Northeastern University

Systems Security Lab

Why is CSP Failing? Trends and Challenges in CSP Adoption

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The World Wide Web...

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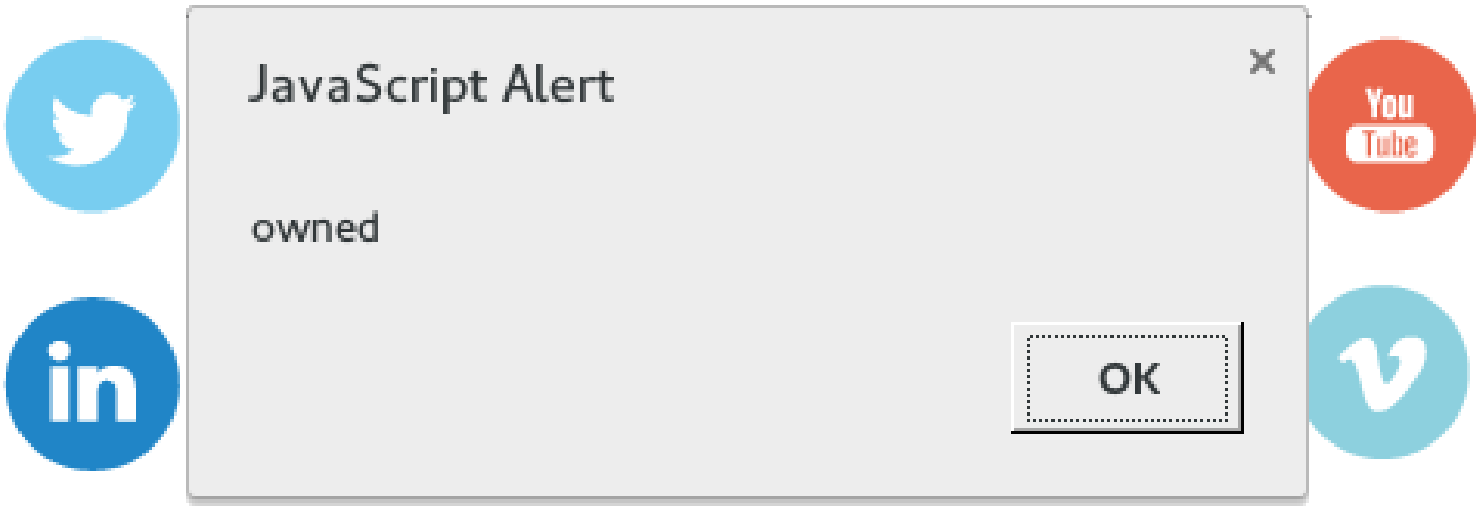


Content Security Policy (CSP) - Overview

- Client-side (browser) policy enforcement
- Document-specific whitelist of resources
- Prevention of site modifications and data leaks
- Two modes of operation
- Recent standard
- Supported by all major browsers
- Delivery as HTTP response header (or meta tag)

CSP Example

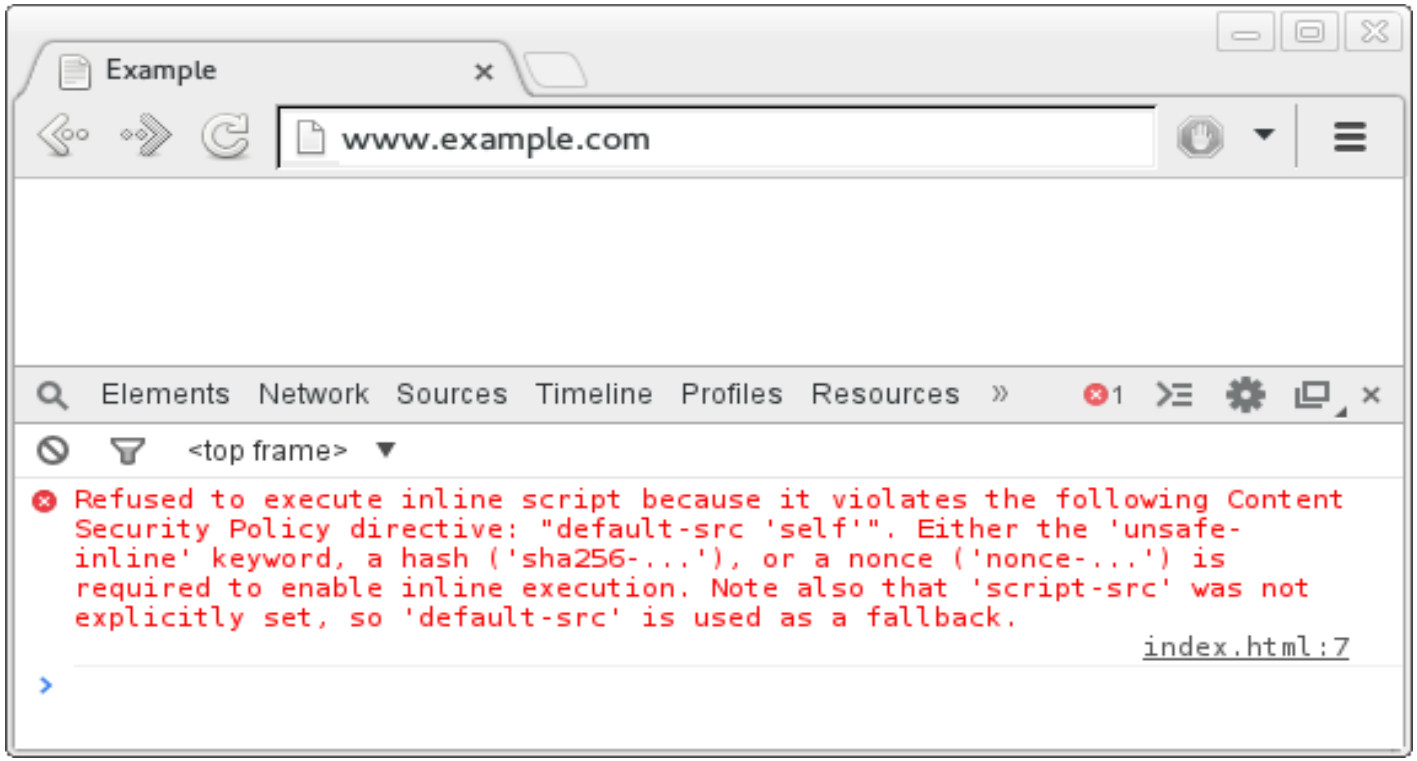
```
$ curl -I http://www.example.com |  grep -i content-
security-policy:

Content-Security-Policy: default-src 'self';
script-src 'static.example.com';
style-src 'static.example.com';
report-uri http://example.com/reports
```

[Line breaks added for clarity]

How to Deploy CSP

- Move inline script to files
- Move resources to separate hosts, e.g., static.example.com
- No eval constructs



“CSP is a great defense – how does it impact the Web?”

Overview

- Study on Content Security Policy
  - Who is using CSP ?
  - Can we improve the state of adoption ?

- Contributions
  - First long-term analysis of CSP adoption in the wild
  - Investigate challenges in adopting CSP
  - Evaluate the feasibility of incremental deployments
  - Suggest avenues for enhancing CSP

“Who is using Content Security Policy,
and how are they using it?”

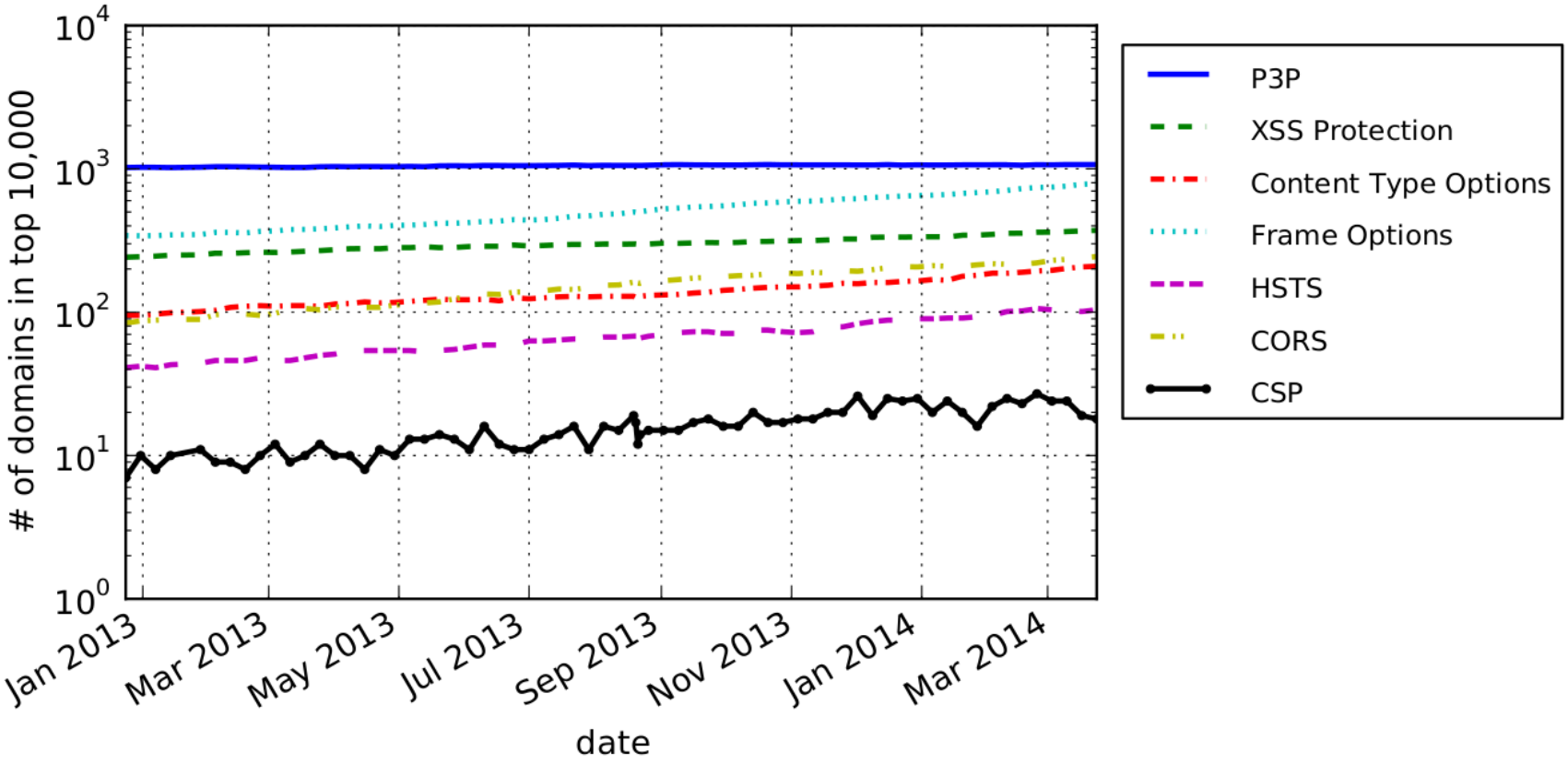
Data Collection Methodology

- Crawl of Alexa Top 1M
- Weekly, starting December '12
- For every domain x.com, connect to:
  - http://x.com
  - https://x.com
  - http://www.x.com
  - https://www.x.com
- Using up to date Firefox User Agent
- We only access the front page

Security Headers We Collected

- Platform for Privacy Preferences (P3P)
- DNS Prefetch Control
- XSS Protection
- Content Type Options
- Frame Options
- HTTP Strict Transport Security (HSTS)
- Cross-Origin Resource Sharing (CORS)

Security Headers Dec '12 – April '14



CSP is the least popular security HTTP response header

Top 1M

- Top 1M snapshot of March '14
- Split into logarithmic brackets, 1-10, 11-100 etc.
- CSP statistics
  - Top 100: 2%
  - 900,000 least popular sites: 0.00086%
- In comparison, CORS:
  - All brackets between 0.7% and 2.6%
- More popular sites are more likely to adopt CSP
- That likelihood is still low

Policy Overview

- Enforcement mode: 815 (23 collecting reports)
- Report-only: 35
- Learned rules: dnb.no, 74 sources
- Observed policies add only marginal benefit
  - Mostly unsafe-inline, eval

“Can we improve adoption by generating rules automatically?”

How To Create Policies

- Manual
- Violation reports by users
- Violation reports by our crawler

Violation Reports

- Policy: img-src 'none'; report-uri /sink.cgi
- http://seclab.nu/test.html
- Includes resource: http://seclab.nu/pic.gif
- JSON Report:


```
{
  "blocked-uri": "http://seclab.nu/pic.gif",
  "violated-directive": "img-src 'none'",
  "document-uri": "http://seclab.nu/test.html"
}
```

Derive CSP Through report-only Mode

- Add headers to four websites
- Disallow all resources
- Collect violation reports
- Derive one whitelist usable for the entire site

Policy For Simple Website

- Expected policy

```
default-src 'none'; img-src 'self' data:; style-src 'unsafe-inline'
```

Policy For Simple Website

- Expected policy

```
default-src 'none'; img-src 'self' data:; style-src 'unsafe-inline'
```

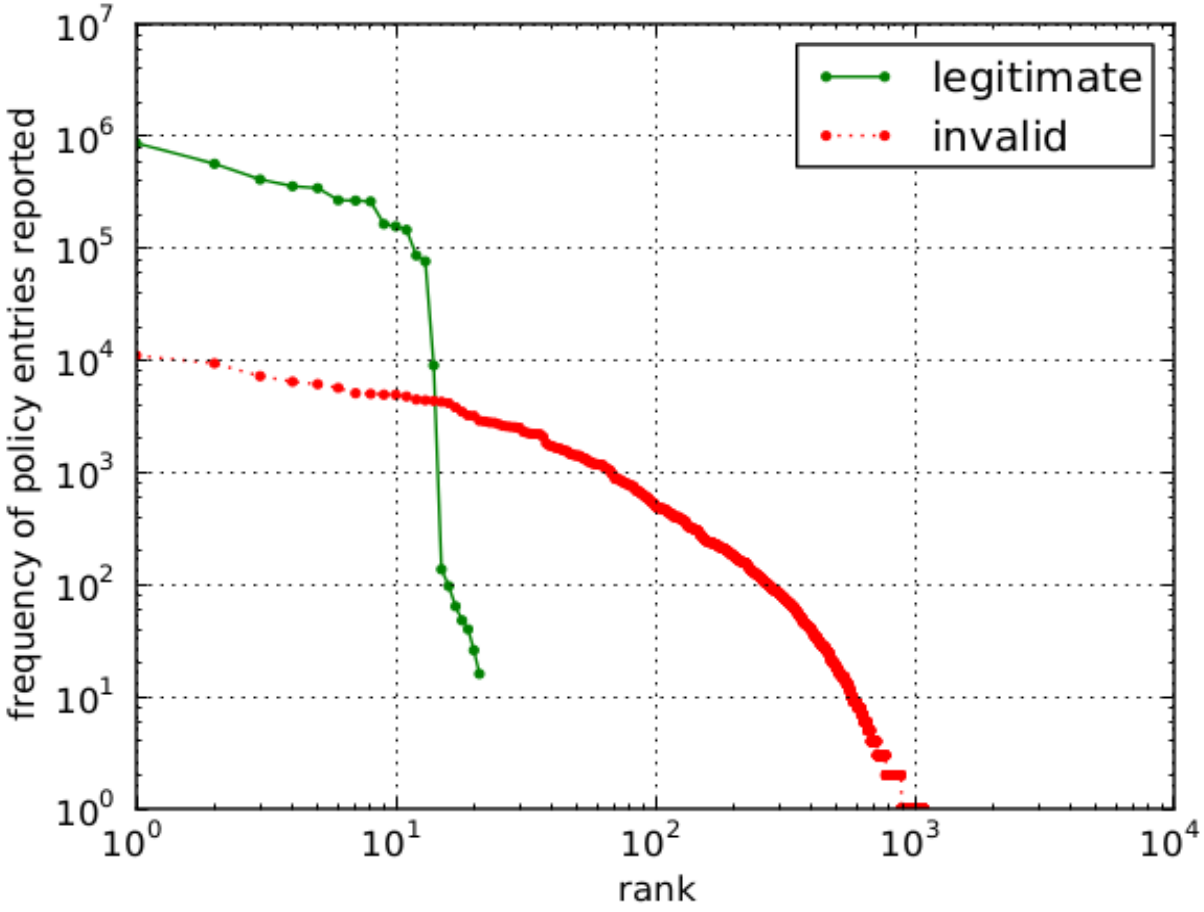
- Derived policy

```
default-src `none';
frame-src https://srv.mzcdn.com;
img-src 'self' data: http://1.2.3.11;
object-src http://www.ajaxcdn.org;
script-src 'unsafe-eval' 'unsafe-inline' http://ajax.googleapis.com
http://f.ssfiles.com http://i.bestoffersjs.info
http://srv.mzcdn.com http://www.superfish.com
https://www.superfish.com;
style-src 'unsafe-inline'
```

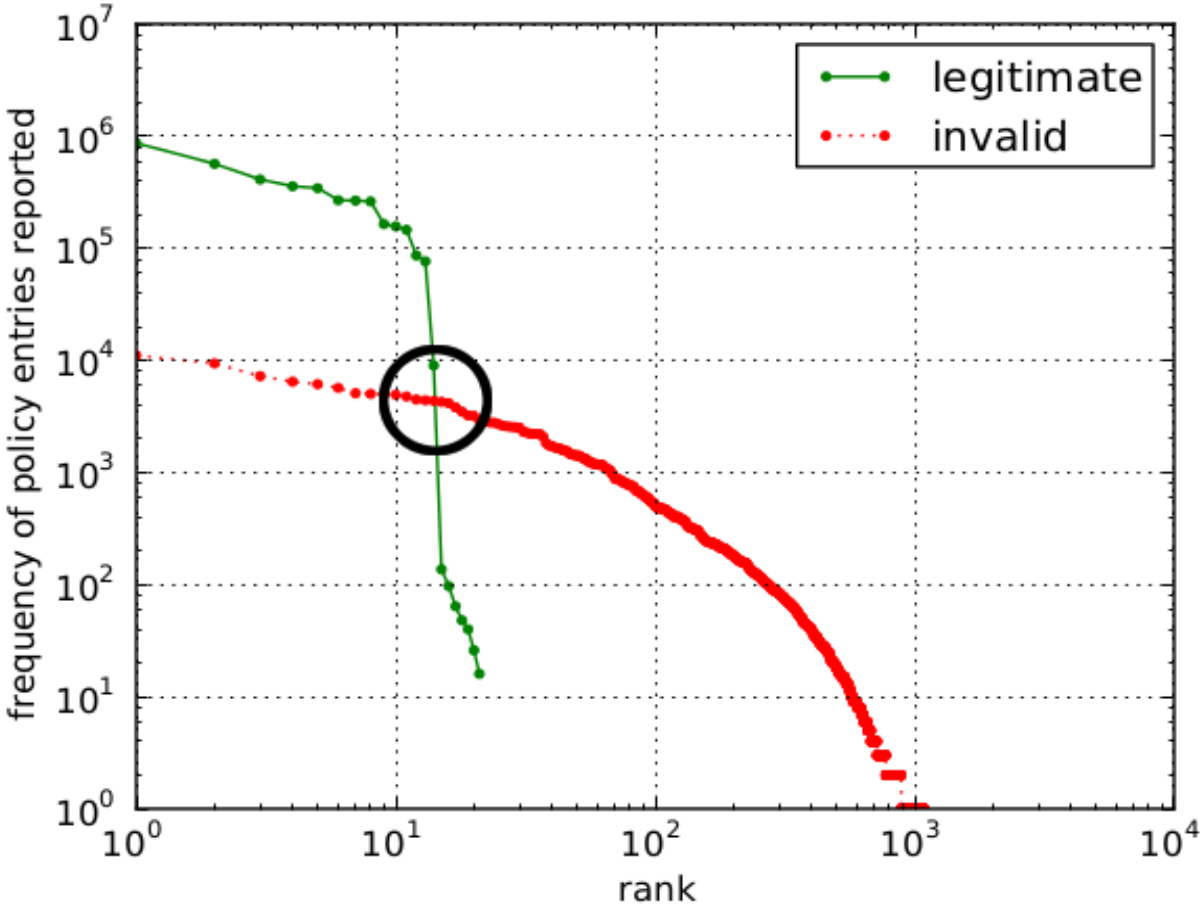
Sources of Noise

- Chrome Extensions
  - AdBlock
  - AdBlock Plus
  - Grooveshark Downloader
  - (Extensions can modify policies)
- Modifications in flight
  - Mobile ISPs
- Can these be filtered automatically, e.g.: by frequency?

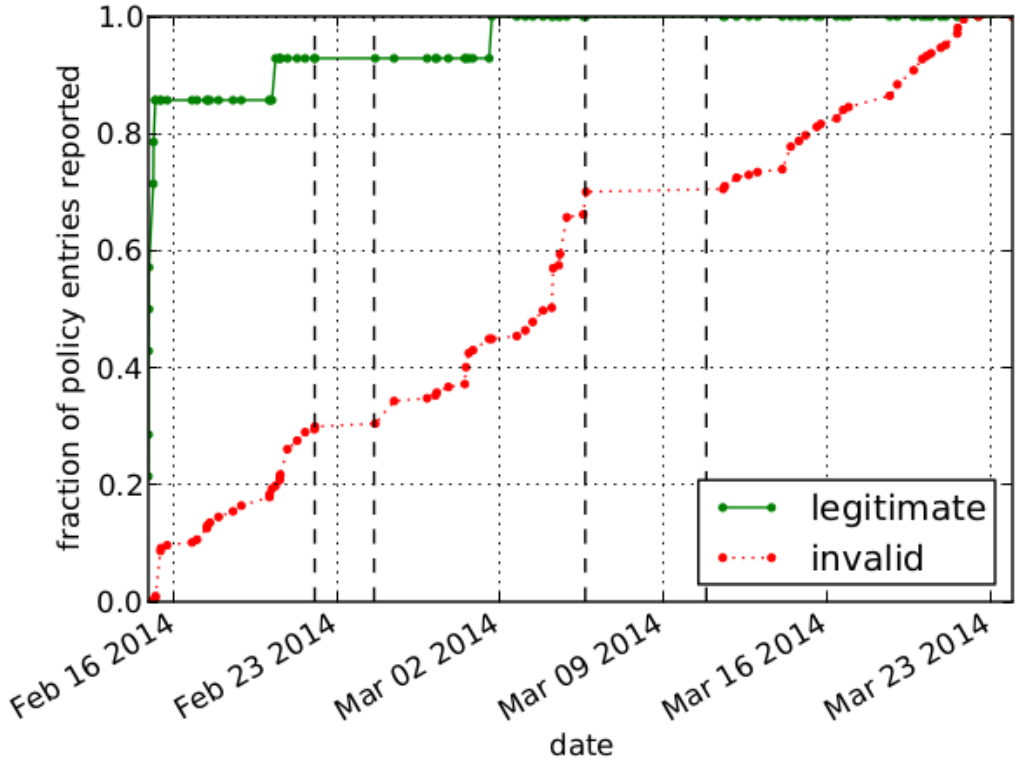
Policy Frequency Comparison



Policy Frequency Comparison



New Policy Entries Discovered Over Time



Derive CSP Through Trusted Crawler

- Approach
  - Use Chrome, driven through browser extension
  - Rewrite HTTP response header in proxy to generate violations
  - Catch violation reports in proxy
  - No semantic gap to other browsers
- Targets
  - Four previous websites
  - Sites that use CSP as ground truth
  - Complex websites

Crawler Overview

- How stable are policies over time?
- How secure are the policies?
- Evaluation
  - Compare to manual browsing
  - Use sites with CSP as ground truth

Crawler Results

- Stability depends on architecture
  - Integration of ads: CNN vs. BBC
  - Separation of content: Twitter
- Security
  - Most sites: eval, inline
  - Benefits: less data leaks

Open Questions

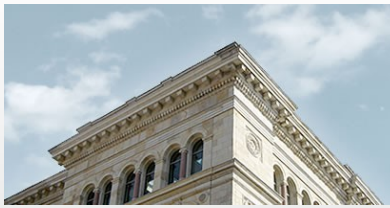
- Can the approaches be combined?
  - High volume, untrusted
  - Low volume, trusted
- Can machine learning help?
- Improve the crawler?

Discussion

- Discussions with engineers
  - Websites want to keep inline script
  - Changes to legacy code are expensive
  - Enforcement over extensions is considered a bug
- Suggested improvements
  - Isolate ads
  - Adoption by frameworks anticipated
  - Browsers should not enforce CSP on extensions
- Vendor Response
  - PHPMyAdmin
  - Facebook
  - GitHub

Conclusions

- CSP adoption significantly lags other headers
- If deployed, benefits are marginalized
- Automatically deriving rules is hard
- CSP holds promise, hopefully v1.1 will address shortcomings



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Thank you!

Questions?

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