Internet Applications Design and Implementation

(Lecture 10 - State Management. Flux&Redux: Design Patterns to the rescue)

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Specialization block

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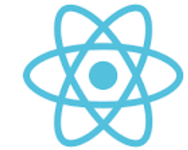
React



- React implements a presentation layer
- React Pros:
  - Highly structured and stable applications
  - Highly Composable and reusable UI components
  - Loose coupling of components (through binding and render)
  - Great match with specification languages like IFML.
- React Cons:
  - There is not a great way to connect to a back-end.
  - Poor scalability with relation to the size of state and number of actions needed (coupling rises).

(Recall) Identify the UI minimal complete state

- Is it passed in from a parent via props? If so, it probably isn't state.
- Does it remain unchanged over time? If so, it probably isn't state.
- Can you compute it based on any other state or props in your component? If so, it isn't state.

(Recall) Find the state component by Q&A

For each piece of state in your application:

- Identify every component that renders something based on that state.
- Find a common owner component (a single component above all the components that need the state in the hierarchy).
- Either the common owner or another component higher up in the hierarchy should own the state.
- If you can't find a component where it makes sense to own the state, create a new component simply for holding the state and add it somewhere in the hierarchy above the common owner component.

Problem?

- The main model entities for a React application will be placed on the state of the application.
  - Application class will be cluttered with Layout, State and State changing and sync code (controllers?)
  - The whole application will be (re)rendered on every state change (efficiency problem?)
  - Solution 1: functions passed through props.
  - Solution 2: controller object(s) with groups of functions will be passed through props.
  - These are “indirect pointers” in the ownership hierarchy!
  - Although React creates new objects and clones state well, the code coupling does not scale well, needs a lot of lifecycle management code.

Problem?

- Problem 1: Prop drilling

  Properties that need to be accessed in many different places (views) in the application tend to be passed through props in “all” components. This makes reuse a lot harder…

  Solution 1: Use children components to structure your application

  Solution 2: Use render props to compute the components in advance

  Solution 3: Use React.Context to store and distribute global information

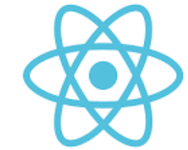
- Problem 2: Remote connections and Callback hell

  When state is kept at the top level (or near), loading of state and state updates are encoded in many callbacks. This makes reuse a lot harder. One must resort to more sophisticated patterns/libraries/frameworks.

Example

```
const App = () => {
  const username = "mary"
  const roles = ["admin", "editor"]
  return <div>
    <Header username={username}/>
    <Container roles={roles}/>
  </div>
}

/* This header cannot be reused in other places without a username and userbox!! */

const Header =
  ({ username }: { username: string }) =>
     <div style={{ border: "1px solid" }}>This is the header <UserBox username={username} /></div>

const UserBox = ({ username }: { username: string }) =>
  <div> <p>The username is {username}</p> </div>

/* This container cannot be reused in other places without an array of roles and the children components below!! */

const Container = ({roles}:{roles:string[]}) =>
  <div>
    <div>
      {roles.includes("admin") && <p> This is a ADMIN part of the container </p>}
      {roles.includes("editor") && <p>This is an Editor part of the container </p>}
    </div>
  </div>
```

Component Composition/Inclusion

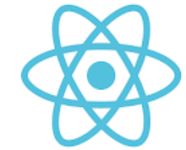


```
const App = () => {
  const username = "mary"
  const roles = ["admin", "editor"]
  return <div>
    <Header>
      <UserBox username="username"/>
    </Header>
    <Container>
      <div>
        {roles.includes("admin") && <p> This is a ADMIN part of the container </p>}
        {roles.includes("editor") && <p>This is an Editor part of the container </p>}
      </div>
    </Container>
  </div>
}

const Header : React.FunctionComponent<{}> =
  (props) => <div style={{ border: "1px solid" }}>This is the header { props.children }</div>

const UserBox = ({username}:{username:string}) =>
      <div> <p>The username is {username}</p> </div>

const Container: React.FunctionComponent<{}> = (props) =>
    <div>
    { props.children }
    </div>
```

Render props

```
const App = () => {
   const username = "mary"
   const roles = ["admin", "editor"]

  const userBox = () => <div> <p>The username is {username}</p> </div>

  const content = () => <div>
       {roles.includes("admin") && <p> This is a ADMIN part of the container </p>}
       {roles.includes("editor") && <p>This is an Editor part of the container </p>}
     </div>

   return <PageLayout userBox = {userBox} content={content}/>
}

const PageLayout = ({userBox, content}:any) =>
  <div>
     <div style={{ border: "1px solid" }}>This is the header {userBox()} </div>
     <div> {content()} </div>
  </div>
```

React.Context - A side channel



```
interface ContextInterface { username: string | null; roles:string[] }

const UserContext = React.createContext<ContextInterface>({username:null, roles:[]})

const App = () =>
    <UserContext.Provider value={({username:"mary", roles:["admin","editor"]})}>
    <div>
      <Header/>
      <Container/>
    </div>
    </UserContext.Provider>

const Header = () => <div style={{border: "1px solid"}}>This is the header <UserBox/></div>

const UserBox = () =>
  <UserContext.Consumer>
    {value => <div><p>The username is {value.username}</p></div> }
  </UserContext.Consumer>

const Container = () =>
  <UserContext.Consumer>
  { value => <div>
        { value.roles.includes("admin") && <p> This is a ADMIN part of the container </p> }
        { value.roles.includes("editor") && <p>This is an Editor part of the container </p>}
      </div>
  }
  </UserContext.Consumer>
```

Sketch for remote connections (with jquery :-))

```
componentDidMount() {
    $.getJSON(this.TASKS_URL)
        .then( doneFilter: (data:Task[]) =>
                this.setState(
            f: (state:StateSig) =>
                this.setState( state: {...state, tasks:data})))
    $.getJSON(this.SPRINTS_URL)
        .then( doneFilter: (data:Sprint[]) =>
                this.setState(
            f: (state:StateSig) =>
                this.setState( state: {...state, sprints:data})))
    $.getJSON(this.USERS_URL)
        .then( doneFilter: (data:User[]) =>
                this.setState(
            f: (state:StateSig) =>
                this.setState( state: {...state, users:data})))
}
```

Sketch

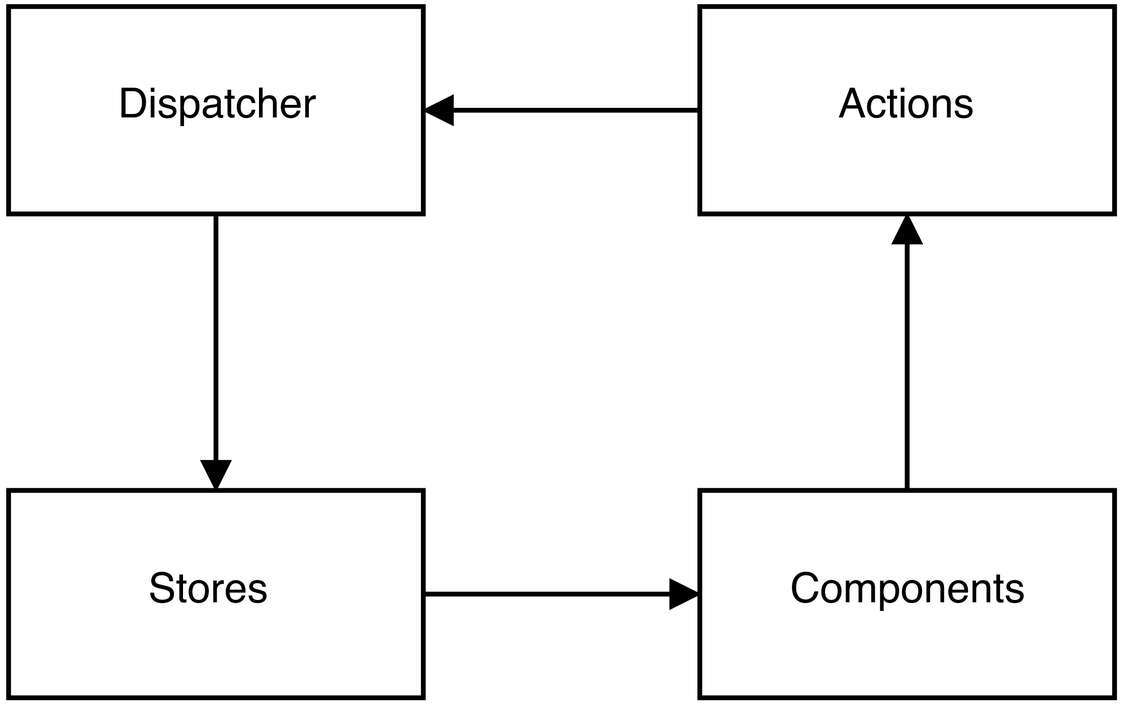
```
addSprint = (sprint:Sprint) =>
    $.post(this.SPRINTS_URL, JSON.stringify(sprint))
        .then( doneFilter: ()=> this.setState( f: (state:any)=>({...state, sprints:[sprint,...state.sprints]})))

addTask = (task:Task) =>
    $.post(this.SPRINTS_URL, JSON.stringify(task))
        .then( doneFilter: ()=>(this.setState( f: (state:any)=>({...state, tasks:[task,...state.tasks]}))))
```

Solution: complete a (kind of) client-side MVC

- Flux pattern extends the React with a store and dispatcher components.
- Implements a uni-directional flow of data
  (controller does not intermediate the views)
  It's not really MVC or MVP.
- React components (views) bind to stored elements.
- Actions (store functions) are triggered by the view
- Actions get dispatched to have effect on a store

Flux pattern

- diagram



A Store is an EventEmitter (“Subject”)

```
import { EventEmitter } from "events"
import {Task} from "../Tasks";


class TasksStore extends EventEmitter {
    tasks:Task[]

    constructor() {
        super()
        this.tasks = [
            {id: 1, name:"Go shopping", dueDate:"2017-10-23"},
            {id: 2, name:"Do the dishes", dueDate:"2017-10-22"},
            {id: 3, name:"Do homework", dueDate:"2017-10-21"},
        ] // Later will have to be managed from the server
    }

    getAllTasks() {
        return this.tasks;
    }
}

const tasksStore = new TasksStore()

export default tasksStore
```

A Store is an EventEmitter (“Subject”)

```
class TasksStore extends EventEmitter {
    tasks:Task[]
    count:number

    constructor() {...}

    createTask(name:string, dueDate:string) {
        this.tasks.push({id: this.count++, name, dueDate})
        this.emit( event: "change")
    }

    getAllTasks() {...}
}
```

App:

```
componentWillMount() {
    tasksStore.on( event: "change",
        listener: () => this.setState(
            f: (state:StateSig) => ({...state, tasks:tasksStore.getAllTasks()})
        ))
}
```

Flux - connect with server

```
class TasksStore extends EventEmitter {
    private TASKS_URL: "/tasks"

    tasks:Task[]
    count:number

    constructor() {...}

    createTask(task:Task) {
        this.tasks.push({...task, id: this.count++})
        $.post(this.TASKS_URL,JSON.stringify(task))
            .then( doneFilter: ()=>this.emit( event: "change"))
            .fail( failCallback: () => this.emit( event: "TASK_ERROR"))
    }

    getAllTasks() {...}
}
```

Redux

Redux - Learn with the authors…

FREE

Fundamentals of Redux Course from Dan Abramov

Instructor
Dan Abramov

react redux 2h 1m CC

★ ★ ★ ★ ½ **4.7** **9769** people completed

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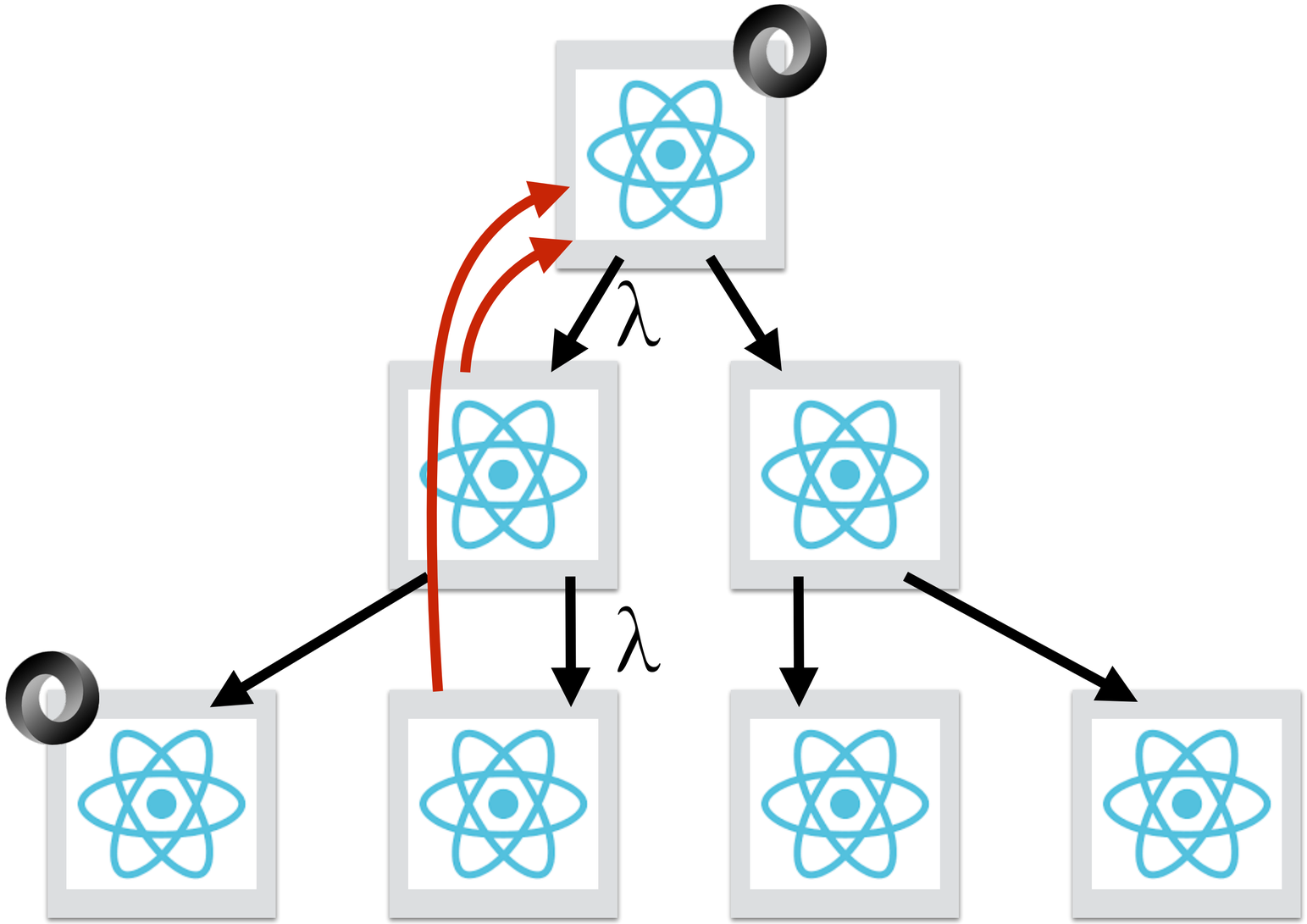
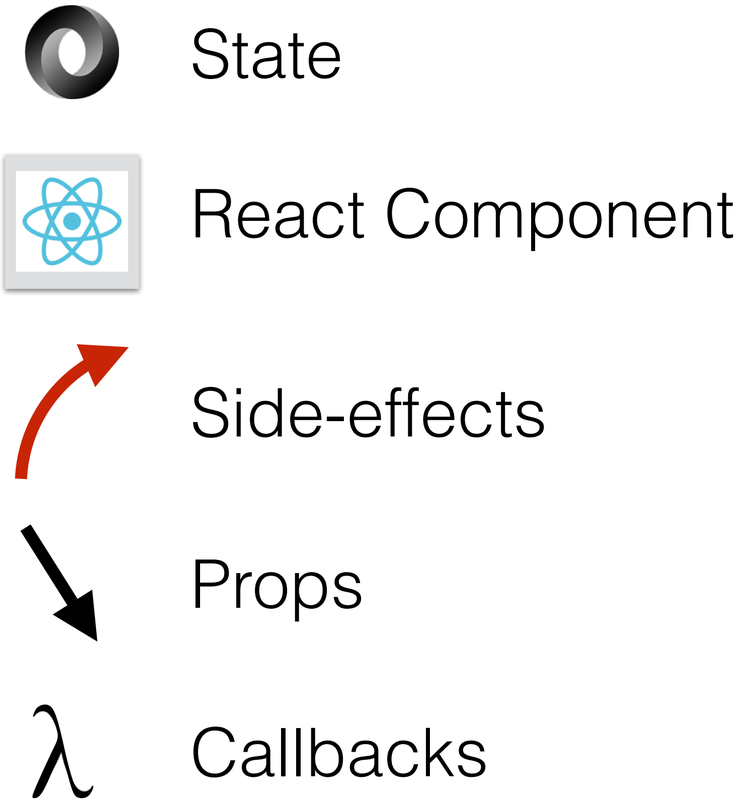
In this comprehensive tutorial, Dan Abramov - the creator of Redux - will teach you how to manage state in your React application with Redux.

State management is absolutely critical in providing users with a well-crafted experience with minimal bugs.

▶ Start Watching

React





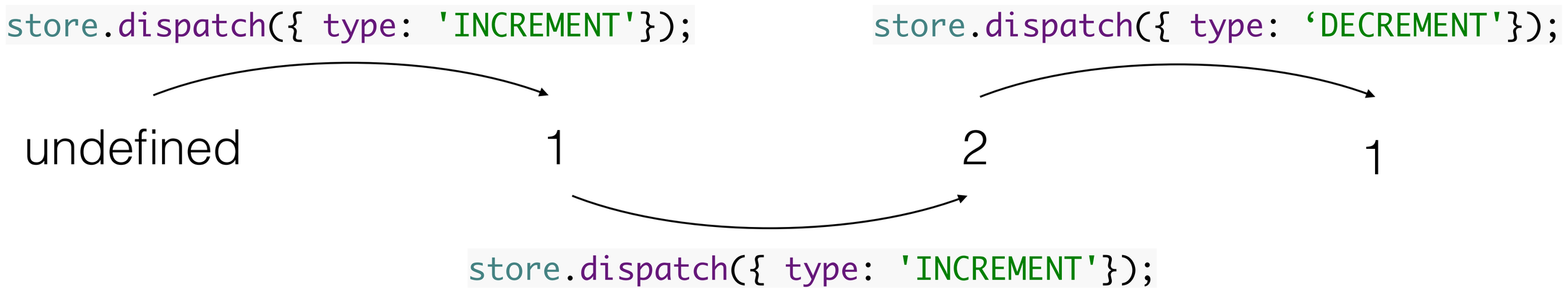
Redux

- Implements a variant of a flux pattern.
- Based on functional state transformations. The state is read-only, can only be changed by action dispatching.
- A store that implements the observer pattern.
- Ingredients are Actions, Store, Reducers.

https://redux.js.org/introduction/getting-started

```
import {Action, createStore} from 'redux'

function counter(state = 0, action:Action) {
    switch (action.type) {
        case 'INCREMENT':
            return state + 1;
        case 'DECREMENT':
            return state - 1;
        default:
            return state
    }
}

let store = createStore(counter);

store.subscribe(() => console.log(store.getState()));

store.dispatch({ type: 'INCREMENT'});
store.dispatch({ type: 'INCREMENT'});
store.dispatch({ type: 'DECREMENT'});
```

Redux - reducers




```
counter(undefined, {type:'INCREMENT'}) = 1
counter(1, {type:'INCREMENT'}) = 2
counter(2, {type:'DECREMENT'}) = 1
```

Redux - reducers

- The state can be compositionally built from smaller pieces.
- Reducers can be combined to form a more elaborate state.

```
class ToDo { text:string; completed:boolean;
    constructor(text:string, completed: boolean) {
        this.text = text; this.completed = completed;
    }
}
interface AddTodoAction extends Action { text:string }
interface CompleteTodoAction extends Action { index:number }

function todos(state = [] as ToDo[], action:Action): ToDo[] {
    switch (action.type) {
        case 'ADD_TODO':
            let a1 = action as AddTodoAction;
            return [...state, new ToDo(a1.text, false)]
        case 'COMPLETE_TODO':
            let a2 = action as CompleteTodoAction;
            return state.map((todo:ToDo, index) => {
                return index == a2.index ? {...todo, completed:true}: todo
            });
        default:
            return state
    }
}
```

Redux - reducers

- The state can be compositionally built from smaller pieces.
- Reducers can be combined to form a more elaborate state.

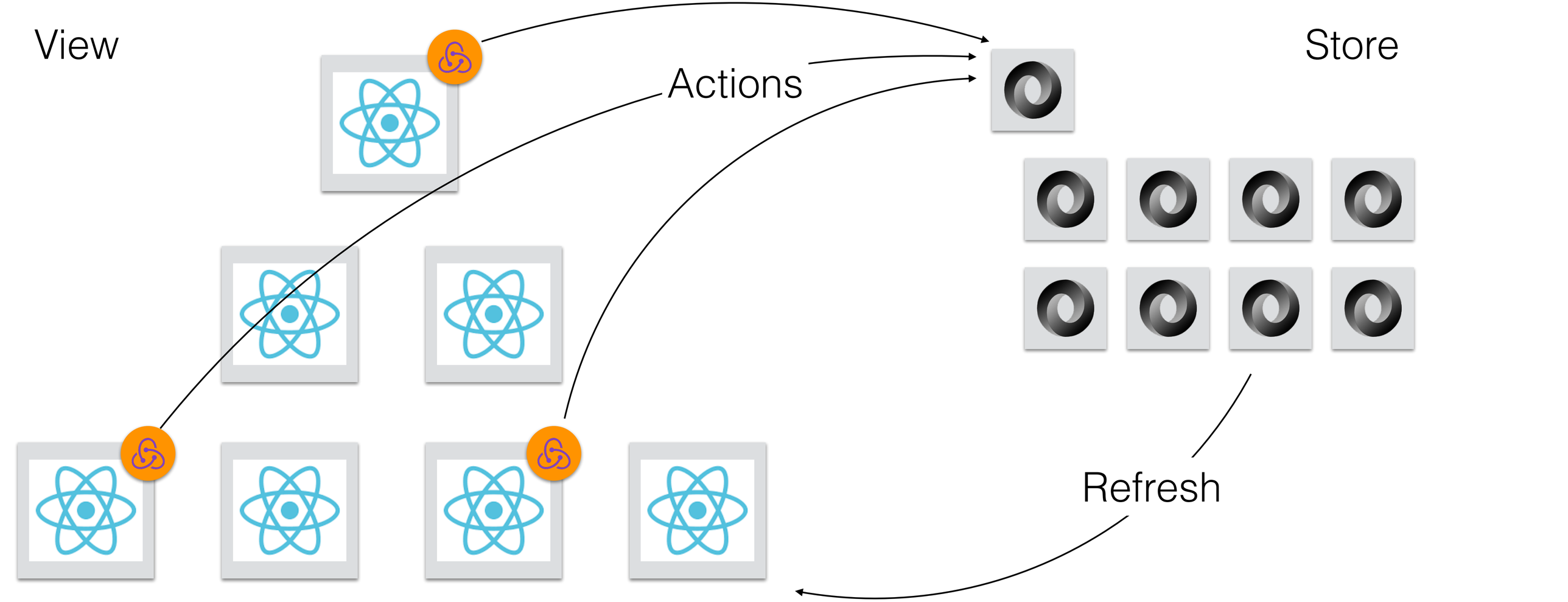
```
interface SetFilterAction extends Action { filter: string }

function filter(state = 'SHOW_ALL', action:Action): string {
    switch (action.type) {
        case 'SET_FILTER':
            return (action as SetFilterAction).filter;
        default:
            return state;
    }
}

const reducer = combineReducers({ todos, filter });
const todoStore = createStore(reducer);

todoStore.subscribe(() => console.log(todoStore.getState()));

todoStore.dispatch({type:'ADD_TODO', text:'Complete the project'});
todoStore.dispatch({type:'ADD_TODO', text:'Start the project'});
todoStore.dispatch({type:'ADD_TODO', text:'Submit the project'});
todoStore.dispatch({type:'COMPLETE_TODO', index:0});
todoStore.dispatch({type:'COMPLETE_TODO', index:1});
todoStore.dispatch({type:'COMPLETE_TODO', index:2});
```

Redux - reducers

- The state can be compositionally built from smaller pieces.
- Reducers can be combined to form a more elaborate state.

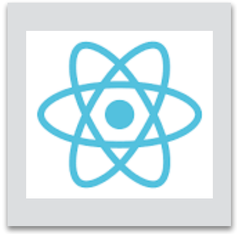
```
[ ToDo { text: 'Complete the project', completed: false } ]

[ ToDo { text: 'Complete the project', completed: false },
  ToDo { text: 'Start the project', completed: false } ]

[ ToDo { text: 'Complete the project', completed: false },
  ToDo { text: 'Start the project', completed: false },
  ToDo { text: 'Submit the project', completed: false } ]

[ { text: 'Complete the project', completed: true },
  ToDo { text: 'Start the project', completed: false },
  ToDo { text: 'Submit the project', completed: false } ]

[ { text: 'Complete the project', completed: true },
  { text: 'Start the project', completed: true },
  ToDo { text: 'Submit the project', completed: false } ]

[ { text: 'Complete the project', completed: true },
  { text: 'Start the project', completed: true },
  { text: 'Submit the project', completed: true } ]
```

Redux-react



Presentational Components

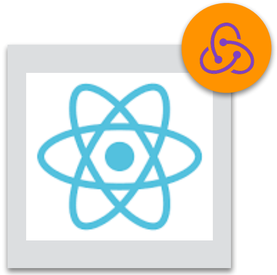
- React and redux can be combined by having a presentational component, extended with connections to the state generated automatically.



```
interface ToDoItemInterface {text:string, completed:boolean, onClick:() => void}
const ToDoItem = ({text, completed, onClick}:ToDoItemInterface) =>
    <li
        onClick={onClick}
        style={{textDecoration: completed ? 'line-through': 'none'}}
    >
        {text}
    </li>;

interface ToDoListInterface { todos: ToDo[], onToDoClick: (index:number) => void}
const ToDoList = ({todos, onToDoClick}:ToDoListInterface) =>
    <ul>
        { todos.map( (todo, index) => {
            console.log(index);
            return <ToDoItem key={index} {...todo} onClick={() => onToDoClick(index) }/>
        })}
    </ul>;
```

Presentational Components

- React and redux can be combined by having a presentational component, extended with connections to the state generated automatically.



```
const mapStateToProps =
  (state:ToDoAppStateInterface) => ({todos: filterTodos(state.todos, state.filter)}};

const completeToDo = (index:number) => ({ type:'COMPLETE_TODO', index});
const mapDispatchToProps = (dispatch:(action:Action)=>void) =>
    ({ onToDoClick: (id:number) => { dispatch(completeToDo(id)) }});

const VisibleToDoList = connect(mapStateToProps, mapDispatchToProps)(ToDoList);

const ToDoListWithStore = () =>
    <Provider store={todoStore}>
       <VisibleToDoList/>
    </Provider>;
```

Async actions

- All changes to the s
- Integration with asy

```
class Pet { name:string; constructor(name:string) { this.name = name; }}
interface PetState { pets: Pet[] }

const ADD_PET = 'ADD_PET';
const REQUEST_PETS = 'REQUEST_PETS';
const RECEIVE_PETS = 'RECEIVE_PETS';

const addPet = (name:string) => ({type: ADD_PET, name:string});

interface AddPetAction extends Action { name:string }

function petsReducer(pets = [] as Pet[], action:Action):Pet[] {
    switch (action.type) {
        case ADD_PET:
            let addPet = action as AddPetAction;
            return [...pets, new Pet(addPet.name)];
        default:
            return pets
    }
}
```

Async actions

- All changes
- Integration v

```
const requestPets = () => ({type: REQUEST_PETS});
const receivePets = (data:Pet[]) => ({type: RECEIVE_PETS, data:data});

function fetchPets() {
    return (dispatch) => {
        dispatch(requestPets());
        return fetch("/pets")
            .then( response => response.json())
            .then( data => dispatch(receivePets(data)))
    }
}

const loggerMiddleware = createLogger();

const store =
    createStore( combineReducers({pets: petsReducer}),
                 applyMiddleware( thunkMiddleware, loggerMiddleware ) );
store.dispatch(fetchPets()).then(() => console.log(store.getState()));
```

Using Redux Toolkit (Slices)

```
import { createSlice, configureStore } from '@reduxjs/toolkit'

const counterSlice = createSlice({
  name: 'counter',
  initialState: {
    value: 0
  },
  reducers: {
    incremented: state => {
     state.value += 1
    },
    decremented: state => {
      state.value -= 1
    }
  }
})

export const { incremented, decremented } = counterSlice.actions

const store = configureStore({ reducer: counterSlice.reducer })

// Can still subscribe to the store
store.subscribe(() => console.log(store.getState()))

// Still pass action objects to `dispatch`, but they're created for us
store.dispatch(incremented()) // {value: 1}
store.dispatch(incremented()) // {value: 2}
store.dispatch(decremented()) // {value: 1}
```

https://redux.js.org/introduction/getting-started

Using React Redux (Hooks)

```
import React from 'react'
import { useSelector, useDispatch } from 'react-redux'
import { decrement, increment } from './counterSlice'


export function Counter() {
  const count = useSelector((state) => state.value)
  const dispatch = useDispatch()

  return (
    <div>
       <button
          className={styles.button}
          aria-label="Increment value"
          onClick={() => dispatch(increment())}
        >
          +
        </button>
        <span className={styles.value}>{count}</span>
        <button
          className={styles.button}
          aria-label="Decrement value"
          onClick={() => dispatch(decrement())}
        >
          -
        </button>
      </div>
   </div>
  )
}
```

Further readings

- https://redux.js.org/introduction/getting-started
- https://react-redux.js.org/
- https://egghead.io/courses/getting-started-with-redux
- https://react-redux.js.org/next/api/hooks
- https://egghead.io/lessons/react-redux-the-single-immutable-state-tree
- https://redux.js.org/advanced/async-actions