

ReactJS.

The Component model

Topics

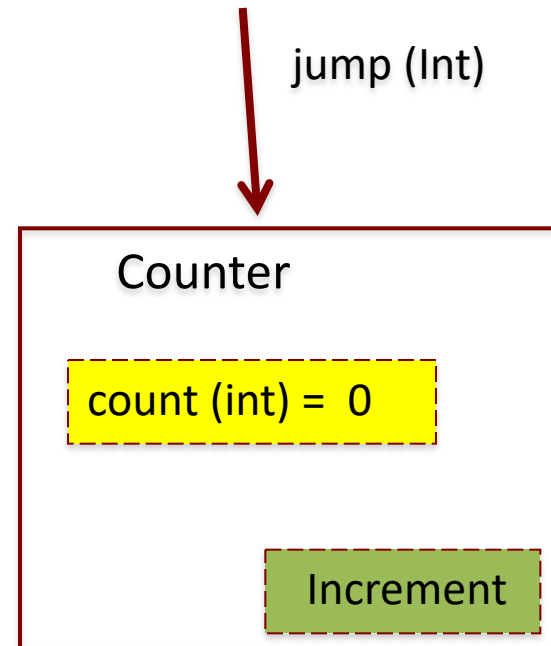
- **Component State.**
 - **Basis for dynamic, interactive UI.**
- **Data Flow patterns.**
- **Hooks.**
- **The Virtual DOM**

Component DATA

- **A component has two sources of data:**
 1. **Props - Passed in to a component; Immutable; the props object.**
 2. **State - Internal to the component; Causes the component to re-render when changed / mutated.**
 - **Both can be any data type - primitive, object, array.**
- **Props-related features:**
 - **Default values.**
 - **Type-checking.**
- **State-related features:**
 - **Initialization.**
 - **Mutation – using a setter method.**
 - **Automatically causes component to re-render. *****
 - **Performs an overwrite operation, not a merge.**

Stateful Component Example

- **The Counter component.**
- **Ref. basicReactLab samples – sample 06.**
- **The useState() function:**
 - **Declares a state variable.**
 - **Returns a Setter / Mutator method.**
 - **Termed a React hook.**
- **Aside: Static function property,**
e.g. defaultProps, proptypes



React's event system.

- **Cross-browser support.**
- **Event handlers receive a SyntheticEvent – a cross-browser wrapper for the browser's native event.**
- **React event naming convention slightly different to native:**

React	Native
onClick	onclick
onChange	onchange
onSubmit	onsubmit

- See <https://reactjs.org/docs/events.html> for full details,

Automatic Re-rendering.

- **EX.: The Counter component.**

User clicks button

→ *onClick event handler executes (incrementCounter)*

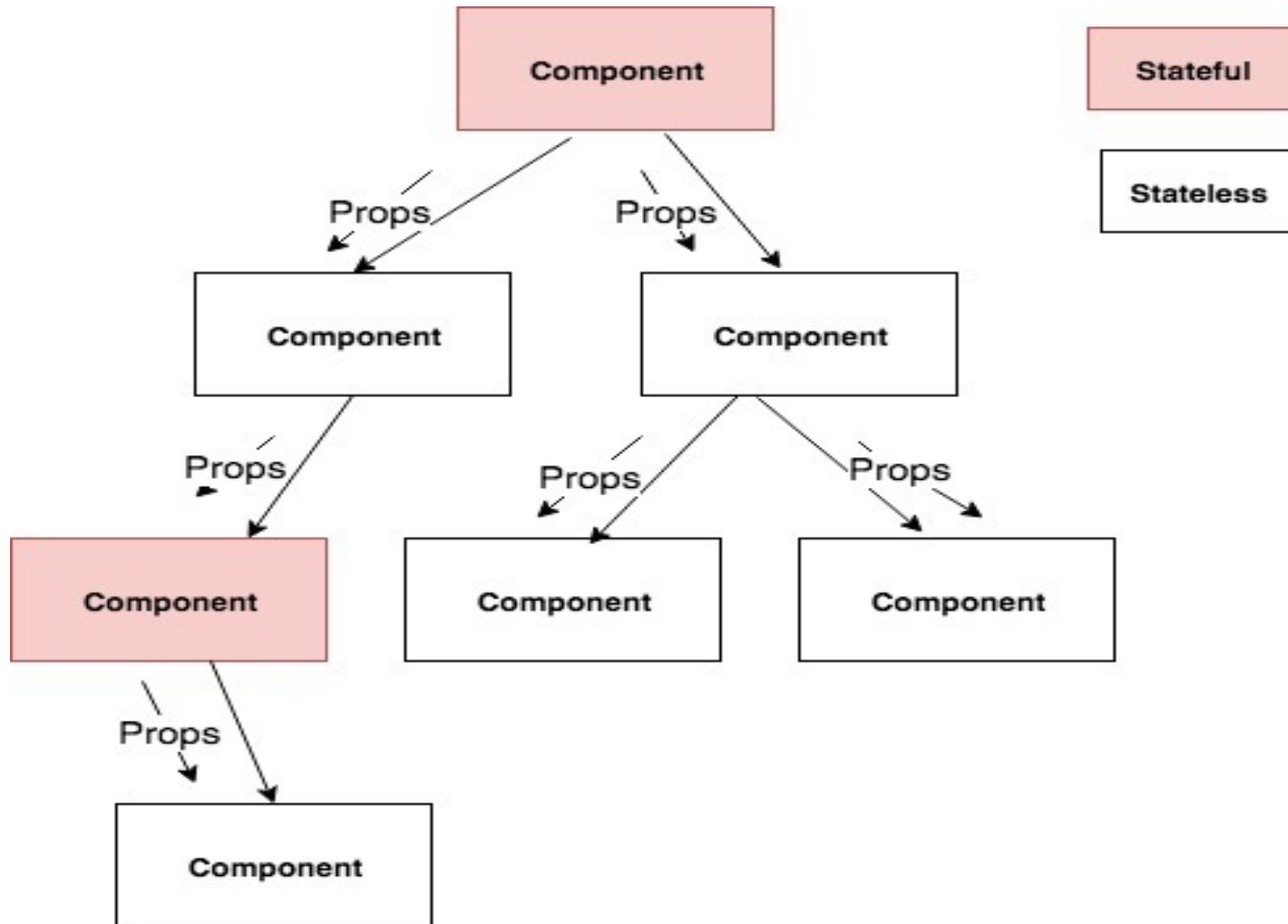
→ *handler changes component's state (setCount())*

→ *component function re- executed (**re-rendering**)* 

Topics

- **Component State.** ✓
- **Data Flow patterns.**
- **Hooks.**
- **The Virtual DOM**

Unidirectional data flow



Unidirectional data flow

- **In React, data flow is unidirectional ONLY.**
 - **Other SPA frameworks use two-way data binding.**
- **Typical React app pattern: A small subset of the components are stateful; the majority are stateless.**
- **Stateful component execution flow:**
 1. **User interaction causes a component state change.**
 2. **Component re-renders (re-executes).**
 3. **Component recomputes the props for its subordinate components.**
 4. **Subordinate components re-render, and recomputes props for its subordinates.**
 5. **etc.**

Topics

- **Component State.** ✓
- **Data Flow patterns.** ✓ *(more later)*
- **Hooks**
- **The Virtual DOM**

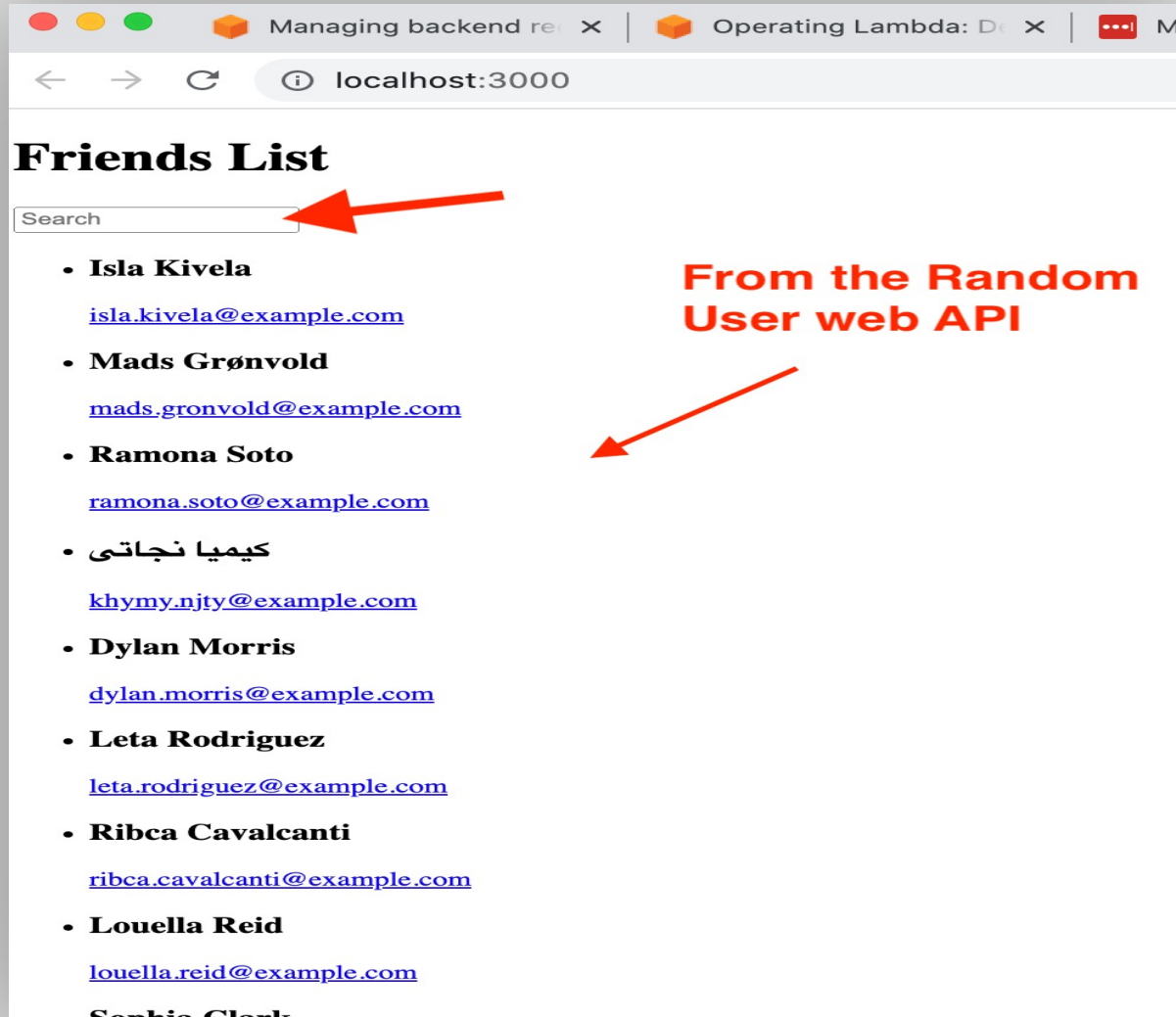
React Hooks

- Introduced in version 16.8.0 (February 2019)
- React Hooks are:
 1. Functions (some are HOFs).
 2. That performs component *state manipulation and lifecycle management*.
- Examples: `useState`, `useEffect`, `useContext`, `useRef`, etc
 - ‘use’ prefix is necessary for linting tools.
- Usage Rule:
 - Can only call hooks at the ‘top level’ in a component.
 - i.e. Don’t call hooks inside loops or condition statements.

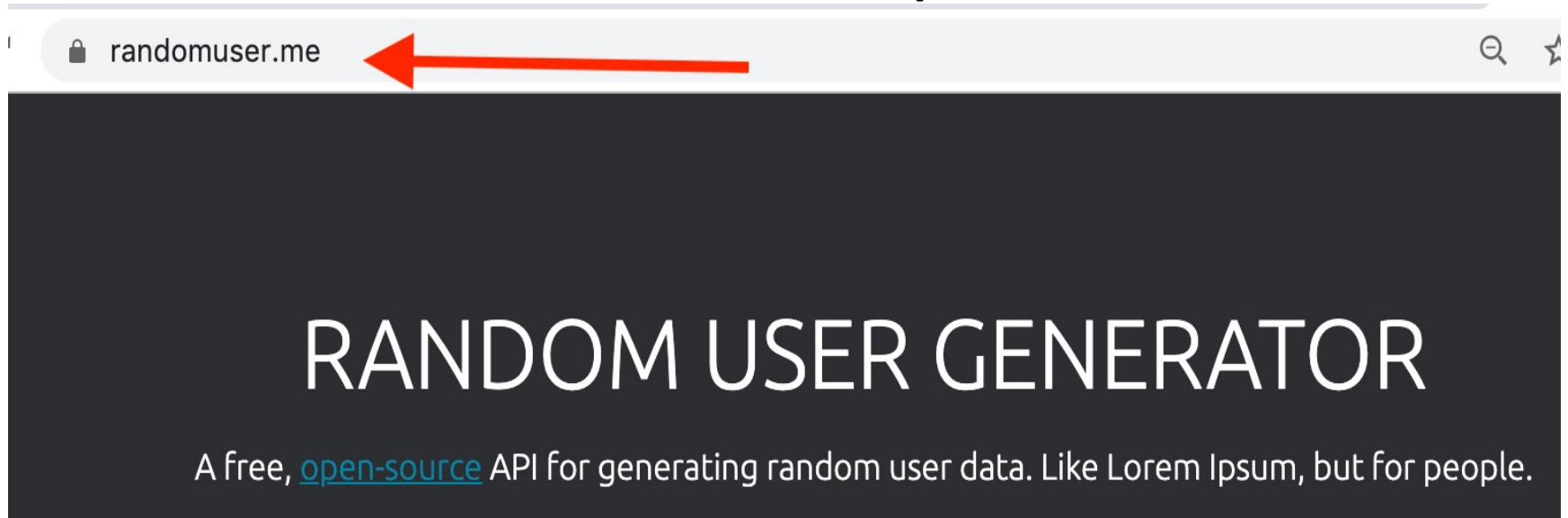
useEffect Hook

- **Used when a component needs to perform side effects.**
- **Side Effect example:**
 - **fetching data from a web API.**
 - **Subscribe to a browser events, e.g. window resize.**
- **Signature:** `useEffect(callback, dependency array)`
 - **The *callback* contains the side effect code.**
 - **Dependencies **determine when a hook is executed.****
- **useEffect is executed:**
 - 1. On component mounting.**
 - 2. On every rendering that coincides with a dependency entry update.**
 - **An empty dependency array restricts execution to mount-time only.**

Sample App



RandomUser open API

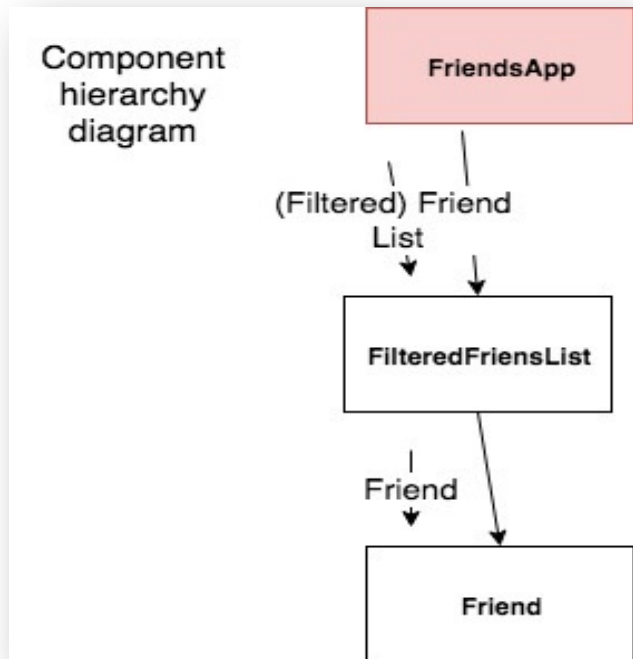


- Returns an auto-generated list of user profiles (friends).
- e.g. Get 10 user profiles:

GET <https://randomuser.me/api/?results=10>

Sample App 1

(see lecture archive)



Friends List

- **Joe Bloggs**
jbloggs@here.com
- **Paula Smith**
psmith@here.com
- **Catherine Dwyer**
cdwyer@here.com
- **Paul Briggs**
pbriggs@here.com

FriendsApp component:

1. **Manages** state (i.e. text box, full list of friends).
2. **Fetches** data from a web API – side effect.
3. **Computes** matching friends.
4. **Controls** list rendering.

Sample App - *useEffect* Hook

- **useEffect runs AT THE END of a component's mount process.**
i.e. First rendering occurs **BEFORE** the API data is available.
 - We must accommodate this in the implementation.

The screenshot shows a web application on the left and its React DevTools component inspector on the right. The web application, titled "Friends List", features a search input field containing the letter "w". Below the input, there is a list of two items: "Iida Wuori" with the email iida.wuori@example.com, and "Luke Brown" with the email luke.brown@example.com. The component inspector on the right displays the component tree for the "FriendsApp". The initial state shows "Render FriendsApp", "fetch effect", and "Render FriendsApp". A red box highlights the first "Render FriendsApp" and the "fetch effect" line, with a red label "Initial mounting" pointing to it. Below this, another "Render FriendsApp" is shown, with a red label "After typing 1 character" pointing to it. The top of the inspector shows a log message: "[HMR] Waiting for update signal from WDS...".

Friends List

w

- Iida Wuori
iida.wuori@example.com
- Luke Brown
luke.brown@example.com

[HMR] Waiting for update signal from WDS...

Render FriendsApp
fetch effect
Render FriendsApp
Render FriendsApp

Initial mounting

After typing 1 character

Sample App - *useEffect* Hook

- **You must allow for asynchronous nature of API calls:**
 1. **UI must remain interactive while waiting for API data.**
 2. **Components should render without errors before API data is available.**

- **Correct approach:**

```
const [friends, setFriends] = useState( [ ] ); // Store API data
```

- **Incorrect approach:**

```
const [friends, setFriends] = useState(null);
```

- **Resulting error**

TypeError: Cannot read property 'filter' of null

Unidirectional data flow & Re-rendering

(Assume we request 6 friends from web API)

The screenshot shows a web application titled "Friends List" with a search input field containing the text "se". Below the input field, there is a list of two friends:

- **Malou Jensen**
malou.jensen@example.com
- **Tobias Larsen**
tobias.larsen@example.com

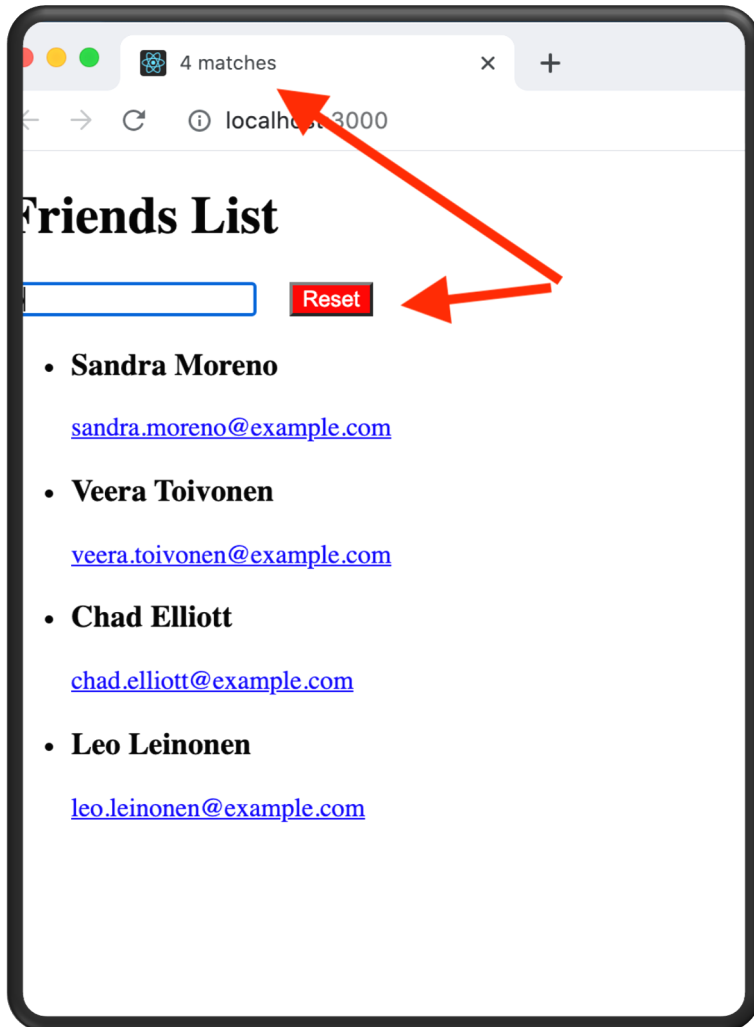
To the right of the application, the DevTools component inspector is open, showing a tree of components. The components are grouped into three sections, each highlighted with a red box:

- Section 1 (Top):** Render FriendsApp, Render of FilteredFriendList, fetch effect, Render FriendsApp, Render of FilteredFriendList, Render of Friend (Malou Jensen), Render of Friend (Grace Alvarez), Render of Friend (Melissa Pearson), Render of Friend (نیما کریمی), Render of Friend (Tobias Larsen), Render of Friend (Gildo Mendes).
- Section 2 (Middle):** Render FriendsApp, Render of FilteredFriendList, Render of Friend (Malou Jensen), Render of Friend (Melissa Pearson), Render of Friend (Tobias Larsen), Render of Friend (Gildo Mendes).
- Section 3 (Bottom):** Render FriendsApp, Render of FilteredFriendList, Render of Friend (Malou Jensen), Render of Friend (Tobias Larsen).

Red text annotations on the right side of the DevTools window indicate the state of the search input:

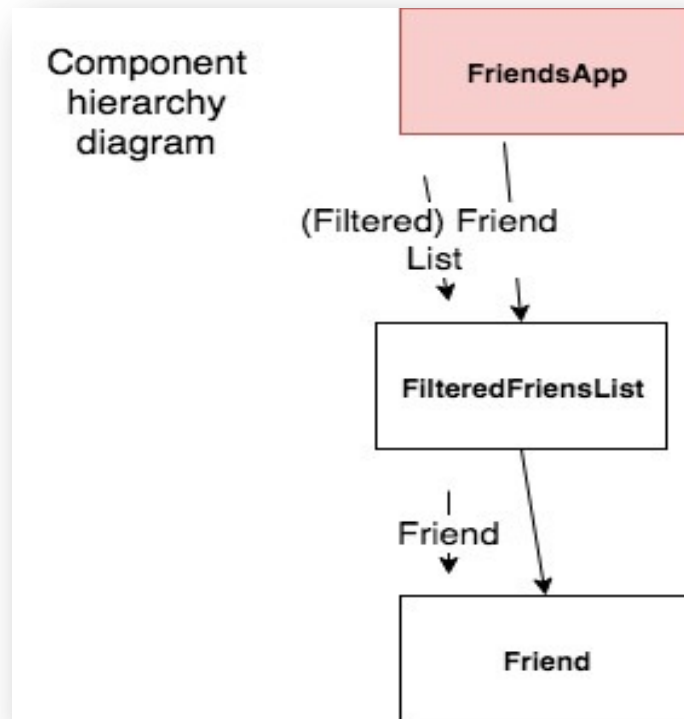
- Typed s in text box** (next to the middle section)
- Typed e in text box** (next to the bottom section)

Sample App 1 – Version 2



- **App UI changes:**
 1. A 'Reset' button – loads a new list of friends (overwriting the current list).
 2. Browser tab title - shows # of matching friends (side effect).
- **Ref. lecture archive for source code**

Sample App 1 (v2) - Design



- **3 state variables:**
 1. **List of friends from API.**
 2. **Text box content.**
 3. *Reset button toggle.*
- **2 side effects, both with dependency arrays:**
 1. **'Fetch API data' - reset button toggle dependency.**
 2. **'Set browser tab title' - matching list length dependency.**

Sample App 1 (v2) - Events

The image shows a web application on the left and its Redux DevTools log on the right. The web application, titled "Friends List", features a "Reset" button and a list of four friends: Dennis Allen, Valerie Welch, Tobias Thomsen, and Gissele Oliveira. Each friend's name is followed by a blue hyperlink to their email address. The Redux DevTools log on the right shows the sequence of actions and state changes. The log is divided into three sections by red boxes and labels: "Initial mounting", "After typing 1 character", and "After clicking reset button".

Friends List

Reset

- **Dennis Allen**
dennis.allen@example.com
- **Valerie Welch**
valerie.welch@example.com
- **Tobias Thomsen**
tobias.thomsen@example.com
- **Gissele Oliveira**

[HMR] Waiting for update signal from WDS...

Initial mounting

- Render FriendsApp
- fetch effect
- set title effect
- Render FriendsApp
- set title effect

After typing 1 character

- Render FriendsApp
- set title effect

After clicking reset button

- Render FriendsApp
- fetch effect
- Render FriendsApp
- set title effect

Sample App 1 (v2) - Events.

- **On mounting of FriensApp component:**
Both effects execute (Set browser tab to '0 matches').
 - **'Fetch data' effect initializes 'friends list' state.**
 - **Component re-renders → 'Set browser tab' effect executes.**
- **On typing a character in the text box:**
'Text box' state changes.
 - **FriendsApp rerenders + recomputes matching friends list**
 - **'Set browser title' effect executes.**
- **On clicking Reset button:**
'Reset toggle' state changes.
 - **FriendsApp re-renders.**
 - **'Fetch data' effect executes.**
 - **'Friends list' state changes.**
 - **FriendsApp re-renders + recomputes matching list**
 - **'Set browser title' effect executes.**

Topics

- **Component State.**



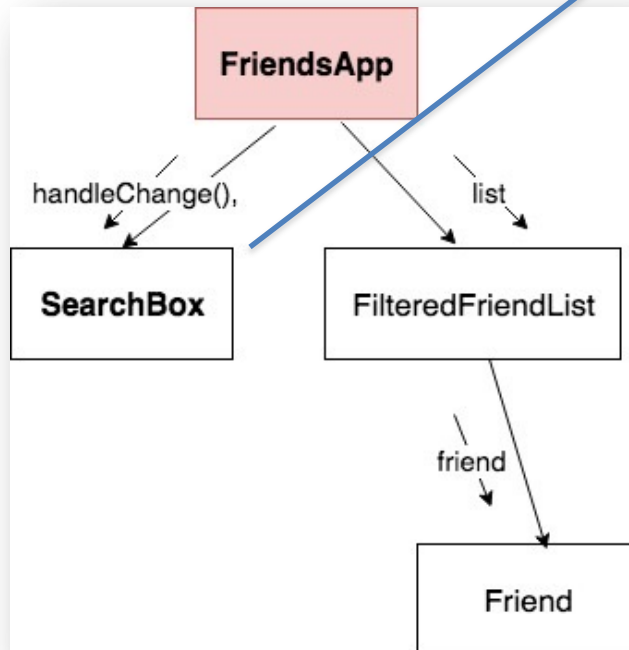
- **Data Flow patterns.**

- **Hooks.**

Sample App 2

(Data down, actions up pattern or Inverse data flow pattern)

- **Often a component's state change is caused by an event in a subordinate component.**
- **Solution: Use the data down, action up pattern.**



Friends List

Search

- **Joe Bloggs**
jbloggs@here.com
- **Paula Smith**
psmith@here.com
- **Catherine Dwyer**
cdwyer@here.com
- **Paul Briggs**
pbriggs@here.com

Data down, Action up.

Pattern:

1. Stateful component provides a callback to the subordinate.
2. Subordinate invokes callback when the event occurs.

```
const FriendsApp = () => {  
  const [searchText, setSearchText] = useState("");  
  const [friends, setFriends] = useState([]);  
  
  useEffect(() => { ...  
  }, []);  
  
  const filterChange = text =>  
    setSearchText(text.toLowerCase());  
  
  const updatedList = friends.filter(friend => { ...  
  });  
  return (  
    <>  
      <h1>Friends List</h1>  
      <SearchBox handleChange={filterChange} />  
      <FilteredFriendList list={updatedList} />  
    </>  
  );  
}
```

```
const SearchBox = props => {  
  const onChange = event => {  
    event.preventDefault();  
    const newText = event.target.value.toLowerCase();  
    props.handleChange(newText);  
  };  
  
  return <input type="text" placeholder="Search"  
    onChange={onChange} />;  
};
```

Topics

- **Component State.** ✓
- **Data Flow patterns.**
- **Hooks.**
- **The Virtual DOM**

Modifying the DOM

- **DOM** – an internal data structure representing the browser's current 'display area' ; **DOM** always in sync with the display.
- **Traditional performance best practice:**
 1. Minimize direct accessing of the **DOM**.
 2. Avoid 'expensive' **DOM** operations.
 3. Update elements offline, then replace in the **DOM**.
 4. Avoid changing layouts in Javascript.
 5. . . . etc.
- Should the developer be responsible for low-level **DOM** optimization? Probably not.
 - React provides a *Virtual DOM* to shield developers from these concerns.

The Virtual DOM

- **How React works:**
 1. At app startup it create a lightweight, efficient form of the DOM, termed the *Virtual DOM*.
 2. The app changes the V. DOM whenever a component re-renders.
 3. When the re-rendering cycle is complete, the React engine:
 1. Performs a *diff* operation between the current and previous V. DOM instance.
 2. Computes the *set of changes* to apply to real DOM.
 3. Batch update the real DOM.
- **Benefits:**
 - a) Cleaner, more descriptive programming model.
 - b) Optimized DOM updates and reflows.

Automatic Re-rendering (detail)

- **EX.: The Counter component.**

User clicks button

→ onClick event handler executed

→ component state is changed

→ component re-executed (re-renders)

→ The Virtual DOM has changed

→ React diffs the changes between the current and previous Virtual DOM

→ React batch updates the Real DOM

Re-rendering & the real DOM

- **What happens when the user types in the text box?**

User types a character in text box

→ onChange event handler executes

→ Handler changes a state variable

→ React re-renders FriendsApp component

→ React re-renders children (FilteredFriendList) with new prop values.

***→ React re-renders children of FilteredFriendList.
(Re-rendering completed)***

→ (Pre-commit phase) React computes the updates required to the browser's DOM

→ (Commit phase) React batch updates the DOM.

→ Browser repaints screen

Summary

- **A state variable change always causes a component to re-render.**
 - **State change logic is usually part of an event handler function.**
 - **Event handler may be in a subordinate component.**
- **Side effects:**
 - **Always execute at mount time.**
 - **The dependency array will either reference a state variable, a value computed from a state variable, or a prop.**
 - **Can be multiple entries**
 - **Callback performs the side-effect, and may also cause a state change.**
- **Data flows downward, actions flow upward.**