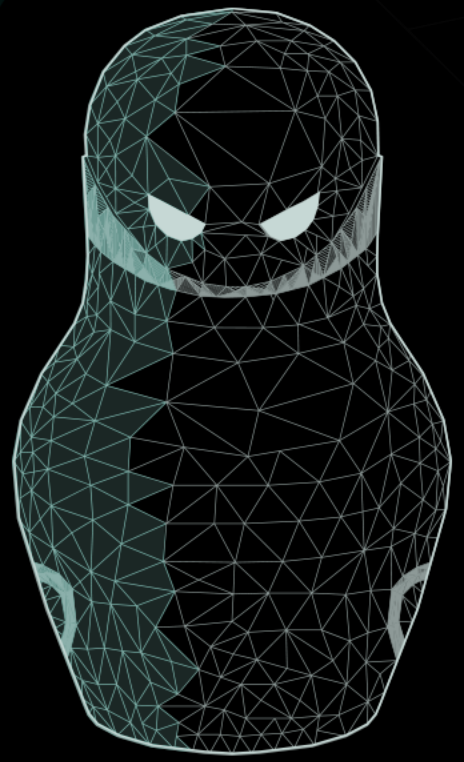

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Getting The Most Out Of CSP: A Deep Dive

Sergey Shekyan

Canadian Staging Professionals (CSP)

CSP CERTIFIED STAGING PROFESSIONALS™

- CSP® Home Staging Certification Course Is Simply The Best Education and Support For Your New Career
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Content Security Policy

Sike!

Content Security Policy

is a mechanism to declare content restrictions for web resources in a browser

- disables normally enabled capabilities in web pages
- helps to detect and prevent XSS, UI Redressing, mixed-content and other attacks

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History

Revision history of "Security/CSP"

View logs for this page

Browse history

From year (and earlier): 2009 From month (and earlier): March Tag filter: Go

Diff selection: Mark the radio boxes of the revisions to compare and hit enter or the button at the bottom.
Legend: **(cur)** = difference with latest revision, **(prev)** = difference with preceding revision, **m** = minor edit.

(newest | oldest) View (newer 50 | older 50) (20 | 50 | 100 | 250 | 500)

Compare selected revisions

- (cur | prev) 15:22, 16 March 2009 Sidstamm (Talk | contribs) . . (460 bytes) (+38) . . *(→Tasks to Complete)*
- (cur | prev) 15:21, 16 March 2009 Sidstamm (Talk | contribs) . . (422 bytes) (+123) . . *(→Welcome)*
- (cur | prev) 10:53, 11 March 2009 Bsterne (Talk | contribs) . . (299 bytes) (+299) . . *(New page: == Welcome == This page is a placeholder for now and will be expanded as decisions are made about Content Security Policy. == Tasks to Complete == * Finish documentation of restrictions *...)*

Compare selected revisions

(newest | oldest) View (newer 50 | older 50) (20 | 50 | 100 | 250 | 500)

- Initial proposal by Brandon Sterne - 2009
- CSP level 1 - Nov 2012
- CSP level 2 - July 2014
- CSP level 3 will introduces A LOT of changes

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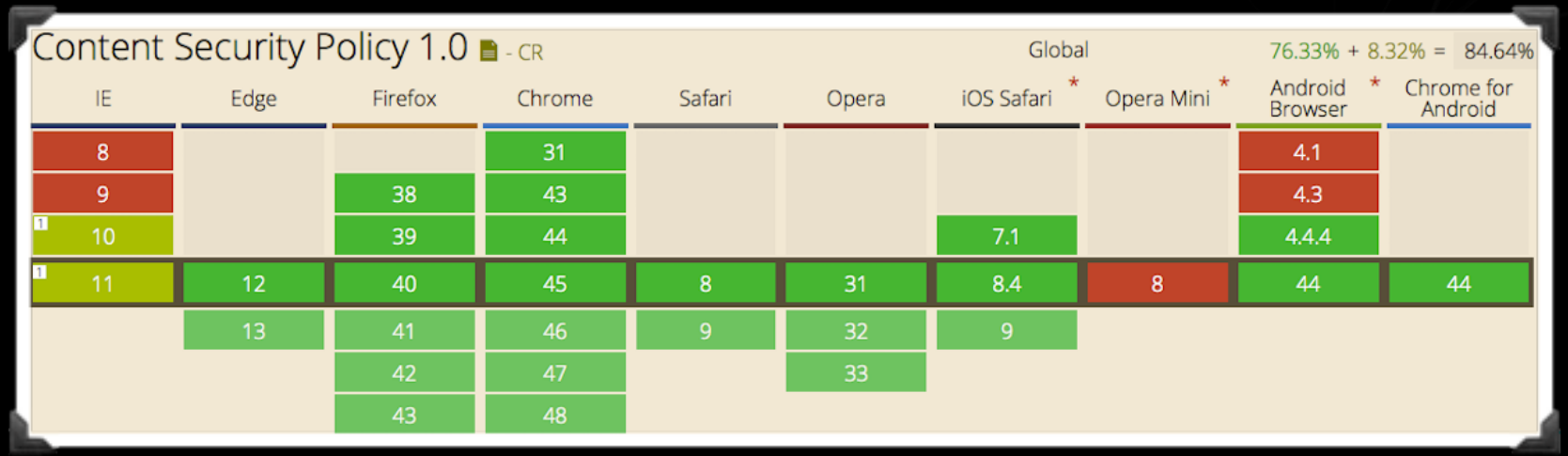
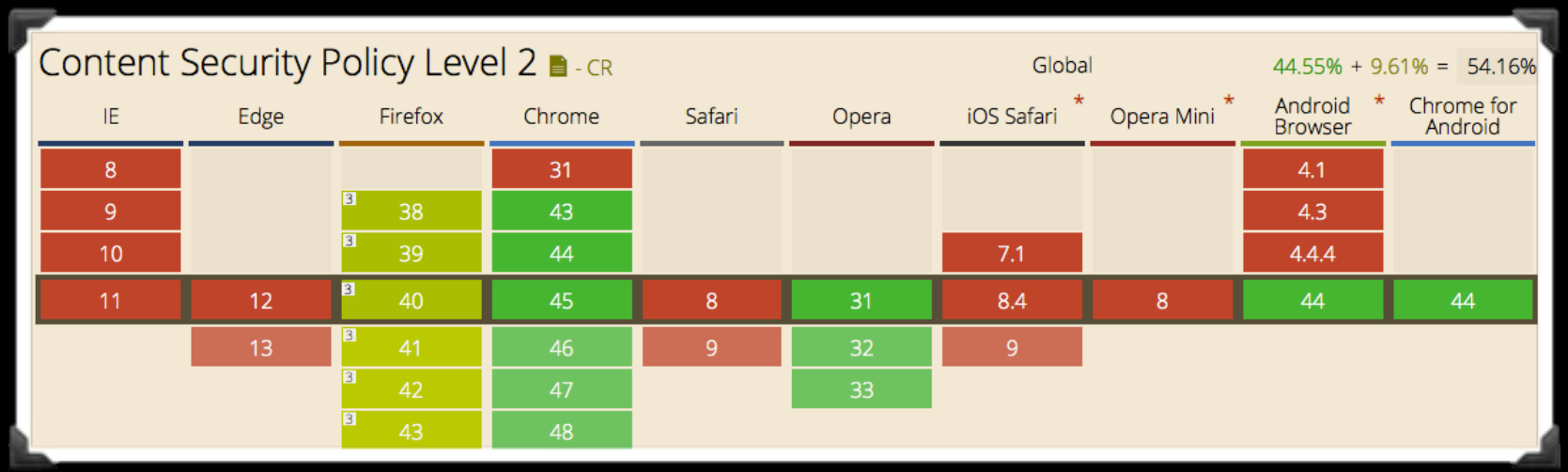
Adoption: Browsers



Content Security Policy 1.0 - CR

Global 76.33% + 8.32% = 84.64%

IE	Edge	Firefox	Chrome	Safari	Opera	iOS Safari *	Opera Mini *	Android Browser *	Chrome for Android
8			31					4.1	
9		38	43					4.3	
10 [1]		39	44			7.1		4.4.4	
11 [1]	12	40	45	8	31	8.4	8	44	44
	13	41	46	9	32	9			
		42	47		33				
		43	48						



Content Security Policy Level 2 - CR

Global 44.55% + 9.61% = 54.16%

IE	Edge	Firefox	Chrome	Safari	Opera	iOS Safari *	Opera Mini *	Android Browser *	Chrome for Android
8			31					4.1	
9		38 [3]	43					4.3	
10		39 [3]	44			7.1		4.4.4	
11	12	40 [3]	45	8	31	8.4	8	44	44
	13	41 [3]	46	9	32	9			
		42 [3]	47		33				
		43 [3]	48						

Adoption: Websites

Less than **0.2%** of Alexa top 100000 use CSP on landing page

- many nonsensical policies
- many invalid policies
- few web properties use nonce-source/hash-source
- most use `'unsafe-inline'` and `'unsafe-eval'`
- some use deprecated policies

Content Security Policy

source-list

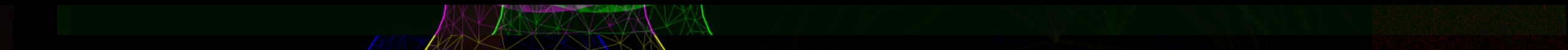
Delivered over HTTP header

```
Content-Security-Policy: script-src https: example.com 'self'
```

directive-name scheme-source host-source keyword-source

Delivered over meta tag

```
<meta http-equiv="Content-Security-Policy" content="script-src https: example.com; 'self'">
```

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Combining source expressions

```
script-src 'self' https: *.example.com
```

<= **served by http://www.site.com**

A URL url is said to match a source list for protected resource if at ***least* one** source expression in the set of source expressions obtained by parsing the source list matches url for protected resource.

```
<script src='http://www.site.com'>  ✔
<script src='http://api.site.com'>  ✘
<script src='https://google.com'>   ✔
<script src='http://example.com'>   ✘
<script src='http://api.example.com'> ✔
<script src='http://api.example.com'> ✔
```

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Matching

```
script-src https:;
```

```
<script src='https://a.com'>
<script src='https://a.com:8080'>
<script src='ws://a.com:80'>
```

```
script-src a.com;
```

```
<script src='https://a.com'>
<script src='http://a.com:8080'>
<script src='http://a.com'>
```

```
script-src a.com/b;
```

```
<script src='http://a.com/b'>
<script src='http://a.com/bbb'>
<script src='http://a.com/b/'>
```

```
script-src a.com/b/;
```

```
<script src='https://a.com/b'>
<script src='https://a.com/b/a'>
<script src='https://a.com/b/'>
```

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Directives

source-list

- default-src
- child-src
- script-src
- frame-src
- style-src
- object-src
- img-src
- connect-src
- font-src
- media-src
- form-action
- base-uri

ancestor-source-list

- frame-ancestors

media-type-list

- plugin-types

uri-reference

- report-uri

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Dealing with keywords

Good

```
script-src 'none';
style-src 'none';
```

HTML

```
<script src='evil.com'></script>
<body onclick='alert(1337)'>
<script>eval(evilCode);<script>
```

Bad

```
script-src * 'unsafe-inline';
style-src * 'unsafe-inline'
```

HTML

```
<script src='evil.com'></script>
<body onclick='alert(1337)'>
<script>eval(evilCode);<script>
```

Bad

```
script-src * 'unsafe-eval';
style-src * 'unsafe-eval'
```

HTML

```
<script src='evil.com'></script>
<body onclick='alert(1337)'>
<script>eval(evilCode);<script>
```

Granular whitelisting

```
script-src 'sha256-nnn';
style-src 'sha256-mmm';
```

```
<script src='evil.com'></script>
<body onclick='alert(1337)'>
<script>eval(evilCode);<script>
<script>goodCode()<script>
```

HTML

Use hash (sha256, sha-384, sha-512) if have to have inline scripts or styles. Good for whitelisting static content.

```
script-src 'nonce-123';
style-src 'nonce-123';
```

```
<script src='evil.com'></script>
<body onclick='alert(1337)'>
<script>eval(evilCode);<script>
<script nonce='123'>goodCode()<script>
```

HTML

Use nonce if have to have inline scripts or styles. Good for whitelisting dynamic content.

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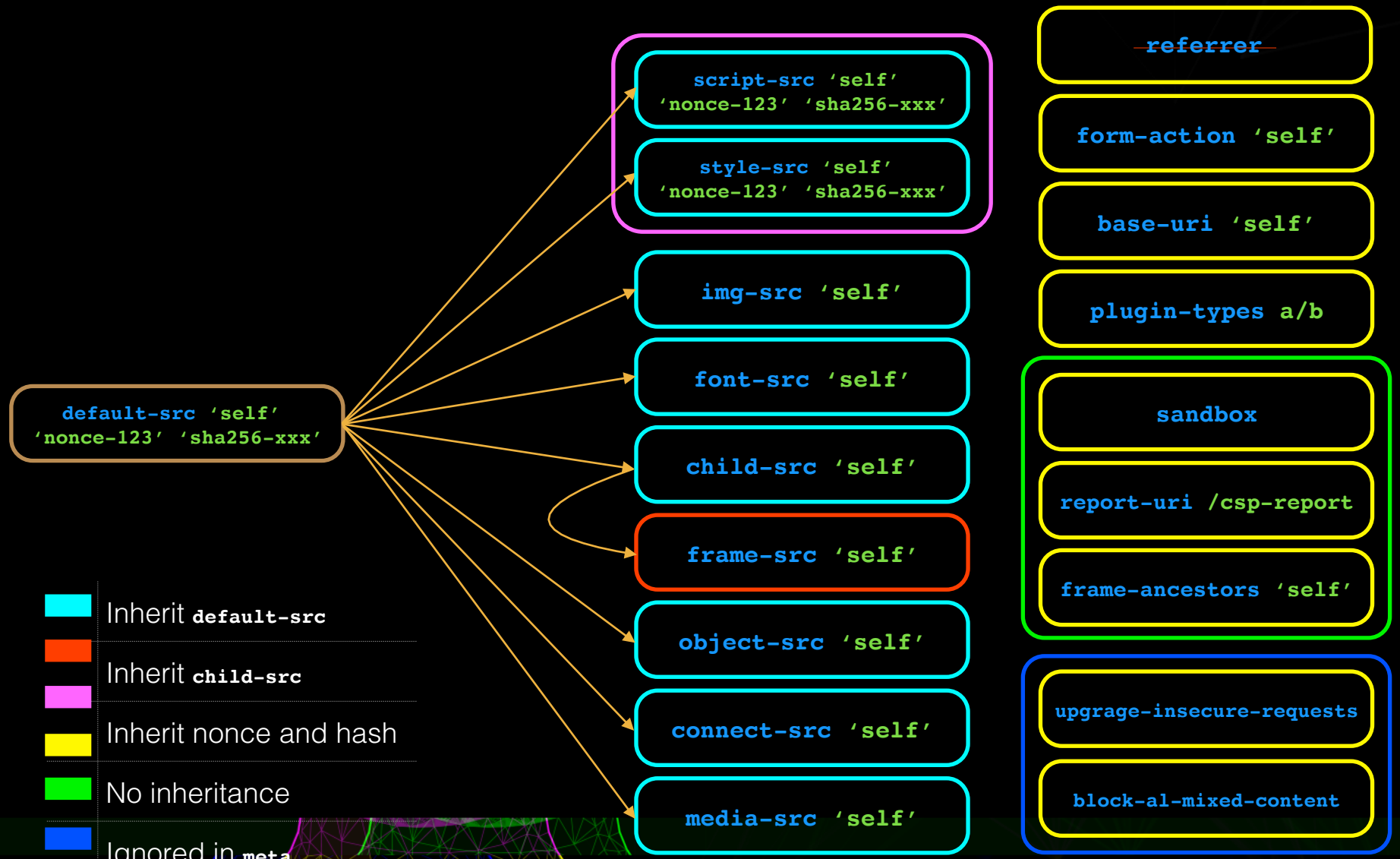
CSP2 Cheatsheet



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Combining source lists

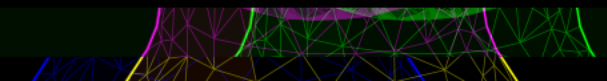
When multiple policies are present, the resource must match **all** of them

```
Content-Security-Policy: script-src *.example.com;
Content-Security-Policy: script-src 'self';
Content-Security-Policy: script-src https: report-uri /report;
```

==

Combine multiple headers into one by comma-separated

```
Content-Security-Policy: script-src *.example.com, script-src 'self',
script-src https: report-uri /report;
```



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Combining source lists

```
Content-Security-Policy: script-src *.example.com, script-src 'self',
script-src https: report-uri /report;
```

!=

If you instead try to combine policies by combining source lists of given directives, the resulting policy will behave differently

```
Content-Security-Policy: script-src *.example.com 'self' https:;
report-uri /report;
```

```
Content-Security-Policy: script-src *.example.com, script-src 'self',
script-src https: report-uri /report;
```

==

Match all, remember? do not forget about reporting context

```
Content-Security-Policy: 'none'; report-uri /report;
```

Grammar & Semantics

```
default-src a b c;
script-src d;
style-src d;
img-src d;
font-src d;
child-src d;
connect-src d;
object-src d;
```

==

```
default-src d
```

frame-src is missing. Are there policies identical? Yes, because:
frame-src is always derived from child-src, if not explicitly specified
frame-src => **frame-src** *

Grammar & Semantics

```
script-src 'none'
```

==

```
script-src
```

```
default-src 'none'
```

==

```
default-src
```

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Defaults in scheme and port

```
script-src http://example.com:80
```

==

```
script-src http://example.com
```

==

```
script-src example.com
```

Default scheme – 4.2.2 Matching Source Expressions
If the source expression does not have a scheme, return does not match if any of the following are true:
the scheme of the protected resource's URL is a case insensitive match for HTTP, and url-scheme is not a case insensitive match for either HTTP or HTTPS
the scheme of the protected resource's URL is not a case insensitive match for HTTP, and url-scheme is not a case insensitive match for the scheme of the protected resource's URL.
In non-spec English, default scheme is `http`

Default port	
ftp	21
file	
gopher	70
http	80
https	443
ws	80
was	443

Most permissive policy

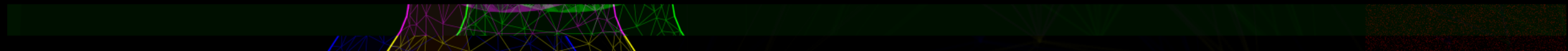
==

```
Content-Security-Policy:
```

==

```
Content-Security-Policy: default-src * ‘unsafe-inline’ ‘unsafe-eval’
data: filesystem: blob:
```

Missing Content-Security doesn’t touch any web page capabilities



Most restrictive policy

```
Content-Security-Policy: default-src; frame-ancestors 'none'; form-action
                         'none'; sandbox
```

CSP host-source

`connect-src 'self' https:;` **served by https://example.com**

`XMLHttpRequest` **to http://example.com** ✗

`XMLHttpRequest` **to https://example.com:8080** ✗

`XMLHttpRequest` **to https://example.com** ✔

`XMLHttpRequest` **to https://example.com:443** ✔

`WebSocket` **to ws://example.com:80** ✗

`WebSocket` **to wss://example.com** ✗

CSP Examples

```
default-src 'self' ;
script-src 'unsafe-inline' 'unsafe-eval' 'self' * ;
style-src 'unsafe-inline' 'self' * ;
frame-src 'self' * ;
object-src 'self' * ;
img-src 'self' data: * ;
media-src 'self' * ;
font-src 'self' * ;
connect-src 'self' *
```

Bad: **default-src * ‘unsafe-inline’ + ‘unsafe-eval’** + allows **data:** for image

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CSP Examples

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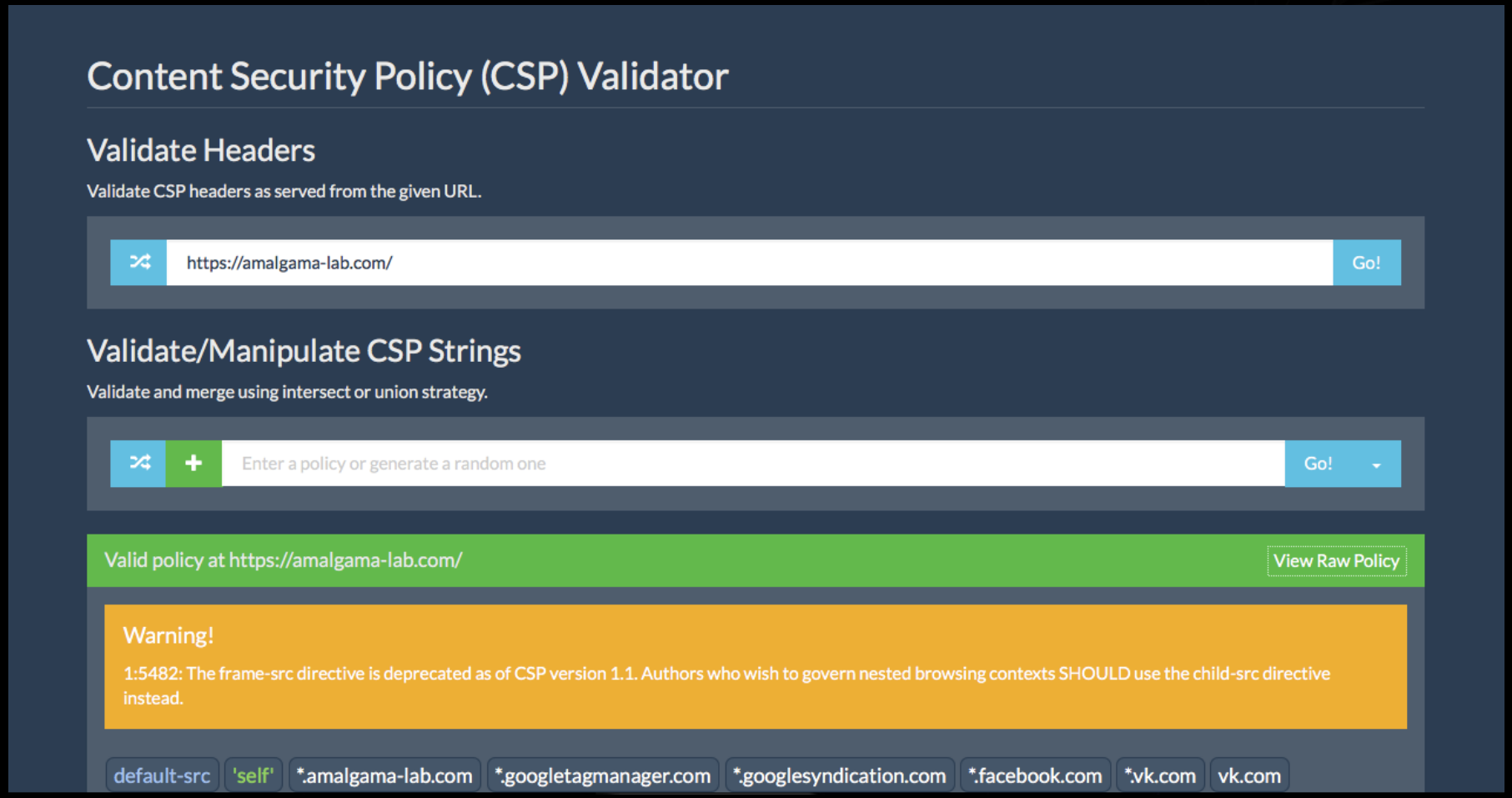
CSP Examples



CSP Examples

https://apis.google.com *.google.com *.google.ru *.google.com.ua *.google.ca *.twitter.com *.youtube.com https://www.youtube.com
*.odnoklassniki.ru *.rutarget.ru *.adriver.ru *.doubleclick.net *.bidswitch.net *.yandex.ru https://accounts.google.com
https://googleads.g.doubleclick.net https://s-static.ak.facebook.com https://www.facebook.com https://login.vk.com ;
script-src 'self' 'unsafe-inline' 'unsafe-eval' *.amalgama-lab.com *.google.ru http://*.google.ru http://cse.google.ru *.google.ru:*
https://*.google.ru:* *.google.com http://*.google.com *.google.com.ua *.google.com:* https://*.google.com:* *.google.ca
https://apis.google.com ajax.googleapis.com https://*.googleapis.com *.googleapis.com *.mixmarket.biz 4294953203.kt.mixmarket.biz
*.revsci.net *.republer.com http://yastatic.net https://*.republer.com *.gstatic.com https://*.gstatic.com *.yandex.net
https://*.yandex.net *.yandex.st *.yandex.ru https://*.yandex.ru yastatic.net *.yastatic.net *.yastatic.net:* https://*.yastatic.net
mc.yandex.ru https://mc.yandex.ru an.yandex.ru https://an.yandex.ru *.yandex.ua https://*.googlesyndication.com
http://*.googlesyndication.com https://googleads.g.doubleclick.net https://*.doubleclick.net *.doubleclick.net *.luxup.ru luxup.ru
*.luxadv.com *.luxcdn.com vk.com *.twitter.com connect.facebook.net graph.facebook.com connect.mail.ru *.pinterest.com
*.advertur.ru advertur.ru *.betweendigital.com counter.rambler.ru www.googletagservices.com www.googletagmanager.com
*.google-analytics.com *.googleadservices.com https://*.googleadservices.com yadro.ru https://yadro.ru *.yadro.ru https://*.yadro.ru
go.youlamedia.com *.adlabs.ru *.adriver.ru *.kavanga.ru https://*.kavanga.ru *.ok.ru ok.ru *.sociomantic.com *.odnoklassniki.ru
.googleusercontent.com https://.google-analytics.com https://google-analytics.com *.imrkcrv.net *.imrk.net *.infostatsvc.com
*.avocet.io ;
img-src 'self' data: *.amalgama-lab.com *.mixmarket.biz *.rutarget.ru *.smartyads.com https://*.republer.com sync.republer.com
*.revsci.net yastatic.net *.yastatic.net *.adhigh.net *.datamind.ru counter.yadro.ru *.ytimg.com *.yandex.net *.yandex.st *.yandex.ru
*.yandex.ua *.google.am *.google.it *.google.jo *.google.cz *.google.ch *.google.no *.google.ae *.google.at *.google.az *.google.bg

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CSP Examples

*.google.me *.google.hr *.google.co.id *.google.co.il *.google.dk *.google.fr *.google.ge *.google.nl *.google.rs *.google.gr
*.google.ba *.google.ro *.google.dz *.google.se *.google.sk *.google.md *.google.ee *.google.lv *.google.pl *.google.tn *.google.es
*.google.si *.google.com.kw *.google.com.ng *.google.lu *.google.ca *.google.lt *.google.com.tr *.google.de *.google.com.cy
*.google.com.au *.google.com.sg *.google.com.eg *.google.co.uk *.google.co.jp *.google.co.in *.google.co.ve *.google.com.kh
*.google.com.mt *.google.com.np *.google.com.pe *.google.com.ph *.google.fi *.google.hu *.google.mn *.google.pt *.google.com.mx
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.googlesyndication.com https://.googlesyndication.com https://pagead2.googlesyndication.com www.google-analytics.com *.google.com
*.google.ru *.google.by *.google.com.ua *.google.be *.google.ie *.google.com.ar *.google.kz *.gstatic.com https://*.gstatic.com
counter.rambler.ru *.betweendigital.com *.luxup.ru *.luxup.ru:* *.imrk.net *.adlabs-retail.ru go.youlamedia.com *.gravatar.com
front.facetz.net ad.dumedia.ru rtb.rtcdn.ru g.mp.luxcdn.com *.rtb-media.ru *.whisla.com *.adlabs.ru *.recreativ.ru *.mail.ru
*.tns-counter.ru x.bidswitch.net *.luxadv.com *.sociomantic.com *.adriver.ru *.kavanga.ru b.kavanga.ru https://*.kavanga.ru
*.hubrus.com *.doubleclick.net https://stats.g.doubleclick.net https://*.doubleclick.net https://googleads.g.doubleclick.net *.2mdn.net
.googleapis.com https://.googleapis.com https://*.2mdn.net *.madnet.ru *.spotxchange.com https://*.spotxchange.com
https://*.adform.net *.republer.com *.intencysrv.com *.googleadservices.com *.yahoo.com *.admitad.com 109.206.167.217
109.206.167.109 mc.yandex.ru mc.yandex.ru:* https://mc.yandex.ru https://*.yandex.ru *.google-analytics.com google-analytics.com
https://*.google-analytics.com https://google-analytics.com *.rontar.com *.paradocs.ru *.uptolike.com *.adap.tv *.r24-tech.com
*.adnxs.com *.rubiconproject.com *.btrll.com *.adtech.de *.liverail.com *.adadvisor.net *.openx.com *.upstats.ru *.advertising.com
*.adsniper.ru *.lijit.com *.openx.net *.adframesrc.com *.targetix.net *.trafex.net *.imrkcrv.net *.tovarro.com *.begun.ru *.avocet.io
*.advombat.ru *.smaclick.com *.yadro.ru https://*.yadro.ru *.liveinternet.ru https://*.liveinternet.ru ;

CSP Examples

style-src 'self' 'unsafe-inline' *.amalgama-lab.com *.gstatic.com https://*.gstatic.com https://fonts.googleapis.com fonts.googleapis.com *.google.com *.sociomantic.com yastatic.net *.yastatic.net *.yastatic.net:* https://*.yastatic.net ;
media-src 'self' *.amalgama-lab.com *.youtube.com youtube.com ;
object-src 'self' *.amalgama-lab.com http://imrkcrv.net *.imrkcrv.net *.adriver.ru *.gstatic.com *.googlesyndication.com https://*.googlesyndication.com https://*.gstatic.com *.datariver.ru *.kavanga.ru *.googlevideo.com googlevideo.com *.ytimg.com ytimg.com *.youtube.com youtube.com an.yandex.ru https://an.yandex.ru *.yandex.ru ;
frame-src 'self' *.amalgama-lab.com *.googlesyndication.com https://*.googlesyndication.com *.googleadservices.com https://*.googleadservices.com *.doubleclick.net https://stats.g.doubleclick.net https://*.doubleclick.net https://googleads.g.doubleclick.net *.google.ru *.google.com *.yandex.st *.imrk.net yastatic.net *.yastatic.net *.yastatic.net:* https://*.yastatic.net ;
font-src 'self' data: *.amalgama-lab.com *.gstatic.com *.googleusercontent.com *.googleapis.com https://*.googleapis.com https://*.gstatic.com ;
connect-src 'self' data: *.amalgama-lab.com mc.yandex.ru *.yandex.ru https://mc.yandex.ru www.google-analytics.com www.liveinternet.ru *.google-analytics.com google-analytics.com https://*.google-analytics.com https://google-analytics.com https://*.yandex.ru ;
report-uri http://www.amalgama-lab.com/csp/report0.php

CSP Validator was built by Sergey Shekyan, Michael Ficarra, Lewis Ellis, Ben Vinegar, and the fine folks at Shape Security.

CSP Examples

Worst policy ever?

```
allow 'self'; frame-ancestors 'self'
```

"The 'allow' directive has been replaced with 'default-src'. Please use that directive instead, as 'allow' has no effect."

Didn't make into CSP level 1.

"Unrecognized Content-Security-Policy directive 'frame-ancestors'."

Introduced by CSP level 2, replaces **`frame-src`**

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Browser Handling of Bad Policies

```
script-src 'self' foo.com/\U0001F4A9
```

```
The value for Content Security Policy directive 'script-src' contains an invalid character: 'http://google.com/Ã£'. Non-whitespace characters outside ASCII 0x21-0x7E must be percent-encoded, as described in RFC 3986, section 2.1: http://tools.ietf.org/html/rfc3986#section-2.1.
```

Parsing error skips the whole directive

```
Content Security Policy: Couldn't parse invalid source http://google.com/Ð°
```

```
Content Security Policy: The page's settings blocked the loading of a resource at self ("script-src 'none'").
```

Parsing error skips only bad source source expression

Some of Security Bugs

```
script-src *.x.y
```

```
<script src='//x.y/file'>
```

Chromium bug 534542 - *.x.y must match host that ends with .x.y, but not x.y

```
script-src *
```

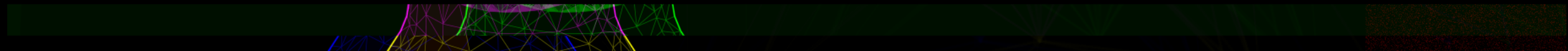
```
<script src='data:applicication/
javascript, alert(1337)'>
```

Chromium bug 534570 - wildcard (*) should not match data:, filesystem:, blob:

CSP Reporting

```
report-uri /csp-report /another-endpoint
```

- sends report to every report URL
- multiple policies do not share reporting context, meaning every policy violation will be reported to it's `report-uri`
- If the origin of report URL is the same as the origin of the protected resource, cookies will be sent too (except Firefox)
- there are as many report formats as there are browsers, so normalize



CSP Reporting

```
Content-Type: application/csp-report
{"csp-report":{
     "document-uri":"http://example.com",
    "referrer":"",
    "violated-directive":"script-src 'self'",
    "effective-directive":"script-src",
    "original-policy":"default-src 'none';script-src 'self' ;img-src 'self'; connect-src
'self';style-src 'self';frame-ancestors 'none';form-action 'self';report-uri /csp-report",
    "blocked-uri":"http://www.evil.com",
     “status-code":200
}}
```

```
Content-Type: application/json
{"csp-report":{
   "blocked-uri":"http://www.evil.com/animate.js",
   “document-uri”:”http://example.com“,
   "original-policy":"default-src 'none'; script-src http://example.com; img-srchttp://
example.com; connect-srchttp://example.com; style-src http://example.com; frame-
ancestors 'none'; form-action http://example.com; report-uri http://example.com/csp-report“,
   "referrer":"",
   "violated-directive":"script-srchttp://example.com",
   "user-agent":"Mozilla/5.0 (Macintosh; Intel Mac OS X 10.10; rv:41.0) Gecko/20100101 Firefox/
41.0",
   "level":"info",
   "message":"",
   "timestamp":"2015-10-20T19:54:51.248Z"
}}
```

Reports Can Leak Data

- make report URI query string unique for segmentation and to avoid dealing with poisoned logs. It is harder to spoof `report-uri /csp-report?id=nonce`
- hacked server with big audience might become DDoS orchestrator

Evaluate before deploying

```
Content-Security-Policy-Report-Only:
'self'; report-uri /csp-report
```

- `Content-Securty-Policy-Report-Only` header monitors, reports but doesn't enforce
- Try new policy with `Content-Securty-Policy-Report-Only` along with your current policy delivered by `Content-Security-Policy` to catch problems before it's too late

Salvation

general purpose FOSS Java library supports:

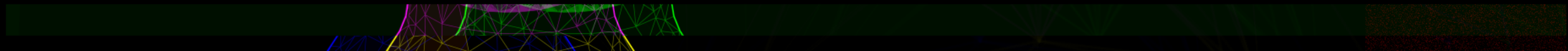
- warnings and syntax errors with position info
- policy optimisation
- merging using union or intersection strategyanswering questions like `allowsConnectTo`, `allowsScriptFromSource`, `allowsStyleWithHash`, `allowsChildFromSource`, etc

is used in production

the only CSP implementation outside of the browser

get it from:

- https://github.com/shapesecurity/salvation
- Maven Central



Merging CSP policies

- ***Union***, which is useful when crafting a policy, starting with a restrictive policy and allowing each resource that is needed.

```
default-src a b
```

U

```
default-src b c
```

==

```
default-src a b c
```

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Merging CSP policies

- ***Intersection*** combines policies in such a way that the result will behave similar to how browsers enforce each policy individually.

```
default-src a b
```

∩

```
default-src; script-src *; style-src c
```

==

```
default-src; script-src a b
```

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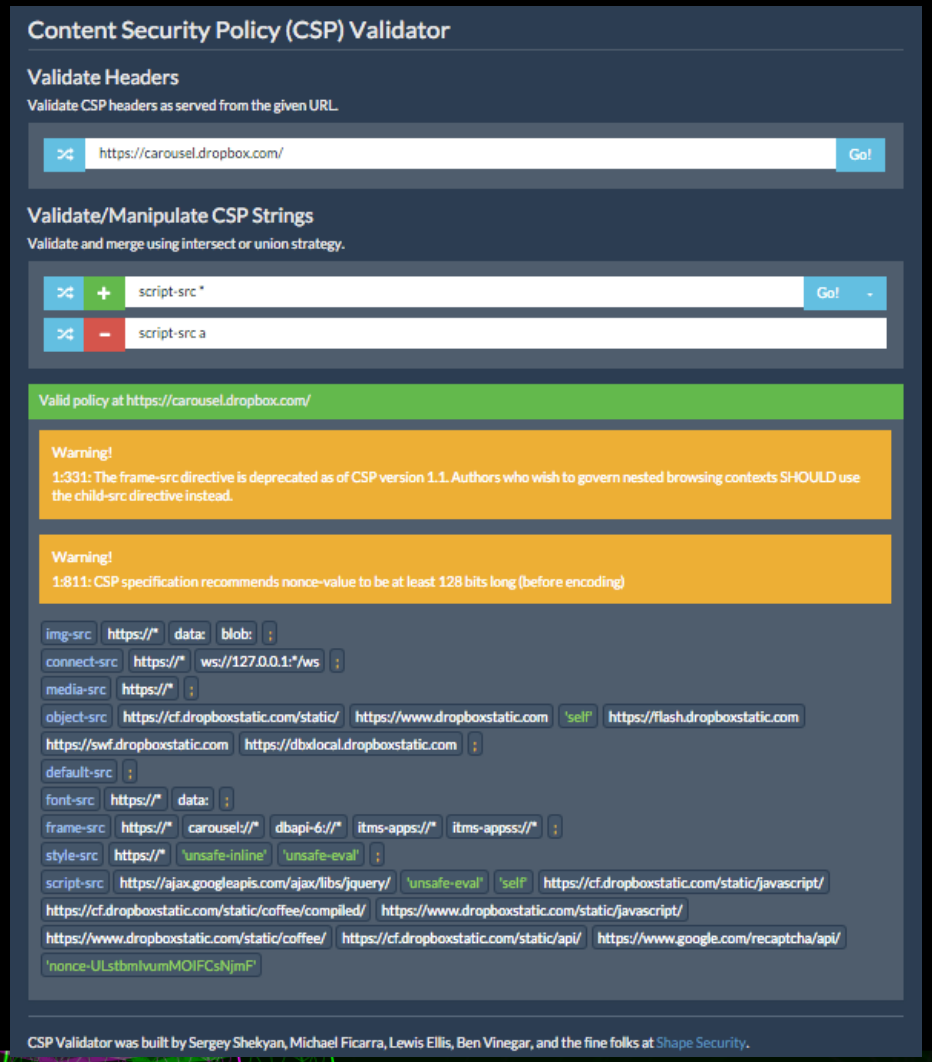
https://cspvalidator.org



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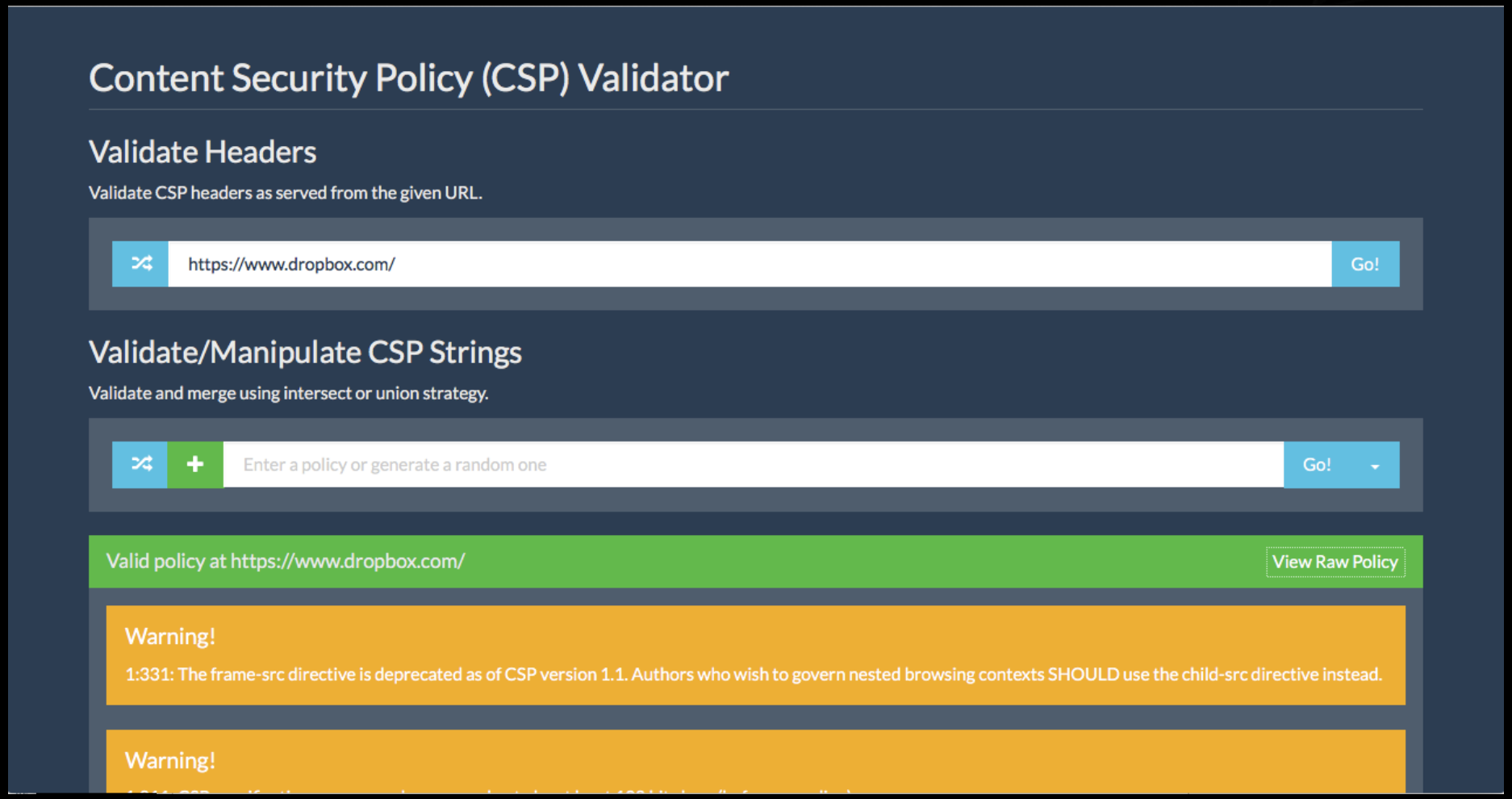

https://cspvalidator.org

Warning!

1:811: CSP specification recommends nonce-value to be at least 128 bits long (before encoding)

img-src	https://* data: blob: ;
connect-src	https://* ws://127.0.0.1:*/ws ;
media-src	https://* ;
object-src	https://cf.dropboxstatic.com/static/ https://www.dropboxstatic.com 'self' https://flash.dropboxstatic.com https://swf.dropboxstatic.com https://dbxlocal.dropboxstatic.com ;
default-src	;
font-src	https://* data: ;
frame-src	https://* carousel://* dbapi-6://* itms-apps://* itms-appss://* ;
style-src	https://* 'unsafe-inline' 'unsafe-eval' ;
script-src	https://ajax.googleapis.com/ajax/libs/jquery/ 'unsafe-eval' 'self' https://cf.dropboxstatic.com/static/javascript/ https://cf.dropboxstatic.com/static/coffee/compiled/ https://www.dropboxstatic.com/static/javascript/ https://www.dropboxstatic.com/static/coffee/ https://cf.dropboxstatic.com/static/api/ https://www.google.com/recaptcha/api/ 'nonce-4Kslap8Tije6SugZfxXZ'

CSP Validator was built by Sergey Shekyan, Michael Ficarra, Lewis Ellis, Ben Vinegar, and the fine folks at Shape Security.

Powered by Salvation, a Java library for working with CSP policies.

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https://cspvalidator.org

- Exposes a subset of Salvation features
- validates, inspects, merges
- try random policy buttons 
- compare raw policy served by web site with optimised one 

- share policies
  - https://cspvalidator.org/#url=https://www.twitter.com/
  - https://cspvalidator.org/#headerValue%5B%5D=script-src+example.com&headerValue%5B%5D=&strategy=union
- Web app takes advantage of browser security features like HPKP, HSTS, CSP, security headers

How does good CSP policy look like?

```
default-src ;
script-src 'self' https://www.google-analytics.com
https://code.jquery.com https://
maxcdn.bootstrapcdn.com ;
img-src 'self' https://www.google-analytics.com ;
font-src 'self' https://fonts.gstatic.com https://
bootswatch.com ;
connect-src 'self' ;
style-src 'self' https://bootswatch.com https://
fonts.googleapis.com ;
frame-ancestors 'none' ;
form-action 'self' ;
report-uri https://cspvalidator.org/csp-report
```

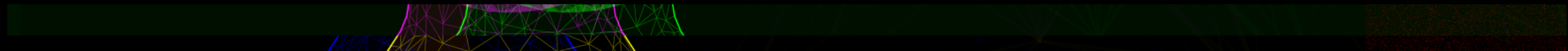
Contributing to CSP

While developing Salvation

- >10 bugs reported against the CSP specification
- >10 bugs reported against Chromium CSP implementation

Use Salvation!

Participate! We haven't looked at other browsers



Useful stuff

- https://github.com/w3c/webappsec-csp/issues
- https://oreoshake.github.io/csp/twitter/2014/07/25/twitters-csp-report-collector-design.html
- https://github.com/yahoo/csptester
- https://github.com/slightlyoff/CriSP

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Thanks!

@sshekyan @jspedant