Addressing the Adverse Impacts of JavaScript on Web Archives




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How Modern Web Archives Operate?

Web servers

ı and store web page

Web archive

Fetch archived page

User

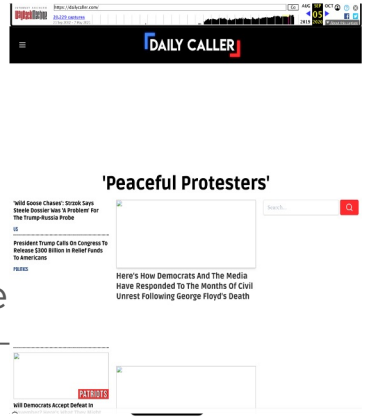
Problems With Web Archives: **Poor Page Fidelity**

Web servers

ı and store web page

Web archive

Fetch archived page



User

Problems With Web Archives: **Poor Page Fidelity**

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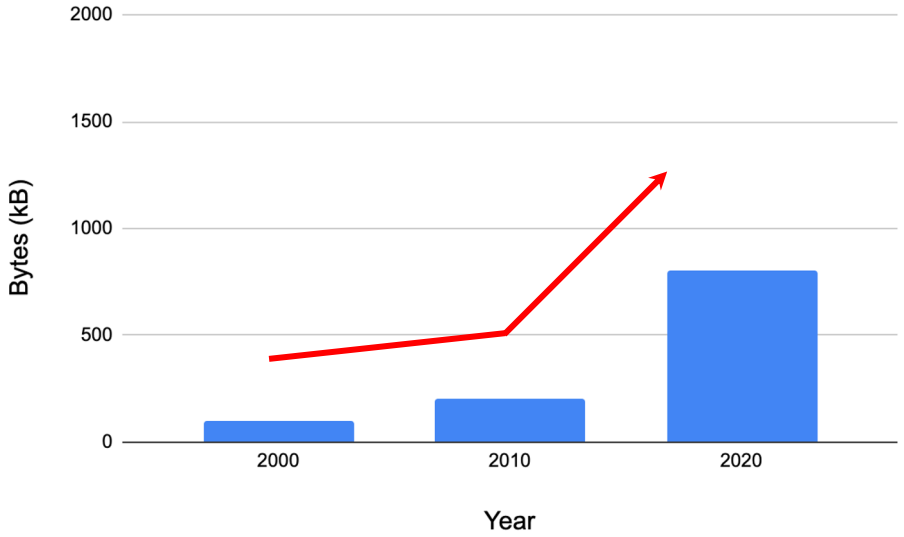
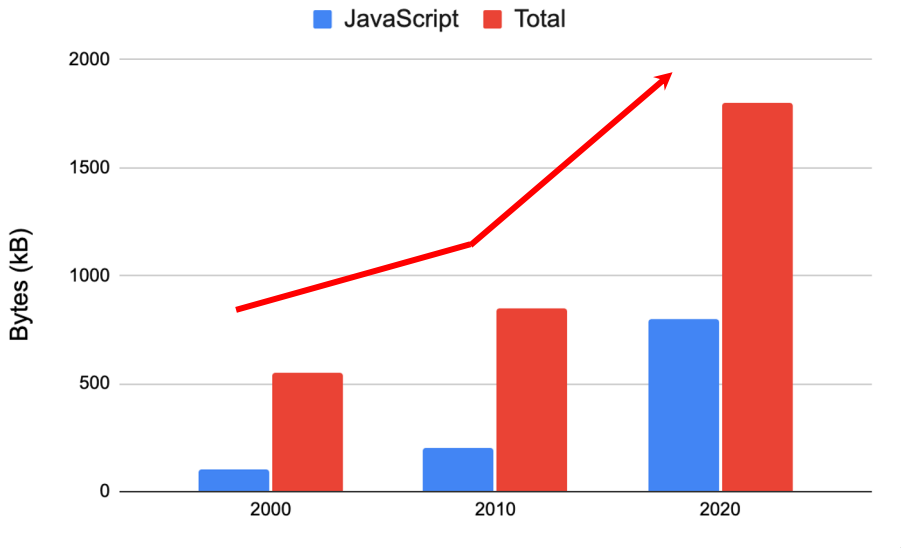
Browser Errors: Missing Resources (404) and Runtime Errors

Root Cause: **Increasing JavaScript** on Web Pages



Corpus: Landing pages of 300 Alexa sites

Root Cause: **Increasing JavaScript** on Web Pages

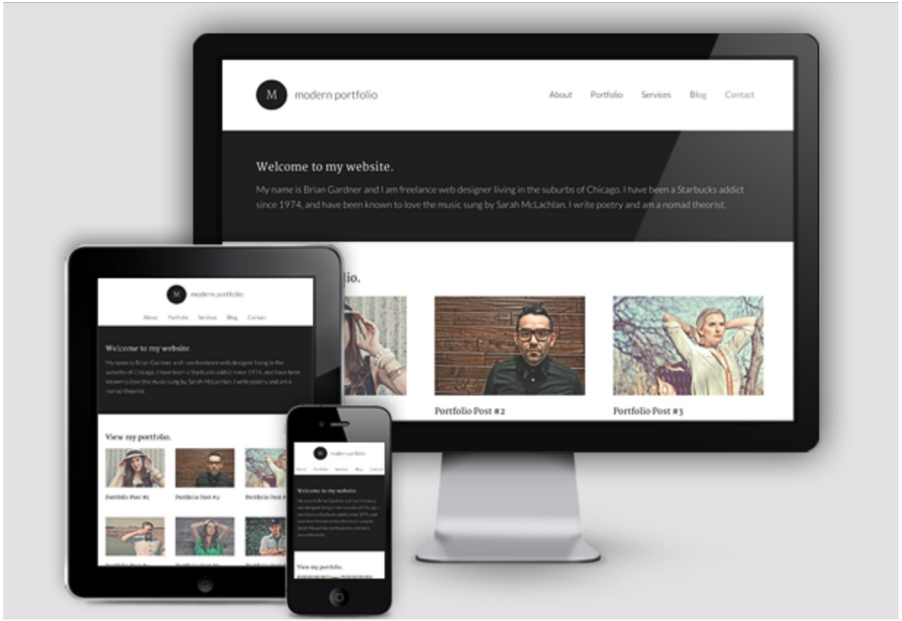


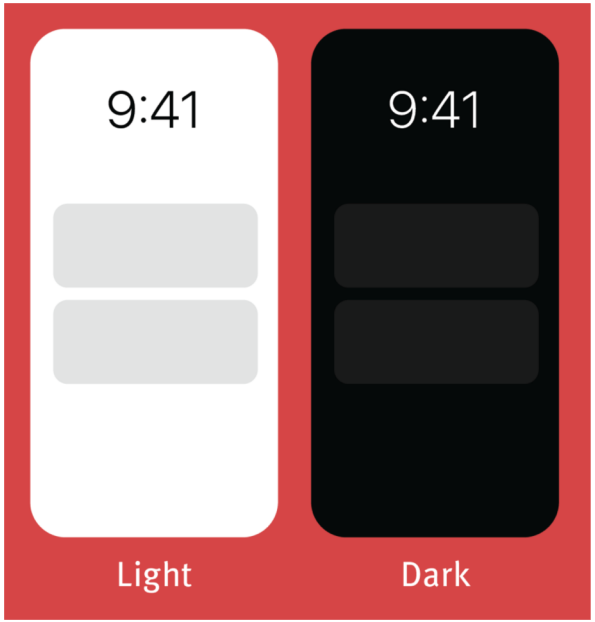
Corpus: Landing pages of 300 Alexa sites

Root Cause: ~~JS Execution Varies Across Loads of Same Page~~

Non-determinism

Resources fetched different from **crawled → Poor page fidelity**





Sources of JavaScript Non-Determinism

- ➔ Browser vendor (Chrome, Firefox, Edge)
- ➔ Operating system (Linux, Windows, Mac)
- ➔ Screen dimensions (height, width)
- ➔ Type of internet connection (wifi, cellular)
- ➔ Geolocation
- ➔ Hardware specs: # CPUs, memory

Client characteristics

- ➔ Current time
- ➔ Random number
- ➔ Performance

DRP APIs

Strawman Fix: Remove All Non-determinism

Vendor: Chrome
OS: Linux
Time: 7:01pm, 1/1/1970
Random number: 7878567

Fetch and store web page

Web servers

Web archive

Vendor: Chrome
OS: Linux
Time: 7:01pm, 1/1/1970
Random number: 7878567

Fetch archived page

User

Non-determinism Critical to Page Functionality

Original page

JavaScript Tetris

Level: 1 Lines: 0 Start Pause

Goal: fill as many rows as possible!

Control Keys

To move left	press **4** or ←
To move right	press **6** or →
To rotate	press **5** or **8** or ↑
To drop faster	press **space** or ↓

Mouse Control

To move left	click to the left of the piece
To move right	click to the right of the piece
To rotate	click on/above the piece
To drop faster	click below the piece

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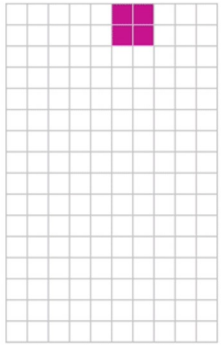

Deterministic page (broken)

JavaScript Tetris

Level: 1 Lines: 0 Start Pause

Goal: fill as many rows as possible!

Control Keys

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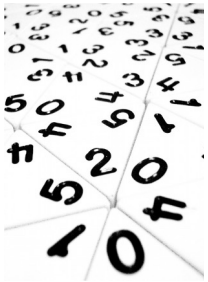
Analyze How Non-determinism Impacts Resources Fetched

Date, Math.random, Performance (DRP)



Client characteristics

Analyze impact on resources fetched

No impact on resource fetches

➔ retain the non-determinism

Influences resources fetched

➔ Eliminate non-determinism

Strawman Fix: Remove All Non-determinism

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~~**Time**: 7:01pm, 1/1/1970~~
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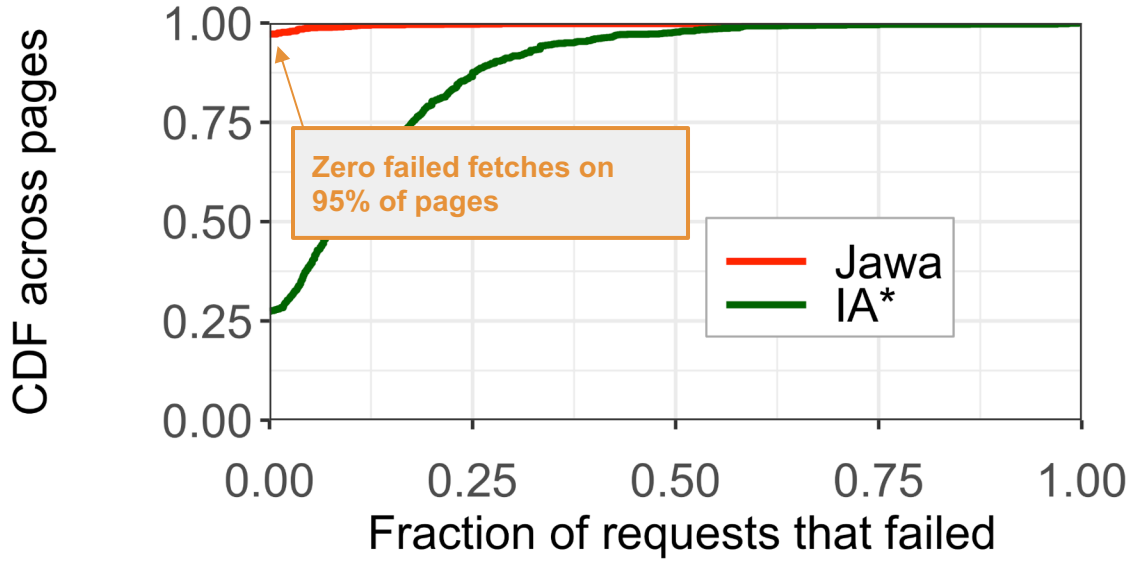
Eliminated Almost All Failed Resource Fetches

Corpus: 3000 web pages from 300 sites

Eliminated Almost All Failed Resource Fetches



Corpus: 3000 web pages from 300 sites

Summary

1) JavaScript's non-determinism negatively impacts web archival
    a) Missing resources, runtime errors

2) Key to fixing this is to selectively remove non-determinism

3) Store and reuse values of all client-characteristic APIs

https://gist.github.com/goelayu/bbc1348f4b5913ce9a304f3cfd708bb1

goelayu@umich.edu

Backup slides

Client-characteristics: **Remove Non-Determinism**

- ➔ While archiving page, store values of client characteristic APIs
  - Vendor: Chrome
  - OS: Linux
  - Chrome version: 110
  - Screen dimensions: 1200x800

- ➔ While loading archived page, reuse the stored client characteristic values

Questions

DRP APIs: Use

Handle

- ➔ Browser vendor (Chrome, Firefox, Edge)
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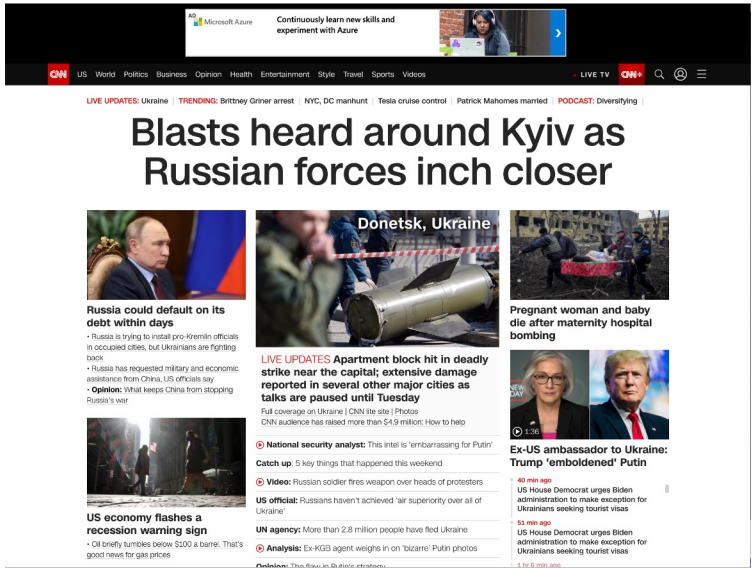
Impact of Browser Vendor On Archived Page

Archived using Chrome



Loaded using IE

Problems with Web Archives: **Poor Page Fidelity**

Sources of JavaScript non-determinism

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Outline

- Web page trend (increasing JS)
- What is the utility of increasing JS
- Web archives suffer detrimentally
- variation can break the page – runtime errors; missing resources
- simple solution: remove all non-determinism
- our analysis