Node.js with Express

CSCI2720 2020–21 Term 2

Building Web Applications

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Outline

- Overview of Node.js
- Express Basics
  - Routing
  - Retrieving data from query string (GET) and from body (POST)
  - Retrieving header fields from a request
  - Setting header fields in a response
  - Generating content of a response

Web servers

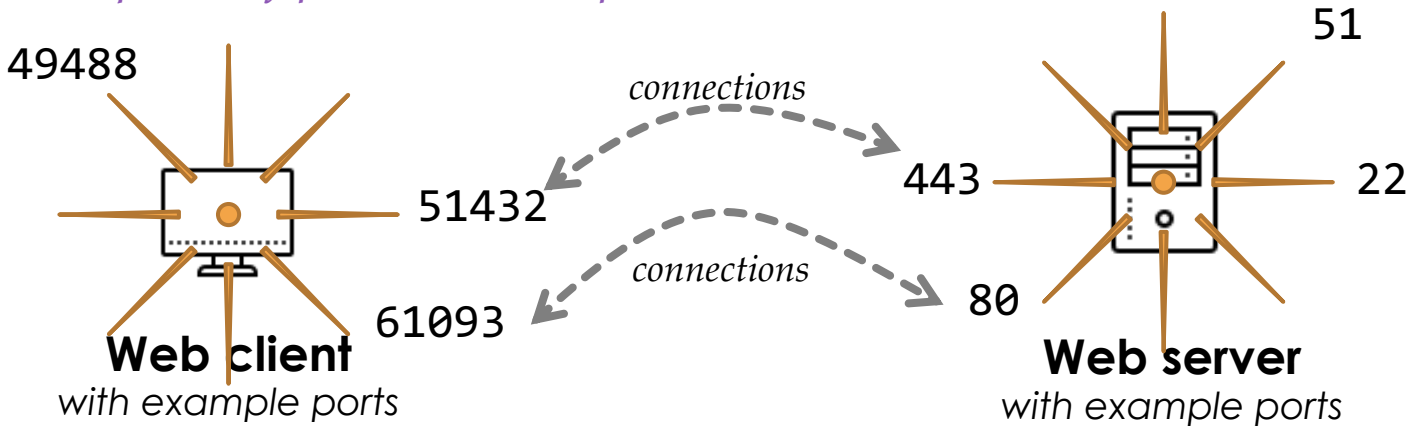
- A web server usually provides these features
  - Handling of HTTP requests and make responses
  - Serving static files including HTML, images, etc.
  - Receiving forms and file uploads from clients
  - Supporting server-side scripting (e.g. PHP, ASP, etc.)
  - URL rewrite and redirection
- Popular web servers
  - Apache, nginx, Microsoft IIS, etc.
- See more: *https://en.wikipedia.org/wiki/Comparison_of_web_server_software*

Communicating over ports

- In networking, connections are made on ports of a network device
- Each port is served by one piece of software (server/client)
  - Well known ports: 0 – 1023 (**HTTP**: 80, **HTTPS**: 443)
  - Registered ports: 1024 – 49151
  - Private ports: 49152 – 65535
- *See: https://www.webopedia.com/quick_ref/portnumbers.asp*

Web servers (e.g. Apache) listen on **ports *80* and *443***, but you can customize that!

The client normally use a random private port for every new connection

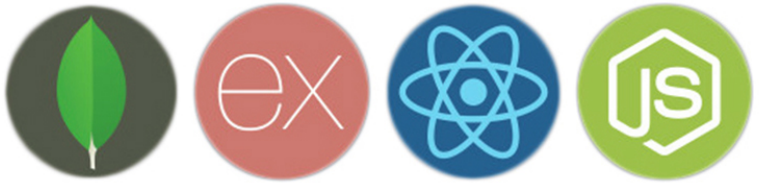


Node.js and Express

- **Node.js**—A JavaScript run-time environment
  - was first released in 2009
  - makes writing servers (including *web servers*) easier
  - runs JavaScript on server side (using Chrome V8 engine)
- Node.js uses ***non-blocking I/O***
  - No waiting for I/O, network operations and other software
- **Express**—A module (add-in) for Node.js
  - allows easy set up of web and mobile applications

Node.js and Express

- With Node.js, to implement a web application, a common approach is to create a ***custom-made web server*** by
  - incorporating a web application framework like ***Express***
  - including only the needed modules
  - writing application specific script in JavaScript



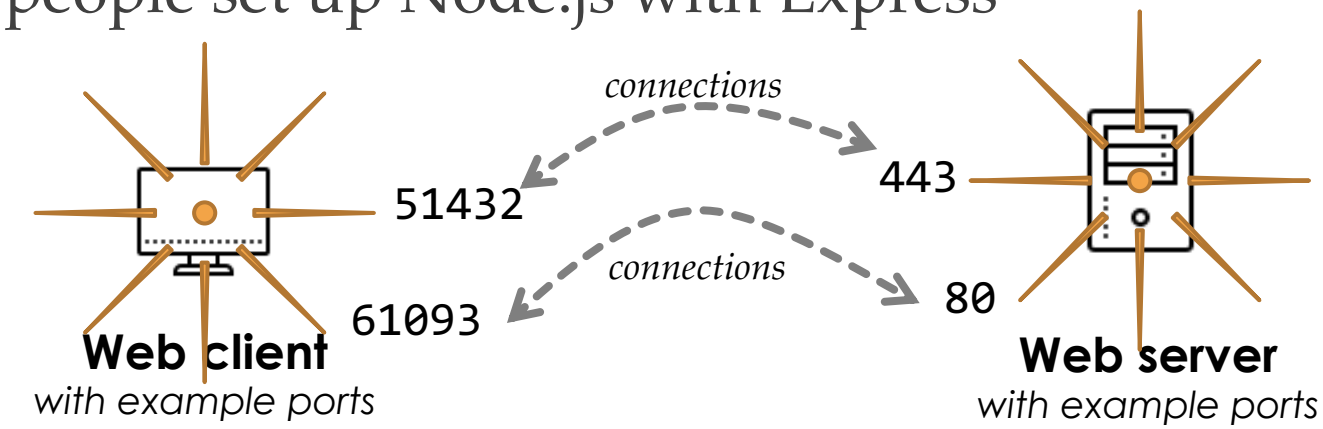
M E R N

THE stack!

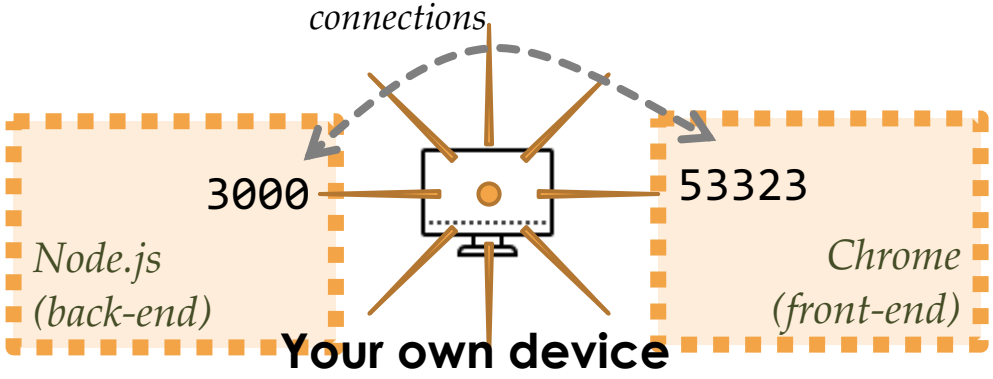
See: https://blog.hyperiondev.com/index.php/2018/09/10/everything-need-know-mern-stack/

Usual Scenario of Node.js

- This is often how people set up Node.js with Express



- But you can also do this:



Process of the Web Server

- Typical steps involved in a Request-Response cycle
  1. Routing
     - Deciding the actions to take based on URL and HTTP method
  2. Retrieve data from an HTTP request
  3. Process the data, *e.g.*
     - Validation
     - Apply business logic
     - Update database
  4. Generate an HTTP response

The Express Framework

- Express is a minimal and flexible Node.js web application framework
- Core features of Express allows one to
  - Define a routing table
    - To map request URI and HTTP method to an action
  - Set up middleware to respond to HTTP Requests
  - Use template engine to produce HTML output
- *Ref: http://www.tutorialspoint.com/nodejs/nodejs_express_framework.htm*

Installation

- To use Node.js, it needs to be installed onto the machine which will act as the web server
- Available as **Current** and **LTS** (long term support) versions
  - Multiple platforms
  - *https://nodejs.org/en/download/current/*

- ***Note***: Although you can run a zip version without installing, Node.js ***cannot listen to the server ports*** on a machine without administrator rights

npm

- Node.js allows the management of modules through a package manager
  - *npm*—Node package manager
- Modules are like libraries and we can install them when needed
- Set up the folder: **`npm init`** *(and accept default answers)*
  - The installed modules will exist as a folder `node_modules` under the app folder
- To install additional modules using npm, e.g. Express

```
npm install express
```

- More steps are indeed required by Express, see *http://expressjs.com/en/starter/installing.html*

Hello World!

- After setting up Node.js and Express, create `app.js` (the entry point) anywhere on your computer

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

// Assign a callback function to handle ALL requests
app.all('/*', function (req, res) {
  // When this callback function is called, send this to client
  res.send('Hello World!');
});

// Set the web server to listen to port 3000 (can be any port)
const server = app.listen(3000);
```

req is an object representing the current HTTP request
res is an object representing the current HTTP response

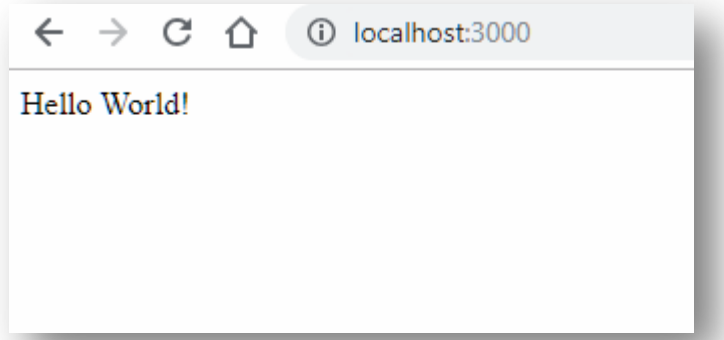
https://runkit.com/chuckjee/2720l13-eg1

Hello World!

- Then, start the server with the command

```
node app.js
```

  - The system path may need to be adjusted for the command to run
- Now the server is ready to be accessed at port *3000*
  - To try on the same machine, access **`http://localhost:3000`**
- *See: https://expressjs.com/en/starter/hello-world.html*



Serving static files

```
// Like ordinary web servers,
// ALL contents in public are served as-is
app.use(express.static('public'));

// Use a virtual path /img to serve contents in directory images
// If the request is for '/img/2720.jpg',
// serve './images/2720.jpg'
app.use('/img', express.static('images'));
```

Routing

- Routing is to determine the response based on the request URI and method
  - Virtual files and paths can be specified in the URL
  - The path specified by the URL is simply parsed as a string
- In Express, routing depends on the HTTP method

```
app.METHOD(route_path, callback);
```

  - ***METHOD*** can be one of **`get`**, **`post`**, **`put`**, **`delete`**, **`all`**
- The route path can be strings, string patterns, or regular expressions
  - *See: https://expressjs.com/en/guide/routing.html*
- Query strings are ***not*** part of the route path
  - If a URL is `http://hostname/x/y?key1=value1` only `/x/y` will be matched against the route path

Route based on request method

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

// To handle a GET request for /path1
app.get('/path1', function(req, res) { res.send("You made a GET request"); });

// To handle a POST request for /path2
app.post('/path2', function(req, res) { res.send("You made a POST request"); });

// To handle all requests (regardless of request method)
app.all('/*', function(req, res) { res.send("You made a request"); });

// The order in which routes are set up is important!
app.get('/path3', function(req, res) { res.send("You will not see this"); });
// In this example, a GET request for /path3 will be intercepted by app.all('/*', ...)
```

Route path

```
// Exact match (match 'index' respectively)
app.all('/index', function(req, res) { res.send("Looking for index?"); });

// String patterns matching
// '?': this character/string can exist or not
app.all('/csci?2720', function(req, res) { res.send("csci2720 or csc2720?"); });
app.all('/(csci)?2720', function(req, res) { res.send("csci2720 or 2720?"); });

// '+': this character/string can occur multiple times
app.all('cu+hk', function(req, res) { res.send(" cuhk or cuuhk or cuuuuuuhk"); });

// '*': any character/string
app.all('/dir1/*', function(req, res) { res.send("This is something in dir1"); });
```

http://runkit.com/chuckjee/2720l13-eg2

***Note**: some rules are not working in newest Node+Express…*

Route path

```
// Regular expression matching: e.g. any path that ends with .jpg
// Note: The expression is not enclosed by any quotes
app.all(/.*\.jpg$/, function(req, res) {
    res.send("You requested a JPG file");
});
// Route parameters matching
// e.g. http://hostname/course/2720/lecture/6
app.all('/course/:cID/lecture/:lID', function(req, res) {
    res.send(req.params);
    // Output: {"cID":"2720", lID":"6"}
});
// hyphen and dot (- and .) are interpreted literally
// e.g. http://hostname/csci2720-t2
app.all('/:course-:tutorial', function(req, res) {
    res.send(req.params);
    // Output: {"course":"csci2720", "tutorial":"t2"}
});
```

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Generating file content dynamically

```
app.get('/content.html', function (req, res) {
  var buf= '';

  // Create the content of a file as a string here
  ...

  // Send the string in the HTTP response
  // By default, it's treated as the content of an HTML file
  res.send(buf);    // Note: send() can only be called once!
});
```

Serving static files

- **`res.sendFile()`** transfers the file at the given ***absolute path***
- It sets the **`Content-Type`** response HTTP header field based on the filename extension

```
app.get('/', function (req, res) {
  // Send the file 'index.html' in the folder of the current script
  res.sendFile(__dirname + '/index.html');
  // __dirname holds absolute path of the folder of the current script
});
```

- *See: https://expressjs.com/en/4x/api.html#res.sendFile*

Get parameters from a query string

http://runkit.com/chuckjee/2720l13-eg3

```
// Handle GET request to /search?mykey=some_value
app.get('/search', function (req, res) {
  var keyword = req.query['mykey'];

  if (keyword === undefined || keyword === '')
    res.send('No keyword specified');
  else
    res.send('The keyword is ' + keyword);
});
```

The parameters **key1=value1&key2=value2&...&keyN=valueN** is decoded and made available as properties of `req.query`

Post parameters in request body

```
// This module is for parsing the content in a request body
// (installed separately using npm)
const bodyParser = require('body-parser');

// Use parser to obtain the content in the body of a request
app.use(bodyParser.urlencoded({extended: false}));

// Handle POST request to /login
// Assuming the two parameters are "loginid" and "passwd"
app.post('/login', function (req, res) {
 // Parameters are made available as properties of req.body
 var id = req.body['loginid'], pwd = req.body['passwd'];
});
```

http://runkit.com/chuckjee/2720l13-eg3

***Note**: Try this using Postman!*

Retrieving request headers

```
// HTTP Request Header contains info about a client,
// info about the content embedded in the body, cookies, and more...
app.get('/*', function (req, res) {
  // Header fields in the request found as properties in req.headers
  console.log( req.headers );

  // Helper function to get the value of a specific header
  // with header name case-insensitive; returns undefined
  // if the header does not exist
  console.log( req.get('user-agent') );

});
```

Setting response headers

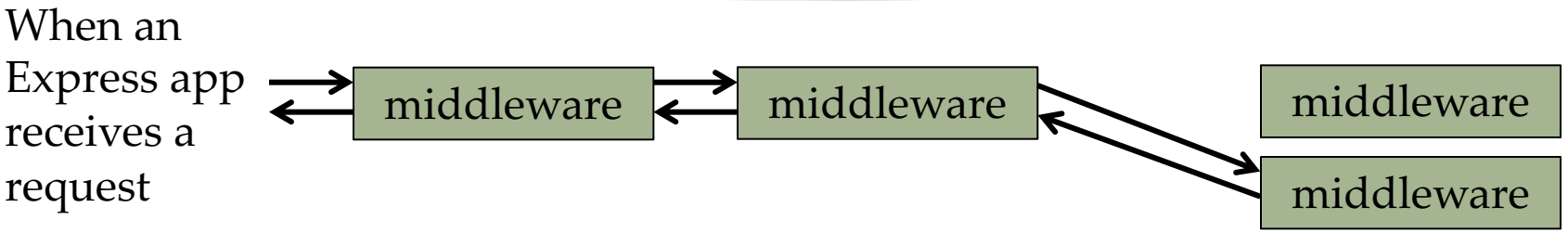
```
// HTTP Response Header contains info about a server,
// info about the content embedded in the cookies, and more...
app.get('/*', function (req, res) {

  var buf = 'This is plain text; "<br>" will appear as is.\n';

  res.set('Content-Type', 'text/plain');

  // Note: Headers can only be set before any output is sent
  res.send(buf);
});
```

Middleware and Routing



- Middleware is a function in the form

```
function (req, res, next) { ... }
```

- An Express application is essentially a series of middleware calls
- ***Routing*** – defining how middleware(s) are used to handle a request

Built-in Middleware

- These middleware functions come with Express
  - **`express.static()`**
    - For serving static files
  - **`express.json()`**
    - For parsing JSON in incoming requests
  - **`express.urlencoded()`**
    - For parsing URL-encoded contents
- Third-party middleware can be loaded using `require()`
- *See: http://expressjs.com/guide/using-middleware.html*

Designing URL

- The URL of a page to show the detailed view of an item (with a specific ID) can be represented as

```
http://domain/show_item?id=123456789
```

  - i.e. representing the ID as a name-value pair in query string
    - *Query parsing in* `req.query[]`
- or as

```
http://domain/show_item/123456789
```

  - i.e. embedding the ID in a particular path fragment
    - *Route parameters parsing in* `req.params[]`
- What is the difference between these two designs?

Node.js/Express vs. other technologies

Node.js/Express

Node.js/Express: since 2009

Lightweight modules

Real-time small event-driven request/response

Wide community support

ME*N stack

Apache/PHP: since 1995

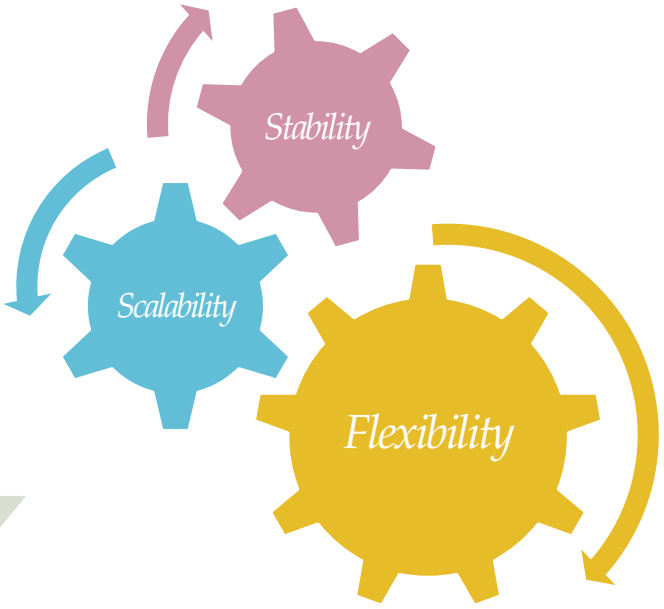
Multi-purpose intensive applications

Good for large amount of data processing

Wide community support

LAMP stack

Apache/PHP



See: https://hackernoon.com/nodejs-vs-php-which-is-better-for-your-web-development-he7oa24wp

Other web servers on Node.js

- Express is only one of the implementations of web servers on Node.js
- With React, there are also other possibilities:
  - create-react-app runs a web server automatically with **`npm start`**, to show the React app in development mode
  - For static deployment, the server **`serve`** can be used
  - *See: https://create-react-app.dev/docs/deployment/*

Read further…

- Express 4 APIs
  - *http://expressjs.com/4x/api.html*
- Express Guide
  - Routing: *http://expressjs.com/guide/routing.html*
  - Writing middleware: *http://expressjs.com/guide/writing-middleware.html*
  - Using middleware: *http://expressjs.com/guide/using-middleware.html*

Checkpoint

Why should I use Express?
How could I parse the URL?
Can static files still be served?