Day 01 — React Fundamentals: What's Under the Hood

JSX → Elements ● Virtual DOM ● Reconciliation (Fiber) ● Render & Commit ● Lifecycle & Hooks ● When to choose React ● Ecosystem

> Goal: Build a solid mental model of **how React updates the UI efficiently** and when to use it.

Agenda

1. What is React & why it exists
2. JSX & React Elements
3. Element Tree (blueprint)
4. Virtual DOM & Flow
5. Reconciliation (Fiber) & Keys
6. Render & Commit phases (Two-Phase Cycle)
7. Lifecycle & Hooks essentials
8. When to choose React
9. Ecosystem tour
10. Mini–hands-on exercises & quiz

Learning Outcomes

By the end of Day 01, you will:

- Explain how JSX becomes **React elements** and ultimately **DOM**.
- Describe **Virtual DOM**, **diffing**, and why React updates are efficient.
- Understand **Fiber** and the difference between **render** and **commit** phases.
- Use basic **hooks** (`useState` , `useEffect`) and reason about lifecycle.
- Identify scenarios where **React** is (and isn’t) the right choice.

Why React Exists

- Direct DOM manipulation is **imperative** → error-prone and hard to scale.
- DOM updates are **expensive** (reflows, repaints).
- Performance issues appear as UIs grow complex.
- **Declarative approach**: Describe **what** UI should look like; React figures out **how** to update it.
- Predictable updates via **state → re-render → diff → commit**.

Imperative vs Declarative

Imperative (vanilla DOM)

```
const el = document.createElement("button");
el.textContent = "Clicked 0 times";
let count = 0;
el.addEventListener("click", () => {
  count++;
  el.textContent = `Clicked ${count} times`;
});
document.body.appendChild(el);
```

Declarative (React)

```
function Button() {
  const [count, setCount] = React.useState(0);
  return (
    <button onClick={() => setCount((c) => c + 1)}>
      Clicked {count} times
    </button>
  );
}
```

> In React, we re-describe the **UI for a given state**; React updates the DOM efficiently.

JSX & React Elements

- **JSX** = JavaScript XML, syntax sugar for describing UI.
- Transpiled by Babel/TypeScript to `React.createElement` calls.

JSX

```jsx
const el = <h1 className="title">Hello, React!</h1>;
```

Transpiled (conceptually)

```jsx
const el = React.createElement("h1", { className: "title" }, "Hello, React!");
```

React Element (plain object)

```
{
  type: 'h1',
  props: { className: 'title', children: 'Hello, React!' }
}
```

> Elements are **lightweight descriptions** of what to render, not real DOM nodes.

Element Tree (React 18+)

```
import { createRoot } from "react-dom/client";
import App from "./App";

const container = document.getElementById("root");
const root = createRoot(container);
root.render(<App />);
```

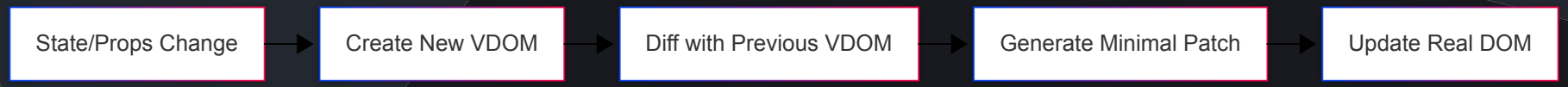
- React builds a **tree of elements** from your components.
- The tree is compared to the previous one → **diff** → minimal DOM updates.

Virtual DOM

- A **lightweight JS representation** of the real DOM.
- React updates **Virtual DOM** first, then determines the **minimal set of real DOM changes**.
- **Key benefit:** Only update what changed.

Why it’s fast

- JS operations are cheaper than touching DOM.
- React batches updates to avoid layout thrashing.



Reconciliation & Fiber (High-level)

- **Reconciliation** = comparing the new element tree with the previous one (**diffing**).
- **Fiber** = React’s internal architecture for splitting work into **units** that can be paused and resumed.
- Enables **responsive UIs** by prioritizing urgent updates and batching non-urgent ones.

Key heuristics

- Different `type` → **replace** node.
- Same `type` → **update** props and children.
- **Keys** help React match children across renders.

Example:

```
<!-- Old -->
<ul>
  <li>Apple</li>
  <li>Banana</li>
</ul>

<!-- New -->
<ul>
  <li>Apple</li>
  <li>Mango</li>
</ul>
```

React updates only the changed `<li>`.

Keys Matter

Bad (index as key)

```
{
  items.map((item, i) => <Row key={i} value={item} />);
}
```

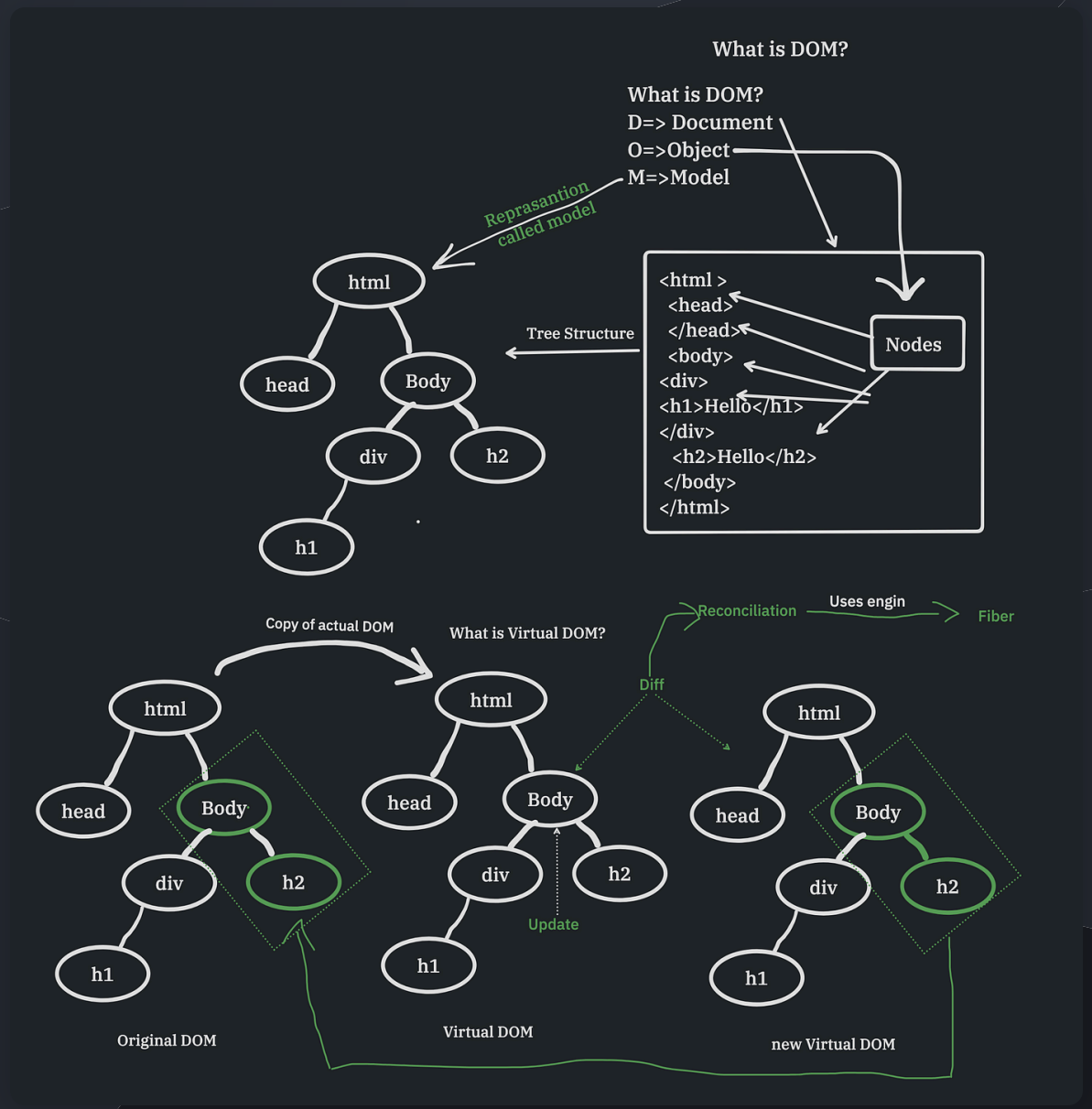
Good (stable unique key)

```
{
  items.map((item) => <Row key={item.id} value={item} />);
}
```

> Using indices as keys can cause incorrect state association and extra re-renders when items are inserted/removed/reordered.

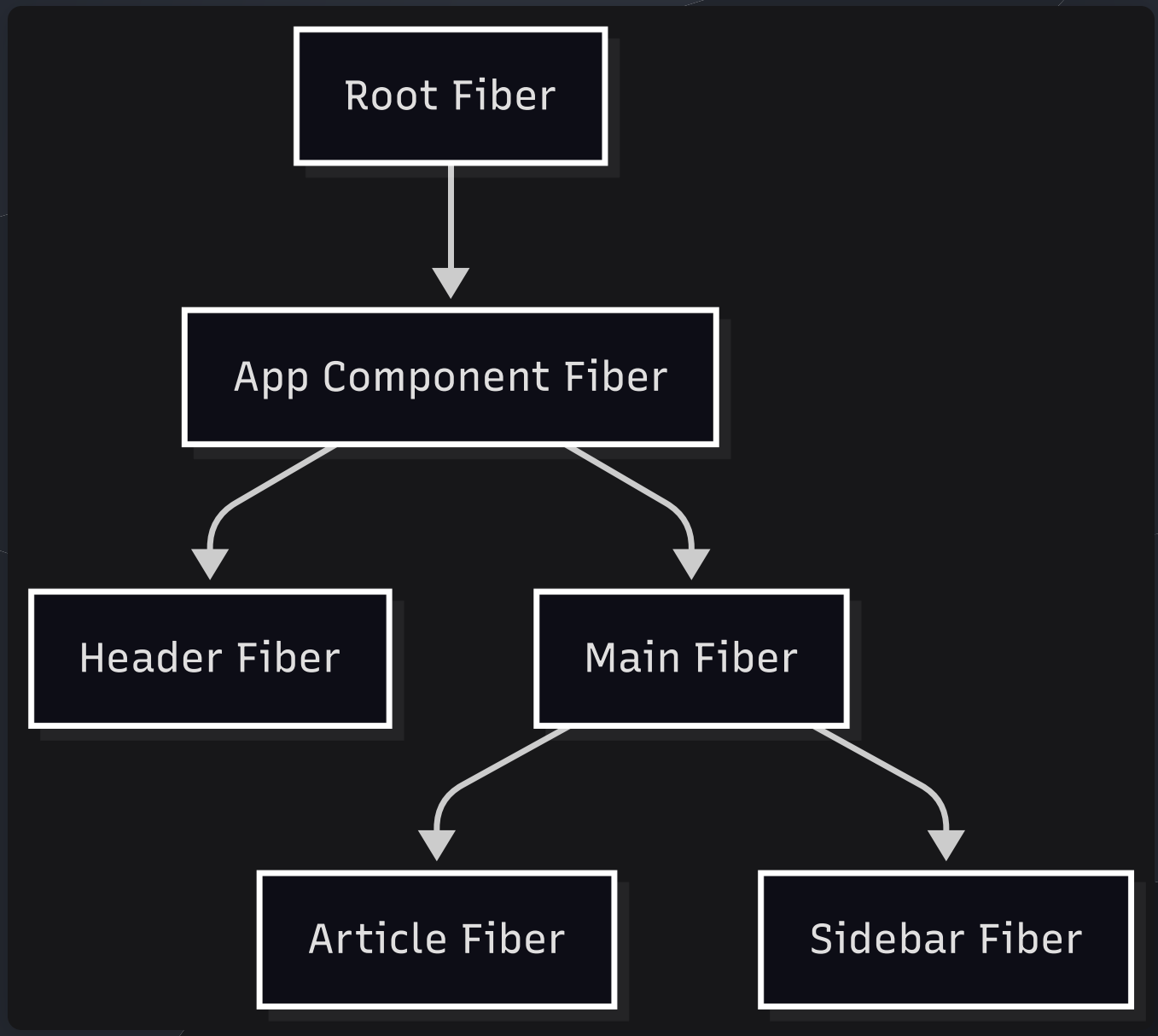
Fiber Architecture

- Fiber = React’s internal architecture (React 16+).
- Breaks rendering into **units of work (Fibers)**.
- Benefits:
  - Interruptible & async rendering
  - Prioritization of updates
  - Pausing & resuming work


What is DOM?
What is DOM?
D=> Document
O=>Object
M=>Model
Reprasantion
called model
html
head
Body
div
h2
h1
Tree Structure
<html >
<head>
</head>
<body>

<h1>Hello</h1>

<h2>Hello</h2>
</body>
</html>
Nodes
Copy of actual DOM
What is Virtual DOM?
Reconciliation
Uses engin
Fiber
Diff
Update
Original DOM
Virtual DOM
new Virtual DOM


Root Fiber
App Component Fiber
Header Fiber
Main Fiber
Article Fiber
Sidebar Fiber

Render vs Commit (Two-Phase Cycle)

1. **Render / Reconciliation Phase**
   - Build work-in-progress Fiber tree
   - Diffing happens here
   - Async & interruptible (Can be paused)
2. **Commit Phase**
   - Apply changes to real DOM synchronously
   - Run lifecycle methods & effects (`useEffect` , `componentDidMount`)

Automatic batching (React 18+)

```
setCount((c) => c + 1);
setText("hello");
// One re-render, one commit (batched)
```

Component Lifecycle & Hooks

Lifecycle moments

- **Mount** → component added to the DOM
- **Update** → state/props change triggers render
- **Unmount** → component removed

Hooks

- `useState` — local state
- `useEffect` — side effects (fetch, timers, cleanup)

```
function Clock() {
  const [now, setNow] = React.useState(() => new Date());
  React.useEffect(() => {
    const id = setInterval(() => setNow(new Date()), 1000);
    return () => clearInterval(id);
  }, []);
  return <time>{now.toLocaleTimeString()}</time>;
}
```

When to Choose React

Great fit

- Interactive UIs, complex state flows, dashboards, SPAs/MPAs.
- Teams valuing component reuse, strong ecosystem, TS support.

Maybe not

- Mostly static sites with minimal interactivity.
- Extremely simple pages where vanilla HTML/CSS/JS suffices.

Ecosystem Overview

- **Rendering targets**: `react-dom`, React Native
- **State**: Context, Redux, Zustand, Jotai
- **Styling**: CSS Modules, Tailwind CSS, styled-components
- **Tooling**: Babel, Webpack, Vite, SWC
- **Frameworks**: Next.js App Router
- **DevTools**: React DevTools, ESLint, Prettier

Hands-on #1 — Counter (JSX + State)

```
function Counter() {
  const [count, setCount] = React.useState(0);
  return (
    <div>
      <h2>Count: {count}</h2>
      <button onClick={() => setCount((c) => c + 1)}>+1</button>
      <button onClick={() => setCount(0)}>Reset</button>
    </div>
  );
}
```

Hands-on #2 — List & Keys

```
function PlayersList({ players }) {
  return (
    <ul>
      {players.map((p) => (
        <li key={p.id}>{p.name}</li>
      ))}
    </ul>
  );
}
```

Common Pitfalls

- **Directly mutating state** instead of using setter
- Using **array index as key**
- Placing **side effects in render body** (should be in `useEffect`)
- Assuming **state updates are synchronous**
- Forgetting to **clean up effects**

Quick Quiz

1. What does JSX compile to?
2. What’s the purpose of the Virtual DOM?
3. When should you avoid using array index as a key?
4. Name the two high-level phases of an update.

Discussion Prompts

- Where in your current codebase would React’s declarative model simplify logic?
- Which components could benefit most from stable keys and memoization?

Appendix — Batching & Transitions (Preview)

Automatic batching even across async boundaries.

```
function Example() {
  const [count, setCount] = React.useState(0);
  const [text, setText] = React.useState("");

  function handleClick() {
    fetch("/api/data").then(() => {
      setCount((c) => c + 1);
      setText("Loaded!");
    });
  }

  return (
    <div>
      <button onClick={handleClick}>Load</button>
      <div>{count}</div>
      <div>{text}</div>
    </div>
  );
}
```

Transitions mark non-urgent updates.

```
import { startTransition } from "react";

function Search({ query, setQuery }) {
  function onInput(e) {
    const q = e.target.value;
    setQuery(q); // urgent
    startTransition(() => {
      // non-urgent
      // setFilteredData(expensiveFilter(q));
    });
  }
  return <input value={query} onChange={onInput} />;
}
```

Resources

- React Docs: *Main Concepts* & *Reconciliation*
- React DevTools (Chrome/Firefox)
- Babel REPL (to view JSX → JS transform)

Next Session

- **JavaScript advanced refresher**: ES6+, arrays, async/await, closures.
- Prepare: Bring an example of imperative DOM code you've written recently.