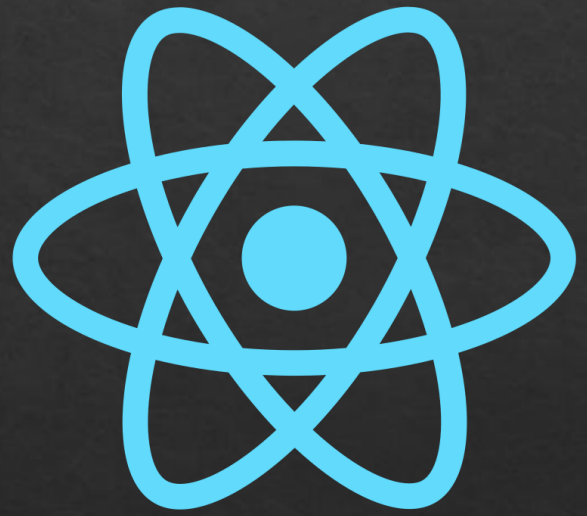
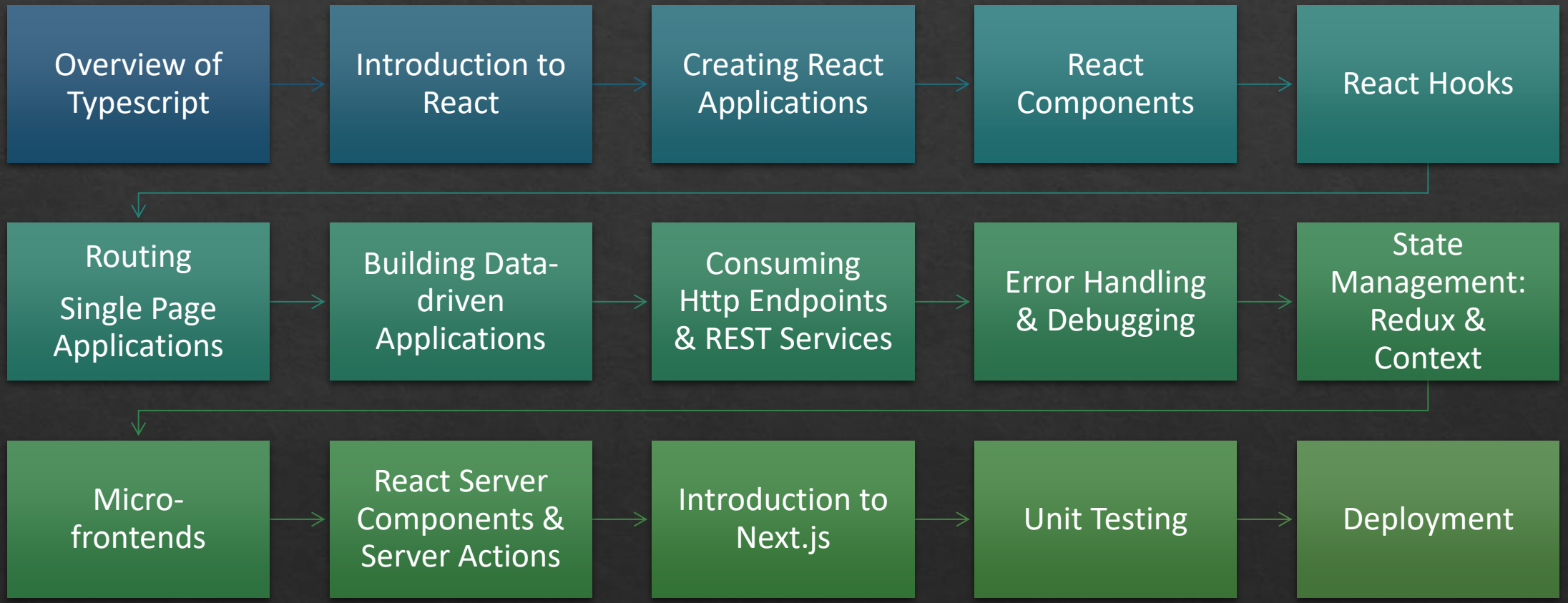
React



ANIL JOSEPH

Agenda


Overview of Typescript
Introduction to React
Creating React Applications
React Components
React Hooks
Routing
Single Page Applications
Building Data-driven Applications
Consuming Http Endpoints & REST Services
Error Handling & Debugging
State Management: Redux & Context
Micro-frontends
React Server Components & Server Actions
Introduction to Next.js
Unit Testing
Deployment

Anil Joseph

Introduction

- Over 20 years of experience in the industry
- Technologies
  - C, C++
  - Java, Enterprise Java
  - .NET & .NET Core
  - **UI Technologies: React, Angular, jQuery, ExtJs**
  - Mobile: Native Android, React Native
- Worked on numerous projects
- Conducting trainings for corporates (700+)

Software

Node.js & NPM

HTML, CSS, JavaScript, TypeScript Editor

(Visual Studio Code)

Postman

Browsers(Chromium)

JavaScript

An interpreted language

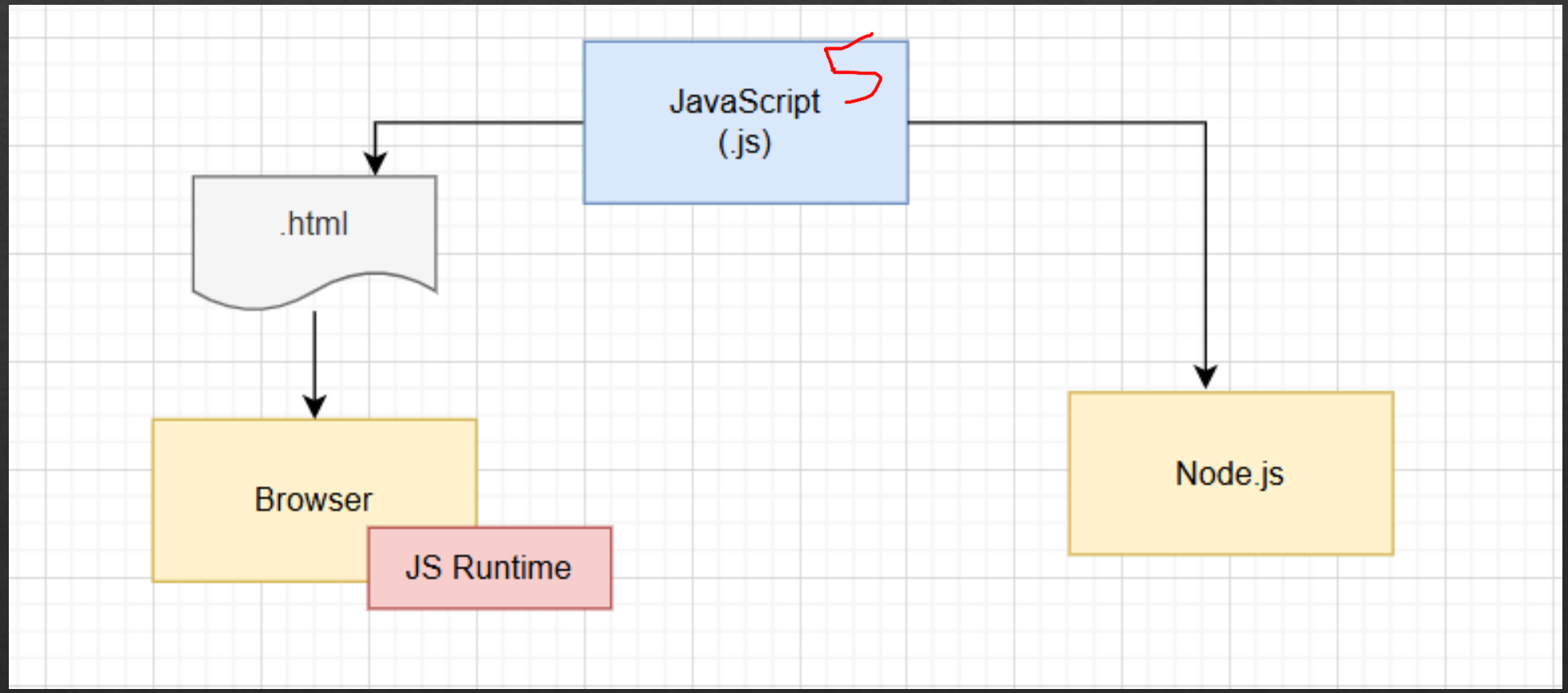
Dynamic

Object-oriented

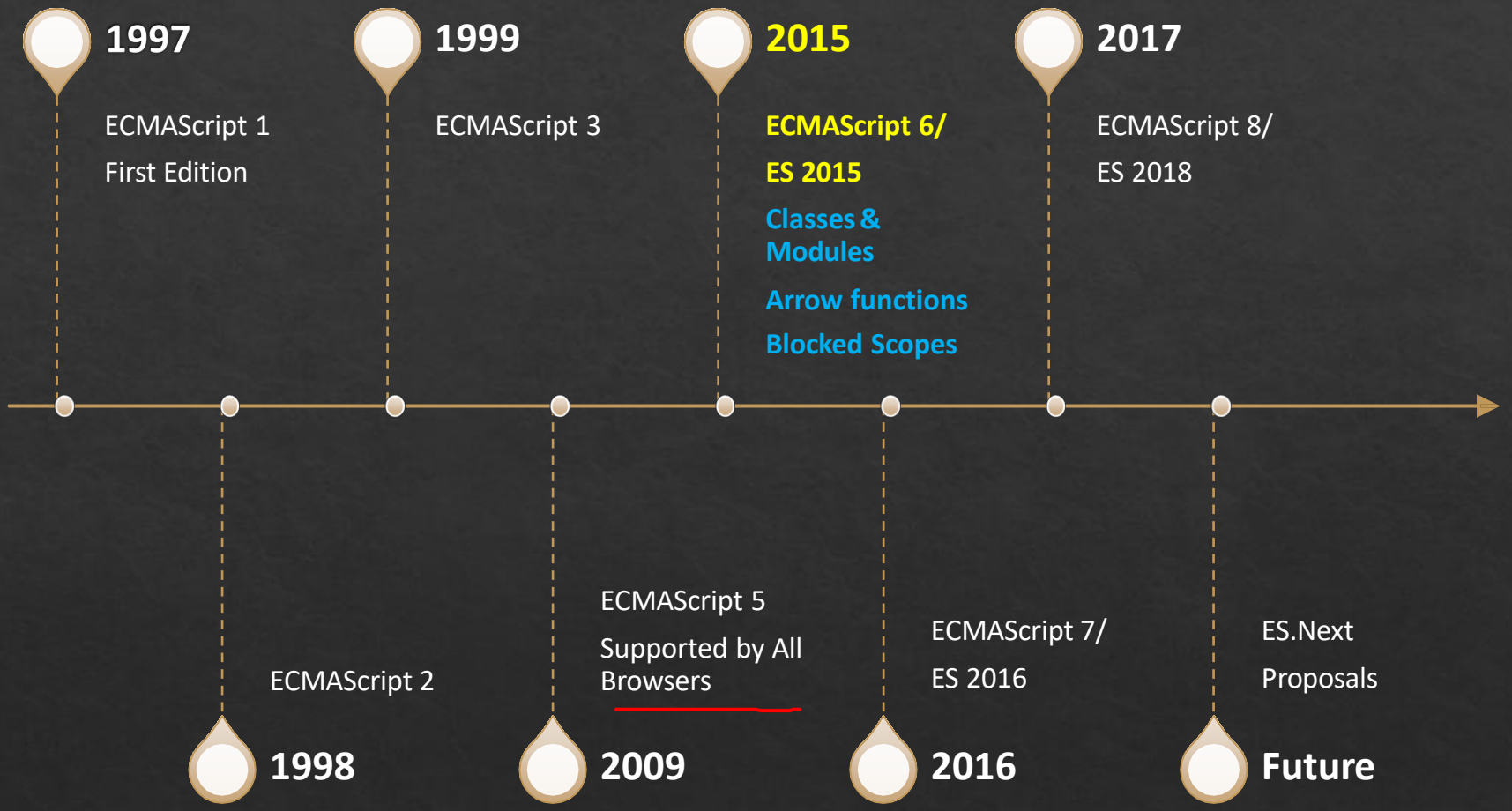
Supports Functional style of programming

Available on the browsers and Node.js

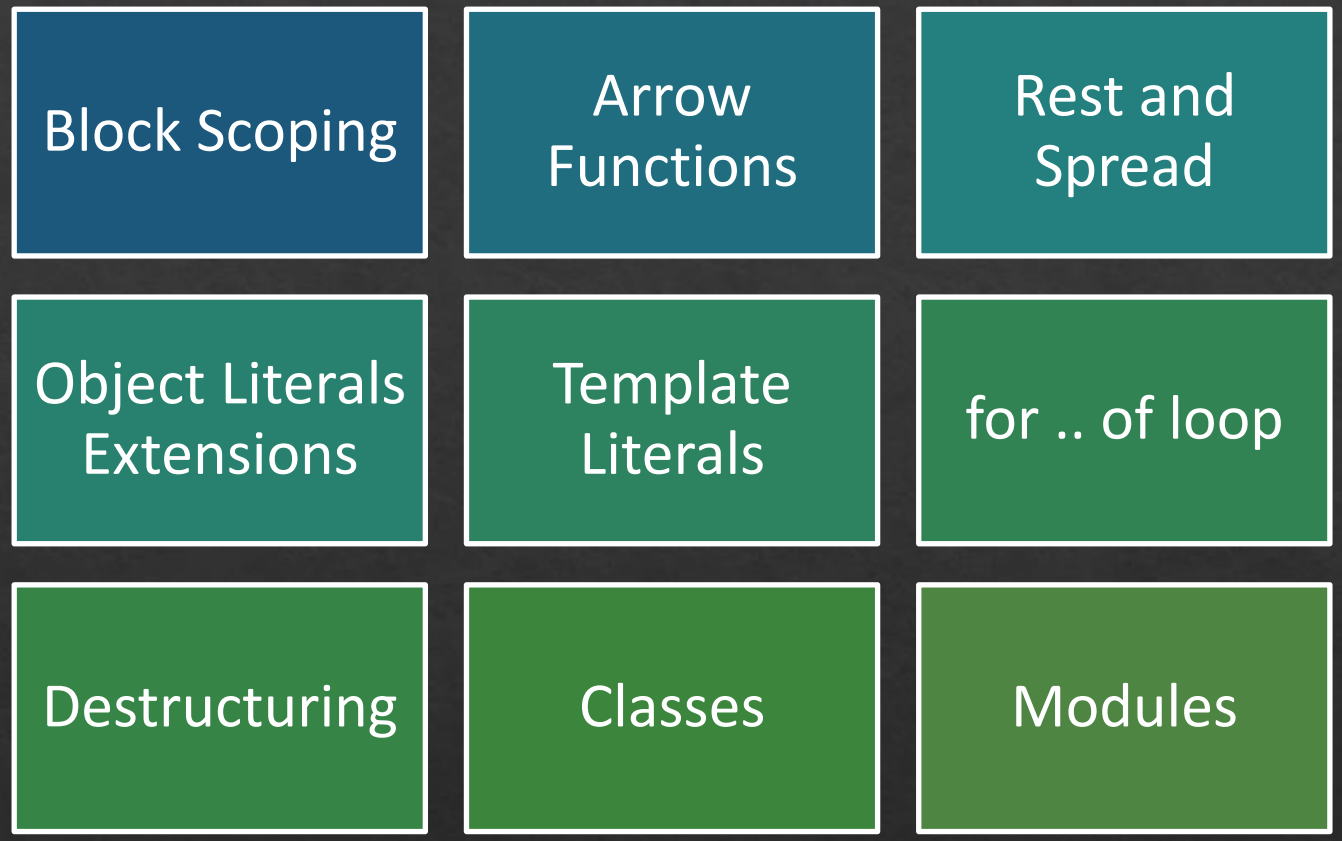
JavaScript Runtimes



ECMAScript Versions



ES6 New Syntax



TypeScript

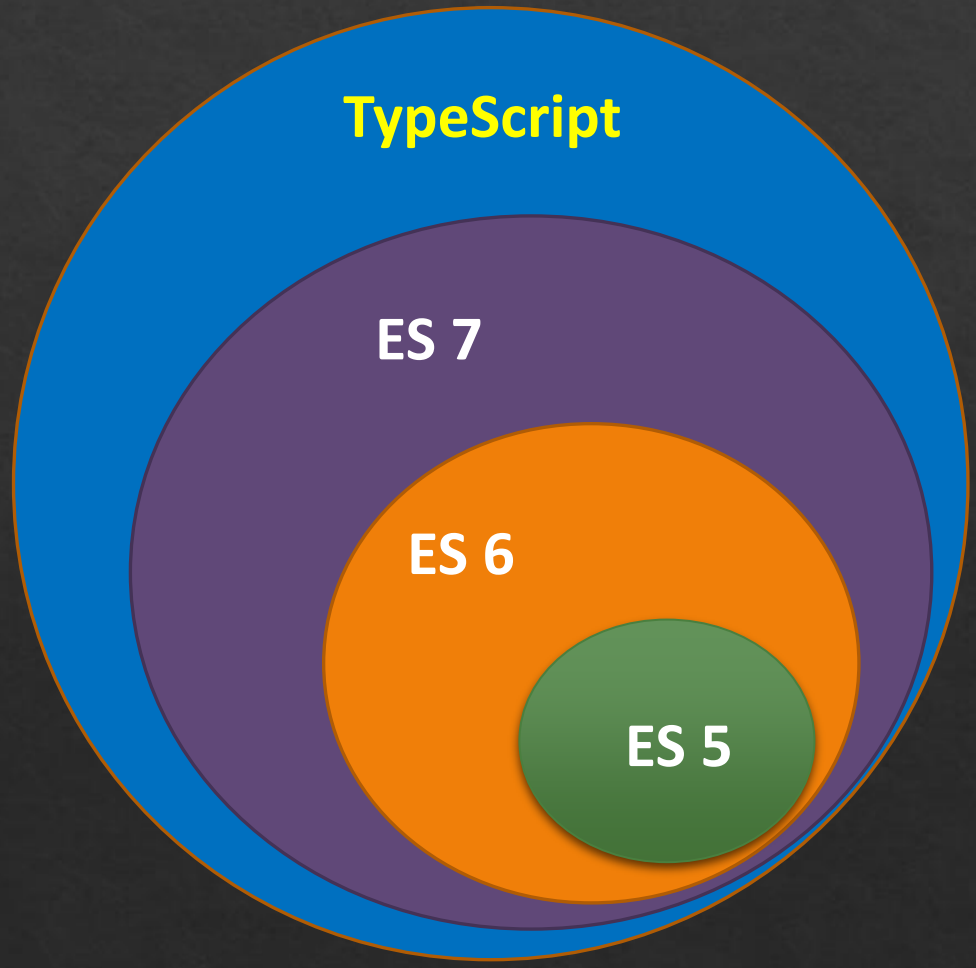
TypeScript is programming language developed and maintained by Microsoft.

TypeScript is a typed superset of JavaScript.

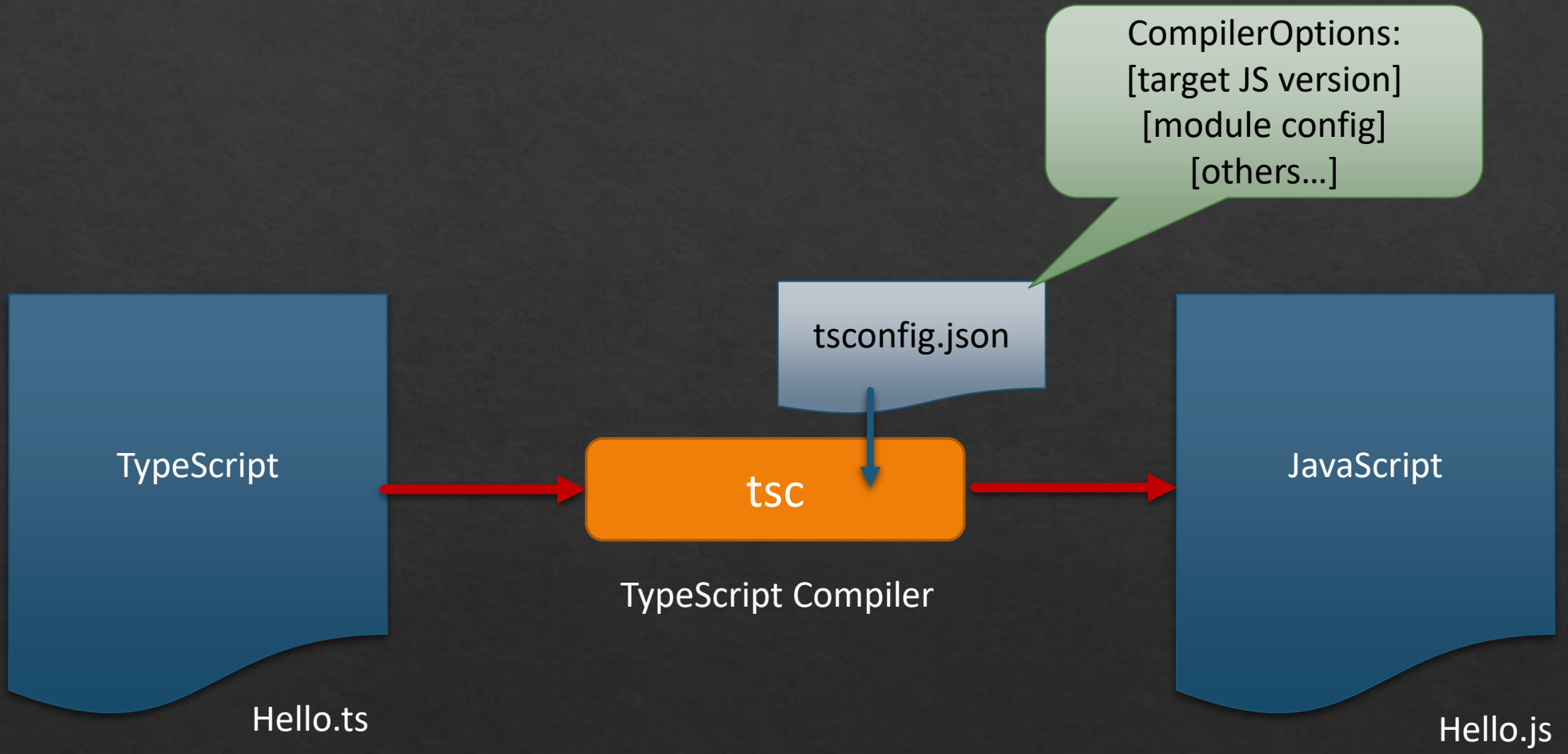
Transcompiles to JavaScript.

Designed for development of large applications.

Open Source.



TypeScript


CompilerOptions:
[target JS version]
[module config]
[others…]
tsconfig.json
TypeScript
tsc
JavaScript
TypeScript Compiler
Hello.ts
Hello.js

TypeScript Features

- Type Annotations
- Compile-Time Type Checking
- Type Inference
- Interfaces
- Classes and Inheritance
- Namespaces and Modules
- Generics
- Decorators
- Arrow Functions

TypeScript Installation

- Install NodeJs and NPM
- Run the command **npm install -g typescript**

TypeScript Types

Boolean

- **let** isAvailable:boolean = false

Number

- **let** age: number = 16;

String

- **let** name: string = “Anil";

Array

- **let** list: number[] = [1, 2, 3];
- **let** list: Array<number> = [1, 2, 3];

TypeScript Types

Enum

- **enum** Color {Red, Green, Blue}
- **let** c: Color = Color.Green;

Any

- **let** x: any = 4;
- x = “hello”

void

```
function foo(): void {
  console.log(“foo");
}
```

null and undefined

- var x: string = null;
- var y:string= undefined

Defining New Types

- Type alias
  - Used to give a type a new name. It's like creating a shorthand for a more complex type.
- Interfaces
  - Used to define the shape of an object or the signature of a function. They are more extensible than type aliases because they can be reopened to add new properties.
- Classes
  - Define both the shape and the behavior of objects. A class can implement interfaces.
- Enums
  - Allow you to define a set of named constants. Using enums can make it easier to document intent, or create a set of distinct cases.

Type aliases

- A type alias is declared using the ***type*** keyword followed by an identifier and a type annotation. Once defined, the alias can be used anywhere a type can be used.
- Flexibility: Type aliases can represent primitive types, unions, intersections, and any other valid TypeScript types.
- Readability: Using type aliases can make complex type definitions easier to work with and understand.

Interfaces

- Interfaces are a powerful way of defining contracts.
- Example

```
interface Vehicle{

    name: string;
    speed: number;
    gear?: number;

    applyBrakes(decrement: number): void;
}
```

- Interfaces can extend interfaces
  - (keyword extends)
- Classes implements interfaces
  - (keyword implements)

Classes

- Traditionally JavaScript uses functions and prototype-based inheritance to build up reusable components.
- Starting with ECMAScript 2015(ES6), JavaScript introduced the object-oriented class-based approach.
- Typescript supports classes that compile down JavaScript.
  - Works across all major browsers and platforms, without having to wait for the next version of the browser.

Classes

- Access Modifiers
  - public, private, protected
- Constructors
- Properties
- Static Members
- Inheritance
- Abstract classes and methods

Arrow Functions

Represents a function expression

An arrow function expression has a shorter syntax than a function expression.

They do not receive the implicit arguments “this” and “arguments”.

Used widely for asynchronous and functional programming

Modules

- Use the import and export statements.

```
let foo = function(){
   //some code
}

export default foo;
```

one.js

```
import foo from ‘./one’;

foo();
```

two.js

```
import bar from ‘./one’;

bar();
```

three.js

Modules

```
export let foo = function(){
   //some code
}


 export let bar = function(){
    //some code
 }
```

one.js

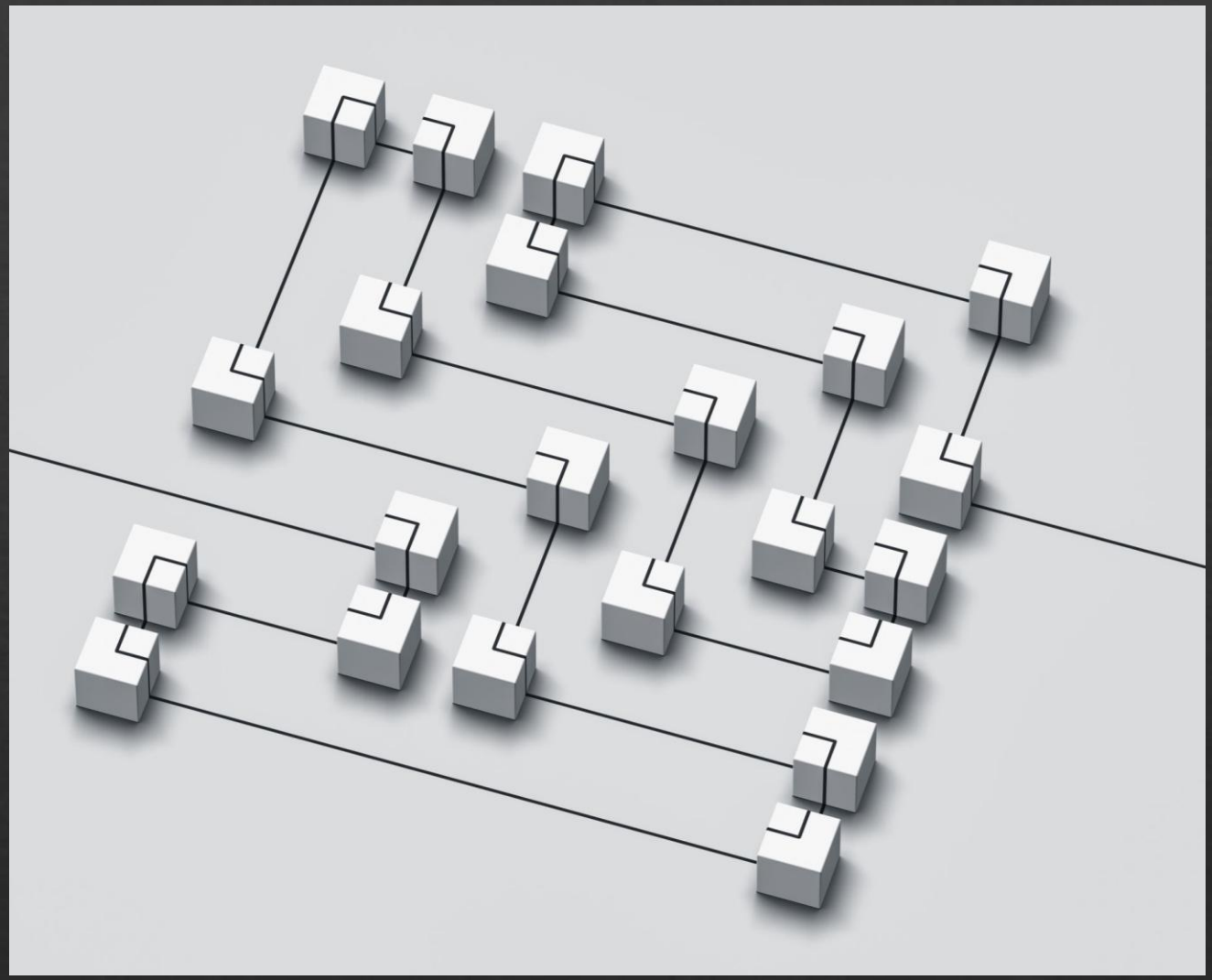
```
import {foo, bar} from ‘./one’;


 foo();
 bar();
```

two.js

TypeScript Modules

- Starting with ECMAScript 2015(ES6), JavaScript has the concept of modules.
- Modules have a scope of their own
- In the module system every JS file is a module and all declarations in the file is scoped to that module.
- The same concept is shared in TypeScript



Scopes

- Scope of a variable determines where it can be accessed and modified. There are several types of scope:
- Global
  - Variables declared outside of any function or block have global scope. They can be accessed from anywhere in the code.
- Function
  - Variables declared inside a function using var are scoped to that function. They cannot be accessed outside the function.
- Block(ES6)
  - Variables declared inside a block (i.e., a pair of curly braces {}) using let or const are scoped to that block. They cannot be accessed outside the block.

Scopes

- Lexical
  - JavaScript uses lexical scoping, which means that the scope of a variable is determined by its location within the source code, and nested functions have access to variables declared in their outer scope.
- Module(ES6)
  - When using ES6 modules, variables declared inside a module are scoped to that module and are not accessible outside it unless explicitly exported.

Hoisting

- Hoisting is a JavaScript behavior where variable and function declarations are moved to the top of their containing scope during the compilation phase, before the code is executed.
- This means that you can use variables and functions before they are declared in the code,
- Depending on whether you use var, let, const, or function declarations, the behavior changes.

- Variables declared with var are hoisted to the top of their function or global scope and are initialized with undefined.
- Variables declared with let and const are hoisted to the top of their block scope, but are not initialized.

NPM(Node Package Manager)

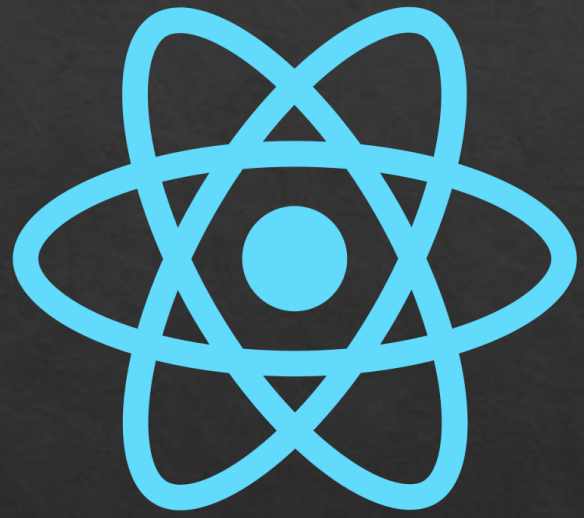
- NPM is a package manager for the JavaScript programming language.
- Allows users to consume and distribute JavaScript modules that are available on the registry
- The default package manager for Node.
- Comprises of
  - Command line client, also called npm
  - An online database called the npm registry.
    - Public
    - Paid-for private packages
  - NPM website
- The package manager and the registry are managed by npm, Inc.

NPM Packages

- Packages are reusable code published in the npm registry.
- A directory with one or more files a metadata file called package.json.
- A package is a building block that solves a specific problem.
- An application generally depends on many packages.
- Packages can be used on
  - Server side. Example: Express, Request
  - Client Side. Example Angular, React
  - Command based. Typescript, Angular CLI, JSLint

React

- JavaScript Library: React is a library for building user interfaces.
- Component-Based: UIs are built using reusable components.
- Declarative: React allows developers to write declarative code, making UIs predictable and easier to debug.
- Single-Page Applications (SPAs): Ideal for building interactive SPAs that load content dynamically without full page reloads.



Core Features

- **JSX (JavaScript XML):**
  - Combines JavaScript and HTML-like syntax to make UI structure more readable.
  - Allows embedding JavaScript logic within HTML-like markup.
- **Component-Based Architecture:**
  - UIs are split into reusable components, each managing its own state and logic.
  - Components can be nested, composed, and reused throughout the app.
- **Virtual DOM**:
  - React uses a **Virtual DOM** to optimize performance.
  - Changes in the UI are first applied to the Virtual DOM, and only the differences (diffs) are applied to the real DOM.

Core Features

- Ecosystem Flexibility:
  - Can be used with other libraries or frameworks (like Redux for state management or Next.js for server-side rendering).
- Developer Experience:
  - Tools like React Developer Tools, JSX, and a clear component structure improve the overall development experience.
- SEO-Friendly (with SSR):
  - React can be combined with server-side rendering (SSR) using libraries like Next.js to improve SEO by rendering pages on the server.

React History

- 2011: Origins
  - Developed by Jordan Walke, a software engineer at Facebook.
- 2013: Open Source
  - React was first released to the public at JSConf US in May 2013.
- 2014: React Grows
  - Instagram adopted React for their web app, marking a major milestone in React's real-world use.
- 2015: React Native
  - Launch of React Native, extending React’s core concepts to mobile app development for iOS and Android.
- 2017: React 16 (Fiber Release)
  - React 16 was released, powered by the Fiber architecture, improving the ability to handle updates efficiently and improving performance.

Getting Started

Two React Libraries

- React
- ReactDOM

JSX

- A JavaScript extension syntax allowing quoting of HTML

Babel

- The compiler for writing next generation JavaScript.
- Compiles JSX to JavaScript

Creating a React Project

Creating a React Project

- Create and configure the project manually.
- Requires knowledge of multiple tools and their configuration
- Need to keep up with new versions and technologies
- Highly Customizable

- Use a toolchain
- Easy to start with(Zero configuration)
- Customizations will be challenging

Popular Tool Chains

- Next.js
  - A React framework for building production-ready applications with features like server-side rendering (SSR), static site generation (SSG), and API routes.
- Create React App (CRA)
  - Officially maintained toolchain for quickly bootstrapping new React applications.
  - Provides a zero-config setup with support for JSX, ES6+, and development server out of the box.
- Remix
  - Popular React-based framework that emphasizes server-side rendering (SSR) and focuses on providing an optimized developer experience for full-stack applications.
- Vite
  - A fast build tool and development server, often used for React projects.
- React Native
  - Extends React for building mobile applications.

Create Project - Vite

1

Install NodeJs

- Runtime to run/execute JavaScript on the machine/server
- This installation also installs npm(Node Package Manager)

2

Create React Application

- **npm create vite**
- **Follow Instructions**

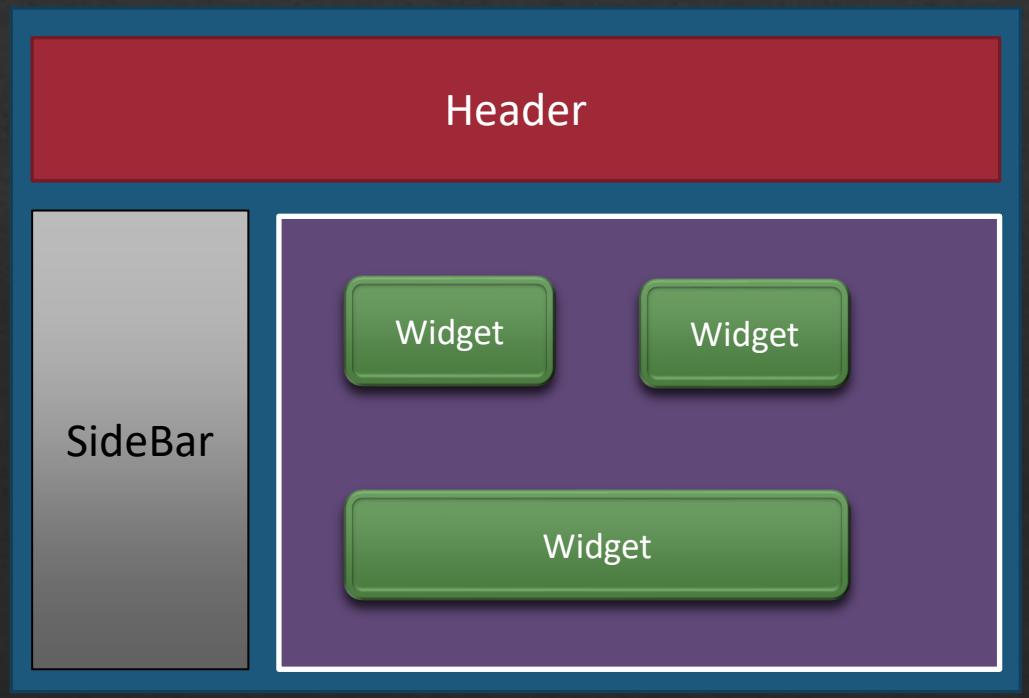
3

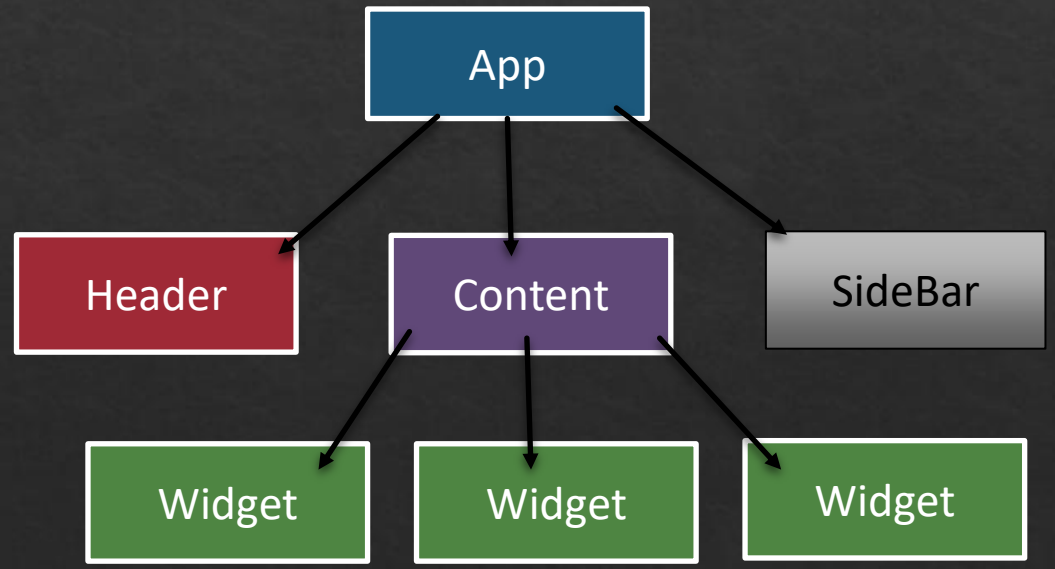
Start the Application

- **cd [appFolder]**
- **npm run dev**

React Components

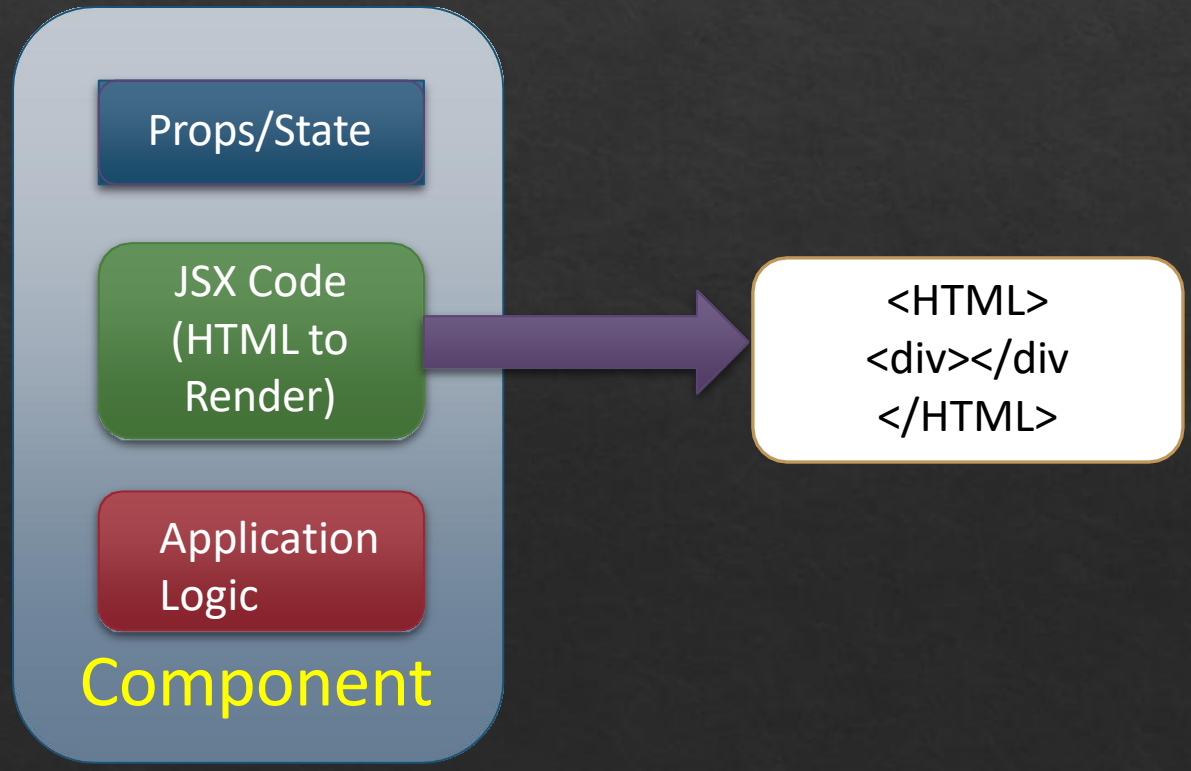
- Components are the core building blocks in React
- Creating a React applications is all about designing and implementing components
- A React application can be depicted as a component tree.





React Components

- The UI in a React Application is composed of components, the building blocks.
- Components are designed to be reusable



Types of Components

Functional

- Presentational
- Stateless (till React 16.8)
- Stateful (using React Hooks)

Class based

- Containers
- Stateful

JSX

- *JSX* is a syntax extension for JavaScript.
- It was written to be used with React.
- JSX code looks a lot like HTML.
  - **It's actually JavaScript**
- A *JSX compiler* will translate any JSX into regular JavaScript.
- JSX elements are treated as JavaScript *expressions*.
  - They can go anywhere that JavaScript expressions can go.
- That means that a JSX element can be
  - Saved in a variable
  - Passed to a function
  - Stored in an object or array

Components: Dynamic Content

- Dynamic content is outputted in the JSX using an expression.
- The syntax
  - `{ expression }`
- This can be any one line expression
- Complex functionalities can be done by calling functions
  - `{ invokeSomeMethod() }`

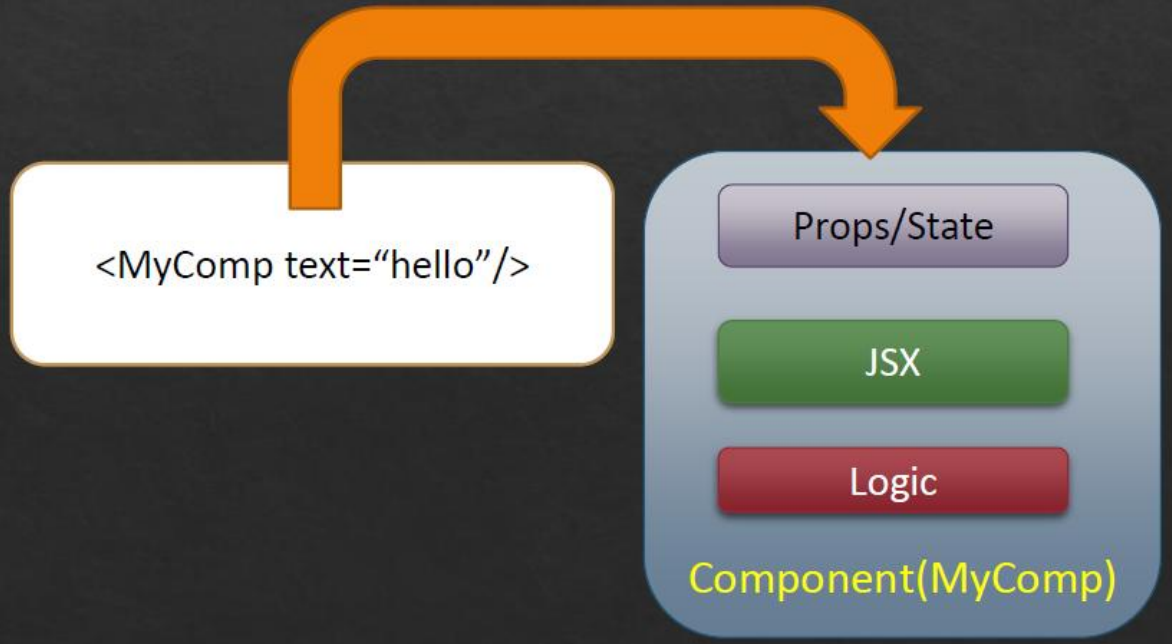
Components: Properties(props)

Most components can be customized with different parameters when they are created.

These creation parameters are called ***"props"***.

Props are used similar to HTML attributes.

Changes to props will automatically re-render the component.



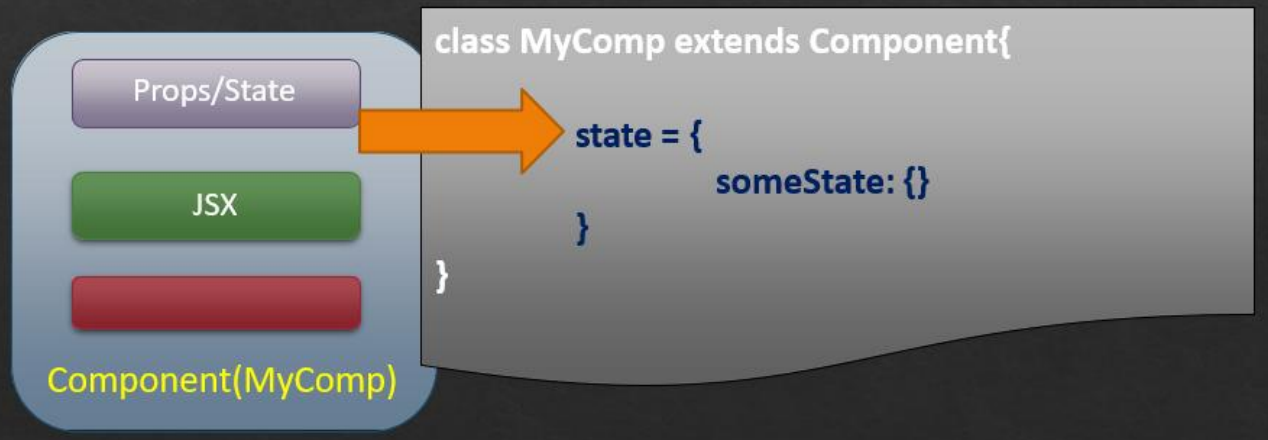
Component State

State holds information about the component

State is used when a component needs to keep track of information between renderings.

State is created and initialized in the component itself.

State updates trigger a rerender of the component.



Props and State

"props" and "state" are CORE concepts of React.

Only changes in "props" and/ or "state" trigger React to re-render the components and potentially update the DOM in the browser

props allow you to pass data from a parent (wrapping) component to a child (embedded) component.

State is used to change the component from within.

Event Handling

- Handling events with React elements is very similar to handling events on DOM elements with some syntactic differences.
- React events are named using camelCase, rather than lowercase.
- With JSX you pass a function as the event handler, rather than a string.
- Event handlers will be passed instances of ***SyntheticEvent***
  - A cross-browser wrapper around the browser's native event
- Details
  - https://reactjs.org/docs/events.html

Component Lifecycle

API calls

- React does not provide any in-built library for API calls to the server.
- Common Libraries
  - Axios
  - Fetch
- Fetch is part of the W3C specifications and is supported by most modern browsers
- Axios is an open-source library based on the XMLHttpRequest(XHR) object with a lot of features.

axios

- Promise based HTTP client for the browser and node.js
- Installation
  - npm install axios
- Features
  - Make http requests
  - Supports the Promise API
  - Intercept request and response
  - Transform request and response data
  - Cancel requests
  - Automatic transforms for JSON data
  - Client side support for protecting against XSRF

axios methods

axios.request({config})
axios.get(url, {config})
axios.post(url,{data}, {config})
axios.delete(url, {config})
axios.put(url,{data}, {config})

axios global defaults

Base URL

- axios.defaults.baseURL = 'https://abc.com’;

Headers

- axios.defaults.headers.common['Authentication'] = AUTH_TOKEN;

Headers for specific methods

- axios.defaults.headers.post['Content-Type'] = 'application/json';

React Hooks

React hooks was introduced in version 16.8

Many React features like state, lifecycle hooks etc. were available only with class-based components prior to 16.8.

Hooks let us use state and other React features in a functional component.

React team recommends the functional components over class-based since they can be highly optimized by the tools.

React Hooks

State Hooks(useState)

- Equivalent of state in class-based components

Effect Hooks(useEffect)

- Used to perform side-effects in a functional component
- Equivalent to lifecycle hooks in class-based components

Context Hooks(useContext)

- Used to access the React Context;

React Hooks

Callback Hooks(useCallback)

- Returns a memoized callback.
- Used to optimize the components

Memo Hooks(useMemo)

- Returns a memoized value.
- Used to optimize the components

Ref Hooks(useRef)

- Returns a mutable ref object

Custom Hooks

- A function
- Uses Other Hooks

Debugging

- Error Messages
  - Messages generated by React during development mode
- Browser Developer Tools
- React Tools
  - Tools for Chrome and Firefox
- Error Boundaries
  - Error boundaries are React components that **catch JavaScript errors anywhere in their child component tree**
  - **Log errors**
  - **Display a fallback UI**

Virtual DOM

- A lightweight, in-memory representation of the real DOM.
- Allows React to efficiently update the UI.
- Differs from the real DOM in that it is not rendered directly to the screen.

Virtual DOM

- Initial Rendering:
  - React renders a virtual DOM tree when the app loads.
- State/Prop Change:
  - When state or props change, React creates a new virtual DOM tree.
- Diffing Algorithm:
  - React compares the new virtual DOM with the previous one (diffing).
- Reconciliation:
  - Only the actual changed elements in the real DOM are updated, making it highly efficient.

Higher-order Components

- A Higher Order Component is just a React Component that wraps another one.
- Higher Order Components is a Pattern used extensively with React
- Uses
  - Code reuse, logic and bootstrap abstraction
  - Render Highjacking
  - State abstraction and manipulation
  - Props manipulation
- Its basically a functions that returns a class component with the Wrapped Component.

Single Page Applications

A single-page application is an application that works inside a browser and does not require page reloading during use.

SPA is fast, as most resources (HTML+CSS+Scripts) are only loaded once throughout the lifespan of application. Only data is transmitted back and forth.

Routing

- Routers allow to navigate between the different views in the application using JavaScript on the client-side.
- Navigations are updated to the browser history which allows to go back and forward
- Usage of path and search parameters are allowed
- React does not provide any API for routing.
- Many other Libraries available which integrates with React
  - React-router(The de-facto standard)
  - Director
  - Aviator
  - Finch

React Router Components

<BrowserRouter>

- A <Router> that uses the HTML5 history to keep your UI in sync with the URL.

<HashRouter>

- A <Router> that uses the hash portion of the to keep your UI in sync with the URL.

<Route>

- The Route component is perhaps the most important component in React Router

<Link>

- Provides declarative, accessible navigation around your application.

<NavLink>

- A special version of the <Link> that will add styling attributes to the rendered element when it matches the current URL.

State Management

React Context

- Available from React 16.3

React Redux

- Library to manage state

Mob

- Library to manage state

RxJs

- Reactive Programming using Observables

Types of State

Local UI State

- Show/Hide UI
- Handled By the Component

Persistent State

- Orders, Blogs
- Stored on Server, can be managed by Redux or React Context

Client State

- IsAuntenticated, Filter Information
- Managed by Redux or React Context

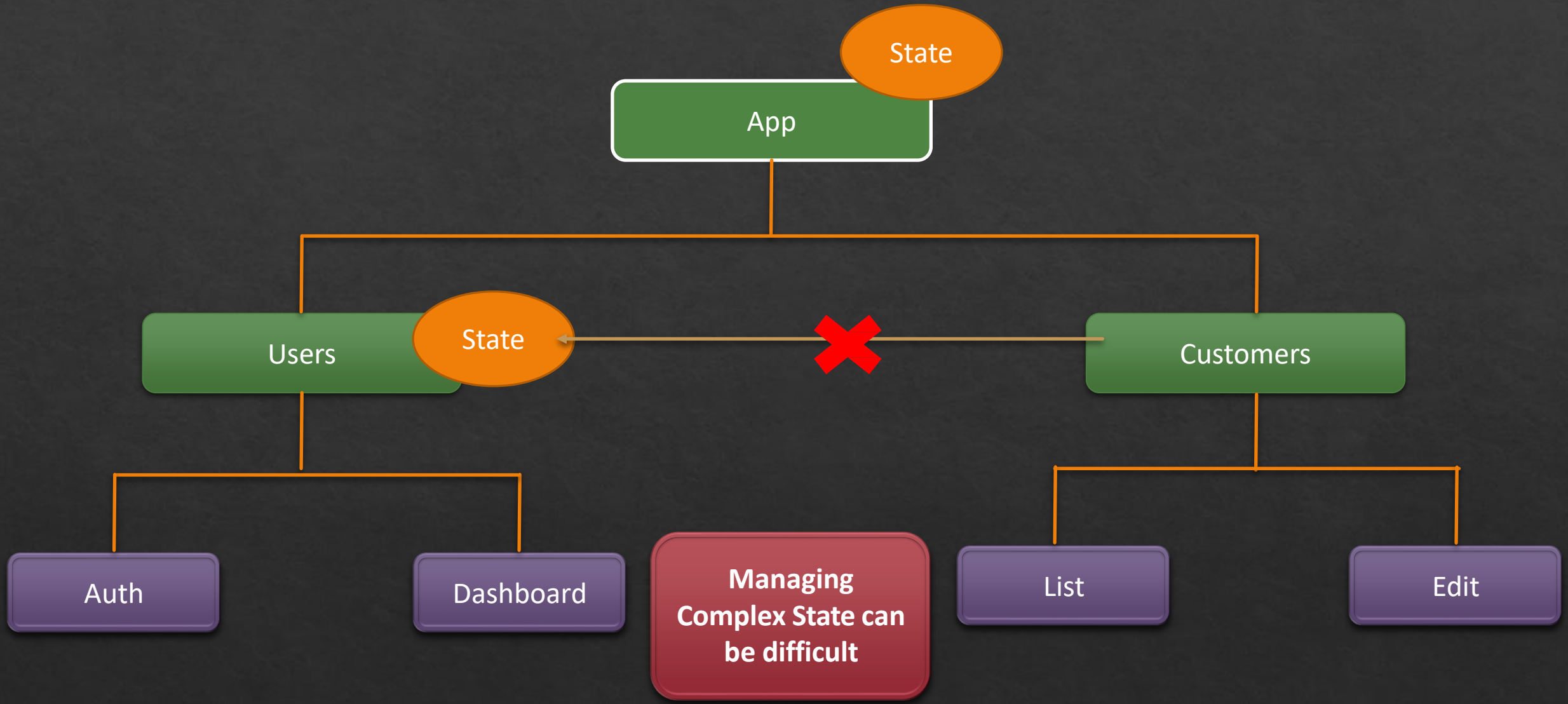
Redux

Redux is an open-source JavaScript library designed for managing application state.

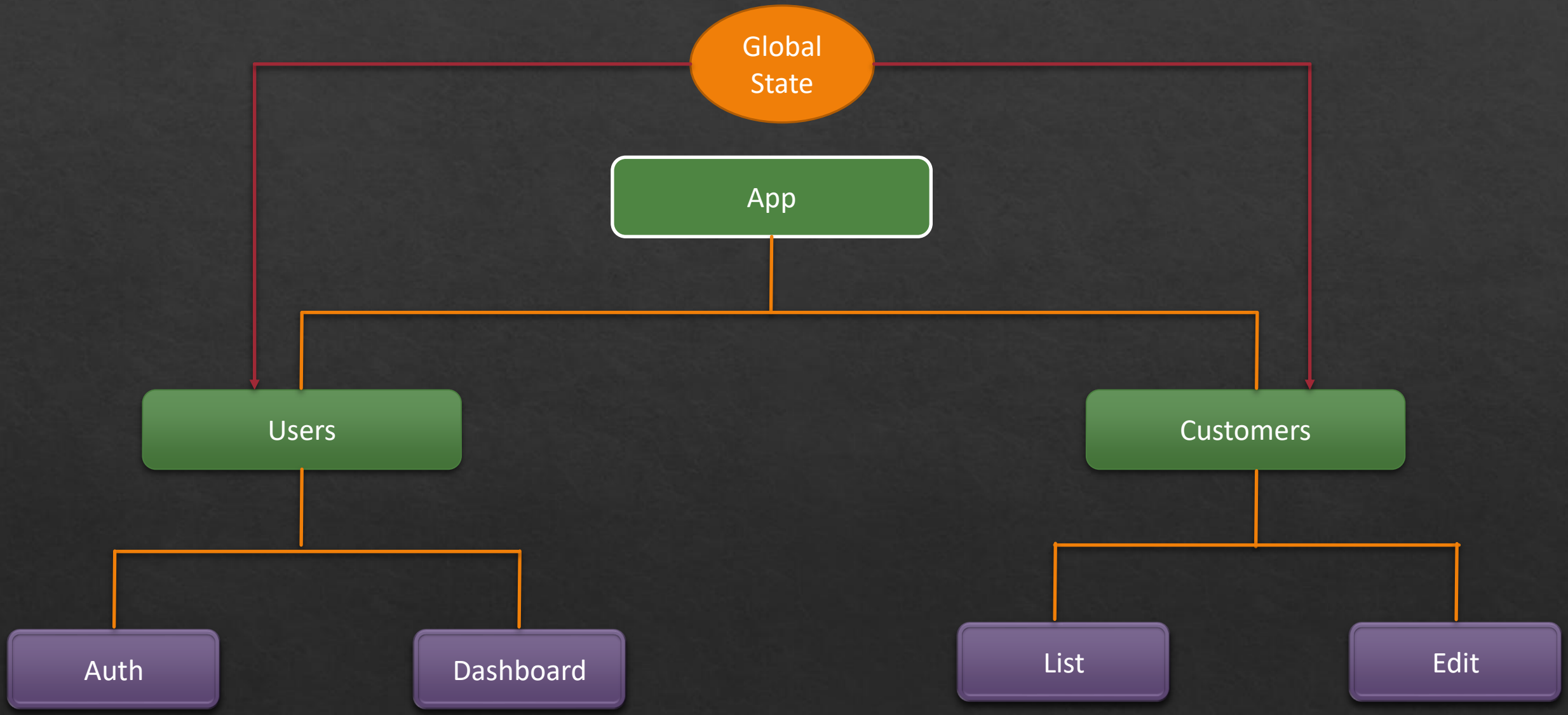
It is primarily used together with React or Angular for building user interfaces.

Redux was built on top of functional programming concepts.

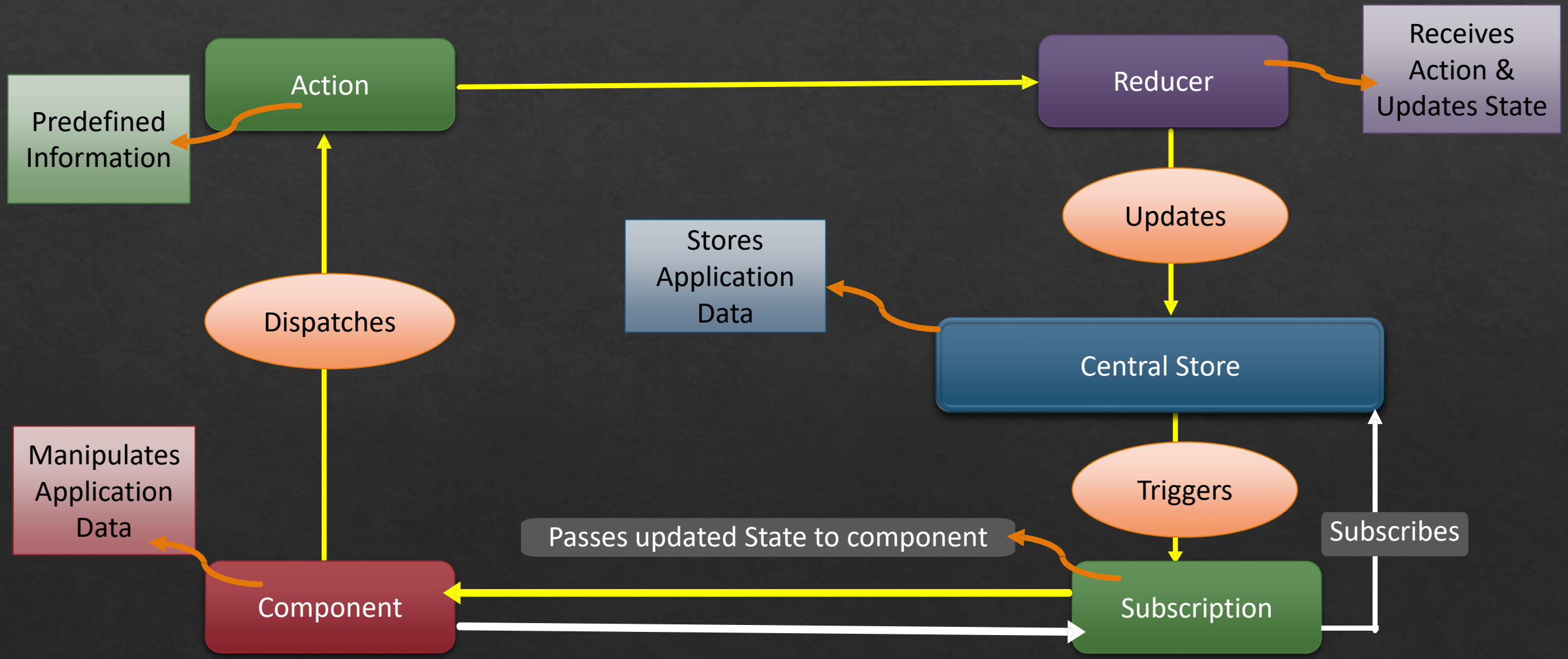
Why Redux?


State
App
Users
State
Customers
Auth
Dashboard
Managing Complex State can be difficult
List
Edit

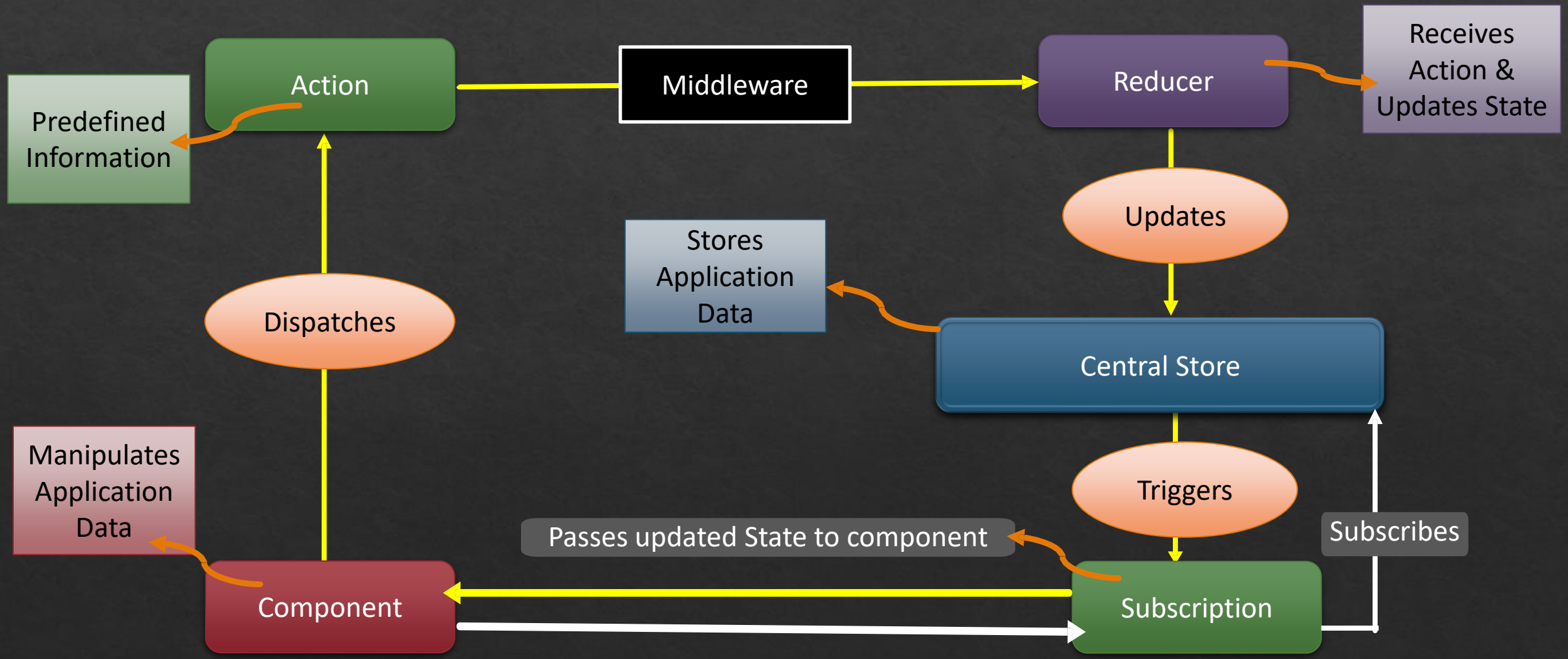
Why Redux?



Redux Flow


Action
Predefined Information
Reducer
Receives Action & Updates State
Updates
Stores Application Data
Dispatches
Central Store
Manipulates Application Data
Triggers
Passes updated State to component
Subscribes
Component
Subscription

Redux Flow


Action
Middleware
Reducer
Receives Action & Updates State
Predefined Information
Updates
Stores Application Data
Dispatches
Central Store
Manipulates Application Data
Triggers
Passes updated State to component
Subscribes
Component
Subscription

Redux Middleware

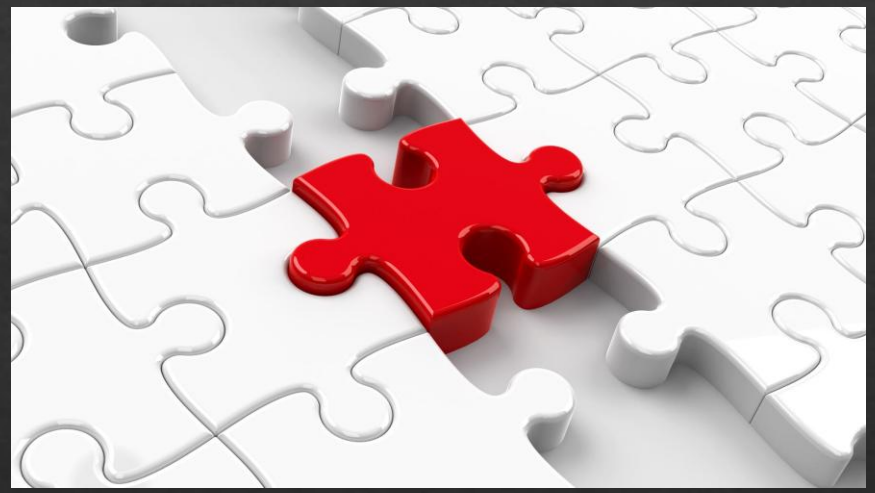
- Middleware in Redux provides an extension point between dispatching an action and the moment it reaches the reducer.
- Enables side effects, such as async operations, logging, and routing.
- Enhances functionality without modifying the core Redux workflow.

Redux Middleware

- Redux Thunk: Allows action creators to return a function instead of an action, enabling asynchronous logic.
- Redux Saga: Manages side effects with generator functions, providing more powerful async capabilities.
- Redux Logger: Logs actions and state changes for debugging purposes.

React Redux

- Redux react is a library that integrates Redux to a React Application
- Comprises of Components & Functions
- Installation
  - npm install react-redux



Redux Toolkit

- An official, opinionated, batteries-included toolset for efficient Redux development.
- Simplifies the process of writing Redux logic and reducing boilerplate code.
- Benefits
  - Reduced Boilerplate:
    - Provides a set of tools and functions that encapsulate common Redux patterns.
  - Improved Code Readability
    - Cleaner and more maintainable code.
  - Optimized Performance
    - Built-in support for creating efficient Redux logic.

Error Boundaries

- Error boundaries are React components that catch JavaScript errors anywhere in their child component tree
  - Used to log errors
  - Display a fallback UI
- Error boundaries do not catch errors for:
  - Event handlers
  - Asynchronous code
  - Server side rendering
  - Errors thrown in the error boundary itself
- A class component becomes an error boundary if it defines(either one)
  - componentDidCatch
  - static getDerivedStateFromError()

React Context

- Context provides a way to pass data through the component tree without having to pass props down manually at every level.
- Example of props to be passed down
  - Theme
  - Locale
  - Authenticated user
- API
  - React.createContext

Error Boundaries

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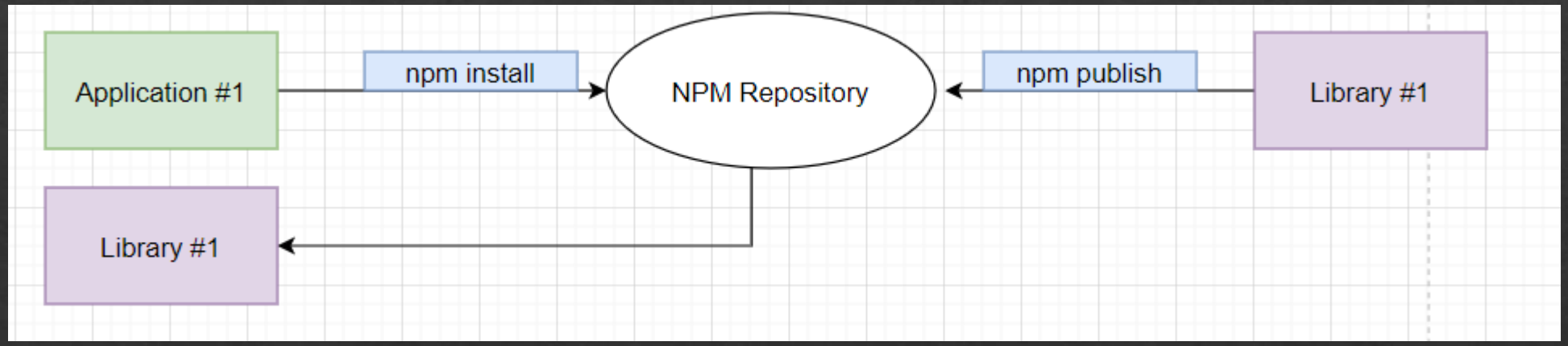
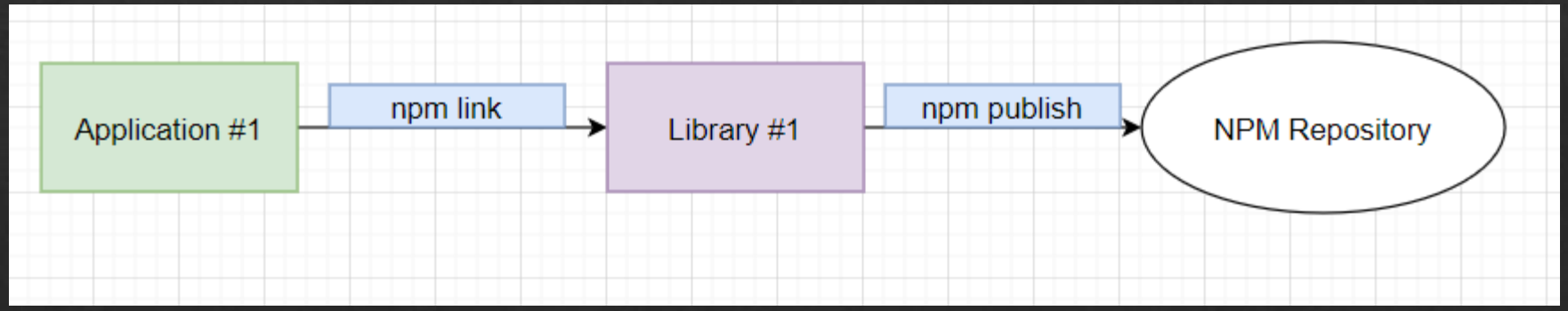
React Library





Code Splitting

- Code splitting allows you to split your app into separate bundles which your users can progressively load.
- API
  - React.lazy
  - Suspense

Micro-Frontends

- Micro-frontends are an architectural style where a frontend application is decomposed into smaller, individual, and loosely coupled pieces, each owned by different teams.
- These pieces, or micro-frontends, can be developed, tested, and deployed independently, allowing for greater flexibility and scalability.
- Each micro-frontend is responsible for rendering a specific part of the user interface
- Each micro-frontend can be built using different technologies or frameworks, making the overall application more modular and easier to maintain.
- The approach extends the principles of microservices to the frontend, promoting better separation of concerns and enabling teams to work more autonomously.

Benefits of MFE

- Independent Deployments:
  - Each micro-frontend can be deployed independently, allowing for faster and more frequent releases without affecting the entire application.
- Improved Scalability:
  - Micro-frontends enable scaling individual parts of the application independently based on the traffic and load they handle.
- Technology Agnostic:
  - Different micro-frontends can be built using different technologies, enabling teams to choose the best tools and frameworks for their specific needs.

Benefits of MFE

- Better Team Collaboration:
  - Teams can work autonomously on their respective micro-frontends, reducing dependencies and improving productivity.
- Reduced Complexity:
  - By breaking down a large monolithic frontend into smaller pieces, the overall complexity of the application is reduced, making it easier to maintain and enhance.
- Enhanced User Experience:
  - Allows for incremental updates and A/B testing, leading to a more responsive and user-centric application.

Technologies to Create Micro-Frontends (MFE)

- Webpack Module Federation:
  - Enables multiple independently built and deployed bundles to form a single application.
  - Facilitates sharing of code and dependencies between different micro-frontends.
- Single SPA (Single Single Page Application):
  - A framework for building micro-frontends, allowing multiple frameworks to coexist in a single app.
  - Provides lifecycle hooks to load and unload micro-frontends.
- Piral
- Luigi

Webpack Module Federation

- Webpack Module Federation is a feature introduced in Webpack 5
- Enables the sharing of modules between separate builds.
- Allows multiple independently built and deployed applications to dynamically share code and dependencies, forming a single cohesive application.

Key Features of Module Federation

- Dynamic Remotes:
  - Allows applications to load remote modules dynamically at runtime, rather than statically at build time.
- Shared Modules:
  - Facilitates sharing of common dependencies (e.g., React, lodash) between different micro-frontends, reducing duplication and ensuring consistency.
- Independent Deployment:
  - Enables each micro-frontend to be developed, tested, and deployed independently, making the development process more agile.

Key Features of Module Federation

- Version Management:
  - Handles different versions of shared libraries gracefully, allowing for compatibility between various parts of the application.
- Reduced Bundle Size:
  - By sharing common dependencies, Webpack Module Federation helps in reducing the overall bundle size, leading to faster load times.
- Seamless Integration:
  - Integrates seamlessly with existing Webpack configurations, making it easy to adopt without significant changes to the build setup.

remoteEntry.js

- The file acts as the manifest that allows a host application to dynamically load and use modules exposed by a remote micro-frontend (MFE).
- Key Features
  - Metadata Provider: Contains metadata about the remote micro-frontend, including the modules it exposes, their locations, and the dependencies required.
  - Dynamic Loading: When the host application requests a module from the remote, the remoteEntry.js file provides the necessary information to locate and load that module at runtime.
  - Shared Dependencies: Includes information about shared dependencies, ensuring that both the host and remote use the same instance of shared libraries (e.g., React)

remoteEntry.js

- When you build your remote MFE, Webpack generates the remoteEntry.js file based on the configuration specified in the ModuleFederationPlugin.
- The file contains references to all the exposed modules and the shared dependencies declared in the remote's Webpack configuration.
- When the host application starts, it fetches the remoteEntry.js file from the remote's server.
- This can be done dynamically at runtime, allowing the host to use the latest version of the remote without needing to rebuild.
- The host uses the metadata in remoteEntry.js to resolve and load the exposed modules dynamically.

Components in React 18

Client Components:

- Rendered and hydrated in the browser.

Server Components:

- Rendered on the server with no client-side JavaScript. Available with the App router

Client Components

- Rendered on the client (browser) after initial page load.
- Can use React hooks like useState, useEffect, and event handlers (onClick).
- Suitable for interactive elements (e.g., buttons, forms).
- Require JavaScript on the client for interactivity.

Server Components

- This is available from React 18
- Rendered only on the server with no client-side interactivity.
- Cannot use client-side hooks like useState, useEffect, or onClick.
- Great for static content or non-interactive UI.
- No JavaScript is sent to the client, resulting in better performance.

React Server Components

- Server Components are a new feature introduced in React to improve performance by rendering parts of the UI on the server and sending it as static HTML to the client.
- No Client-Side JavaScript:
  - Server Components don’t ship any JavaScript to the client. This reduces bundle sizes and improves performance.
- Seamless Integration:
  - Server Components work alongside Client Components, providing a seamless developer experience within the same React tree.
- Improved Performance:
  - By offloading intensive tasks to the server, Server Components reduce the need for client-side processing, leading to faster load times and better scalability.

React Server Components

- Data Fetching:
  - Server Components are ideal for fetching data from databases or APIs without exposing sensitive logic to the client.
- Rendering Heavy UIs:
  - Offload rendering that requires heavy computation or multiple data sources to the server.
- Automatic Caching:
  - Server Components enable automatic caching and reduce unnecessary re-renders by separating the UI from client-side interactivity.

React Server Components: Limitations

- No Interactivity:
  - Server Components cannot handle client-side interactions, like event listeners.
  - Cannot use hooks and other client specific features like Redux, React Context etc.
- Limited Access to Browser APIs:
  - Server Components run on the server, so they cannot directly interact with browser-specific APIs (e.g., window, localStorage).

Client vs. Server Components

- Rendering Environment
  - Client Components: Rendered in the browser on the client-side.
  - Server Components: Rendered on the server and sent as static HTML to the client.
- Interactivity
  - Client Components: Can include interactive elements like event listeners (onClick, onChange), hooks (useState, useEffect), and browser-specific APIs (e.g., localStorage, window, document).
  - Server Components: Cannot include interactivity or use browser-specific APIs. They are designed to handle static data fetching and rendering without any client-side logic.

Client vs. Server Components

- Data Fetching
  - Client Components: Fetch data on the client-side using APIs such as fetch, axios, or any other client-side fetching method. They can only access client-side environment variables.
  - Server Components: Fetch data on the server-side before rendering the component. They have access to both client and server environment variables, and can perform secure server-side operations (like database queries, authentication checks, etc.).
- Rendering Strategy
  - Client Components: Are hydrated after the initial HTML is sent from the server. This means JavaScript code is sent to the browser and executed to make the component interactive.
  - Server Components: Render HTML on the server, and the client receives static HTML. No JavaScript is sent to the client for hydration unless a Client Component is nested inside.

Client vs. Server Components

- Performance
  - Client Components: May impact performance since JavaScript needs to be downloaded, parsed, and executed on the client. Hydration adds additional overhead.
  - Server Components: Better for performance because they only send minimal HTML to the client and don’t include client-side JavaScript unless needed. This leads to faster loading times.
- Bundle Size
  - Client Components: Increase the bundle size because JavaScript code needs to be sent to the client for execution.
  - Server Components: Reduce the bundle size since no client-side JavaScript is needed (except for interactive parts), resulting in a smaller footprint and quicker load times.

Client vs. Server Components

Feature	Client Component	Server Component
Rendered in	Browser (client-side)	Server
Interactivity	Supports interactivity	No interactivity
Data Fetching	Client-side	Server-side
Bundle Size	Increases bundle size	Minimal bundle size
Reactivity	Can use state and effects	No reactivity or state
Hooks	Can use all React hooks	Can only use server hooks (`use`)
Access to Browser APIs	Yes	No
Usage	Forms, dynamic UI elements	Static content, SEO pages
Third-party libraries	Can use client-side libraries	Limited to server-side

Next.js

- Next.js is a popular React framework
- Powerful features for building server-side rendered (SSR) and static web applications.
- Full stack development(JavaScript)

Next.js Features

Full-Stack Framework	File-based Routing	Client-side Rendering (CSR)	Server-side Rendering (SSR)
Static Site Generation (SSG)	Incremental Static Regeneration (ISR)	Hybrid Rendering	API Routes
Automatic Code Splitting	Built-in CSS and Sass Support	Image Optimization	Fast Refresh

Create a Next.js Project

Install NodeJs

- Runtime to run/execute JavaScript on the machine/server
- Use Node 18.8 or above for the latest version(Next 14.x)

Create Next Application

- npx create-next-app@latest

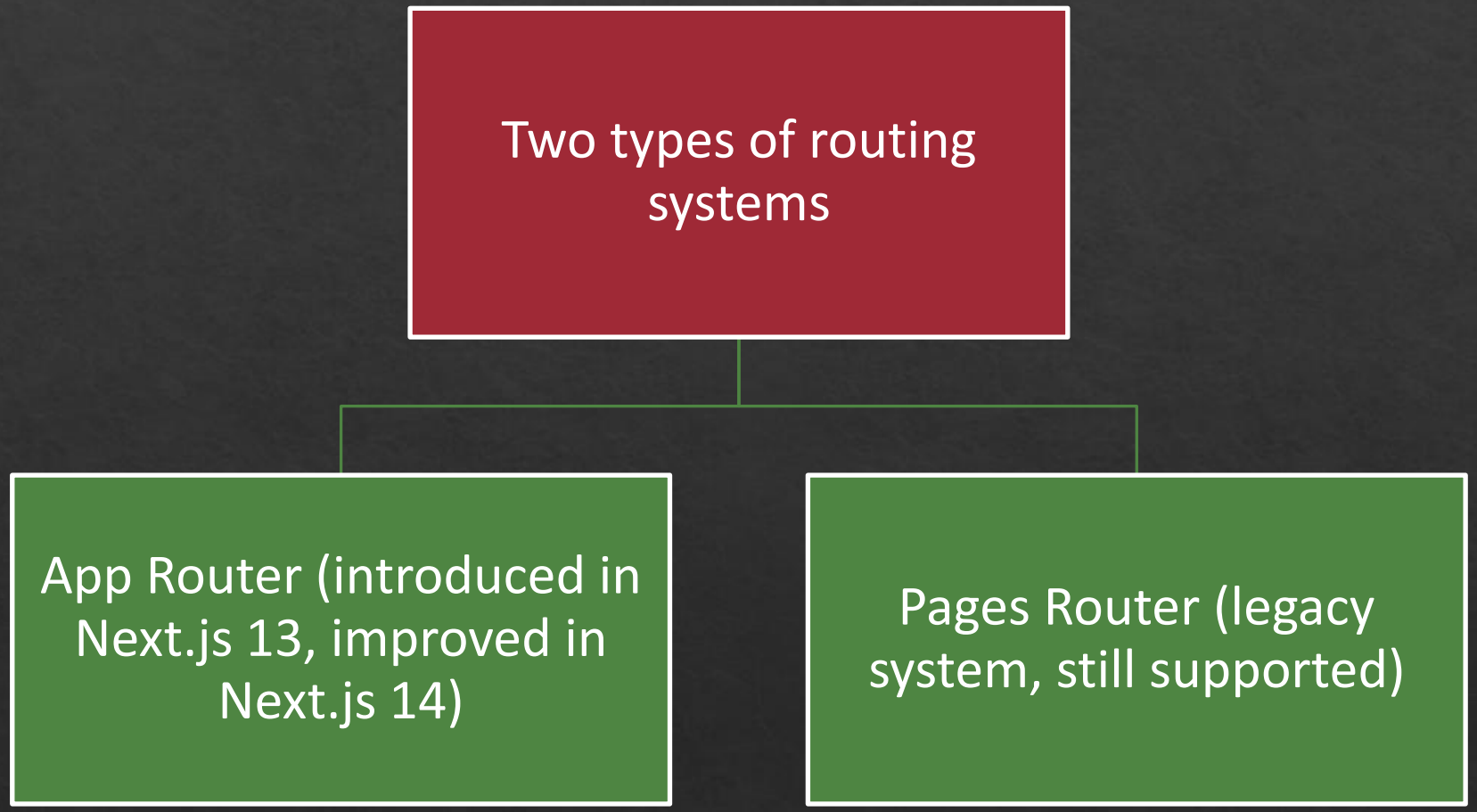
Start the Application

- **Go to the project directory**
- **Run npm run dev**

Next.js Project options

```
√ What is your project named? ... the-awesome-app
√ Would you like to use TypeScript? ... No / Yes
√ Would you like to use ESLint? ... No / Yes
√ Would you like to use Tailwind CSS? ... No / Yes
√ Would you like to use `src/` directory? ... No / Yes
√ Would you like to use App Router? (recommended) ... No / Yes
? Would you like to customize the default import alias (@/*)? » No / Yes
```

Next.js Routing



Next.js App Router

- Introduced in Next.js 13, the App Router continues to evolve in Next.js 14.
- Provides powerful new features:
  - Server Components by default
  - Nested layouts and parallel routes
  - Data fetching at multiple levels (no need for getServerSideProps, getStaticProps)
  - Streaming and Suspense support

App Router

Next.js

```
app/
├── api/                          # API routes folder
│   ├── users/
│   │   └── route.ts              # API route for `/api/users`
│   └── products/
│       └── route.ts              # API route for `/api/products`
├── dashboard/                    # Folder for `/dashboard` route with nested layout
│   ├── layout.tsx                # Nested layout for all routes under `/dashboard`
│   ├── page.tsx                  # Page for `/dashboard`
│   ├── error.tsx                 # Error boundary for `/dashboard` routes
│   ├── loading.tsx               # Loading state for `/dashboard` routes
│   ├── analytics/
│   │   ├── page.tsx              # Nested route for `/dashboard/analytics`
│   │   ├── error.tsx             # Error boundary for `/dashboard/analytics`
│   │   └── loading.tsx           # Loading state for `/dashboard/analytics`
│   └── settings/
│       ├── layout.tsx            # Separate layout for `/dashboard/settings`
│       ├── page.tsx              # Page for `/dashboard/settings`
│       ├── error.tsx             # Error boundary for `/dashboard/settings`
│       └── loading.tsx           # Loading state for `/dashboard/settings`
├── error.tsx                     # Global error boundary for the app
├── global.css                    # Global styles applied across the app
├── layout.tsx                    # Root layout applied to the whole app
├── loading.tsx                   # Loading spinner for suspense or slow pages
├── not-found.tsx                 # 404 page for handling unmatched routes
├── page.tsx                      # Homepage route (`/`)
└── sitemap.ts                    # Custom sitemap generation for SEO
```

Next.js App Router API’s

- usePathname()
  - Returns the current route's pathname (e.g., /dashboard or /products/[id]).
  - Helps determine the current page and react to route changes in Client Components.
- useSearchParams()
  - Returns the current query parameters from the URL (e.g., /products?id=123&category=books).
  - Useful when working with query strings for filtering or dynamic data in Client Components.
- useRouter()
  - Provides methods like push(), replace(), and back() to navigate between routes.
  - Used to programmatically navigate between routes in Client Components.

Next.js App Router API’s

- useParams()
  - Returns the dynamic route parameters (e.g., id in /products/[id]).

Server-Side Rendering(SSR)

- Server-Side Rendering (SSR) is the process where the HTML for a webpage is generated on the server for each request, rather than in the browser.
- SSR provides better SEO and faster initial page load times, especially for content-heavy or data-driven applications.

SSR: Advantages

- Dynamic Data:
  - Pages that rely on data fetched at request time (e.g., user-specific data, time-sensitive content).
- SEO-Critical Pages:
  - Pages that need to be SEO-friendly, like blogs, marketing pages, or e-commerce product pages.Performance for
- First Load:
  - When you want the content to be available immediately on page load, without waiting for client-side JavaScript.

Static Site Generation (SSG)

- Static Site Generation (SSG) is a pre-rendering method where pages are generated at build time and served as static HTML files.
- SSG enables fast, highly-performant pages by serving pre-built static HTML with minimal server-side processing.

Static Site Generation (SSG)

- Static Content:
  - Use SSG for pages where content doesn’t change often or can be updated on a scheduled basis (e.g., blogs, marketing pages, documentation).
- High Traffic Pages:
  - SSG is ideal for pages that receive high traffic because it serves lightweight static HTML.
- SEO-Critical Pages:
  - Similar to SSR, SSG is excellent for SEO as it produces fully rendered HTML for search engines to index.

SSR & SSG in App Router

- In the **App Router** of Next.js, whether a page is statically generated using **Static Site Generation (SSG)** or server-rendered using **Server-Side Rendering (SSR)** depends on how you fetch and handle data in your components.
- Default Behavior:
  - In the App Router, ***components are statically generated by default*** if no asynchronous data fetching occurs during runtime. These components are pre-rendered at build time and served as static HTML files.
- When SSG is Used:
  - The component does not rely on dynamic data fetched during the request.
  - You are fetching static data at build time using generateStaticParams (for dynamic routes).

SSG in App Router

```
export default function HomePage() {
  return (
    <div>
      <h1>Static Home Page</h1>
      <p>This page is statically generated at build time.</p>
    </div>
  );
}
```

SSG in App Router

```
export default async function HomePage() {
  const res = await fetch('https://api.example.com/data');
  const data = await res.json();

  return (
    <div>
      <h1>SSG with Next.js App Router</h1>
      <p>{data.message}</p>
    </div>
  );
}
```

SSR in App Router

- SSR is Triggered:
  - If your component includes asynchronous data fetching or uses dynamic data that is fetched on each request, the App Router will opt for SSR. This ensures that fresh data is rendered for every request.
  - The caching is disabled on the fetch
  - Use any dynamic API’s
    - cookies, headers, connection etc.
  - Enable SSR
    - export const dynamic = 'force-dynamic'

SSR in App Router

```
export default async function DashboardPage() {
  const res = await fetch('https://api.example.com/user-data', {
    cache: 'no-store', // Ensures fresh data is fetched on every request
  });
  const data = await res.json();

  return (
    <div>
      <h1>User Dashboard</h1>
      <p>Welcome, {data.name}</p>
    </div>
  );
}
```

SSR in App Router

```
export default async function PostPage({ params }) {
  const res = await fetch(`https://api.example.com/posts/${params.id}`);
  const post = await res.json();

  return (
    <div>
      <h1>{post.title}</h1>
      <p>{post.content}</p>
    </div>
  );
}
```

Incremental Static Regeneration (ISR)

- Incremental Static Regeneration (ISR) allows you to update static pages after they've been built, without needing to rebuild the entire site.
- Like SSG, ISR initially generates static HTML files at build time for each page.
- These files are served to users with pre-fetched data, making the site very fast.
- With ISR, you can specify a revalidate interval (in seconds), after which the page will be regenerated in the background the next time it is requested.

Incremental Static Regeneration in App Router

```
export const revalidate = 60; // Revalidate every 60 seconds

export default async function PostsPage() {
  // Fetch data from an API
  const res = await fetch('https://api.example.com/posts');
  const posts = await res.json();

  return (
    <div>
      <h1>Latest Posts</h1>
      {posts.map((post) => (
        <div key={post.id}>
          <h2>{post.title}</h2>
          <p>{post.content}</p>
        </div>
      ))}
    </div>
  );
}
```

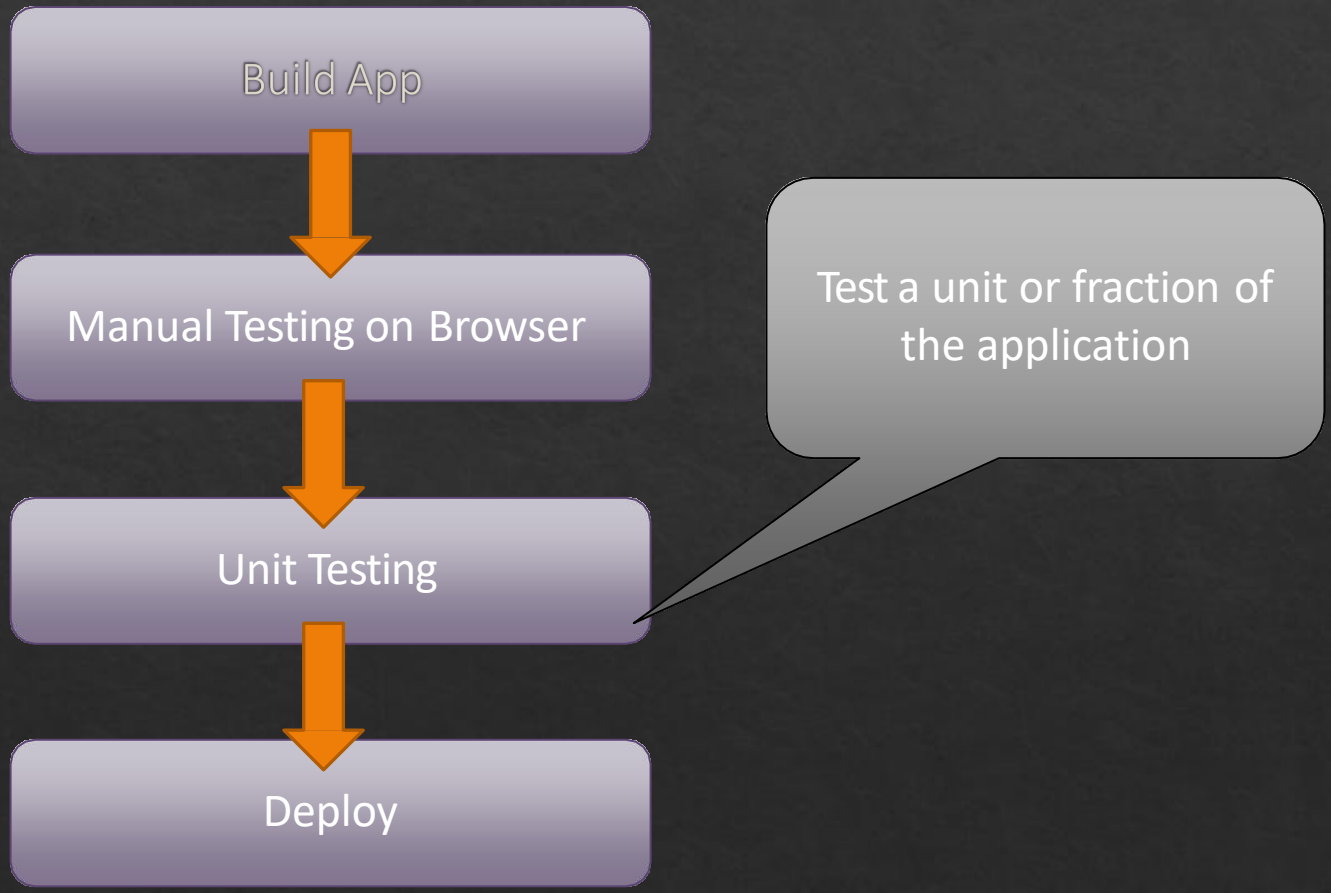
Incremental Static Regeneration (ISR)

```
export async function getStaticProps() {
  const res = await fetch('https://api.example.com/data');
  const data = await res.json();

  return {
    props: { data }, // Data passed to the page
    revalidate: 10,  // Revalidate every 10 seconds
  };
}

export default function HomePage({ data }) {
  return (
    <div>
      <h1>ISR Example</h1>
      <p>{data.message}</p>
    </div>
  );
}
```

React 18 Hooks

- useTransition
  - Allows you to mark non-urgent updates as transitions, keeping the UI responsive by deferring less important state changes until more critical updates (like user interactions) are handled.
- useDeferredValue
  - Defers the rendering of a value that changes frequently, allowing React to prioritize more urgent updates and improving performance by delaying non-essential updates.

Testing


Build App
Manual Testing on Browser
Unit Testing
Deploy
Test a unit or fraction of the application

Testing Tools

Testing API
&
Test Runner

Write the Unit Test.
Executes the Unit Tests.

Jest
(Built over Jasmine)

Test Utilities

Simulate the React App

react-test-renderer

enzyme

testing-library/react

Jest

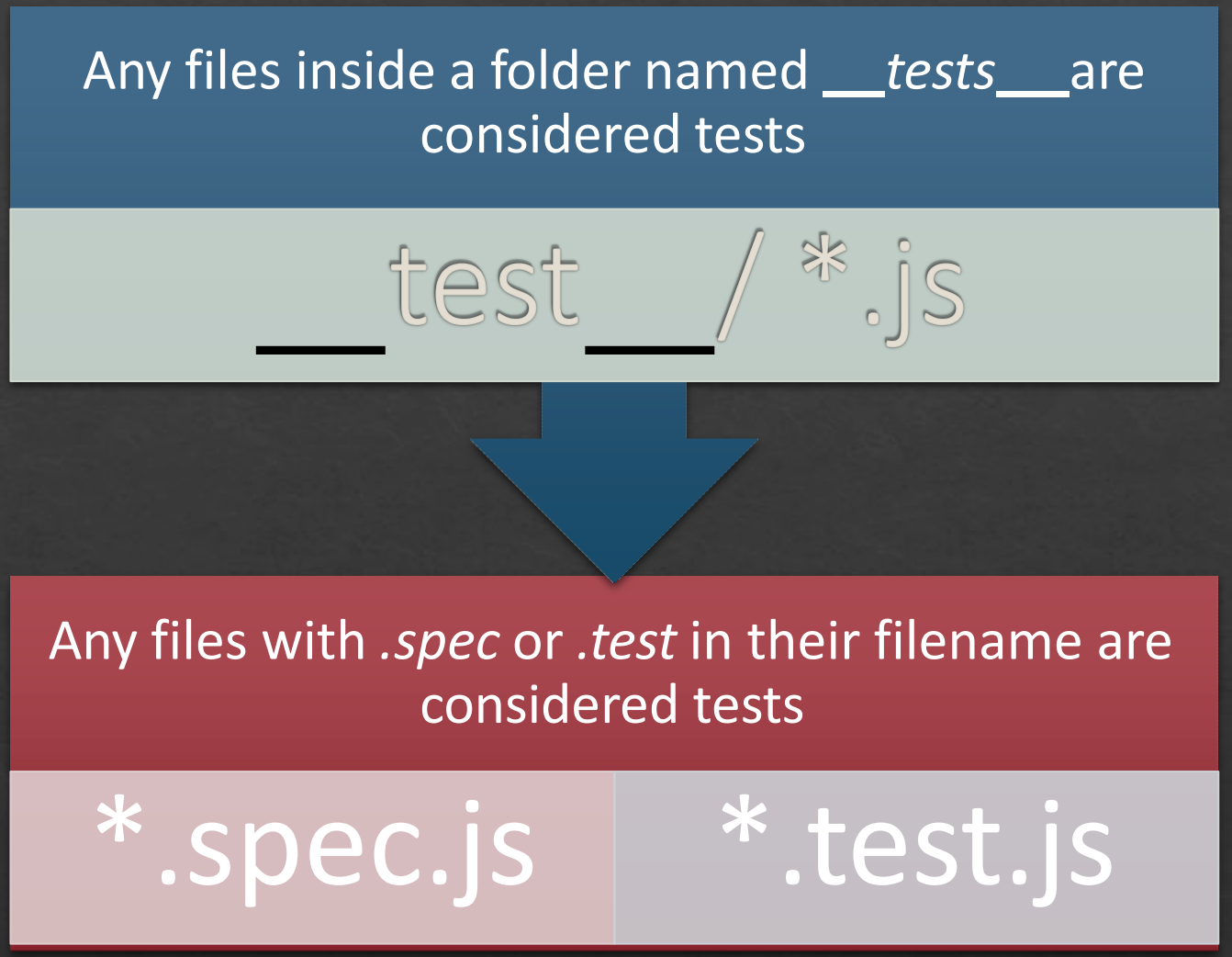
A testing library and test runner with handy features

Created by the members of the React team and the recommended tool for unit testing react

Built on top of Jasmine/Mocha

Additional features like mocking and snapshot testing

Jest: Identifying Test files



Jest Global Methods

it

- Method which you pass a function to, that function is executed as block of tests by the test runner.
- Alias name: test

describe

- An optional method for grouping any number of *it* or *test* statements
- Alias name: suite

Setup & Teardown Global functions

beforeEach	BeforeEach runs a block of code before each test
afterEach	Runs a block of code after each test
beforeAll	BeforeAll runs code just once, before the first test
afterAll	Runs a block of code after the last test)

What to Test?

Test Isolated Components

Test Conditional Outputs

Don’t Test Library Functions

Don’t Test Complex Connection

End to End Test

End-to-end testing is a methodology used to test whether the flow of an application is performing as designed from start to finish.

The purpose of carrying out end-to-end tests is to identify system dependencies and to ensure that the right information is passed between various system components and systems.s

E2E Tools

Cypress

Pupeeter

Selenium Webdriver

Nightwatch.js

Deployment

Set basePath of Router

- <BrowserRouter basename="/app/">

Configure basePath in vite.config.ts

- “base": "/app"

Build and Optimize npm run build

Server must Always serve index.html

Deploy artifacts to Web Server

Thank You

ANIL JOSEPH

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