1. **What is Runtime?**

Runtime refers to the period when a program is executing (i.e., when a website or app is running in the browser). In the context of web development, runtime is when JavaScript executes and styles are applied to the DOM.

1. **How CSS Affects Runtime Performance?**

Certain styling approaches impact runtime performance in different ways. CSS can affect runtime in the following ways:

1. **1. CSS-in-JS and Runtime Overhead**

* Libraries like **Styled Components, Emotion, and JSS** **generate styles dynamically at runtime**.
* The browser has to **process JavaScript** to compute styles, inject them into the DOM, and then apply them.
* This increases **JavaScript execution time**, leading to potential delays in rendering.
* **More JavaScript execution = slower page load, higher CPU usage, and increased battery drain on mobile devices**.

✅ **Performance-friendly alternatives:**

* **Static CSS (Tailwind, traditional CSS files, or CSS Modules)** → These are compiled beforehand, so there is no runtime styling computation.
* **Precompiled CSS-in-JS (Linaria, Vanilla Extract)** → These generate CSS at build time rather than runtime.

1. **2. Blocking Rendering with Large CSS Files**

* If a website loads **large CSS files (e.g., Bootstrap, heavy stylesheets)**, it can **block rendering** because the browser **must download and process CSS before showing content**.
* This affects **First Contentful Paint (FCP)** and **Largest Contentful Paint (LCP)**, key **Core Web Vitals** metrics.

✅ **Solution:**

* Use **CSS minification** and **purging** (Tailwind CSS has built-in PurgeCSS).
* Load **critical CSS inline** and **defer non-essential styles**.

1. **3. Unused CSS Increases Page Size**

* Many traditional CSS frameworks include **thousands of unused styles** (e.g., Bootstrap includes styles for buttons, tables, forms, etc., even if you don’t use them).
* This increases **the amount of data downloaded** by users, slowing down performance.

✅ **Solution:**

* **Tree-shaking CSS frameworks** (like Tailwind’s PurgeCSS).
* Use **CSS Modules or Component-Scoped Styles** to only load what’s necessary.