Client-Side Web Programming: JavaScript (Part 5)

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Objectives

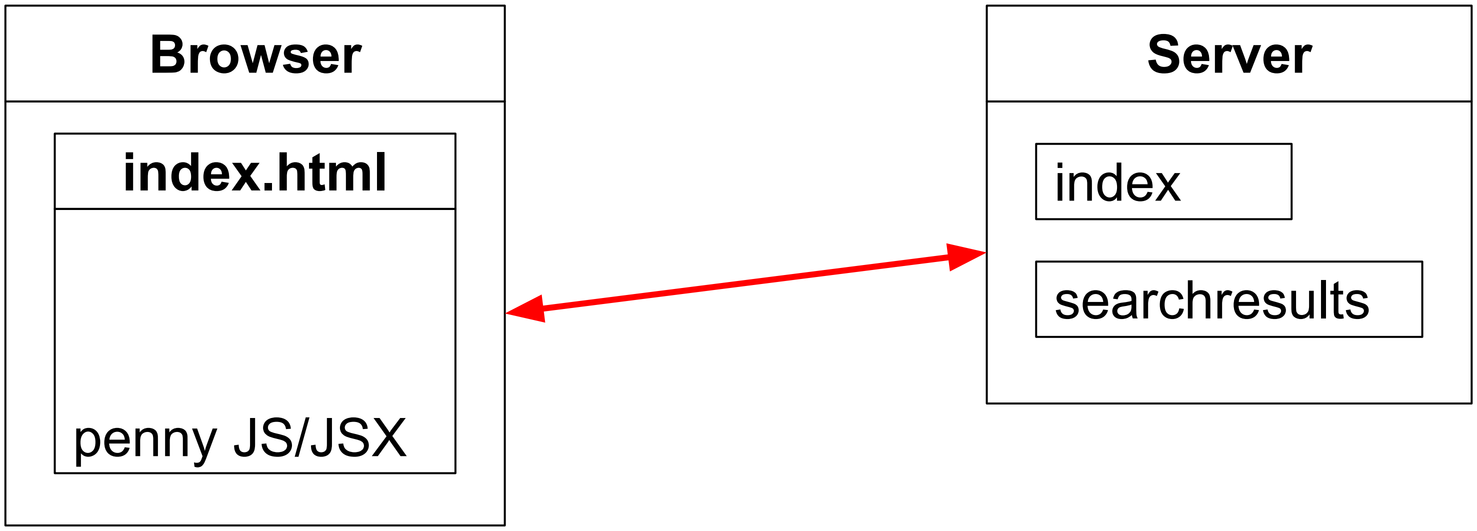
- We will cover:
  - Bundled React
  - Bundled React via Vite

Agenda

- **Bundled React: motivation**
- Bundled React
- Bundled React: Vite

Bundled React: Motivation

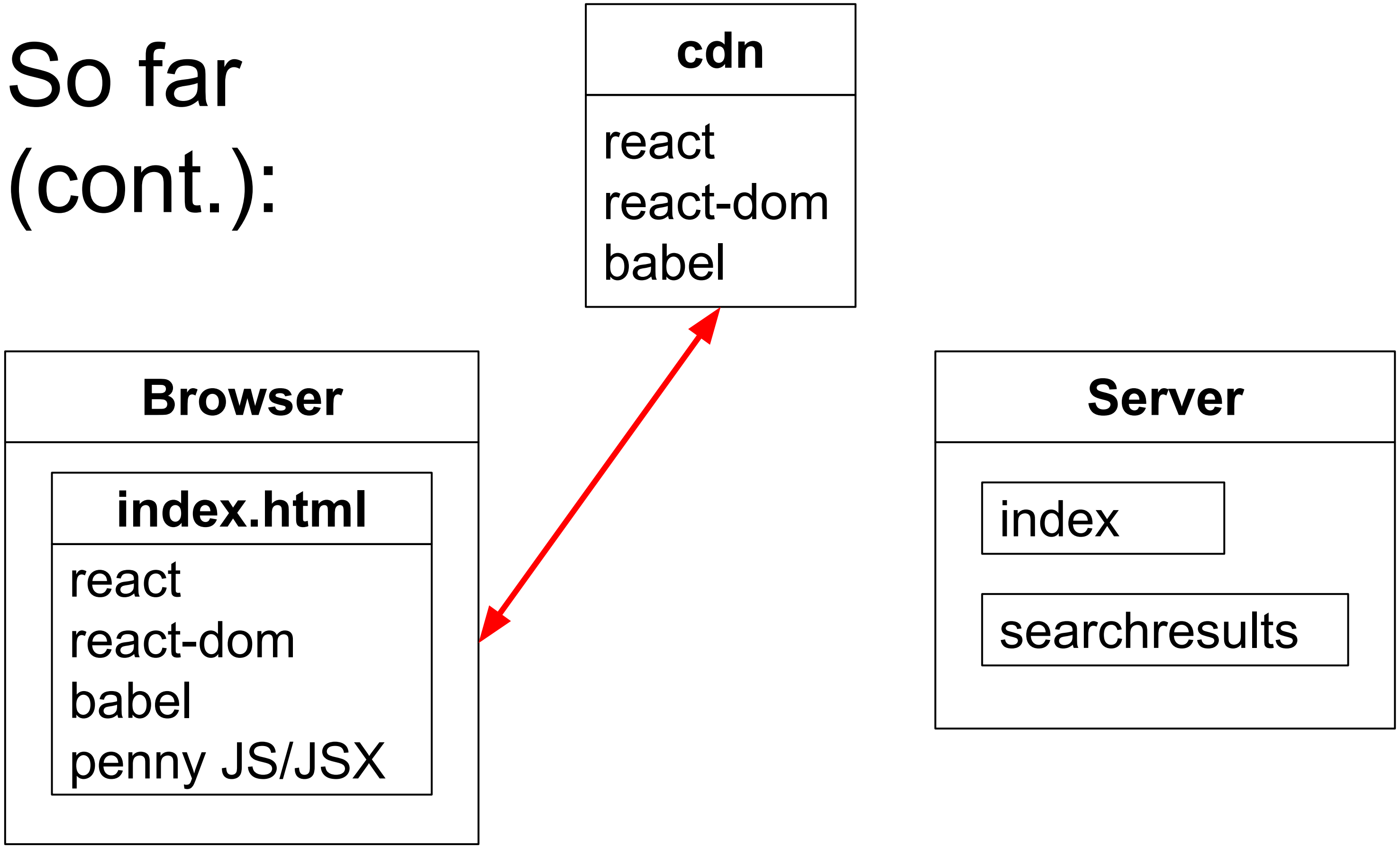
So far:



Browser requests and receives index.html

Bundled React: Motivation

So far (cont.):


cdn

react
react-dom
babel

Browser

index.html

react
react-dom
babel
penny JS/JSX

Server

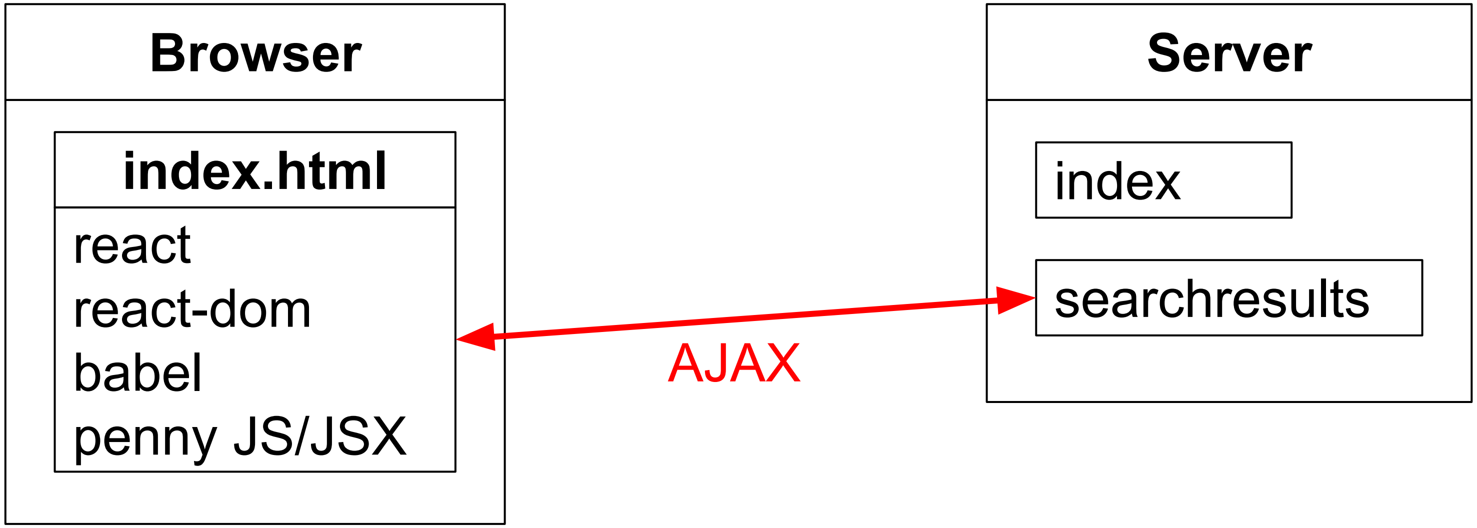
index

searchresults

Browser requests and receives react, react-dom, and babel

Bundled React: Motivation

So far (cont.):



Browser requests and receives book info

Bundled React: Motivation

- **Problem**
  - At run-time:
    - Browser fetches index.html page, and then…
    - Browser fetches react
    - Browser fetches react-dom
    - Browser fetches babel
    - Browser uses babel to convert your JSX code to JavaScript code
    - Browser executes your JavaScript code

Blue => load-time overhead

Agenda

- Bundled React: motivation
- **Bundled React**
- Bundled React: Vite

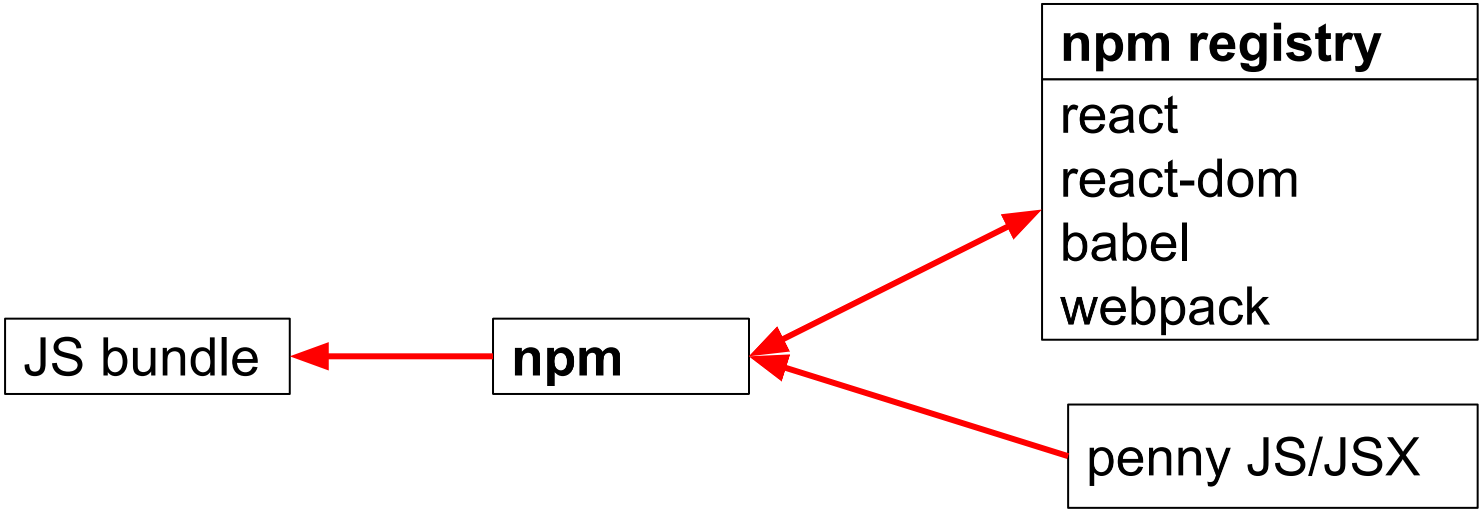
Bundled React

- Preliminary note:
  - **Don’t bundle your Assignment 4 solution!!!**

Bundled React

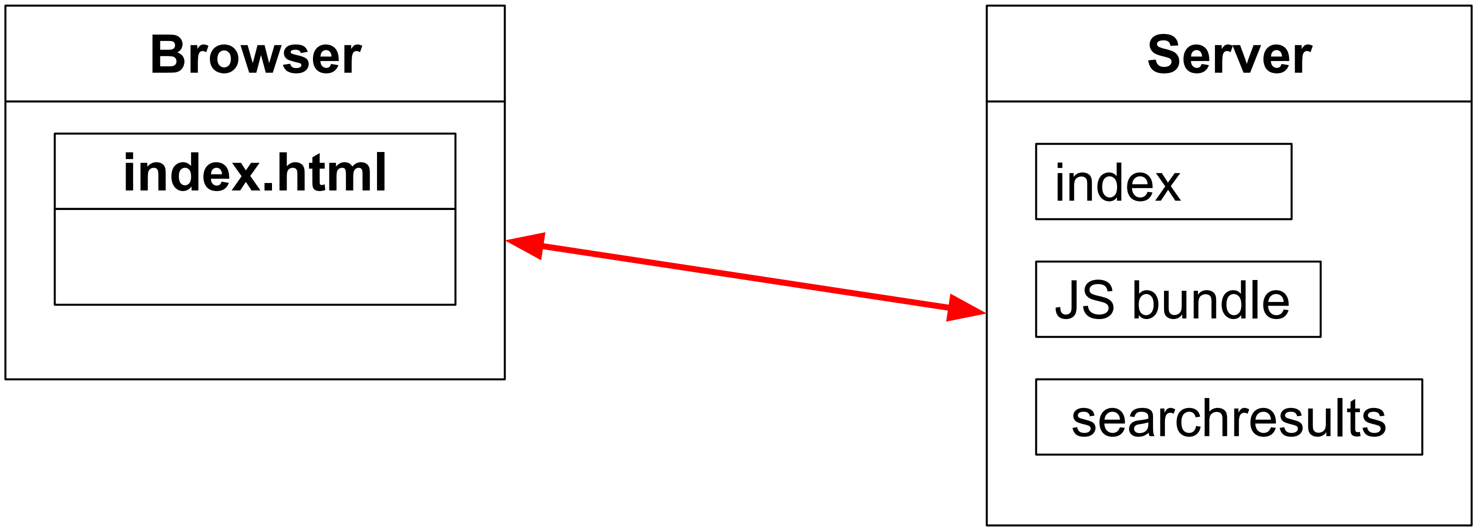
- **Solution**
  - Before load-time:
    - Use babel to convert your JSX code to JavaScript code
    - Place react, react-dom, and your JavaScript code in a JavaScript ***bundle***
  - At load-time:
    - Browser fetches your index.html page
    - Browser fetches your JavaScript bundle
    - Browser executes your JavaScript code

Bundled React



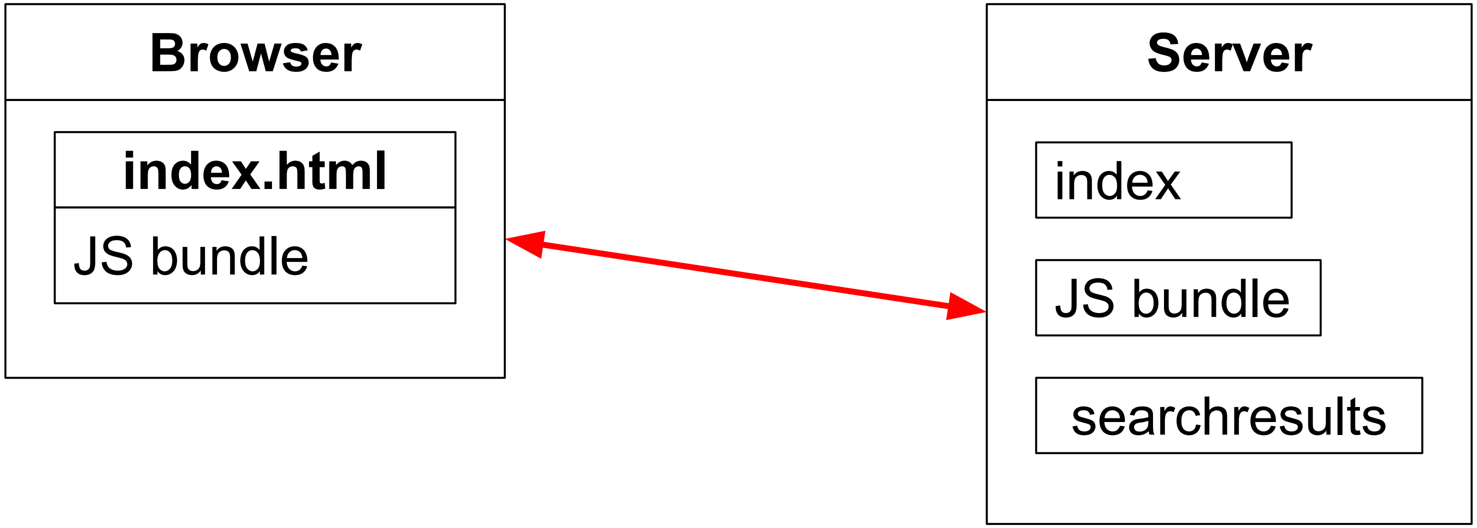
npm requests and receives react, react-dom, babel, webpack
npm creates JS bundle containing those libraries and penny JS

Bundled React



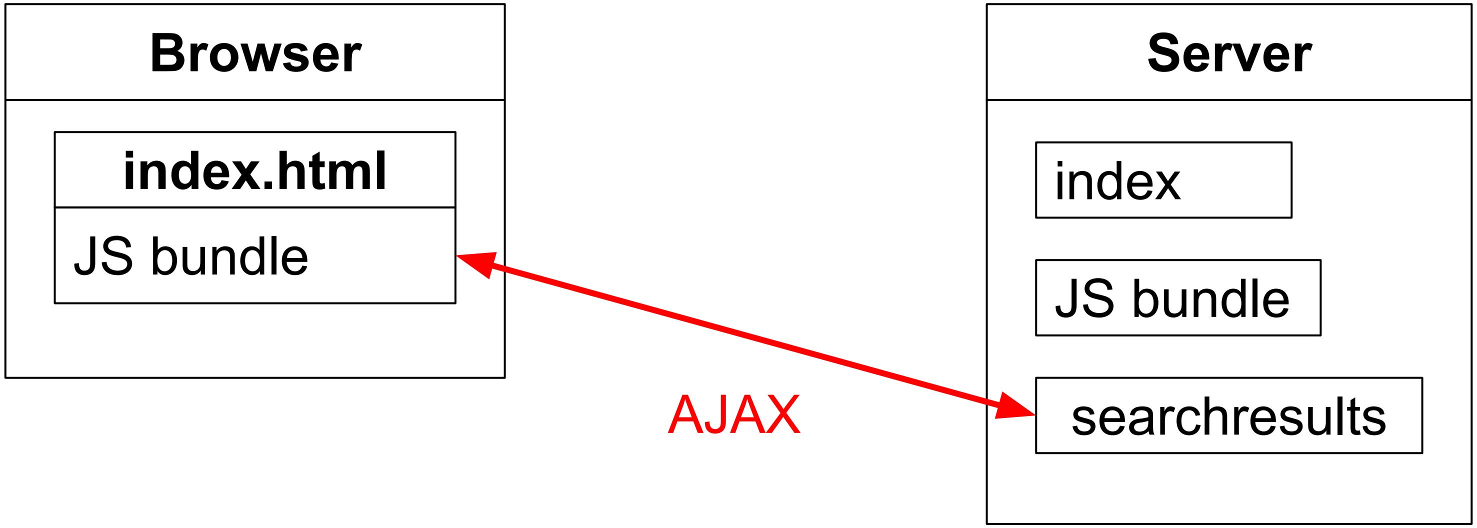
Browser requests and receives index page

Bundled React



Browser requests and receives JS bundle

Bundled React



Browser requests and receives book info

Bundled React

- Detailed instructions…

Bundled React

- Thanks, in part, to Lucas Manning ('20)…
- See **PennyReactBundled** app (cont.)
  - runserver.py
  - penny.sql, penny.sqlite
  - database.py
  - penny.py
  - **PennyHeader.jsx, PennyFooter.jsx, PennySearch.jsx, App.jsx**
  - **main.js**
  - **index.html**

PennyReactBundled/PennyHeader.jsx (Page 1 of 1)

```
//-----------------------------------------------------------------------
// PennyHeader.jsx
// Author: Bob Dondero
//-----------------------------------------------------------------------

import React from ’react’;

//-----------------------------------------------------------------------

function PennyHeader() {
   const [datetime, setDatetime] = React.useState(new Date());

   function updateHeader() {
      window.setInterval(
         () => {setDatetime(new Date());},
         1000
      );
   }

   React.useEffect(updateHeader, []);

   let hours = datetime.getHours();
   let ampm = (hours < 12) ? ’morning’ : ’afternoon’;
   return (
      <div>
         <hr />
         Good {ampm} and welcome to Penny.com
         <hr />
      </div>
   );
}

//-----------------------------------------------------------------------

export default PennyHeader;
```

PennyReactBundled/PennyFooter.jsx (Page 1 of 1)

```
//-----------------------------------------------------------------------
// PennyFooter.jsx
// Author: Bob Dondero
//-----------------------------------------------------------------------

import React from ’react’;

//-----------------------------------------------------------------------

function PennyFooter() {

   const [datetime, setDatetime] = React.useState(new Date());

   function updateFooter() {
      window.setInterval(
         () => {setDatetime(new Date());},
         1000
      );
   }

   React.useEffect(updateFooter, []);

   return (
      <div>
         <hr />
         Date and time: {datetime.toLocaleString()}
         <br />
         Created by&nbsp;
         <a href="https://www.cs.princeton.edu/˜rdondero">
         Bob Dondero</a>
      </div>
   );
}

//-----------------------------------------------------------------------

export default PennyFooter;
```

PennyReactBundled/PennySearch.jsx (Page 1 of 1)

```
//-----------------------------------------------------------------------
// PennySearch.jsx
// Author: Bob Dondero
//-----------------------------------------------------------------------

import React from 'react';

function PennySearch() {
   const [author, setAuthor] = React.useState('');
   const [books, setBooks] = React.useState([]);

   function fetchBooks() {
      function handleResponse() {
         if (this.status !== 200) {
            alert('Error: Failed to fetch data from server');
            return;
         }
         let books = JSON.parse(this.response);
         setBooks(books);
      }
      function handleError() {
         alert('Error: Failed to fetch data from server');
      }
      let encodedAuthor = encodeURIComponent(author);
      let url = '/searchresults?author=' + encodedAuthor;
      let request = new XMLHttpRequest();
      request.onload = handleResponse;
      request.onerror = handleError;
      request.open('GET', url);
      request.send();
      return () => {request.abort();}
   }
   React.useEffect(fetchBooks, [author]);

   let timer = null;
   function debouncedSetAuthor(author) {
      clearTimeout(timer);
      timer = setTimeout(()=>{setAuthor(author);}, 500);
   }

   return (
      <div>
         <h1>Author Search</h1>
         Please enter an author name:&nbsp;
         <input
             type='text'
             onInput={ (event) => {
                debouncedSetAuthor(event.target.value);
             }}
             autoFocus
         />
         <hr />
         {books.map((book) => (
            <div key={book.isbn}>
               {book.isbn}:&nbsp;
               <strong>{book.author}</strong>:&nbsp;
               {book.title}
               <br />
            </div>
         ))}
      </div>
   );
}
export default PennySearch;
```

PennyReactBundled/App.jsx (Page 1 of 1)

```
//-----------------------------------------------------------------------
// App.jsx
// Author: Bob Dondero
//-----------------------------------------------------------------------

import React from 'react';
import PennyHeader from './PennyHeader.jsx';
import PennySearch from './PennySearch.jsx';
import PennyFooter from './PennyFooter.jsx';

//-----------------------------------------------------------------------

function App() {
   return (
      <div>
         <PennyHeader />
         <PennySearch />
         <PennyFooter />
      </div>
   );
}

//-----------------------------------------------------------------------

export default App;
```

PennyReactBundled/main.js (Page 1 of 1)

```
//-----------------------------------------------------------------------
// main.js
// Author: Bob Dondero
//-----------------------------------------------------------------------

import React from 'react';
import ReactDOM from 'react-dom';
import App from './App.jsx';

let domRoot = document.getElementById('root');
let reactRoot = ReactDOM.createRoot(domRoot);

reactRoot.render(
   <React.StrictMode>
      <App />
   </React.StrictMode>
);
```

PennyReactBundled/index.html (Page 1 of 1)

```
<!DOCTYPE html>
<html>
   <head>
      <title>Penny.com</title>
   </head>

   <body>
      <div id="root"></div>
   </body>

   <script src="/static/app.bundle.js"></script>
</html>
```

Bundled React

- Node.js
  - Provides tools to help with development of React client-side
    - Via ***npm***, the Node.js package manager
    - For example: Babel, Webpack

Bundled React

- See **PennyReactBundled** app (cont.)
  - **package.json**
    - Configures npm
  - **webpack.config.js**
    - Configures webpack

PennyReactBundled/package.json (Page 1 of 1)

```
{
   "name": "pennyreactbundled",
   "version": "1.0.0",
   "description": "The Penny Application Using React",
   "main": "main.js",
   "scripts": {
      "build": "NODE_OPTIONS=--openssl-legacy-provider webpack"
   },
   "author": "Bob Dondero",
   "license": "ISC",
   "dependencies": {
      "@babel/core": "7.22.1",
      "@babel/preset-env": "7.22.4",
      "@babel/preset-react": "7.22.3",
      "babel-loader": "9.1.2",
      "react": "18.2.0",
      "react-dom": "18.2.0",
      "webpack": "5.85.0",
      "webpack-cli": "5.1.3"
   }
}
```

PennyReactBundled/webpack.config.js (Page 1 of 1)

```
//-----------------------------------------------------------------------
// webpack.config.js
// Author: Lucas Manning and Bob Dondero
//-----------------------------------------------------------------------

const path = require('path');

module.exports = {

   mode: "production",  // "production", "development", "none"

   entry: './main.js',

   output: {
      // Store the output file in a subdirectory named static.
      path: path.resolve(__dirname, 'static'),

      // Name the output file app.bundle.js.
      filename: 'app.bundle.js'
   },

   module: {
      rules: [ {
            // Use babel-loader as the loader.
            loader: 'babel-loader',

            // Use these loader options.
            options: {
               presets: ['@babel/preset-env', '@babel/preset-react']
            },

            // Include files whose names match the specified pattern.
            test: /\.jsx?$/,

            // Exclude files whose names match the specified pattern.
            exclude: /node_modules/
      } ]
   }
};
```

Bundled React

- To give it a try:
  - Install node.js
  - Install dependencies
    - `npm install`
      - Examines `package.json`
      - (Recursively) installs dependencies into `node_modules` directory
      - Creates `package-lock.json` file
        - Summary of contents of `node_modules` directory

Bundled React

- To give it a try (cont.):
  - Build the bundle
    - `npm run build`
      - Runs **Webpack**
        - » Examines `webpack.config.js`
        - » Uses **Babel** to convert JSX to JavaScript, and transpile JavaScript to ES5
        - » Packs all ES5 JavaScript code into one large bundle (static/app.bundle.js)

Bundled React

```
$ cd PennyReactBundled
$ npm run build

> pennyreactbundled@1.0.0 build
> NODE_OPTIONS=--openssl-legacy-provider webpack

asset app.bundle.js 139 KiB [compared for emit] [minimized] (name: main) 1
related asset
orphan modules 5.51 KiB [orphan] 1 module
modules by path ./node_modules/ 141 KiB
  modules by path ./node_modules/react/ 6.94 KiB
    ./node_modules/react/index.js 190 bytes [built] [code generated]
    ./node_modules/react/cjs/react.production.min.js 6.75 KiB [built] [code
generated]
  modules by path ./node_modules/react-dom/ 130 KiB
    ./node_modules/react-dom/index.js 1.33 KiB [built] [code generated]
    ./node_modules/react-dom/cjs/react-dom.production.min.js 129 KiB
[built] [code generated]
  modules by path ./node_modules/scheduler/ 4.33 KiB
    ./node_modules/scheduler/index.js 198 bytes [built] [code generated]
    ./node_modules/scheduler/cjs/scheduler.production.min.js 4.14 KiB
[built] [code generated]
./main.js + 1 modules 6 KiB [built] [code generated]
webpack 5.85.0 compiled successfully in 3984 ms
$
```

Bundled React

- To give it a try (cont.):
  - Run the app
    - `python runserver.py 55555`

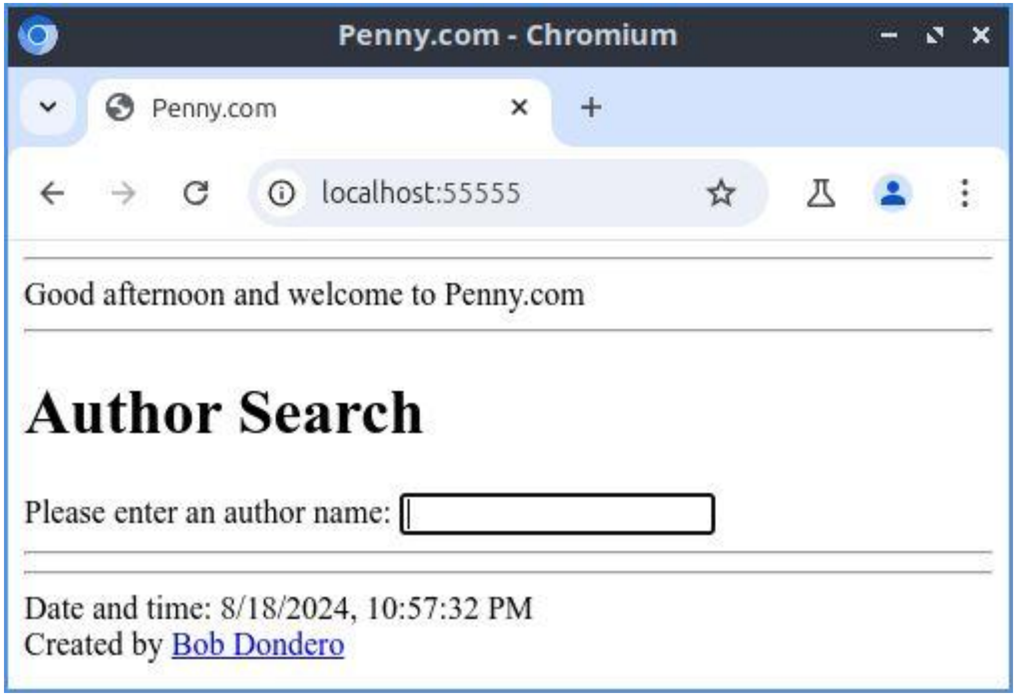
Bundled React

```
$ cd PennyReactBundled
$ python runserver.py 55555
 * Serving Flask app 'penny'
 * Debug mode: on
WARNING: This is a development server. Do not use it in a
production deployment. Use a production WSGI server
instead.
 * Running on all addresses (0.0.0.0)
 * Running on http://127.0.0.1:55555
 * Running on http://192.168.1.10:55555
Press CTRL+C to quit
 * Restarting with stat
 * Debugger is active!
 * Debugger PIN: 957-120-414
```

Bundled React

- To give it a try (cont.):
  - Browse to `http://localhost:55555`

Bundled React



Good afternoon and welcome to Penny.com

Author Search

Please enter an author name:

Date and time: 8/18/2024, 10:57:32 PM
Created by Bob Dondero

Agenda

- Bundled React: motivation
- Bundled React
- **Bundled React: Vite**

Bundled React: Vite

- **Problem**
  - Using npm and webpack is difficult
- **Solution**
  - Use a **React development environment**

Bundled React: Vite

- **React development environments**
  - ***create-react-app***
    - Popular but deprecated
  - ***Next.js***
    - Popular but complicated
  - ***Vite***
    - Popular and (relatively) simple
  - Several others

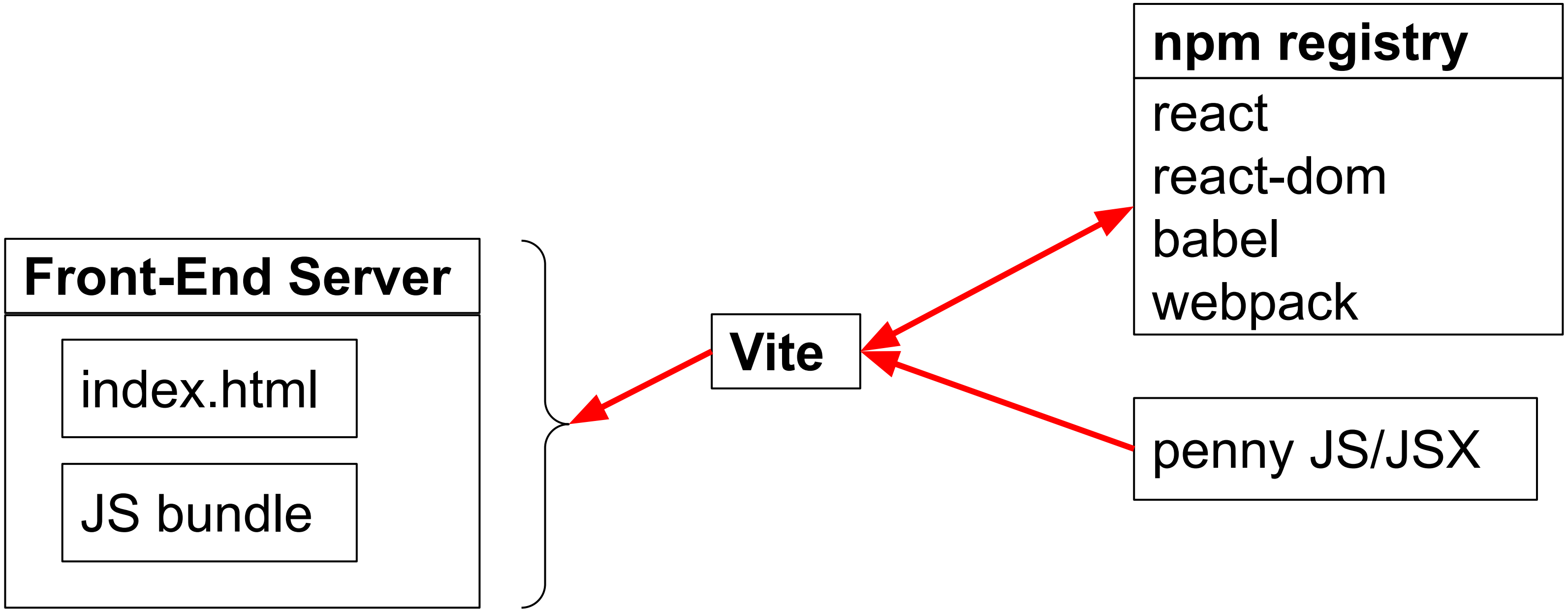
Bundled React: Vite

- ***Vite***
  - A popular React web development environment
  - Recognized for its:
    - Simplicity
    - Speed

Bundled React: Vite

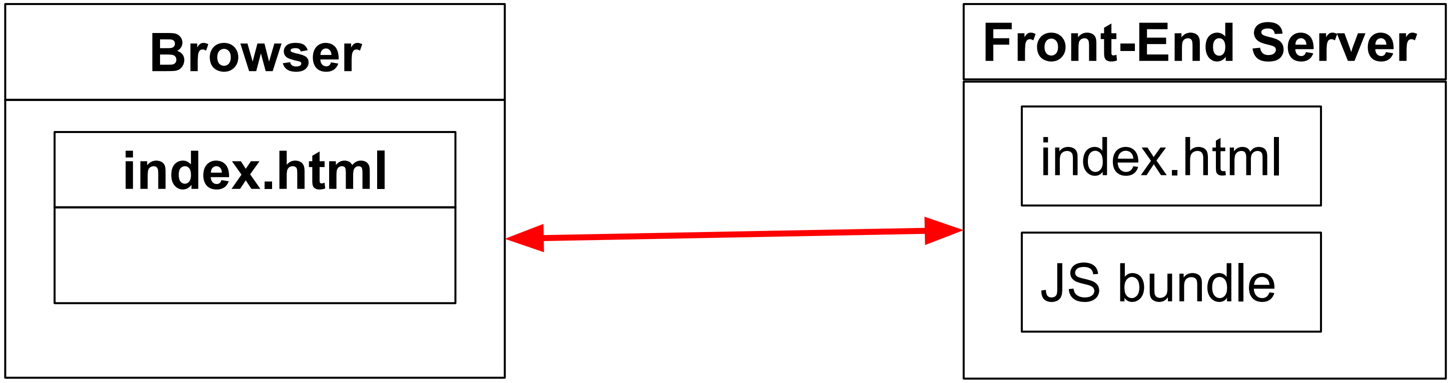
- General approach
  - Through Vite, create a *front-end server*
    - **PennyReactVite**
    - Delivers index.html and JS bundle to browser
  - Independent of Vite, create a *API server*
    - **PennyReactViteApi**
    - Written in Python/Flask/Jinja2 (or whatever!)
    - Provides services (API) to React app
    - Interacts with DB

Bundled React: Vite



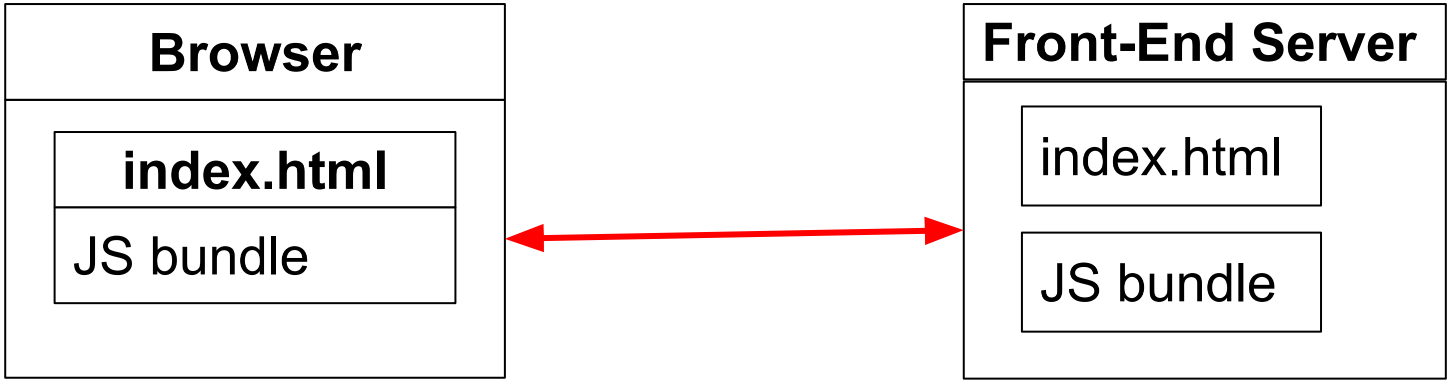
Vite requests and receives react, react-dom, babel, webpack
Vite creates JS bundle containing those libraries and penny JS

Bundled React: Vite



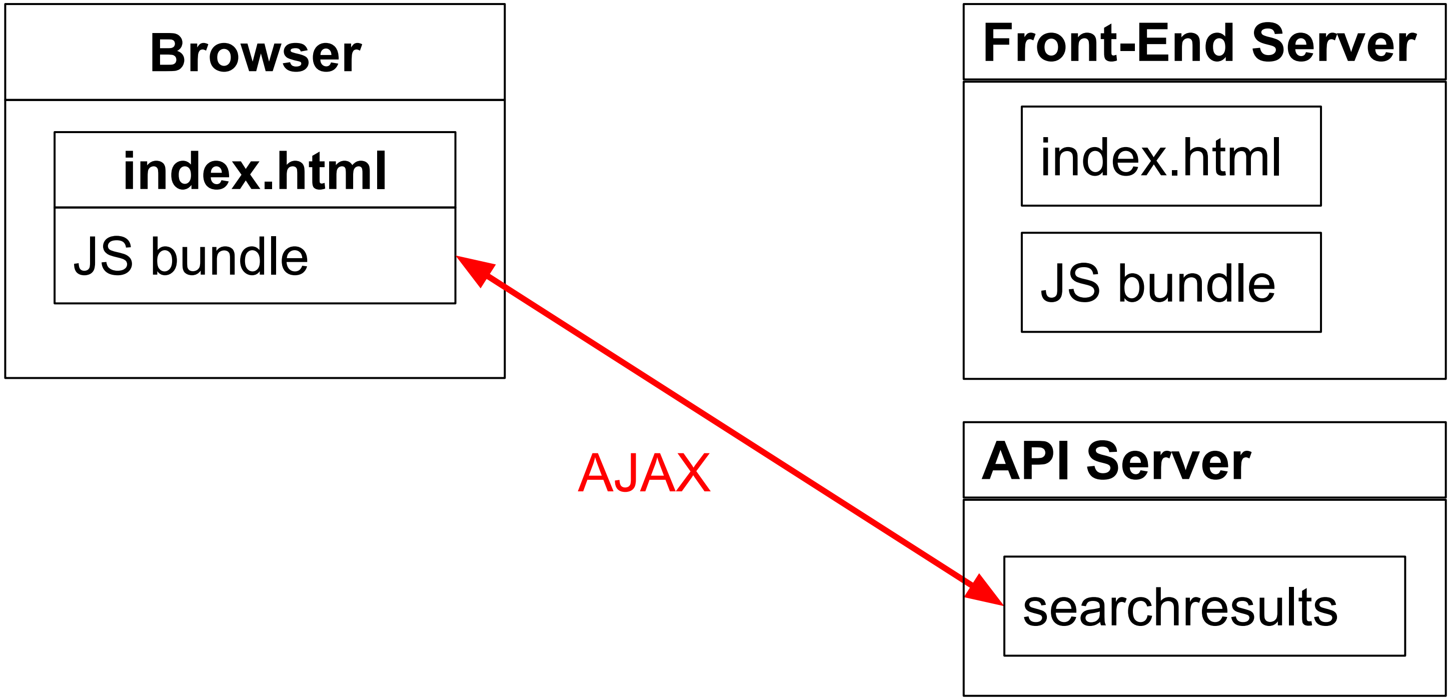
Browser requests and receives index page

Bundled React: Vite



Browser requests and receives JS bundle

Bundled React: Vite



Browser requests and receives book info

Bundled React: Vite

- To deploy to Render/Heroku
  - Deploy front-end server as a *static site*
  - Deploy API server as a *web service*
  - Tricky; see me if interested
- To add authentication
  - Difficult; see me if interested

Bundled React: Vite

- Simpler alternative: hack Vite to create a one-server app
  - Easy; see me if interested

Bundled React: Vite

- Detailed instructions…

Bundled React: Vite

- (1) Create a PennyReactViteApi directory anywhere in your file system
- (2) Place in the PennyReactViteApi directory these files: **runserver.py**, **penny.sql**, penny.sqlite, **database.py**, **penny.py**, **requirements.txt**

PennyReactViteApi/runserver.py (Page 1 of 1)

```python
#!/usr/bin/env python

#-----------------------------------------------------------------------
# runserver.py
# Author: Bob Dondero
#-----------------------------------------------------------------------

import sys
import penny

def main():

    if len(sys.argv) != 1:
        print('Usage: ' + sys.argv[0], file=sys.stderr)
        sys.exit(1)

    PORT = 5000

    try:
        penny.app.run(host='0.0.0.0', port=PORT, debug=True)
    except Exception as ex:
        print(ex, file=sys.stderr)
        sys.exit(1)

if __name__ == '__main__':
    main()
```

PennyReactViteApi/penny.sql (Page 1 of 1)

```sql
DROP TABLE IF EXISTS books;

CREATE TABLE books (isbn TEXT PRIMARY KEY, author TEXT, title TEXT);

INSERT INTO books (isbn, author, title)
   VALUES ('123', 'Kernighan','The Practice of Programming');
INSERT INTO books (isbn, author, title)
   VALUES ('234', 'Kernighan','The C Programming Language');
INSERT INTO books (isbn, author, title)
   VALUES ('345', 'Sedgewick','Algorithms in C');
```

PennyReactViteApi/database.py (Page 1 of 1)

```python
#!/usr/bin/env python

#-----------------------------------------------------------------------
# database.py
# Author: Bob Dondero
#-----------------------------------------------------------------------

import sqlite3
import contextlib

#-----------------------------------------------------------------------

_DATABASE_URL = 'file:penny.sqlite?mode=ro'

#-----------------------------------------------------------------------

def get_books(author):

    books = []

    with sqlite3.connect(_DATABASE_URL, isolation_level=None,
        uri=True) as connection:

        with contextlib.closing(connection.cursor()) as cursor:

            query_str = "SELECT isbn, author, title FROM books "
            query_str += "WHERE author LIKE ?"
            cursor.execute(query_str, [author+'%'])

            table = cursor.fetchall()
            for row in table:
                book = {'isbn': row[0], 'author': row[1],
                    'title': row[2]}
                books.append(book)

    return books

#-----------------------------------------------------------------------

def _test():

    books = get_books('ker')
    for book in books:
        print(book['isbn'])
        print(book['author'])
        print(book['title'])
        print()

if __name__ == '__main__':
    _test()
```

PennyReactViteApi/penny.py (Page 1 of 1)

```python
#!/usr/bin/env python

#-----------------------------------------------------------------------
# penny.py
# Author: Bob Dondero
#-----------------------------------------------------------------------

import os
import json
import flask
import flask_cors
import dotenv
import database

#-----------------------------------------------------------------------

dotenv.load_dotenv()
CLIENT_URL = os.environ['CLIENT_URL']

app = flask.Flask(__name__)

flask_cors.CORS(app, resources={r'/api/*': {'origins': CLIENT_URL}})

#-----------------------------------------------------------------------

@app.route('/api/searchresults', methods=['GET'])
def search_results():

    author = flask.request.args.get('author')
    if author is None:
        author = ''
    author = author.strip()

    if author == '':
        books = []
    else:
        books = database.get_books(author) # Exception handling omitted

    json_doc = json.dumps(books)
    response = flask.make_response(json_doc)
    response.headers['Content-Type'] = 'application/json'
    return response
```

PennyReactViteApi/requirements.txt (Page 1 of 1)

```
Flask
gunicorn
flask-cors
python-dotenv
```

PennyReactVite/src/main.jsx (Page 1 of 1)

```
import React from ’react’
import ReactDOM from ’react-dom/client’
import App from ’./App.jsx’

ReactDOM.createRoot(document.getElementById(’root’)).render(
  <React.StrictMode>
     <App />
  </React.StrictMode>,
)
```

Bundled React: Vite

- Node.js
  - Provides tools to help with development of React client-side
    - Via ***npm***, the Node.js package manager
    - For example: Vite, Babel, Webpack

Bundled React: Vite

- (3) Install node.js
  - See lecture *The JavaScript Language (Part 1)*
- (4) Create a PennyReactVite directory containing a default app anywhere in your file system

  -
    ```
    npm create vite@latest
    PennyReactVite -- --template react
    ```
- (5) Install dependencies
  - `cd PennyReactVite`
  - `npm install`

Bundled React: Vite

- (6) Delete all files from the PennyReactVite/public directory
  ```
  cd PennyReactVite/public
  rm *
  ```
- (7) Delete all files from the PennyReactVite/src directory
  ```
  cd PennyReactVite/src
  rm *
  ```
- (8) In the PennyReactVite/src directory add **main.jsx** and **App.jsx**

PennyReactViteApi/requirements.txt (Page 1 of 1)

```
Flask
gunicorn
flask-cors
python-dotenv
```

PennyReactVite/src/main.jsx (Page 1 of 1)

```
import React from 'react'
import ReactDOM from 'react-dom/client'
import App from './App.jsx'

ReactDOM.createRoot(document.getElementById('root')).render(
  <React.StrictMode>
     <App />
  </React.StrictMode>,
)
```

PennyReactVite/src/App.jsx (Page 1 of 2)

```
//----------------------------------------------------------------------
// App.jsx
// Author: Bob Dondero
//----------------------------------------------------------------------

import * as React from ’react’;
const VITE_SERVER_URL = import.meta.env.VITE_SERVER_URL

//----------------------------------------------------------------------

function PennyHeader() {
   const [datetime, setDatetime] = React.useState(new Date());

   function updateHeader() {
      window.setInterval(
         () => {setDatetime(new Date());},
         1000
      );
   }
   React.useEffect(updateHeader, []);

   let hours = datetime.getHours();
   let ampm = (hours < 12) ? ’morning’ : ’afternoon’;
   return (
      <div>
         <hr />
         Good {ampm} and welcome to Penny.com
         <hr />
      </div>
   );
}

//----------------------------------------------------------------------

function PennySearch() {
   const [author, setAuthor] = React.useState(’’);
   const [books, setBooks] = React.useState([]);
   function fetchBooks() {
      function handleResponse() {
         if (this.status !== 200) {
            alert(’Error: Failed to fetch data from server’);
            return;
         }
         let books = JSON.parse(this.response);
         setBooks(books);
      }
      function handleError() {
         alert(’Error: Failed to fetch data from server’);
      }
      let encodedAuthor = encodeURIComponent(author);
      let url = VITE_SERVER_URL +
         ’/api/searchresults?author=’ + encodedAuthor;
      let request = new XMLHttpRequest();
      request.onload = handleResponse;
      request.onerror = handleError;
      request.open(’GET’, url);
      request.send();
      return () => {request.abort();}
   }
   React.useEffect(fetchBooks, [author]);

   let timer = null;
   function debouncedSetAuthor(author) {
      clearTimeout(timer);
      timer = setTimeout(()=>{setAuthor(author);}, 500);
```

PennyReactVite/src/App.jsx (Page 2 of 2)

```
   }

   return (
      <div>
         <h1>Author Search</h1>
         Please enter an author name:&nbsp;
         <input
             type="text"
             onInput={ (event) => {
                debouncedSetAuthor(event.target.value);
             } }
             autoFocus
         />
         <hr />
         {books.map((book) => (
            <div key={book.isbn}>
               {book.isbn}:&nbsp;
               <strong>{book.author}</strong>:&nbsp;
               {book.title}
               <br />
            </div>
         ))}
      </div>
   );
}

//----------------------------------------------------------------------

function PennyFooter() {
   const [datetime, setDatetime] = React.useState(new Date());

   function updateFooter() {
      window.setInterval(
         () => {setDatetime(new Date());},
         1000
      );
   }
   React.useEffect(updateFooter, []);

   return (
      <div>
         <hr />
         Date and time: {datetime.toLocaleString()}
         <br />
         Created by&nbsp;
         <a href="https://www.cs.princeton.edu/˜rdondero">
         Bob Dondero</a>
      </div>
   );
}

//----------------------------------------------------------------------

function App() {
   return (
      <div>
         <PennyHeader />
         <PennySearch />
         <PennyFooter />
      </div>
   );
}

//----------------------------------------------------------------------
export default App;
```

Bundled React: Vite

- (9) In the PennyReactVite directory add **.env.development** and **.env.production**
- (10) In the PennyReactVite directory edit index.html
  - Change this
    - `<title>Vite + react</title>`
  - to this:
    - `<title>Penny.com</title>`

PennyReactVite/.env.development (Page 1 of 1)

```
VITE_SERVER_URL=http://localhost:5000
```

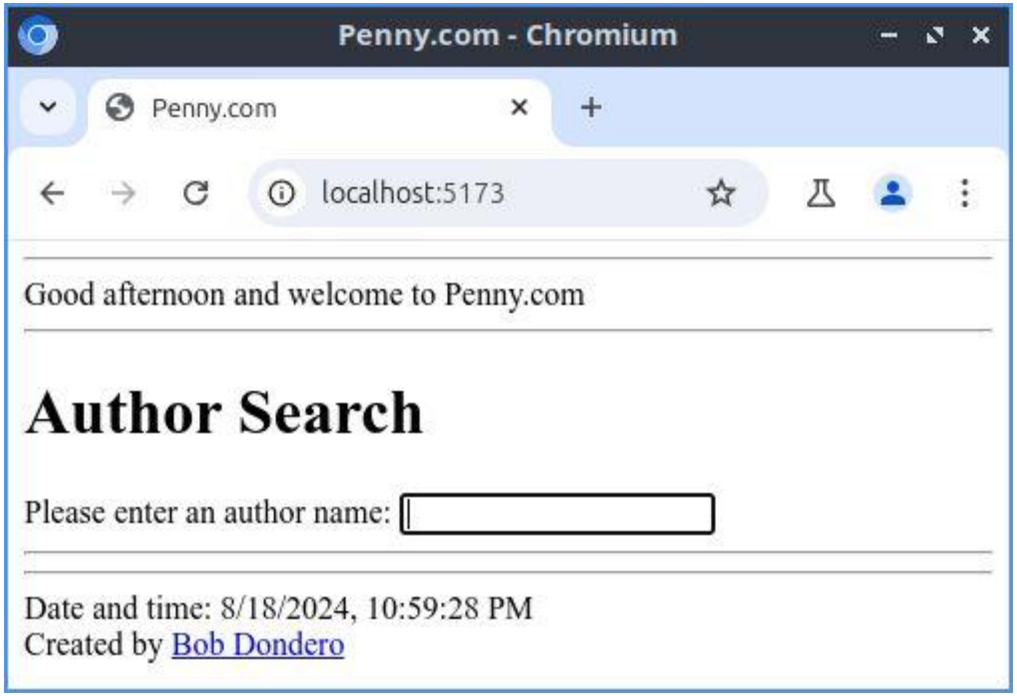
PennyReactVite/.env.production (Page 1 of 1)

```
VITE_SERVER_URL=https://pennyreactviteback.onrender.com
```

Bundled React: Vite

- (11) Run PennyReactViteApi locally
  - `cd PennyReactViteApi`
  - `export CLIENT_URL=http://localhost:5173`
  - `python runserver.py`
    - Starts test server on localhost at port 5000
- (12) Run PennyReactVite locally (development mode)
  - `cd PennyReactVite`
  - `npm run dev`
    - Starts test server on localhost at port 5173
  - Browse to http://localhost:5173

Bundled React: Vite



Good afternoon and welcome to Penny.com

Author Search

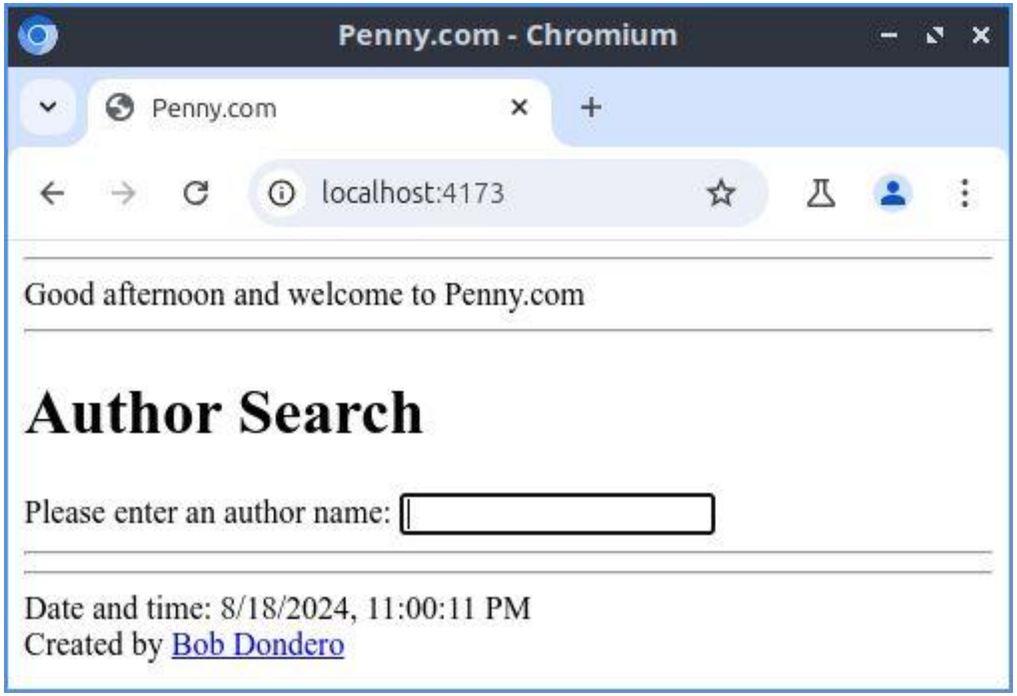
Please enter an author name:

Date and time: 8/18/2024, 10:59:28 PM
Created by Bob Dondero

Bundled React: Vite

- (13) Build PennyReactVite (production mode)
  - `cd PennyReactVite`
  - `npm run build`
- (14) Run PennyReactViteApi locally
  - `cd PennyReactViteApi`
  - `export CLIENT_URL=http://localhost:4173`
  - `python runserver.py`
    - Starts test server on localhost at port 5000
- (15) Run PennyReactVite (production mode) locally
  - `cd PennyReactVite`
  - `npm run preview`
    - Starts test server on localhost at port 4173
- (16) Browse to http://localhost:4173

Bundled React: Vite



Good afternoon and welcome to Penny.com

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More React

- There is **much** more to React…

- Recommended starter book:
  - *The Road to React* (Robin Weiruch)

Summary

- We have covered:
  - Bundled React apps
  - Bundled React apps: Vite

Summary

- We have covered:
  - Client-side web programming using JavaScript
    - The browser DOM
    - AJAX
    - jQuery
    - React
- See also:
    - **Appendix 1**: Arrow Functions

Appendix 1:
Arrow Functions

Arrow Functions

- Recall from JavaScript lectures…
- **Question**: How is `this` bound within a function `f()`?
- **Answer**: Depends upon how `f()` is called:

Function Call	Binding of `this`
`f()`	In `f()`, `this` is `undefined`
`o.f()`	In `f()`, `this` is bound to `o`
`new f()`	In `f()`, `this` is bound to a new empty object

Arrow Functions

- Some terms for this lecture:
  - **Ordinary function**: a non-arrow function
  - **Ordinary variable**: a non-`this` variable

Arrow Functions

- ***Arrow function def expressions***
  - Informally ***arrow functions***
  - Arrow functions vs ordinary functions:
    - More succinct
    - Same semantics - **mostly!!!**

Aside: setInterval & setTimeout

In browsers:

```
window.setInterval(f, ms);
// Call f every ms milliseconds
```

We have seen

```
window.setTimeout(f, ms);
// Call f after ms milliseconds
```

We have seen

In Node.js:

```
setInterval(f, ms);
// Call f every ms milliseconds
```

```
setTimeout(f, ms);
// Call f after ms milliseconds
```

We'll use now

Arrow Functions

- **Fact 1**: In an ordinary function…
  - The value of `this` is determined **dynamically**
    - Based upon the call
    - `o.f()`
      - In the function `this` is bound to `o`
    - `f()`
      - In the function `this` is undefined

Arrow Functions

```
$ node arrow1.js
undefined
$
```

- See **arrow1.js**
  - Notes:
    - Global code calls `main()`
    - `main()` calls `blueCar.writeColor()`
    - `blueCar.writeColor()` calls `setTimeout()`
    - `setTimeout()` calls given ordinary function
      - As `f()`, not as `o.f()`
    - In ordinary function, `this` is undefined

arrow1.js (Page 1 of 1)

```
//-----------------------------------------------------------------------
// arrow1.js
// Author: Bob Dondero
//-----------------------------------------------------------------------

'use strict';

class Car {

   constructor(color) {
      this._color = color;
   }

   writeColor() {
      // Error: this is undefined.
      setTimeout(
         function () { process.stdout.write(this._color + '\n'); },
         2000
      );
   }
}

function main() {
   let blueCar = new Car('blue');
   blueCar.writeColor();
}

if (require.main === module)
   main();
```

arrow2.js (Page 1 of 1)

```
//-----------------------------------------------------------------------
// arrow2.js
// Author: Bob Dondero
//-----------------------------------------------------------------------

'use strict';

class Car {

   constructor(color) {
      this._color = color;
   }

   writeColor() {
      let self = this;
      setTimeout(
         function () { process.stdout.write(self._color + '\n'); },
         2000
      );
   }
}

function main()
{
   let blueCar = new Car('blue');
   blueCar.writeColor();
}

if (require.main === module)
   main();
```

Arrow Functions

- **Fact 2**: In an ordinary function…
  - The value of an ordinary variable is determined **statically**
    - Based upon program block structure

Arrow Functions

```
$ node arrow2.js
blue
$
```

- See **<u>arrow2.js</u>**
  - Notes:
    - Global code calls `main()`
    - `main()` calls `blueCar.writeColor()`
    - `blueCar.writeColor()` calls `setTimeout()`
    - `setTimeout()` calls given ordinary function
      - As `f()`, not as `o.f()`
    - In ordinary function, `this` is undefined
      - But the ordinary function doesn’t use `this`!

arrow1.js (Page 1 of 1)

```
//-----------------------------------------------------------------------
// arrow1.js
// Author: Bob Dondero
//-----------------------------------------------------------------------

'use strict';

class Car {

   constructor(color) {
      this._color = color;
   }

   writeColor() {
      // Error: this is undefined.
      setTimeout(
         function () { process.stdout.write(this._color + '\n'); },
         2000
      );
   }
}

function main() {
   let blueCar = new Car('blue');
   blueCar.writeColor();
}

if (require.main === module)
   main();
```

arrow2.js (Page 1 of 1)

```
//-----------------------------------------------------------------------
// arrow2.js
// Author: Bob Dondero
//-----------------------------------------------------------------------

'use strict';

class Car {

   constructor(color) {
      this._color = color;
   }

   writeColor() {
      let self = this;
      setTimeout(
         function () { process.stdout.write(self._color + '\n'); },
         2000
      );
   }
}

function main()
{
   let blueCar = new Car('blue');
   blueCar.writeColor();
}

if (require.main === module)
   main();
```

Arrow Functions

- **Fact 3**: In an arrow function…
  - The value of `this` (and any ordinary variable) is determined **statically**
    - Based upon program block structure

Arrow Functions

```
$ node arrow3.js
blue
$
```

- See **arrow3.js**
  - Notes:
    - Global code calls `main()`
    - `main()` calls `blueCar.writeColor()`
    - `blueCar.writeColor()` calls `setTimeout()`
    - `setTimeout()` calls given arrow function
      - As `f()`, not as `o.f()`
    - In arrow function, `this` is bound to `blueCar`

arrow3.js (Page 1 of 1)

```
//----------------------------------------------------------------------
// arrow3.js
// Author: Bob Dondero
//----------------------------------------------------------------------

’use strict’;

class Car {

   constructor(color) {
      this._color = color;
   }

   writeColor() {
      setTimeout(
         () => { process.stdout.write(this._color + ’\n’); },
         2000
      );
   }
}

function main() {
   let blueCar = new Car(’blue’);
   blueCar.writeColor();
}

if (require.main === module)
   main();
```

Arrow Functions

- **Question**: Why use arrow functions?
- **Answer 1**: They're often more succinct
- **Answer 2**: `this` is defined statically

- Arrow functions often are appropriate as callback functions