

Introduction

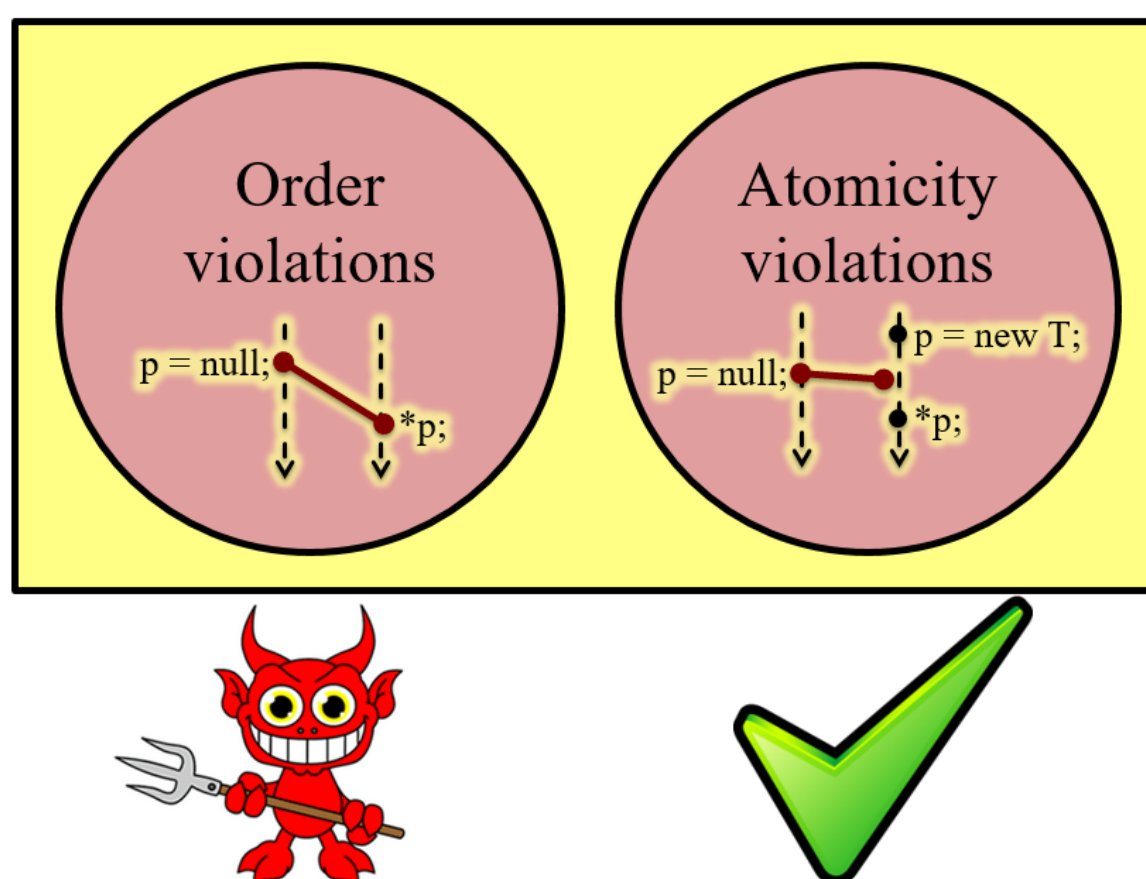
- Modern web pages are becoming increasingly complex with an extensive use of asynchronous events. However, such asynchronous events also give rise to unexpected concurrency errors, although each event is executed atomically.



Event-driven Model

- Web applications are based on the event-driven model, where various kinds of events are queued and executed in a single-threaded manner, thereby preventing many kinds of concurrency errors, but not all of them unfortunately.

- Parsing
- Event handler firing
- Ajax callback
- Timer callback
- Async resources
- ...



```

1 <html>
2 <head> </head>
3 <body>
4 
5 <!-- ... omitted elements ... -->
6 <script id="script1">
7   function image1Loaded() {
8     document.getElementById("button1")
9     .addEventListener("click", func);
10  }
11  function func() {
12    document.getElementById("outputField")
13    .innerHTML = "Well done!";
14  }
15 </script>
16 <!-- ... omitted elements ... -->
17 <button id="button1">button1</button>
18 <!-- ... omitted elements ... -->
19 <div id="outputField"></div>
20 </body>
21 </html>

```

Motivation

- Race conditions in web applications are hard to detect and diagnose.
- Existing race detection tools report too many race warnings, most of which are harmless. They overwhelm developers and therefore are counter-productive.



Contribution

- We proposed the first fully automated method for classifying race conditions in web applications based on program **re-execution and state comparison**.
- Developed a JavaScript based framework without modifying the web browser or JavaScript engine. It's platform/browser independent.
- Demonstrated the effectiveness and efficiency of our method through the experiments.

Experiments

- Tested on benchmarks from existing race detection tool for web applications.
 - ✓ Correctly classified all race conditions
- Tested on 70 websites from the Fortune 500 companies.
 - ✓ Replayed 1878 race conditions
 - ✓ Classified 129 harmful races(7%)
 - ✓ 1.5-2x slowdown

