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2020

Client-Server interactions in React

Re-Connecting to REST APIs

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Outline

- Handling API calls in React
- The “two servers” problem
  – Two servers + CORS
    - Variant: React Development Server
  – Build + Express (single server)
  – Also: Understanding Build (webpack, imports, etc)

https://www.robinwieruch.de/react-fetching-data

The Road to Learn React, Chapter “Getting Real with APIs”

Taming the State in React, Chapter “Local State Management”

React as a REST Client

HANDLING API CALLS IN REACT

Main questions

- How to integrate remote (REST) APIs
- Where/when to load data from remote APIs?
- Delays and “loading…”
- Updating remote data

Different kinds of state

Entity State (or Application State)

- Retrieved from the back-end
- Should update the back-end
  - On user-initiated add/modify/delete actions
- Should periodically check for updates
  - Caused by other users, by other open sessions, or by connected systems
- Globally managed, accessible by various components

View State (or Presentation State)

- Not stored in the backend
- Does not need to persist
- Lives and dies within the controlling Component
- Implemented ad Local State
  - this.state
  - this.setState

Remote Application state

- Application State is stored into a remote database, accessible by REST APIs
- **Dehydrating** state means extracting the state from the React application
  - May happen at several times during application execution
  - Should happen whenever something (in the Application State) is modified
- **Rehydrating** state means retrieving state from the database
  - Must happen when the application bootstraps
  - **Best place**: inside `componentDidMount()` lifecycle method

Rehydrating at mount time

```
componentDidMount() {
  fetch('/api/items')    // backend API call
  .then(response => response.json())
  .then(archivedItems => this.setState(rehydrateItems(archivedItems)));
}

function rehydrateItems(archivedItems) {
  return function(prevState) { // the setState callback function
    return {    // build new state
      archivedItems: [
        ...prevState.archivedItems,   // existing state (if any)
        ...archivedItems              // merged with new state (if any)
      ]
    };
  };
}
```

https://reactjs.org/docs/faq-ajax.html

Dehydrating during updates

```
<ItemList ... addItem={this.addItem} .../>

addItem = (newItem) => {
  fetch('/api/items', {
    method: 'post',
    body: JSON.stringify(newItem)
  }).then(...).catch(...);

  this.setState((state)=>{ [...state.items, newItem] }) ;
}
```

The two updates (remote API, local state) run **in parallel**.

Optimistic state update: assumes that remote state will be updated without errors => **Risky**

“Loading…” indicators

- Rehydrating may require some time, while the component renders “empty” (with the initial state)
- Use a local state variable (e.g., `loading`) to indicate whether rehydrating has completed
- The `render()` will display a message (or a spinner image) if `loading===true`

```
componentDidMount() {
  this.setState(
    {loading: true});

  apiClient.loadItems()
  .then(people => {
     this.setState({
       loading: false,
       people: people});
  });
}
```

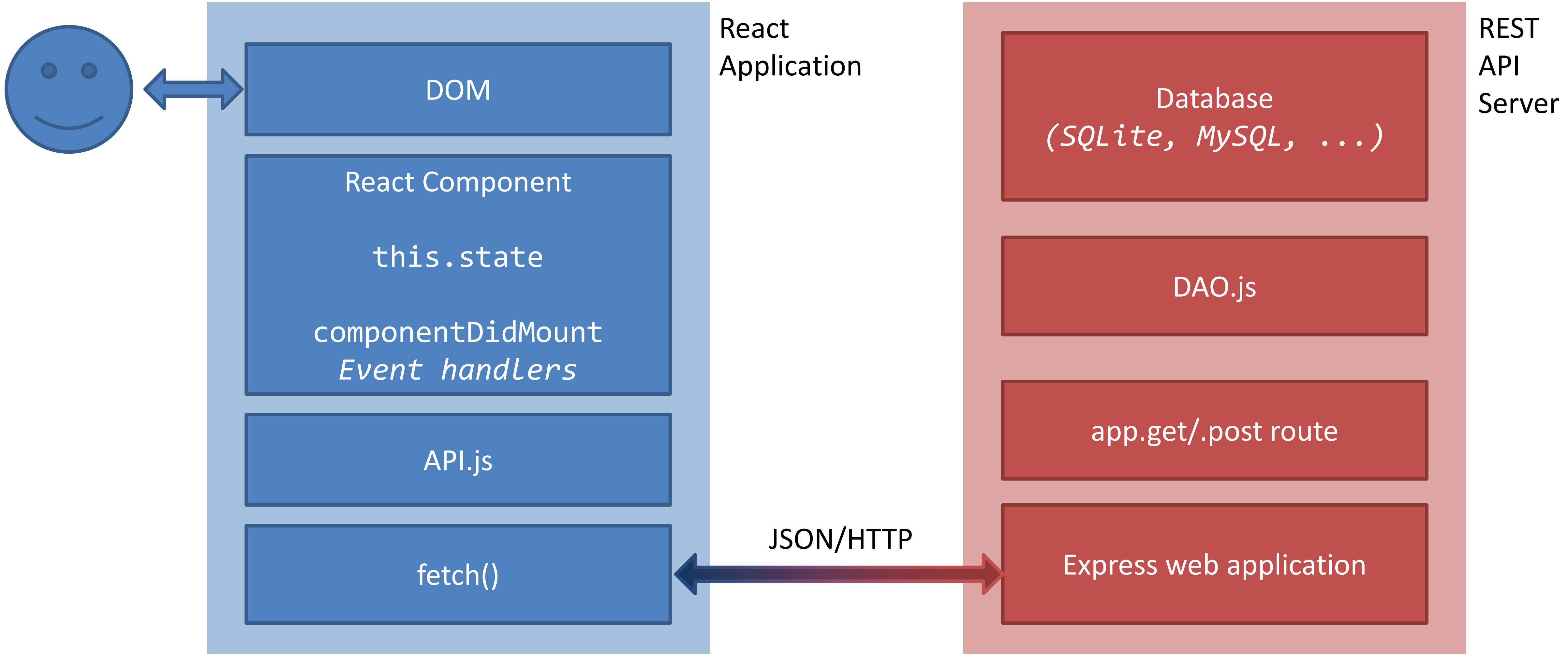
What component should “fetch” the data?

- The fetching component should be:
  - A common parent for all components **interested in this data**
  - A common parent for all components that must **show loading indicators**
  - A common parent for all components that need to **display error messages**
- May be the component holding the state do be Rehydrated
- May be a component **below** the one holding the state, if a rehydrating function is passed down as a prop

API Client Classes

- Recommendation: keep your fetch methods in a separate JS module (e.g., `API.js`)
- Keeps details of REST methods inside the API module
  - API should not depend on React or application state/props
  - Application code should not call fetch or have any REST information
- Allows easy swapping with “stub” methods for testing

Conceptual architecture



Local Storage

- Modern browsers also have client-side [semi-]permanent storage
- Key-value stores
  - Local Storage: permanently stored in the browser, can be retrieved also on future visits
  - Session Storage: expires when the browser session is closed
- Follow the same logic as remote storage (but they are synchronous and fast)
- May be combined with remote storage

https://www.robinwieruch.de/local-storage-react

Data caching

- The result of read APIs (GET) may be *cached* in the Local Storage (or application state, or application Context)
- The API Client module may implement a caching layer
- Future GETs for the same REST Resource may return the result from the cache, rather than the remote server

- But remember: cache invalidation is one of the hardest problems in Computer Science!

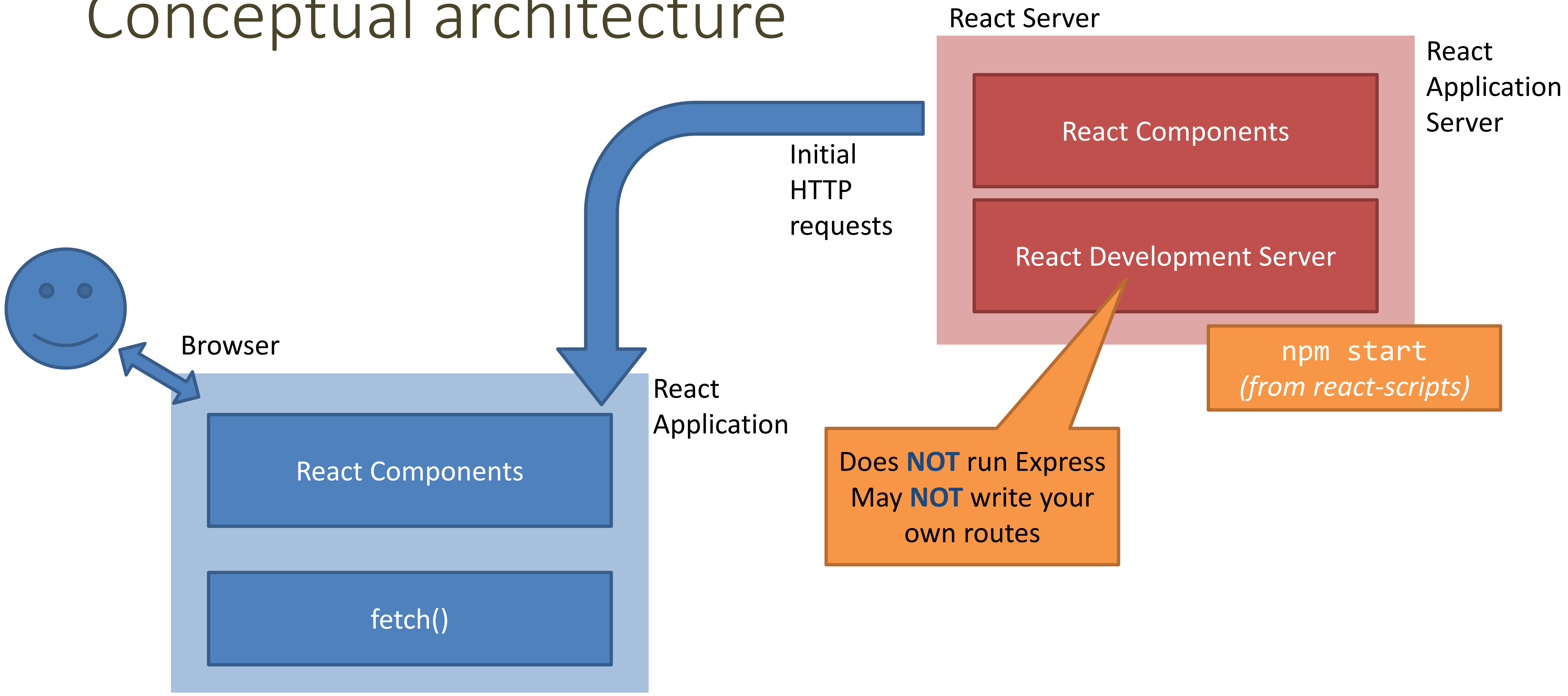
https://www.robinwieruch.de/react-fetching-data

Full Stack React, Chapter “Using Webpack with Create React App”

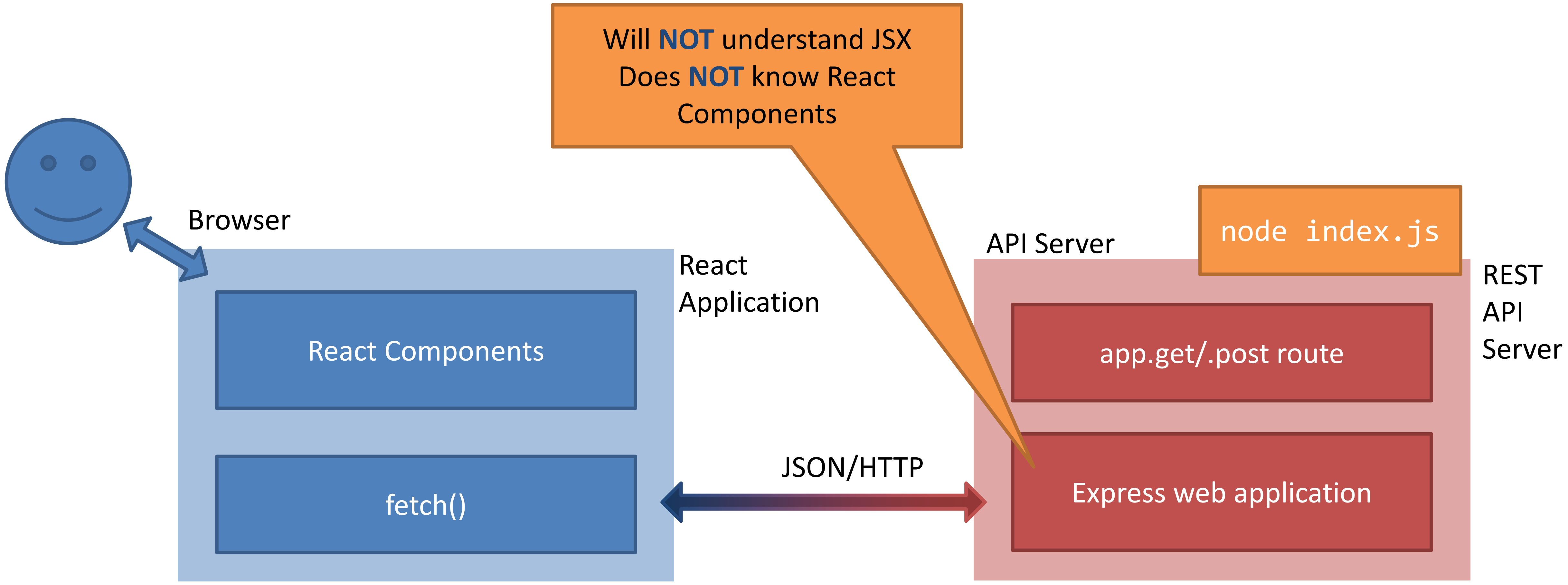
A Client and a Server walk into a bar…

THE “TWO SERVERS” PROBLEM

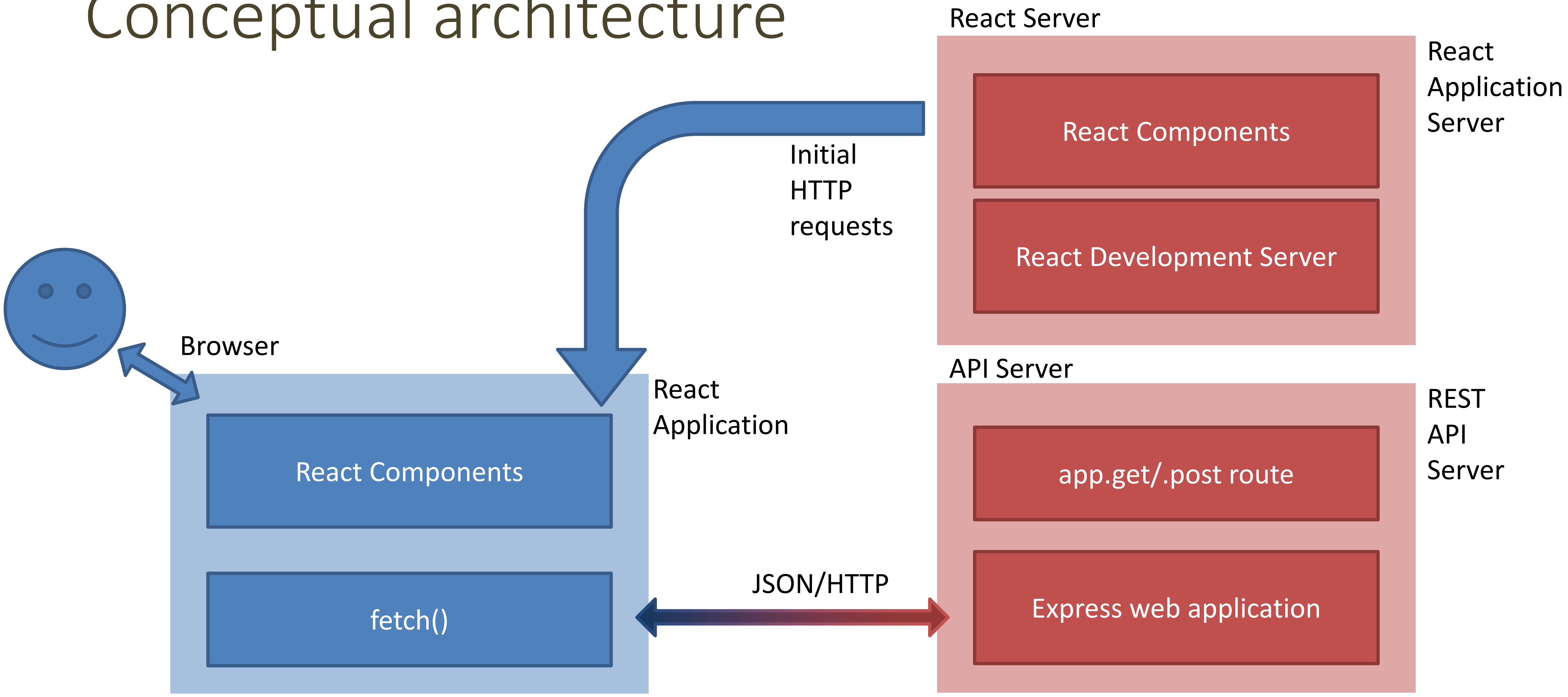
Conceptual architecture



Conceptual architecture



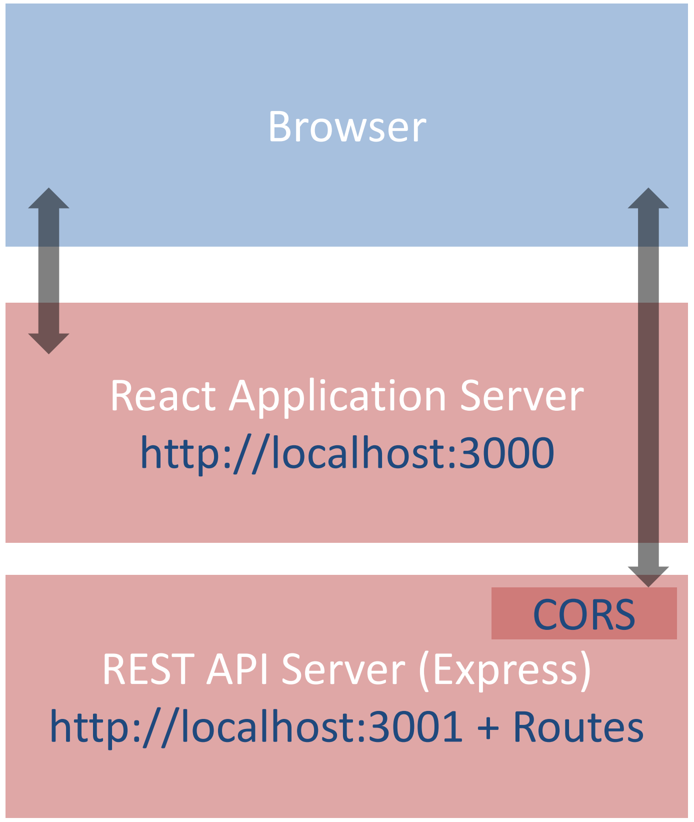
Conceptual architecture

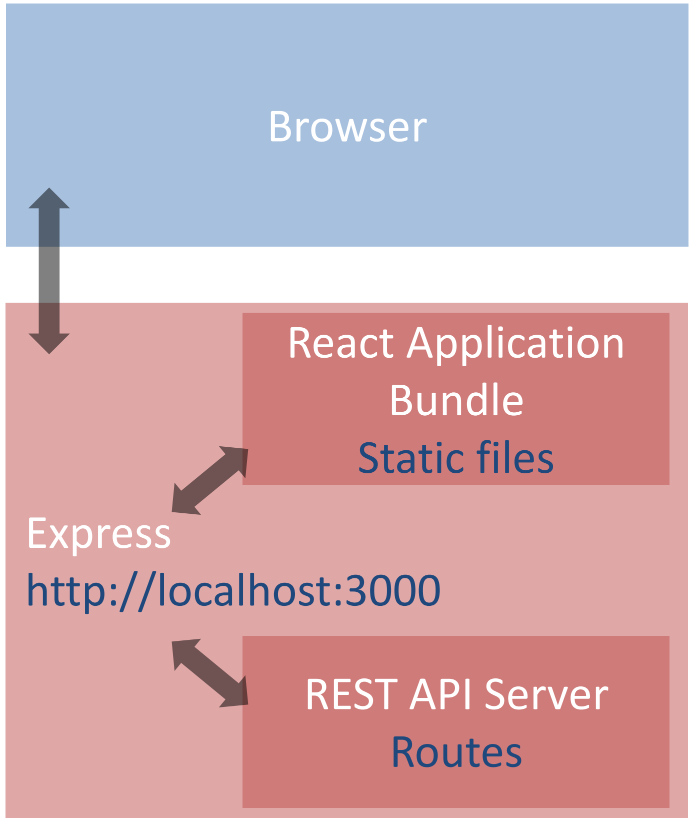


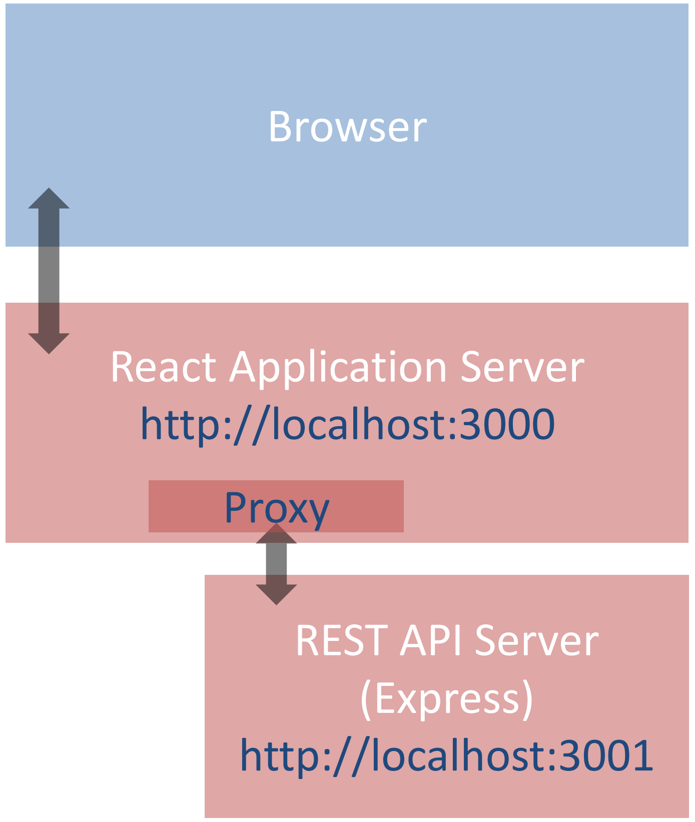
Issues

- Deployment
  - One-server-does-all or two-separate-servers?
  - Development vs Production trade-off
    - convenience/debug/turnaround time vs performance/security
  - Cross-Origin security limitations
- Opportunities
  - Separate the load
  - Use any API Server (even 3rd party ones)

3 Possible Solutions







https://www.newline.co/fullstack-react/articles/using-create-react-app-with-a-server/

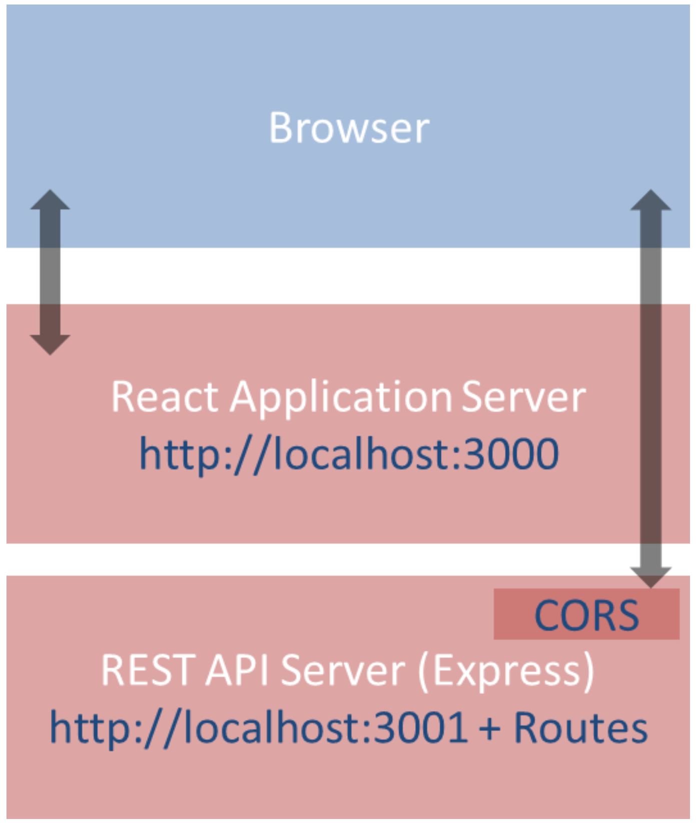
Full Stack React, Chapter "Using Webpack with Create React App / Using Create React App with an API server"

Side-by-side deployment

RUNNING TWO SEPARATE SERVERS

Double-Server Setup

- React Web Server and REST API server are hosted separately
  - Different hosts, and/or
  - Different ports
- The browser:
  - Receives the React application
  - Directs the API requests to the REST server



Double-Server Setup

- Must run two web servers
  - React project: `npm start`
  - Express project: `node index.js`
  - Two projects, in two different directories (or different servers)
- Problem: handle CORS

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CORS

Cross-Origin Resource Sharing

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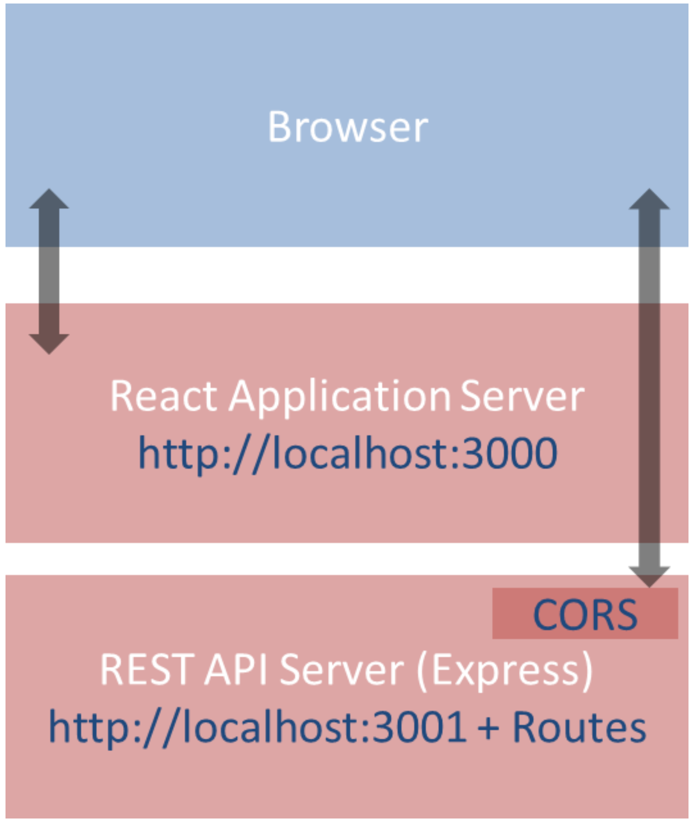


Advantages and disadvantages

- Servers are easy to deploy
- Scalable solution: requests are sent to the appropriate server
- Only possible configuration if the REST API is provided by a third party
  - Public APIs

- Need to configure cross-origin resource sharing (CORS) on API server
- Requires using absolute URLs to access APIs
- Wrongly configured CORS might be a security risk (undesired access to APIs from e.g. mock websites)

How to configure

- Configure CORS on API server for development

```
// index.js (node express server)

//Enable All CORS Requests (for this server)
app.use(cors());
//Use ONLY for development, otherwise restrict domain
```

- In production mode, use different domains for React and API servers, NEVER allow CORS requests from any origin, always specify origin

Example

API.js in the React Application

```
const APIURL=new URL('http://localhost:3001');

async function getCourses() {
  return fetch(new URL('/courses', APIURL))
    .then((response)=>{
      if(response.ok) {
        return response.json() ;
      } else {
        throw response.statusText;
      }
    })
    .catch((error)=>{
      throw error;
    });
}
```

Called in componentDidMount()

index.js for the API Server

```
const express = require('express');
const port = 3001;
const cors = require('cors');
const app = express();
app.use(cors());

app.get('/courses', (req, res) => {
  dao.listCourses()
    .then((courses) => res.json(courses))
    .catch((err)=>
      res.status(503)
         .json(dbErrorObj));
});

app.listen(port, () => console.log(`Example app 
listening at http://localhost:${port}`));
```

Calls DAO.js

https://create-react-app.dev/docs/proxying-api-requests-in-development/

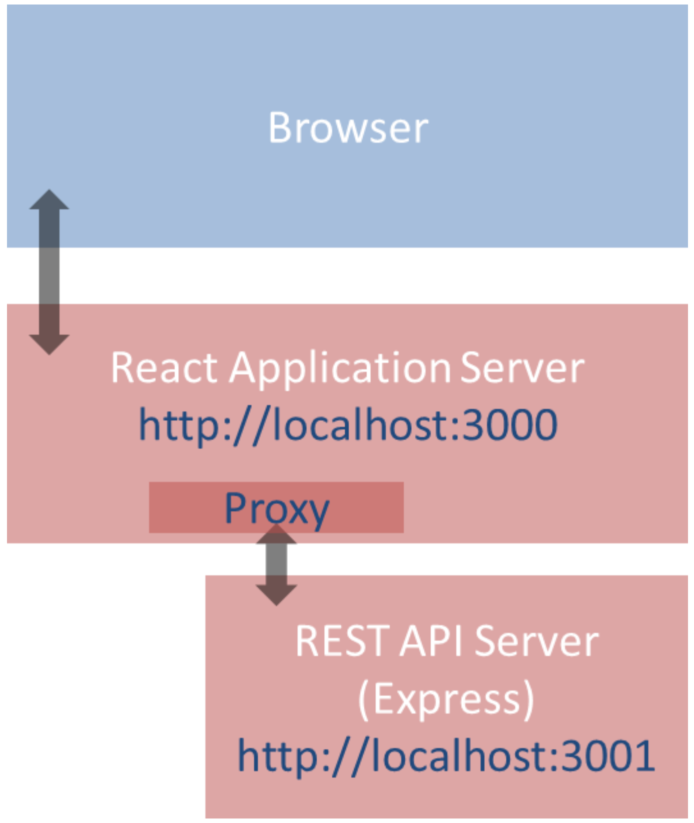
Full Stack React, Chapter “Using Webpack with Create React App / Using Create React App with an API server”

Double-Server made Easier

USING THE REACT DEVELOPMENT PROXY

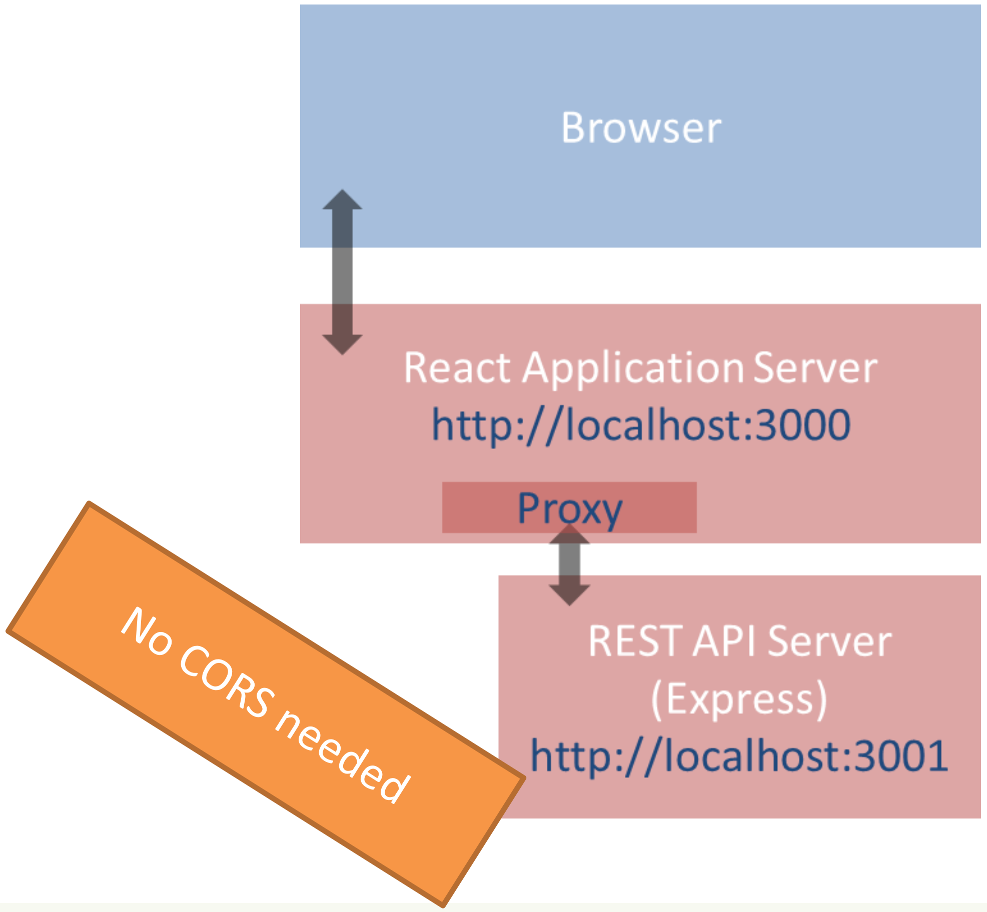
API Server behind Application Server

- A feature provided by the React Development Server
  - uses react-scripts development modules
- Avoids the need to set-up CORS
- The Browser thinks there is only one server



API Server behind Application Server

- Browsers access only one server: the React application server
- The React web server is configured to act as a proxy for certain requests
- Those requests are sent to another web server via a proxy mechanism
- The proxy returns the response unaltered as its own response



How to configure

- Just add one line in `package.json` originally written by create-react-app

```
// package.json
{...
 ...,
"proxy": "http://localhost:3001",
}
```

- NB: Works only in development mode while using the infrastructure of the create-react-app package

Proxy rules

- The React development server will serve requests **directly** if:
  - It is a recognized static asset (e.g., image, css, …)
  - The HTTP Accept header is set to `text/html`
- Otherwise, it will *attempt* to send the request to the **proxy**
  - The proxy response is returned
- If the resource is not found, it will serve the default html page

- Browsers use `text/html` only when expecting HTML content (e.g., first page)
- Best practice: avoid conflicting paths in URLs, if the path is found in React folders, it is served, otherwise it is passed to the proxy
  - Use unique path prefix for REST requests, e.g., `/api`

Use in production mode

- The approach may be useful in production mode if the REST API server should not / cannot be accessed directly from the Internet
  - For instance, application server with private IPs or other network/security configuration reasons
- The main web server (Apache, nginx, etc.) should be able to determine which requests must be redirected to the other web server
  - For instance, depending on URLs (e.g., /api/… requests)

```
# nginx web server
location /api/ {
    proxy_pass http://backend-server;
}
```

```
# Apache web server

ProxyPass /api/ http://backend-server
```

Common errors

- You are still running two web servers, on different ports
  - Remember to start the REST API server before launching the React application
  - May automate it by tweaking the startup scripts in `package.json`
- CORS is not needed
  - Remove it from the Express server
  - The API server is more secure, it will be accessed by React, only
- Production will be different
  - Need to configure the “real” proxy in production in order to be compatible with the same application path and API prefix

Common errors

- You are still running two web servers, on different ports
  - Remember to start the REST API server before launching the React application
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Examples:
- https://www.freecodecamp.org/news/how-to-make-create-react-app-work-with-a-node-backend-api-7c5c48acb1b0/
- https://www.newline.co/fullstack-react/articles/using-create-react-app-with-a-server/

https://create-react-app.dev/docs/deployment/#static-server

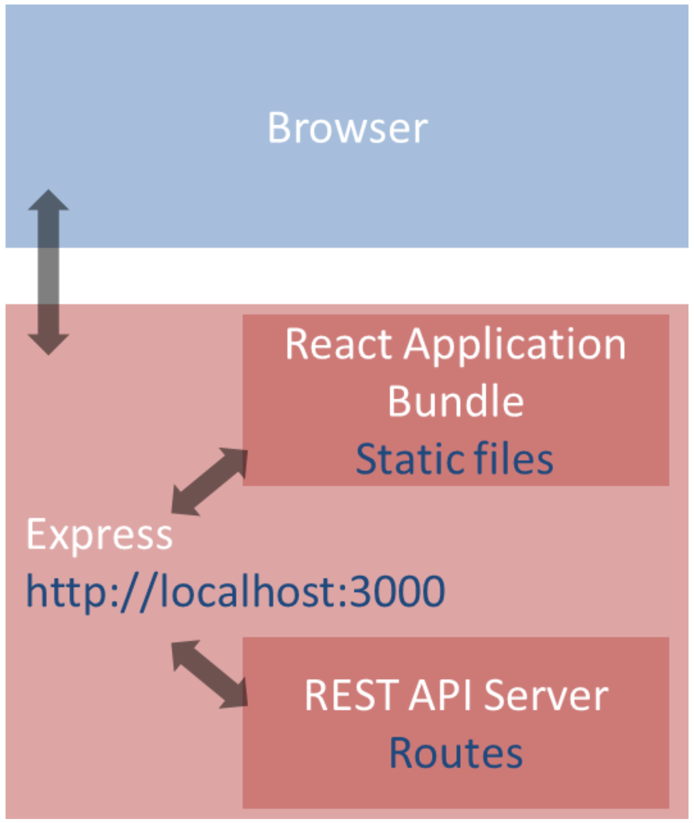
Full Stack React, Chapter “Using Webpack with Create React App / Creating a production build”

Packing and moving the React application into any web server

DEPLOYING A BUILD INSIDE A SERVER

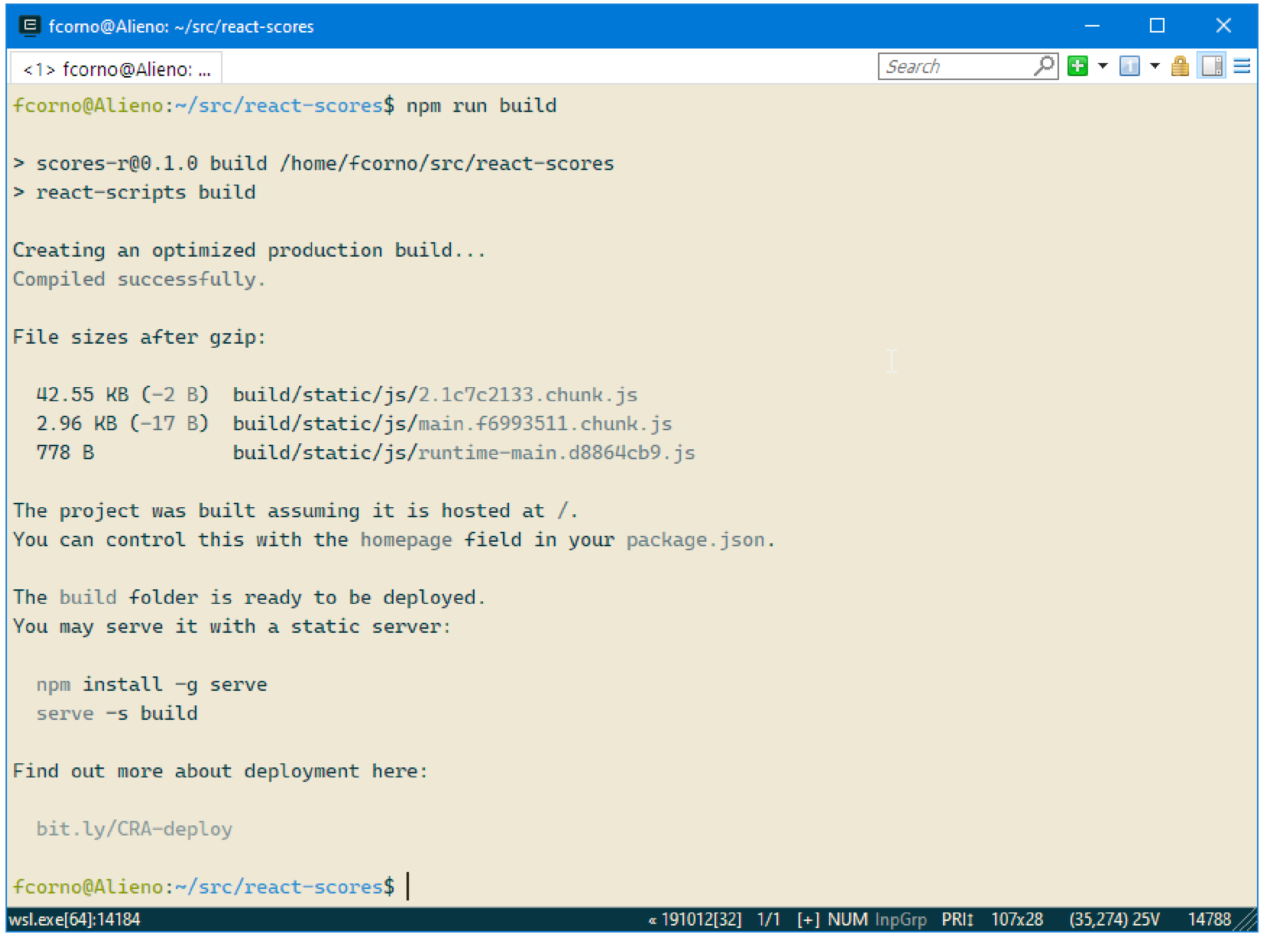
Deploying the React Bundle

- React does not need to run in the Development Server
- `npm run build` will create a “production bundle” with all the contents needed to run the application
- This bundle is composed of static files (html, js, assets) and may be served by *any webserver* (including Apache, nginx, php, …)



Build command

`npm run build`


fcorno@Alieno: ~/src/react-scores
<1> fcorno@Alieno: ...
Search
wsl.exe[64]:14184
« 191012[32] 1/1 [+] NUM InpGrp PRI↕ 107x28 (35,274) 25V 14788

```
fcorno@Alieno:~/src/react-scores$ npm run build

> scores-r@0.1.0 build /home/fcorno/src/react-scores
> react-scripts build

Creating an optimized production build...
Compiled successfully.

File sizes after gzip:

  42.55 KB (-2 B)  build/static/js/2.1c7c2133.chunk.js
  2.96 KB (-17 B)  build/static/js/main.f6993511.chunk.js
  778 B            build/static/js/runtime-main.d8864cb9.js

The project was built assuming it is hosted at /.
You can control this with the homepage field in your package.json.

The build folder is ready to be deployed.
You may serve it with a static server:

  npm install -g serve
  serve -s build

Find out more about deployment here:

  bit.ly/CRA-deploy

fcorno@Alieno:~/src/react-scores$ |
```

Creates everything under `./build`

Publish from / or from 'homepage' property

https://create-react-app.dev/docs/deployment/

What does “build” do?

- Most of the work in “building” the static application is done by Babel and Webpack
  - Babel translates all JSX (and new JS syntax) into basic JS (according to the ‘`production`’ property in `package.json`)
  - Webpack packs and minimizes all JS code into a single file
  - Prepares an index.html that loads all the JS code
- The content of the “build” folder is self-contained and may be moved to the deployment server
- All debugging capabilities are removed

Hosting the build in Express

- `cd express-api-server`
- `cp –r ..../react-app/build .`
- Define a static route in `server.js`

```
app.use(express.static('./build'));

app.get('/', (req,res)=> {res.redirect('/index.html')} );
```

- In the application, you may call APIs locally
  - `fetch('/api/courses')...`

Pros and Cons

- Simple to deploy the final application (anywhere)
- May include the application inside the API server (in production, too)
- The JS code runs on every browser (thanks to polyfills and transpiling)

- The build cannot be directly modified
- Need a save/build/copy/reload cycle for every modification

Other “magic” by Webpack

- Packing of all imported modules
- Bundling of Assets
  - Images
  - CSS files
- CSS Modules

In development mode

- `npm start` runs the “Webpack development server” (WDS)
- All our code is transpiled and packed into a `bundle.js` that is automatically inserted into `index.html`
  - Contains all our code, plus React, plus imported modules
  - Also handles imports of non-JS files
- `bundle.js` does not exist – it’s kept in-memory by the WDS
- Sets up hot-reloading and synchronized error messages (via websockets)

https://create-react-app.dev/docs/adding-a-stylesheet
https://create-react-app.dev/docs/adding-a-css-modules-stylesheet
https://create-react-app.dev/docs/adding-images-fonts-and-files

Imports in Webpack

- `import logo from './logo.svg';`
- `import logo from './logo.png';`
  - Will include the image reference inside the bundle (placed under static/media)
  - Small files are rendered inline
- `import './Button.css’;`
  - This component will use these CSS declarations
  - All CSS will be concatenated into a single file, but here we are stating the dependency
- `import styles from './Button.module.css’;`
  - Files ending with .module.css are CSS modules
  - Styles may be applied with `className={styles.primary}`
  - Class names are *renamed to be unique*: no conflict with other Components’ styles

https://create-react-app.dev/docs/using-the-public-folder

Why use imports

- Scripts and stylesheets get minified and bundled together to avoid extra network requests.
- Missing files cause compilation errors instead of 404 errors for your users.
- Result filenames include content hashes so you don’t need to worry about browsers caching their old versions.

- They are an optional mechanism. “Traditional” loading (with link, img) still works, if you save your files in the public directory

References

- Taming the State in React, Robin Wieruch (2017)
  http://leanpub.com/taming-the-state-in-react
- The Road to learn React, Robin Wieruch (2019)
  http://leanpub.com/the-road-to-learn-react

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