Full Stack JS
Server Side

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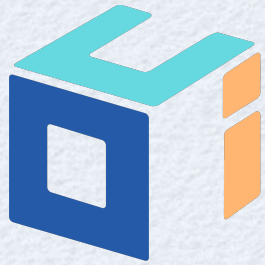


OCI | TRAINING

Outline

- **REST** overview
- **Express** for serving files and implementing REST services
- **cURL** and **Postman** for testing REST services
- **Relational databases** overview
- **MySQL** overview
- **Demo app**
- **Hands on exercises**

Preparation Steps

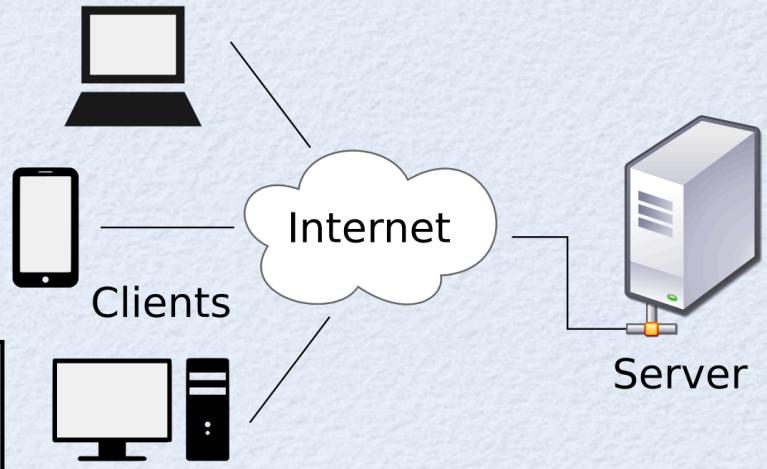
```
git clone https://github.com/mvolkmann/react-tour-of-heroes
cd react-tour-of-heroes
cd server
npm install
cd ../client
npm install
```

Web Application Parts

- Web applications primarily have two parts
- Front-end / client-side
  - dynamic generation of HTML
  - REST calls to retrieve and modify persisted data
  - state management
  - page routing
- Back-end / server-side
  - serve static files
  - implement REST services
  - retrieve and modify persisted data

There are many options.
Most use JavaScript.
Our example app uses React.

There are many options that use many programming languages.
This workshop focuses on writing in JavaScript using Node.js and Express.



REST Overview

- Stands for **RE**presentational **S**tate **T**ransfer
- An architectural style, not a standard or API
- Described in Roy Fielding's dissertation in 2000 (chapter 5)
  - http://www.ics.uci.edu/~fielding/pubs/dissertation/top.htm
- Main ideas
  - a software component requests a "**resource**" from a service
    - by supplying a resource identifier and a desired media type
    - resource identifier can be a URL and request can be made using Ajax
  - a "**representation**" of the resource is returned
    - a sequence of bytes and metadata to describe it
    - can be JSON; name/value pairs in HTTP headers, an image, ...
    - can contain identifiers of other resources
  - obtaining this representation causes the software component to "**transfer**" to a new "**state**"

Typical REST

- Relies on HTTP
- Uses carefully selected URLs to identify resources
- Uses HTTP methods for specific operations

a.k.a. HTTP verbs

primarily for Create-Retrieve-Update-Delete (**CRUD**) operations

  - **GET** - retrieves representation of existing resource identified by URL
  - **POST** - creates a new resource using data in body
    - URL of new resource is not yet known
    - often the request URL identifies an existing parent resource
    - return URL of new resource in **Location header** and **status 201 Created**

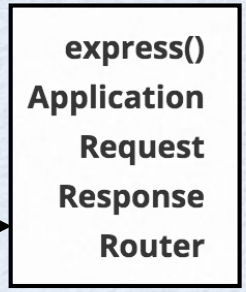
ex. POST to URL for a music artist, supplying data describing a new CD; URL of new CD resource is returned

  - **PUT** - updates existing resource identified by URL using data in body
    - URL of resource is already known
    - like POST, body contains entire description of resource
    - can also create a new resource if its URL is already known
  - **PATCH** - like PUT, but body only describes changes
    - other attributes/properties retain their current value
  - **DELETE** - deletes existing resource identified by URL
  - **POST** - for everything else (non-CRUD operations)

Express

https://expressjs.com/

- "A minimal and flexible Node.js web application framework"
- Provides HTTP request routing and redirection, view rendering, and more
  - routing associates an HTTP method and URL pattern with a function to handle it
  - view rendering typically refers to server-side HTML generation
- Extends request and response objects from Node **`http`** module
  - with extra properties and methods
- To install
  - **`npm install express`**
- API documentation
  - https://expressjs.com/en/4x/api.html
  - click these in upper-right 
- Example code
  - https://github.com/expressjs/express/tree/master/examples



Express Use Cases

- Serve static files
  - HTML, CSS, JavaScript, images, audio, video, PDFs, ...
- Serve dynamically generated content
  - including HTML
- Act as a REST server
  - most popular use case and our focus

Express Does Not Provide

- Help with defining and using model objects
- Database access
- Object-Relational Mapping (ORM)
- HTML templating
- User authentication
- Security

Many other Node modules provide these features!

Middleware ...

- Not a term unique to Express, but it has a specific definition
- A function that takes
  - a request object
  - a response object
  - a `next` function

```
function myMiddleware(req, res, next) {
  // Maybe do something with req.
  // Maybe do something with res.
  // Either call next or
  // cause response to be sent to client.
}
```

If it doesn't call `next` then technically it isn't "middle"-ware.

- A single request can be processed by a sequence of these
  - "middleware stack"
  - run in order registered
- Calling `next` allows next middleware in stack to run
  - supports performing asynchronous actions where the next middleware cannot start until the current one completes an asynchronous action
  - to report an error and skip remaining middleware, pass an `Error` object to `next`, do not throw
    - ex. `next(new Error('something bad happened');`

… Middleware

- Examples include
  logging, authentication, authorization,
  cookie parsing (**`cookie-parser`**),
  request body parsing (**`body-parser`**),
  and response compression
- The only included middleware is **`express.static`**
  - uses npm package **serve-static** to serve files from a given directory
- Many third party middleware modules are available
  - good source is http://expressjs.com/resources/middleware.html

Serving Static Files

```
const express = require('express');

const app = express();

// Can have multiple lines like the following to specify
// each directory to be searched for static files.
app.use(express.static('public'));

const PORT = 1234;
app.listen(PORT,() => console.log('ready'));
```

browse http://localhost:1234/foo/bar.html to see the file **public/foo/bar.html**

Simple Route Handling

```
const express = require('express');

const app = express();

app.get('/',
  (req, res) => res.send('Hello!'));

const PORT = 1234;
app.listen(PORT, () =>
  console.log('browse http://localhost:' + PORT));
```

a middleware function

Using Middleware

- To register a middleware

`app.use(myMiddleware);` or `app.use(path, myMiddleware);` to only run for matching paths

  - can run before or after handlers for specific paths (see next slide)

- Each is called in the order in which it was registered

```
const express = require('express');
const morgan = require('morgan');

const app = express();

app.use(morgan('short')); // request logging

app.use(express.static('public'));

app.get('/hello', (req, res) => {
  res.send('Hello, World!');
});

const port = 3000;
app.listen(port, () =>
  console.log('listening on port', port));
```

a middleware function

browse http://localhost:3000/hello

Routes

- To listen for requests using a specific HTTP method, **`app.`*`method`*`(`*`path`*`, `*`middlewareFn`*`)`**

  referred to as defining "routes"

  - ***`path`*** is a string or regular expression
  - ***`method`*** is one of **`get`**, **`patch`**, **`post`**, **`put`**, **`delete`**, or one of the many less commonly uses HTTP methods
- Can use to implement a REST API
- Can register more than middleware for the same path
  - run in order registered

Request Data Passing Options

- Query parameters
  - at end of URL after `?`
  - ex. `http://cars.com/car?make=MINI&model=Cooper&year=2015`
- Path parameters
  - positional, slash-separated data at end of URL
  - ex. `http://cars.com/car/MINI/Cooper/2015`
- Body
  - can be text or binary data
  - often JSON text
  - specify format in `Content-Type` request header (ex. `application/json`)
  - ex.

```
{
  "make": "MINI",
  "model": "Cooper",
  "year": 2015
}
```

Query Parameters

- Query parameters are gathered in an object stored in **`query`** property of request object that is passed to middleware
  - ex. `http://cars.com/car?make=MINI&model=Cooper&year=2015`
- Can use destructuring to get values

```
const {make, model, year} = req.query;
```

- When query parameters are repeated, the value is an array of strings instead of a string
  - ex. `http://market.com/order?fruit=apple&fruit=banana&dairy=milk`
  - `req.query.fruit` is `['apple', 'banana']`
  - `req.query.dairy` is `'milk'`

Path Parameters

- Include names preceded by colons in route path
  - ex. '`/car/:make/:model/:year`'
- Path parameters are gathered in an object stored in **`params`** property of request object that is passed to middleware
- Can use destructuring to get values

```
const {make, model, year} = req.params;
```

Request Bodies

- Use **`body-parser`** npm package
  - to install, **`npm install body-parser`**
  - to use, **`const bodyParser = require('body-parser');`**
- To parse JSON
  - **`app.use(bodyParser.json());`**
  - used when request **`Content-Type`** header is **`'application/json'`**
- To parse plain text
  - **`app.use(bodyParser.text());`**
  - used when request **`Content-Type`** header is '**`text/plain`**'
- To parse HTML form data
  - **`app.use(bodyParser.urlencoded({extended: true}));`**
  - used when request **`Content-Type`** header is '**`application/x-www-form-urlencoded`**'

can pass an options object to the **`json`**, **`text`**, and **`urlencoded`** methods; see https://www.npmjs.com/package/body-parser

when **`extended`** is **`true`**, the **`qs`** library is used which "allows for rich objects and arrays"

when **`extended`** is **`false`**, the **`querystring`** library is used

Request Properties

- **`body`**
  - object populated when **`body-parser`** middleware parses a request body
- **`ip`**
  - IP address of sender
  - could use as part of authentication solution
- **`params`**
  - object that holds properties extracted from URL path
  - ex. **`/car/:make/:model/:year`**
- **`query`**
  - object that holds parsed query parameters
- and many more

HTTP Status Codes

- Levels
  - **1xx** - informational
  - **2xx** - **success**
  - **3xx** - redirection
  - **4xx** - **client errors**
  - **5xx** - **server errors**
  - **6xx** - unofficial
- Commonly used
  - **200** - OK
  - **304** - Not Modified
  - **400** - Bad Request
  - **404** - Not Found
  - **500** - Internal Server Error
- Less-commonly used
  - **201** - Created; successfully created a resource
  - **202** - Accepted; request will be successful; but will be handled later asynchronously
  - **204** - No Content; success with no response (ex. delete)
  - **301** - Moved Permanently; resource URL changed; new URL is in Location header
  - **401** - Unauthorized; can't perform action because user hasn't authenticated (logged in)
  - **403** - Forbidden; user has authenticated, but doesn't have permission for the action
  - and many more

set in response by calling
`res.status(code)`
(see next slide)

Response Methods

- To send data
  - `res.send(data);`
    - where *data* is a string, object, array, or `Buffer`
  - `res.json(data);`
    - converts *data* to JSON by calling `JSON.stringify(data)`

`Content-Type` response header is automatically set to `text/html` for strings and `application/json` for objects

- To send file content
  - `res.sendFile(filePath);`
- To set response headers
  - `res.set(name, value)` or `res.set(obj)` to set many in one call
- To set response status
  - `res.status(code)`
  - defaults to 200 (success),
    404 if no route matches the URL, and
    500 if any middleware throws an error
  - can chain a call to `send`, `json`, or `sendFile` after this
- and many more

example
```
res.status(400).send('bad car make');
```

Automatic Server Restart

- During iterative server development it's convenient for the server to restart automatically when source files change
- Two good approaches for Node
- **nodemon**
  - http://nodemon.io/
  - good option when not transpiling code
  - `npm install -g nodemon`
  - use `nodemon` command in place of `node` command
  - if server crashes, waits for file changes before restarting
- **babel-watch**
  - https://www.npmjs.com/package/babel-watch
  - good option when using Babel to transpile code

```
"start-dev": "nodemon src/index.js",
```

```
"start-dev": "babel-watch --message 'restarting' --ignore node_modules -- src/index.js",
```

Routers

- A mechanism to organize a server into related routes with each group defined in a separate source file
- Example

index.js

```
import express from 'express';
import fooRouter from './foo-router';

const app = express();

app.use('/foo', fooRouter);
// Can register more routers.

app.listen(3001);
```

foo-router.js

```
import express from 'express';
const router = express.Router();

// Register middleware that is only used
// for routes defined on this router.
router.use(someMiddleware);

function fooBarHandler(req, res) {
  res.send('baz');
}
router.get('/bar', fooBarHandler);

export default router;
```

url to access this is
`http://localhost:3001/foo/bar`

Using HTTPS ...

- Need an SSL certificate
  - many options
- Option #1
  - generate private key - `openssl genrsa -out privatekey.pem 1024`
  - generate signing certificate request - `openssl req -new -key privatekey.pem -out request.pem`
    - answer questions
  - request a certificate using https://letsencrypt.org
- Option #2
  - use openssl

```
openssl req -x509 \
  -sha256 \
  -nodes \
  -newkey rsa:2048 \
  -days 365 \
  -keyout localhost.key \
  -out localhost.crt
```

based on an answer at
http://stackoverflow.com/questions/8169999/how-can-i-create-a-self-signed-cert-for-localhost

… Using HTTPS

- Can configure Express to support both HTTP and HTTPS

```
const express = require('express');
const fs = require('fs');
const http = require('http');
const https = require('https');

const app = express();

// Register middlewares and specify routes.

const HTTP_PORT = 80;
const HTTPS_PORT = 443;

const httpsOptions = {
  key: fs.readFileSync('.localhost.key'),
  cert: fs.readFileSync('.localhost.crt')
};

http.createServer(app).listen(HTTP_PORT);
https.createServer(httpsOptions, app).listen(HTTPS_PORT);
```

browsing https://localhost will use port 443 by default

start server with **`sudo node server.js`**

CORS

- Stands for "Cross-Origin Resource Sharing"
- Allows clients to use services from domains other than the one from which they were served
  - host and/or port differs
- Must enable in servers
- Easiest way for Node servers to support this
  - **`npm install cors`**
    - see https://www.npmjs.com/package/cors
  - can configure to only allow requests from specified domains
    - allows all by default
  - can configure to only allow specified HTTP methods
    - allows all by default

```
import cors from 'cors';
app.use(cors());
```

cURL

- "Client for URLs" to use with Windows, install Cygwin (http://cygwin.com) or see http://curl.haxx.se
- Command-line tool for evaluating many kinds of internet protocol requests
  - HTTP, HTTPS, FTP, LDAP and many more
  - **`curl [`*`options`*`] [`*`urls`*`]`**
- URLs
  - can guess protocol; not necessary to include **`http://`** prefix
  - encode special characters (URI encoding, a.k.a. percent-encoding)
    - ex. **`%20`** for spaces, **`%2F`** for slashes search for "percent-encoding" in Wikipedia
  - ampersands separating query parameters must be preceded by backslashes
    - ex. **`http://foo.com:1234/bar/baz?kind=lucky\&value=7`**

- Exit codes
  - there are a large number of them (~ 80) that can be tested for in scripts
  - ex. 3 = URL malformed; 6 = couldn't resolve host; 7 = failed to connect to host
  - see man page for list (**`man curl`**)

cURL Options ...

- **`--help`** or **`-h`** - output help
- **`--request`** or **`-X verb`** - HTTP verb to be used
  - ex. **`GET`** (default), **`POST`**, **`PUT`**, **`PATCH`**, **`DELETE`**
- **`--header`** or **`-H 'name: value'`** - request header
  - ex. `-H 'Content-Type: application/json'`
  - use once for each request header
- **`--data`** or **`-d 'data'`** - body data
  - use with HTTP **`POST`**, **`PUT`**, and **`PATCH`**
  - changes default verb to **`POST`**
  - to get data from a text file, `-d @file-path`
  - to get data from a binary file, `--data-binary @file-path`
  - to get data from stdio, `-d @-`; after entering data, press return and ctrl-d

space between option and value is optional

option values containing special characters must be surrounded with single or double quotes

... cURL Options

- **`--user`** or **`-u username[:password]`** - for authentication
  - will prompt for password if omitted
- **`--include`** or **`-i`** - include response headers in output
- **`--head`** or **`-I`** - send a **`HEAD`** request
  - same as **`GET`**, but only returns response headers, not body
  - **`-XHEAD`** doesn't work
- **`--location`** or **`-L`** - for redirection
  - if a 3xx status is returned indicating redirection (ex. data has moved), this reissues the command with the new location
- **`--write-out`** or **`-w 'format'`** - for additional output after successful response
  - ex. to add a newline, **`-w '\n'`**
  - many variables can be included in format using **`%{name}`**; see man page for list
  - ex. **`-w '\n%total time = {time-total} seconds\n'`**
- **`--output`** or **`-o file-path`** - write output to a file instead of stdout

`curl` Examples for Demo App

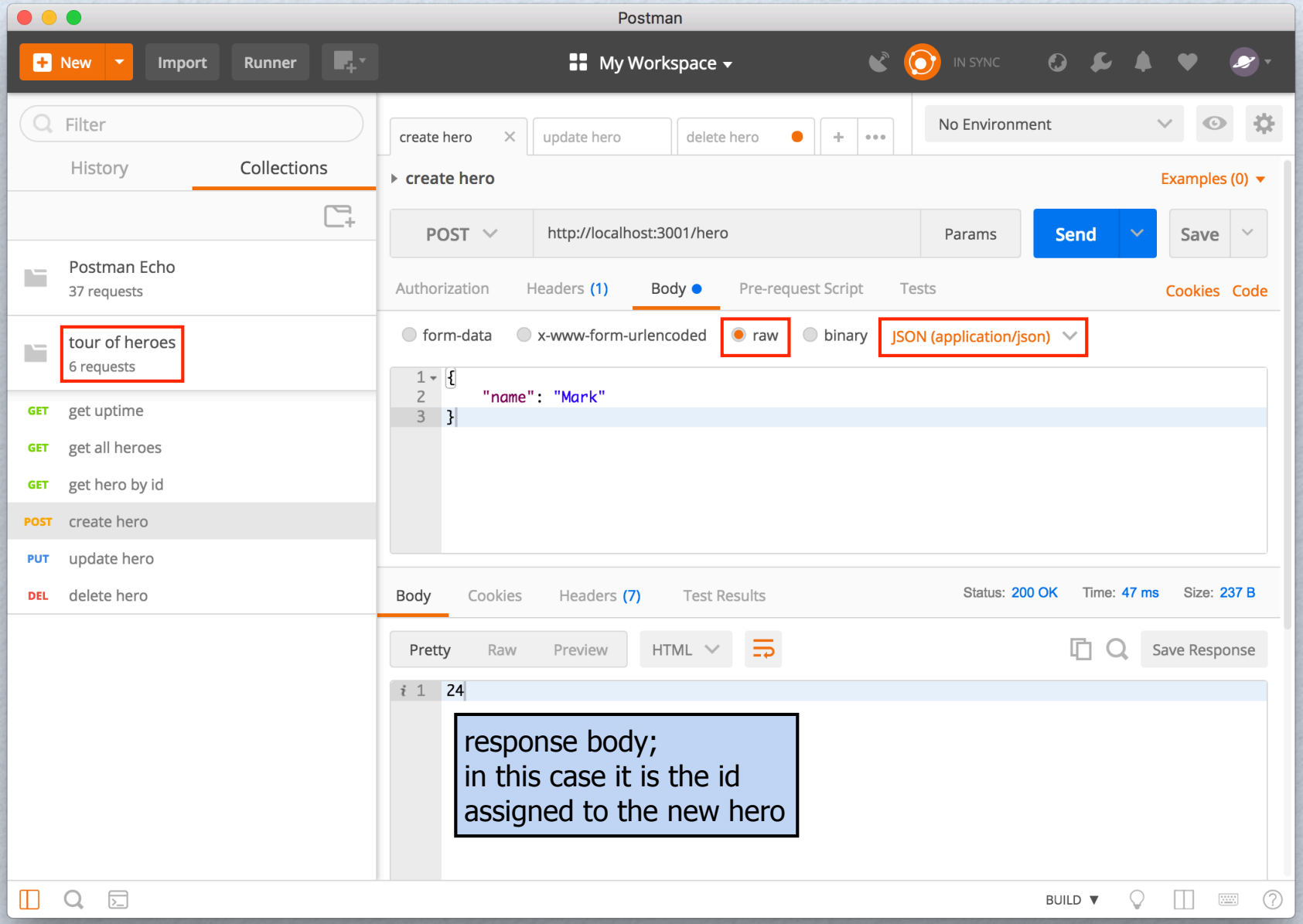
- Get uptime
  - `curl localhost:3001`
- Get all heroes
  - `curl localhost:3001/hero`
- Get hero by id
  - `curl localhost:3001/hero/id`
- Create hero
  - `curl -X POST -H "Content-Type: application/json" \`
    `-d '{"name": "name"}' localhost:3001/hero`
- Update hero
  - `curl -X PUT -H "Content-Type: application/json" \`
    `-d '{"name": "new-name"}' localhost:3001/hero/id`
- Delete hero by id
  - `curl -X DELETE localhost:3001/hero/id`

Postman ...

https://www.getpostman.com/

- Application for testing REST APIs
- Free for basic use cases
- Enter and send HTTP requests
- Organize requests in "collections"
- Name and describe each saved request
- Select a previous request and resend
- To include a JSON request body
  - add `Content-Type` header with a value of `application/json`
  - add body with type "raw" and "JSON" (see next slide)

... Postman


Postman
New
Import
Runner
My Workspace
IN SYNC
Filter
History
Collections
Postman Echo
37 requests
tour of heroes
6 requests
GET get uptime
GET get all heroes
GET get hero by id
POST create hero
PUT update hero
DEL delete hero
create hero
update hero
delete hero
No Environment
create hero
Examples (0)
POST
http://localhost:3001/hero
Params
Send
Save
Authorization
Headers (1)
Body
Pre-request Script
Tests
Cookies
Code
form-data
x-www-form-urlencoded
raw
binary
JSON (application/json)
{
"name": "Mark"
}
Body
Cookies
Headers (7)
Test Results
Status: 200 OK
Time: 47 ms
Size: 237 B
Pretty
Raw
Preview
HTML
Save Response
24
response body;
in this case it is the id
assigned to the new hero
BUILD

Try It!

- Implement a simple REST service
  - add numbers passed in request body JSON array
- Steps
  - create directory **express-demo** and cd to it
  - **npm init**
    - accept all defaults; creates **package.json**
  - **npm install express body-parser**
  - **npm install -g nodemon**
  - edit **package.json scripts**

```
"scripts": {
  "start": "nodemon index.js"
},
```

  - create **index.js**
  - **npm start**
  - test using Postman

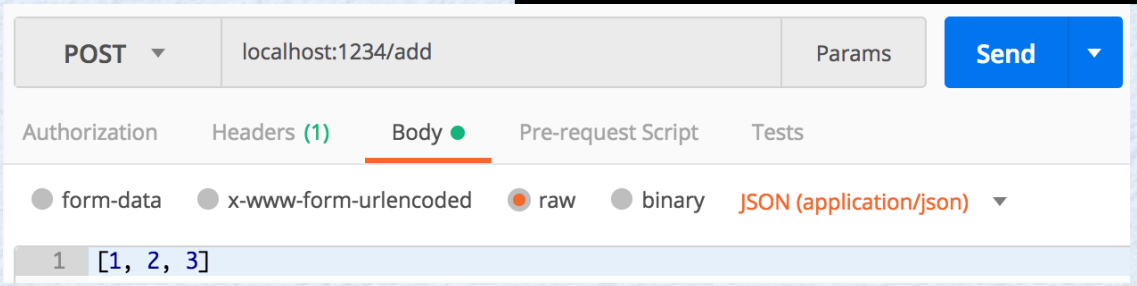
```
const express = require('express');
const bodyParser = require('body-parser');

const app = express();

app.use(bodyParser.json());

app.post('/add', (req, res) => {
  const numbers = req.body;
  const sum = numbers.reduce(
    (sum, n) => sum + n);
  res.send(String(sum));
});

const PORT = 1234;
app.listen(PORT, () => console.log(
  'browse http://localhost:' + PORT));
```



Relational Databases

- There are many ways to persist data on a server
- Relational databases are the most popular option and our focus
- Many npm packages are available for specific databases
- Some npm packages support multiple databases
  - **Sequelize** supports Microsoft SQL Server, MySQL, PostgreSQL, and SQLite
    - http://docs.sequelizejs.com/
- We will focus on MySQL and use **mysql-easier**
  - https://www.npmjs.com/package/mysql-easier

SQL Review

- Language for interacting with relational databases
  - details sometimes vary between databases

Create table

```
create table table-name (
  column-name type modifiers,
  ...
)
```

examples of modifiers include `not null` and `primary key`

Delete table

```
drop table table-name
```

Insert rows

```
insert into table-name
  (column-name, ...)
  values (value, ...)
```

Update rows

```
update table-name
set column-name=value, ...
where condition
```

Delete rows

```
delete from table-name
where condition
```

Retrieve rows

```
select [unique] column-name, ...
from table-name, ...
where condition
order by column-name, ...
```

SQL Joins

- Example "inner join" query

```
select p.name, a.zip
from person p, address a
where p.address_id = a.id
```

- JSON result is

```
[
  {"name": "Mark Volkmann", "zip": 63304},
  {"name": "Matt Bremehr", "zip": 12345}
]
```

person table

id	name	role	address_id
1	Mark Volkmann	developer	19
2	Matt Bremehr	sales	20

address table

id	street	city	state	zip
19	644 Glen Summit	St. Charles	MO	63304
20	123 Some Street	Some City	MO	12345

MySQL

https://www.mysql.com/

- To verify version installed
  - `mysql --version`

npm scripts shown here must be run from `react-tour-of-heroes/server` directory

- To start server
  - `npm run dbstart`
- To stop server
  - `npm run dbstop`

Don't use these in Windows since the MySQL server is installed to run as a Windows service.

- To populate `tour_of_heroes` database with `hero` table and initial data
  - `npm run dbsetup`
- To enter interactive mode where SQL statements can be entered
  - `npm run dbi`

and can run commands like "`show databases`", "`show tables`", and "`describe table-name`"

mysql-easier ...

https://www.npmjs.com/package/mysql-easier

- Makes it very easy to interact with MySQL databases
- **`npm install mysql-easier`**
- Example

For **PostgreSQL**, see
https://www.npmjs.com/package/**postgresql-easy**

```
const mse = require('mysql-easier');
const config = require('./config.json');
mse.configure(config);

async function demo() {
  const conn = await mse.getConnection();
  const newId = await conn.insert(
    'food', {name: 'Apple', color: 'Red'});
  const item = await conn.getById('food', newId);
  console.log(item.name) // Apple
  conn.deleteById('food', newId);

  // If finished with connection ...
  await conn.done();

  // If ready to exit app ...
  await mse.endPool();
}

demo();
```

config.json

```
{
  "database": "myDbName",
  "debug": false,
  "host": "localhost",
  "password": "",
  "port": 3306,
  "user": "root"
}
```

… mysql-easier

- Emphasizes tables with columns named "`id`" that are auto-incrementing primary keys
- `MySqlEasier` methods include
  - `configure`
  - `createPool`, `endPool` ← for pools of connections that support concurrent operations
  - `createConnection` (non-pooled), `getConnection` (from global pool)
- `MySqlConnection` methods include
  - `deleteAll`, `deleteById`
  - `getAll`, `getById`
  - `insert`
  - `query` - accepts any SQL statement and parameters
  - `updateById`, `upsert` — `upsert` updates if present and inserts otherwise
  - `transaction`
  - `done` - closes connection; if from a pool, returns it to pool

Wrap Up

- Server-side recommendations
  - Node.js
  - Express
  - Babel
  - MySQL and mysql-easier
  - PostgreSQL and postgresql-easy
- Recommendations for both sides
  - ESLint
  - Prettier

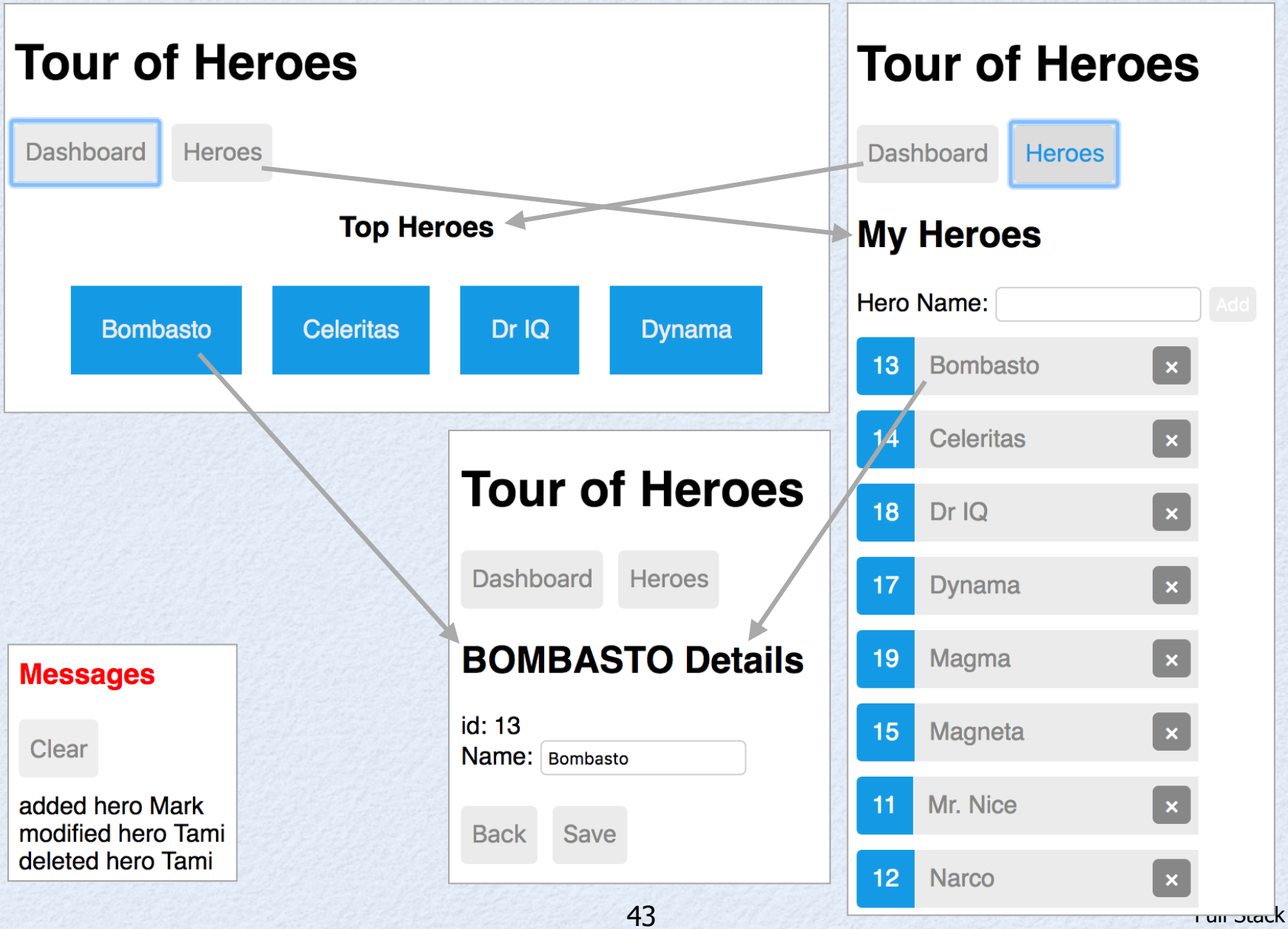
Demo App

- "Tour of Heroes" is the app used in the Angular tutorial
  - https://angular.io/tutorial
- Let's walk through how it can be implemented using Node.js, Express, MySQL, and React
  - code is at https://github.com/mvolkmann/react-tour-of-heroes
- Contains **`client`** and **`server`** directories
- Uses Flow for type checking

Steps to Run Demo App

- `git clone https://github.com/mvolkmann/react-tour-of-heroes.git`
- In terminal window #1
  - `cd` to repo directory
  - `cd server`
  - `npm install`
  - `npm run dbstart` (if not in Windows)
  - `npm run dbsetup`
  - `npm run start-dev`
- In terminal window #1
  - `cd` to repo directory
  - `cd client`
  - `npm install`
  - `npm start`
- In any browser (except IE), browse localhost:3000

Demo Screenshots



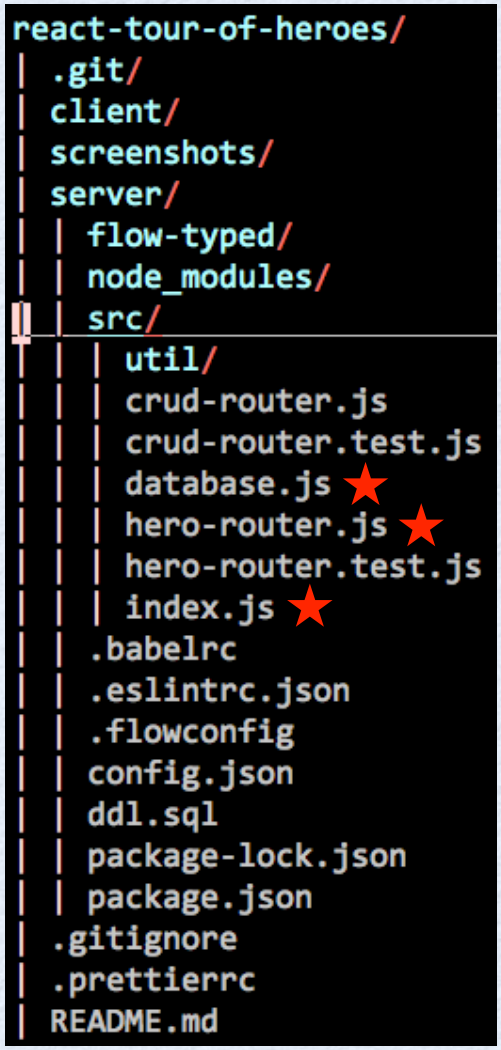
```
react-tour-of-heroes/
| .git/
| client/
| | node_modules/
| | public/
| | | favicon.ico
| | | index.html ★
| | | manifest.json
| | src/
| | | dashboard/
| | | | dashboard.css
| | | | dashboard.js
| | | | dashboard.scss
| | | hero-detail/
| | | | hero-detail.css
| | | | hero-detail.js
| | | | hero-detail.scss
| | | hero-list/
| | | | hero-list.css
| | | | hero-list.js
| | | | hero-list.scss
| | | messages/
| | | | messages.css
| | | | messages.js
| | | | messages.scss
| | | util/
| | | | error-util.js
| | | | rest-util.js
| | | App.css
| | | App.js ★
| | | App.scss
| | | index.js ★
| | | initial-state.js
| | | reducers.js
| | | share.css
| | | share.scss
| | | types.js
| | .eslintrc.json
| | .flowconfig
| | package-lock.json
| | package.json
```

Client-side Files

We will cover this in much more detail in the "Client" section of the workshop!

- `.css` files are generated from `.scss` files using Sass CSS preprocessor
- React components are **`App`**, **`Dashboard`**, **`HeroDetail`**, **`HeroList`**, and **`Messages`**
- Uses redux-easy npm package to simplify use of Redux for state management
  - https://www.npmjs.com/package/redux-easy
- Uses Fetch API to make REST calls
  - encapsulated in **`src/util/rest-util.js`**
- **`public/index.html`** - provides element where **`App`** component will render
- **`src/index.js`** - configures use of Redux using redux-easy
- **`src/App.js`** - topmost component; decides what to render based on **`route`** state property

Server-side Files



- **`src/index.js`** - configures use of many npm packages
  - **body-parser** for parsing request bodies containing JSON and text
  - **cors** for "cross-origin resource sharing"
  - **express** for middleware and REST service routes
  - **express-healthcheck** for uptime stats
  - **morgan** for request logging
- **`src/database.js`** - configures use of MySQL using **mysql-easier**
- **`src/hero-router.js`**
  - used by **`src/index.js`**
  - configures Express routes related to heroes
  - implements REST services
  - see functions **`deleteHero`**, **`getAllHeroes`**, **`getHeroById`** (not used by UI), **`postHero`** (to create new), and **`putHero`** (to modify existing)
  - see **`wrap`** function that gets database connection and provides error handling

REST Calls

to http://localhost:3001

- **`client/src/util/rest-util.js`**
  - exports functions that use the Fetch API to make REST calls
  - includes **`deleteResource`**, **`getJson`**, **`getText`**, **`patchJson`**, **`post`** (no body), **`postJson`**, and **`putJson`**
- **`GET /`** - health check that returns uptime
- **`GET /hero`** - gets JSON array of all heroes in database
  - see **`getJson`** call in **`client/src/index.js`**
- **`POST /hero`** - creates a new hero
  - see **`postJson`** call in **`client/src/hero-list/hero-list.js`**
- **`PUT /hero/id`** - updates a hero
  - currently only a name change
  - see **`putJson`** call in **`client/src/hero-detail/hero-detail.js`**
- **`DELETE /hero/id`** - deletes a hero
  - see **`deleteResource`** call in **`client/src/hero-list/hero-list.js`**

We saw these earlier in curl examples.

Demo Database ...

- Uses MySQL
- To start database daemon
  - `cd server`
  - `npm run dbstart`
  - listens on port 3306 by default
  - to stop, `npm run dbstop`
- Database schema is defined in `server/ddl.sql`
- After changing schema or to restore data
  - `cd server`
  - `npm run dbsetup` (runs this)
  - restart server so it can connect to new database
  - refresh browser

not needed if using Windows and the MySQL server is running as a Windows serivce

```
drop database if exists tour_of_heroes;
create database tour_of_heroes;

use tour_of_heroes;

create table hero (
  id int auto_increment primary key,
  name varchar(100) not null,
  unique uniqueName (name)
);

insert into hero (id, name) values
(11, 'Mr. Nice'),
(12, 'Narco'),
(13, 'Bombasto'),
(14, 'Celeritas'),
(15, 'Magneta'),
(16, 'RubberMan'),
(17, 'Dynama'),
(18, 'Dr IQ'),
(19, 'Magma'),
(20, 'Tornado');
```

a constraint

… Demo Database

- To examine database
  - `cd server`
  - `npm run dbi`
  - `show tables;`
  - enter SQL queries like `select * from hero;`

```
npm run dbi

> server@1.0.0 dbi /Users/Mark/Documents/programming/languages/javascript/reac
t/react-tour-of-heroes/server
> mysql --user root -p tour_of_heroes

Enter password:
Reading table information for completion of table and column names
You can turn off this feature to get a quicker startup with -A

Welcome to the MySQL monitor.  Commands end with ; or \g.
Your MySQL connection id is 1507
Server version: 5.7.20 Homebrew

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affiliates. Other names may be trademarks of their respective
owners.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.
```

```
mysql> show tables;
+--------------------------+
| Tables_in_tour_of_heroes |
+--------------------------+
| hero                     |
+--------------------------+
1 row in set (0.00 sec)

mysql> select * from hero;
+----+-----------+
| id | name      |
+----+-----------+
| 13 | Bombasto  |
| 14 | Celeritas |
| 18 | Dr IQ     |
| 17 | Dynama    |
| 19 | Magma     |
| 15 | Magneta   |
| 11 | Mr. Nice  |
| 12 | Narco     |
| 16 | RubberMan |
| 20 | Tornado   |
+----+-----------+
10 rows in set (0.00 sec)

mysql>
```

Hands On Exercise #1

- Add a REST service to the "Tour of Heroes" app
- Implement ability to search for all heroes whose name contains a given string
  - add a route and a middleware function in **server/src/hero-router.js**

```
router.get('/contains/:contains', wrap(filterHeroes));

export async function filterHeroes(req) {
  const {contains} = req.params;
  // Set sql variable to a SQL string
  // that selects all heroes whose names
  // contain the string in the variable contains.
  // Hint: `where name like "%${contains}%"`
  return conn.query(sql);
}
```

solution is in **server/src/filter-heroes.solution**

- Test using curl or Postman
  - send GET request to proper URL

Hands On Exercise #2

for an example of using **JWT** and cookies,
see https://github.com/mvolkmann/node-rest-demo

- Implement middleware that performs authentication
  - modify **`server/src/index.js`**
  - get "token" from **`Authorization`** header
  - verify it is set to **`'magic token'`**
  - don't check if HTTP method is **`OPTIONS`**

```
function authenticate(req, res, next) {
  // Don't require authentication for OPTIONS requests.
  // Check req.method.
  // Use req.get(name) to get value of a request header.
  // If bad token, set response status to 401
  // and send the text "Unauthorized".
  // If good token, call next().
}

// Authenticate only routes that start with /hero.
app.use('/hero', authenticate);
```

solution is in **`server/src/authenticate.solution`**

In a real app, could have a login page that

- sends username and password to server
- gets an encrypted token that contains things like username, client IP address, and expiration timestamp
- includes encrypted token in **`Authorization`** request header of all REST calls

The server could decrypt tokens and produce an error if the token isn't recognized or has expired.

- Test using curl or Postman
  - GET requests to **`localhost:3001/hero`** should fail unless required **`Authorization`** header set to "**`magic token`**" is present