STATE MANAGEMENT WITH REDUX (MMT-M2019)

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ROADMAP

» Functional Programming 101

» Side Effects with React

» State Management with Redux

TESTING FORMS [1]

```
import React from 'react'
import { render, cleanup, queryByText, fireEvent } from '@testing-library/react'
import Form from './Form'

afterEach(cleanup)
it('submits username as form value', () => {
  const username = 'a value'
  const onSubmit = jest.fn()

  const { container } = render(<Form onSubmit={onSubmit} />)

  fireEvent.change(
    container.querySelector('[name="username"]'),
    { target: { value: username } }
  )
  fireEvent.submit(container.querySelector('form'))

  expect(onSubmit).toHaveBeenLastCalledWith({ username })
})
```

[1] I have forgotten to add this slide in the last lecture. This slide might be required for your homework

FUNCTIONAL PROGRAMMING 101

FUNCTIONAL PROGRAMMING 101

» Immutability

» Pure functions

» Side Effect

FUNCTIONAL PROGRAMMING 101
WHAT IS FUNCTIONAL PROGRAMMING

“Applications developed in a functional style use side-effect free functions as their main building blocks. (Made up definition by myself)”

FUNCTIONAL PROGRAMMING 101
WHY FUNCTIONAL PROGRAMMING

- More testable
  - pure functions simplify testing
- Declarative APIs which are easier to reason about
- Easy concurrency because of statelessness and immutability
  - State is pushed out of the application core to the boundaries

FUNCTIONAL PROGRAMMING - IMMUTABILITY

“An immutable data structure is an object that doesn't allow us to change its value. (Remo H. Jansen)”

FUNCTIONAL PROGRAMMING - IMMUTABILITY
IMMUTABLE OBJECTS IN JS

```
const immutableObject = Object.freeze({ test: 1 })
immutableObject.test = 10
console.log(immutableObject) // => { test: 1 }
```

FUNCTIONAL PROGRAMMING - IMMUTABILITY
CHANGING AN IMMUTABLE VALUE

```
const immutableObject = Object.freeze({ a: 1, b: 2 })
const updatedObject = Object.freeze({ ...immutableObject, a: 2 })
console.log(updatedObject) // => { a: 2, b: 2 }
```

FUNCTIONAL PROGRAMMING - IMMUTABILITY
UNFREEZE AN OBJECT

```
const immutableObject = Object.freeze({ test: 1 })
const unfrozenCopy = { ...immutableObject }
```

FUNCTIONAL PROGRAMMING - IMMUTABILITY
WHY IMMUTABILITY

» race conditions impossible

» state of the application is easier to reason about

» easier to test

FUNCTIONAL PROGRAMMING - SIDE EFFECTS

“A side effect is a change of system state or observable interaction with the outside world that occurs during the calculation of a result. (Chris Barbour)”

FUNCTIONAL PROGRAMMING - SIDE EFFECTS

SOME SIDE EFFECTS

- DB/HTTP calls
- changing the file system
- querying the DOM
- printing/logging
- accessing system state (eg. Clock, Geolocation,...)

FUNCTIONAL PROGRAMMING - SIDE EFFECTS
WHERE TO DEAL WITH SIDE EFFECTS

» Moved to the boundaries of the system

» Business logic stays pure functional

FUNCTIONAL PROGRAMMING - PURE FUNCTIONS

- A function is considered pure when:
  - for the same input it always returns the same output
  - it has no side effects
  - no mutation of non-local state

```
const add = (a, b) => a + b
```

FUNCTIONAL PROGRAMMING - PURE FUNCTIONS
PURE OR IN-PURE

```
const array = [1, 2, 3, 4, 5, 6]
const fn1 = (array) => array.slice(0, 3)
const fn2 = (array) => array.splice(0, 3)
const fn3 = (array) => array.shift()
const fn4 = (array) => array.pop()
const fn5 = (array) => array.sort((a, b) => a - b)
const fn6 = (array) => [...array].sort((a, b) => a - b)
const fn7 = (array) => array.map((item) => item * 2)
const fn8 = (array) => array.forEach((item) => console.log(item))
```

FUNCTIONAL PROGRAMMING - PURE FUNCTIONS
PURE OR IN-PURE

```
const array = [1, 2, 3, 4, 5, 6]
const fn1 = (array) => array.slice(0, 3) // ✅
const fn2 = (array) => array.splice(0, 3) // 🚫
const fn3 = (array) => array.shift() // 🚫
const fn4 = (array) => array.pop() // 🚫
const fn5 = (array) => array.sort((a, b) => a - b) // 🚫
const fn6 = (array) => [...array].sort((a, b) => a - b) // ✅
const fn7 = (array) => array.map((item) => item * 2) // ✅
const fn8 = (array) => array.forEach((item) => console.log(item)) // 🚫
```

FUNCTIONAL PROGRAMMING - PURE FUNCTIONS
PURE OR IN-PURE

```
const config = { minimumAge: 18 }
const isAllowedToDrink = (age) => age >= config.minimumAge
```


```
const config = { minimumAge: 18 }
const isAllowedToDrink = (age) => age >= config.minimumAge
```

FUNCTIONAL PROGRAMMING - PURE FUNCTIONS
PURE OR IN-PURE

```
const config = { minimumAge: 18 }
const isAllowedToDrink = (age) => age >= config.minimumAge

const config = { minimumAge: 18 }
const isAllowedToDrink = (age) => age >= config.minimumAge

// both are not pure. const saves the pointer. config is still mutable
isAllowedToDrink(18) // true
config.minimumAge = 19
isAllowedToDrink(18) // false
```

FUNCTIONAL PROGRAMMING - PURE FUNCTIONS
PURE OR INPURE? 2/2

```
const config = Object.freeze({ minimumAge: 18 })
const isAllowedToDrink = (age) => age >= config.minimumAge

// freezing the config makes the function pure
isAllowedToDrink(18) // true
config.minimumAge = 19
isAllowedToDrink(18) // true
```

FUNCTIONAL PROGRAMMING - SUMMARY

- Immutability
  - Object can't be changed after its creation
- Side-Effects
  - Communication with the outside world (eg. db, http, ...)
- Pure-Functions
  - returns the same output for the same input

SIDE EFFECTS WITH REACT

SIDE EFFECTS WITH REACT
RECAP USEEFFECT

“The Effect Hook lets you perform side effects in function components”

SIDE EFFECTS WITH REACT
RECAP USEEFFECT

```
// Executed on every rerender
useEffect(() => {})

// Executed when component rendered initially
useEffect(() => {}, [])

// Executed when component rendered initially
// and when variable changes.
useEffect(() => {}, [variable])

// Cleanup when component unmounts (eg. eventHandlers, setInterval/setTimeout)
useEffect(() => {
  // do something fancy
  return () => { console.log('cleanup') }
}, [variable])
```

SIDE EFFECTS WITH REACT
RECAP USEEFFECT

```
export const MoneyTransactions = () => {
  const [moneyTransactions, setMoneyTransactions] = useState([])
  useEffect(() => {                                          // 1)
    fetch("http://localhost:3001/money-transaction")         // 2)
      .then((response) => response.json())                   // 3)
      .then((json) => setMoneyTransactions(json))            // 4)
  }, [])                                                     // 5)

  // 1) define the useEffect hook
  // 2) make the HTTP request to the backend
  // 3) get the JSON from the response
  // 4) set the response as state
  // 5) call the effect when the component is mounted

  // ... remaining component
}
```

SIDE EFFECTS WITH REACT
EXTRACT INTO CUSTOM HOOK

```
const useHTTPEffect = (endpoint) => {
  const [response, setResponse] = useState([])
  useEffect(() => {
    fetch(endpoint)
      .then((response) => response.json())
      .then((json) => setResponse(json))
  }, [])

  return response;
}

export const MoneyTransactions = () => {
  const moneyTransactions = useHttpEffect("http://localhost:3001/money-transaction")
  const users = useHttpEffect("http://localhost:3001/user")

  // ...
}
```

STATE MANAGEMENT WITH REDUX

REDUX - STATE
WHAT IS APPLICATION STATE

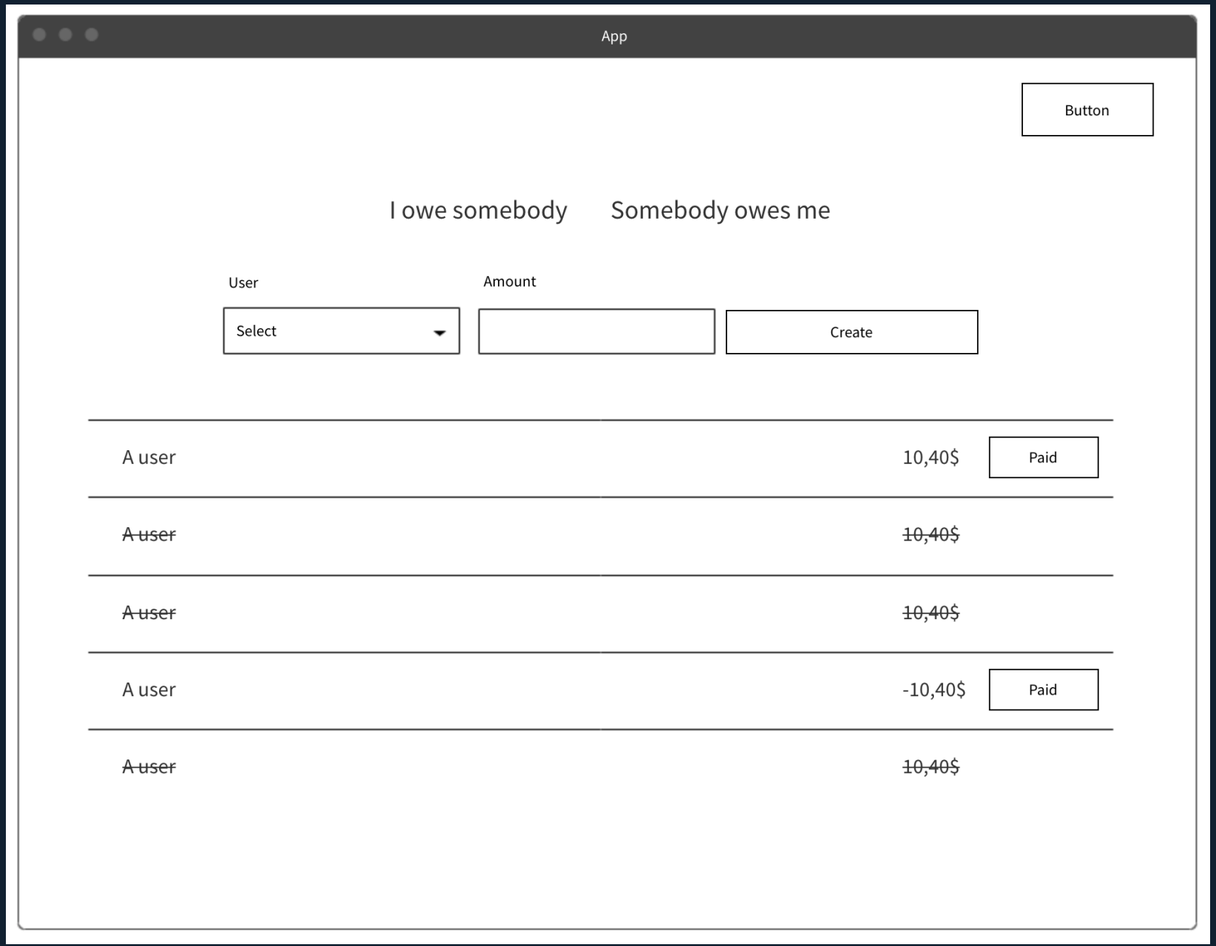
“An application's state is roughly the entire contents of its memory. (sarnold)”

REDUX - STATE
STATE IN REDUX TERMS

“Every bit of information the application needs in order to render.”

REDUX - STATE

WHAT INFORMATION DO WE NEED TO RENDER THIS PAGE



REDUX - STATE

WHAT INFORMATION DO WE NEED TO RENDER THIS PAGE

QUESTION?	STATE NAME
Is the user authenticated?	authenticationStatus
Is a form already filled with values?	formValues
Is the input field hovered/focused/ filled?	inputStatus
Am I owning money to somebody?	moneyTransactions
Is somebody owning me some money?	moneyTransactions
Which users can I owe some money?	users
Which components should be rendered?	url

REDUX - STATE
CATEGORISING DIFFERENT TYPES

- Relevant for other parts of the application?
  - add to global state
- Irrelevant for other parts of the application?
  - use component state (useState or setState)
  - also known as UI State

REDUX - STATE
GLOBAL/LOCAL/URL

STATE NAME	STATE TYPE
authenticationStatus	
moneyTransactions	
users	
formValues	
inputStatus	
url	

REDUX - STATE
GLOBAL/LOCAL/URL

STATE NAME	STATE TYPE
authenticationStatus	global
moneyTransactions	global
users	global
formValues	local
inputStatus	local
url	url

REDUX - STATE
GLOBAL STATE

- relevant for other components
- could be seen as a client side database
  - or a cached version of the server data
- domain object should be stored here
  - eg. users, money transactions, authentication token

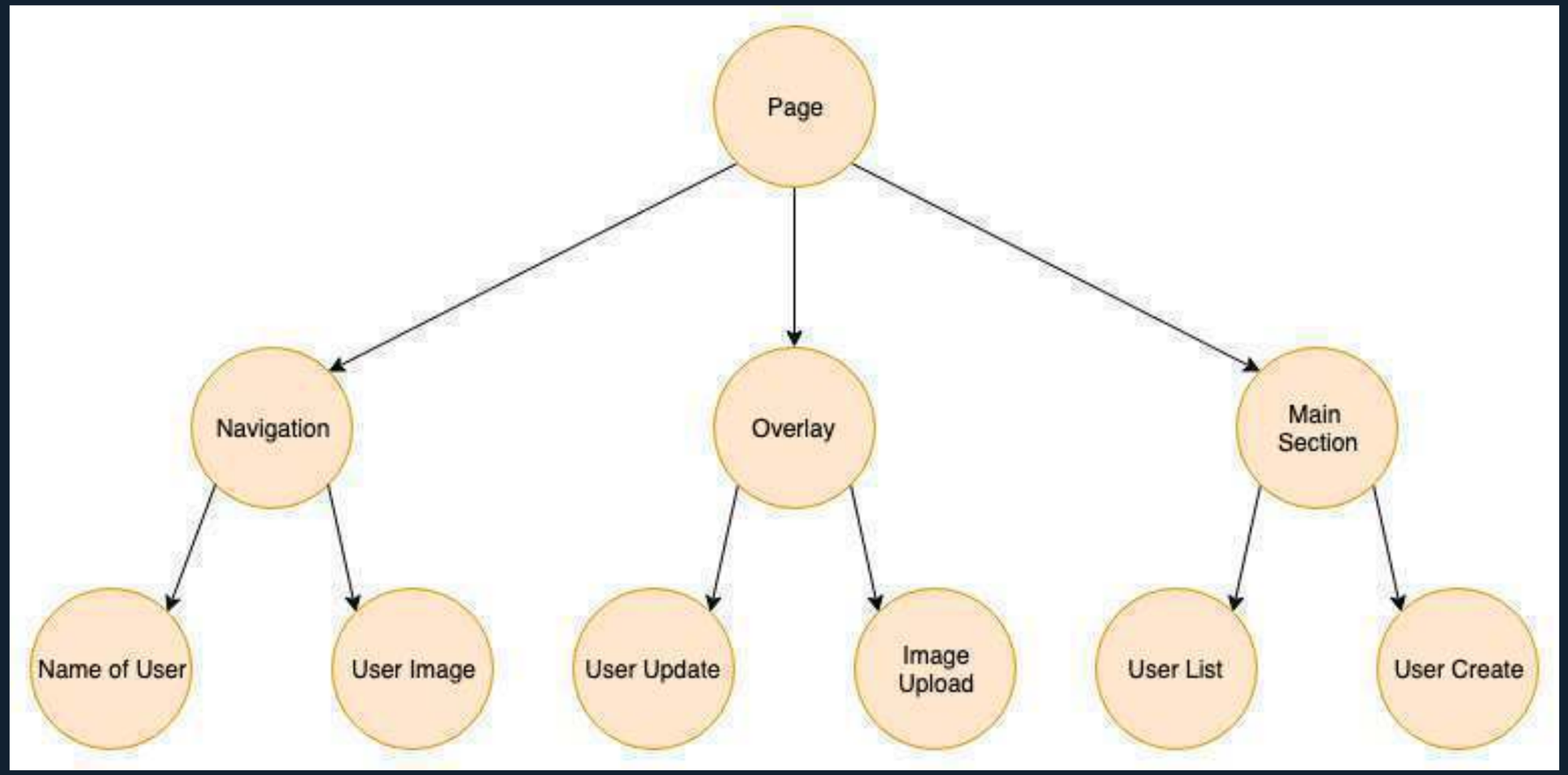
REDUX - STATE
UI STATE

- irrelevant for other parts of the application
  - or state which shouldn't be shared with others
- What to store in UI state?
  - Form states
  - visual enhancements

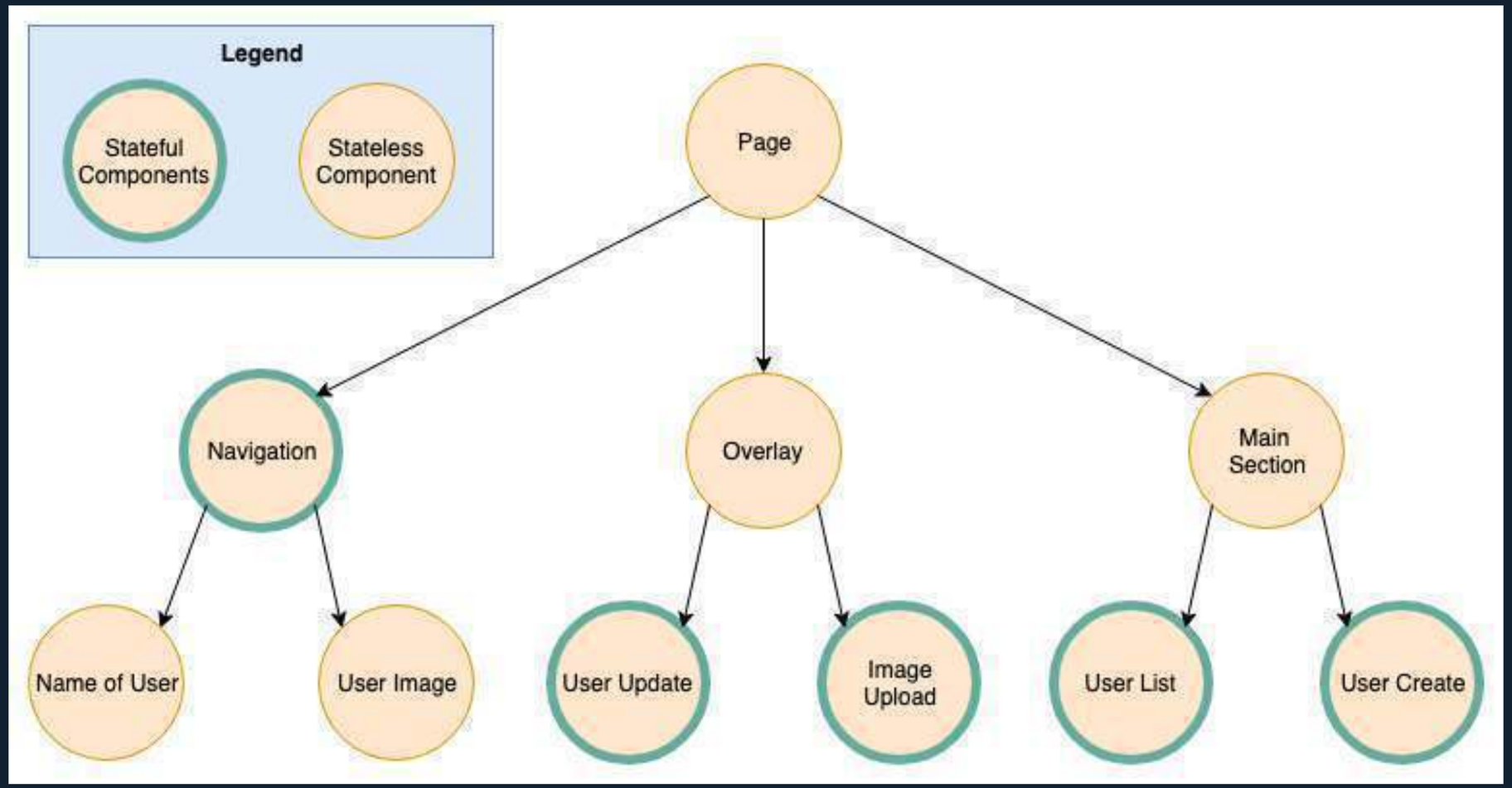
REDUX - STATE
URL STATE

- defines which set of components should be rendered
- persists on page reloads
- What to store in URL state?
  - the current route
  - the current page of a paginated list

REDUX - STATE
REACT COMPONENT TREE



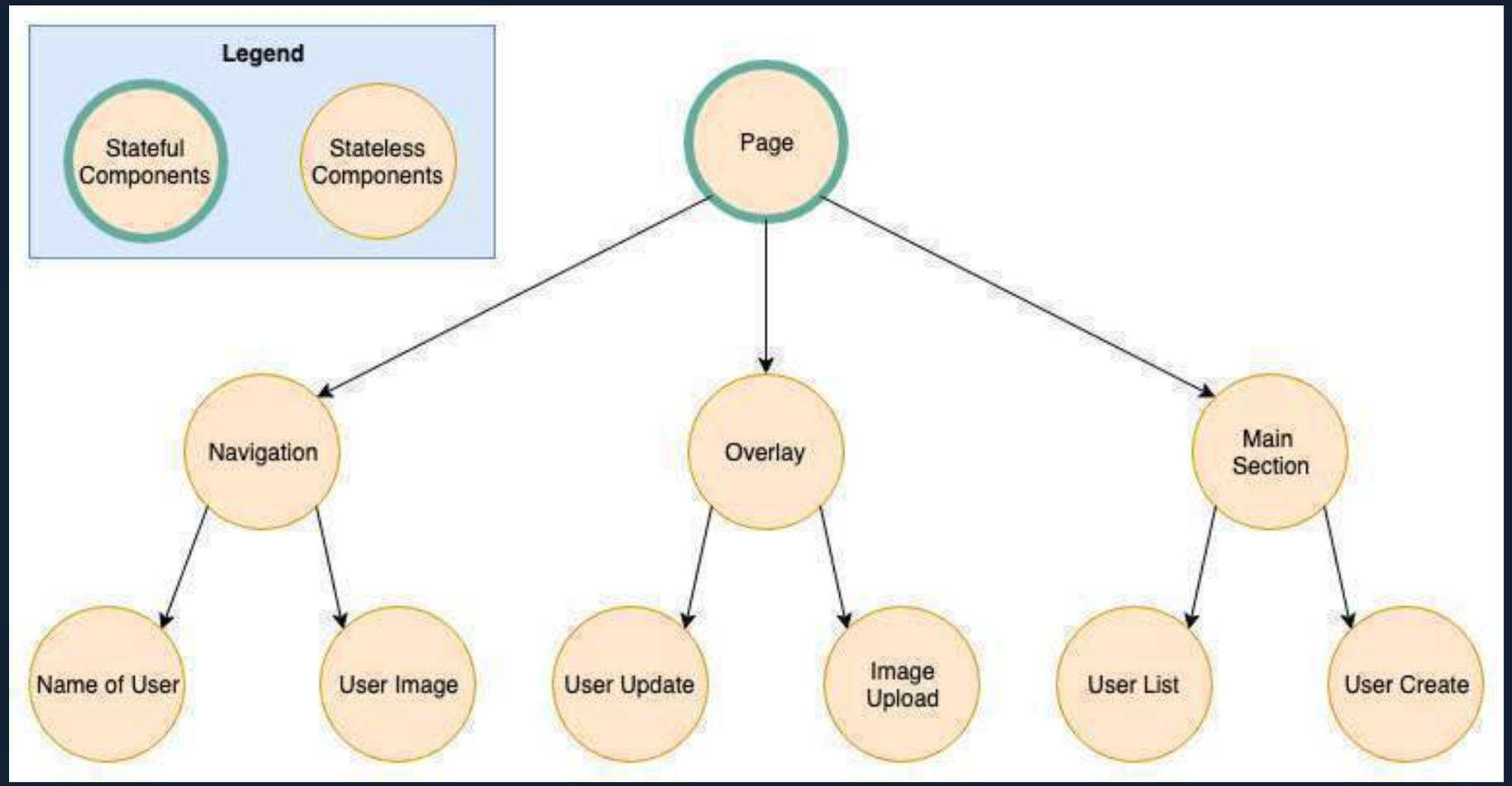
REDUX - STATE
STORING STATE IN COMPONENTS



REDUX - STATE
STORING STATE IN COMPONENTS

- Pros
  - Components are independent
  - eg. "Navigation" doesn't know about "User Update"
- Cons
  - User data needs to be fetched multiple times
  - If UserUpdate component changes name of user

REDUX - STATE
STORING STATE IN THE ROOT COMPONENT



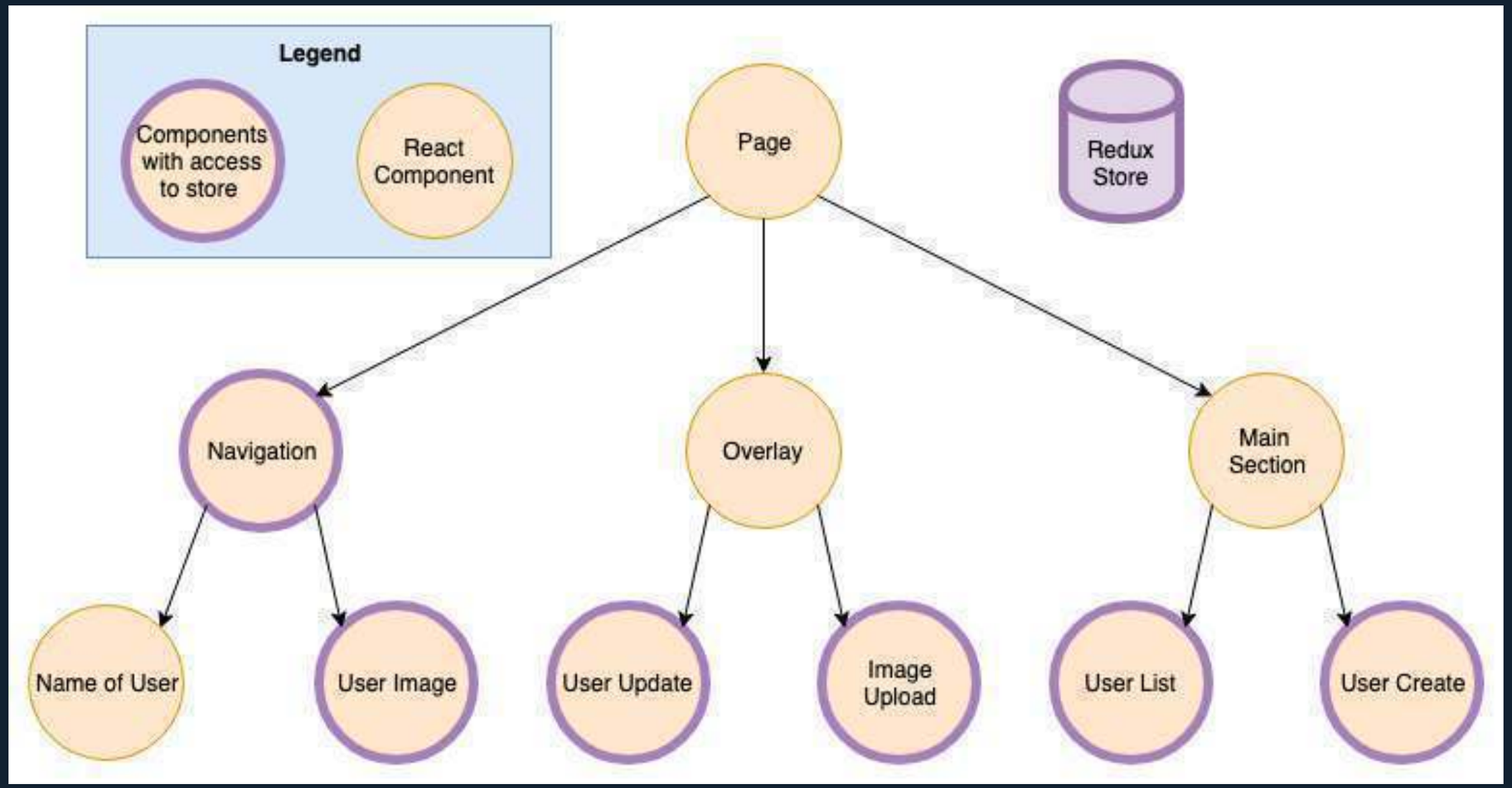
REDUX - STATE
STORING STATE IN THE ROOT COMPONENT

- Pros
  - User data could be fetched only once
  - If UserUpdate component changes name of user
  - navigation component is automatically updated
- Cons
  - State needs to be passed down to every component
  - (Root component contains all state logic)

REDUX - STATE

STORING STATE IN THE ROOT COMPONENT

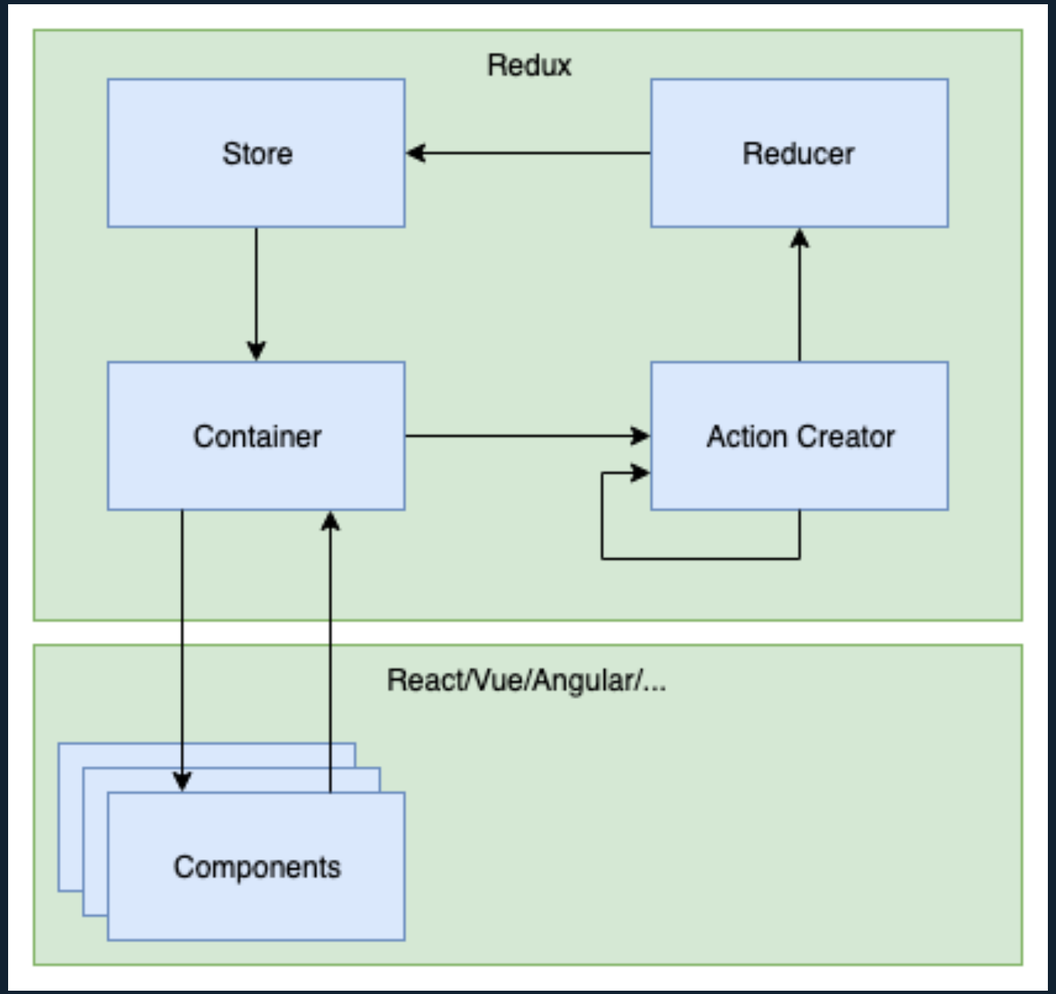
REDUX - STATE
STORING STATE IN REDUX



REDUX - STATE
STORING STATE IN REDUX

- Global state which acts like local state
- Pros:
  - Components are independent
  - eg. Navigation doesn't know about UserUpdate
  - State changes are synchronised with the whole app
  - State doesn't need to be passed down the tree

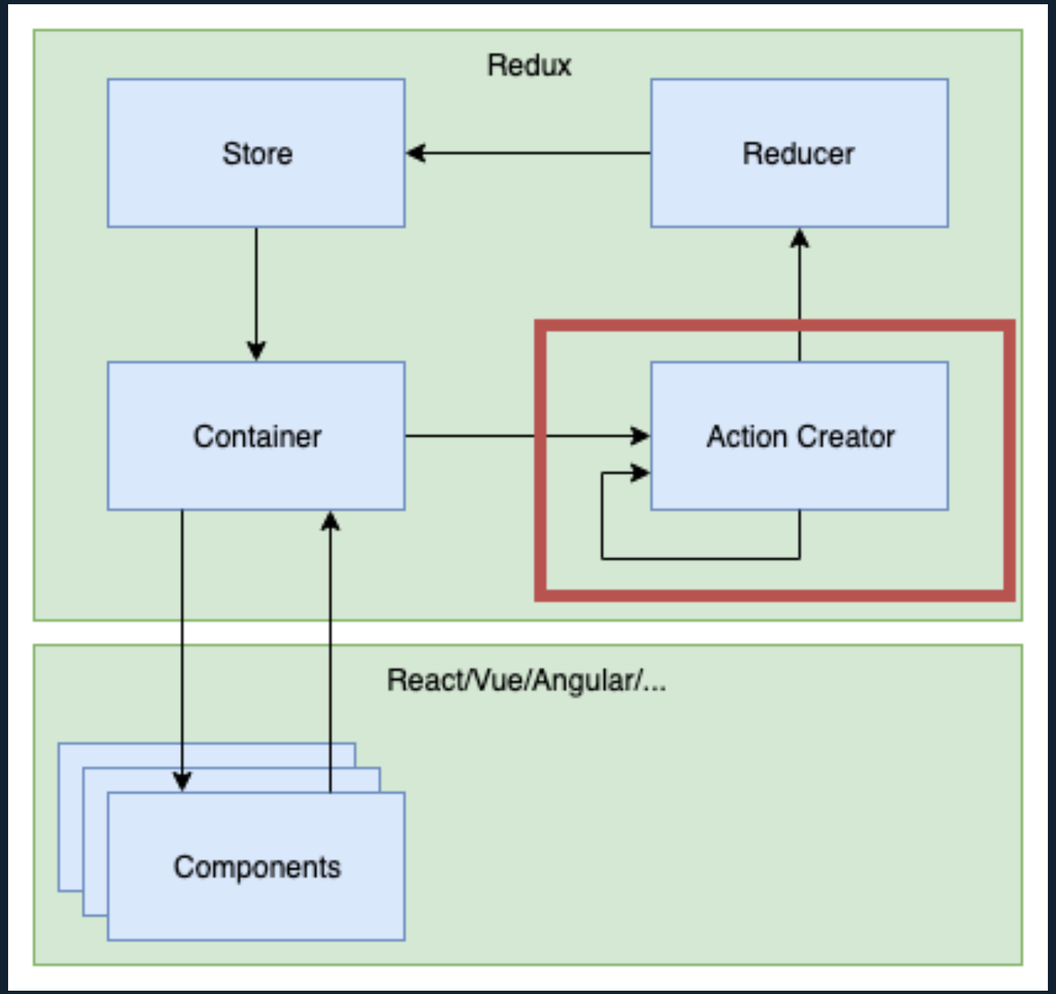
REDUX


Redux
Store
Reducer
Container
Action Creator
React/Vue/Angular/...
Components

WHY REDUX

- Managing state in react can be challenging
  - How to synchronize state between distant UI parts
- Redux provides a predictable way to manage state
- State can only be changed by dispatching an action
- Each action might change the previous state to a new updated state
- Works with react, vue, angular, ...

REDUX - ACTIONS



REDUX - ACTIONS

“Something happened in the app which might be interesting.”

REDUX - ACTIONS

» An action is data from the application which might be relevant for the store

» Information is sent to the store via store.dispatch

```
const signInAction = {
  type: 'signIn',
  payload: {
    username: 'peter',
    password: 'the clam'
  }
}

store.dispatch(signInAction)
```

REDUX - ACTION CREATORS

» A functions which creates actions

» With redux-thunk action creators can dispatch itself

» This is where side effects are handled

```
const actionCreator = () => (dispatch) => {
  dispatch({ type: 'action1', payload: {} })
  dispatch({ type: 'action2', payload: { something: 'random' } })
  dispatch({ type: 'action3', payload: { something: 'random' } })
  // ...
}

store.dispatch(actionCreator())
```

REDUX - ACTION CREATORS
ASYNC ACTION CREATORS

```
const actionCreatorWithData = ({ username, password }) => (dispatch) => {
  dispatch({ type: 'action1', payload: { username, password } })
  dispatch({ type: 'action2/success', payload: { something: 'random' } })
}

store.dispatch(signInAction({ username: 'Mike', password: '1234' }))
```

REDUX - ACTION CREATORS
ASYNC ACTION CREATORS

```
const createMoneyTransaction = ({ creditorId, debitorId, amount }) =>
  async (dispatch) => {
    dispatch({ type: 'createMoneyTransaction/initiated', payload: {} })
    try {
      const moneyTransaction = await fetch('/money-transaction/', {
        creditorId,
        debitorId,
        amount
      })
      dispatch({
        type: 'createMoneyTransaction/success',
        payload: moneyTransaction
      })
    } catch (e) {
      dispatch({ type: 'createMoneyTransaction/error', payload: e })
    };
  }

store.dispatch(createMoneyTransaction({ creditorId: 1, debitorId: 2, amount: 10.3 }))
```

TASK 1 - REDUX SETUP

- Download
  - React dev tools
  - Redux dev tools
- in src/store.js
  - add window.store = store;

TASK 2 - ACTIONS

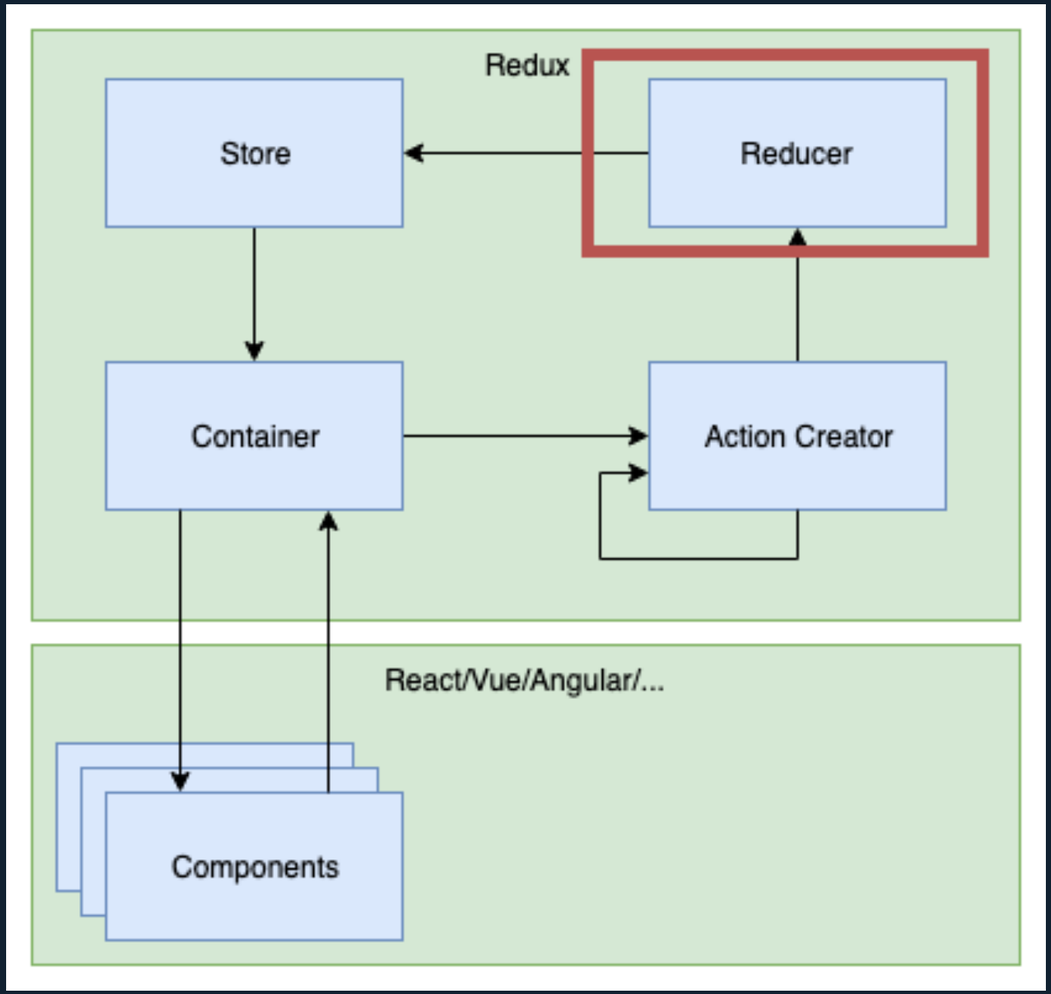
```
» npm run start:app

» go to localhost:3000

» open dev tools/redux tab

» store.dispatch({ type: 'signIn', payload: { name:
  'name', password: 'password' } })
```

TASK 3 - ASYNC ACTION CREATOR

» Create an action creator which calls /user and /money-transaction

» dispatch result of http call

REDUCERS


Redux
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Components

REDUCERS

“Reducers specify how the application's state changes in response to actions sent to the store. (Source)”

REDUCERS

» Specify how state changes in response to actions.

» Pure function

  » input appState and action

  » output next application state

```
const initialState = {}
const reducer = (previousState = initialState, action) => {
  // do something with the state
  return nextState
}
```

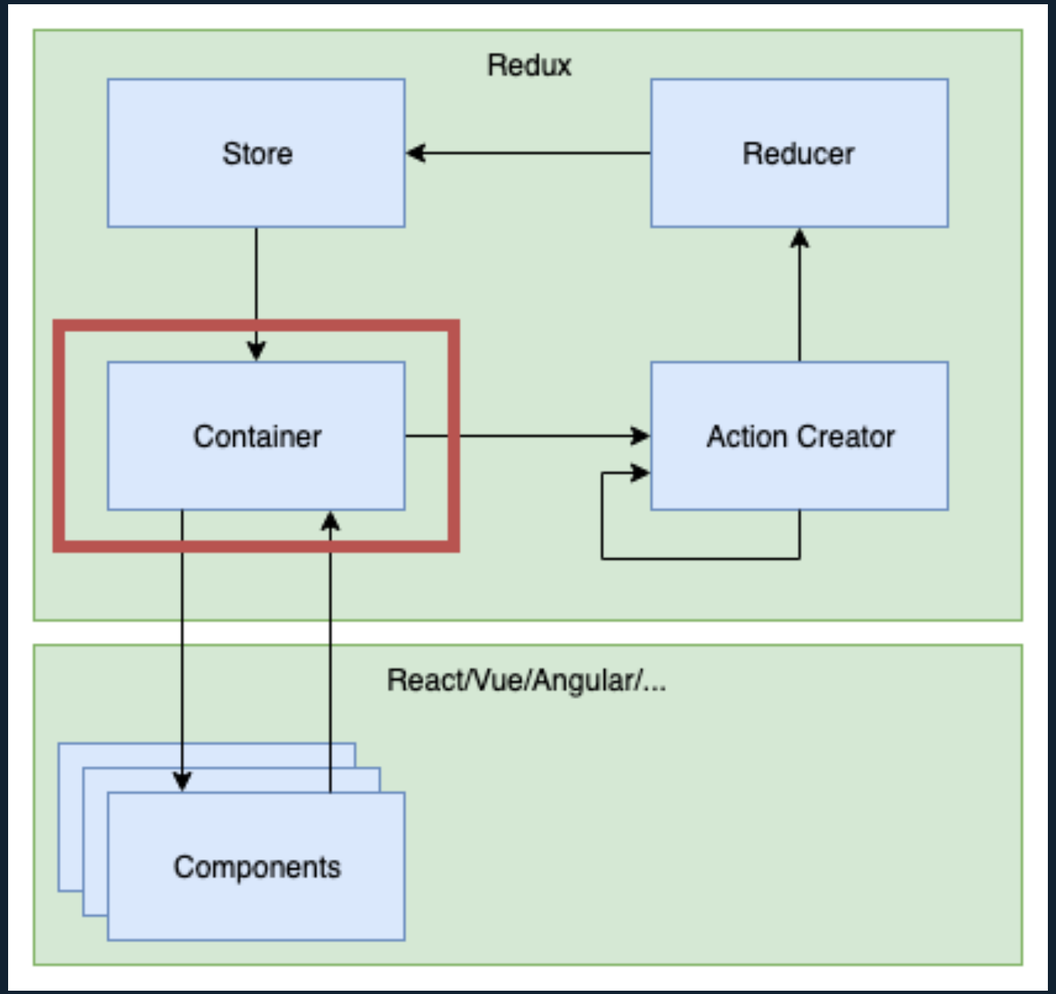
REDUCERS

```
const initialState = []
const moneyTransactionReducer = (previousState = initialState, action) => {
  switch (action.type) {
    case 'createMoneyTransaction/success':
      return [...previousState, action.payload]
    case 'reset':
      return initialState
    default:
      return previousState
  };
}
```

TASK 1 (REDUCER)

- Add a userReducer reducer
  - entry point: src/reducer/index.js
  - listen to 'fetchUser/success'
  - try to populate the redux store with a new user

CONTAINER COMPONENTS



CONTAINER COMPONENTS

» Glue between react and redux

» Provides data from the global store to the components

» Provides "callbacks" to trigger actions

CONTAINER COMPONENTS

```
import { createMoneyTransaction } from '../action-creators/money-transactions'
const mapStateToProps = (state, props) => {
  return {
    moneyTransactions: state.moneyTransactions
  }
}

const mapDispatchToProps = (dispatch, props) => {
  return {
    createMoneyTransaction: (payload) =>
      dispatch(createMoneyTransaction(payload))
  }
}

export default connect(
  mapStateToProps,
  mapDispatchToProps
)(MoneyTransactionList)
```

MAPSTATETOPROPS

- extract data from the store and provides it to a component
- data filtering can be done here
- function mapStateToProps(state, ownProps?)
  - state -> the entire application state
  - ownProps -> properties which are passed from other components
- Docs

MAPDISPATCHTOPROPS

- binds actions with the store and provides those actions to a component
- function mapStateToProps(dispatch, ownProps?)
  - dispatch -> the stores dispatch function
  - ownProps -> properties which are passed from other components
- Docs

TASK 1 (CONTAINER)

» Try to connect your moneyTransactionCreate dropdown with users from the store

TASK 2 (CONNECT TO BACKEND)

» Try to connect fetchUsers action creator

FURTHER LINKS

» Redux Tutorial

» Mostly adequate guide to FP

» Hands-On Functional Programming with TypeScript

» Immutable Data Structures

FEEDBACK

» Questions: tmayrhofer.lba@fh-salzburg.ac.at

» https://de.surveymonkey.com/r/8TW92LL