Full-stack Application Development

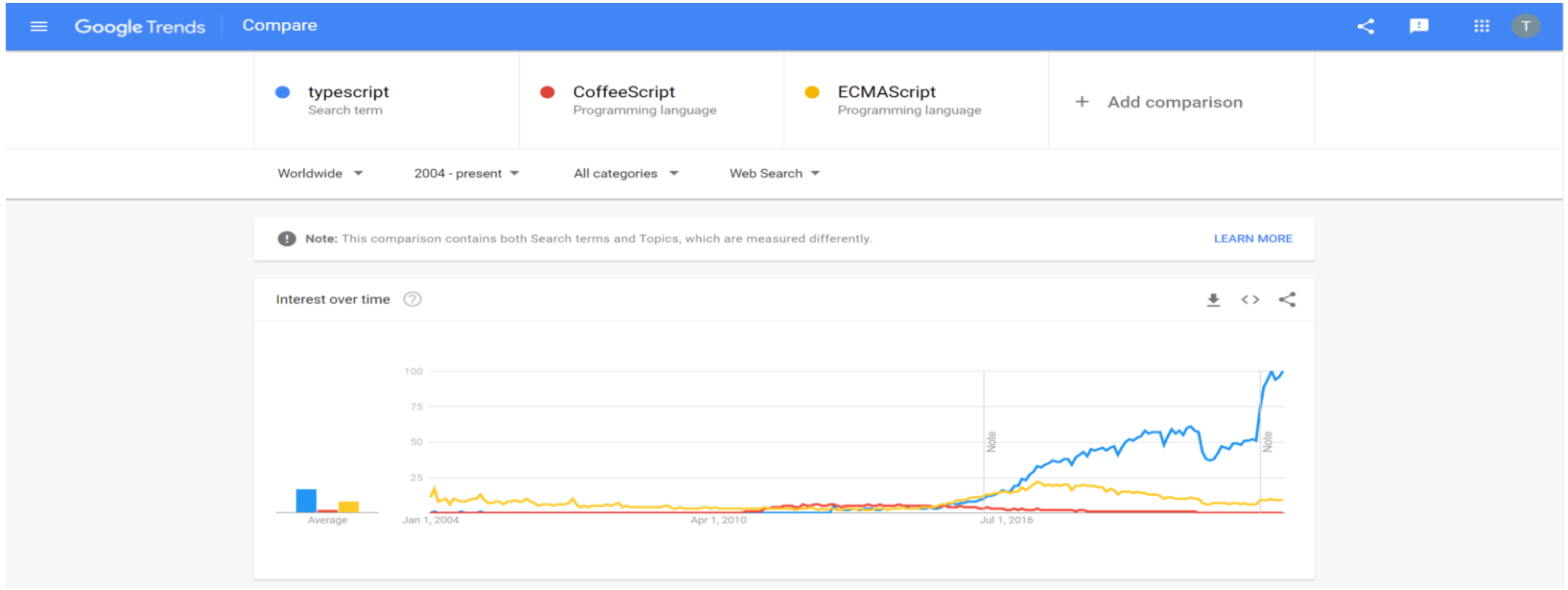
TypeScript

Where to Find The Code and Materials?

https://github.com/iproduct/react-typescript-academy-2022

TypeScript
[http://www.typescriptlang.org/]

- Typescript → since October 2012, Anders Hejlsberg (lead architect of C# and creator of Delphi and Turbo Pascal)
- Targets large scale client-side and mobile applications by compile time type checking + @Decorators -> Microsoft, Google
- TypeScript is strictly superset of JavaScript, so any JS is valid TS



Source: Google Trends comparison

TypeScript Hello World I

- Installing Typescript: **npm install -g typescript**
- Create new directory: **md 02-ts-demo-lab**
- Create a new TS project using npm: **npm init**
- Write a simple TS function – file **greeter.ts** :

```
function greeter(person: string) {
    return 'Hello, ' + person + ' from Typescript!';
}
const user = 'TypeScript User';
document.body.innerHTML = greeter(user);
```

TypeScript Hello World II

- Compile TypeScript to JavaScript (ES5): **tsc greeter.ts**
- Include script in **index.html** :

```
<html>
<head>
    <title>ES6 Simple Demo 01</title>
</head>
<body>
    <script src="greeter.js"></script>
</body>
</html>
```

- And open it in web browser – thats all :)
- If you make changes - use watch flag: **tsc -w greeter.ts**

Configuring, Building and Deploying TypeScript Project

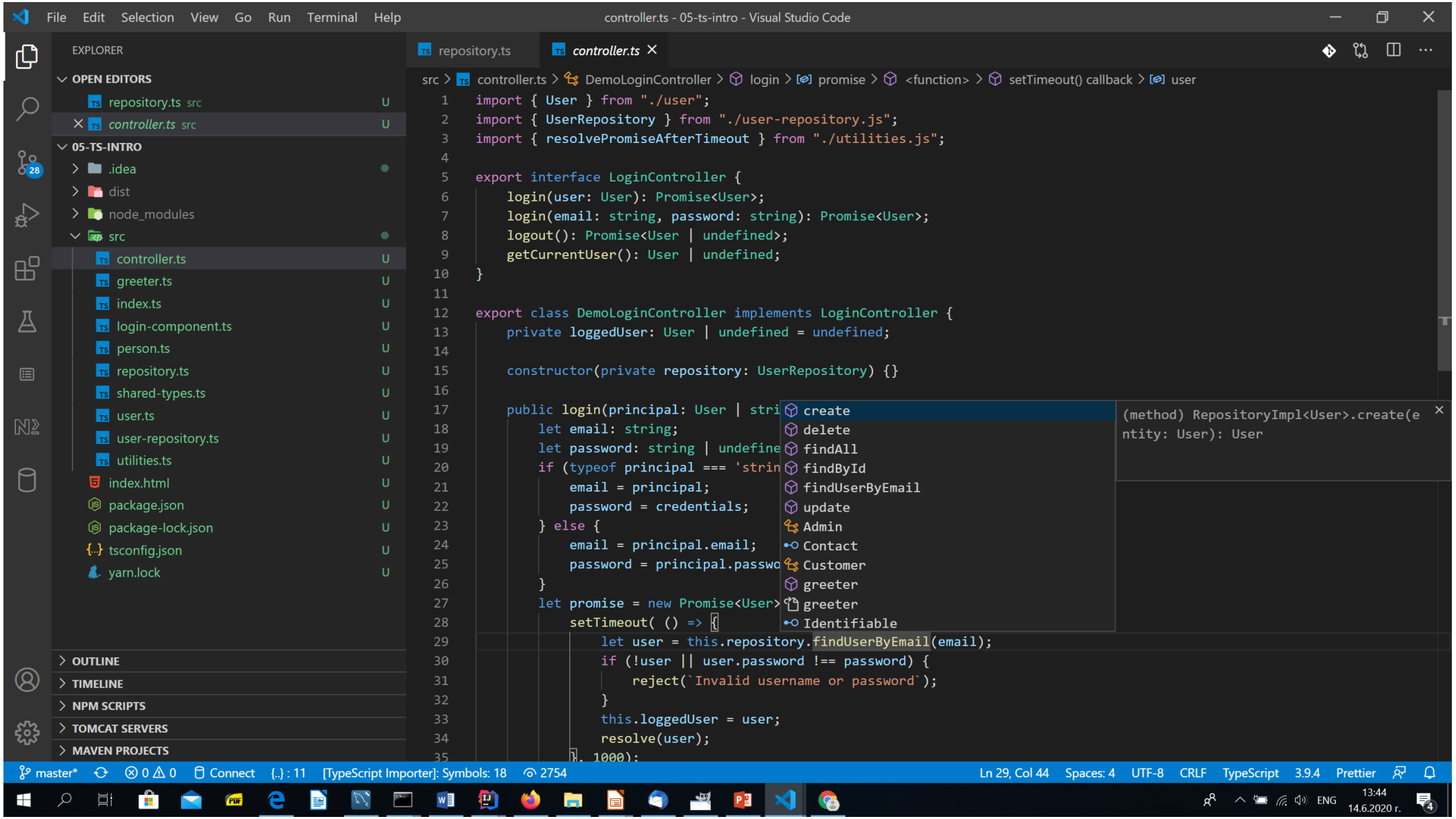
- Node package manager (**npm**) configuraton – **package.json**
- TypeScript configuration – **tsconfig.json**, to generate it run: **tsc --init**
- Configuring System.js module loader – **systemjs.config.js**
- Using external JS librarries – **@types** and npm packages
- TypeScript compiler options: http://www.typescriptlang.org/docs/handbook/compiler-options.html
- Linting TypeScript code – **tslint.json -> .eslintrc.js**: https://palantir.github.io/tslint/rules/
- Developing simple TS project – **Login Demo**

typescript-eslint configuration: **.eslintrc.cjs**

- *npm install --save-dev @typescript-eslint/parser @typescript-eslint/eslint-plugin eslint typescript*
- *yarn add --dev @typescript-eslint/parser @typescript-eslint/eslint-plugin eslint typescript*
- .eslintrc.cjs:

```
/* eslint-disable no-undef */
module.exports = {
    extends: ['eslint:recommended', 'plugin:@typescript-eslint/recommended'],
    parser: '@typescript-eslint/parser',
    plugins: ['@typescript-eslint'],
    root: true,
    rules: {
        "@typescript-eslint/no-non-null-assertion": "off",
    }
};
```

Visual Studio Code



Visual Studio Code

```
10  export default class UserView extends Component<Props> {
        2 references
11      render() {
12          return (
13              |
14          );
15      }
16
        0 references
17      private getYearJoined(user: User) {
18          return _.padStart(user.dateJoined.format('yyyy'), 6);
19      }
20
        0 references
21      private getDisplayName(user: User) {
```

VS Code: Popular Angular/TS Plugins I

- **TSLint** - linter for the TypeScript language, help fixing error in TS code. Must have when working with TS -> merged with **ESLint**.
- **ESLint** - linter for the ECMAScript and TypeScript languages, help fixing error in TS code. TSLint announced that it will merge with ESLint: https://github.com/typescript-eslint/tslint-to-eslint-config
- **ES7 React/Redux/GraphQL/React-Native snippets** - This extension provides you JavaScript and React/Redux snippets in ES7 with Babel plugin features for VS Code. **Supported languages:** JavaScript (.js), JavaScript React (.jsx), TypeScript (.ts), TypeScript React (.tsx)
- **JavaScript (ES6) code snippets** – This extension contains code snippets for JavaScript in ES6 syntax for Vs Code editor – supports both JavaScript and TypeScript.
- **Typescript React code snippets** – code snippets for React with Typescript.
- **React + Typescript Code Snippets** – opinionated code snippets for React with Typescript

VS Code: Popular Angular/TS Plugins II

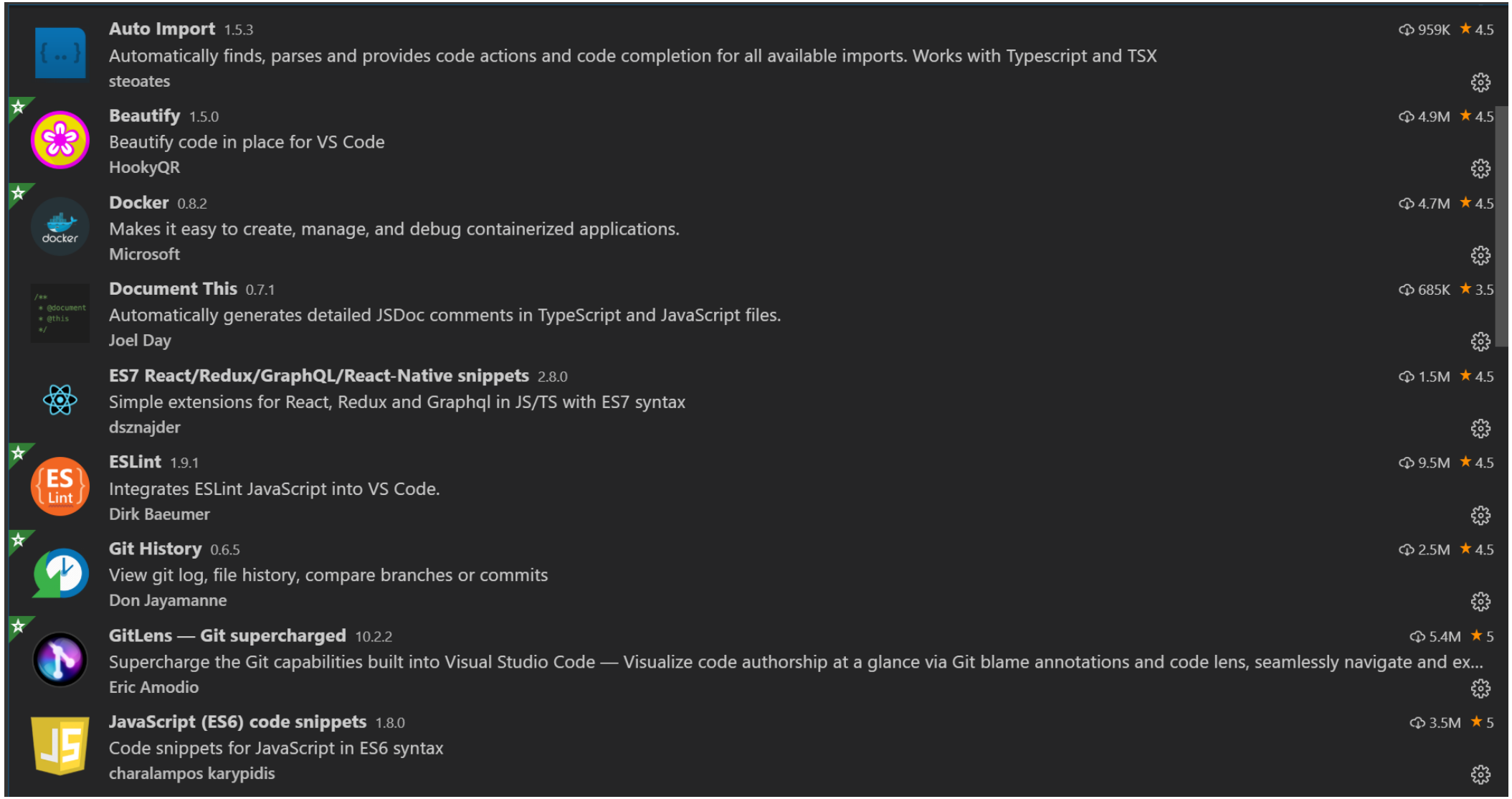
- **TypeScript Hero** - Sorts and organizes your imports according to convention and removes imports that are unused (Ctrl+Alt+o on Win/Linux or Ctrl+Opt+o on MacOS).

- **Path Intellisense** - VSCode has a very good auto import capability, but sometime you still need to import some files manually, and this extension helps a lot in these cases.

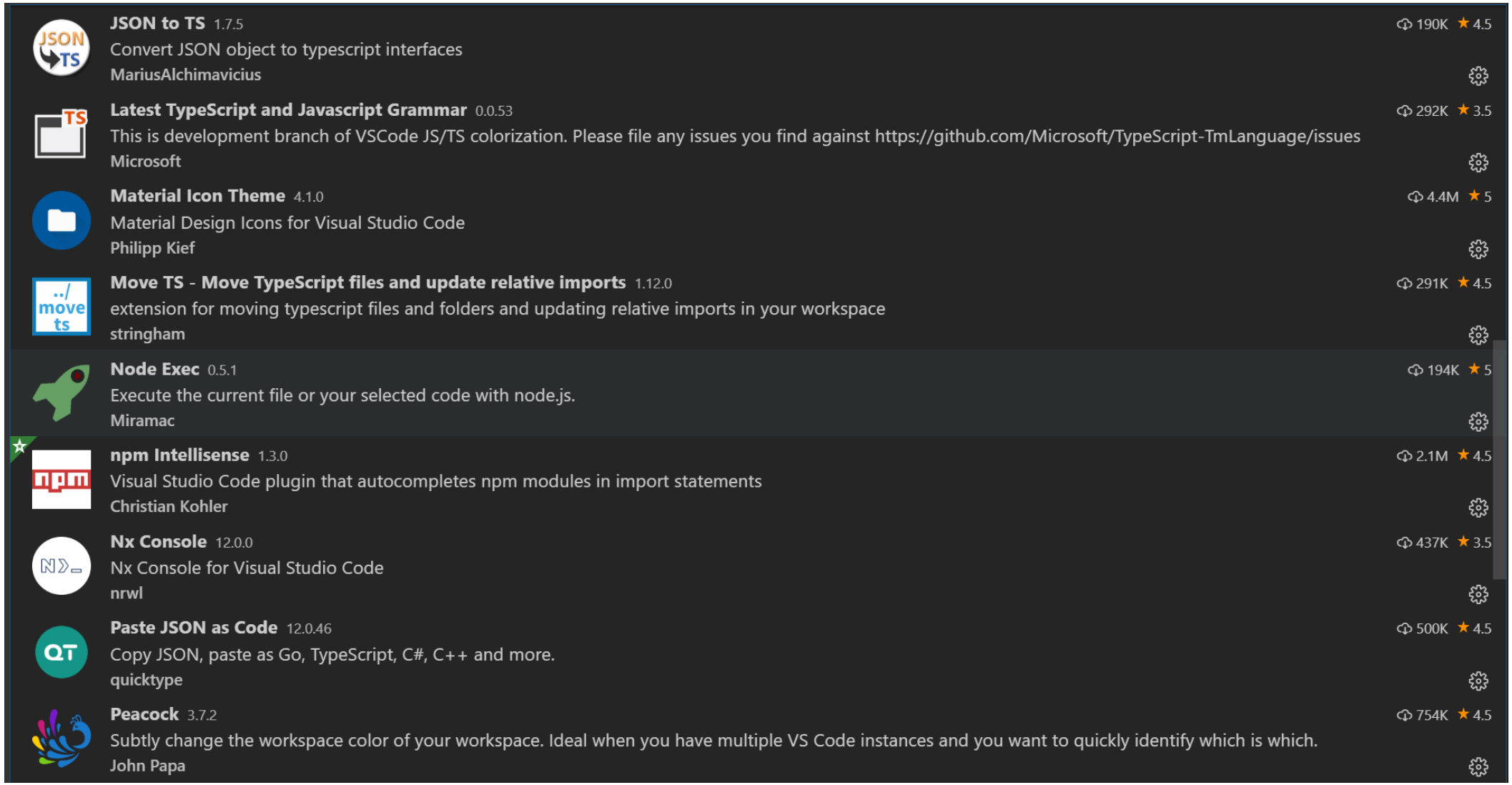
- **TypeScript Importer** - Automatically searches for TypeScript definitions in workspace files and provides all known symbols as completion item to allow code completion.

- **Debugger for Chrome** - allows to debug using chrome and add your breakpoints in VSCode.

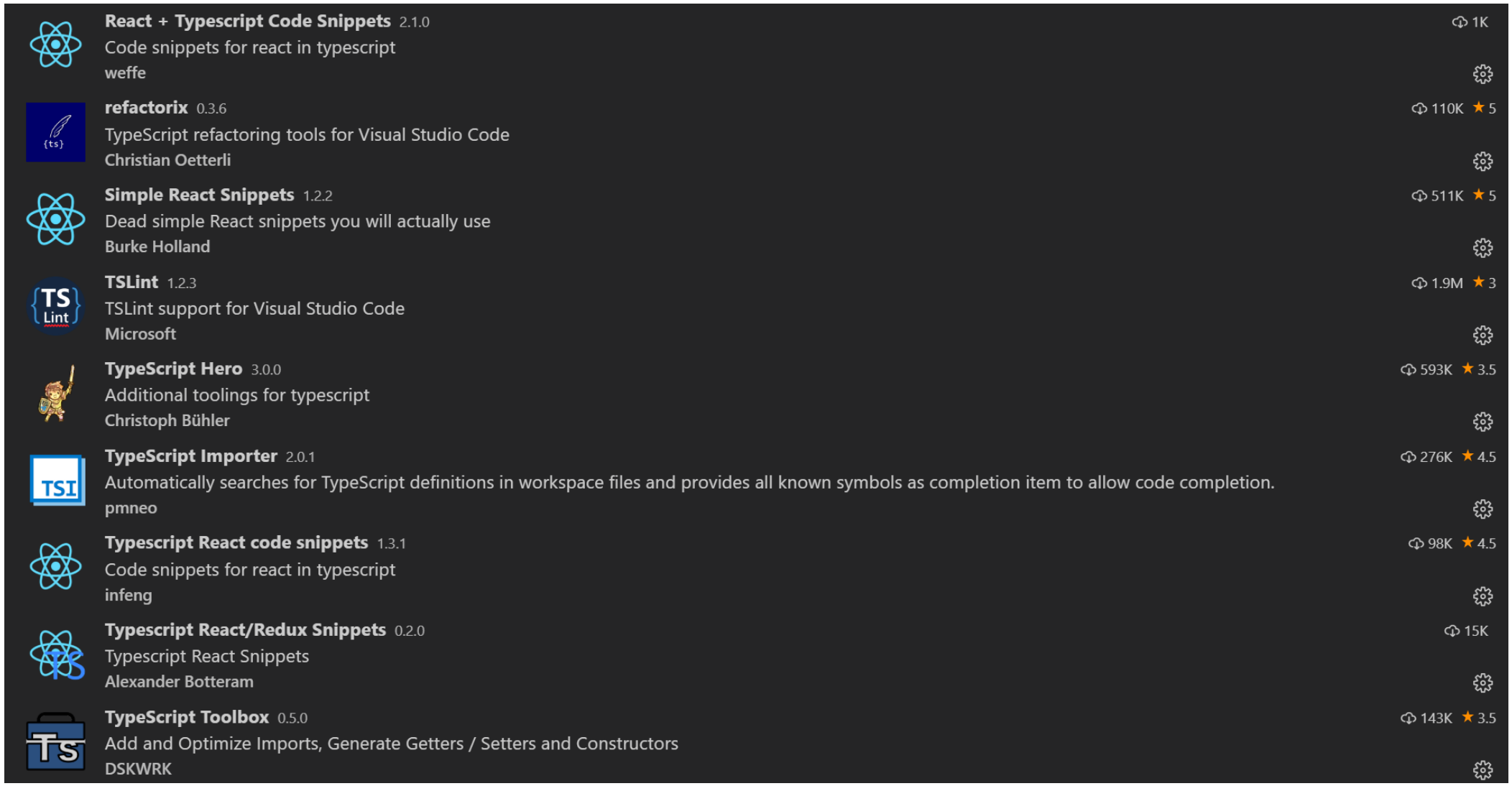
Let's Install Some VSCode Plugins III



Let's Install Some VSCode Plugins IV



Let's Install Some VSCode Plugins V



Introduction to TypeScript I

- Functions, interfaces, classes and constructors.
- Common types – **Boolean, Number, String, Array, Tuple, Enum, Any, Void, Null, Undefined**.
- **--strictNullChecks** flag
- Type assertions: let length: number = (**<string>** data).length;

  let length: number = (data **as string**).length;
- **Duck typing** = structural similarity based typing
- Declaring variables – **let**, **const** and **var**. Scopes, variable capturing, Immediately Invoked Function Expressions (IIFE), closures and **let**.

Declaring Contracts using Interfaces I

```
export interface User {
    id: number;
    firstName: string;
    lastName: string;
    email: string;
    password: string;
    contact?: Contact;
    roles: Role[];
    getSalutation(): string;
}
```

← Optional properties

← Required methods

Declaring Contracts using Interfaces II

```
import { User } from './users';
export interface UserRepository {
    addUser(user: User): void;
    editUser(user: User): void;
    ...
    findAllUsers(): User[];
}
export class DemoUserRepository implements UserRepository {
    private users = new Map<number, User>();
    public addUser(user: User): void {
        if (this.findUserByEmail(user.email)) {
            throw `User with email ${user.email} exists.`;
        }
        user.id = this.getNextId();
        this.users.set(user.id, user);
    }
    ...
```

Declaring Contracts using Interfaces II

- Properties, optional properties and readonly properties:

```
interface UserRepository {
    readonly size: number;
    addUser: (user: User) => void;
}
```

- Function types:

```
interface RoleFinder {
   (user: User) : Role[];
}
```

- Array (indexable) types. Dictionary pattern:

```
interface EmailUserMap {
   [key: string]: User;
}
```

Class Types

```
export class Customer implements User {
  public id: number; // set automatically by repository
  constructor(public firstName: string,
      public lastName: string,
      public email: string,
      public password: string,
      public contacts?: Contact,
      public roles: Array<Role> = [ Role.CUSTOMER ]) {
  }
  public get salutation() {
      return `${this.firstName} ${this.lastName}
              in role ${Role[this.roles[0]]}`;
  }
}
```

Default value

Extension of Interfaces. Hybrid Types.

```
export interface Person {
    id: number;
    firstName: string;
    lastName: string;
    email: string;
    contact?: Contact;
}

export interface User extends Person{
    password: string;
    roles: Role[];
    getSalutation(): string;
}
```

Classes

- Constructors, constructor arguments as properties
- Public/private/protected properties
- Get and set accessors

```
export interface User extends Person{
    password: string;
    roles: Role[];
    readonly salutation: string;
} ...
public get salutation() {
    return `${this.firstName} ${this.lastName}`;
}
```

- Static and instance sides of a class. Abstract classes

Functions and Function Types

- Optional, default and **rest (...)** parameters

```
export class Person {
    public restNames: string[];
    constructor(public firstName: string, ...restNames: string[]) {
        this.restNames = restNames;
    }
    public get salutation() {
        let salutation = this.firstName;
        for (let name of this.restNames) {
            salutation += ' ' + name;
        }
        return salutation;
    }
}
console.log(new Person('Ivan', 'Donchev', 'Petrov').salutation);
```

Function Lambdas (=>) and Use of this

```
export class LoginComponent {
    constructor(private jqElem: string, private loginC: LoginController){
        const keyboardEventHandler = (event: JQueryKeyEventObject) => {
            if (event.keyCode === 13) {
                loginEventHandler();
            }
        };
        const loginEventHandler = () => {
            this.loginC.login(usernameInput.val(), passwordInput.val())
                .then(() => {
                    this.showCurrentUser();
                }).catch(err => {
                    this.showError(err);
                });
            return false;
         };
    ...
```

Type Guards & Method Overloading

```
export class DemoLoginController implements LoginController {
    public login(email: string, password: string): Promise<User>;
    public login(user: User): Promise<User>;
    public login(principal: User | string, credentials?: string)
           : Promise<User> {
        let email: string, password: string;
        if (typeof principal === 'string') {
            email = principal;
            password = credentials;
         } else {
            email = principal.email;
            password = principal.password;
        }
        let promise = new Promise<User>( (resolve, reject) => { … });
        return promise;
  }
```

Using Enums

- Defining enumeration:

```
enum Role {
    ADMIN = 1, CUSTOMER
}
```

- In generated code an enum is compiled into an object that stores both forward (name -> value) and reverse (value -> name) mappings.

- Getting enumerated name by value:

```
public get salutation() {
   return `${this.name} in role ${Role[this.roles[0]]}`;
}
```

JavaScript Module Systems – ES6

```
//  lib/math.js
export function sum (x, y) { return x + y }
export var pi = 3.141593

//  someApp.js
import * as math from "lib/math"
console.log("2π = " + math.sum(math.pi, math.pi))

//  otherApp.js
import { sum, pi } from "lib/math"
console.log("2π = " + sum(pi, pi))
```

Modules in TypeScript

- **Namespaces** and **modules** – former internal and external modules – prefer **namespace X { … }** instead module X { … }
- ES6 modules (preferred) – using **export** and **import**:

```
export interface Person {...}
export interface User extends Person{...}
export interface Contact {...}
export enum Role { ADMIN, CUSTOMER }
export class Customer implements User {...}
import {User} from './users';
import {resolvePromiseAfterTimeout} from './utilities';
import $ from 'jquery';
import * as repository from './user-repository';//default import
import './my-module.js'; //import a module for side-effects only
let module = await import('/modules/my-module.js'); // dynamic
```

Interoperability with External JS Libraries

- Ambient type declarations and ambient modules **(*.d.ts)** – **typings**, **@types** – Example **node.d.ts** (simplified):

```
declare module "url" {
    export interface Url {
        protocol?: string;
        hostname?: string;
        pathname?: string;
    }
    export function parse(urlStr: string, parseQueryString?,
 slashesDenoteHost?): Url;
}
/// <reference path="node.d.ts"/>
import * as URL from "url";
let myUrl = URL.parse("https://github.com/iproduct");
```

Source: http://www.typescriptlang.org/docs/handbook/modules.html, License: Apache v2.0, Example is modified

Generic Type Parameters I

- Writing generic functions, interfaces and classes – Examples:

```
interface Repository {
    findById<T>(id: number): T;
    findAll<T>(): Array<T>;
}

//OR

interface Repository<T> {
    findById: (id: number) => T;
    findAll(): Array<T>;
}
```

Generic Type Parameters II

```
export class RepositoryImpl<T> implements Repository<T> {
    private data = new Map<number, T>();
    public findById(id: number): T {
        return this.data.get(id);
    }
    public findAll(): T[] {
        let results: T[] = [];
        this.data.forEach(item => results.push(item));
        return results;
    }
}
```

- Bounded generics
- Generic constructors

Advanced Types – Creating Types from Types

- Generics - Types which take parameters
- Keyof Type Operator - Using the keyof operator to create new types
- Typeof Type Operator - Using the typeof operator to create new types
- Indexed Access Types - Using Type['a'] syntax to access a subset of a type
- Conditional Types - Types which act like if statements in the type system
- Mapped Types - Creating types by mapping each property in an existing type
- Template Literal Types - Mapped types which change properties via template literal strings

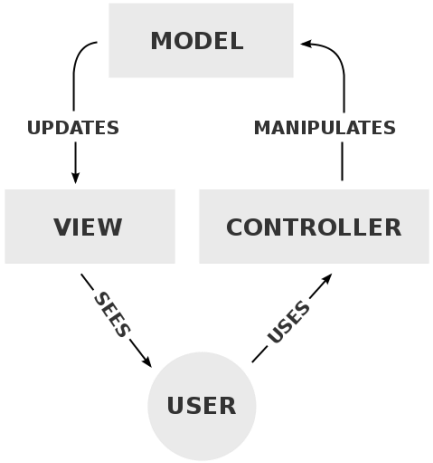
Source: https://www.typescriptlang.org/docs/handbook/2/types-from-types.html

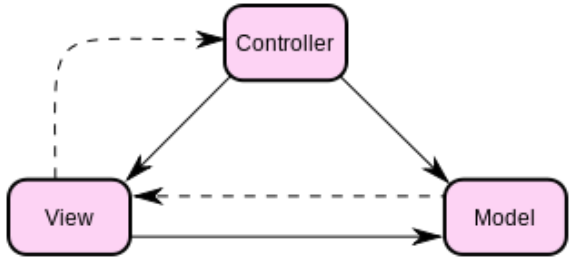
Exercise: Users Login Demo

https://github.com/iproduct/fullstack-typescript-react/tree/master/05-ts-intro

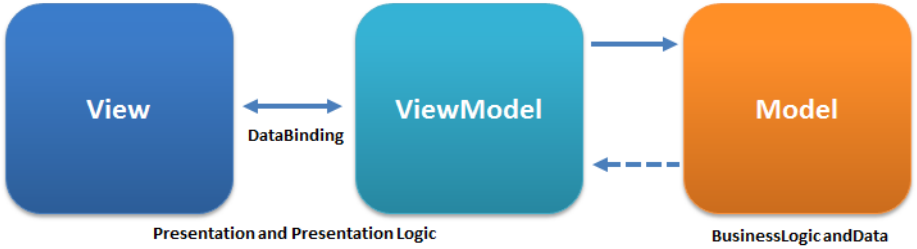
MVC Comes in Different Flavors

- MVC

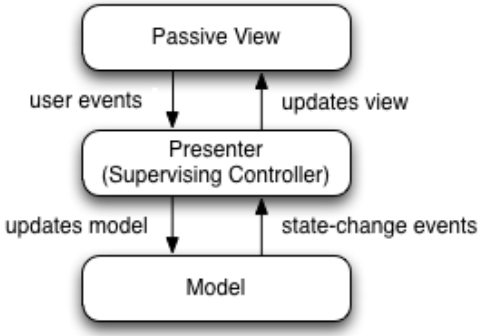




- MVVM



- MVP



Using JavaScript Libraries in TypeScript: JQuery I

```
import { LoginController } from './controller';
import '../node_modules/jquery/dist/jquery.js';

export class LoginComponent {
    private messagesElement: JQuery;
    constructor(private jqElementSelector: string, private loginController: LoginController) {

        const keyboardEventHandler = (event: JQuery.Event) => {
            if (event.keyCode === 13) {
                loginEventHandler();
            }
        };

        const loginEventHandler: any = () => {
            this.loginController.login(usernameInputElem.val() as string, passwordInputElem.val() as string)
            .then(() => {
                this.showCurrentUser();
            }).catch(err => {
                this.showError(err);
            });
            return false;
        };
```

(- continues -)

Using JavaScript Libraries in TypeScript: JQuery II

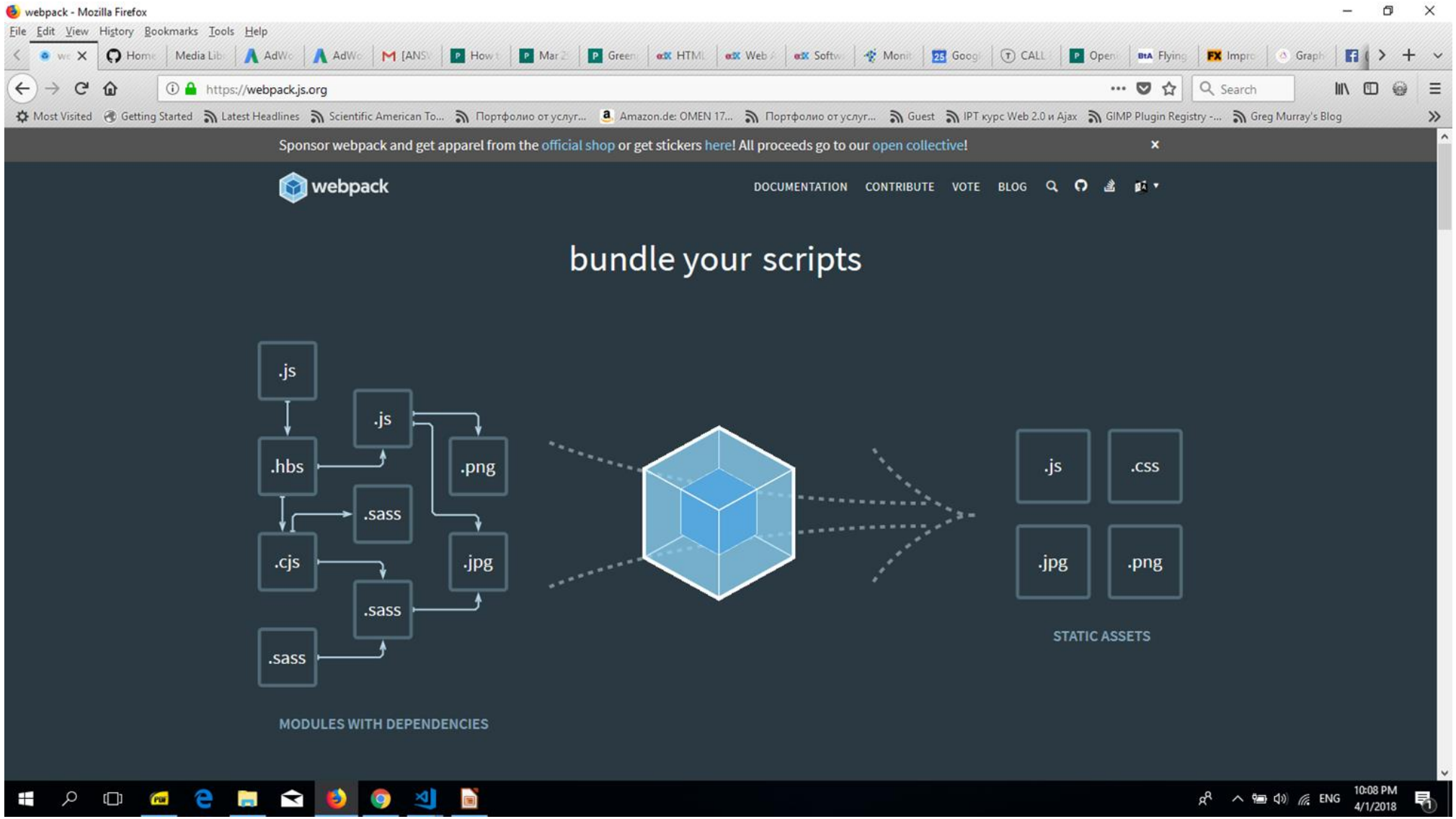
```
    const formElem = $("<form class='form-inline' role='form'>").addClass('form-inline');
    const usernameInputElem: JQuery<HTMLElement> =
        $("<input id='username' type='email' placeholder='email'>")
        .addClass('form-control').bind('keypress', keyboardEventHandler);
    const passwordInputElem: JQuery<HTMLElement> =
        $("<input id='password' type='password' ', keyboardEventHandler);
    const loginButtonElem: JQuery<HTMLElement> =
        $('<button>Login</buttton>').addClass('btn btn-primary')
        .click(loginEventHandler);


    // build the login form
    formElem.append(usernameInputElem);
    formElem.append(passwordInputElem);
    formElem.append(loginButtonElem);
    this.messagesElement = $('<div id="message" class="well well-lg">');
    $(jqElementSelector).append(formElem).append(this.messagesElement);

    this.showCurrentUser();
}

public showCurrentUser(): void {
    const user = this.loginController.getCurrentUser();
    this.messagesElement.html(user ? `Welcome ${user.salutation}.` : `No user is logged in.`);
}
```

Webpack Builder & Bundler Tool



Basic webpack.config.js when using Webpack 5 or 4

```
const path = require('path');
module.exports = {
    entry: './src/index.ts',
    module: {
        rules: [
            {
                test: /\.tsx?$/,
                use: 'ts-loader',
                exclude: /node_modules/,
            },
        ],
    },
    resolve: {
        extensions: ['.tsx', '.ts', '.js'],
    },
    output: {
        filename: 'bundle.js',
        path: path.resolve(__dirname, 'dist'),
    },
};
```

Creating New Project: NPM + WebPack + React

```
mkdir my-project
cd my-project
npm init
npm install --save-dev webpack webpack-cli webpack-dev-server
touch index.html src/index.js webpack.config.js
npm install --save react react-dom
npm install --save-dev @types/react @types/react-dom
npm install --save-dev typescript ts-loader source-map-loader
// OR npm install typescript awesome-typescript-loader --save-dev
npm install css-loader style-loader css-to-string-loader --save-dev
npm install file-loader url-loader html-loader clean-webpack-plugin --save-dev
npm install extract-text-webpack-plugin html-webpack-plugin --save-dev
npm i --save-dev eslint @typescript-eslint/parser @typescript-eslint/eslint-plugin eslint-plugin-react
```

In package.json:

```
"scripts": {
    "start": "webpack-dev-server --inline –hot --open",
    "watch": "webpack --watch",
    "build": "webpack -p"
},
```

Minimal tsconfig.json

```
{
  "compilerOptions": {
    "outDir": "./dist/",
    "sourceMap": true,
    "noImplicitAny": true,
    "strictNullChecks": true,
    "module": "ESNext",
    "moduleResolution": "node",
    "target": "ES6",
    "jsx": "react",
    "allowSyntheticDefaultImports": true,
  },
  "include": [ "src/**/*" // *** The files TypeScript should type check ***  ],
  "exclude": ["node_modules", "build"] // *** The files to not type check ***
}
```

- For more complete TS config see: https://www.sitepoint.com/react-with-typescript-best-practices/

React Component File: /src/components/Hello.tsx

```
import * as React from 'react';

export interface HelloProps {
  compiler: string;
  framework: string;
}

// 'HelloProps' describes the shape of props. State is never set so we use the '{}' type.
export class Hello extends React.Component<HelloProps, {}> {
  render() {
    return (
      <h1>
          Hello from {this.props.compiler} and {this.props.framework}!
      </h1>
    );
  }
}
```

React Main File: /src/index.tsx

```
import * as React from "react";
import * as ReactDOM from "react-dom";

import { Hello } from "./components/Hello";

ReactDOM.render(
    <Hello compiler="TypeScript" framework="React" />,
    document.getElementById("demo")
);
```

Simple webpack.config.js I

```
const path = require('path');
const HtmlWebpackPlugin = require('html-webpack-plugin');
const { CleanWebpackPlugin } = require('clean-webpack-plugin');
module.exports = {
    mode: 'development',
    entry: {
        app: './src/index.tsx',
    },
    devtool: 'inline-source-map',
    devServer: {
        contentBase: './dist',
        compress: true,
        hot: true,
        port: 9000
    },
    plugins: [
        new CleanWebpackPlugin({ cleanStaleWebpackAssets: false }),
        new HtmlWebpackPlugin({
            template: path.join(__dirname, 'index.html'),
            title: 'Hello React',
        }),
    ],
```

Simple webpack.config.js II

```
output: {
    filename: '[name].bundle.js',
    path: path.resolve(__dirname, 'dist'),
},
resolve: {
    extensions: [".wasm", ".ts", ".tsx", ".mjs", ".js", ".json"],
},

module: {
    rules: [
        {
            test: /\.ts(x?)$/,
            exclude: /node_modules/,
            use: [
                {
                    loader: "awesome-typescript-loader"
                }
            ]
        }]
},
```

Simple webpack.config.js III

```
    // optimization
    optimization: {
        splitChunks: {
            cacheGroups: {
                default: false,
                vendors: false,
                // vendor chunk
                vendor: {
                    // sync + async chunks
                    chunks: 'all',
                    // import file path containing node_modules
                    test: /node_modules/
                }
            }
        }
    }
};
```

Webpack Loaders and Plugins

- Loaders are transformations (functions running in node.js) that are applied on a resource file of your app
- You can use loaders to to load ES6/7 or TypeScript
- Loaders can be chained in a pipeline to the resource. The final loader is expected to return JavaScript
- Loaders can be synchronous or asynchronous
- Loaders accept query parameters – loader configuration
- Loaders can be bound to extensions / RegExps
- Loaders can be published / installed through npm
- Plugins – more universal than loaders, provide more features

WebPack Loaders

- ts-loader, awesome-typescript-loader -TypeScript => ES 5 or 6
- babel-loader - turns ES6 code into vanilla ES5 using Babel
- file-loader - emits the file into the output folder and returns the url
- url-loader - like file loader, but returns Data Url if file size <= limit
- extract-loader - prepares HTML and CSS modules to be extracted into separate files (alt. to ExtractTextWebpackPlugin)
- html-loader - exports HTML as string, requiring static resources
- style-loader - adds exports of a module as style to DOM
- css-loader - loads css file resolving imports and returns css code
- sass-loader - loads and compiles a SASS/SCSS file
- postcss-loader - loads and transforms a CSS file using PostCSS
- raw-loader - lets you import files as a string

WebPack Main Plugins

- ExtractTextWebpackPlugin - extracts CSS from your bundles into a separate file (e.g. app.bundle.css) → mini-css-extract-plugin
- CompressionWebpackPlugin - prepare compressed versions of assets to serve them with Content-Encoding
- I18nWebpackPlugin - adds i18n support to your bundles
- HtmlWebpackPlugin - simplifies creation of HTML files (index.html) to serve your bundles
- ProvidePlugin - automatically loads modules, whenever used
- UglifyJsPlugin – tree transformer and compressor which reduces the code size by applying various optimizations
- ~~CommonsChunkPlugin~~ - generates chunks of common modules shared between entry points and splits them to separate bundles → SplitChunksPlugin

Resources

- TypeScript Cheat Sheets – https://www.typescriptlang.org/cheatsheets
- TypeScript Handbook – https://www.typescriptlang.org/docs/handbook/2/basic-types.html
- Typescript Reference: Utility types – https://www.typescriptlang.org/docs/handbook/utility-types.html
- Official Webpack repo @ GiytHub – https://github.com/webpack/webpack

Thank's for Your Attention!

Trayan Iliev

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