React Training - Day 1 - Part II

Performance and Optimization

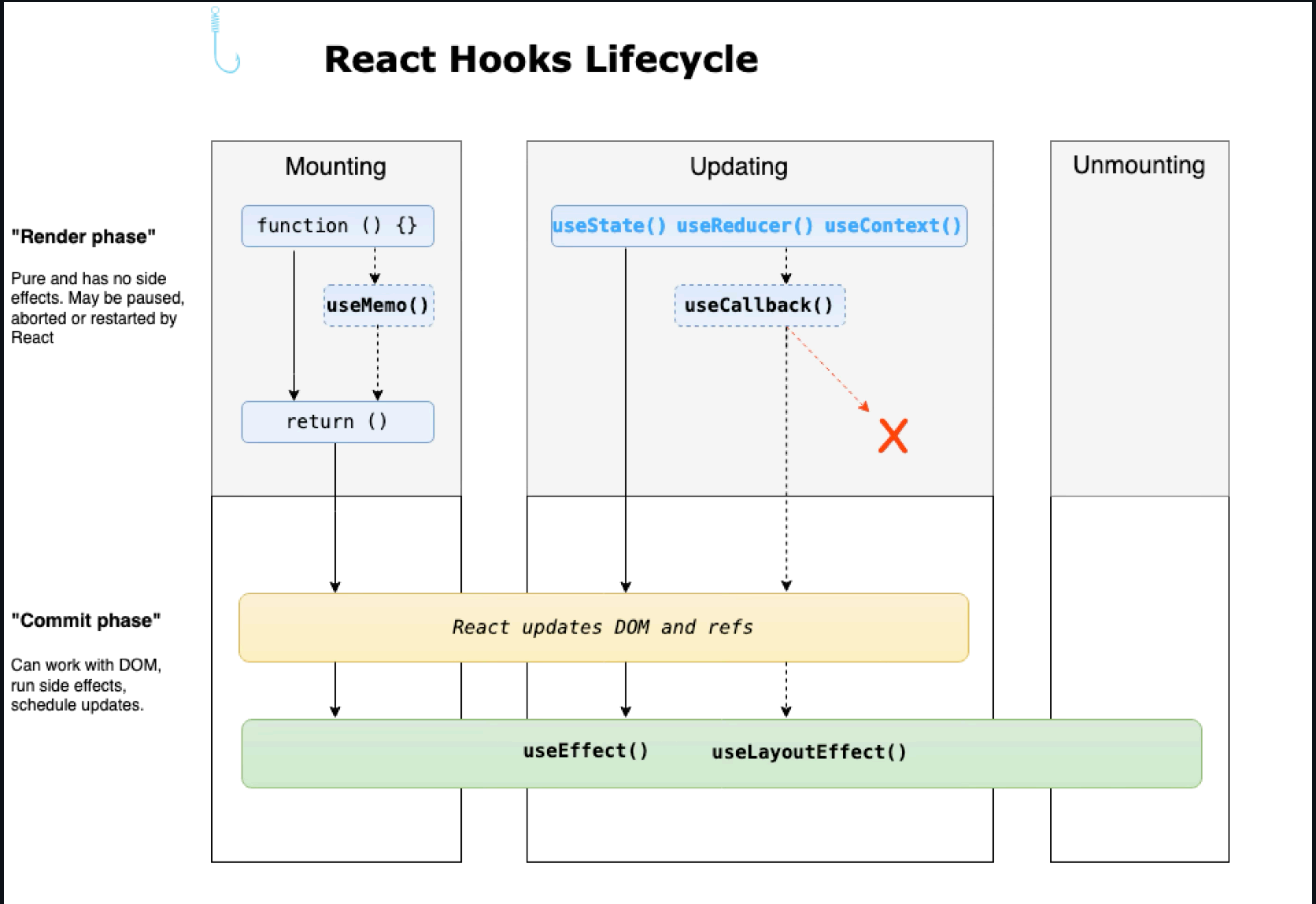
About Me

- **Productboard** (since March 2025)
    - Product Staff Engineer
    - Tech Lead Nucleus Guild, member of FE guild
- **React Experience**
    - React Lover (10+ years)
    - Consultant
    - Courses & Workshops
        - React, Next.js, QA
    - Video courses for Skillmea

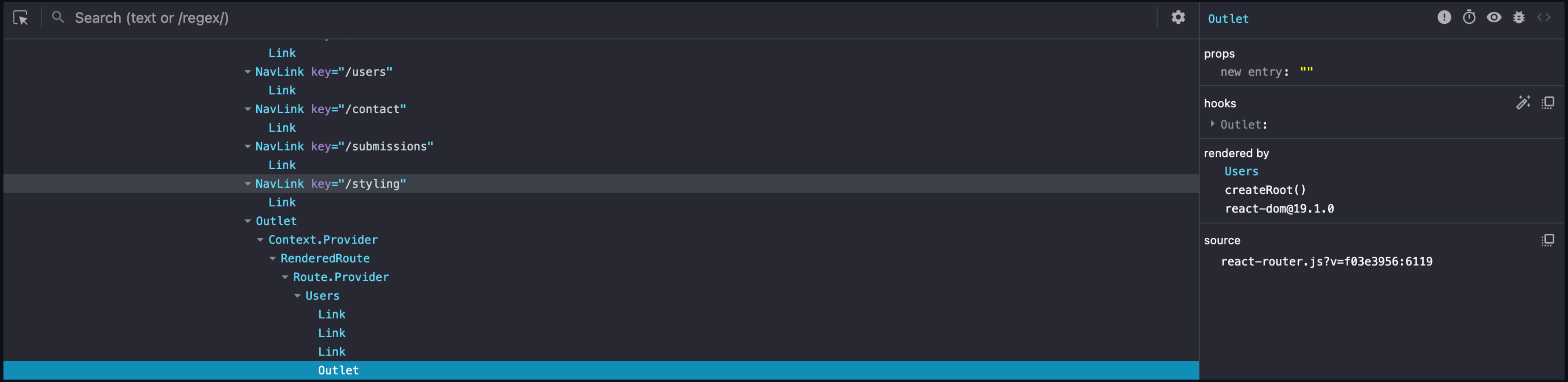
Agenda

1. Component's Lifecycle
2. React Profiler - DevTools
3. React Profiler API
4. Manual Memoization
5. Code Splitting & Lazy Loading
6. Background work - useTransition, useDeferredValue

Component's Lifecycle


React Hooks Lifecycle
Mounting
Updating
Unmounting
"Render phase"
Pure and has no side effects. May be paused, aborted or restarted by React
function () {}
useMemo()
return ()
useState() useReducer() useContext()
useCallback()
X
"Commit phase"
Can work with DOM, run side effects, schedule updates.
React updates DOM and refs
useEffect()
useLayoutEffect()

React Profiler - DevTools

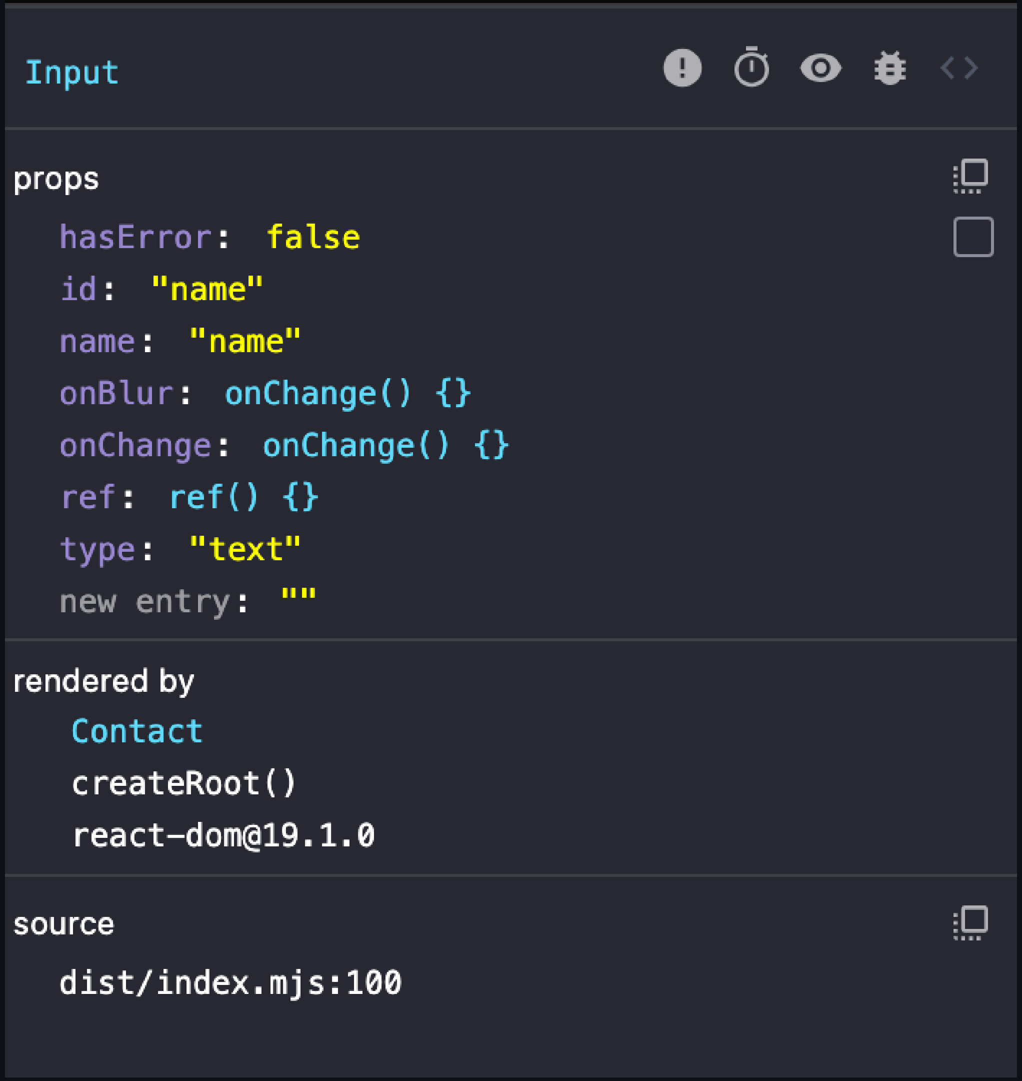


```
Link
▾ NavLink key="/users"
    Link
▾ NavLink key="/contact"
    Link
▾ NavLink key="/submissions"
    Link
▾ NavLink key="/styling"
    Link
▾ Outlet
  ▾ Context.Provider
    ▾ RenderedRoute
      ▾ Route.Provider
        ▾ Users
            Link
            Link
            Link
            Outlet
```

```
Outlet
props
  new entry: ""
hooks
  ▸ Outlet:
rendered by
  Users
  createRoot()
  react-dom@19.1.0
source
  react-router.js?v=f03e3956:6119
```

- Record and analyze component renders
- Identify performance bottlenecks
- Measure render times
- Track component updates

React DevTools - Components Tab



```
Input

props
  hasError: false
  id: "name"
  name: "name"
  onBlur: onChange() {}
  onChange: onChange() {}
  ref: ref() {}
  type: "text"
  new entry: ""

rendered by
   Contact
   createRoot()
   react-dom@19.1.0

source
  dist/index.mjs:100
```

React DevTools - Profiler Tab

- Record performance profiles
- Analyze render durations
- Identify slow components
- Track component updates

DevTools Demo

React Profiler API

```
// Profiler usage in component
<Profiler
  id="UserList"
  onRender={(
    id,          // ID of the component being profiled
    phase,       // "mount" | "update" | "nested-update"
    actualDuration, // Time spent rendering (ms)
    baseDuration,   // Estimated time without memoization (ms)
    startTime,      // When rendering started
    commitTime      // When rendering completed
  ) => {
    console.log({
      id,
      phase,
      actualDuration,
      baseDuration,
      startTime,
      commitTime
    });
  }}
>
  <UserList users={users} />
</Profiler>
```

Profiler Parameters

Parameter	Description
`id`	Identifier of the profiled component
`phase`	Render phase: - `mount` : Initial render - `update` : Re-render - `nested-update` : Nested component update
`actualDuration`	Actual time spent rendering in ms (including memoization)
`baseDuration`	Estimated time without memoization in ms (helps identify memoization benefits)
`startTime`	Timestamp when rendering started
`commitTime`	Timestamp when rendering completed

Manual Memoization

React.memo

> "React.memo is a higher order component that lets you skip re-rendering a component when its props are unchanged."

```tsx
// UserList.tsx
export const UserList: FC<{
  users: User[];
  onUserSelect: (userId: string) => void;
}> = memo(({ users, onUserSelect }) => {
  console.log('UserList render');

  return (
    <ul className="space-y-2">
      {users.map(user => (
        <UserItem key={user.id} user={user} onSelect={onUserSelect} />
      ))}
    </ul>
  );
});
```

```tsx
// UserItem.tsx
const UserItem: FC<{ user: User; onSelect: (id: string) => void }> = memo(({ user, onSelect }) => {
  console.log(`UserItem ${user.id} render`);

  return (
    <li onClick={() => onSelect(user.id)}>
      ...
    </li>
  );
};
```

useMemo & useCallback

> "useMemo caches calculation results, useCallback caches function definitions between re-renders."

```tsx
// App.tsx
const App = () => {
  const [users] = useState<User[]>(MOCK_USERS);
  const [search, setSearch] = useState('');
  const [selectedUserId, setSelectedUserId] = useState<string | null>(null);

  // Memoize filtered users
  const filteredUsers = useMemo(() => {
    console.log('Filtering users...');
    return users.filter(user =>
      user.name.toLowerCase().includes(search.toLowerCase())
    );
  }, [users, search]);

  // Memoize user selection handler
  const handleUserSelect = useCallback((userId: string) => {
    setSelectedUserId(userId);
  }, []); // No dependencies needed

  ...
  return (
    <div>
      <SearchInput value={search} onChange={setSearch} />
      <UserList
        users={filteredUsers}
        onUserSelect={handleUserSelect}
      />
      <UserStats users={users} selectedUserId={selectedUserId} />
    </div>
  );
};
```

When to Use Memoization

React.memo

- Pure components with same props
- Components that re-render often
- Components with expensive renders
- List items in large lists

useMemo

- Expensive calculations (filtering, sorting)
- Creating new objects/arrays
- Preventing unnecessary re-renders
- Derived state calculations

useCallback

- Event handlers passed as props
- Functions used in dependency arrays
- Callbacks in optimized components
- List item click handlers

Profiling Demo

Data-way App (memoized, unmemoized)

Concurrent React

Video - Ariel Shulman - Conquering Concurrent React

Code Splitting & Lazy Loading

React.lazy & Suspense

Split work

```
// DeclarativeRoutes.tsx
const Users = lazy(() => import('./components/Users').then(module => ({ default: module.Users })));

export const DeclarativeRoutes = () => (
  <Routes>
    <Route path="users">
      <Route
        index
        element={
          <Suspense fallback={<UsersLoading />}>
            <Users />
          </Suspense>
        }
      />
    </Route>
  </Routes>
);
```

Code Splitting & Lazy Loading Demo

Declarative-way App (DeclarativeRouter)

Data-way App (App)

Background Work

useTransition

> "useTransition is a React Hook that lets you update the state without blocking the UI."

Why useTransition?

- Prevents UI from blocking during state updates
- Improves perceived performance
- Better user experience during heavy operations
- Maintains UI responsiveness
- Helps with concurrent rendering
- Great for form actions

Basic Usage

```tsx
// SearchComponent.tsx
const SearchComponent = () => {
  const [isPending, startTransition] = useTransition();
  const [query, setQuery] = useState('');
  const [results, setResults] = useState<SearchResult[]>([]);

  const handleSearch = (event: ChangeEvent<HTMLInputElement>) => {
    // Urgent: Update input
    setQuery(event.target.value);

    // Non-urgent: Update results
    startTransition(() => {
      setResults(performExpensiveSearch(e.target.value));
    });
  };

  return (
    <div>
      <input
        value={query}
        onChange={handleSearch}
        className={isPending ? 'searching' : ''}
      />
      {isPending ? (
        <Spinner />
      ) : (
        <SearchResults results={results} />
      )}
    </div>
  );
};
```

useDeferredValue

> "useDeferredValue is a React Hook that lets you defer updating a part of the UI."

Why useDeferredValue?

- Defer updates to non-critical UI
- Maintain UI responsiveness
- Automatic value deferring
- Works with any value type
- No manual transition management needed

Basic Usage

```tsx
// SearchResults.tsx
const SearchResults = ({ query }: { query: string }) => {
  // Defer the search results update
  const deferredQuery = useDeferredValue(query);

  // Memoize the search results
  const results = useMemo(() => {
    return performExpensiveSearch(deferredQuery);
  }, [deferredQuery]);

  return (
    <div>
      {query !== deferredQuery && <Spinner />}
      <ResultsList results={results} />
    </div>
  );
};
```

With Suspense

```
const SearchPage = () => {
  const [query, setQuery] = useState('');
  const deferredQuery = useDeferredValue(query);

  return (
    <div>
      <SearchInput value={query} onChange={setQuery} />
      <Suspense fallback={<Spinner />}>
        <SearchResults query={deferredQuery} />
      </Suspense>
    </div>
  );
};
```

Comparison: useTransition vs useDeferredValue

Feature	useTransition	useDeferredValue
Control	Manual (startTransition)	Automatic
Use Case	State updates	Any value
Granularity	Per update	Per value
Integration	With state setters	With any value (prefer primitives)
Best for	Controlled updates	Automatic deferring

Characteristics

1. **useTransition**
    - Use for state updates that can be deferred
    - Group related state updates
    - Show loading states with isPending
    - Keep UI responsive during transitions
2. **useDeferredValue**
    - Use for values that can be stale
    - Combine with useMemo for expensive calculations
    - Show loading states when value is stale
    - Works well with Suspense
    - For third-party libs

When to Use Which?

- **useTransition**: When you need control over when the transition starts, and have access to the state updating
- **useDeferredValue**: When you want automatic deferring of value updates, and do not have access to the state updating
- **Both**: Can be used together for complex scenarios but mostly not needed!

More & Caveats

- useTransition
- useDeferredValue

Background Work Demo

Declarative-way App (UserStats, SearchableUserList)

UseOptimistic

Demo App

Resources

- React Documentation

Thank You!

Questions?

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