available
 - *general usage*
 - *custom modules*
 - *custom library example*

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

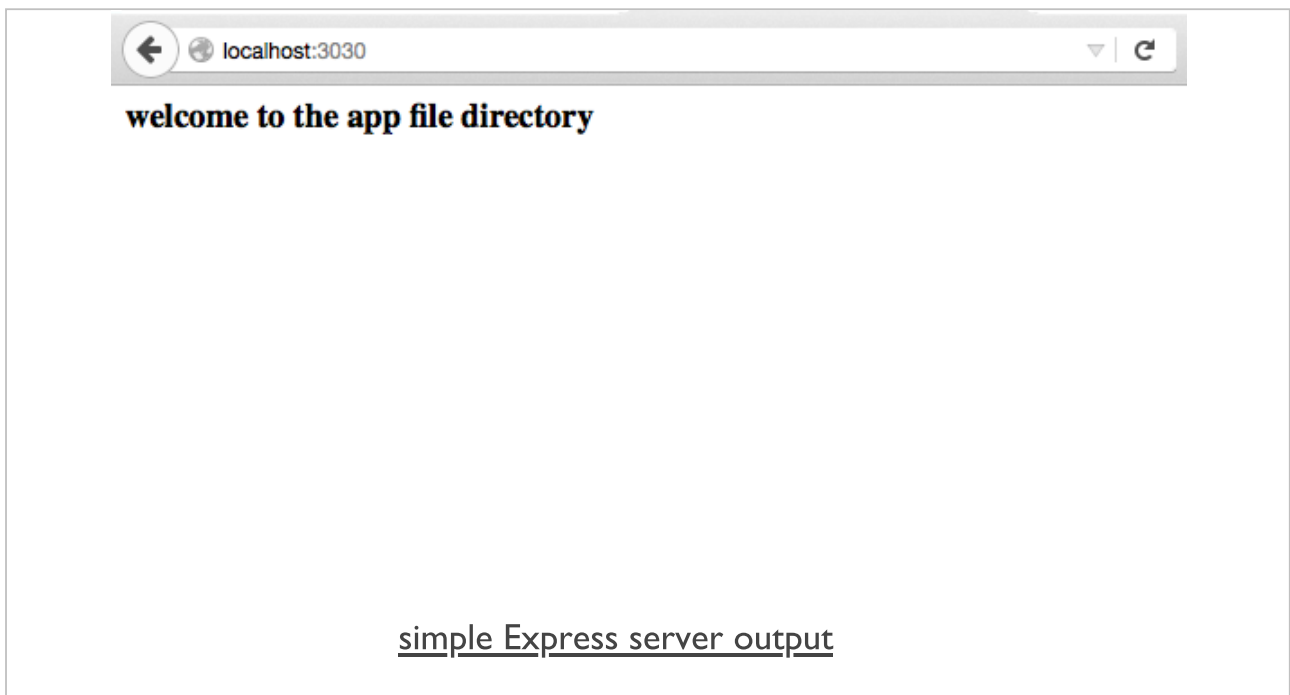
initial Express server - server.js - part 3

- 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

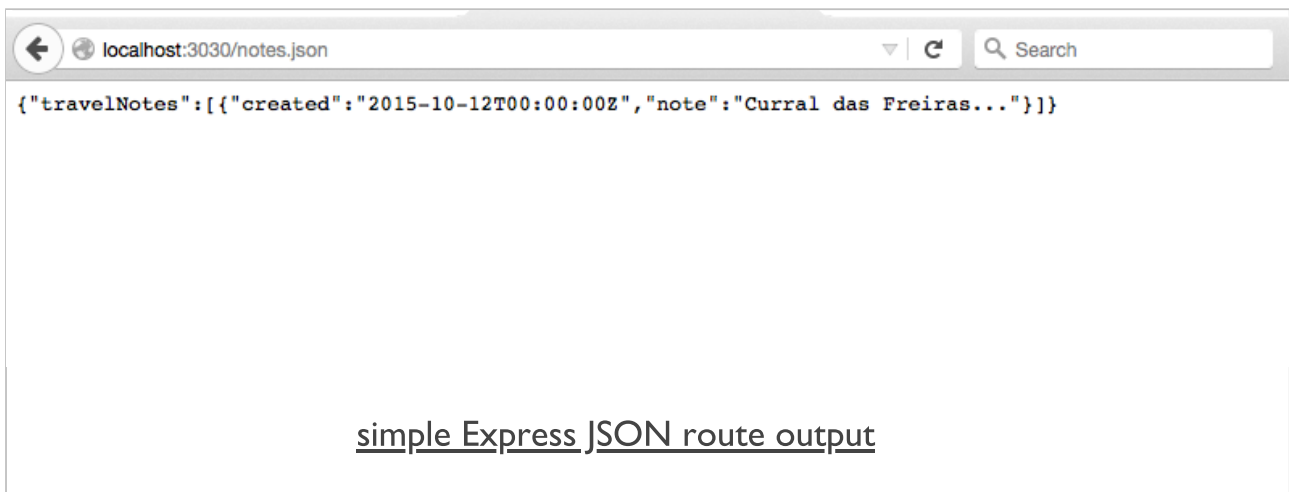
```
var express = require('express'),
    http = require("http"),
    jsonApp = express(),
    notes = {
      "travelNotes": [{
        "created": "2015-10-12T00:00:00Z",
        "note": "Curral das Freiras..."
      }]
    };

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

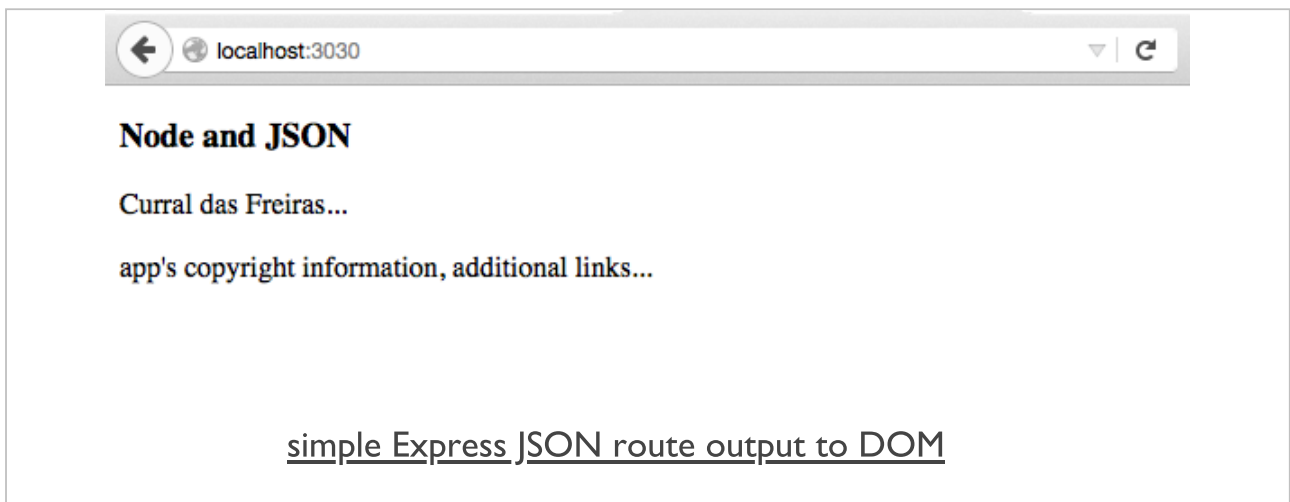
working with data - JSON

- 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-json I

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*
 - *then 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

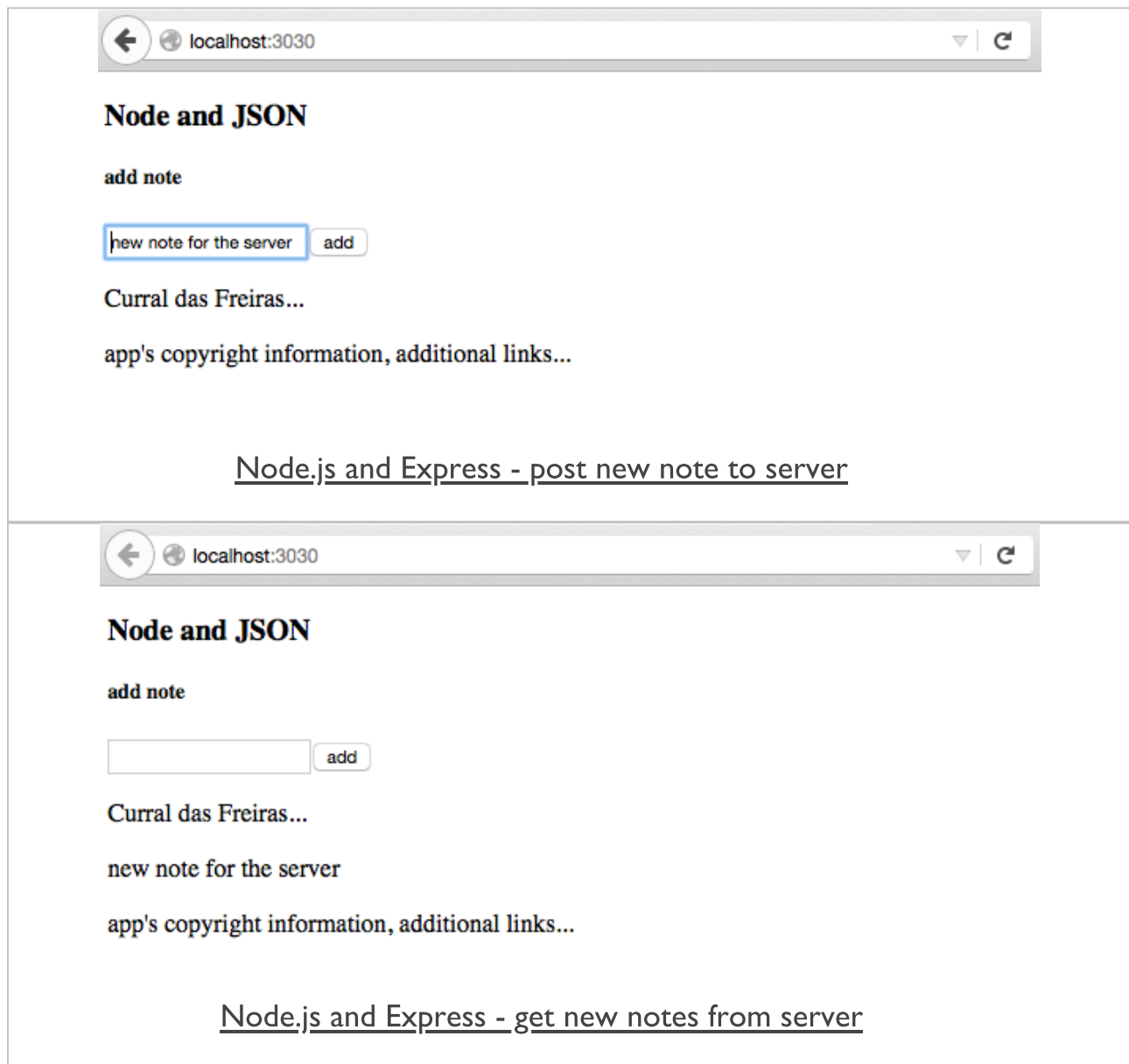
```
$(".note-input button").on("click", function() {  
    //get values for new note  
    var note_text = $(".note-input input").val();  
    var created = new Date();  
    //create new note  
    var newNote = {"created":created, "note":note_text};  
    //post new note to server  
    $.post("notes",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



Node.js extras - API examples

- various custom API examples
 - *ToDo's & ToDo's with testing*
 - *authentication examples*
 - *Notetaking*
 - *...with Socket.io*
 - *...*
- Twitter with Node.js custom server
 - *user queries &c.*
 - *OAuth based login and authentication*
- Yelp with Node.js custom server
 - *custom server and remote API query*
 - *sample handling of local API for queries*

JavaScript - modular design

ES Module pattern - intro

- simpler and easier to work with than CommonJS
 - *in most examples...*
- JavaScript `strict` mode is enabled by default
- `strict` mode helps with language usage - check for poor usage
 - *stops hoisting of variables*
 - *variables must be declared*
 - *function parameters must have unique name*
 - *assignment to read-only properties throws errors*
 - ...
- modules are exported with `export` statements
- modules are imported with `import` statements

JavaScript - modular design

ES Module pattern - export statements

- ES6 modules are individual files
 - *expose an API using `export` statements*
- declarations are scoped to the local module
- e.g. variables declared inside a module
 - *not available to other modules*
 - *need to be explicitly exported in module API*
 - *need to be imported for usage in another module*
- export statements may only be added to *top-level* of a module
 - *e.g. not in function expression &c.*
- cannot dynamically define and expose API using methods
 - *unlike CommonJS module system - Node.js &c.*

JavaScript - modular design

ES Module pattern - export default

- common option is to export a default binding, e.g.

```
export default `hello world`
```

```
export default {  
  name: 'Alice',  
  place: 'Wonderland'  
}
```

```
export default [  
  'Alice', 'Wonderland'  
]
```

```
export default function name() {  
  ...  
}
```

JavaScript - modular design

ES Module pattern - bindings

- ES modules export **bindings**
 - *not values or references*
- e.g. an export of `count` variable from a module
 - *`count` is exported as a binding*
 - *export is bound to `count` variable in the module*
 - *value is subject to changes of `count` in module*
- offers flexibility to exported API
 - *e.g. `count` might originally be bound to an object*
 - *then changed to an array...*
- other modules consuming this export
 - *they would see change as `count` is modified*
 - *modified in module and exported...*
- **n.b.** take care with this usage pattern
 - *useful for counters, logs &c.*
 - *can cause issues with API usage for a module*

JavaScript - modular design

ES Module pattern - named export

- we may define bindings for export
- instead of assigning properties to implicit export object
 - e.g.

```
export let counter = 0
export const count = () => counter++
```

- cannot refactor this example for named export
 - *syntax error will be thrown*
 - e.g.

```
let counter = 0
const count = () => counter++
export counter // this will return syntax error
export count
```

- rigid syntax helps with analysis, parsing
 - *static analysis for ES modules*

JavaScript - modular design

ES Module pattern - export lists

- lists provide a useful solution to previous refactor issue
- syntax for list export easy to parse
- export lists of named *top-level* declarations
 - *variables &c.*
- e.g.

```
let counter = 0
const count = () => counter++
export { counter, count }
```

- also rename binding for export, e.g.

```
let counter = 0
const count = () => counter++
export { counter, count as increment }
```

- define default with export list, e.g.

```
let counter = 0
const count = () => counter++
export { counter as default, count as increment }
```

JavaScript - modular design

ES Module pattern - export from ...

- expose another module's API using `export from...`
 - *i.e. a kind of pass through...*
- e.g.

```
export { increment } from './myCounter.js'
```

- bindings are not imported into module's local scope
- current module acts as conduit, passing bindings along export/import chain...
- module does not gain direct access to `export from ...` bindings
 - *e.g. if we call `increment` it will throw a `ReferenceError`*
- aliases are also possible for bindings with `export from...`
 - e.g.

```
export { increment as addition } from './myCounter.js'
```

JavaScript - modular design

ES Module pattern - import statements

- use `import` to load another module
- `import` statements are only allowed in top level of module definition
 - *same as `export` statements*
 - *helps compilers simplify module loading &c.*
- import default exports
 - *give default export a name as it is imported*
 - e.g.

```
import counter from './myCounter.js'
```

- importing binding to `counter`
- syntax different from declaring a JS variable

JavaScript - modular design

ES Module pattern - import named exports

- also imported any named exports
 - *import more than just default exports*
- named import is wrapped in braces
 - e.g.

```
import { increment } from './myCounter.js'
```

- also import multiple named exports
 - e.g.

```
import { increment, decrement } from './myCounter.js'
```

- import aliases are also supported
 - e.g.

```
import { increment as addition } from './myCounter.js'
```

- combine default with named
 - e.g.

```
import counter, { increment } from './myCounter.js'
```

JavaScript - modular design

ES Module pattern - import with wildcard

- we may also import using the *wildcard* operator
 - e.g.

```
import * as counter from './myCounter.js'  
counter.increment()
```

- name for wildcard import acts like object for module
- call module exports on wildcard

```
import * as counter from './myCounter.js'  
counter.increment()
```

- common pattern for working with libraries &c.

JavaScript - modular design

ES Module pattern - benefits & practical usage

- offers ability to explicitly publish an API
 - *keeps module content local unless explicitly exported*
- similar function to getters and setters
 - *explicit way in and out of modules*
 - *explicit options for reading and updating values...*
- code becomes simpler to write and manage
 - *module offers encapsulation of code*
- import binding to variable, function &c.
 - *then use it as normal...*
- removes need for encapsulation in main JS code
 - *e.g. with patterns such as IIFE...*
- *n.b.* need to be careful how we use modules
 - *e.g. priority for access, security, testing &c.*
 - *all now moved to individual modules...*

JavaScript - modular design

ES Module pattern - Lib structure

- Modules in JavaScript are not a new concept
 - e.g. *CommonJS* is a popular option for modular development with *Node.js*
- a built-in option for plain JavaScript, *ES Modules*.
- use this option to develop and structure custom module libraries
- e.g.
 - *abstract utility modules*
 - *custom draw libraries*
 - *game renderers*
 - ...

JavaScript - modular design

ES Module pattern - JS library

- an example JS library - define the following directory structure

```
.
|-- lib
|   |-- spire
|   |   |-- helpers
|   |   |   |-- log.js
|   |   |   |-- spire.js
|   |-- main.js
|   ...
```

- lib directory contains custom JS libraries, which may then be imported for use within an app
- for app usage, we might structure it as follows

```
.
|-- lib
|   |-- spire
|   |   |-- helpers
|   |   |   |-- log.js
|   |   |   |-- spire.js
|-- index.html
|-- main.js
|   ...
```

JavaScript - modular design

ES Module pattern - JS library - main.js

- `main.js` file is loaded from the `index.html` file
 - *acts as the loader file for JS in an example app*
- also import example *Spire* JS library into an app using this main loader file, e.g.

```
import Spire from './lib/spire/spire.js';
```

- `Spire` object is the access point to the exported methods and variables for custom JS library

JavaScript - modular design

ES Module pattern - JS library - basic usage

- a custom JS library may then be accessed using this `Spire` object
- e.g. we might call a method from the library

```
const greeting = 'greetings from the planet Earth';  
// basic log to console  
Spire.log(`${greeting}...we wish you well`);
```

- custom method `log ()` provides a reusable method
 - e.g. use for various logging options in the application
- might also call the following method using the same pattern

```
Spire.dir({ 'name': 'test dir logger...' });
```

JavaScript - modular design

ES Module pattern - JS library - module usage

- sample usage might include such *helpers*
 - we may package in the directory *spire/helpers/*
 - e.g., we currently have a *log.js* module for various custom loggers

```
// basic logger to console
function log(value, ...values) {
  const logValue = console.log(value, ...values);

  return logValue;
}

// directory logger to console
function dir(value, ...values) {
  const dirValue = console.dir(value, ...values);

  return dirValue;
}
```

- we may then simply export these methods from the *log.js* module, e.g.

```
export {
  log,
  dir
}
```

- interface for this module has now been defined relative to the above exported modules

JavaScript - modular design

ES Module pattern - JS library - import modules

- import this module
 - *allow a module to use these exported methods*
 - *interact with the exposed interface*
- as part of the JS library structure we may define
 - *a root module for organising a unified interface for the overall library*
- e.g. use the module `spire.js` to import required modules and their interfaces

```
import * as loggers from './helpers/log.js';
```

- then define a `Spire` object for the overall library, e.g.

```
const Spire = {  
  log: loggers.log,  
  dir: loggers.dir,  
}
```

- this is then exported as the general interface for the `Spire JS` library, e.g.

```
export default Spire;
```

Responsive Design & Development - Modular Designs

Fun Exercise

Three responsive designs,

- Modular designs -
<http://linode4.cs.luc.edu/teaching/cs/demos/424/gifs/modular/>
 - *Home Design*
 - *Reminders*
 - *Watches*

For each design, consider the following

- define perceived modules for each app
 - *where might you use a module?*
- what type of modules can you define in each app?
 - *e.g. logical, structural, design, performance...*
- from a developer perspective
 - *consider primary modular groupings*
 - *does each module purpose help with testing?*
 - *can each module be decoupled from app?*
 - *e.g. test and use outside of current app...*

~ 10 minutes

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/>*
 - *try WSL*
 - **n.b.** *Redis on Windows is not recommended...*
- 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

Resources

- Chocolatey for Windows
 - *Chocolatey package manager for Windows*
- Homebrew for OS X
 - *Homebrew - the missing package manager for OS X*
- Node.js
 - *Node.js home*
 - *Node.js - download*
 - *ExpressJS*
- Redis
 - *redis.io*
 - *redis commands*
 - *redis - npm*
 - *try redis*
 - *Windows support*