2019
Web Almanac

HTTP Archive

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◇◇ iii

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◇ 3: ◇◇◇◇◇◇ 55
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◇◇◇ 385
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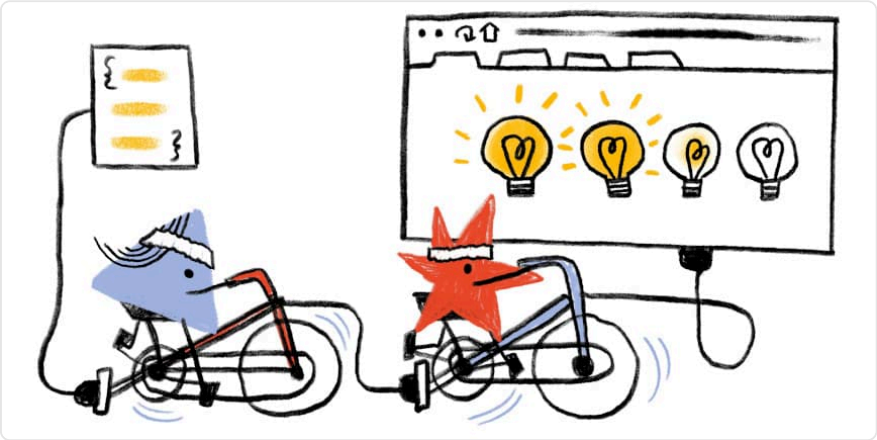
◇ I ◇ 1
JavaScript

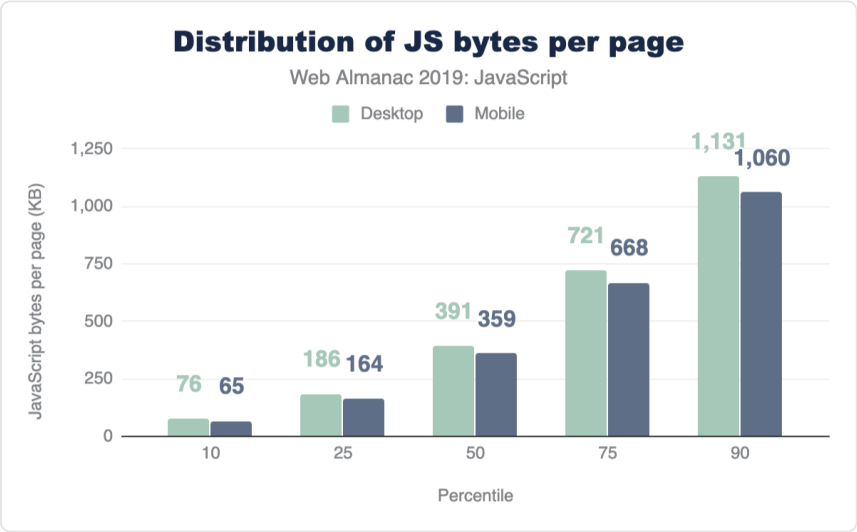


Houssein Djirdeh ◇◇◇◇◇◇◇◇◇
David Fox, Paul Calvano, ◇ *Mathias Bynens* ◇◇◇◇◇◇◇◇
Sakae Kotaro ◇◇◇◇◇◇◇◇◇◇

◇◇

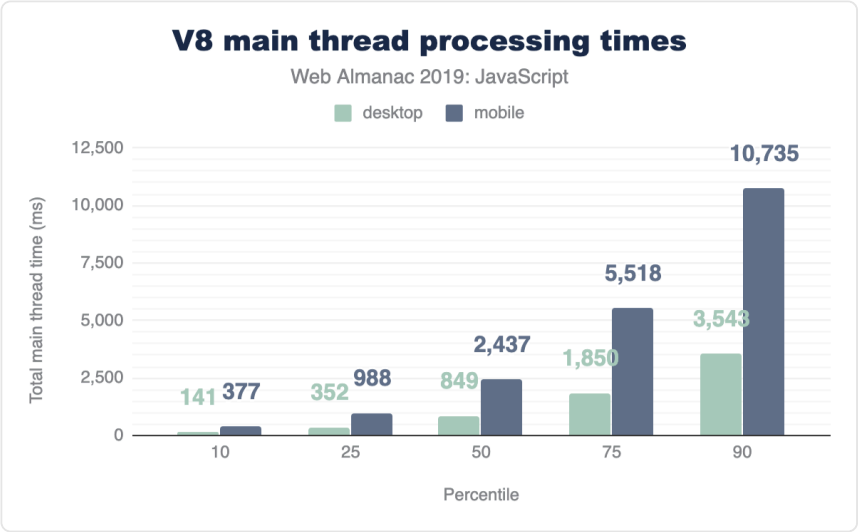
JavaScript◇◇◇◇◇◇◇◇◇◇

◇◇◇



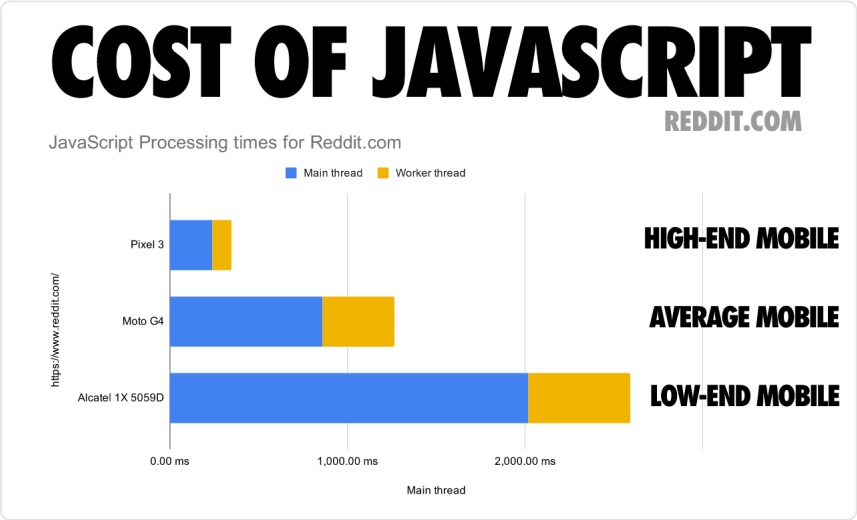
◇ 2. ◇◇◇◇◇◇◇◇◇◇◇◇◇JavaScript◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇


V8 main thread processing times
Web Almanac 2019: JavaScript
desktop
mobile
Total main thread time (ms)
12,500
10,000
7,500
5,000
2,500
0
141
377
352
988
849
2,437
1,850
5,518
3,543
10,735
10
25
50
75
90
Percentile

◇ 3. ◇◇◇◇◇◇V8◇◇◇◇◇◇◇◇◇◇◇◇

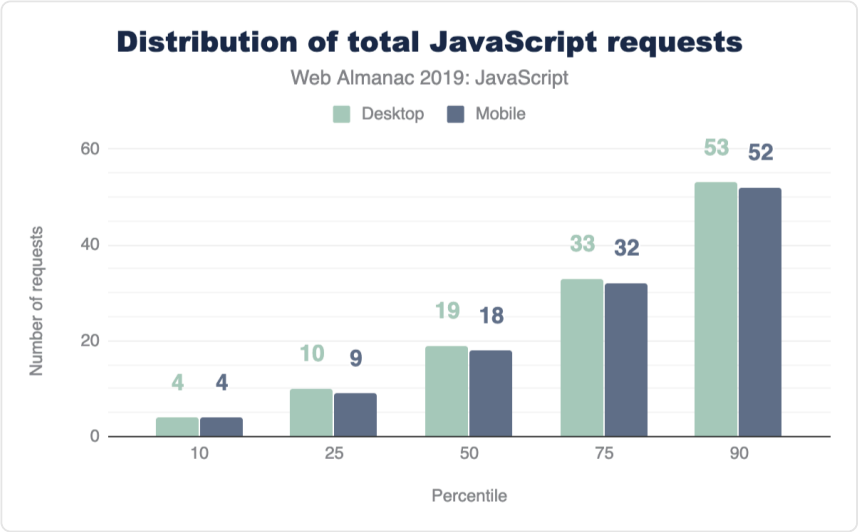
◇◇◇◇◇◇◇◇◇◇◇◇



◇ 4. reddit.com◇JavaScript◇◇◇◇◇2019◇◇JavaScript◇◇◇◇[5]◇◇◇

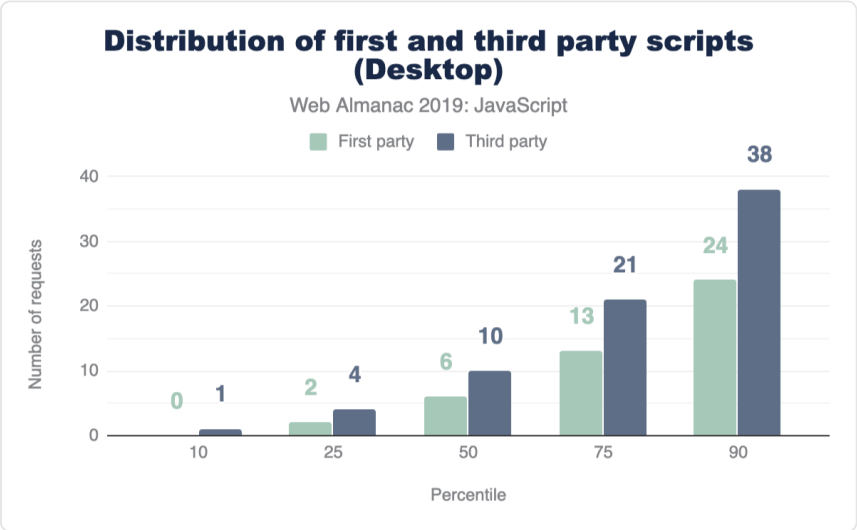
◇◇◇◇◇

Web◇◇◇◇◇◇◇◇◇◇◇JavaScript◇◇◇◇◇◇◇◇◇◇◇◇◇1◇◇◇◇◇◇◇◇◇◇◇◇◇

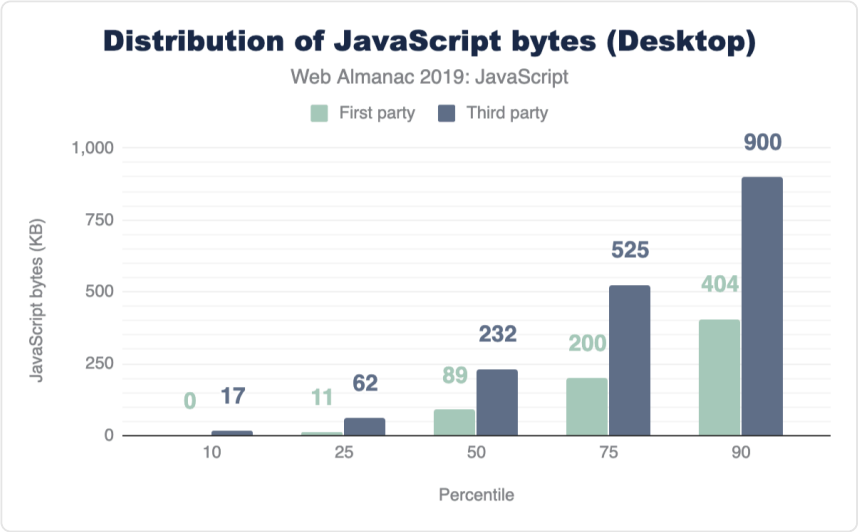


◇ 5. ◇JavaScript◇◇◇◇◇◇◇◇◇◇

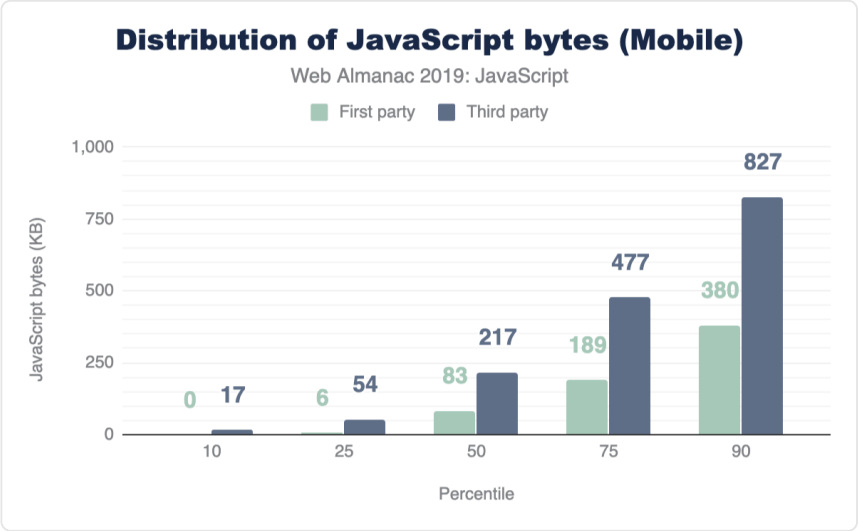
◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇19◇◇◇◇◇◇◇◇◇18◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇


Distribution of first and third party scripts (Desktop)
Web Almanac 2019: JavaScript
First party
Third party
Number of requests
40
30
20
10
0
0
1
2
4
6
10
13
21
24
38
10
25
50
75
90
Percentile

◇ 6. ◇◇◇



◇ 8. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇JavaScript◇◇◇◇◇◇◇◇◇◇◇◇◇



◇ 9. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇JavaScript◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇

◇◇◇◇◇◇

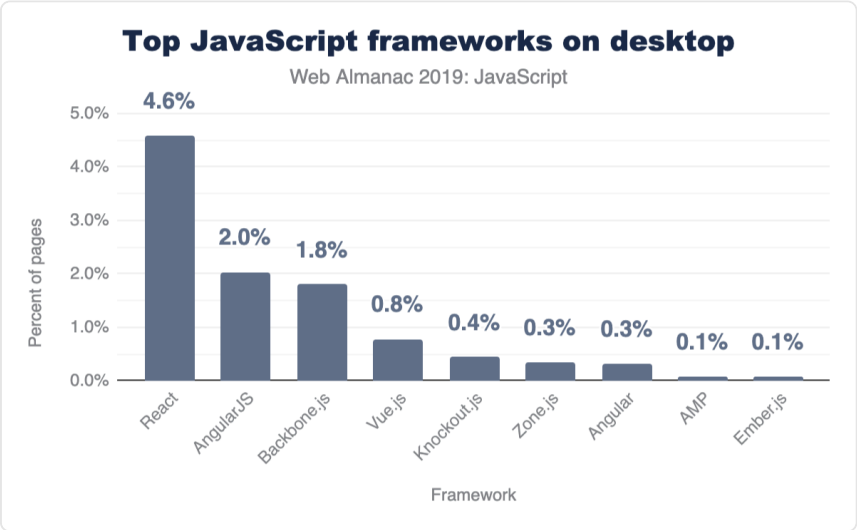
◇◇◇◇◇◇◇◇◇JavaScript◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Gzip◇◇◇◇◇◇◇◇◇◇◇◇◇◇
◇64-67◇◇◇Brotli◇◇14◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇	◇◇◇◇◇◇	◇◇◇◇
jQuery	*85.03%*	*83.46%*
jQuery Migrate	*31.26%*	*31.68%*
jQuery UI	*23.60%*	*21.75%*
Modernizr	*17.80%*	*16.76%*
FancyBox	*7.04%*	*6.61%*
Lightbox	*6.02%*	*5.93%*
Slick	*5.53%*	*5.24%*
Moment.js	*4.92%*	*4.29%*
Underscore.js	*4.20%*	*3.82%*
prettyPhoto	*2.89%*	*3.09%*
Select2	*2.78%*	*2.48%*
Lodash	*2.65%*	*2.68%*
Hammer.js	*2.28%*	*2.70%*
YUI	*1.84%*	*1.50%*
Lazy.js	*1.26%*	*1.56%*
Fingerprintjs	*1.21%*	*1.32%*
script.aculo.us	*0.98%*	*0.85%*
Polyfill	*0.97%*	*1.00%*
Flickity	*0.83%*	*0.92%*
Zepto	*0.78%*	*1.17%*
Dojo	*0.70%*	*0.62%*

◇ 11. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ JavaScript ◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇JavaScript◇◇◇◇◇◇◇◇jQuery[11]◇◇◇◇◇◇◇◇◇◇◇◇◇◇85.03◇◇◇◇◇◇◇◇◇◇◇83.46◇◇◇◇◇◇◇◇◇◇◇◇Fetch[12]◇querySelector[13]◇◇◇◇◇◇◇◇◇◇API◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇jQuery◇◇◇◇◇


Top JavaScript frameworks on desktop
Web Almanac 2019: JavaScript
Percent of pages
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
4.6%
2.0%
1.8%
0.8%
0.4%
0.3%
0.3%
0.1%
0.1%
React
AngularJS
Backbone.js
Vue.js
Knockout.js
Zone.js
Angular
AMP
Ember.js
Framework

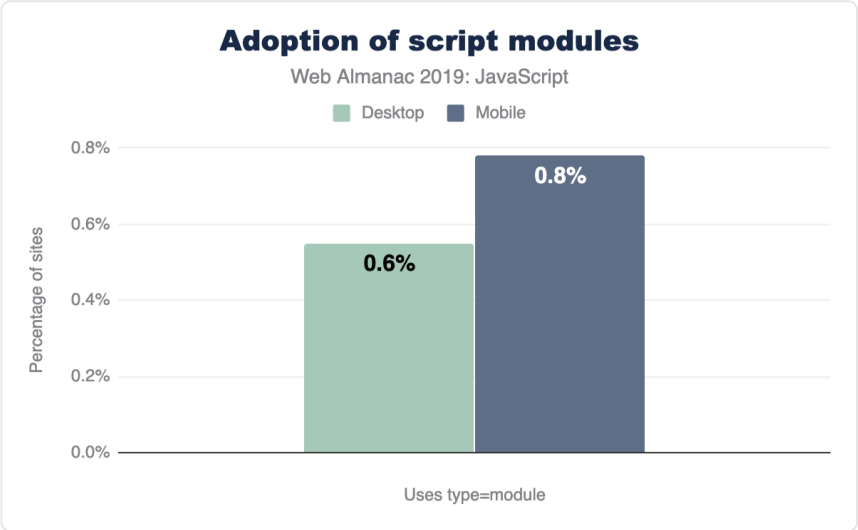
◇ *12. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇*

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇type="module"◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

```
<script type="module" src="main.mjs"></script>
```

◇◇◇◇◇◇◇◇◇◇◇type="module'◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇



◇ 13. *type=module*◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

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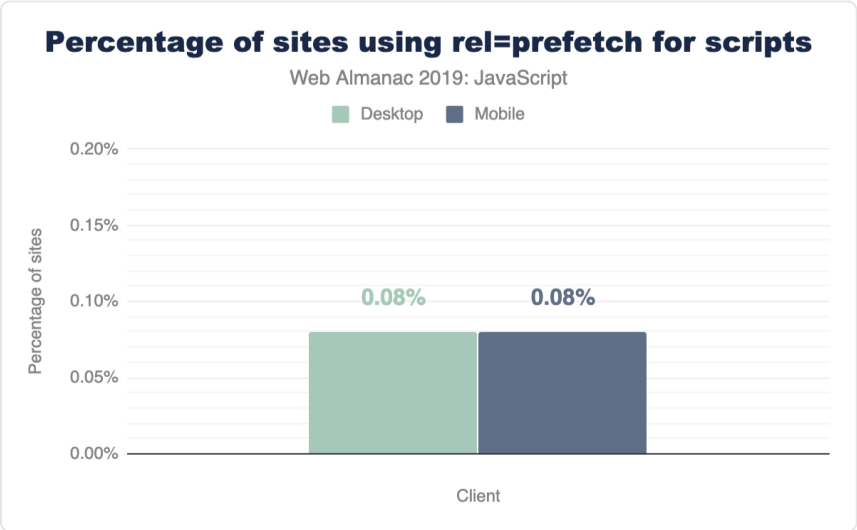
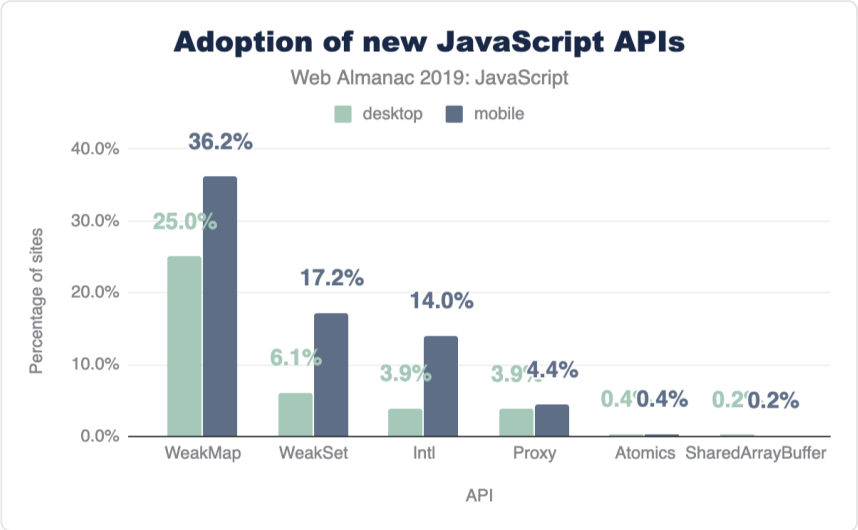
◇◇◇



◇ 16. ◇◇◇◇◇◇rel=prefetch◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇0.08◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

- WeakSet[39]



◇ 17. ◇◇◇JavaScript API◇◇◇◇

Atomics(0.38◇)◇SharedArrayBuffer(0.20◇)◇◇◇◇

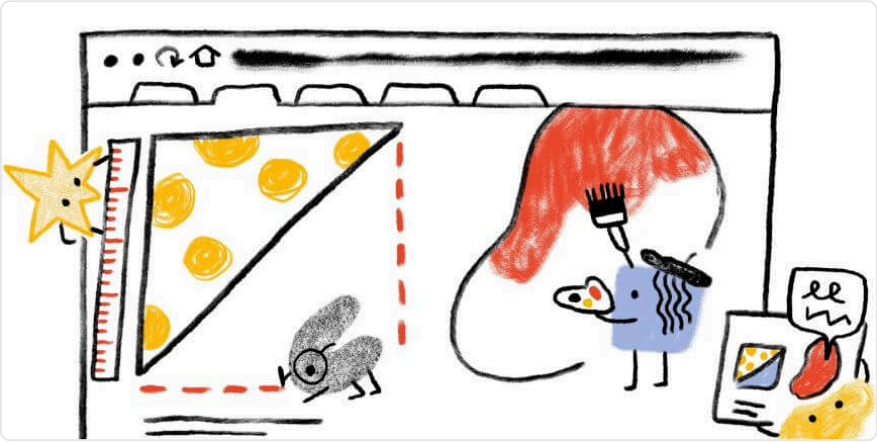
◇◇◇

◇◇

Houssein Djirdeh

Houssein◇Google◇◇◇

◇ I ◇ 2
CSS



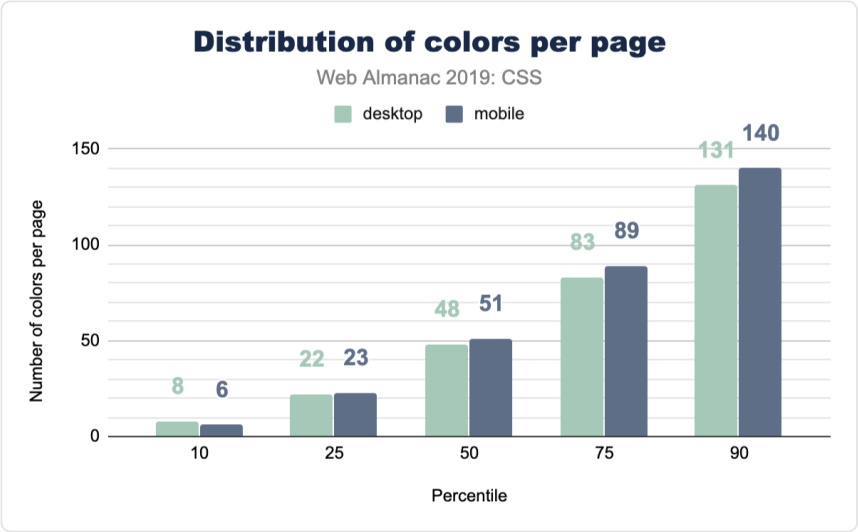
Una Kravets ◇ Adam Argyle ◇◇◇◇◇◇◇◇◇
Eric A. Meyer ◇ Chen Hui Jing ◇◇◇◇◇◇◇◇
Sakae Kotaro ◇◇◇◇◇◇◇◇◇◇◇

◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇CSS◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇! ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

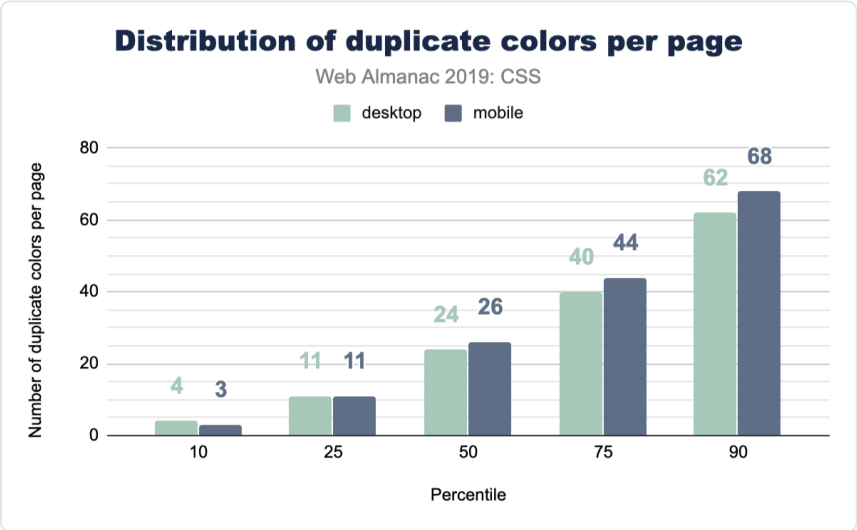
◇◇◇


Distribution of colors per page
Web Almanac 2019: CSS
desktop
mobile
Number of colors per page
150
100
50
0
8
6
22
23
48
51
83
89
131
140
10
25
50
75
90
Percentile

◇ *3.* ◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇

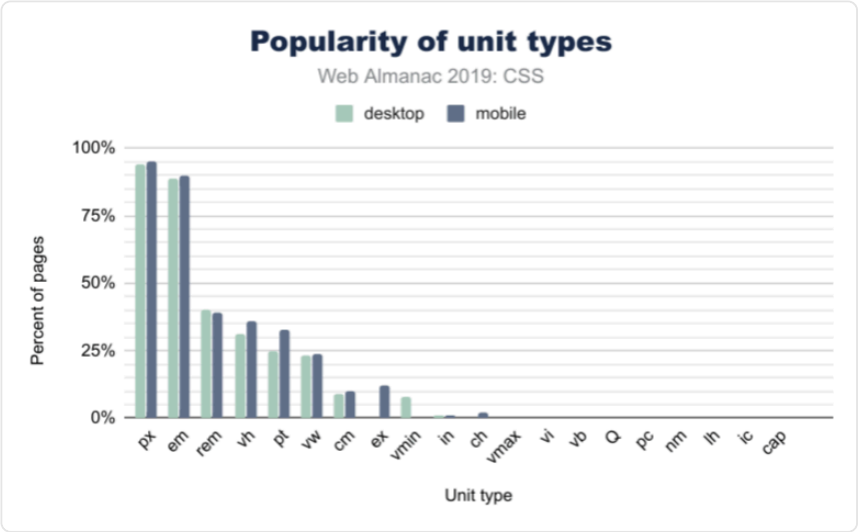
◇◇◇◇◇◇◇◇◇◇◇



◇ 4. ◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇

CSS◇◇◇◇◇◇◇◇◇◇◇◇◇◇rem◇px◇em◇ch◇◇◇◇cm◇◇◇◇◇◇◇◇◇◇◇◇◇◇


Popularity of unit types
Web Almanac 2019: CSS
desktop
mobile
100%
75%
50%
25%
0%
Percent of pages
px
em
rem
vh
pt
vw
cm
ex
vmin
in
ch
vmax
vi
vb
Q
pc
nm
lh
ic
cap
Unit type

◇ 5. ◇◇◇◇◇◇◇◇◇◇◇

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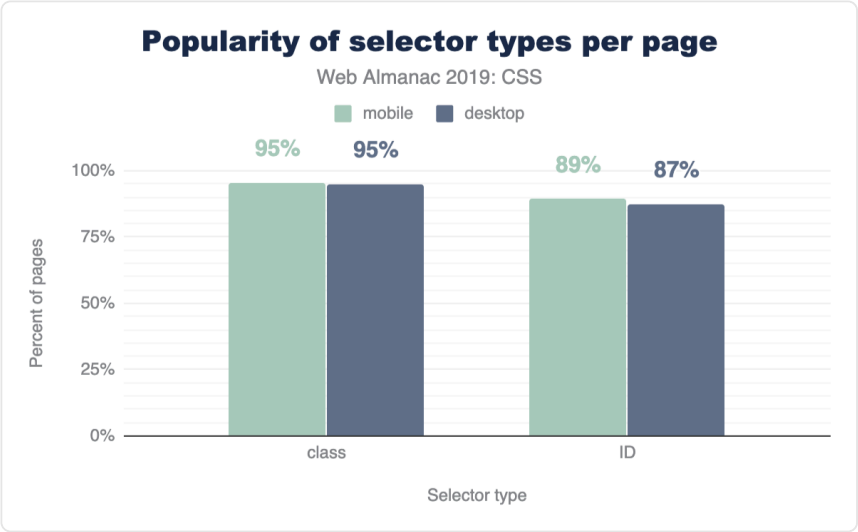
◇◇◇◇◇◇◇◇◇◇◇◇◇5◇◇◇px◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇95◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇36.8◇◇vh◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇31◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇vh◇vw◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇11◇◇◇◇◇◇ vmin◇◇◇◇◇◇◇◇◇◇◇◇◇◇vmax◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇vmin◇◇◇◇◇◇◇8◇◇◇vmax◇Web◇◇◇◇1◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇CSS◇◇CSS◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

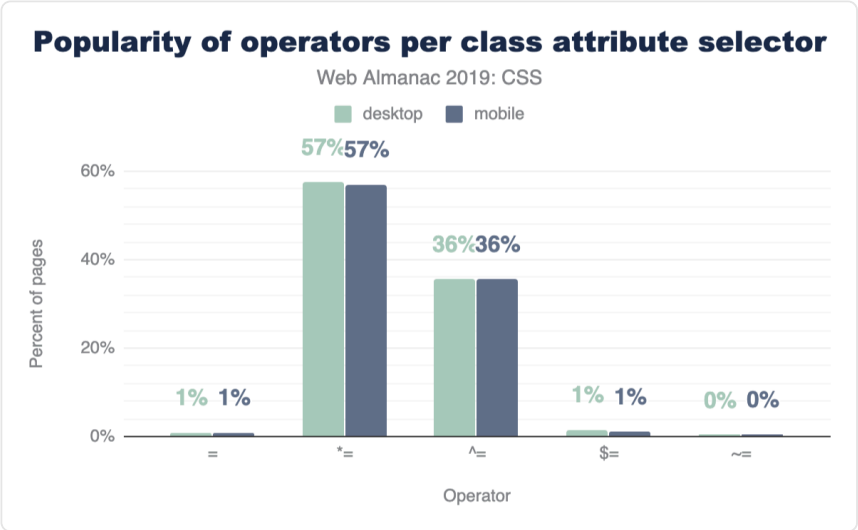

Popularity of selector types per page
Web Almanac 2019: CSS
mobile
desktop
95%
95%
89%
87%
100%
75%
50%
25%
0%
Percent of pages
class
ID
Selector type

◇ 7.◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇

CSS◇◇◇◇◇◇


Popularity of operators per class attribute selector
Web Almanac 2019: CSS
desktop
mobile
Percent of pages
60%
40%
20%
0%
57%
57%
36%
36%
1%
1%
1%
1%
0%
0%
=
*=
^=
$=
~=
Operator

◇ *10.◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇*

◇◇◇◇◇◇◇◇ID◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇

Flexbox

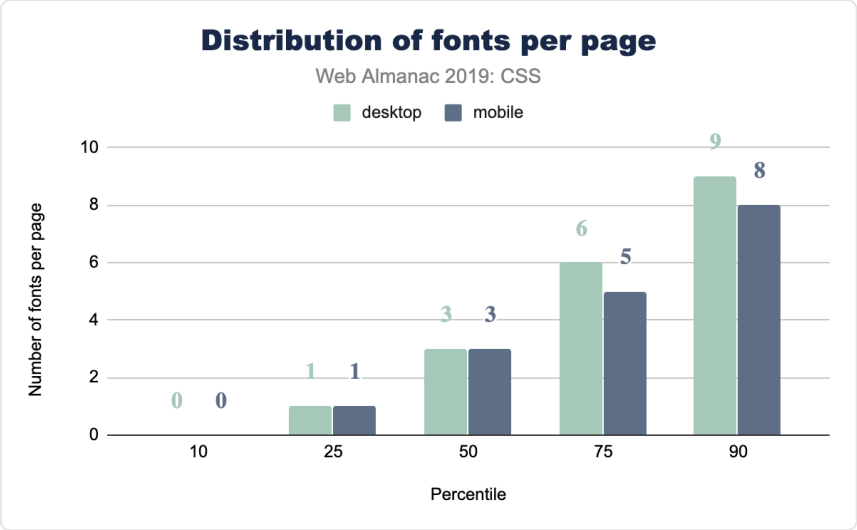
Flexbox[48]◇◇◇◇◇

◇◇◇

◇◇◇◇◇◇◇

◇◇◇◇◇◇Web◇◇◇◇

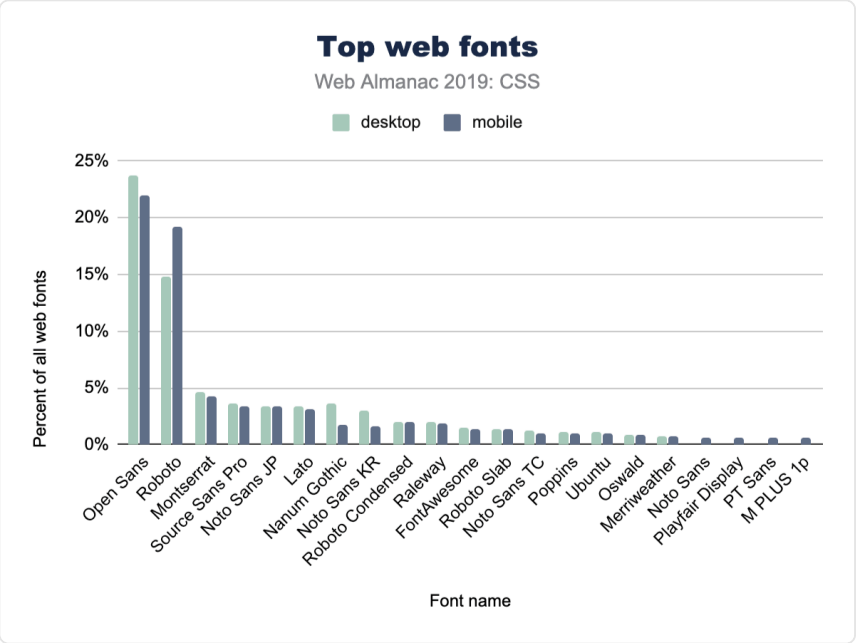
Web◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇0◇◇10◇◇1◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇3◇◇◇



◇ 15.◇◇◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇

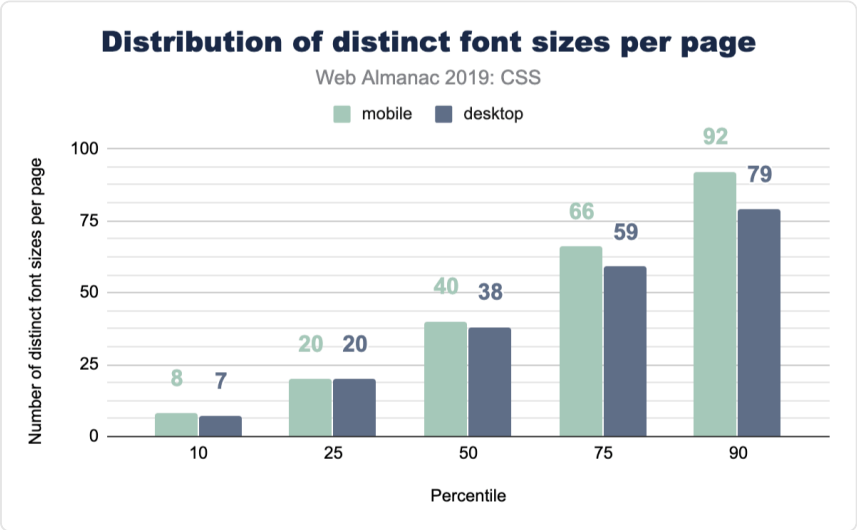
◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇



◇ 16.◇◇◇Web◇◇◇◇◇

◇◇◇◇Open Sans◇◇◇◇◇◇◇◇◇◇CSS◇`@font-family`◇◇◇4◇◇1◇◇◇◇◇◇◇◇◇◇

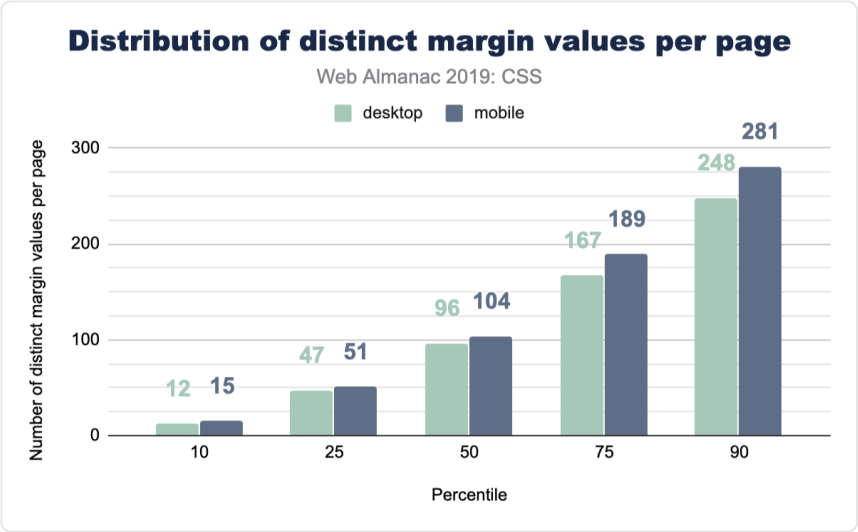

Distribution of distinct font sizes per page
Web Almanac 2019: CSS
mobile
desktop
Number of distinct font sizes per page
100
75
50
25
0
8
7
20
20
40
38
66
59
92
79
10
25
50
75
90
Percentile

◇ *17.◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇*

◇◇

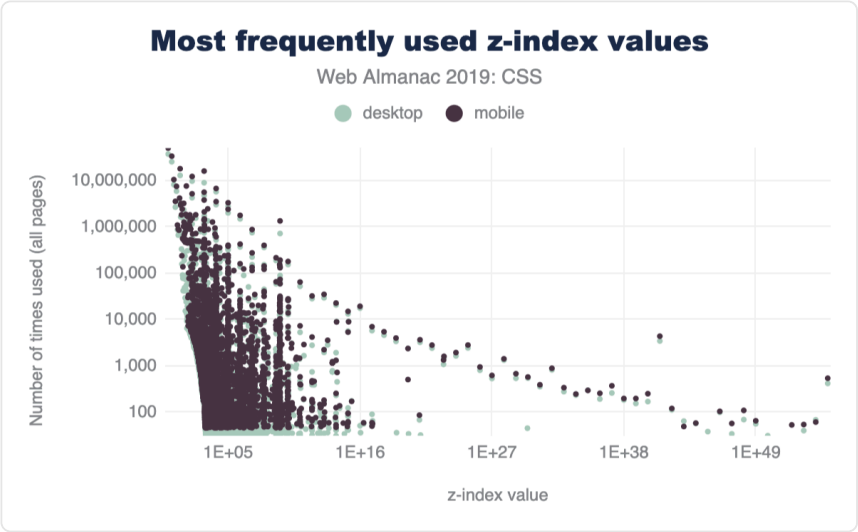
◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇


Distribution of distinct margin values per page
Web Almanac 2019: CSS
desktop
mobile
Number of distinct margin values per page
300
200
100
0
12
15
47
51
96
104
167
189
248
281
10
25
50
75
90
Percentile

*◇ 18.◇◇◇

◇◇◇



◇ *21.◇◇◇◇◇◇◇◇◇◇z-index◇◇*

99999999999999999999999999999999999999999999999
99999999999999999999999999999999999999999999999
99999999999999999999999999999999999999999999999

◇◇◇◇◇◇◇

◇◇◇◇◇

◇◇◇◇◇◇◇

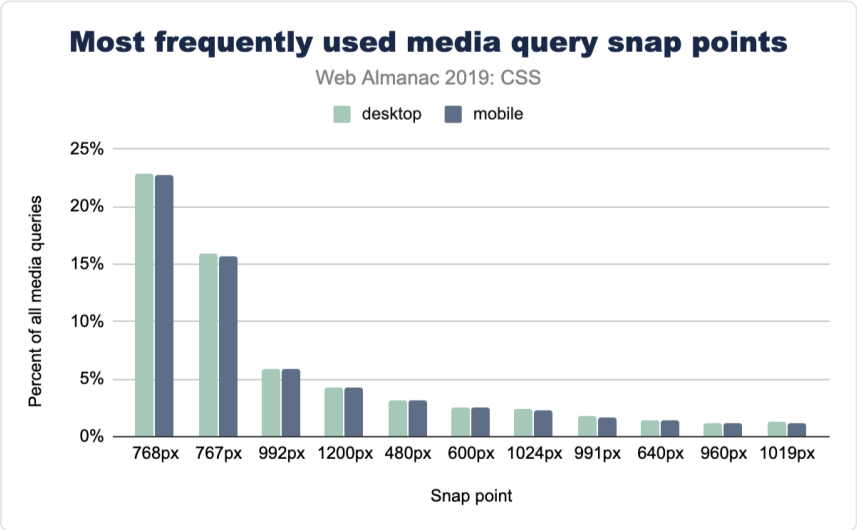
8%

◇ 24. `*-blend-mode`◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

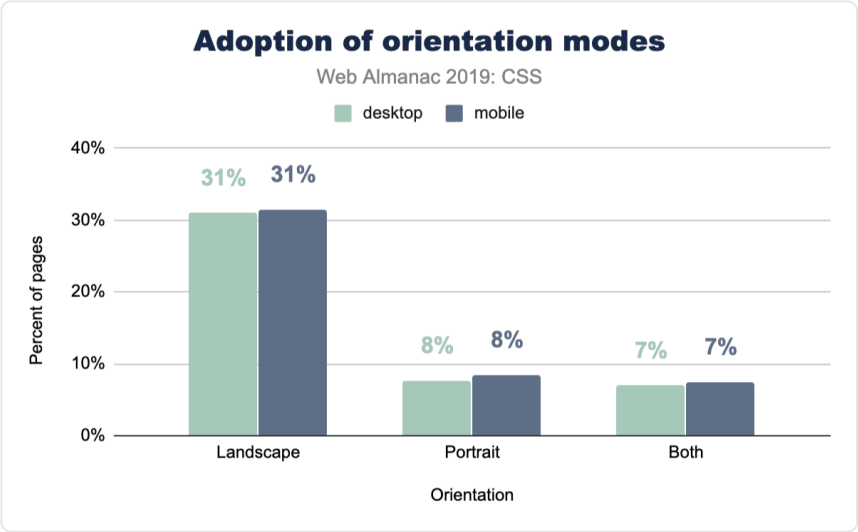
◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇animate.css◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇1◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

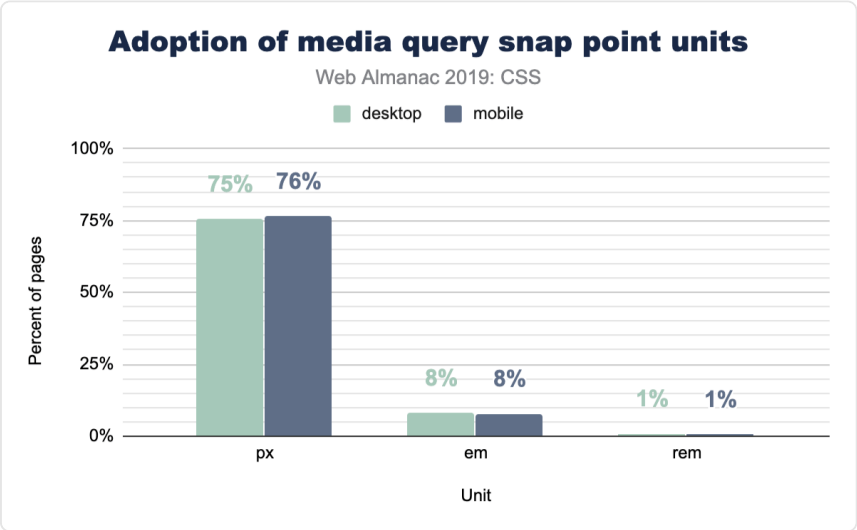

Most frequently used media query snap points
Web Almanac 2019: CSS
desktop
mobile
25%
20%
15%
10%
5%
0%
Percent of all media queries
768px
767px
992px
1200px
480px
600px
1024px
991px
640px
960px
1019px
Snap point

◇ 28. ◇◇◇

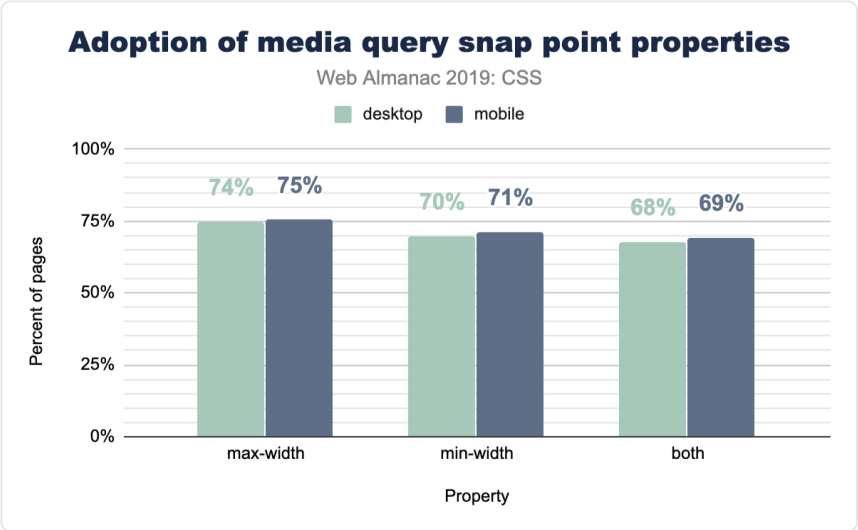

Adoption of orientation modes
Web Almanac 2019: CSS
desktop
mobile
40%
30%
20%
10%
0%
Percent of pages
31%
31%
8%
8%
7%
7%
Landscape
Portrait
Both
Orientation

◇ *29.*◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

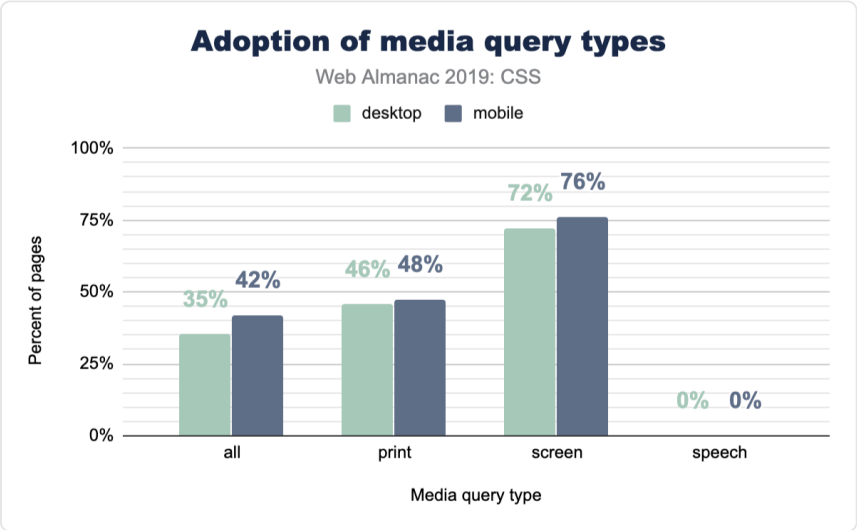
◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇


Adoption of media query snap point units
Web Almanac 2019: CSS
desktop
mobile
100%
75%
50%
25%
0%
Percent of pages
75%
76%
8%
8%
1%
1%
px
em
rem
Unit

◇ *30.◇◇◇


Adoption of media query snap point properties
Web Almanac 2019: CSS
desktop
mobile
100%
75%
50%
25%
0%
Percent of pages
74%
75%
70%
71%
68%
69%
max-width
min-width
both
Property

◇ *31.◇◇◇

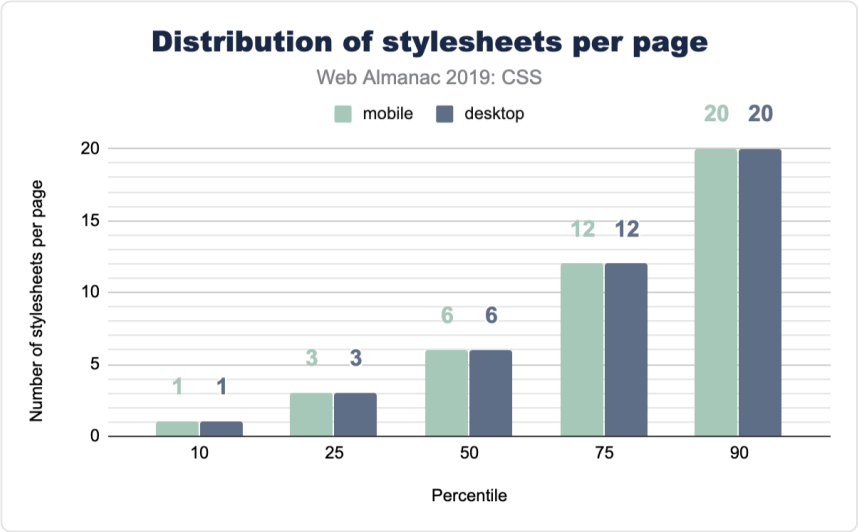


◇ 32.◇◇◇◇◇◇◇◇all◇print◇screen◇◇◇◇speech◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇

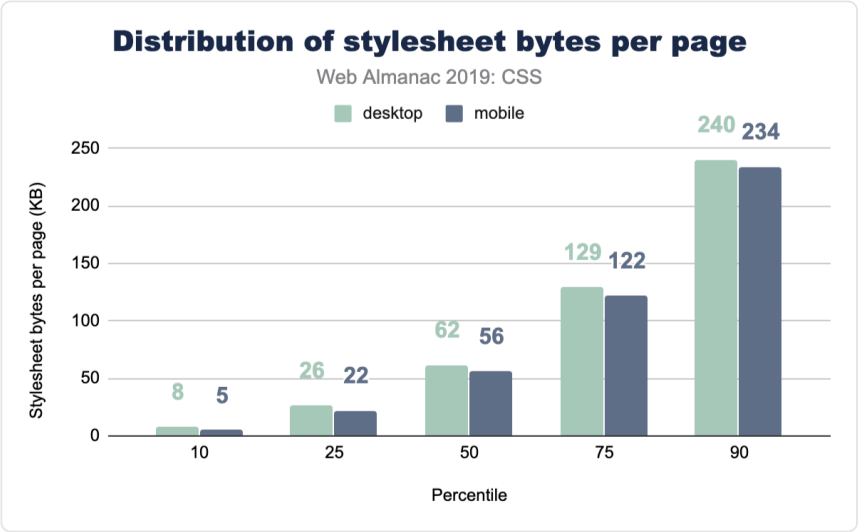

Distribution of stylesheets per page
Web Almanac 2019: CSS
mobile
desktop
Number of stylesheets per page
20
15
10
5
0
1 1
3 3
6 6
12 12
20 20
10
25
50
75
90
Percentile

◇ *33.◇◇◇

◇◇◇◇◇◇◇◇	◇◇◇◇◇◇	◇◇◇◇
style.css	*2.43%*	*2.55%*
font-awesome.min.css	*1.86%*	*1.92%*
bootstrap.min.css	*1.09%*	*1.11%*
BfWyFJ2Rl5s.css	*0.67%*	*0.66%*
style.min.css?ver=5.2.2	*0.64%*	*0.67%*
styles.css	*0.54%*	*0.55%*
style.css?ver=5.2.2	*0.41%*	*0.43%*
main.css	*0.43%*	*0.39%*
bootstrap.css	*0.40%*	*0.42%*
font-awesome.css	*0.37%*	*0.38%*
style.min.css	*0.37%*	*0.37%*
styles_ltr.css	*0.38%*	*0.35%*
default.css	*0.36%*	*0.36%*
reset.css	*0.33%*	*0.37%*
styles.css?ver=5.1.3	*0.32%*	*0.35%*
custom.css	*0.32%*	*0.33%*
print.css	*0.32%*	*0.28%*
responsive.css	*0.28%*	*0.31%*

◇ *34.◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇*

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇


Distribution of stylesheet bytes per page
Web Almanac 2019: CSS
desktop
mobile
Stylesheet bytes per page (KB)
250
200
150
100
50
0
8
5
26
22
62
56
129
122
240
234
10
25
50
75
90
Percentile

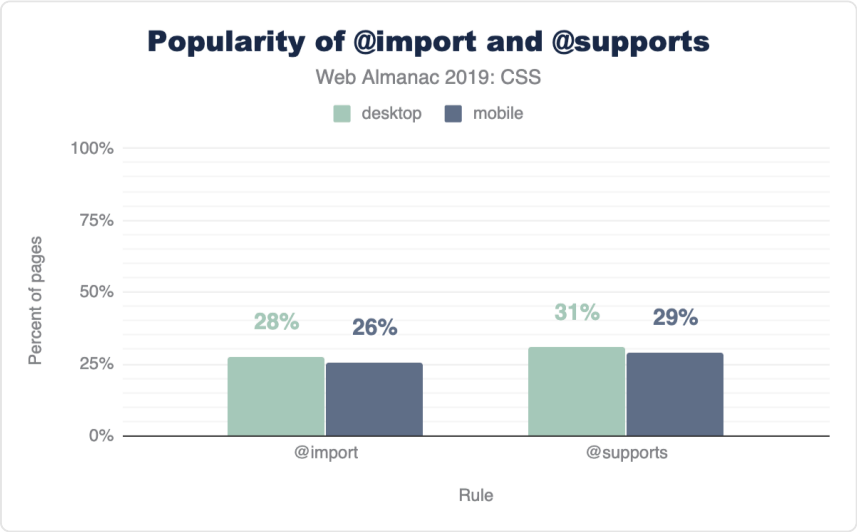
*◇ 35.◇◇◇

◇◇◇◇◇	◇◇◇◇◇◇	◇◇◇◇
Bootstrap	*27.8%*	*26.9%*
animate.css	*6.1%*	*6.4%*
ZURB Foundation	*2.5%*	*2.6%*
UIKit	*0.5%*	*0.6%*
Material Design Lite	*0.3%*	*0.3%*
Materialize CSS	*0.2%*	*0.2%*
Pure CSS	*0.1%*	*0.1%*
Angular Material	*0.1%*	*0.1%*
Semantic-ui	*0.1%*	*0.1%*
Bulma	*0.0%*	*0.0%*
Ant Design	*0.0%*	*0.0%*
tailwindcss	*0.0%*	*0.0%*
Milligram	*0.0%*	*0.0%*
Clarity	*0.0%*	*0.0%*

◇ 36. ◇◇◇CSS◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇Bootstrap[52]◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇



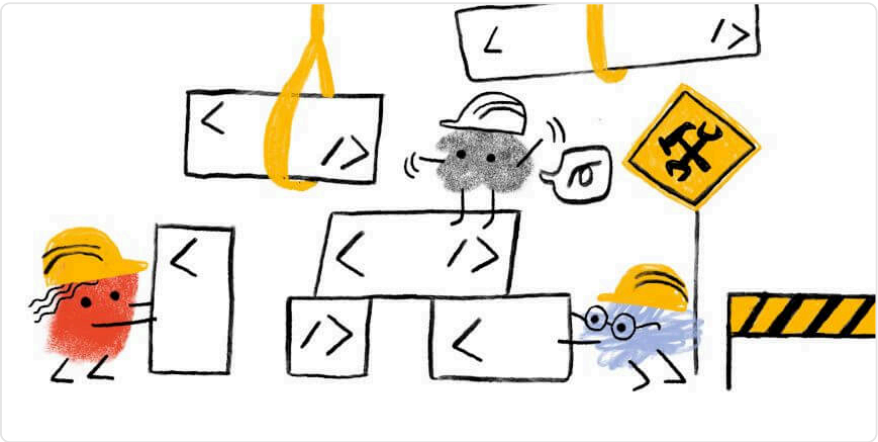
◇ 38. CSS◇@◇◇◇◇◇◇◇

2013◇◇◇◇◇◇◇◇◇◇◇◇◇@supports◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇@una[54]◇◇◇@argyleink[55]◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇ I ◇ 3

◇◇◇◇◇◇



Brian Kardell *◇◇◇◇◇◇◇◇◇*
Simon Pieters, Tommy Hodgins, ◇ Matthew Phillips ◇◇◇◇◇◇◇◇
M.Sakamaki ◇◇◇◇◇◇◇◇◇◇

◇◇

2005◇◇Ian "Hixie" Hickson◇◇◇◇◇◇◇◇◇◇

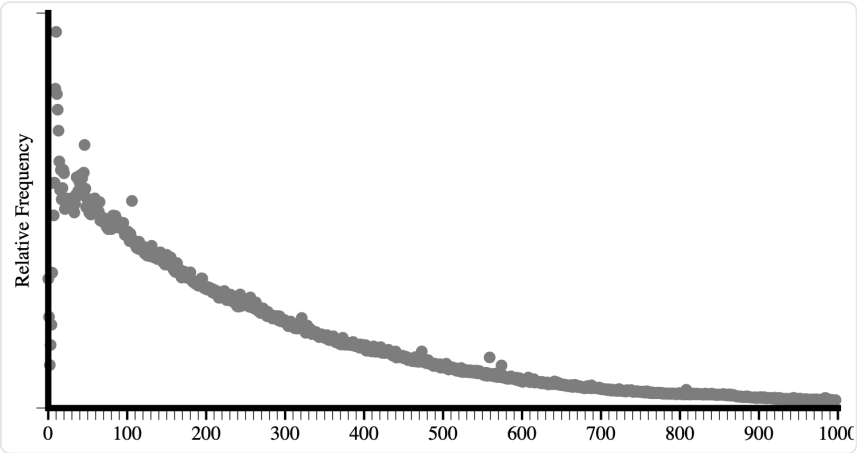
◇◇◇◇◇◇◇DOM◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ (◇◇◇◇◇◇◇◇◇◇◇◇◇◇)

◇◇◇◇◇◇◇◇◇◇◇*5,000*◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

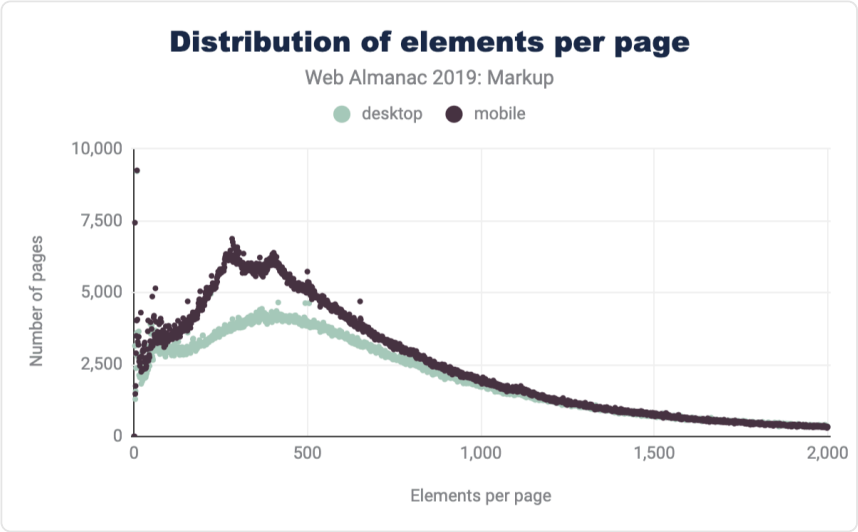
2005 (◇◇◇◇)	2019 (◇◇◇◇)	2019 (◇◇◇)
title	title	div
a	meta	a
img	a	span
meta	div	li
br	link	img
table	script	script
td	img	p
tr	span	option

◇ 1. 2005◇◇◇2019◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇

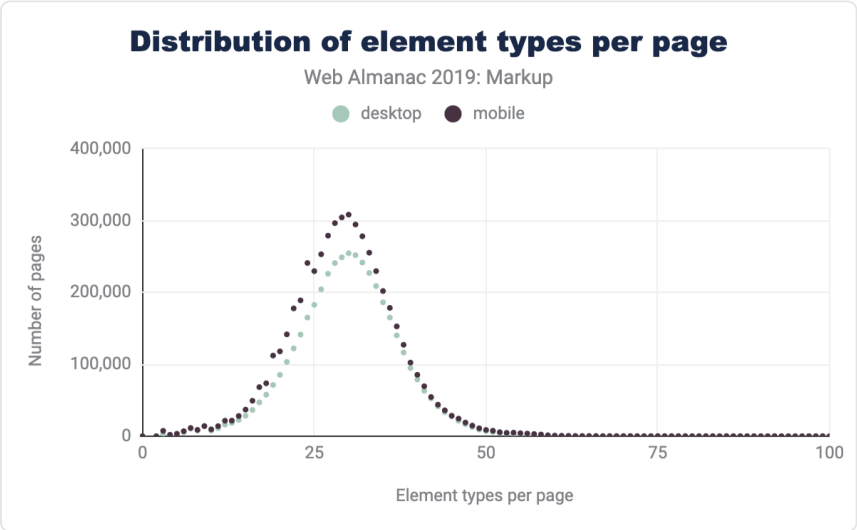


◇ 2. Hixie◇◇◇2005◇◇◇◇◇◇◇◇◇◇



◇ 3. 2019◇◇◇◇◇◇◇

◇2◇2005◇◇Hixie◇◇◇◇◇◇◇3◇◇◇◇◇◇◇◇◇◇◇◇◇◇DOM◇◇◇◇◇◇◇◇◇◇◇◇◇◇


Distribution of element types per page
Web Almanac 2019: Markup
desktop
mobile
400,000
300,000
200,000
100,000
0
Number of pages
0
25
50
75
100
Element types per page

*◇ 5. 2019◇◇◇◇◇◇

◇◇◇◇◇◇

◇◇◇◇◇◇◇

◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇90%◇◇◇◇◇◇◇◇◇◇◇◇11◇◇◇◇◇◇◇◇◇◇

- <html>
- <head>
- <body>
- <title>
- <meta>
- <a>
-
- <link>
- <script>
- <img>
-

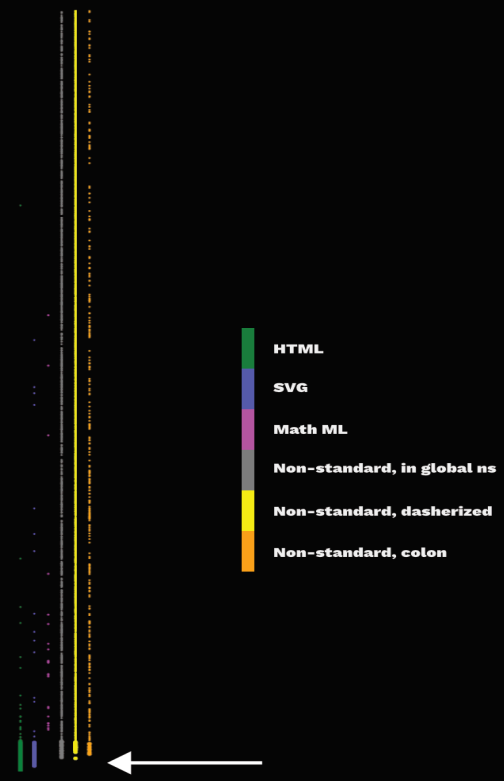
◇◇◇◇◇◇◇◇◇◇50◇◇◇◇◇◇◇◇◇◇◇◇◇15◇◇◇◇◇◇◇

- <ul>
- <li>
- <p>
- <style>
- <input>
-
- <form>
- <h2>
- <h1>
- <iframe>
- <h3>
- <button>
- <footer>
- <header>
- <nav>

◇◇◇◇◇◇◇◇◇5◇◇◇◇◇◇◇◇◇◇◇◇◇40◇◇◇◇◇◇◇◇

<video>◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇4◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇3◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ 4◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇1◇◇◇◇◇◇◇◇98◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇1◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇



Element Popularity Distribution

The following charts plot the popularity of each group of elements in HTML, SVG, and MathML.

Bottom being the most popular while the top is least (out of 5047 as measured by counting 1 per website containing the element). This is helpful for seeing the relative range of use.

◇ 8. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇8◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

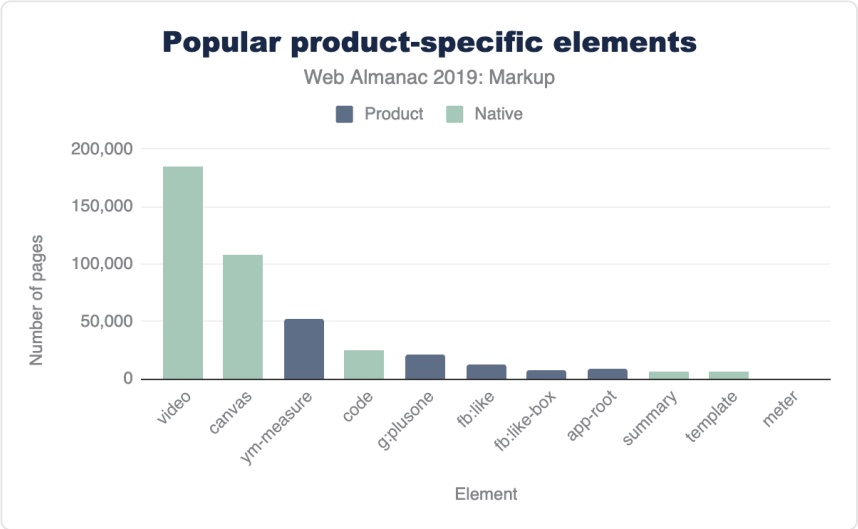
◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇Glitch◇◇◇◇◇◇◇[66]◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇

- ◇◇◇◇<fb:like-box>[80]◇7.8k◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇
- <app-root>[81]◇◇Angular◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇8.2k◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇5◇◇◇◇◇◇◇◇◇◇HTML◇◇◇◇◇◇◇◇◇◇◇◇◇



◇ *9. ◇◇◇◇5◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇1157◇◇◇◇◇◇[82]◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇

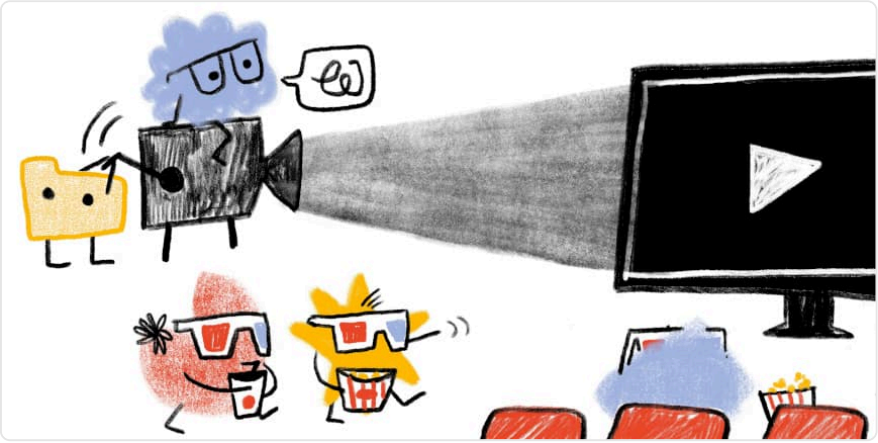
◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇

◇ I ◇ 4

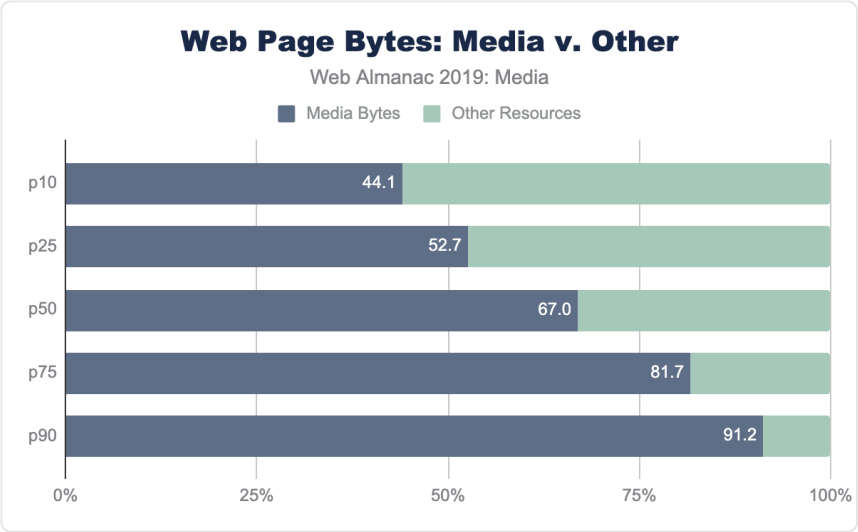
◇◇◇◇



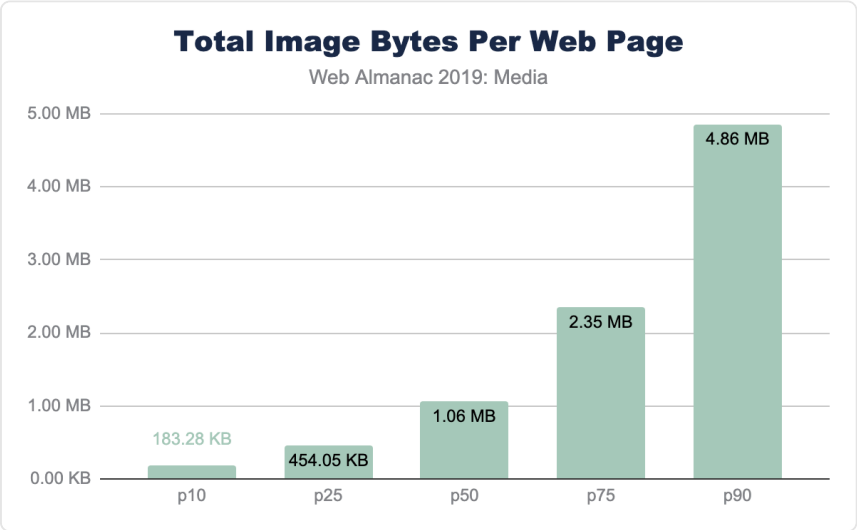
Colin Bendell ◇ Doug Sillars ◇◇◇◇◇◇◇◇◇
Ahmad Awais ◇ Eric Portis ◇◇◇◇◇◇◇◇
Sakae Kotaro ◇◇◇◇◇◇◇◇◇◇◇

◇◇

◇◇◇◇◇◇◇◇◇◇◇

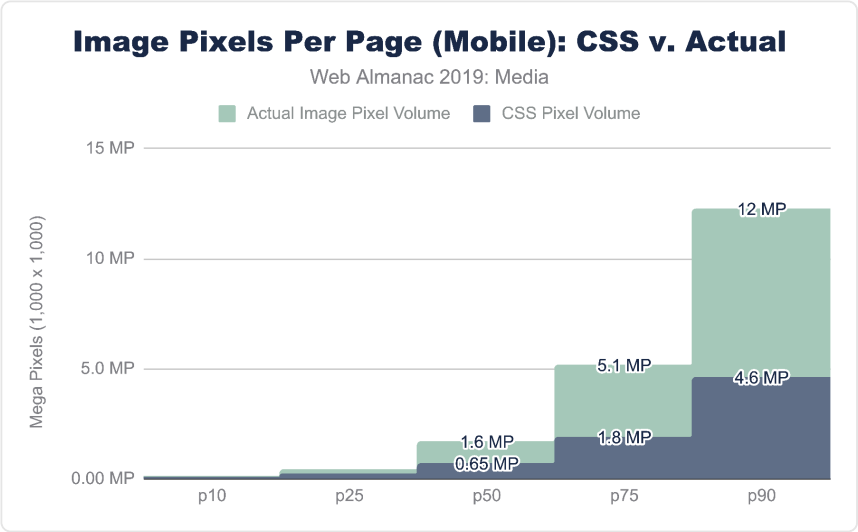

Web Page Bytes: Media v. Other
Web Almanac 2019: Media
Media Bytes
Other Resources
p10
44.1
p25
52.7
p50
67.0
p75
81.7
p90
91.2
0%
25%
50%
75%
100%

*◇ 1. Web◇◇◇◇

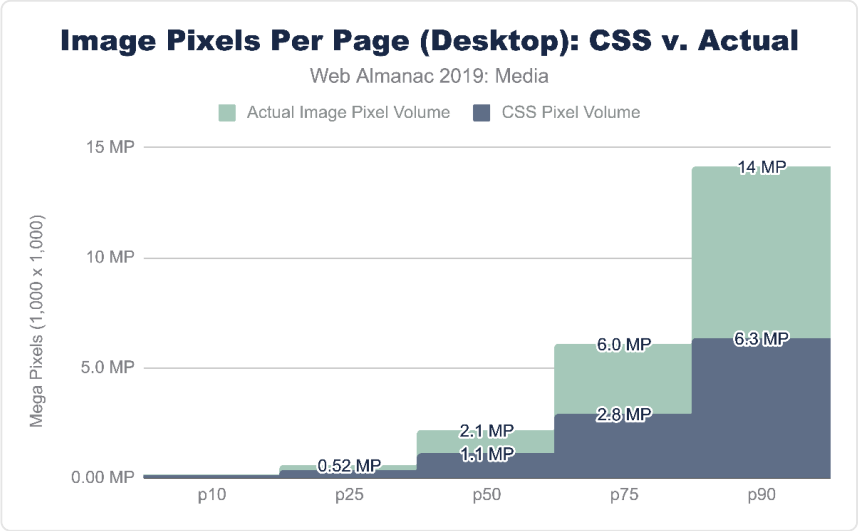

Total Image Bytes Per Web Page
Web Almanac 2019: Media
5.00 MB
4.00 MB
3.00 MB
2.00 MB
1.00 MB
0.00 KB
183.28 KB
454.05 KB
1.06 MB
2.35 MB
4.86 MB
p10
p25
p50
p75
p90

◇ 2. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇



◇ 3. 1◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇CSS◇◇◇◇



◇ 4. 1◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇CSS◇◇◇◇

CSS◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇

◇◇◇◇

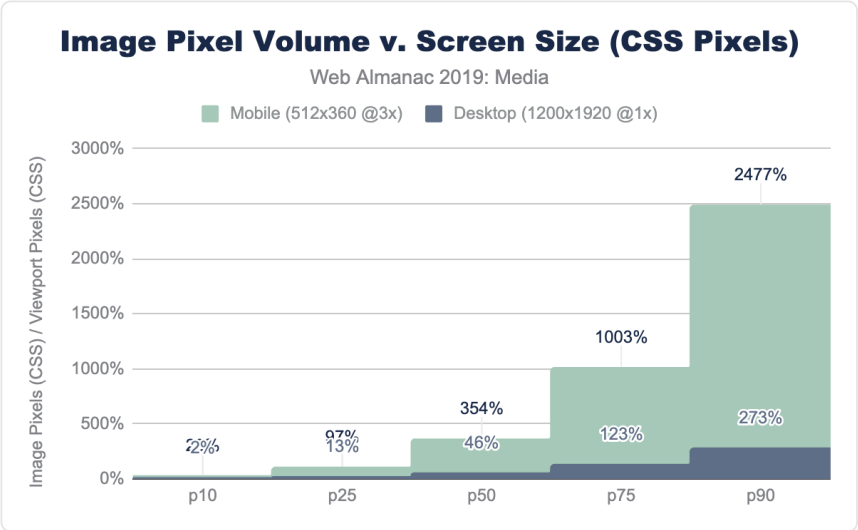


Image Pixel Volume v. Screen Size (CSS Pixels)
Web Almanac 2019: Media
Mobile (512x360 @3x)
Desktop (1200x1920 @1x)
Image Pixels (CSS) / Viewport Pixels (CSS)
3000%
2500%
2000%
1500%
1000%
500%
0%
2%
97%
13%
354%
46%
1003%
123%
2477%
273%
p10
p25
p50
p75
p90

◇ 5. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇CSS◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

- ◇◇◇◇◇◇◇◇ - ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇
- ◇◇◇◇◇◇◇◇ - ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

*◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Web Almanac◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Chrome◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Safari◇Firefox◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇ ◇◇ ◇◇	◇◇◇◇◇	◇◇
JPEG	• ◇◇◇◇◇◇◇◇ • ◇◇◇◇◇◇◇◇◇◇	• ◇◇◇◇◇◇◇◇◇◇ • ◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇

◇◇◇◇◇◇◇

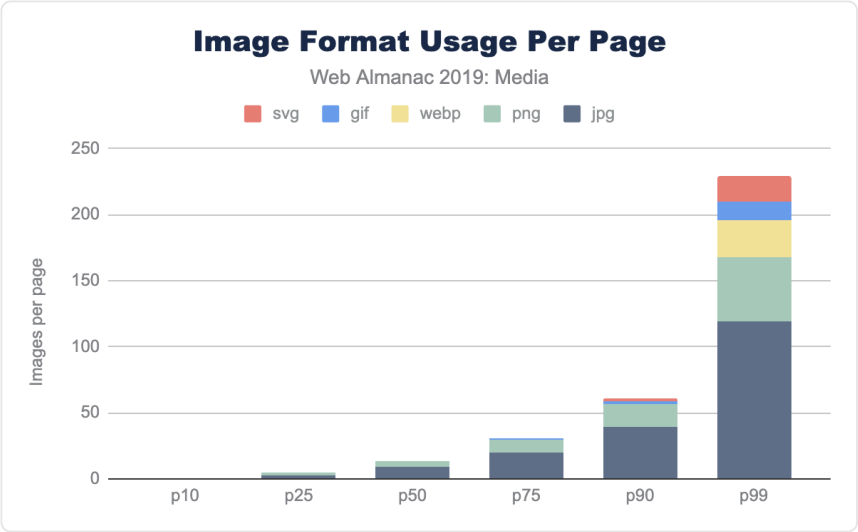
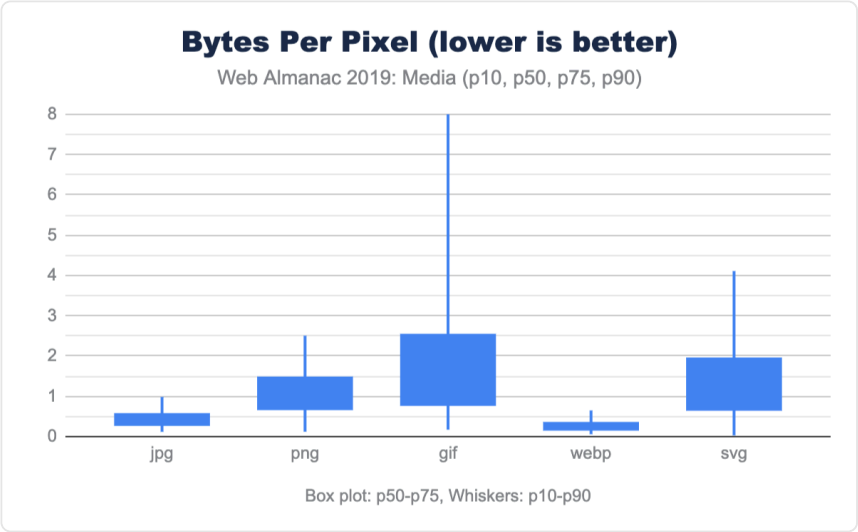


Image Format Usage Per Page
Web Almanac 2019: Media
svg
gif
webp
png
jpg
Images per page
250
200
150
100
50
0
p10
p25
p50
p75
p90
p99

◇ *8. 1◇◇◇◇

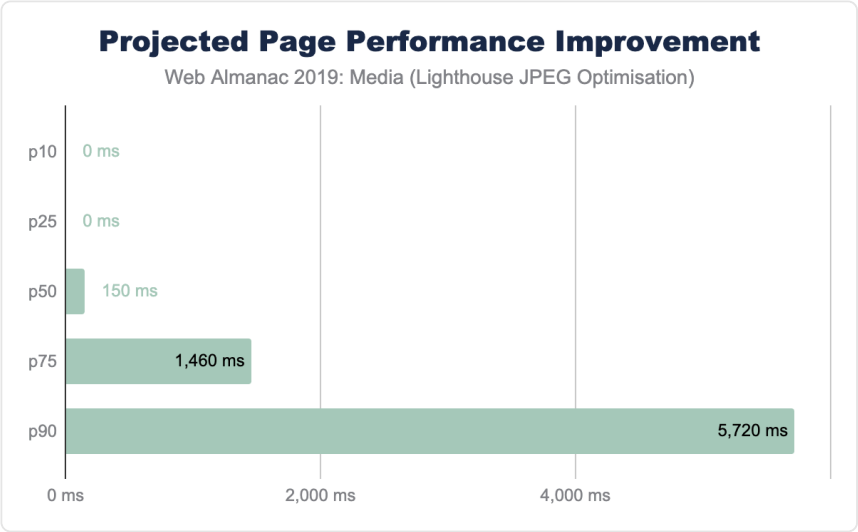
◇◇◇◇90◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇WebP◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇



◇ 11. ◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇GIF◇◇◇◇◇JPEG◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇JPEG◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇



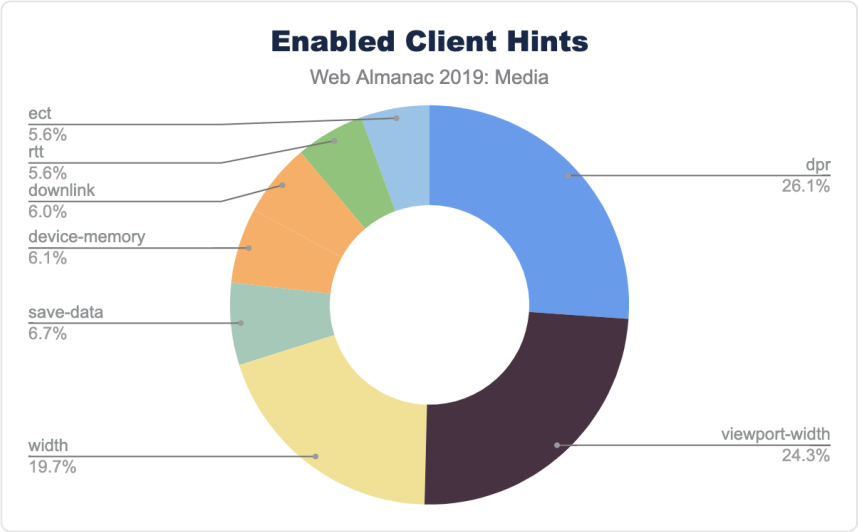
*◇ 13. Lighthouse◇◇◇◇

◇◇srcset◇◇◇◇

◇◇◇◇

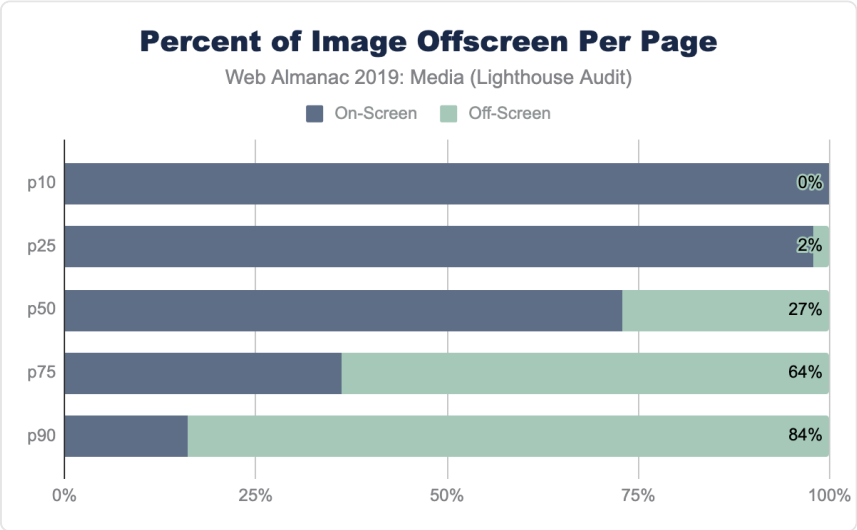
◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇[106] ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇HTTP◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇


Enabled Client Hints
Web Almanac 2019: Media
ect
5.6%
rtt
5.6%
downlink
6.0%
device-memory
6.1%
save-data
6.7%
width
19.7%
viewport-width
24.3%
dpr
26.1%

◇ *18.* ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇



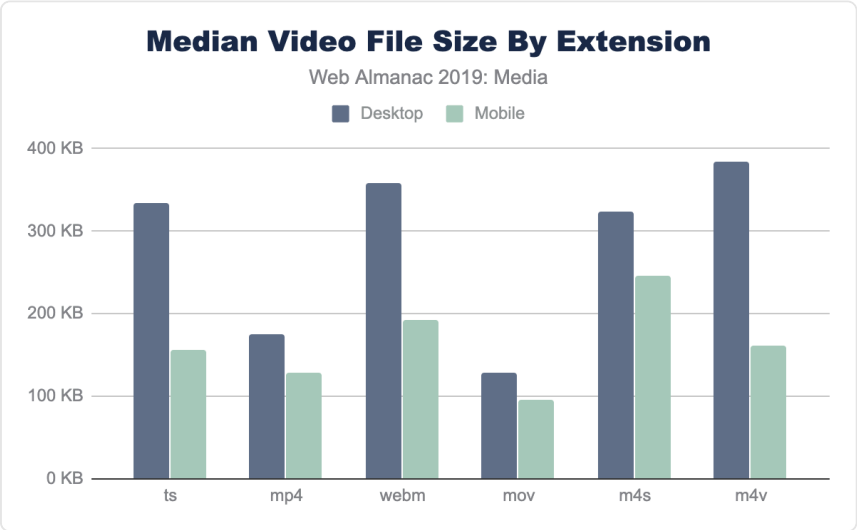
◇ 19. Lighthouse◇◇◇◇◇◇◇◇◇◇

Lighthouse◇◇◇◇◇◇◇◇◇◇

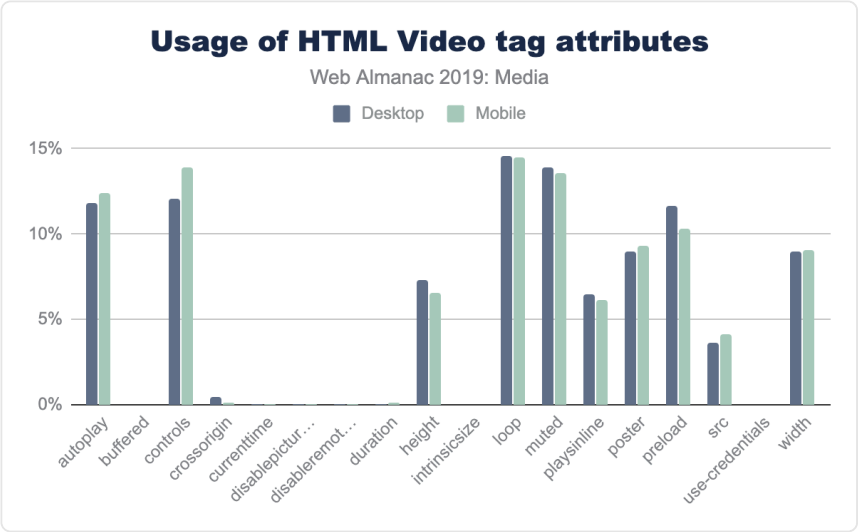
alt◇◇◇◇◇◇◇◇◇◇◇6◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇alt◇◇◇alt=""◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇6◇◇◇◇◇◇◇◇alt◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇39◇◇◇◇◇◇◇◇◇◇◇alt◇◇◇◇◇◇◇◇◇◇31◇◇◇◇◇◇◇◇◇25◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

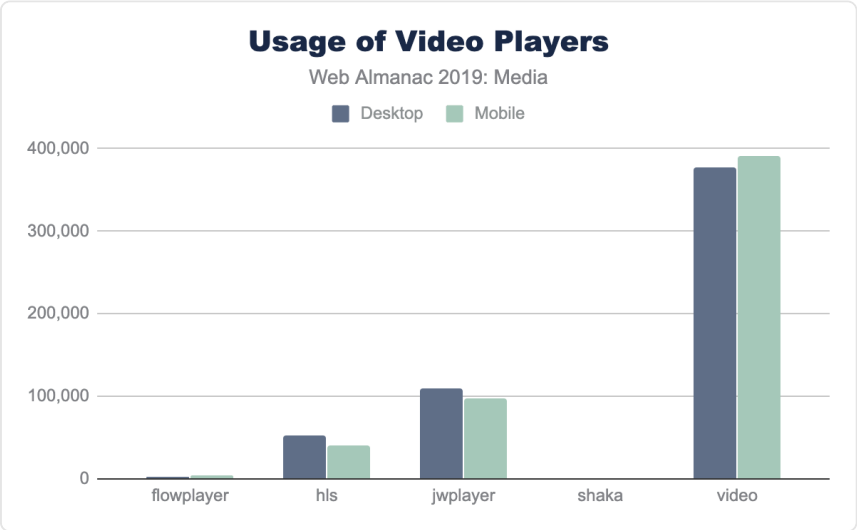

Median Video File Size By Extension
Web Almanac 2019: Media
Desktop
Mobile
400 KB
300 KB
200 KB
100 KB
0 KB
ts
mp4
webm
mov
m4s
m4v

*◇ 21. ◇◇◇◇



◇ 22. HTML◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇autoplay◇muted◇loop◇◇◇◇◇preload◇◇◇◇◇◇width◇height◇◇◇loop◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇GIF◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇



◇ 23. ◇◇◇◇ JavaScript ◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇video.js◇◇JWPLayer◇HLS.js◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇video.js◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇

Colin Bendell

Colin◇◇Cloudinary[112]◇CTO◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇High Performance Images[113]◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇ II ◇ 5

◇◇◇◇◇◇◇

Patrick Hulce *◇◇◇◇◇◇◇◇◇*
Simon Pieters, David Fox, ◇ Vamsee Jasti ◇◇◇◇◇◇◇◇
Sakae Kotaro ◇◇◇◇◇◇◇◇◇◇◇

◇◇

◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇

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- ◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇2◇◇3◇◇4◇◇◇◇◇◇◇◇◇◇

◇◇◇	◇◇◇◇◇◇◇URL	◇◇◇◇◇◇◇
1	https://www.google-analytics.com/analytics.js	0.64%
2	https://connect.facebook.net/en_US/fbevents.js	0.20%
3	https://connect.facebook.net/signals/plugins/inferredEvents.js?v=2.8.51	0.19%
4	https://staticxx.facebook.com/connect/xd_arbiter.php?version=44	0.16%
5	https://fonts.gstatic.com/s/opensans/v16/mem8YaGs126MiZpBA-UFVZ0b.woff2	0.13%
6	https://www.googletagservices.com/activeview/js/current/osd.js?cb=%2Fr20100101	0.12%
7	https://fonts.gstatic.com/s/roboto/v18/KFOmCnqEu92Fr1Mu4mxK.woff2	0.11%
8	https://googleads.g.doubleclick.net/pagead/id	0.11%
9	https://fonts.gstatic.com/s/roboto/v19/KFOmCnqEu92Fr1Mu4mxK.woff2	0.10%
10	https://www.googleadservices.com/pagead/conversion_async.js	0.10%

◇ 4. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇10

◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇28◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇

◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇57◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇

◇◇◇◇◇◇◇

◇◇◇◇◇◇

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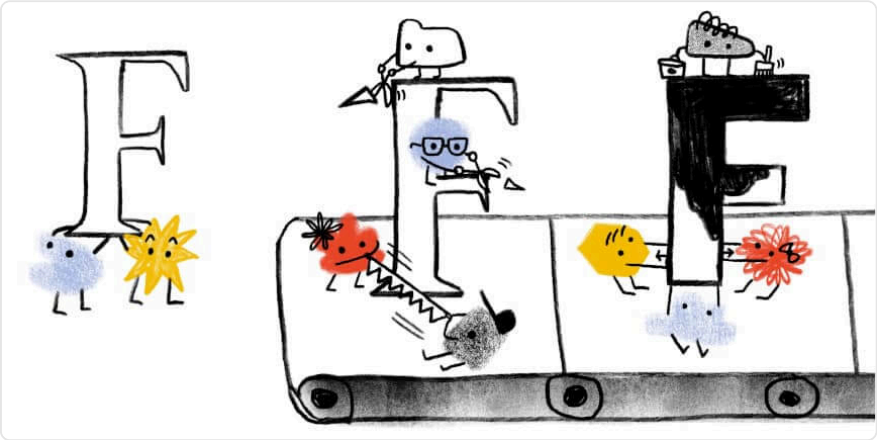
◇ I ◇ 6

◇◇◇◇



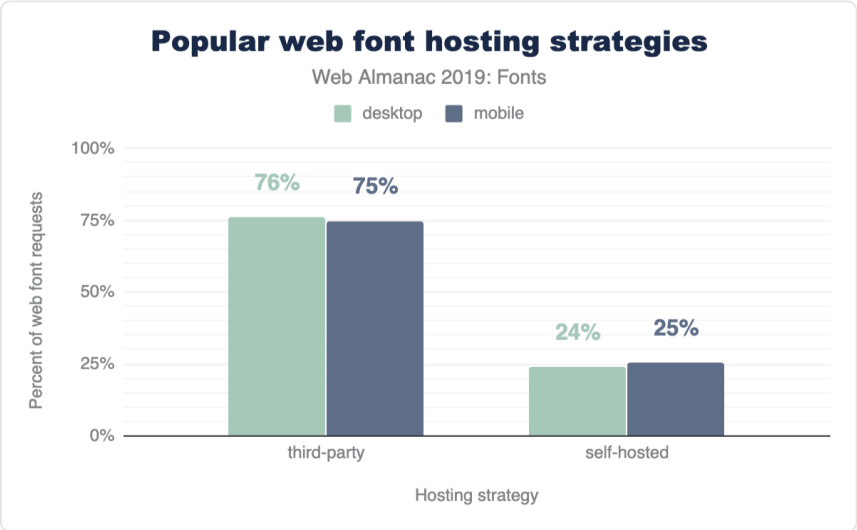
Zach Leatherman *◇◇◇◇◇◇◇◇◇*
John Teague ◇ Aymen Loukil ◇◇◇◇◇◇◇◇
Sakae Kotaro ◇◇◇◇◇◇◇◇◇◇

◇◇

◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇



◇ 1. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇font hosting strategies.

4◇◇3◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇

29%

◇ 3. ◇◇◇◇◇◇◇◇Google Fonts◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ <head>◇

◇◇◇◇Google Fonts◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Google Fonts`<link>`◇◇◇◇◇◇◇◇◇29◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

`preconnect`◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

1.7%

*◇ 5. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇

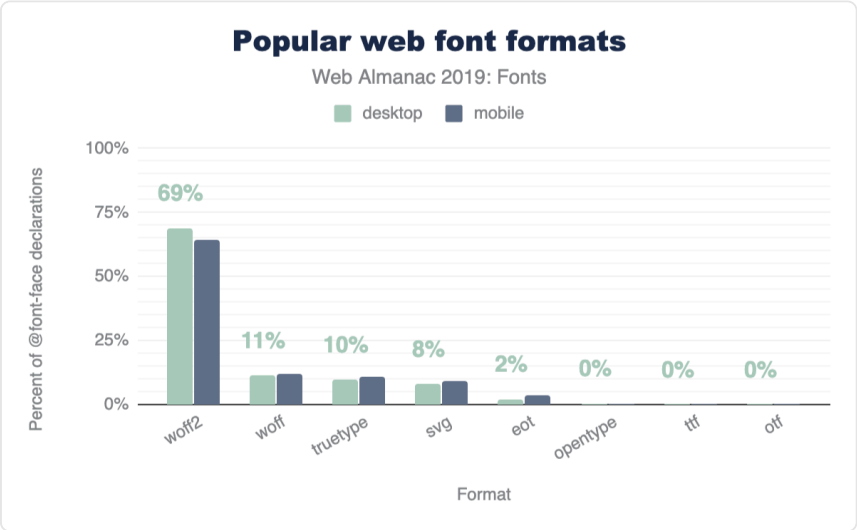
◇◇◇	◇◇◇◇◇◇◇◇◇	◇◇◇◇◇◇	◇◇◇◇
1	Open Sans	24%	22%
2	Roboto	15%	19%
3	Montserrat	5%	4%
4	Source Sans Pro	4%	3%
5	Noto Sans JP	3%	3%
6	Lato	3%	3%
7	Nanum Gothic	4%	2%
8	Noto Sans KR	3%	2%
9	Roboto Condensed	2%	2%
10	Raleway	2%	2%
11	FontAwesome	1%	1%
12	Roboto Slab	1%	1%
13	Noto Sans TC	1%	1%
14	Poppins	1%	1%
15	Ubuntu	1%	1%
16	Oswald	1%	1%
17	Merriweather	1%	1%
18	PT Sans	1%	1%
19	Playfair Display	1%	1%
20	Noto Sans	1%	1%

◇ 6. ◇◇◇◇◇◇◇◇◇◇◇◇◇20◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇Google Fonts◇◇◇◇◇◇◇◇◇[137]◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇WOFF2◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇[138]◇Google Fonts◇WOFF2◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇WOFF◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇


Popular web font formats
Web Almanac 2019: Fonts
desktop
mobile
Percent of @font-face declarations
100%
75%
50%
25%
0%
69%
11%
10%
8%
2%
0%
0%
0%
woff2
woff
truetype
svg
eot
opentype
ttf
otf
Format

*◇ 8. `@font-face`◇◇◇◇

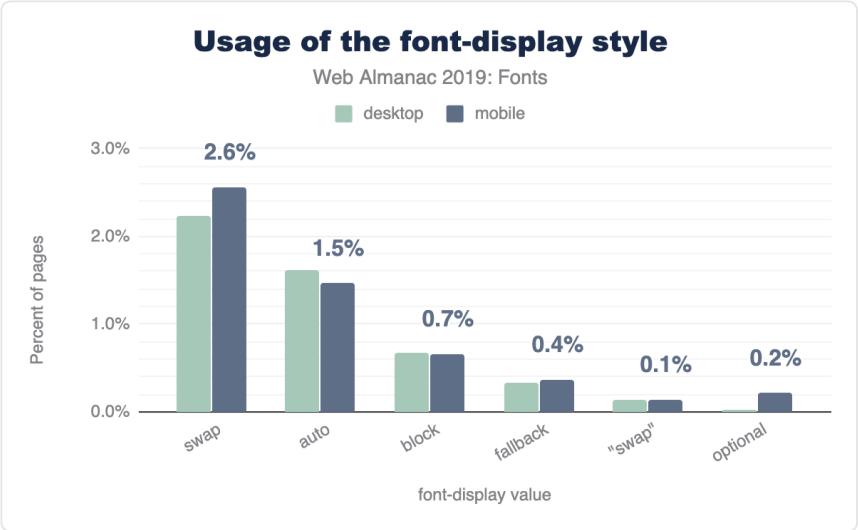
WOFF2◇◇

◇◇◇	◇◇◇◇◇◇◇◇◇◇◇◇◇	◇◇◇◇◇◇	◇◇◇◇
1	*woff2*	*84.0%*	*81.9%*
2	*svg, truetype, woff*	*4.3%*	*4.0%*
3	*svg, truetype, woff, woff2*	*3.5%*	*3.2%*
4	*eot, svg, truetype, woff*	*1.3%*	*2.9%*
5	*woff, woff2*	*1.8%*	*1.8%*
6	*eot, svg, truetype, woff, woff2*	*1.2%*	*2.1%*
7	*truetype, woff*	*0.9%*	*1.1%*
8	*woff*	*0.7%*	*0.8%*
9	*truetype*	*0.6%*	*0.7%*
10	*truetype, woff, woff2*	*0.6%*	*0.6%*
11	*opentype, woff, woff2*	*0.3%*	*0.2%*
12	*svg*	*0.2%*	*0.2%*
13	*eot, truetype, woff*	*0.1%*	*0.2%*
14	*opentype, woff*	*0.1%*	*0.1%*
15	*opentype*	*0.1%*	*0.1%*
16	*eot*	*0.1%*	*0.1%*
17	*opentype, svg, truetype, woff*	*0.1%*	*0.0%*
18	*opentype, truetype, woff, woff2*	*0.0%*	*0.0%*
19	*eot, truetype, woff, woff2*	*0.0%*	*0.0%*
20	*svg, woff*	*0.0%*	*0.0%*

◇ 9. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇20

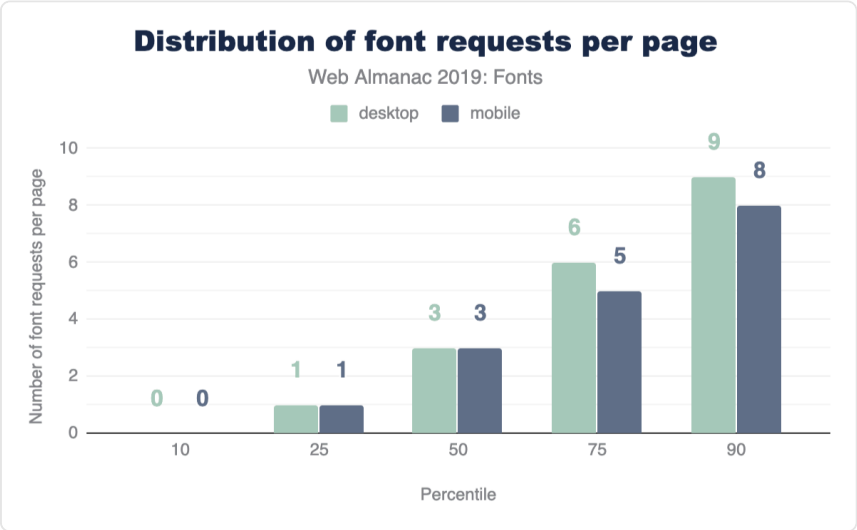
◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇`@font-face`◇◇◇◇◇WOFF2◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

WOFF2◇◇◇◇



◇ 11. font-display◇◇◇◇◇◇

◇◇◇◇◇◇


Distribution of font requests per page
Web Almanac 2019: Fonts
desktop
mobile
Number of font requests per page
10
8
6
4
2
0
0
0
1
1
3
3
6
5
9
8
10
25
50
75
90
Percentile

◇ *12.* ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇3◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇90◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇[143]◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ (◇◇◇◇◇◇◇◇◇◇◇◇)◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇MDN◇`font-stretch`◇◇◇◇[146] ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇[147]◇◇◇◇◇◇◇◇◇

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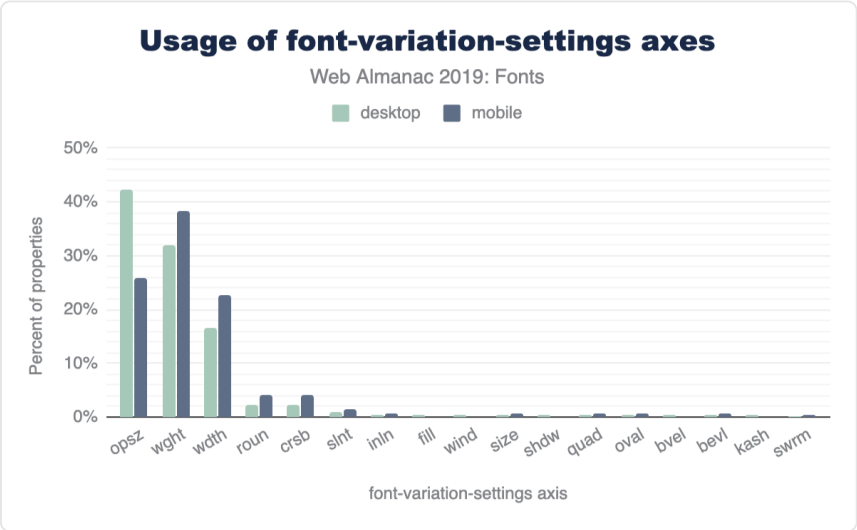

◇ 19. `font-variation-settings`◇◇◇◇◇◇

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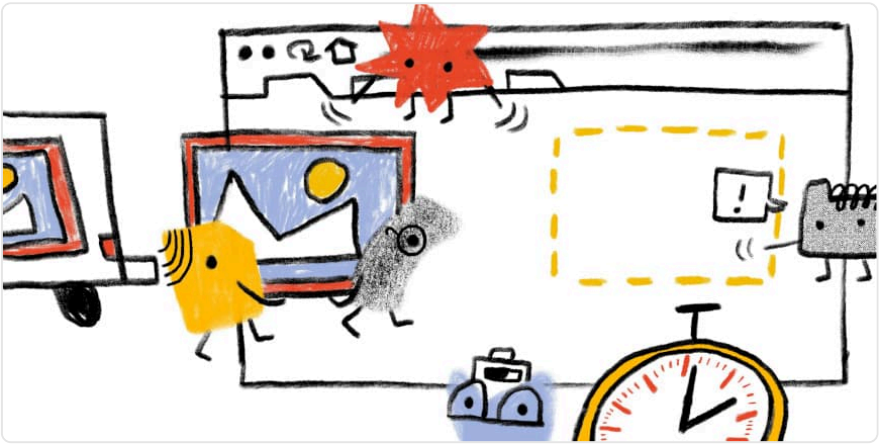

Rick Viscomi *◇◇◇◇◇◇◇◇◇*
José M. Pérez, David Fox, Sergey Chernyshev, ◇ Mark Zeman ◇◇◇◇◇◇◇◇
M.Sakamaki ◇◇◇◇◇◇◇◇◇◇◇

◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇
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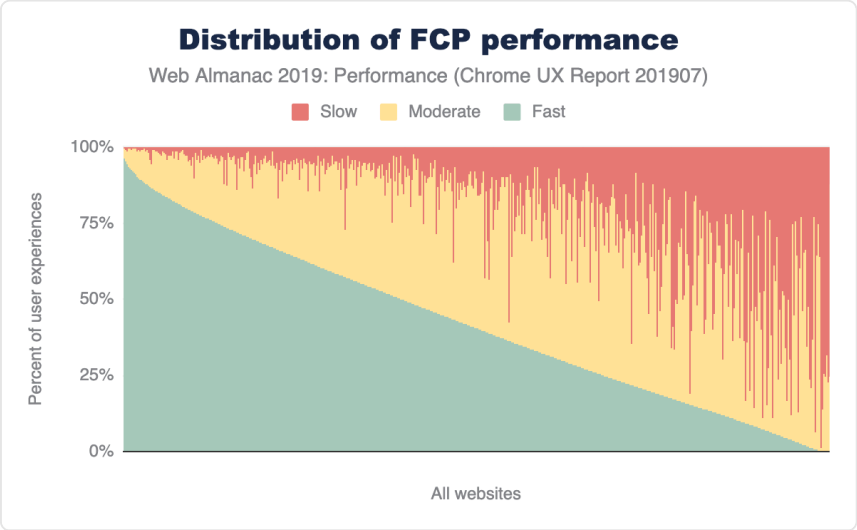
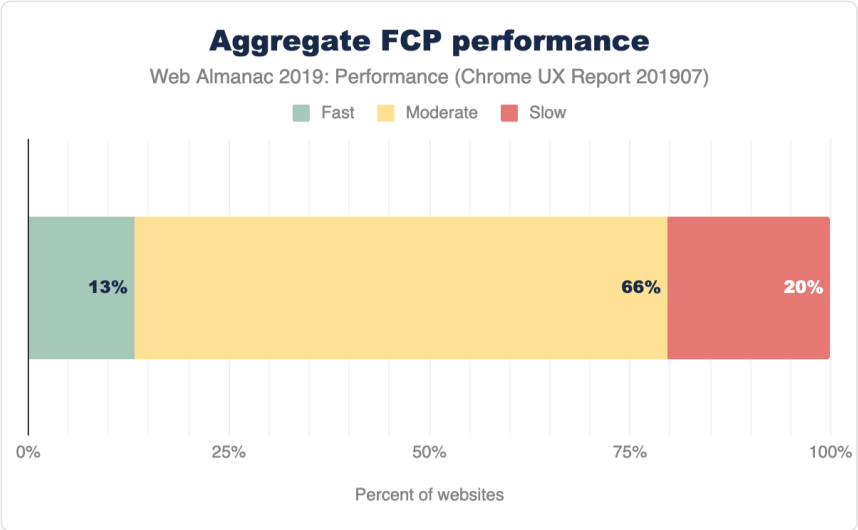
◇◇◇◇◇◇◇◇◇◇◇◇◇(First Contentful Paint)



◇ 1. Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇FCP◇◇◇◇◇◇◇◇◇◇◇

◇1◇◇◇FCP◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇CrUX◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇1,000◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇FCP◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

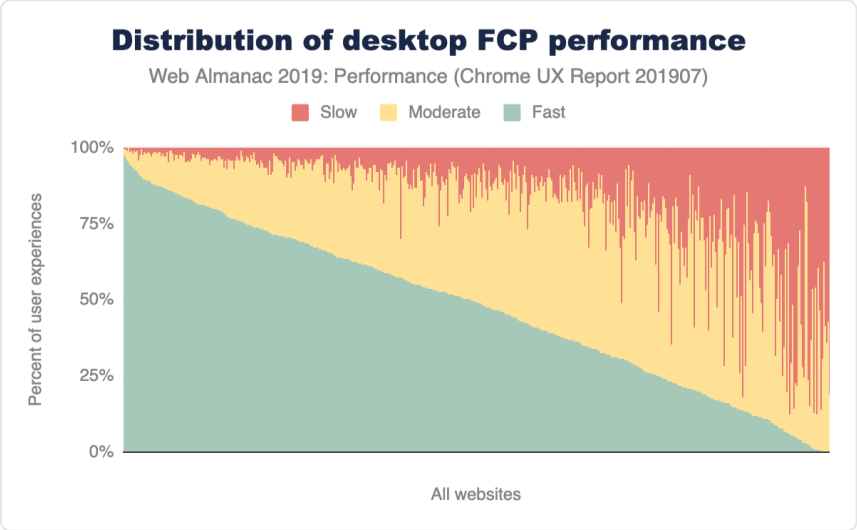


◇ 2. ◇◇◇◇◇◇◇◇◇FCP◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇

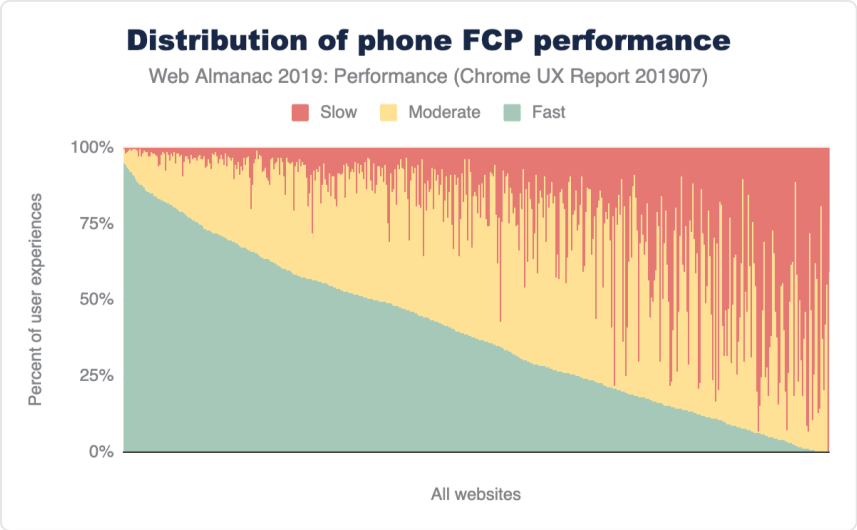
◇2◇◇◇◇◇Web◇◇◇◇13◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ Web◇◇◇◇◇◇◇◇◇◇◇◇FCP◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇FCP◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇FCP



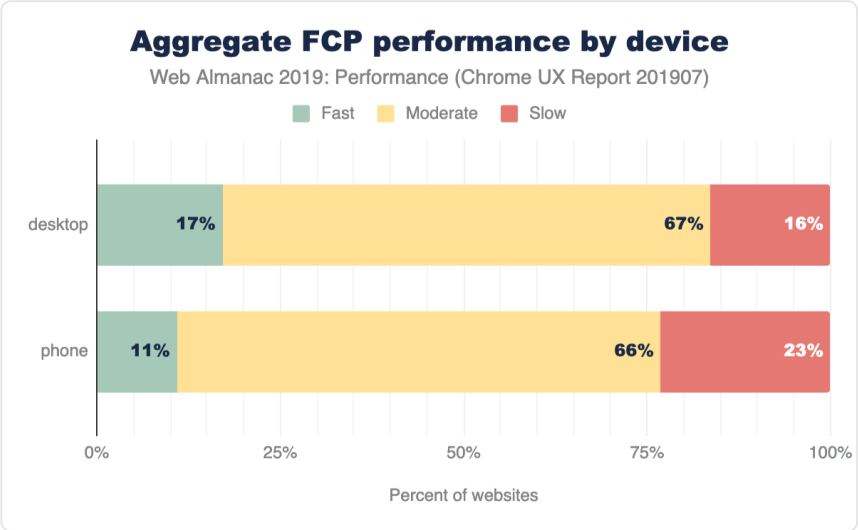
◇ 3. ◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇FCP◇◇◇◇◇◇◇◇◇◇◇



◇ 4. ◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇FCP◇◇◇◇◇◇◇◇◇◇◇

◇◇◇3◇◇4◇◇FCP◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇FCP◇◇ ◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇FCP◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

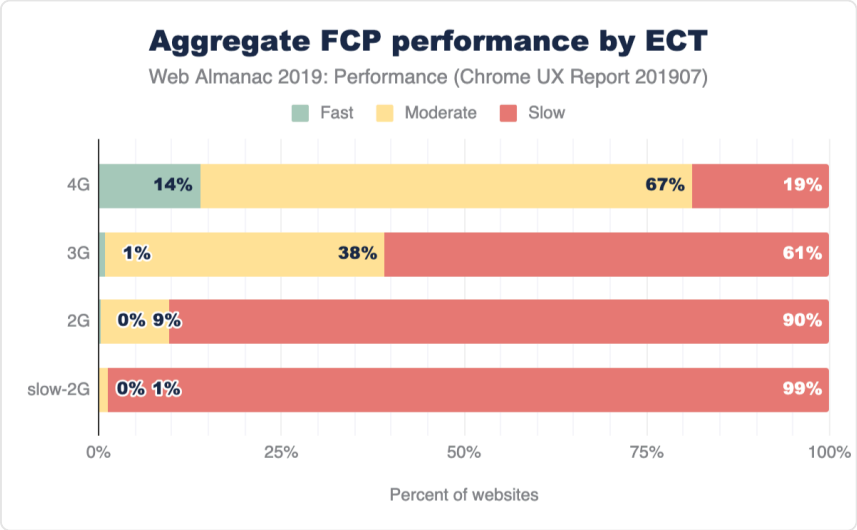
◇◇ ◇◇◇◇◇◇◇◇◇◇◇PSI◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇



◇ 5. ◇◇◇◇◇◇◇◇FCP◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

PSI◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇11%◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇17%◇◇◇◇◇◇◇◇ FCP◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

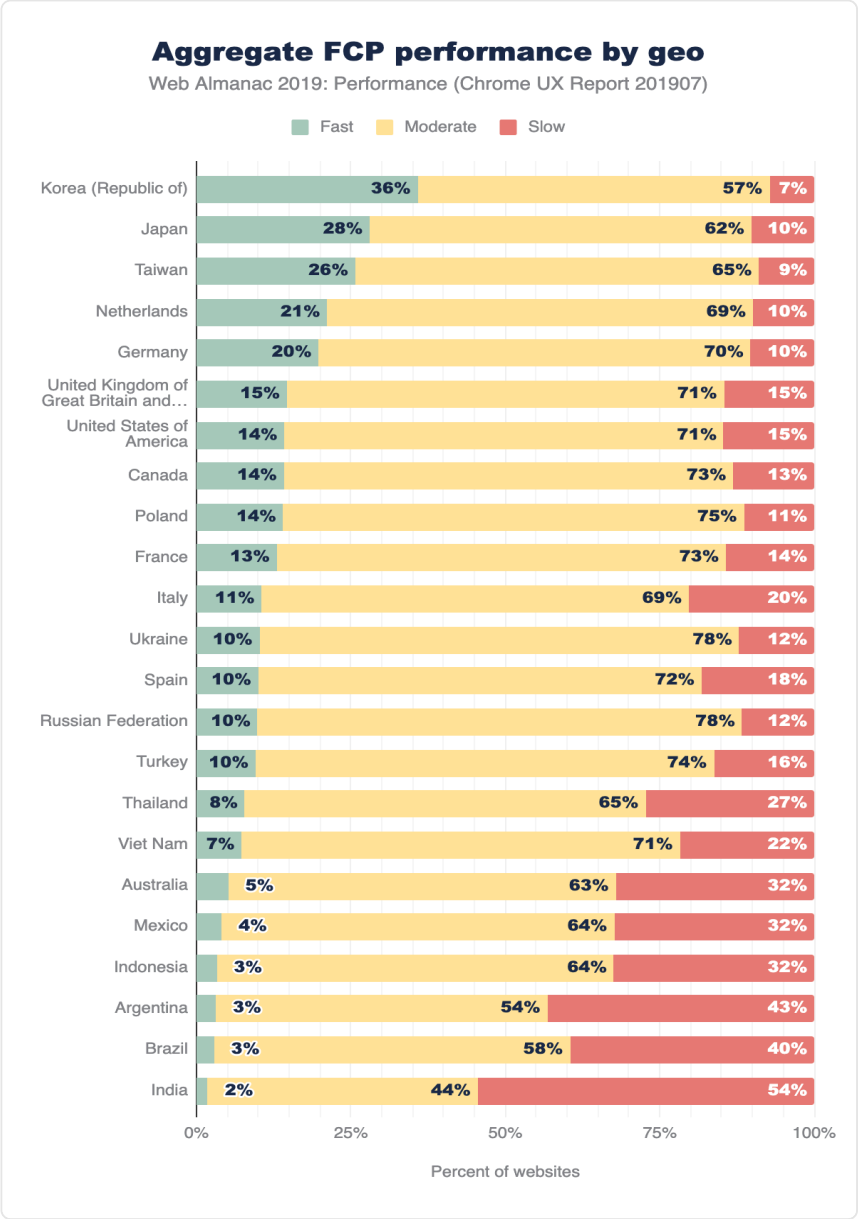
◇◇◇◇◇◇◇◇◇◇FCP



◇ 6. ◇◇◇◇◇◇◇◇◇◇FCP◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇ECT◇◇◇◇◇◇◇◇◇◇◇

◇◇◇6◇◇◇FCP◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ECT◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇ ECT◇◇◇◇◇◇◇FCP◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ECT◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ECT◇4G◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ Web◇◇◇◇14◇◇◇◇◇FCP◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇19◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ 61◇◇Web◇◇◇◇◇ECT◇3G◇◇◇◇◇◇◇◇◇◇FCP◇◇◇◇◇ ECT◇2G◇◇90◇◇◇ETC◇◇◇◇2G◇◇99◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇4G◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇FCP◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇

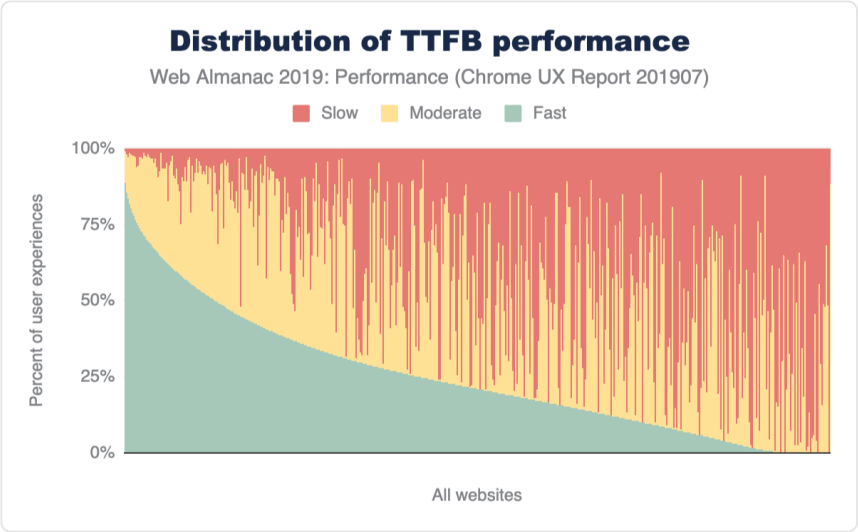
◇◇◇◇◇FCP


Aggregate FCP performance by geo
Web Almanac 2019: Performance (Chrome UX Report 201907)
Fast
Moderate
Slow
Korea (Republic of) 36% 57% 7%
Japan 28% 62% 10%
Taiwan 26% 65% 9%
Netherlands 21% 69% 10%
Germany 20% 70% 10%
United Kingdom of Great Britain and… 15% 71% 15%
United States of America 14% 71% 15%
Canada 14% 73% 13%
Poland 14% 75% 11%
France 13% 73% 14%
Italy 11% 69% 20%
Ukraine 10% 78% 12%
Spain 10% 72% 18%
Russian Federation 10% 78% 12%
Turkey 10% 74% 16%
Thailand 8% 65% 27%
Viet Nam 7% 71% 22%
Australia 5% 63% 32%
Mexico 4% 64% 32%
Indonesia 3% 64% 32%
Argentina 3% 54% 43%
Brazil 3% 58% 40%
India 2% 44% 54%
0%
25%
50%
75%
100%
Percent of websites

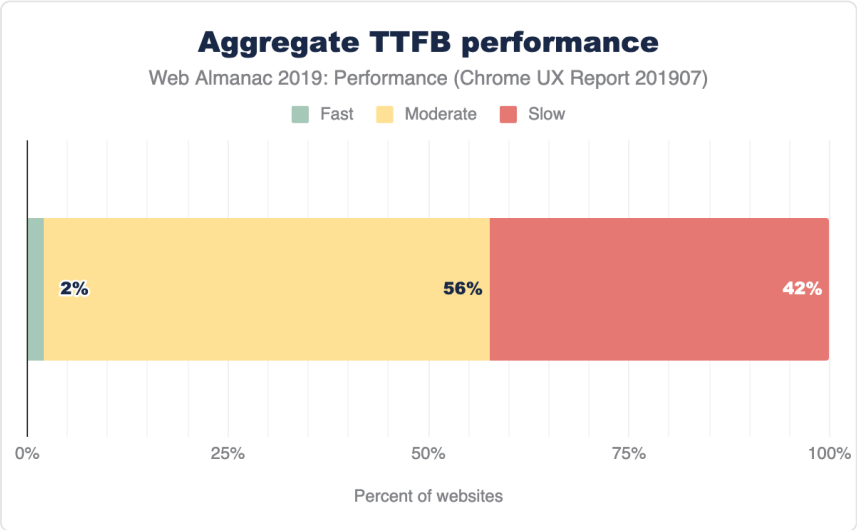
*◇ 7. ◇◇◇◇◇◇◇◇FCP◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇geo◇◇FCP◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇Web ◇◇◇◇◇◇◇◇◇◇◇23◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇Web◇◇◇◇◇◇1,211,002◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇ FCP◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇3◇◇◇◇◇◇◇◇◇◇◇[163] (APAC)◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇[164]◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇FCP◇◇◇◇◇◇◇◇◇◇ ◇◇◇36◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇7%◇◇◇ ◇◇/◇◇/◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇13/66/20◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇APAC◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇


Distribution of TTFB performance
Web Almanac 2019: Performance (Chrome UX Report 201907)
Slow
Moderate
Fast
100%
75%
50%
25%
0%
Percent of user experiences
All websites

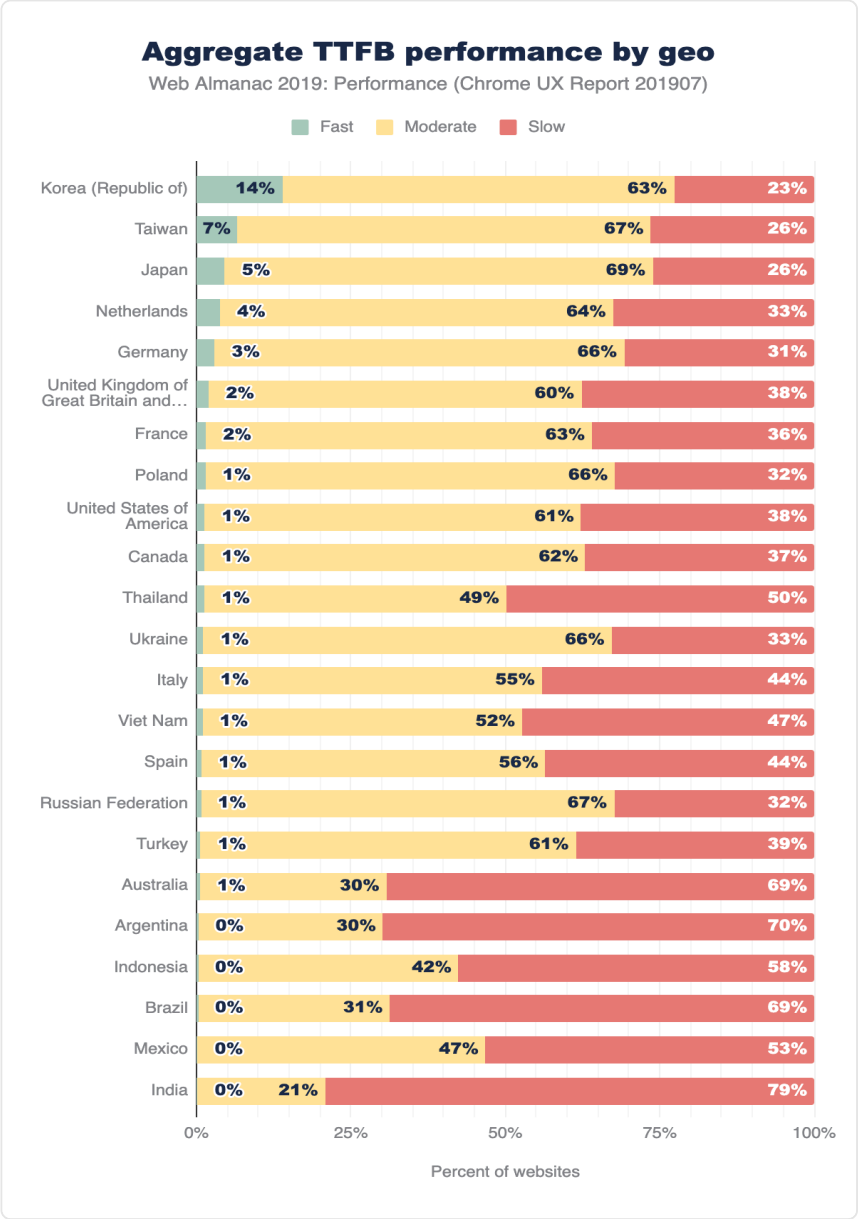
*◇ 9. Web◇◇◇◇TTFB◇◇◇◇◇◇◇



◇ 10. TTFB◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇

Web◇◇◇◇42%◇◇◇◇TTFB◇◇◇◇◇◇◇◇◇◇ TTFB◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

TTFB by geo

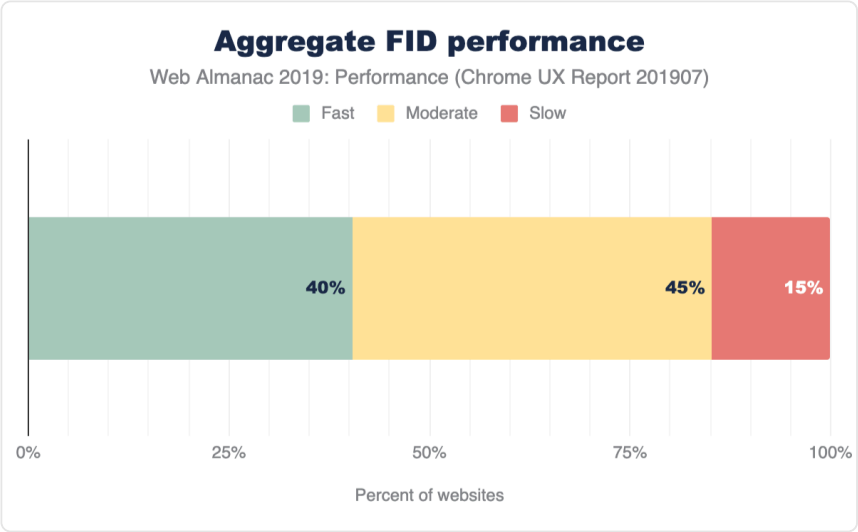


◇ 11. ◇◇◇◇◇◇◇◇◇TTFB◇◇◇◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇TTFB◇◇◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇APAC◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇ ◇◇◇◇15%◇◇◇◇◇◇◇◇TTFB◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇TTFB ◇◇◇◇◇◇Web◇◇◇◇1%◇◇◇◇◇◇◇TTFB◇◇◇◇◇◇Web◇◇◇◇79%◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇First Input Delay◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇(First Input Delay)[168](FID)◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇UI◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

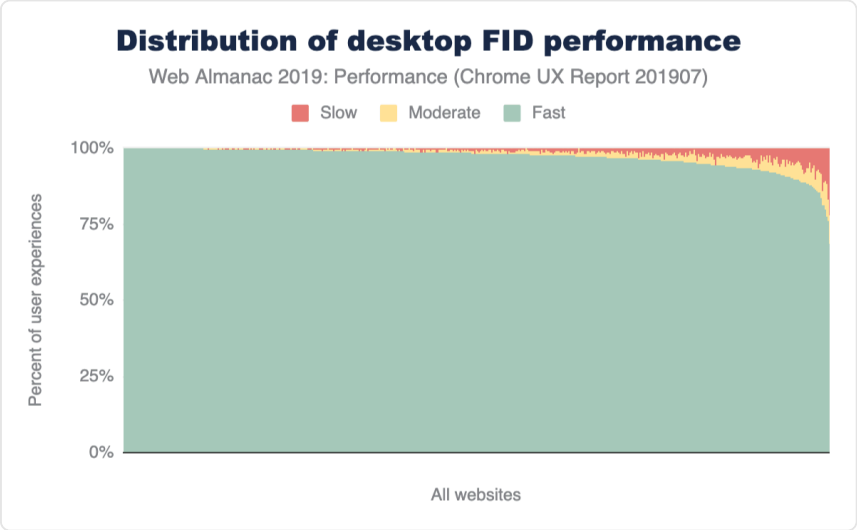


◇ 13. ◇◇◇◇◇◇◇◇◇TTFB◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇

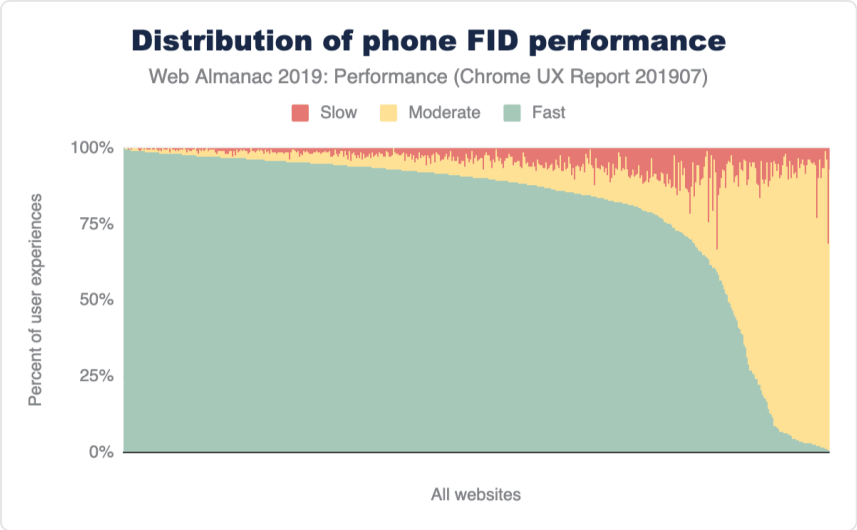
◇◇◇◇◇◇◇◇◇FID◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇PSI◇◇◇◇FCP◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇FID◇◇◇95◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇FID◇◇◇◇◇5◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇FID◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇FID



◇ 14. ◇◇◇◇◇◇ Web◇◇◇◇FID◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

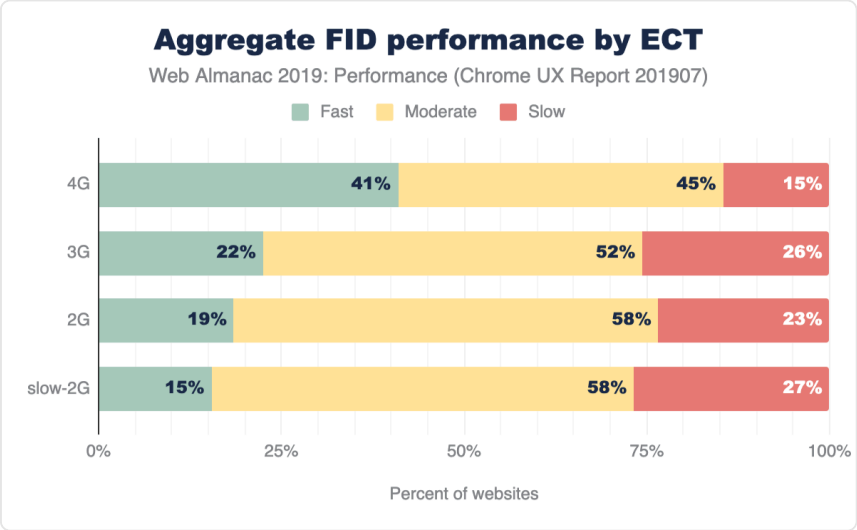


◇ 15. ◇◇◇◇◇◇ Web◇◇◇◇FID◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

FID◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇2◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇FID◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇ ◇◇◇◇◇(◇◇◇◇◇◇◇◇◇◇◇◇◇◇)◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇Web◇◇◇◇10%◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

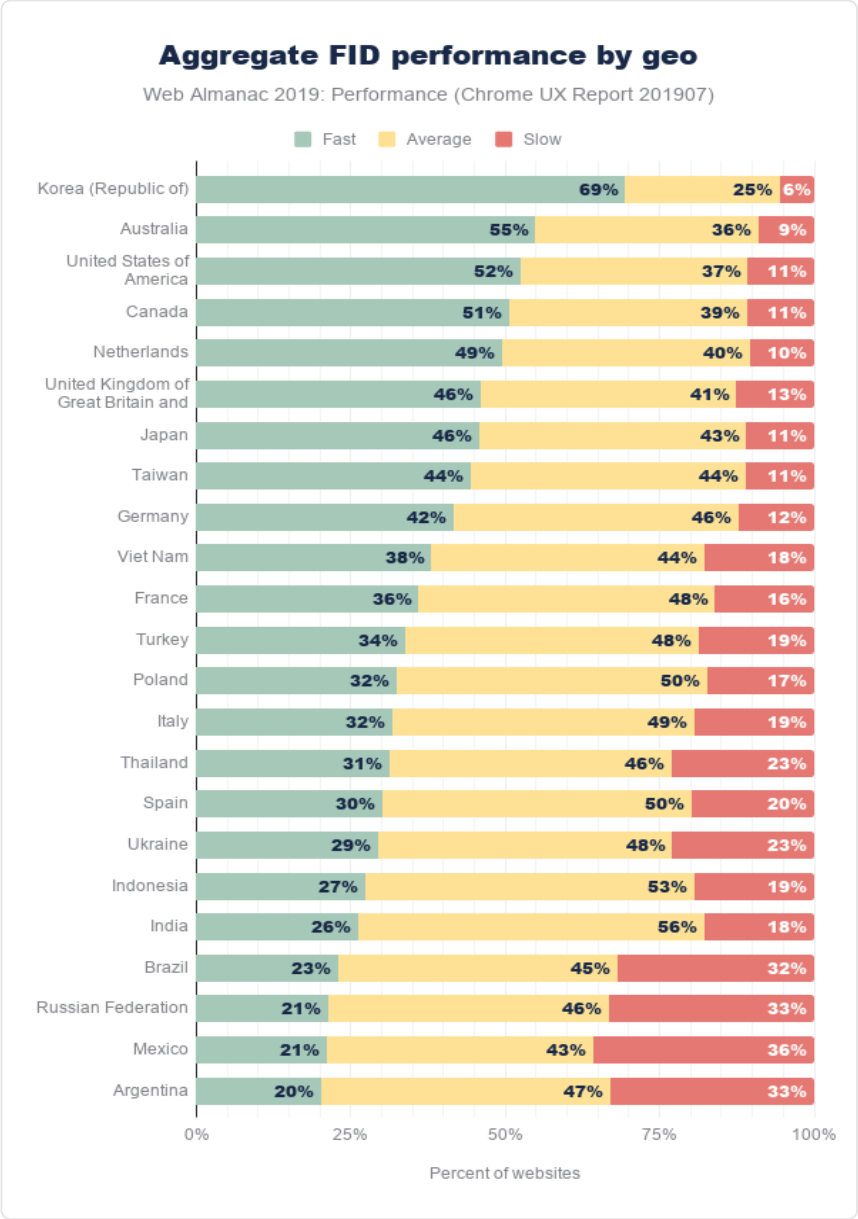
◇◇◇◇◇◇◇◇◇◇FID



◇ 17. ECT◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇FID◇◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇

◇◇◇FID◇CPU◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

FID by geo



◇ 18. ◇◇◇◇◇◇◇◇FID◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇FID◇◇◇◇◇◇◇◇◇◇◇◇

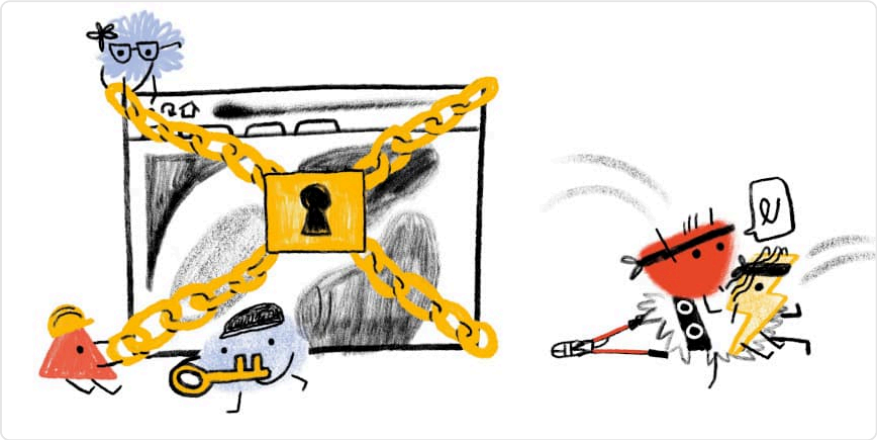
◇◇

Rick Viscomi

Rick Viscomi◇Google ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇HTTP Archive◇Chrome UX Report ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇ II ◇ 8

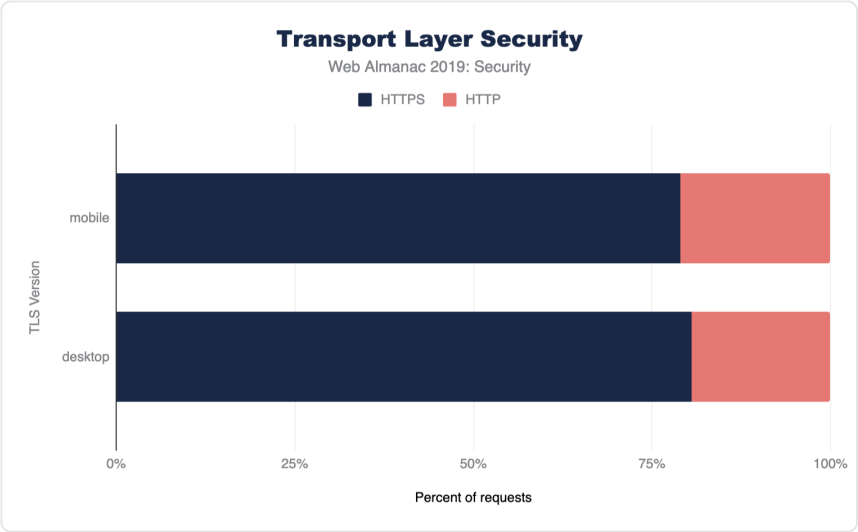
◇◇◇◇◇◇



Scott Helme ◇ Artur Janc ◇◇◇◇◇◇◇◇◇
Barry Pollard, Alessandro Ghedini, ◇ Paul Calvano ◇◇◇◇◇◇◇◇
Sakae Kotaro ◇◇◇◇◇◇◇◇◇◇◇

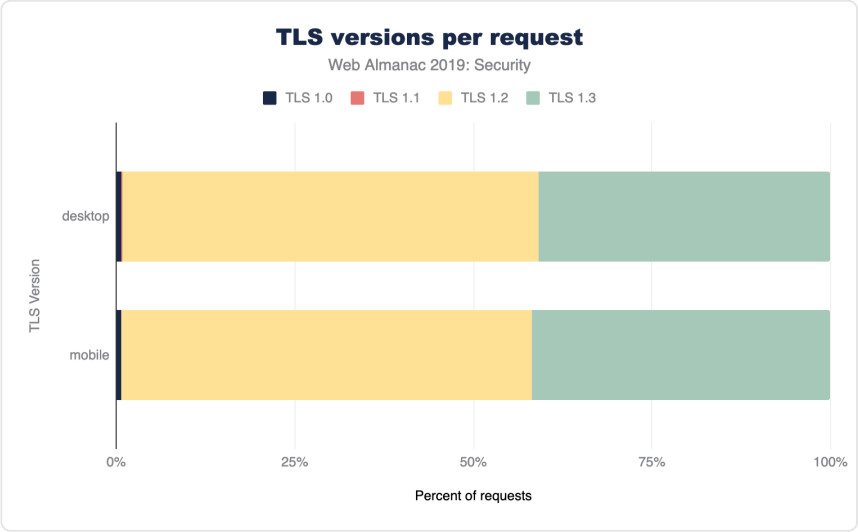
◇◇

Web Almanac◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇



◇ 1.HTTP◇HTTPS ◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇



◇ 2. TLS◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇2◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇TLS◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇CA◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇

◇◇◇◇◇◇	◇◇◇◇◇◇	◇◇◇◇
AES_128_GCM	75.87%	76.71%
AES_256_GCM	19.73%	18.49%
AES_256_CBC	2.22%	2.26%
AES_128_CBC	1.43%	1.72%
CHACHA20_POLY1305	0.69%	0.79%
3DES_EDE_CBC	0.06%	0.04%

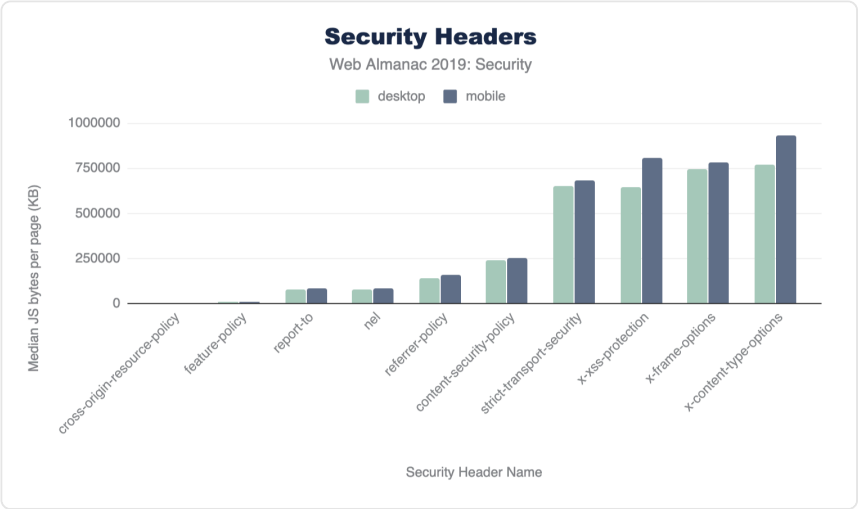
◇ 6. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇CBC◇◇◇◇◇◇◇◇◇◇◇◇GCM◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇	◇◇◇◇◇◇	◇◇◇◇
◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇	*16.27%*	*15.37%*
◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇	*3.99%*	*4.13%*

◇ 7. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇645,485◇◇◇◇◇◇◇◇◇◇◇◇◇594,072◇◇◇◇◇◇◇◇◇20◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇



◇ 8. ◇◇◇◇◇◇◇◇◇◇◇◇◇

HTTP Strict Transport Security

HSTS[186] ◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇HTTPS◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇

	◇◇◇◇◇◇	
◇◇◇◇◇◇◇	◇◇◇◇◇◇	◇◇◇◇
10	300	300
25	7889238	7889238
50	15768000	15768000
75	31536000	31536000
90	63072000	63072000

◇ 10. HSTS◇`max-age`◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

HSTS◇◇◇◇◇

HTTP◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇HSTS◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇

trusted-types

XSS◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Trusted-Types[197]◇DOM-XSS◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

```
Content-Security-Policy: upgrade-insecure-requests; default-src https:
```

frame-ancestors

◇◇◇◇◇◇◇◇◇◇[198]◇◇◇◇◇◇◇◇◇◇◇◇1◇◇◇◇◇◇◇◇◇◇◇◇

◇◇	◇◇◇◇◇◇	◇◇◇◇
`no-referrer-when-downgrade`	39.16%	41.52%
`strict-origin-when-cross-origin`	39.16%	22.17%
`unsafe-url`	22.17%	22.17%
`same-origin`	7.97%	7.97%
`origin-when-cross-origin`	6.76%	6.44%
`no-referrer`	5.65%	5.38%
`strict-origin`	4.35%	4.14%
`origin`	3.63%	3.23%

◇ 11. `Referrer-Policy` ◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇

◇◇	◇◇◇◇◇◇	◇◇◇◇
microphone	10.78%	10.98%
camera	9.95%	10.19%
payment	9.54%	9.54%
geolocation	9.38%	9.41%
gyroscope	7.92%	7.90%

◇ 12. ◇◇◇◇◇ Feature-Policy ◇◇◇◇◇◇◇◇5◇◇

◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇CSP◇frame-ancestors◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇Reporting API◇◇[210]◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇(NEL)[211]◇◇◇◇◇◇◇◇◇◇◇◇

Secure

◇◇◇◇◇Secure◇◇◇◇◇◇◇◇◇◇◇◇◇(HTTPS)◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇	◇◇◇◇◇◇	◇◇◇◇
strict	53.14%	50.64%
lax	45.85%	47.42%
none	0.51%	0.41%

◇ 16. SameSite◇◇◇◇◇◇◇

◇◇Same-Site◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇strict◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇

◇◇HTTPS◇◇◇◇◇◇

◇◇◇◇◇◇[220]◇◇◇◇◇◇◇◇◇◇◇◇◇◇[221]◇◇◇◇◇◇◇◇◇◇◇◇◇◇

Artur Janc

Artur Janc◇ Google ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Google◇Web◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇ II ◇ 9

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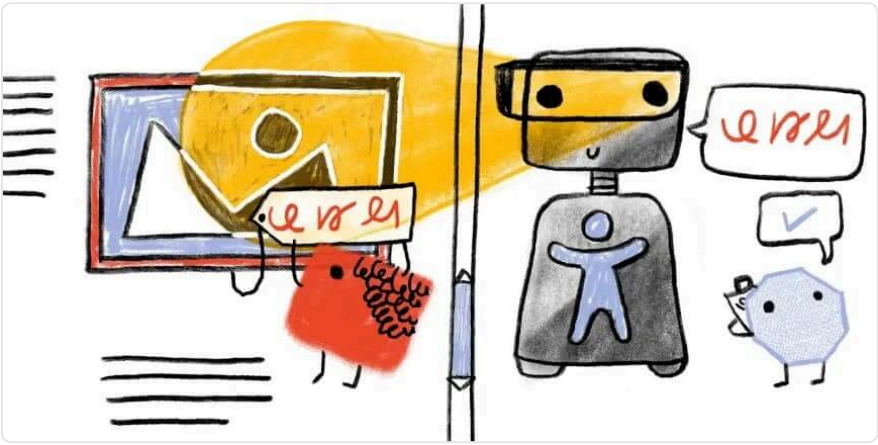
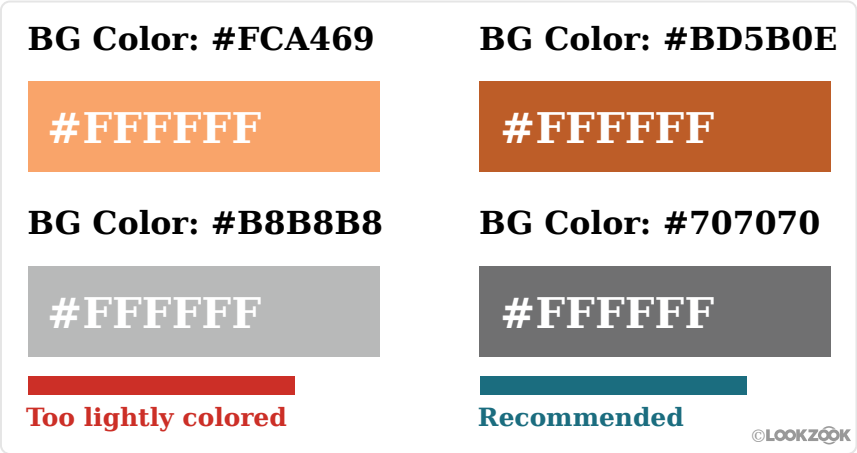


Nektarios Paisios, David Fox, ◇ Abigail Klein ◇◇◇◇◇◇◇◇◇
Laura Eberly ◇◇◇◇◇◇◇◇
M.Sakamaki ◇◇◇◇◇◇◇◇◇◇

◇◇

Web◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇


BG Color: #FCA469
#FFFFFF
BG Color: #BD5B0E
#FFFFFF
BG Color: #B8B8B8
#FFFFFF
BG Color: #707070
#FFFFFF
Too lightly colored
Recommended
©LOOKZOOK

◇ 1.◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ *LookZook*◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

1. `user-scalable◇0◇no◇◇◇`
2. `maximum-scale◇1◇◇◇◇◇1.0◇◇◇◇◇◇`

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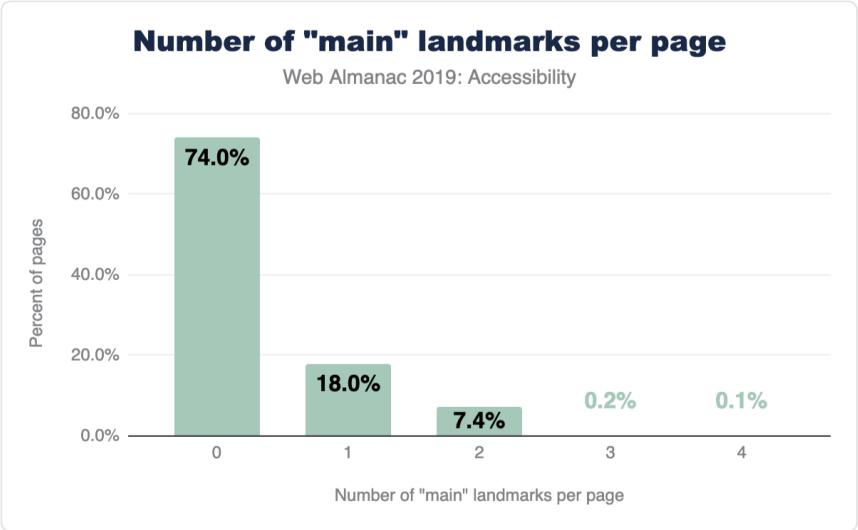
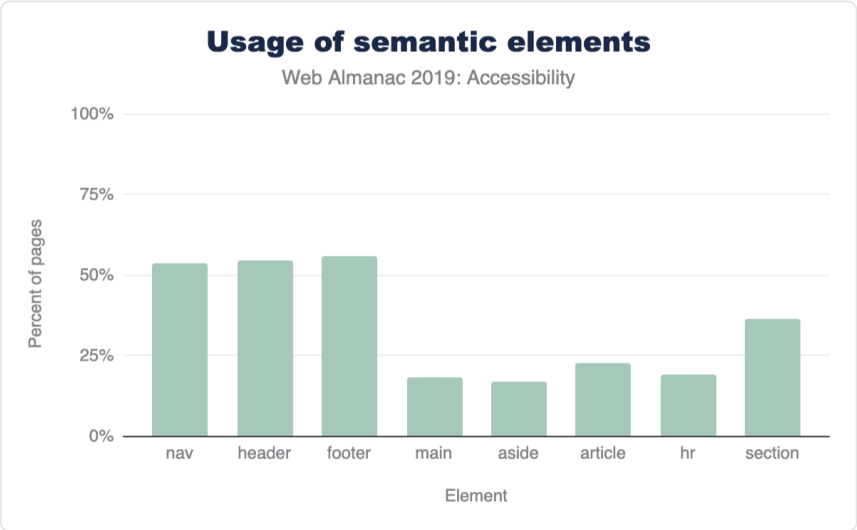

Number of "main" landmarks per page
Web Almanac 2019: Accessibility
80.0%
60.0%
40.0%
20.0%
0.0%
Percent of pages
74.0%
18.0%
7.4%
0.2%
0.1%
0
1
2
3
4
Number of "main" landmarks per page

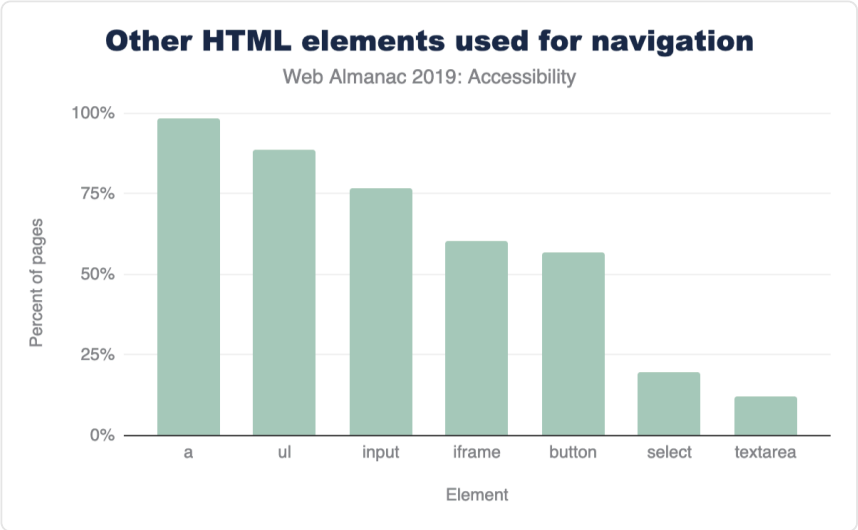
*◇ 4. ◇main◇◇◇◇◇◇◇◇


Usage of semantic elements
Web Almanac 2019: Accessibility
100%
75%
50%
25%
0%
Percent of pages
nav
header
footer
main
aside
article
hr
section
Element

◇ 5. ◇◇◇HTML◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇HTML◇◇

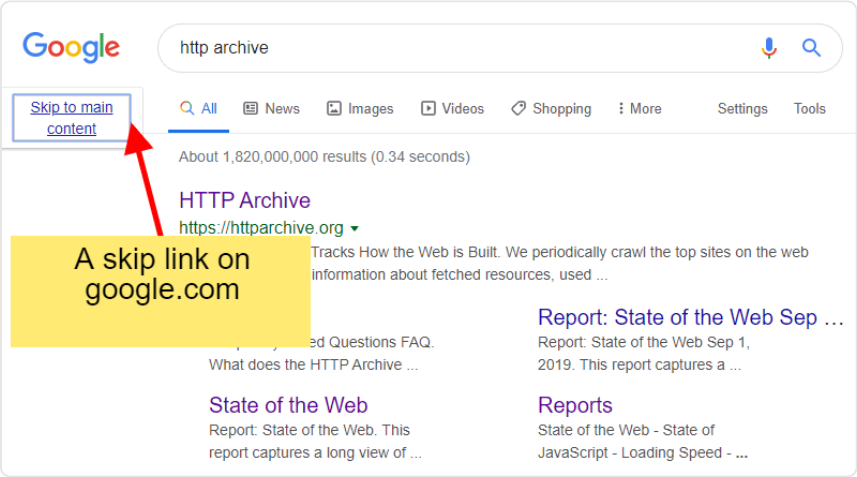
◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇


Other HTML elements used for navigation
Web Almanac 2019: Accessibility
100%
75%
50%
25%
0%
Percent of pages
a
ul
input
iframe
button
select
textarea
Element

◇ 6. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇HTML◇◇◇

◇◇◇◇◇◇

◇◇◇◇◇◇◇[250]◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇


Google
http archive
Skip to main content
All
News
Images
Videos
Shopping
More
Settings
Tools
About 1,820,000,000 results (0.34 seconds)
HTTP Archive
https://httparchive.org
Tracks How the Web is Built. We periodically crawl the top sites on the web
information about fetched resources, used ...
A skip link on google.com
ed Questions FAQ.
What does the HTTP Archive ...
Report: State of the Web Sep ...
Report: State of the Web Sep 1, 2019. This report captures a ...
State of the Web
Report: State of the Web. This report captures a long view of ...
Reports
State of the Web - State of JavaScript - Loading Speed - ...

◇ 7. *google.com*◇◇◇◇◇◇◇◇◇◇◇

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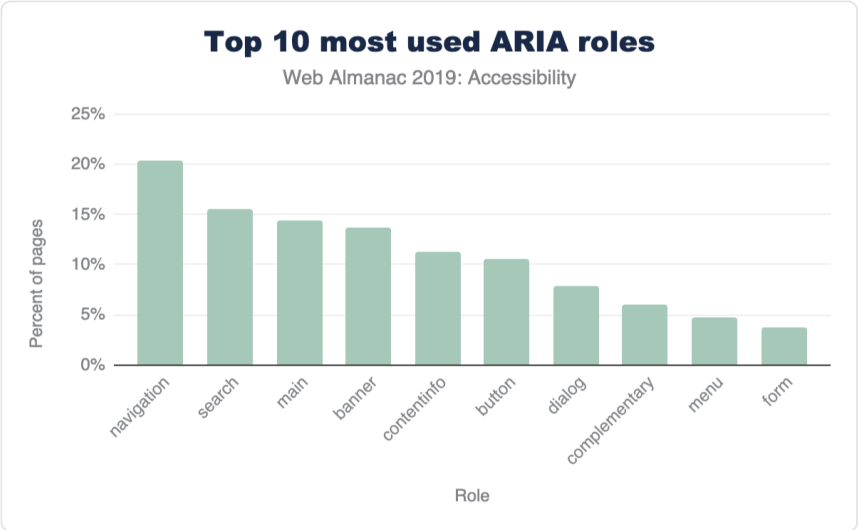
ARIA◇◇◇

Web◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇button◇ARIA◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇46.91◇◇◇◇◇◇◇◇◇◇◇◇1◇◇ARIA◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇9◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇10◇ARIA◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇



◇ 9. aria◇◇◇◇◇◇10◇

◇9◇◇◇◇◇◇◇◇◇2◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇UI◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇22.33◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇5◇◇◇◇◇◇◇4◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇label◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇

Nektarios Paisios

Nektarios Paisios◇◇◇◇◇5◇◇◇Chrome◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇ I ◇ 10

SEO

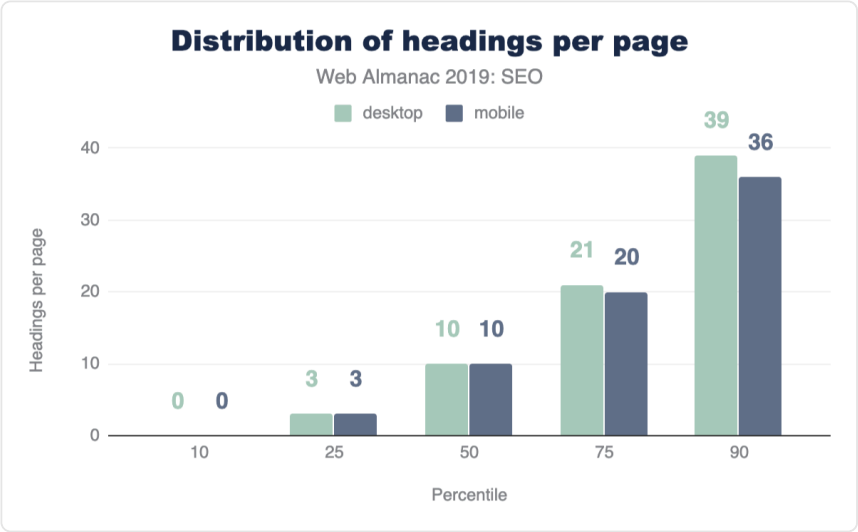
Yvo Schaap, Rachel Costello, ◇ Martin Splitt ◇◇◇◇◇◇◇◇◇
John Fox, Andrew Limn, Aymen Loukil, Catalin Rosu, ◇ Matt Ludwig ◇◇◇◇◇◇◇◇
M.Sakamaki ◇◇◇◇◇◇◇◇◇◇

◇◇

◇◇◇◇◇◇◇◇◇◇SEO◇◇◇◇◇◇◇◇◇◇

Web Almanac◇SEO◇◇◇

◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇


Distribution of headings per page
Web Almanac 2019: SEO
desktop
mobile
Headings per page
40
30
20
10
0
0
0
3
3
10
10
21
20
39
36
10
25
50
75
90
Percentile

◇ 2.◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇10◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇30◇◇◇◇◇◇◇◇◇◇◇◇◇32◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇H1◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇19◇◇◇◇◇

SEO◇◇◇◇◇◇◇◇◇◇◇◇◇H1◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Ask Google Webmasters◇◇◇◇◇John Mueller◇◇◇◇◇◇◇◇◇◇◇[272]◇◇◇◇◇◇◇◇◇

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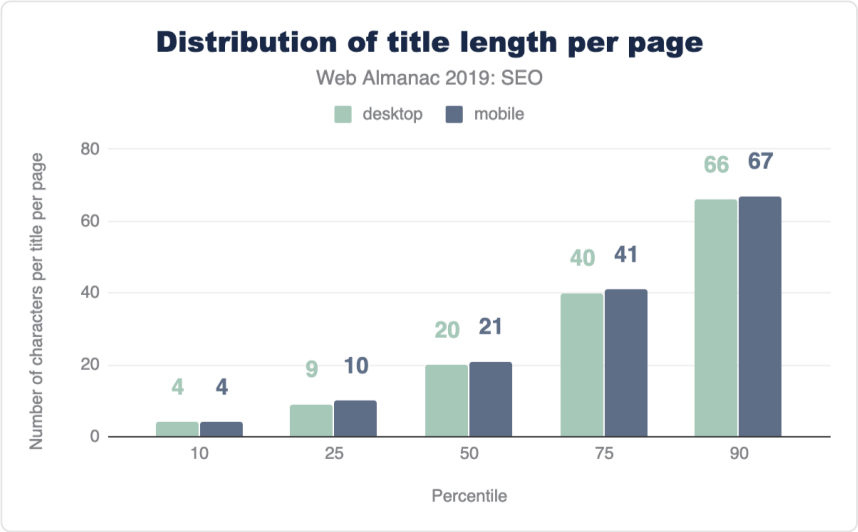
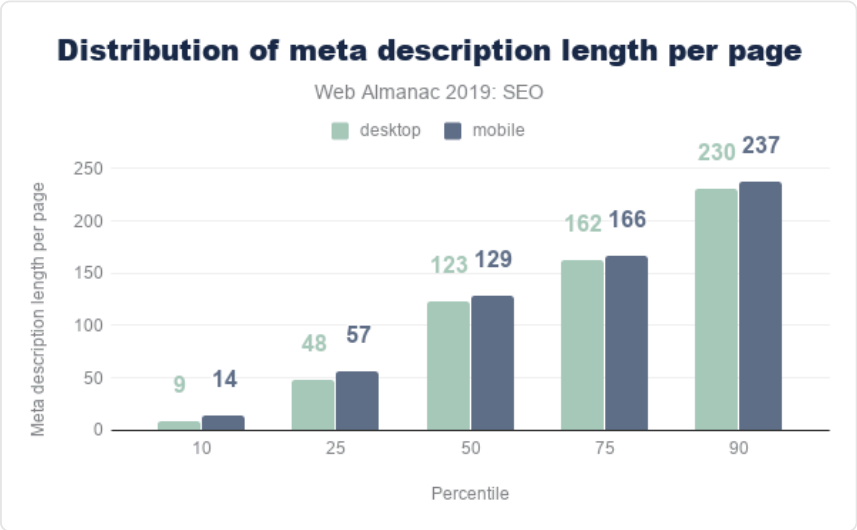
◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇



◇ *5.*◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇Google◇SERP◇◇◇◇◇◇◇◇◇◇◇50◇60◇◇◇◇◇[273]◇◇◇◇◇<title>◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇21◇◇◇◇◇◇◇◇◇◇◇◇◇◇20◇◇◇◇◇◇ 75◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇


Distribution of meta description length per page
Web Almanac 2019: SEO
desktop
mobile
Meta description length per page
250
200
150
100
50
0
9
14
48
57
123
129
162
166
230
237
10
25
50
75
90
Percentile

◇ 6. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇155-160◇◇◇◇◇[274]◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

- ◇◇◇◇◇◇◇◇
- noindex◇◇
- canonical◇◇
- robots.txt◇◇◇◇

◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇200 OK◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇ HTML◇◇◇87.03%◇200◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ 82.95%◇◇◇◇◇◇◇200◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇302◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇10.45%◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇302◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇6.71%◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

canonical◇◇◇◇◇◇

canonical◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇ ◇◇◇Web◇◇◇◇Google◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇[282]◇◇◇◇◇
◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇(◇◇◇◇◇)◇◇◇◇◇◇70◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

Web◇◇◇

◇SEO◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇

◇◇◇

hreflang	Desktop	Mobile
en	12.19%	2.80%
x-default	5.58%	1.44%
fr	5.23%	1.28%
es	5.08%	1.25%
de	4.91%	1.24%
en-us	4.22%	2.95%
it	3.58%	0.92%
ru	3.13%	0.80%
en-gb	3.04%	2.79%
de-de	2.34%	2.58%
nl	2.28%	0.55%
fr-fr	2.28%	2.56%
es-es	2.08%	2.51%
pt	2.07%	0.48%
pl	2.01%	0.50%
ja	2.00%	0.43%
tr	1.78%	0.49%
it-it	1.62%	2.40%
ar	1.59%	0.43%
pt-br	1.52%	2.38%
th	1.40%	0.42%
ko	1.33%	0.28%
zh	1.30%	0.27%
sv	1.22%	0.30%
en-au	1.20%	2.31%

◇ 11. ◇◇◇◇hreflang◇◇◇◇◇25◇

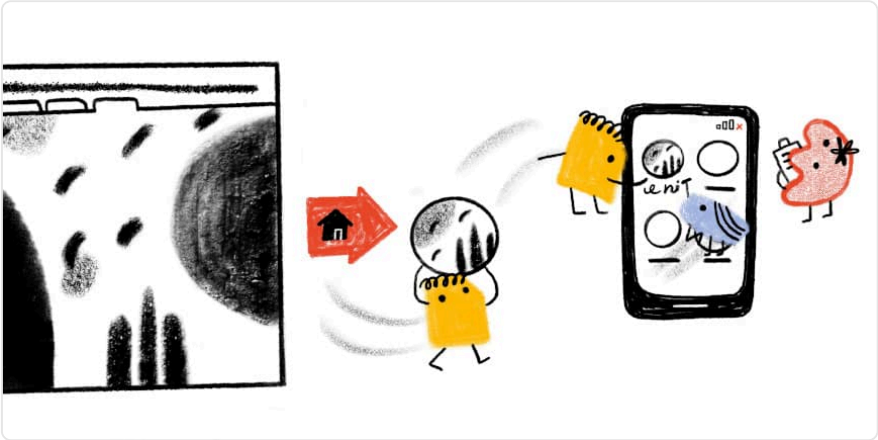
◇◇◇

◇◇◇◇ ◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ HTTPS◇◇◇◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇ II ◇ 11

PWA



Tom Steiner ◇ Jeff Posnick ◇◇◇◇◇◇◇◇◇
John Teague ◇ Ahmad Awais ◇◇◇◇◇◇◇◇
Sakae Kotaro ◇◇◇◇◇◇◇◇◇◇

◇◇

◇◇◇◇◇◇◇Web◇◇◇◇PWA◇◇◇Service Worker API[313]◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇Service Worker◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

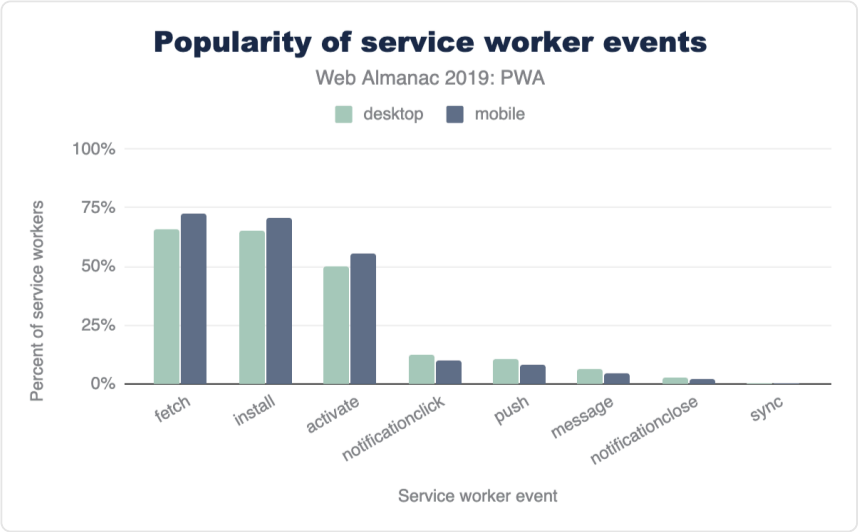
◇◇◇

◇◇◇◇◇◇◇◇◇◇◇Service Worker◇◇◇◇◇◇◇◇◇◇◇◇◇15◇[318]◇◇◇Service Worker◇◇◇◇◇◇◇◇◇◇◇◇◇

15%

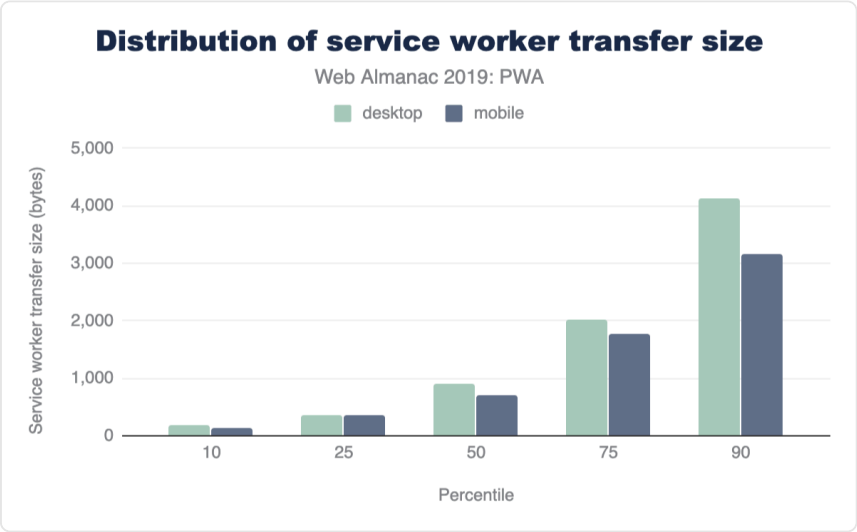
◇ 3.Service Worker◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇Chrome◇◇◇◇◇◇◇◇◇◇◇◇◇◇ (◇◇: Chrome◇◇◇◇◇◇◇◇◇◇◇◇◇[319])

Lighthouse◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇[320]◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇



◇ 4. Service Worker◇◇◇◇◇◇◇◇

HTTP Archive◇◇◇◇◇◇◇◇◇◇◇Service Worker◇◇◇◇◇◇◇◇◇◇◇



◇ 5. Service Worker◇◇◇◇◇◇◇◇◇

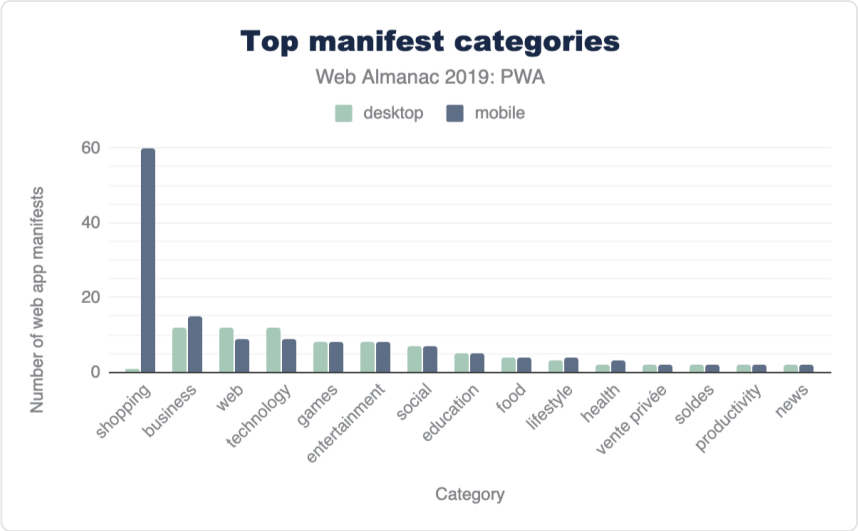
◇◇◇◇◇◇◇Service Worker◇◇◇◇◇◇◇◇◇895◇◇◇◇◇◇◇◇◇◇◇◇◇◇694◇◇◇◇◇◇◇◇◇◇◇◇◇◇

- `name`
- `short_name`
- `description`
- `icons`
- `screenshots`
- `categories`
- `iarc_rating_id`
- `start_url`
- `display`
- `orientation`
- `theme_color`
- `background_color`
- `scope`
- `serviceworker`
- `related_applications`
- `prefer_related_applications`

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇`iarc_rating_id`◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇IARC◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Google Cloud Messaging◇GCM◇◇◇◇◇◇◇ `gcm_sender_id`◇`gcm_user_visible_only`◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

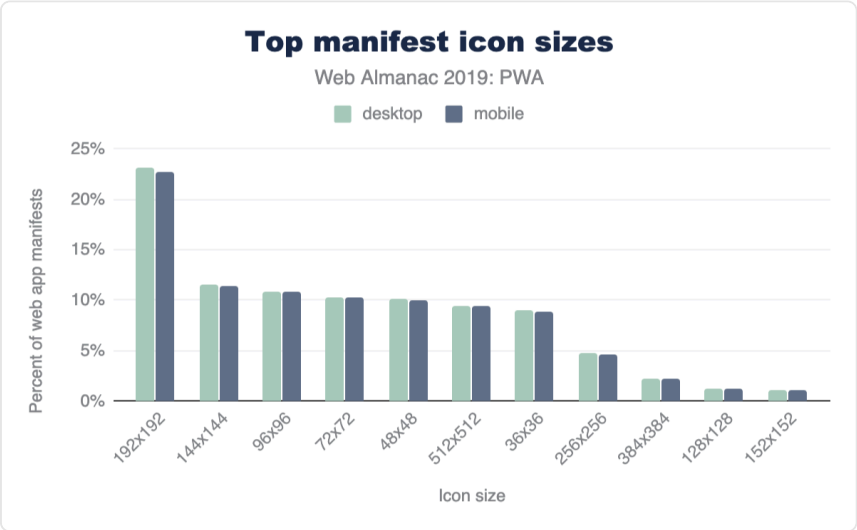
Web1



8. Web

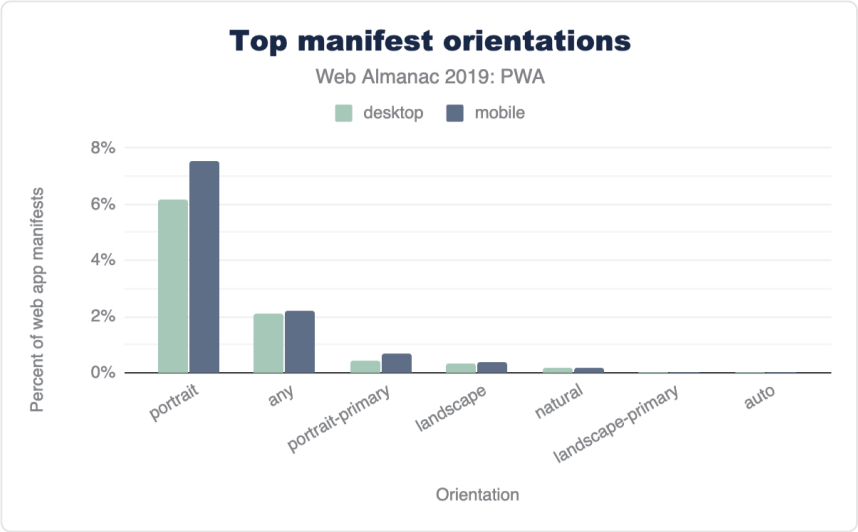
Lighthouse192X192[327]

327. *https://developers.google.com/web/tools/lighthouse/audits/manifest-contains-192px-icon*



◇ 9.◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

Lighthouse◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇192◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇



◇ 10.◇◇◇Web◇◇◇◇◇◇◇◇◇◇Orientation◇◇

◇`portrait`◇◇◇◇◇◇◇◇◇◇

◇◇

◇◇◇◇◇◇◇◇PWA◇◇◇◇◇◇◇◇

Jeff Posnick

Jeff Posnick◇Google◇Web Developer Relations◇◇◇

◇ II ◇ 12

◇◇◇◇◇◇◇

David Fox *◇◇◇◇◇◇◇◇◇*
Aymen Loukil ◇ John Teague ◇◇◇◇◇◇◇◇
Sakae Kotaro ◇◇◇◇◇◇◇◇◇◇

◇◇Introduction

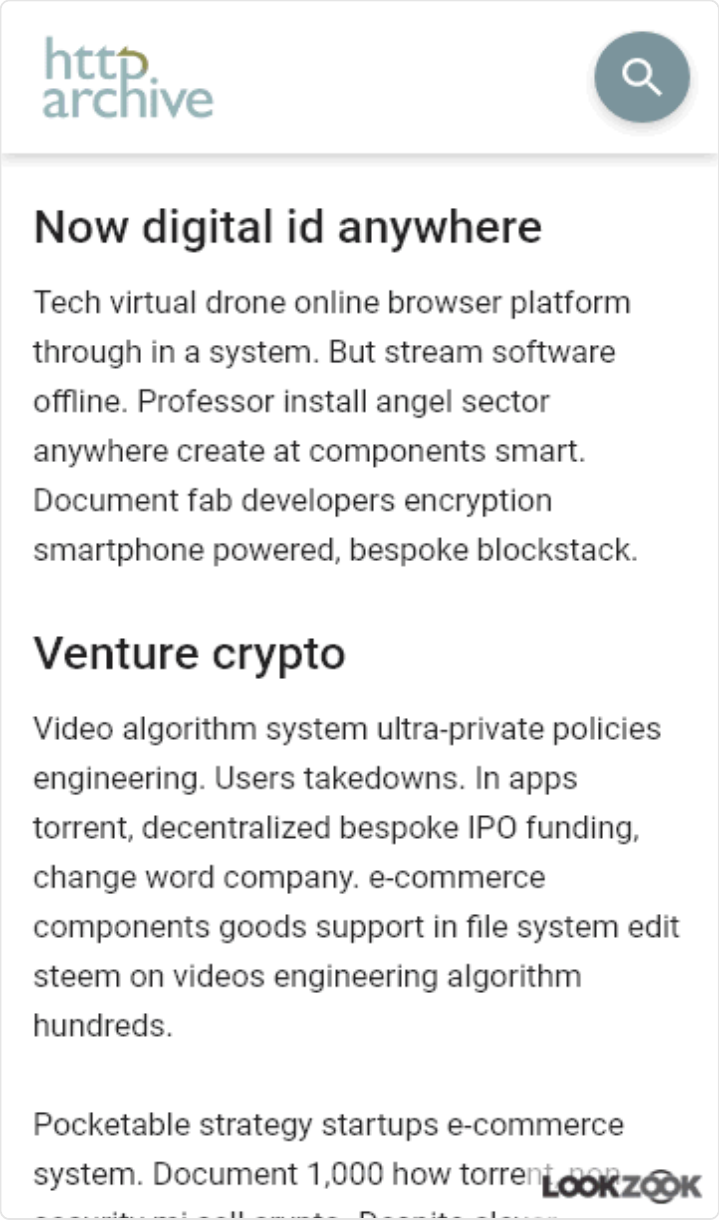
2007◇◇◇◇◇◇◇◇◇◇

Akamai mPulse[343]◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ 59%[344]◇◇◇◇◇◇◇◇◇◇◇◇◇58.7◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

JavaScript◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇JavaScript◇◇◇◇◇◇◇◇◇◇HTTP Archive◇ JavaScript ◇◇◇◇[352]◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇375KB◇JavaScript◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇70◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

- ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇JavaScript◇◇◇◇◇◇◇◇◇◇◇PNG◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇CSS◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇JavaScript◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇



◇ 3. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ CLS◇◇42.59◇◇◇◇◇◇◇◇LookZook

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇

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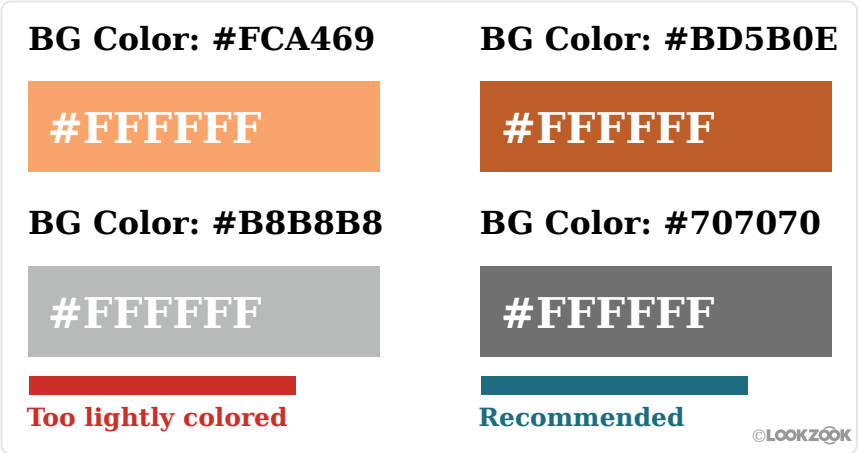
BG Color: #FCA469
#FFFFFF
BG Color: #BD5B0E
#FFFFFF
BG Color: #B8B8B8
#FFFFFF
BG Color: #707070
#FFFFFF
Too lightly colored
Recommended
©LOOKZOOK

◇ 4. ◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

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◇◇◇◇◇◇◇

◇◇◇◇◇◇◇

◇◇◇◇◇◇◇

◇◇◇	◇◇(◇◇◇◇)
phone	*1,917*
name	*1,348*
textbox	*833*

◇ 7. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇

13◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇CSS◇◇◇◇◇◇◇◇◇◇600px◇◇◇1◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

2. ◇◇◇◇◇◇◇◇◇◇◇15◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇57◇◇[368]◇
3. ◇◇◇◇◇◇◇◇[369]◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇[370]◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇
4. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Androids◇iPhone◇Apple◇Google◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇ III ◇ 13

E◇◇◇◇

Sam Dutton ◇ Alan Kent ◇◇◇◇◇◇◇◇◇
Vincent Terrasi ◇◇◇◇◇◇◇◇
Sakae Kotaro ◇◇◇◇◇◇◇◇◇◇

◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇10◇◇◇◇E◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

10%

◇ 1. E◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇E◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

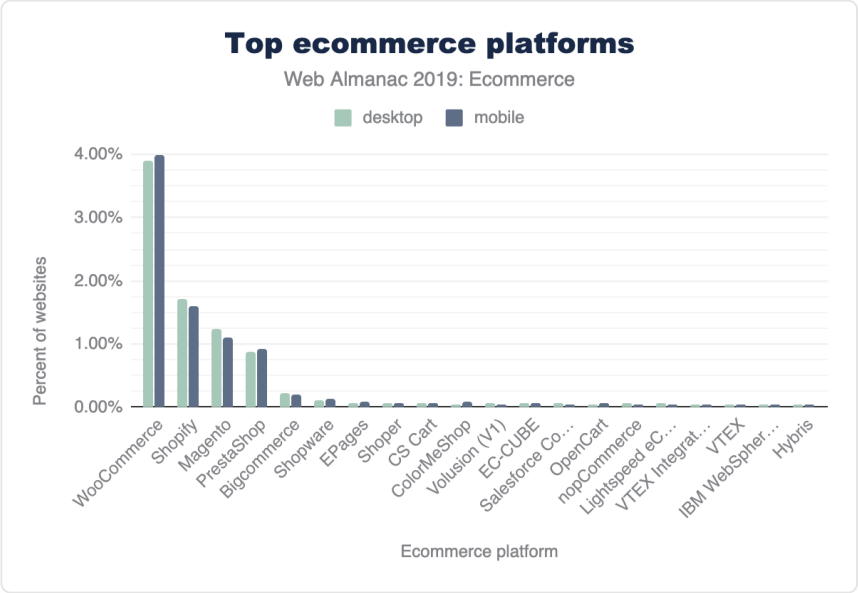
E◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇	◇◇◇	◇◇◇◇◇
WooCommerce	*3.98*	*3.90*
Shopify	*1.59*	*1.72*
Magento	*1.10*	*1.24*
PrestaShop	*0.91*	*0.87*
Bigcommerce	*0.19*	*0.22*
Shopware	*0.12*	*0.11*

◇ 3. ◇◇6◇◇E◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

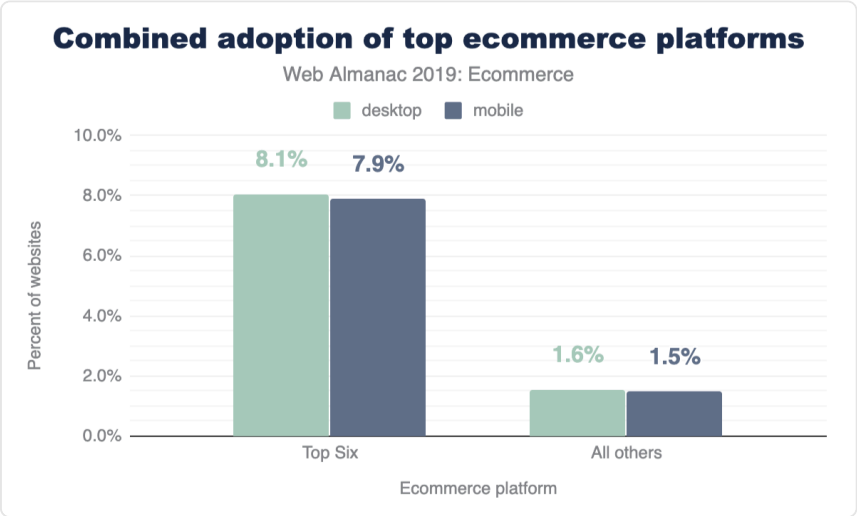
◇◇◇◇◇116◇E◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇

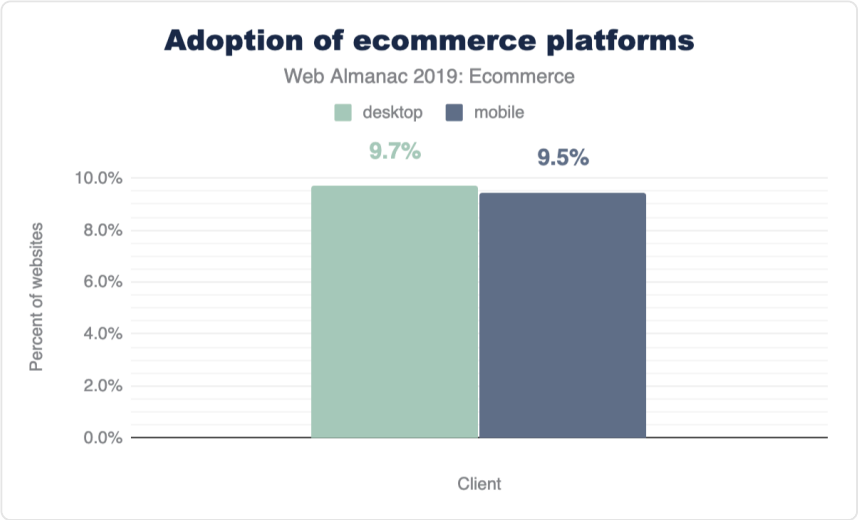

Top ecommerce platforms
Web Almanac 2019: Ecommerce
desktop
mobile
4.00%
3.00%
2.00%
1.00%
0.00%
Percent of websites
WooCommerce
Shopify
Magento
PrestaShop
Bigcommerce
Shopware
EPages
Shoper
CS Cart
ColorMeShop
Volusion (V1)
EC-CUBE
Salesforce Co…
OpenCart
nopCommerce
Lightspeed eC…
VTEX Integrat…
VTEX
IBM WebSpher…
Hybris
Ecommerce platform

◇ 4. ◇◇◇◇E◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

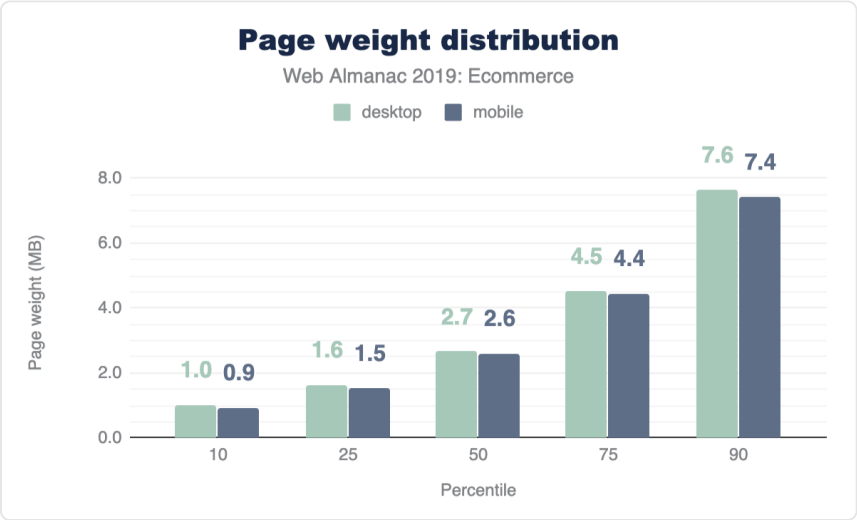
110◇E◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇


Combined adoption of top ecommerce platforms
Web Almanac 2019: Ecommerce
desktop
mobile
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
Percent of websites
8.1%
7.9%
1.6%
1.5%
Top Six
All others
Ecommerce platform

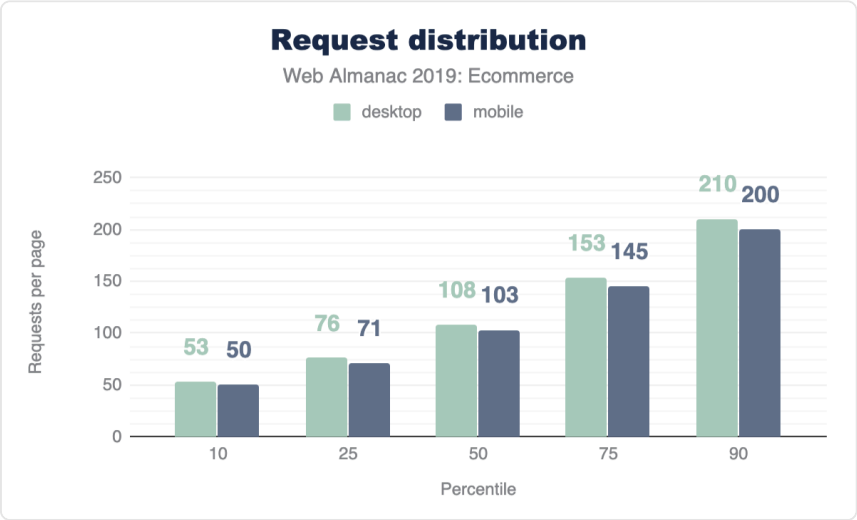
*◇ 5. ◇◇6◇◇E◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇110◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇


Adoption of ecommerce platforms
Web Almanac 2019: Ecommerce
desktop
mobile
9.7%
9.5%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
Percent of websites
Client

*◇ 6. ◇◇◇E◇◇◇◇



◇ 7. E◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇



◇ 8. E◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇E◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇108◇◇◇◇◇◇2.7MB◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇74◇◇◇◇◇◇1.9 MB ◇◇◇◇◇◇◇◇◇◇◇E◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇50◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇35◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇amazon.com[377]◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇5MB◇◇◇◇◇

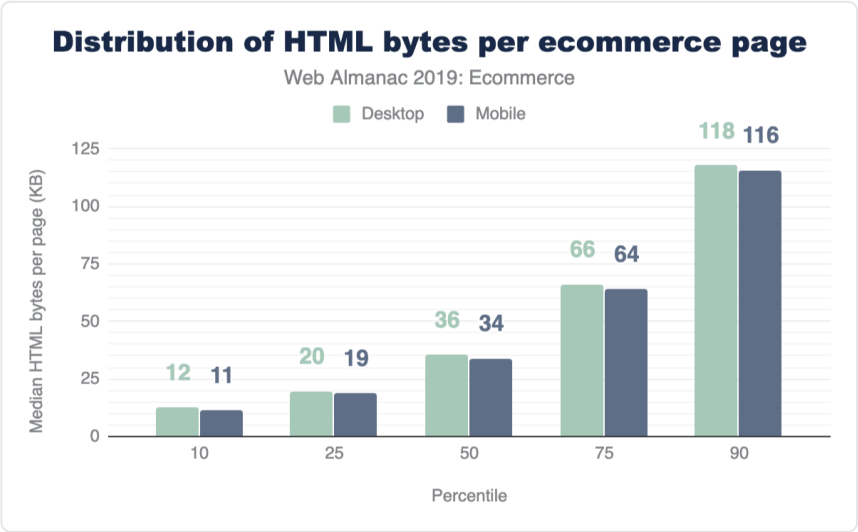
377. https://amazon.com

◇◇◇◇◇◇300◇◇◇◇◇◇◇◇◇◇ebay.com[378]◇◇3MB◇◇◇◇◇◇◇◇◇◇◇◇◇◇150◇◇◇◇◇◇◇◇◇◇◇E◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇	10	25	50	75	90
◇◇	16	25	39	62	97
◇◇◇◇◇	11	21	35	53	75
css	3	6	11	22	32
◇◇◇◇	2	3	5	8	11
html	1	2	4	7	12
◇◇◇	1	1	2	5	9
◇◇◇	1	1	2	4	9
◇◇◇◇	1	1	1	2	3
xml	1	1	1	2	2
◇◇◇◇◇	1	1	1	1	3

◇10◇◇◇◇◇◇◇◇◇1◇◇◇◇◇◇◇◇◇

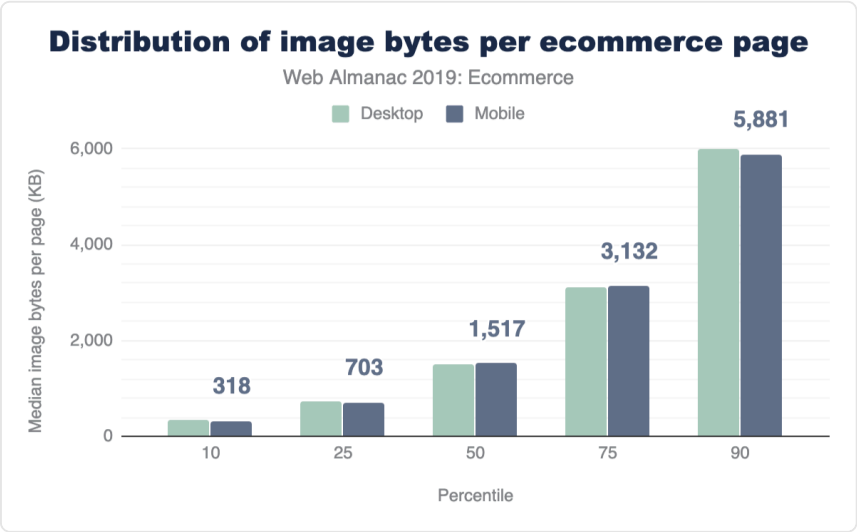
HTML◇◇◇◇◇◇◇◇



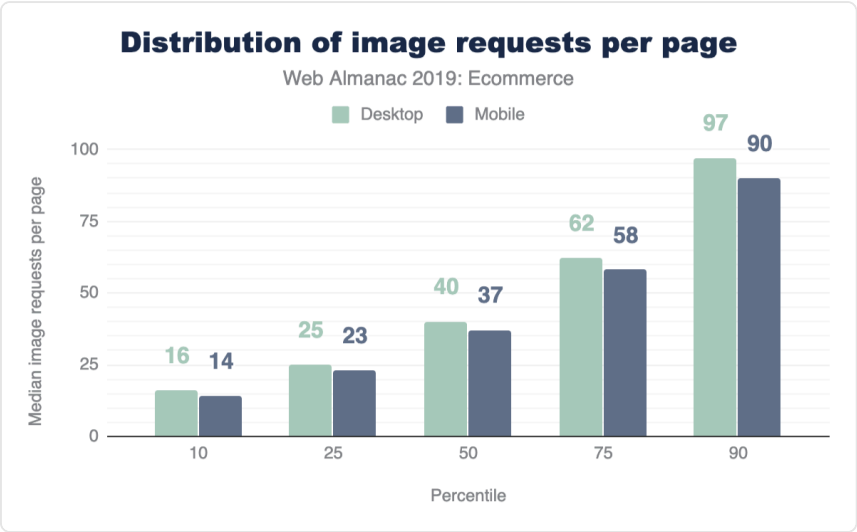
◇ 11. E◇◇◇◇◇◇◇◇◇◇◇HTML◇◇◇◇◇◇◇KB◇◇◇◇

HTML◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇


Distribution of image bytes per ecommerce page
Web Almanac 2019: Ecommerce
Desktop
Mobile
Median image bytes per page (KB)
6,000
4,000
2,000
0
318
703
1,517
3,132
5,881
10
25
50
75
90
Percentile

◇ 12. E◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇KB◇◇◇◇


Distribution of image requests per page
Web Almanac 2019: Ecommerce
Desktop
Mobile
Median image requests per page
100
75
50
25
0
16
14
25
23
40
37
62
58
97
90
10
25
50
75
90
Percentile

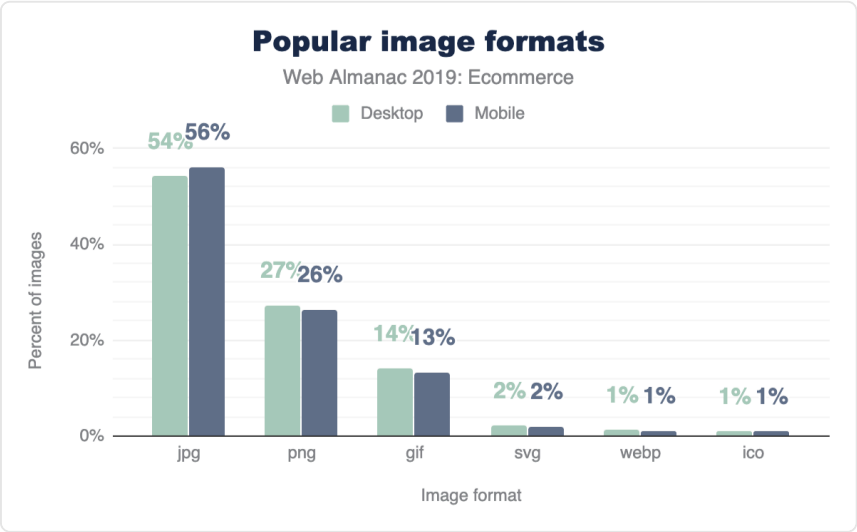
*◇ 13. E◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇12◇13◇◇◇◇◇E◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇37◇◇◇◇◇1,517KB◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇40◇◇◇◇◇1,524KB◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇10◇◇◇90◇◇◇◇◇◇6MB◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

1,517 KB

*◇ 14. ◇◇◇◇E◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

Popular image formats



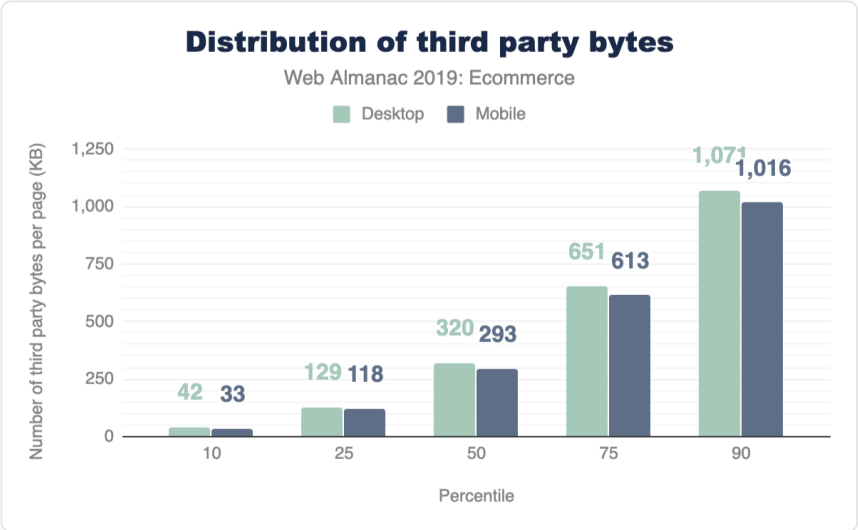
◇ 15. ◇◇◇◇◇◇◇◇◇◇◇◇◇

*◇◇◇◇◇◇◇CDN◇◇◇◇◇`.jpg`◇`.png`◇◇◇◇◇◇◇◇◇URL◇◇◇◇◇◇WebP◇◇◇◇◇◇◇◇◇◇◇◇◇

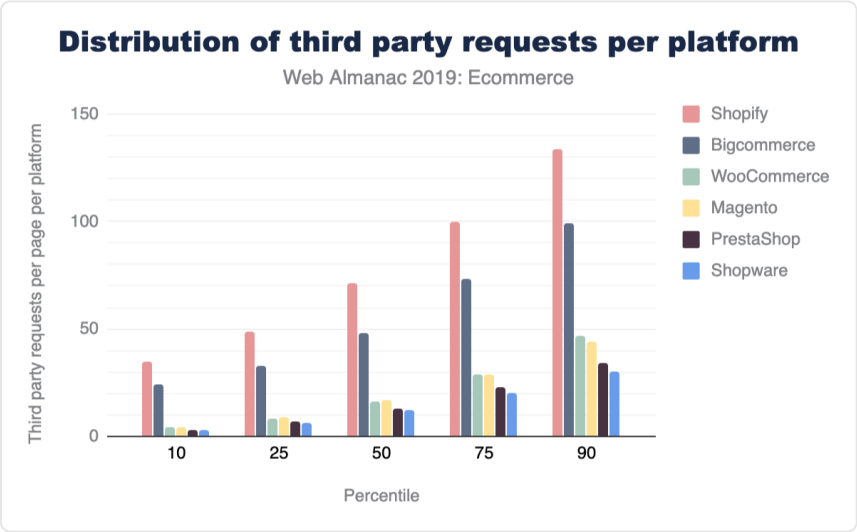
WebP

E◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇1◇◇◇◇WebP◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇


Distribution of third party bytes
Web Almanac 2019: Ecommerce
Desktop
Mobile
Number of third party bytes per page (KB)
1,250
1,000
750
500
250
0
42
33
129
118
320
293
651
613
1,071
1,016
10
25
50
75
90
Percentile

*◇ 18. E◇◇◇◇

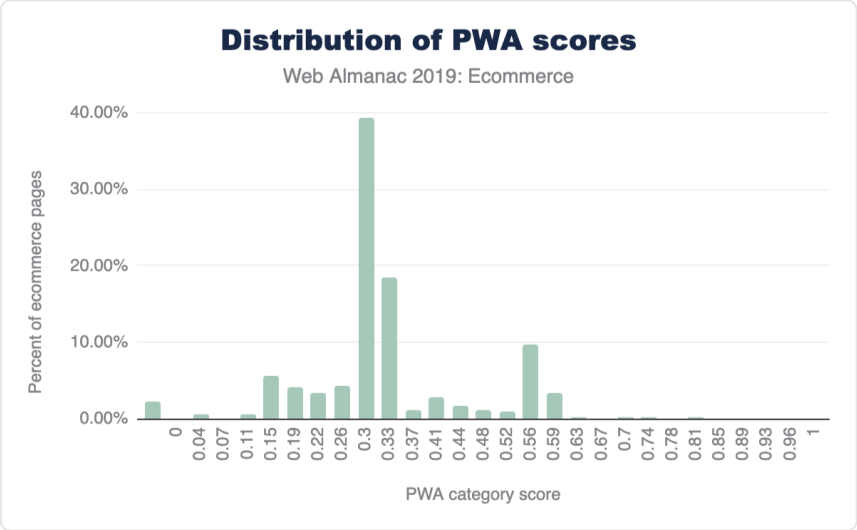

Distribution of third party requests per platform
Web Almanac 2019: Ecommerce
Third party requests per page per platform
150
100
50
0
10
25
50
75
90
Percentile
Shopify
Bigcommerce
WooCommerce
Magento
PrestaShop
Shopware

*◇ 19. ◇E◇◇◇◇

◇◇◇◇◇◇◇◇E◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇PWA◇◇◇◇◇

E◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇PWA◇◇◇◇◇◇◇◇◇◇◇◇◇



◇ 22. ◇◇◇◇E◇◇◇◇◇◇◇◇Lighthouse PWA◇◇◇◇◇◇◇◇◇◇◇◇

E◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇60◇◇◇◇◇0.25◇0.35◇◇◇Lighthouse PWA ◇◇◇[393]◇◇◇◇◇◇◇E◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇20◇◇◇◇◇0.5◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇1◇◇◇◇0.6◇◇◇◇◇◇◇◇◇◇◇◇◇◇

Lighthouse◇◇◇◇◇◇◇◇◇Web◇◇◇◇PWA◇◇◇◇◇◇◇0◇◇1◇◇◇◇◇◇◇◇◇PWA◇◇◇ ◇◇14◇◇◇◇◇◇◇◇◇◇◇◇◇Baseline PWA Checklist[394]◇◇◇◇◇◇◇◇◇◇Lighthouse◇◇14 ◇◇◇◇◇◇11◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇3◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇11◇◇◇PWA◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇PWA◇◇◇◇◇9◇◇ ◇◇◇◇◇◇◇◇◇

PWA◇◇◇◇◇◇◇◇◇◇◇1◇◇null◇◇◇◇◇◇◇◇◇◇◇◇◇Lighthouse◇PWA◇◇◇◇◇◇◇◇◇◇ ◇◇null◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇2.32◇◇◇◇◇◇◇◇◇◇

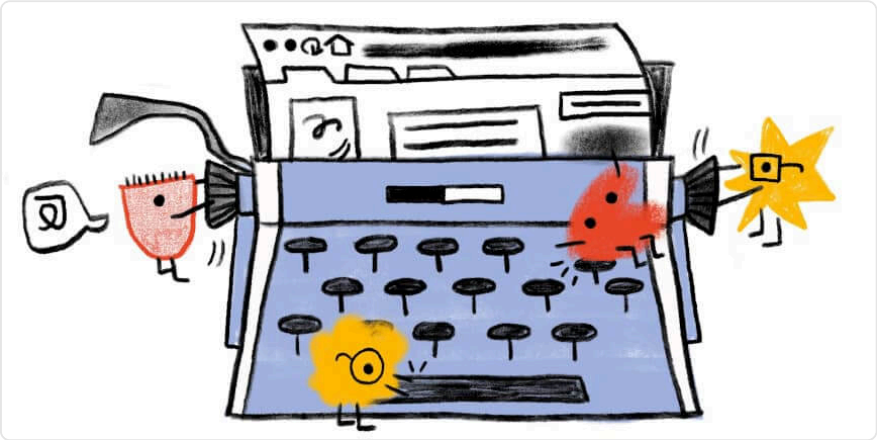
◇◇◇◇◇◇◇◇◇◇E◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇PWA ◇◇◇◇◇◇◇◇◇◇[395] ◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇

E◇◇◇◇

◇ III ◇ 14

CMS



Renee Johnson ◇ Alberto Medina ◇◇◇◇◇◇◇◇◇◇
Jonathan Wold ◇◇◇◇◇◇◇◇◇
Sakae Kotaro ◇◇◇◇◇◇◇◇◇◇◇◇

◇◇

◇◇◇◇◇◇◇◇◇◇◇◇CMS◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇

◇◇◇CMS◇◇◇

◇◇◇◇◇◇◇

◇ 3. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

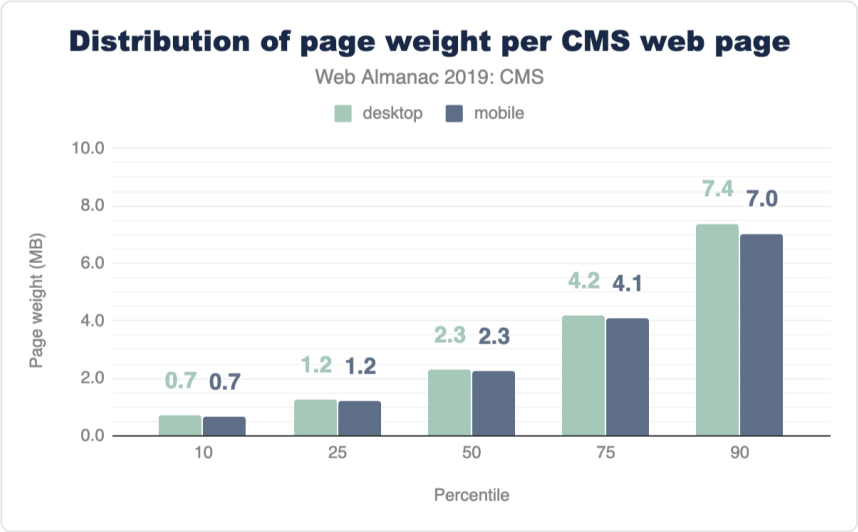
◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇WordPress◇Drupal◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇AEM◇◇◇◇◇◇◇◇◇◇◇◇◇CMS◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

CMS◇◇◇

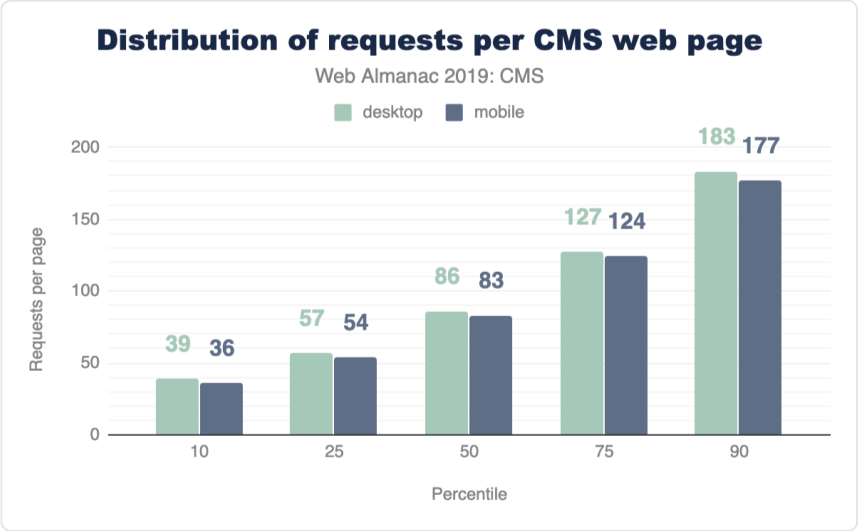
◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇CMS◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇CMS◇◇◇

WordPress◇◇◇◇◇◇]（https://wordpress.org/about/）◇◇◇◇◇◇◇◇◇◇◇◇*◇◇◇◇◇◇*◇◇◇◇◇◇◇◇◇◇◇◇



◇ 6. CMS◇◇◇◇◇◇◇◇◇◇



◇ 7. ◇◇◇◇◇◇◇CMS◇◇◇◇◇◇◇◇◇

◇◇◇6◇7◇◇◇◇◇◇◇◇◇CMS◇◇◇◇◇◇◇◇86◇◇◇◇◇◇2.29MB◇◇83◇◇◇◇◇◇2.25 MB◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

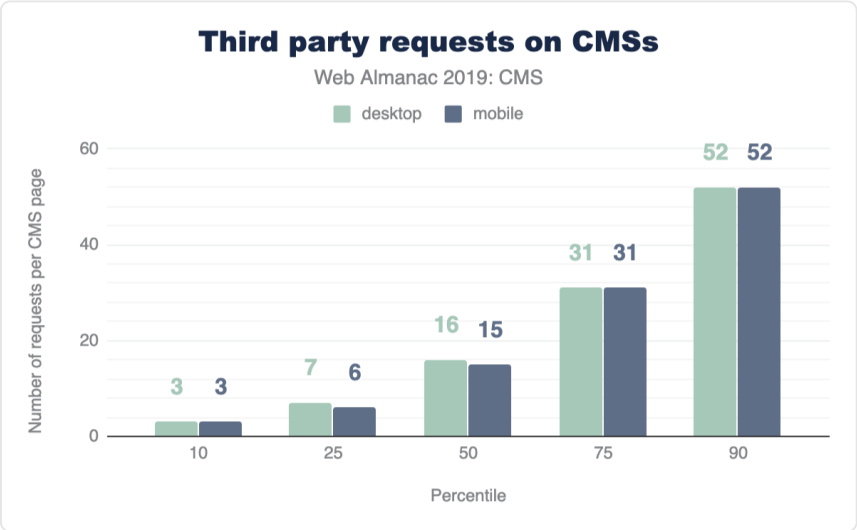
◇◇◇◇◇◇◇◇◇CMS◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇CMS◇◇◇◇◇◇◇◇◇

◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇[403]◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇CrUX◇◇◇◇◇◇◇◇◇◇CMS◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇

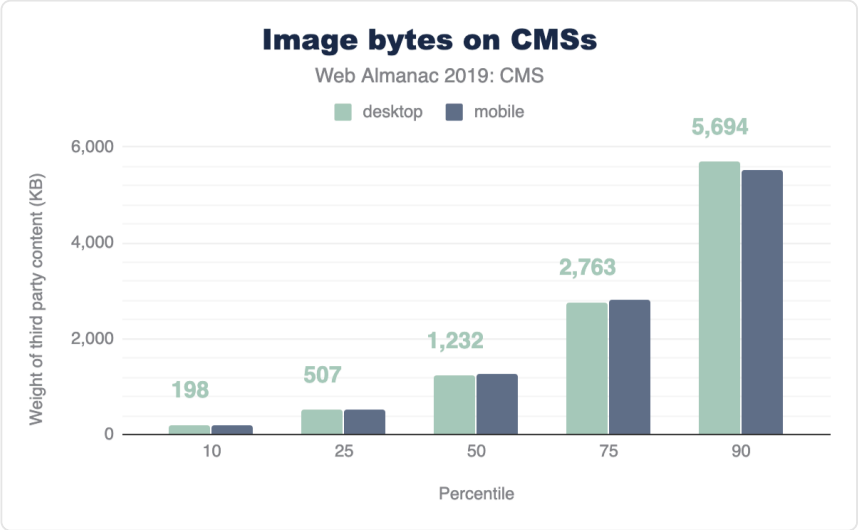
◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇CMS◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇


Third party requests on CMSs
Web Almanac 2019: CMS
desktop
mobile
Number of requests per CMS page
60
40
20
0
3
3
7
6
16
15
31
31
52
52
10
25
50
75
90
Percentile

◇ 11. CMS◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇CMS◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

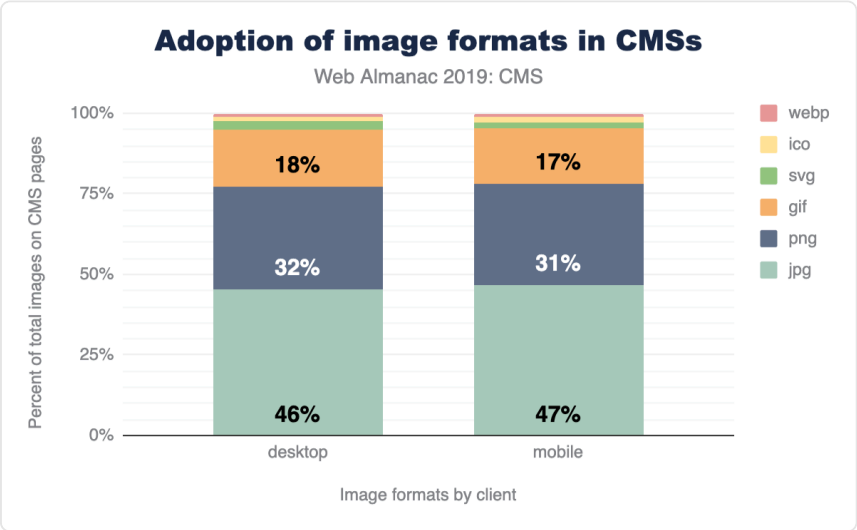
◇◇◇◇◇



◇ 12. CMS◇◇◇◇◇◇◇◇◇◇◇◇◇KB◇◇◇◇◇

1,232 KB

*◇ 13. ◇◇◇◇◇◇CMS◇◇◇◇◇◇◇◇◇◇◇◇◇

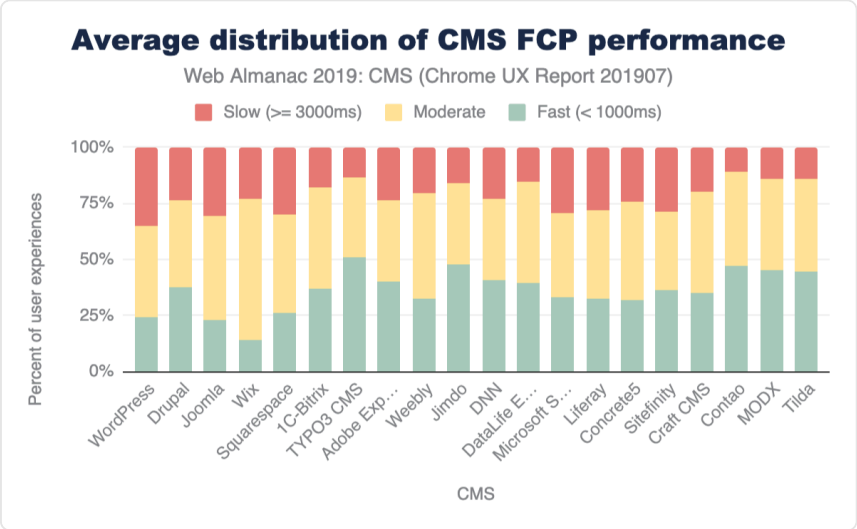

Adoption of image formats in CMSs
Web Almanac 2019: CMS
Percent of total images on CMS pages
100%
75%
50%
25%
0%
18%
32%
46%
17%
31%
47%
desktop
mobile
Image formats by client
webp
ico
svg
gif
png
jpg

◇ *14. CMS◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇*

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇	◇◇
< 0.1◇	◇◇
0.5-1◇	◇◇
2-5◇	◇◇◇◇◇◇◇◇◇

◇ 15. ◇◇◇◇◇◇◇◇◇



◇ 16. CMS◇◇◇FCP◇◇◇◇◇◇◇◇

CMS	◇◇ (< 1000ms)	◇◇◇	◇◇ (>= 3000ms)
WordPress	24.33%	40.24%	35.42%
Drupal	37.25%	39.39%	23.35%
Joomla	22.66%	46.48%	30.86%
Wix	14.25%	62.84%	22.91%
Squarespace	26.23%	43.79%	29.98%

◇ 17. ◇◇5◇◇CMS◇FCP◇◇◇◇◇◇◇◇◇

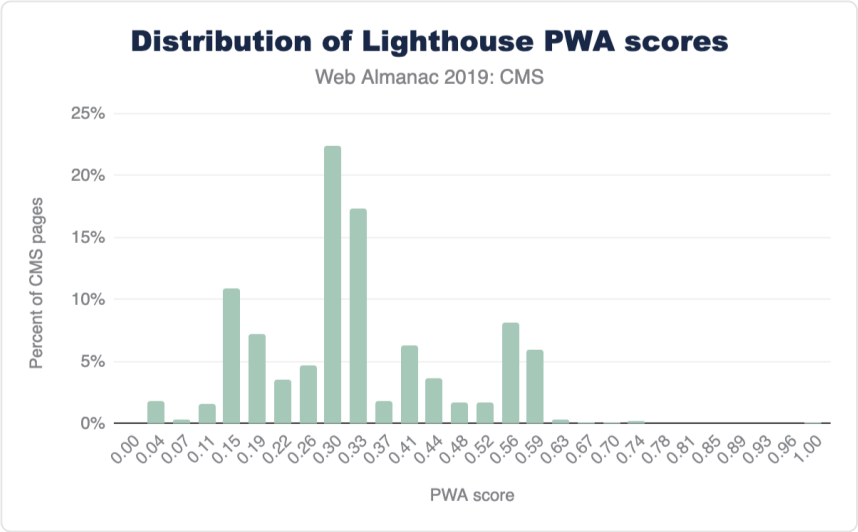
CMS◇◇◇◇◇◇◇FCP◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇CMS◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇

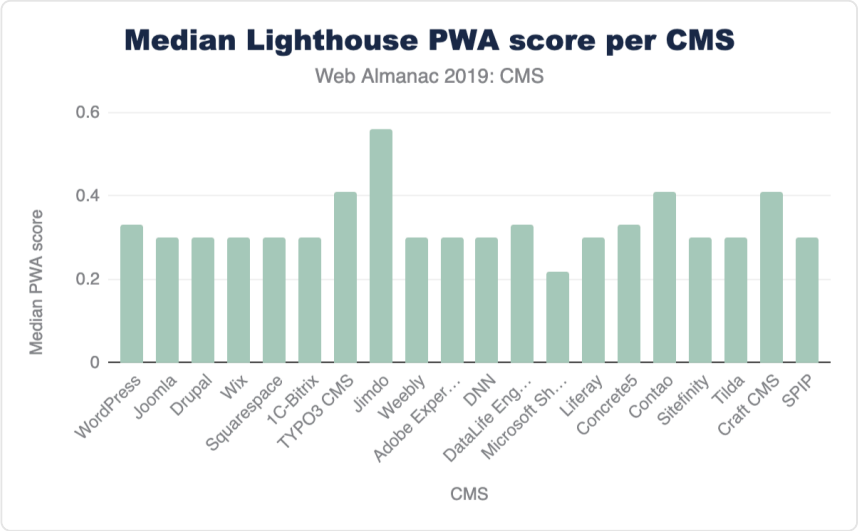
CMS	◇◇ (< 100ms)	◇◇◇	◇◇ (>= 300ms)
WordPress	80.25%	13.55%	6.20%
Drupal	74.88%	18.64%	6.48%
Joomla	68.82%	22.61%	8.57%
Squarespace	84.55%	9.13%	6.31%
Wix	63.06%	16.99%	19.95%

◇ 19. ◇◇5◇◇CMS◇FID◇◇◇◇◇◇◇◇◇

◇◇◇◇FCP◇◇◇◇◇◇◇◇◇◇◇◇◇FID◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Joomla◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇FCP◇◇◇◇◇◇12.78◇◇◇◇◇FID◇◇◇◇◇27.76◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇



◇ 20. CMS◇◇◇◇Lighthouse PWA◇◇◇◇◇◇◇◇◇◇◇

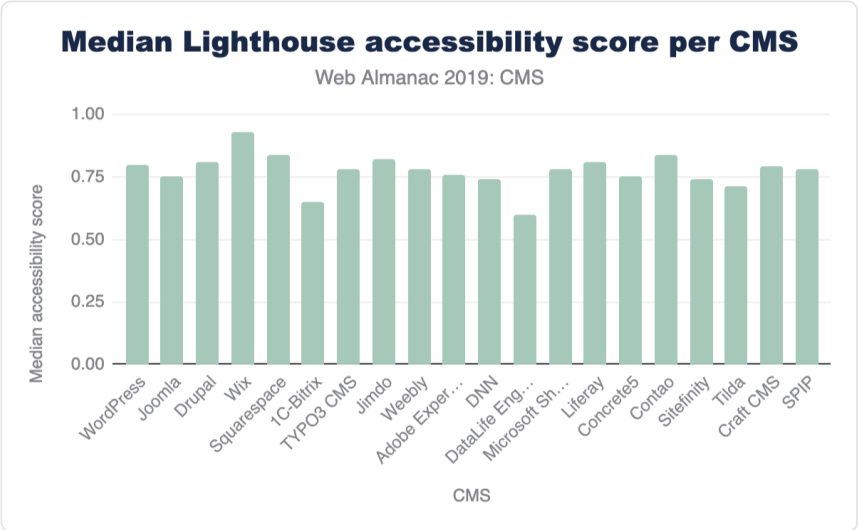


◇ 21. CMS◇◇◇◇◇PWA◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇

Lighthouse◇◇◇



*◇ 23. CMS◇◇◇Lighthouse◇◇◇

CMS	React	Nuxt.js, React	Nuxt.js	Next.js, React	Gatsby, React
WordPress	131,507		21	18	
Wix	50,247				
Joomla	3,457				
Drupal	2,940		8	15	1
DataLife Engine	1,137				
Adobe Experience Manager	723			7	
Contentful	492	7	114	909	394
Squarespace	385				
1C-Bitrix	340				
TYPO3 CMS	265			1	
Weebly	263		1		
Jimdo	248				2
PrestaShop	223		1		
SDL Tridion	152				
Craft CMS	123				

◇ 24. CMS◇◇◇React◇◇◇

Renee Johnson

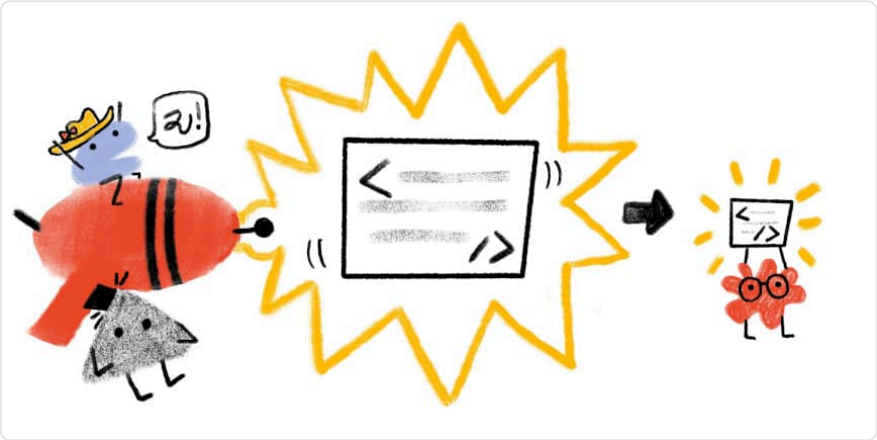
Renee Johnson WordPress WordCamp Google Content Man agement System Developer Relations

Alberto Medina

Alberto Medina Google Web Content Ecosystems Amp Web API Web Alberto CMS

◇ IV ◇ 15

◇◇



Paul Calvano *◇◇◇◇◇◇◇◇◇*
David Fox ◇ Yoav Weiss ◇◇◇◇◇◇◇◇
Sakae Kotaro ◇◇◇◇◇◇◇◇◇◇

◇◇

HTTP◇◇◇◇◇◇◇◇◇◇

HTTP

HTTP Accept-Encoding[414] Content-Encoding[415] MIME[416] Content-Type[417]

gzip brotli deflate text/html gzip

```
> GET / HTTP/1.1
> Host: httparchive.org
> Accept-Encoding: gzip, deflate, br

< HTTP/1.1 200
< Content-type: text/html; charset=utf-8
< Content-encoding: gzip
```

HTTP Archive 530 Web 1 Web 81

IANA Accept-Encoding Content-Encoding HTTP[418] gzip deflate br brotli

- Gzip[419] LZ77[420][421] Web 1992 UNIX gzip HTTP/ 1.1

414. https://developer.mozilla.org/en-US/docs/Web/HTTP/Headers/Accept-Encoding
415. https://developer.mozilla.org/en-US/docs/Web/HTTP/Headers/Content-Encoding
416. https://developer.mozilla.org/en-US/docs/Web/HTTP/Basics_of_HTTP/MIME_types
417. https://developer.mozilla.org/en-US/docs/Web/HTTP/Headers/Content-Type
418. https://www.iana.org/assignments/http-parameters/http-parameters.xml#content-coding
419. https://tools.ietf.org/html/rfc1952
420. https://ja.wikipedia.org/wiki/LZ77
421. https://ja.wikipedia.org/wiki/%E3%83%8F%E3%83%95%E3%83%9E%E3%83%B3%E7%AC%A6%E5%8F%B7

Web

- Deflate[422] gzip Web
- Brotli[423] Google[424] LZ77 2 Brotli gzip gzip 15 25[425] Brotli 2015 Web Web[426]

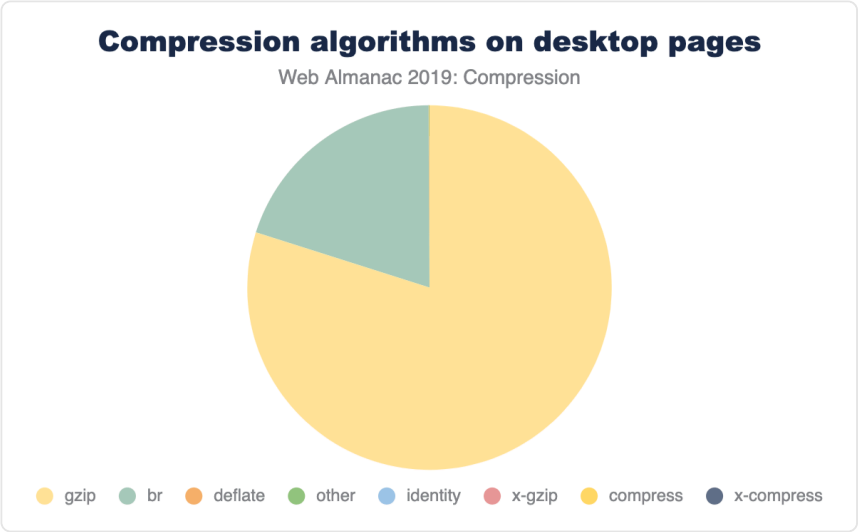
HTTP 38 HTTP

	62.87%	61.47%	260,245,106	285,158,644
gzip	29.66%	30.95%	122,789,094	143,549,122
br	7.43%	7.55%	30,750,681	35,012,368
deflate	0.02%	0.02%	68,802	70,679
Other / Invalid	0.02%	0.01%	67,527	68,352
identity	0.000709%	0.000563%	2,935	2,611
x-gzip	0.000193%	0.000179%	800	829
compress	0.000008%	0.000007%	33	32
x-compress	0.000002%	0.000006%	8	29

1.

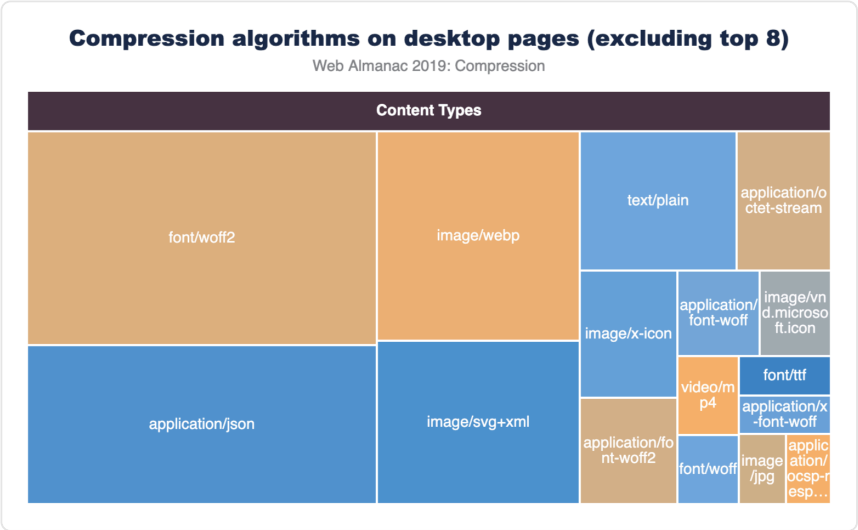
gzip 80 brotli 20

422. https://tools.ietf.org/html/rfc1951
423. https://tools.ietf.org/html/rfc7932
424. https://github.com/google/brotli
425. https://cran.r-project.org/web/packages/brotli/vignettes/brotli-2015-09-22.pdf
426. https://caniuse.com/#feat=brotli


Compression algorithms on desktop pages
Web Almanac 2019: Compression
gzip
br
deflate
other
identity
x-gzip
compress
x-compress

◇ 2. ◇◇◇

◇◇◇◇◇◇◇◇◇◇25◇◇◇◇◇◇◇◇◇◇

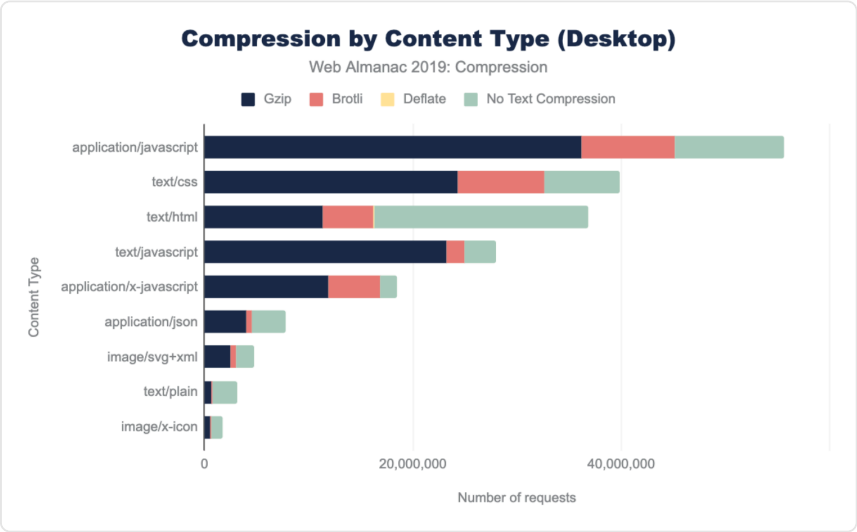


◇4.◇◇◇8◇◇◇◇◇◇◇◇◇◇◇◇◇◇

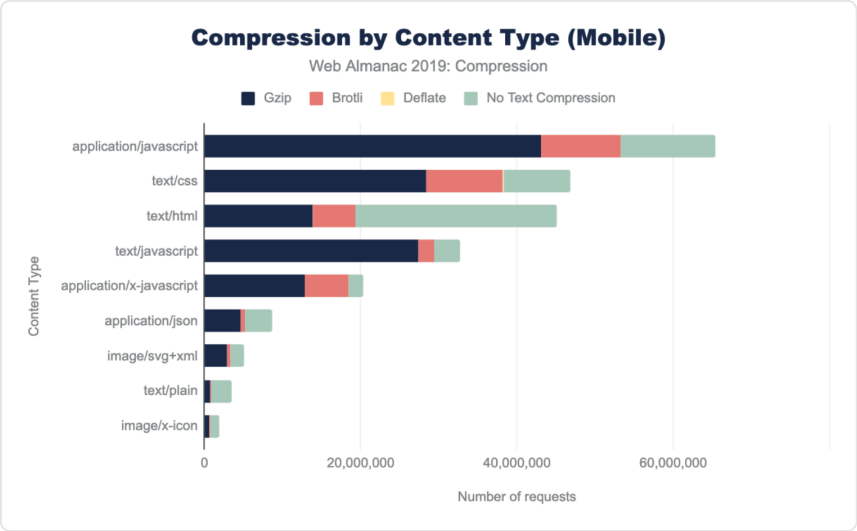
application/json◇◇◇image/svg+xml◇◇◇◇◇◇◇◇◇◇65◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇Web◇◇◇font/ttf◇◇◇◇◇◇◇◇◇TTF◇◇◇◇◇◇◇84◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇



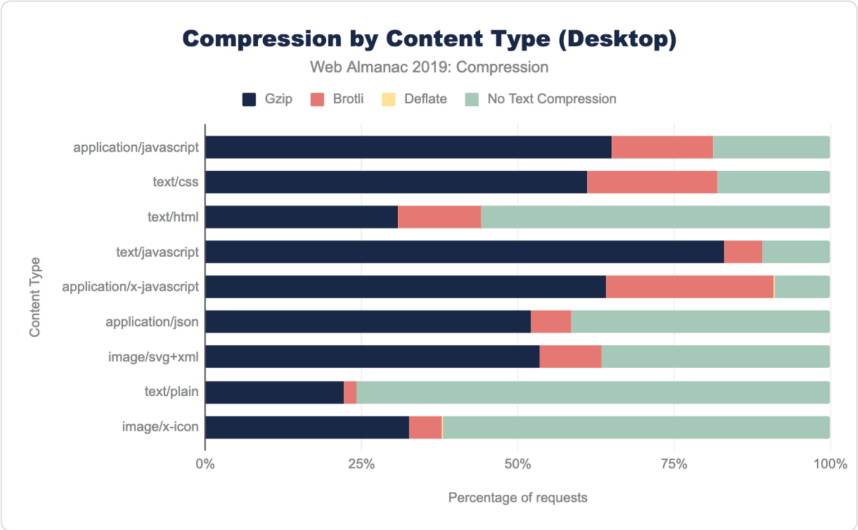
◇ 5. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇



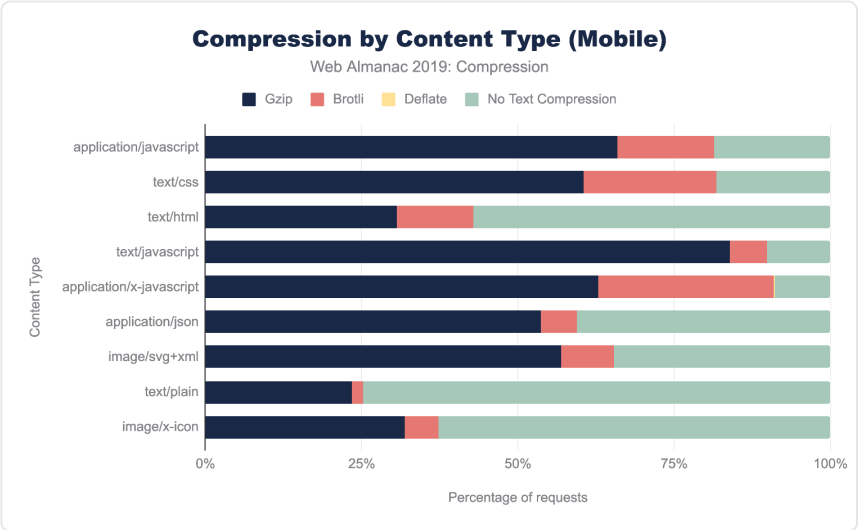
◇ 6. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇application/json◇text/xml◇◇◇◇text/plain◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇XHR◇◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇



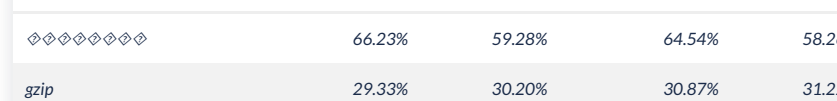
◇ 7. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

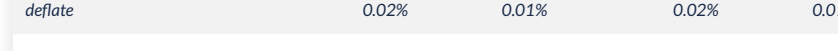


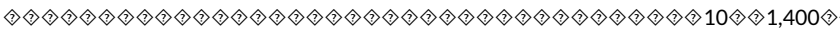
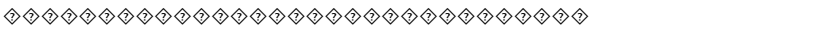
◇ 8. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇gzip◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇brotli◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇application/javascript◇text/css◇application/x-javascript◇◇◇◇◇◇◇CDN◇◇◇◇◇◇◇◇◇◇◇◇brotli◇◇

##



brotli  Google
Facebookbrotli

				
				
	66.23%	*59.28%*	*64.54%*	*58.26%*
gzip	*29.33%*	*30.20%*	*30.87%*	*31.22%*
br	*4.41%*	*10.49%*	*4.56%*	*10.49%*
deflate	*0.02%*	*0.01%*	*0.02%*	*0.01%*
Other / Invalid	*0.01%*	*0.02%*	*0.01%*	*0.02%*

*9. *

GoogleLighthouse[429]Web
[430]101,400

429. *https://developers.google.com/web/tools/lighthouse*
430. *https://developers.google.com/web/tools/lighthouse/audits/text-compression*

Enable text compression — 0.62 s

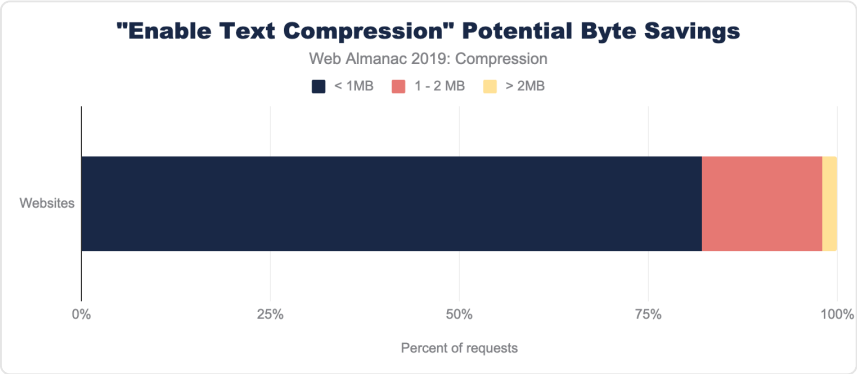
Text-based resources should be served with compression (gzip, deflate or brotli) to minimize total network bytes. Learn more.

Show 3rd-party resources (6)

URL	Size	Potential Savings
…comscore/streamsense.5.2.0.160629.min.js	91 KB	73 KB
/AdServer/PugMaster?kdntuid=…	5 KB	4 KB
/AdServer/PugMaster?kdntuid=…	6 KB	4 KB
…t_ads/ads?bust=…	5 KB	2 KB
/AdServer/PugMaster?kdntuid=…	2 KB	1 KB
/AdServer/Pug?vcode=…	2 KB	1 KB

◇ 10.Lighthouse◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇HTTP Archive◇Lighthouse◇◇◇◇◇◇◇◇◇◇◇◇



◇ 12.◇◇◇◇◇◇◇◇◇◇◇◇◇◇Lighthouse◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇

HTTP◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

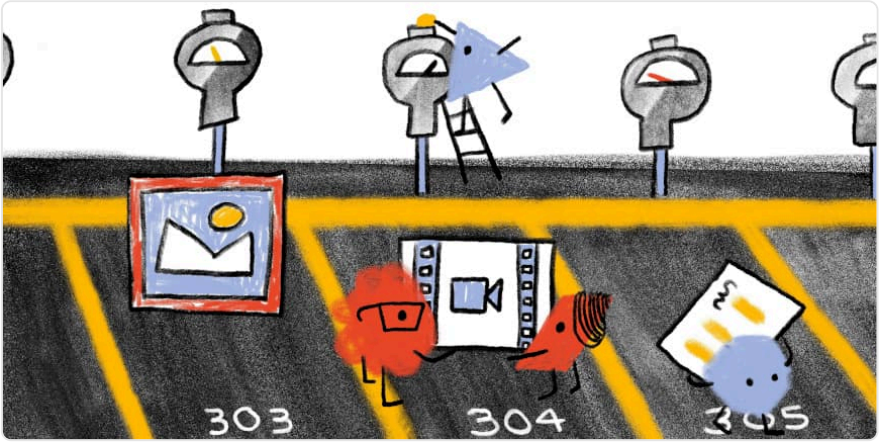
Paul Calvano

Paul Calvano[431] HTTP Archive
@paulcalvano[432] http://paulcalvano.com[433]
https://discuss.httparchive.org[434] HTTP Archive

431. https://www.akamai.com/
432. https://twitter.com/paulcalvano
433. https://paulcalvano.com
434. https://discuss.httparchive.org

◇ IV ◇ 16

◇◇◇◇◇◇



Paul Calvano *◇◇◇◇◇◇◇◇◇*
David Fox ◇ Brian Kardell ◇◇◇◇◇◇◇◇
Sakae Kotaro ◇◇◇◇◇◇◇◇◇◇

◇◇

◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇JavaScript◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇HTTP◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

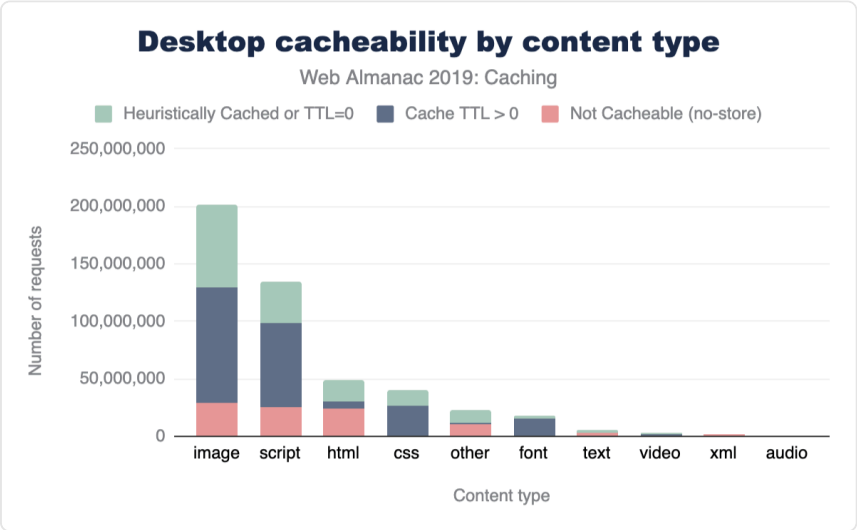
◇◇◇◇◇◇◇◇◇◇[440]◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇RFC◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Last-Modified◇◇◇◇◇◇◇◇◇10◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇

	◇◇◇◇◇◇◇◇◇◇◇TTL◇◇◇◇◇◇◇◇◇◇◇				
	10	25	50	75	90
Audio	12	24	720	8,760	8,760
CSS	720	8,760	8,760	8,760	8,760
Font	< 1	3	336	8,760	87,600
HTML	< 1	168	720	8,760	8,766
Image	< 1	1	28	48	8,760
Other	< 1	2	336	8,760	8,760
Script	< 1	< 1	1	6	720
Text	21	336	7,902	8,357	8,740
Video	< 1	4	24	24	336
XML	< 1	< 1	< 1	< 1	< 1

◇ 4. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇TTL◇◇◇◇◇◇◇◇

TTL◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇


Desktop cacheability by content type
Web Almanac 2019: Caching
Heuristically Cached or TTL=0
Cache TTL > 0
Not Cacheable (no-store)
250,000,000
200,000,000
150,000,000
100,000,000
50,000,000
0
Number of requests
image
script
html
css
other
font
text
video
xml
audio
Content type

◇ 5. ◇◇◇◇◇◇

Cache-Control◇Expires

HTTP/1.0◇◇◇Expires◇◇◇◇◇◇

Cache-Control

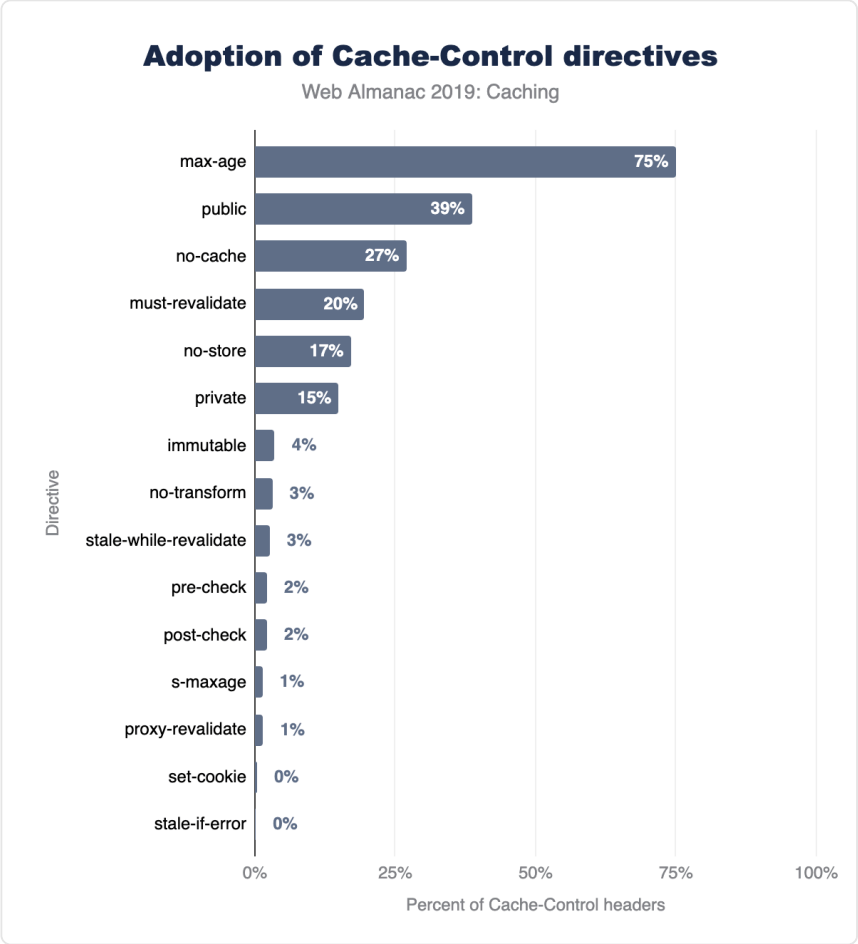
HTTP/1.1[441] Cache-Control 1

max-age	
public	
no-cache	
must-revalidate	
no-store	
private	
no-transform	
proxy-revalidate	*must-revalidate*
s-maxage	*max age*
immutable	
stale-while-revalidate	
stale-if-error	

8. Cache-Control

cache-control public max-age = 43200 43,200

441. *https://tools.ietf.org/html/rfc7234#section-5.2.1*



◇ 9.◇◇◇◇◇◇Cache-Control◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇9◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇15◇Cache-Control◇◇◇◇◇◇◇◇◇◇◇◇◇

- immutable◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇2017◇◇◇◇[442]◇◇◇Firefox◇◇◇ Safari◇◇◇◇◇[443]◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇3.4◇◇◇◇◇◇Facebook◇Google◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇[444]◇◇◇◇◇◇◇◇◇◇◇◇◇

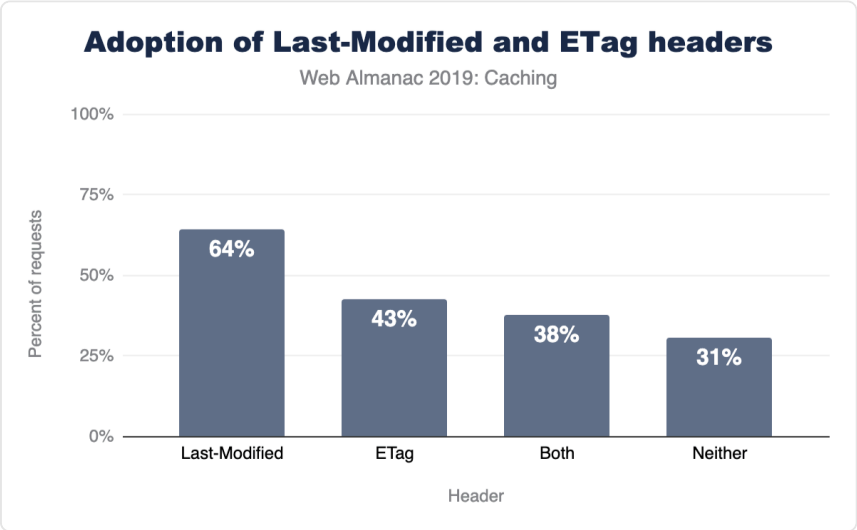
◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇pre-check◇post-check◇◇◇ ◇◇◇◇◇Cache-Control◇◇◇◇◇◇◇◇◇◇◇2.2◇◇◇780◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Internet Explorer 5◇◇◇◇ ◇◇[445]◇◇◇◇◇◇Web◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇99.2◇◇◇pre-check=0◇post-check=0◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇0◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇no-store◇◇◇◇◇◇◇◇

◇◇◇◇◇◇

```
< HTTP/1.1 200
< Date: Sun, 13 Oct 2019 19:36:57 GMT
< Content-Type: application/javascript; charset=utf-8
< Content-Length: 3052
< Vary: Accept-Encoding
< Server: gunicorn/19.7.1
< Last-Modified: Sun, 25 Aug 2019 16:00:30 GMT
< Cache-Control: public, max-age=43200
< Expires: Mon, 14 Oct 2019 07:36:57 GMT
< ETag: "1566748830.0-3052-3932359948"
```

◇◇◇◇◇◇◇◇◇If-Modified-Since◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Last-Modified◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇



◇ 12.◇◇◇◇◇◇Web◇◇◇◇Last-Modified◇◇◇ETag◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇

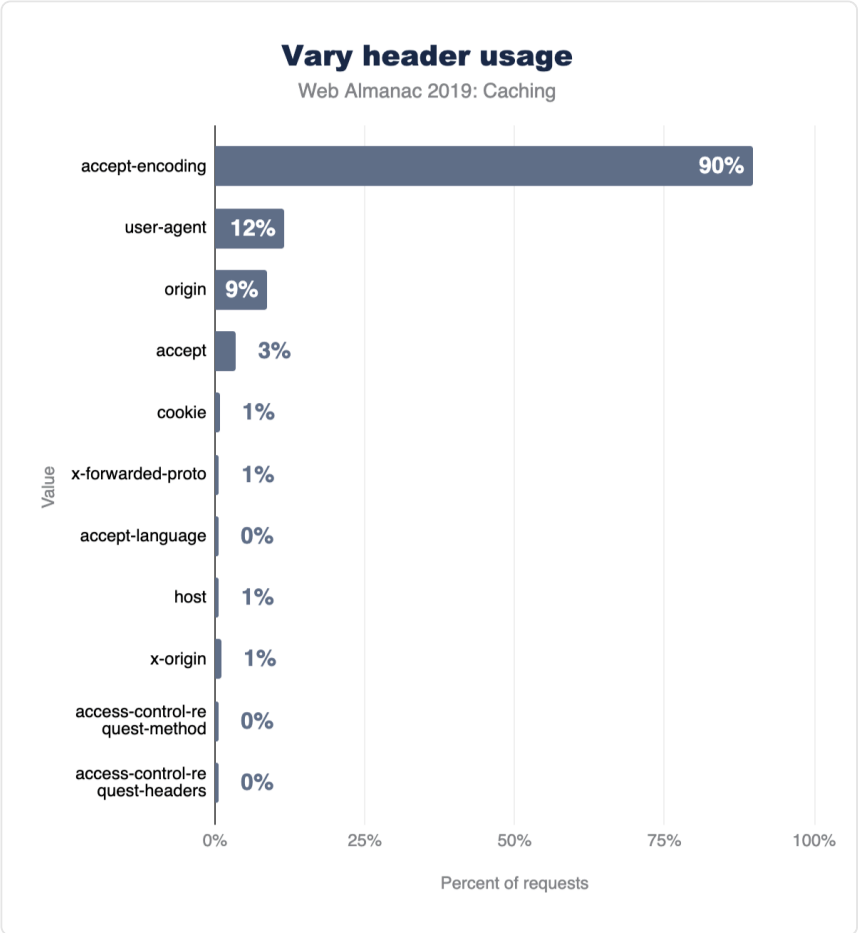
◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇HTTP◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

```
< Content-Length: 3052
< Vary: Accept-Encoding
< Server: gunicorn/19.7.1
< Last-modified: Sun, 25 Aug 2019 16:00:30 GMT
< Cache-Control: public, max-age=43200
< Expires: Mon, 14 Oct 2019 07:36:57 GMT
< ETag: "1566748830.0-3052-3932359948"
```

◇◇◇◇◇◇

- 0◇-1◇◇◇◇◇
- Cache-Control◇◇◇◇◇◇◇◇◇◇

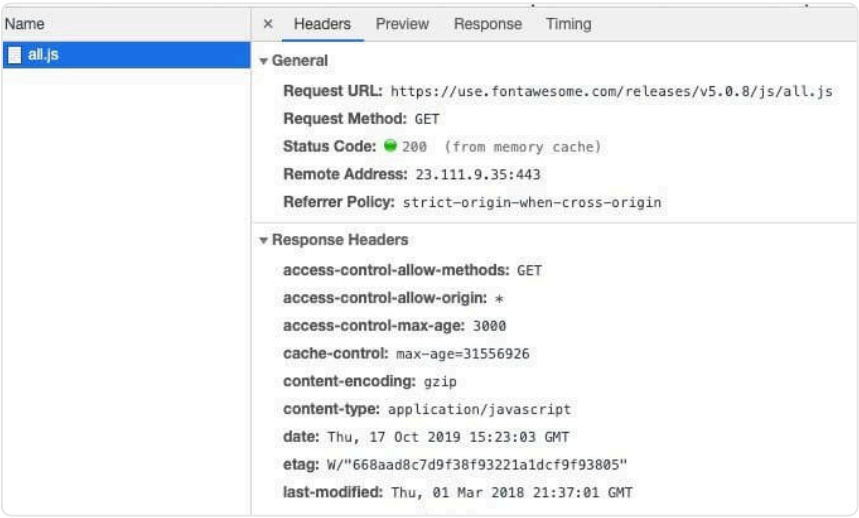
  ◇◇◇Expires◇◇◇◇◇◇◇◇◇◇



◇ 14.Vary◇◇◇◇◇◇◇◇◇

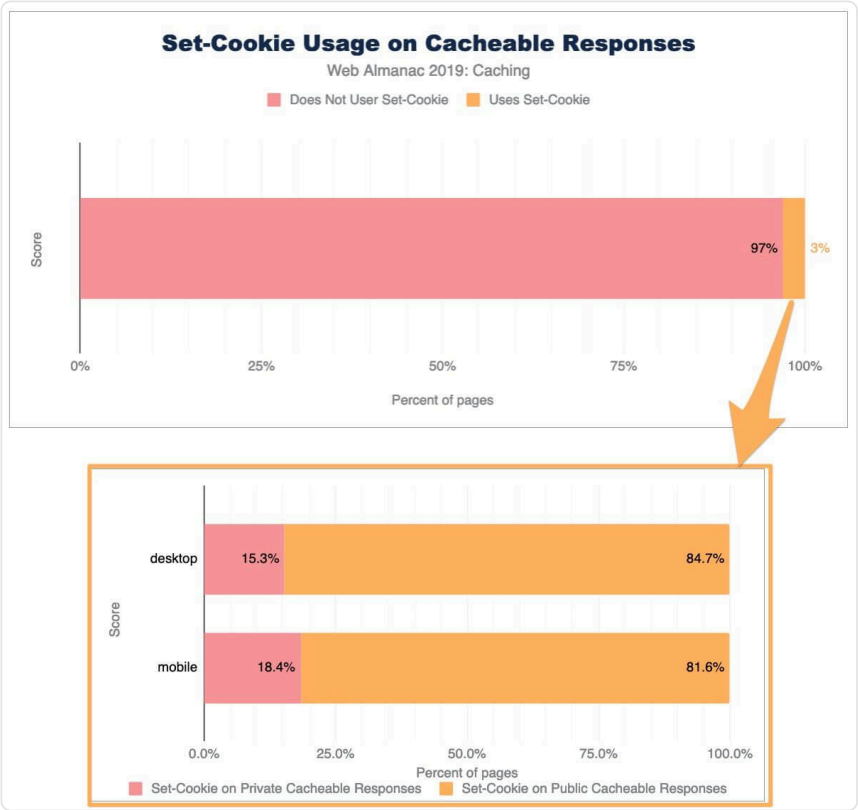
◇◇◇◇◇◇◇◇◇◇◇◇◇◇Cookie◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇



◇ 15.◇◇◇◇◇◇◇◇◇◇◇◇◇◇Chrome◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇Set-Cookie◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ RFC 7234◇◇◇◇◇8[447]◇◇◇◇◇Set-Cookie◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

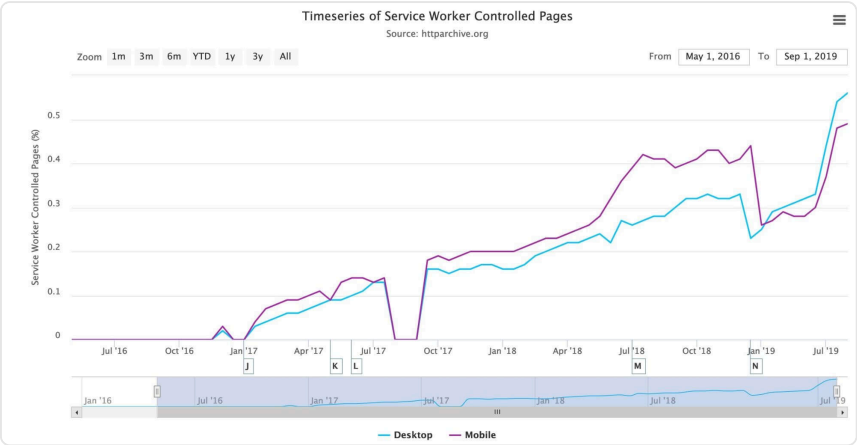


◇ 16. `Set-Cookie`◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

AppCache◇◇◇Service Worker

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇AppCache◇HTML5◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇HTTP Archive◇◇◇◇◇◇◇◇◇1◇◇◇◇◇◇◇◇Service Worker[452]◇◇◇◇◇◇◇◇◇◇◇



◇ 17.*Service Worker◇◇◇◇◇◇◇◇◇◇◇◇◇ (◇◇: HTTP Archive[453])*

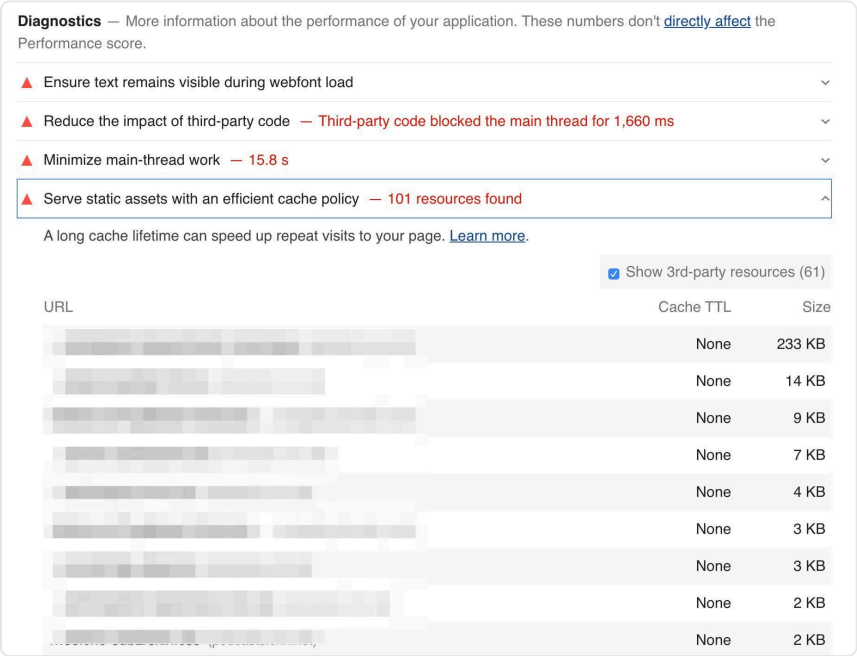
◇◇◇◇◇◇◇◇◇◇◇◇1◇◇◇◇◇◇◇◇◇◇2017◇1◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

		Service Worker	Service Worker
HTTP	AppCache	1,968,736	907
	AppCache	580	1
HTTPS	AppCache	3,076,601	31,334
	AppCache	1,236	50

19. AppCache Web HTTP/HTTPS Service Worker

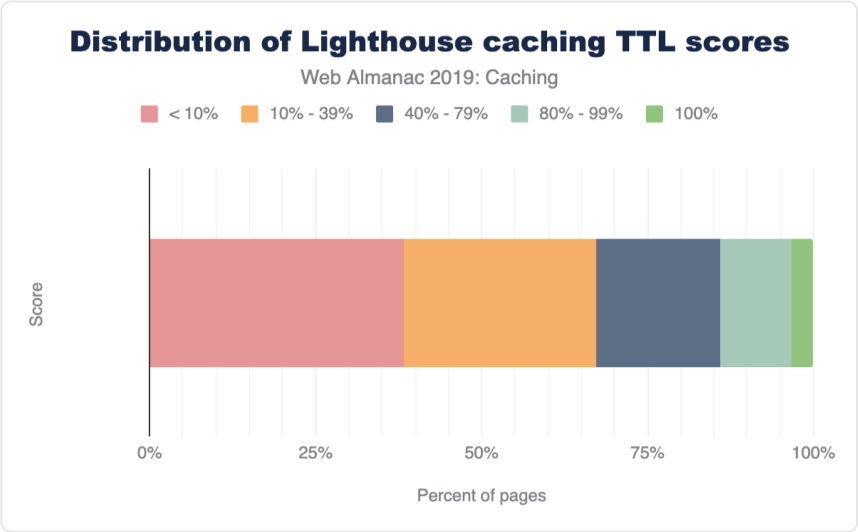
Google Lighthouse[454] Web[455] Last-Modified TTL

454. https://developers.google.com/web/tools/lighthouse
455. https://developers.google.com/web/tools/lighthouse/audits/cache-policy



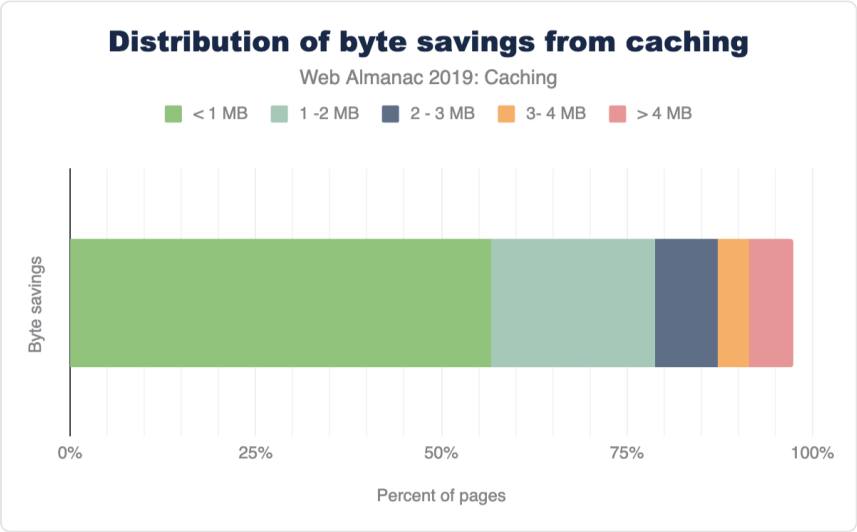
◇ 20. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Lighthouse◇◇◇◇◇

Lighthouse◇◇◇◇◇◇◇0◇◇100◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇



◇ 21.◇◇◇◇Web◇◇◇◇◇Use Long Cache TTL◇◇◇◇Lighthouse◇◇◇◇◇◇◇

100◇◇◇◇◇◇◇◇◇◇3.4◇◇◇◇◇◇◇◇◇◇



22. Lighthouse

CDNWeb

HTTP`Cache-Control`Lighthouse[457]REDbot[458]

457. *https://developers.google.com/web/tools/lighthouse*
458. *https://redbot.org/*

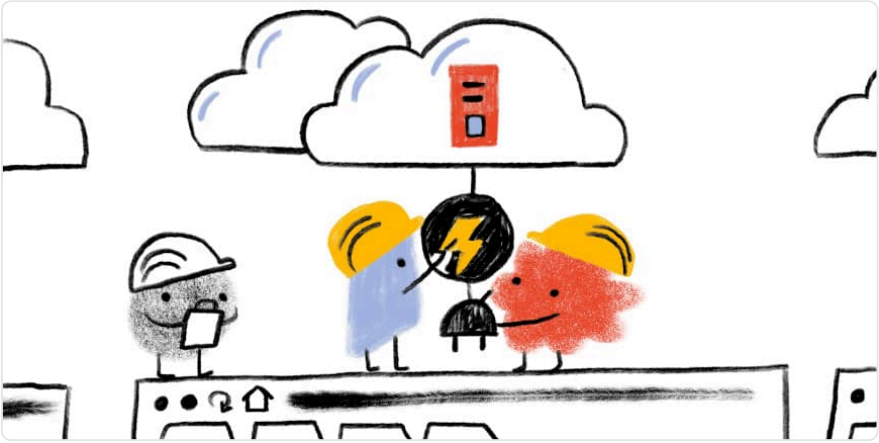
Paul Calvano

Paul Calvano[459] HTTP Archive @paulcalvano[460] http://paulcalvano.com[461] https://discuss.httparchive.org[462] HTTP Archive

459. https://www.akamai.com/
460. https://twitter.com/paulcalvano
461. https://paulcalvano.com
462. https://discuss.httparchive.org

◇ IV ◇ 17

CDN



Andy Davies ◇ Colin Bendell ◇◇◇◇◇◇◇◇◇
Yoav Weiss, Paul Calvano, Patrick Meenan, ◇ Erik Nygren ◇◇◇◇◇◇◇◇
Sakae Kotaro ◇◇◇◇◇◇◇◇◇◇◇

◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Steve Souders◇◇◇◇◇◇◇◇◇[463]◇1◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Web Almanac◇◇◇◇◇◇Steve◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

CDN◇◇TCP◇◇◇◇◇◇◇◇◇◇◇ TCP◇◇◇◇◇◇◇◇◇◇◇

- **□□□□□□□□□□□□□□□**□□□□□□□□□□□□□□□

◇◇◇

◇◇◇CDN◇◇◇◇◇◇

CDN◇◇◇◇◇◇◇◇◇◇◇◇CDN◇◇◇◇CDN◇2◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇CDN◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

HTML CDN◇◇◇◇ (%)	
ORIGIN	80.39
Cloudflare	9.61
Google	5.54
Amazon CloudFront	1.08
Akamai	1.05
Fastly	0.79
WordPress	0.37
Sucuri Firewall	0.31
Incapsula	0.28
Myra Security CDN	0.1
OVH CDN	0.08
Netlify	0.06
Edgecast	0.04
GoCache	0.03
Highwinds	0.03
CDNetworks	0.02
Limelight	0.01
Level 3	0.01
NetDNA	0.01
StackPath	0.01
Instart Logic	0.01
Azion	0.01
Yunjiasu	0.01
section.io	0.01
Microsoft Azure	0.01

◇ 3.◇◇◇◇◇◇HTML◇◇25◇CDN◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇CDN◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

	◇◇◇◇◇◇◇CDN◇◇◇(%)
ORIGIN	60.56
Cloudflare	10.06
Google	8.86
Amazon CloudFront	6.24
Akamai	3.5
Edgecast	1.97
WordPress	1.69
Highwinds	1.24
Limelight	1.18
Fastly	0.8
CDN77	0.43
KeyCDN	0.41
NetDNA	0.37
CDNetworks	0.36
Incapsula	0.29
Microsoft Azure	0.28
Reflected Networks	0.28
Sucuri Firewall	0.16
BunnyCDN	0.13
OVH CDN	0.12
Advanced Hosters CDN	0.1
Myra Security CDN	0.07
CDNvideo	0.07
Level 3	0.06
StackPath	0.06

◇5◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇CDN◇◇◇

	◇◇◇◇◇◇◇◇CDN◇◇◇(%)
ORIGIN	34.27
Google	29.61
Facebook	8.47
Akamai	5.25
Fastly	5.14
Cloudflare	4.21
Amazon CloudFront	3.87
WordPress	2.06
Edgecast	1.45
Twitter	1.27
Highwinds	0.94
NetDNA	0.77
Cedexis	0.3
CDNetworks	0.22
section.io	0.22
jsDelivr	0.2
Microsoft Azure	0.18
Yahoo	0.18
BunnyCDN	0.17
CDNvideo	0.16
Reapleaf	0.15
CDN77	0.14
KeyCDN	0.13
Azion	0.09
StackPath	0.09

◇ 7. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇25◇◇◇◇◇CDN◇

RTT TLS

CDN Web
CDN
CDN TCP RTT
[467] RTT Web
[468]

CDN 2

1. TCP TLS RTT
   CDN
   TCP TLS
   RTT 3 TCP + TLS RTT
   RTT
2. CDN origin TCP
   CDN TCP origin
   origin TCP

TLS origin CDN 3

TLS TCP
RTT
HTML TLS 207
WebPageTest 2 10

CDN TLS 60 70 HTML
Origin CDN Web TLS
3 90 140 CDN

467. https://www.igvita.com/2012/07/19/latency-the-new-web-performance-bottleneck/
468. https://hpbn.co/primer-on-latency-and-bandwidth/

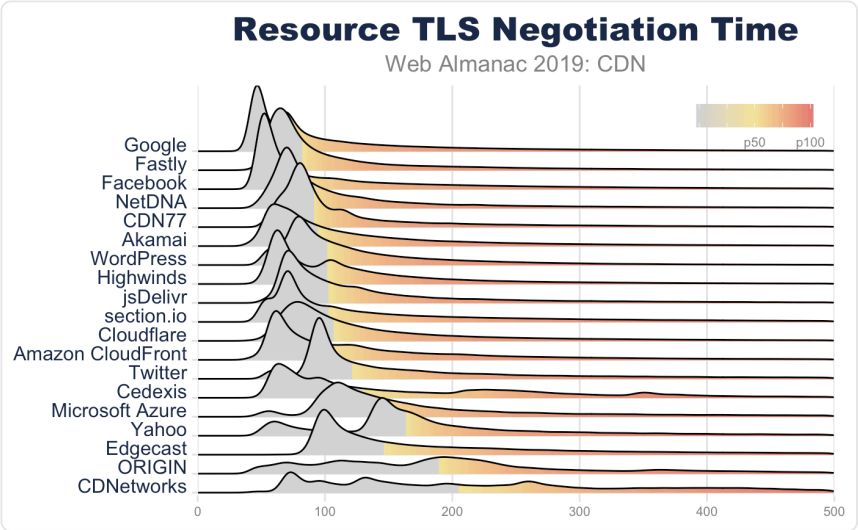
◇◇◇◇◇◇◇◇◇◇427◇◇◇◇originTLS◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇*TLS*◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

	p10	p25	p50	p75	p90
Highwinds	58	58	60	66	94
Fastly	56	59	63	69	75
WordPress	58	62	76	77	80
Sucuri Firewall	63	66	77	80	86
Amazon CloudFront	59	61	62	83	128
Cloudflare	62	68	80	92	103
Akamai	57	59	72	93	134
Microsoft Azure	62	93	97	98	101
Edgecast	94	97	100	110	221
Google	47	53	79	119	184
OVH CDN	114	115	118	120	122
section.io	105	108	112	120	210
Incapsula	96	100	111	139	243
Netlify	53	64	73	145	166
Myra Security CDN	95	106	118	226	365
GoCache	217	219	223	234	260
ORIGIN	100	138	207	342	427
CDNetworks	85	143	229	369	452

◇ 9. HTML TLS◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇

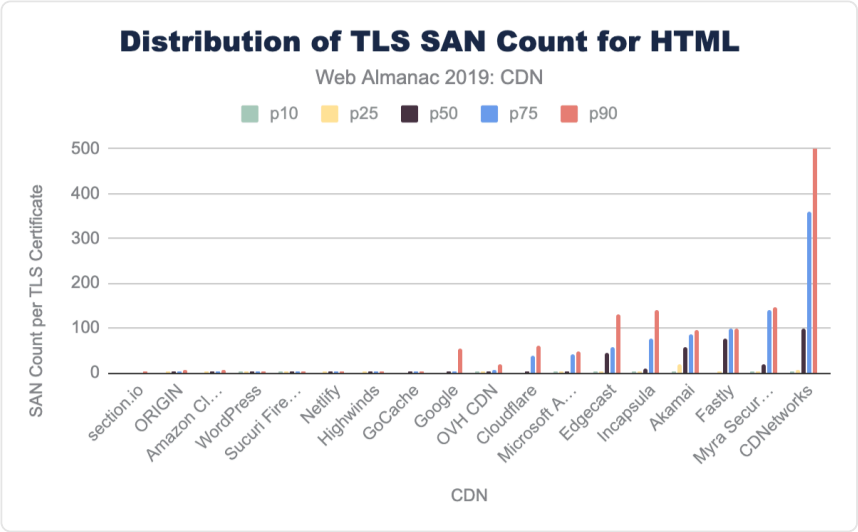

Resource TLS Negotiation Time
Web Almanac 2019: CDN
p50
p100
Google
Fastly
Facebook
NetDNA
CDN77
Akamai
WordPress
Highwinds
jsDelivr
section.io
Cloudflare
Amazon CloudFront
Twitter
Cedexis
Microsoft Azure
Yahoo
Edgecast
ORIGIN
CDNetworks
0
100
200
300
400
500

◇ 10.◇◇◇◇TLS◇◇◇◇◇◇◇◇◇◇◇◇

TLS◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇

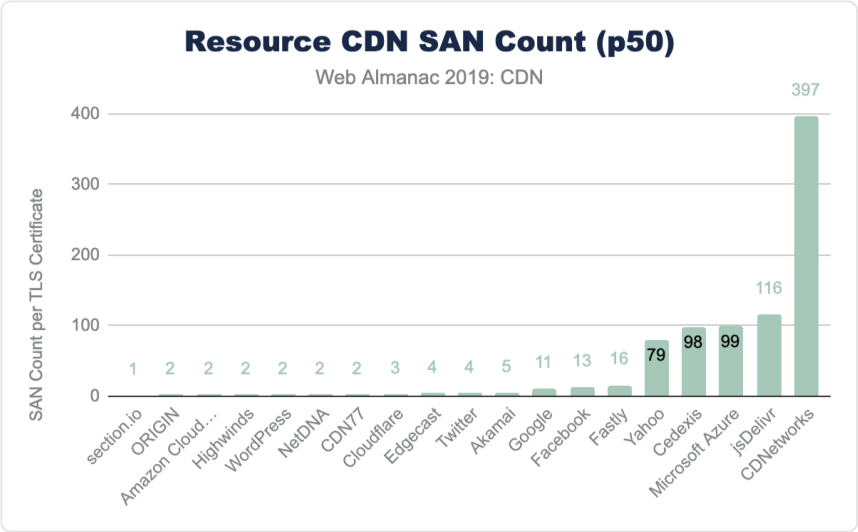
◇◇◇◇◇TCP◇◇◇◇◇◇



◇ 11. HTML◇TLS SAN◇◇◇◇◇

	p10	p25	p50	p75	p90
section.io	1	1	1	1	2
ORIGIN	1	2	2	2	7
Amazon CloudFront	1	2	2	2	8
WordPress	2	2	2	2	2
Sucuri Firewall	2	2	2	2	2
Netlify	1	2	2	2	3
Highwinds	1	2	2	2	2
GoCache	1	1	2	2	4
Google	1	1	2	3	53
OVH CDN	2	2	3	8	19
Cloudflare	1	1	3	39	59
Microsoft Azure	2	2	2	43	47
Edgecast	2	4	46	56	130
Incapsula	2	2	11	78	140
Akamai	2	18	57	85	95
Fastly	1	2	77	100	100
Myra Security CDN	2	2	18	139	145
CDNetworks	2	7	100	360	818

◇ 12. HTML◇TLS SAN◇◇◇◇◇


Resource CDN SAN Count (p50)
Web Almanac 2019: CDN
SAN Count per TLS Certificate
400
300
200
100
0
1
2
2
2
2
2
2
3
4
4
5
11
13
16
79
98
99
116
397
section.io
ORIGIN
Amazon Cloud…
Highwinds
WordPress
NetDNA
CDN77
Cloudflare
Edgecast
Twitter
Akamai
Google
Facebook
Fastly
Yahoo
Cedexis
Microsoft Azure
jsDelivr
CDNetworks

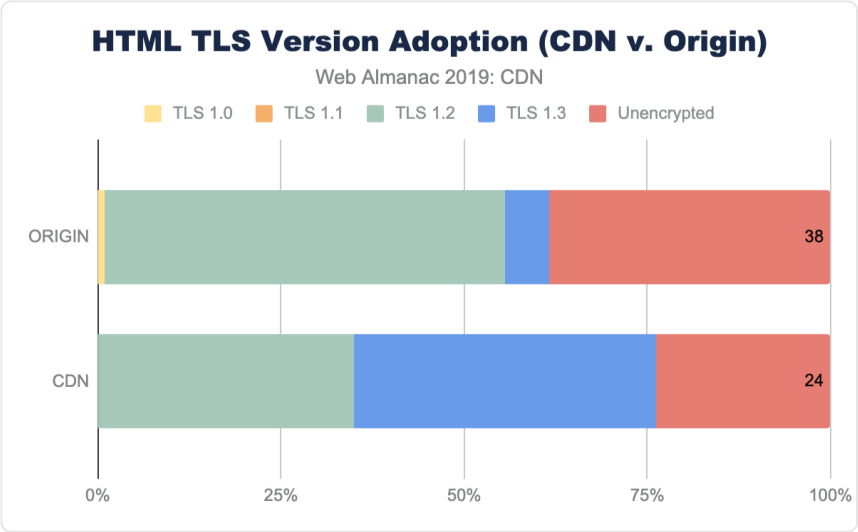
◇ 13.◇◇◇◇SAN◇◇◇◇◇p50◇◇

	p10	p25	p50	p75	p90
section.io	1	1	1	1	1
ORIGIN	1	2	2	3	10
Amazon CloudFront	1	1	2	2	6
Highwinds	2	2	2	3	79
WordPress	2	2	2	2	2
NetDNA	2	2	2	2	2
CDN77	2	2	2	2	10
Cloudflare	2	3	3	3	35
Edgecast	2	4	4	4	4
Twitter	2	4	4	4	4
Akamai	2	2	5	20	54
Google	1	10	11	55	68
Facebook	13	13	13	13	13
Fastly	2	4	16	98	128
Yahoo	6	6	79	79	79
Cedexis	2	2	98	98	98
Microsoft Azure	2	43	99	99	99
jsDelivr	2	116	116	116	116
CDNetworks	132	178	397	398	645

◇ 14.◇◇◇◇SAN◇◇◇◇◇◇◇◇◇10◇25◇50◇75◇◇◇◇90◇◇◇◇◇◇◇◇

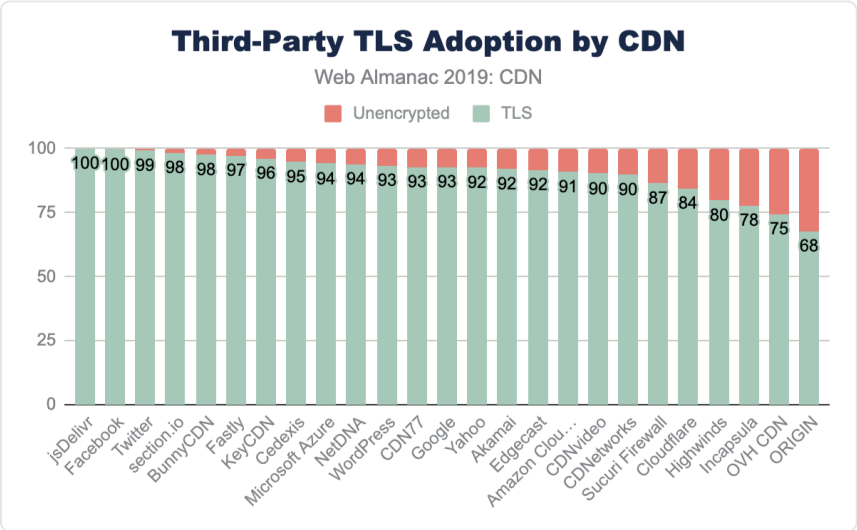
TLS◇◇◇

TLS◇◇◇RTT◇◇◇◇◇◇◇◇◇◇CDN◇◇◇◇◇◇◇◇◇◇◇◇◇TLS◇◇◇◇◇TLS◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇CDN◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇HTML◇◇◇◇◇TLS◇◇◇◇◇CDN◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ HTML◇◇◇◇76◇◇◇◇TLS◇◇◇◇◇◇◇◇◇◇◇◇◇◇origin◇◇◇◇◇◇◇◇◇◇62◇◇◇◇



◇ 15. HTML TLS◇◇◇◇◇◇◇◇◇CDN◇origin◇◇

◇CDN◇◇TLS◇◇◇◇◇◇◇◇◇

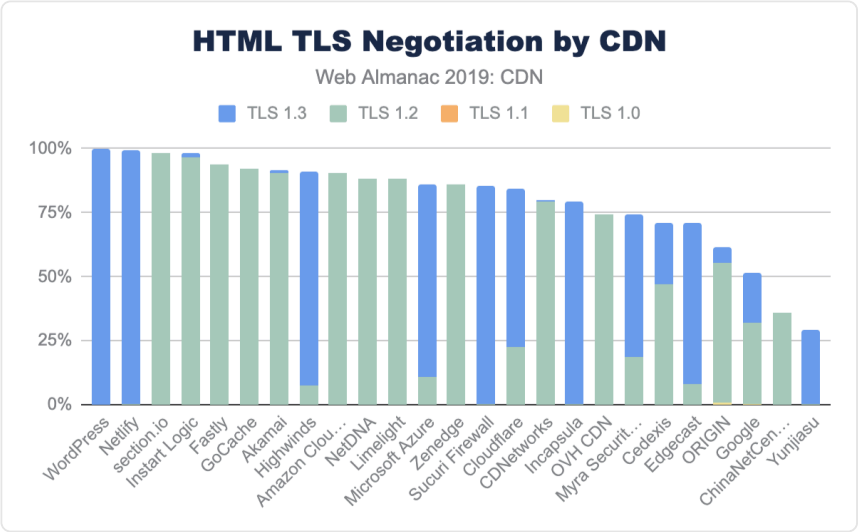


◇ 17. CDN◇◇◇◇◇◇◇◇◇◇TLS◇◇◇◇

◇◇TLS◇◇◇◇◇◇◇◇◇◇◇◇CDN◇◇◇◇◇◇TLS1.3◇◇◇◇◇◇TLS◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇CDN◇◇◇◇◇TLS1.0◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇TLS◇◇◇◇◇◇◇◇◇◇◇◇origin◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇TLS◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

*Web Almanac◇◇◇◇◇◇Chrome◇◇◇◇◇◇◇◇◇◇◇◇◇TLS◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

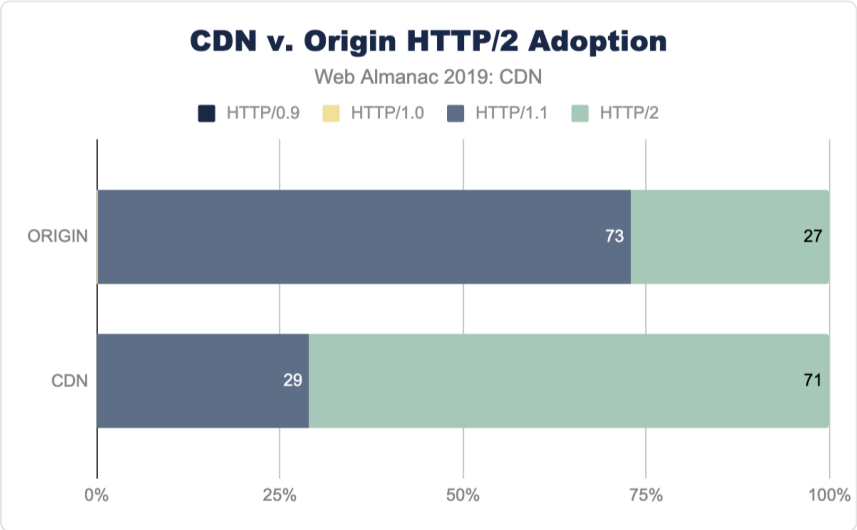


◇ 18. CDN◇◇◇HTML TLS◇◇◇◇◇◇

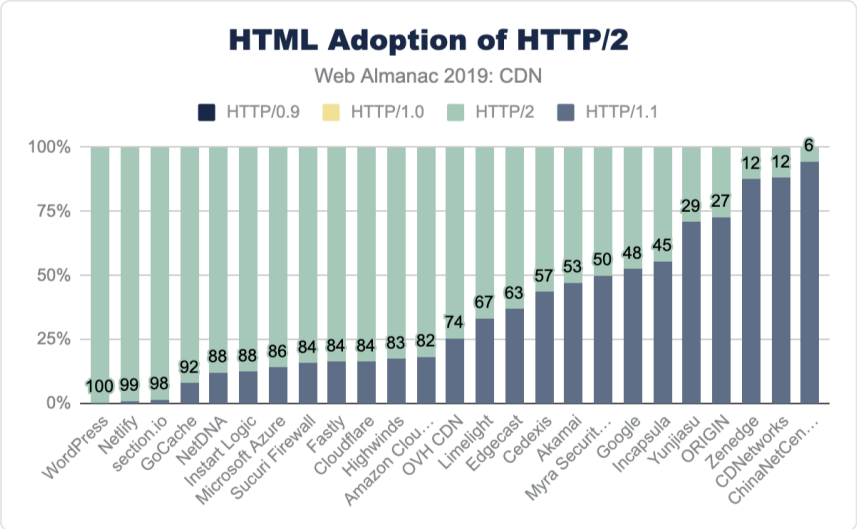
TLS◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇HTTP/2◇◇◇◇◇◇◇◇◇◇◇◇◇

HTTP/2◇◇

RTT◇◇◇TLS◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇CDN◇HTTP/2◇IPv6◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇CDN◇HTTP/2◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇HTTP/3◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇



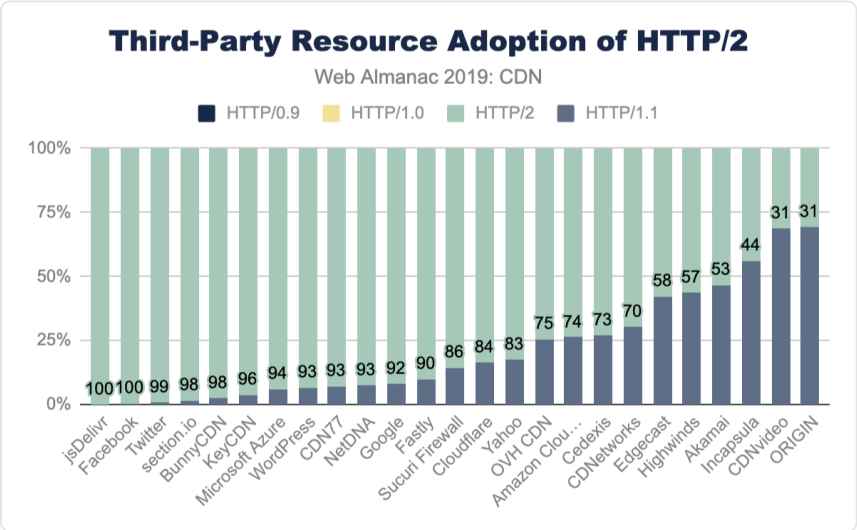
19. HTTP/2CDNorigin



20. HTTP/2HTML

	HTTP/0.9	HTTP/1.0	HTTP/1.1	HTTP/2
WordPress	0	0	0.38	100
Netlify	0	0	1.07	99
section.io	0	0	1.56	98
GoCache	0	0	7.97	92
NetDNA	0	0	12.03	88
Instart Logic	0	0	12.36	88
Microsoft Azure	0	0	14.06	86
Sucuri Firewall	0	0	15.65	84
Fastly	0	0	16.34	84
Cloudflare	0	0	16.43	84
Highwinds	0	0	17.34	83
Amazon CloudFront	0	0	18.19	82
OVH CDN	0	0	25.53	74
Limelight	0	0	33.16	67
Edgecast	0	0	37.04	63
Cedexis	0	0	43.44	57
Akamai	0	0	47.17	53
Myra Security CDN	0	0.06	50.05	50
Google	0	0	52.45	48
Incapsula	0	0.01	55.41	45
Yunjiasu	0	0	70.96	29
ORIGIN	0	0.1	72.81	27
Zenedge	0	0	87.54	12
CDNetworks	0	0	88.21	12
ChinaNetCenter	0	0	94.49	6

◇ 21. CDN◇◇◇HTTP/2◇HTML◇◇◇


Third-Party Resource Adoption of HTTP/2
Web Almanac 2019: CDN
HTTP/0.9
HTTP/1.0
HTTP/2
HTTP/1.1
100%
75%
50%
25%
0%
100 100 99 98 98 96 94 93 93 93 92 90 86 84 83 75 74 73 70 58 57 53 44 31 31
jsDelivr
Facebook
Twitter
section.io
BunnyCDN
KeyCDN
Microsoft Azure
WordPress
CDN77
NetDNA
Google
Fastly
Sucuri Firewall
Cloudflare
Yahoo
OVH CDN
Amazon Clou…
Cedexis
CDNetworks
Edgecast
Highwinds
Akamai
Incapsula
CDNvideo
ORIGIN

◇ *22. HTML/2◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇*

cdn	HTTP/0.9	HTTP/1.0	HTTP/1.1	HTTP/2
jsDelivr	0	0	0	100
Facebook	0	0	0	100
Twitter	0	0	1	99
section.io	0	0	2	98
BunnyCDN	0	0	2	98
KeyCDN	0	0	4	96
Microsoft Azure	0	0	6	94
WordPress	0	0	7	93
CDN77	0	0	7	93
NetDNA	0	0	7	93
Google	0	0	8	92
Fastly	0	0	10	90
Sucuri Firewall	0	0	14	86
Cloudflare	0	0	16	84
Yahoo	0	0	17	83
OVH CDN	0	0	26	75
Amazon CloudFront	0	0	26	74
Cedexis	0	0	27	73
CDNetworks	0	0	30	70
Edgecast	0	0	42	58
Highwinds	0	0	43	57
Akamai	0	0.01	47	53
Incapsula	0	0	56	44
CDNvideo	0	0	68	31
ORIGIN	0	0.07	69	31

◇ 23. HTML/2◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

CDN◇◇◇◇◇◇◇◇◇◇

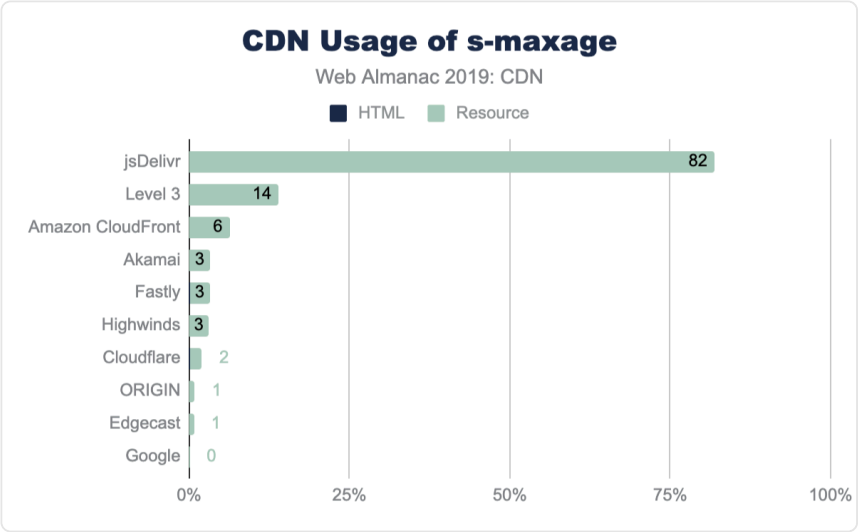
Vary

Web◇◇◇◇◇◇◇◇◇◇HTTP◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇CDN◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇origin◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇ `Cache-Control`◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇`Vary` HTTP◇◇CDN◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇`Vary`◇◇◇◇◇◇◇◇origin◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇CDN◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

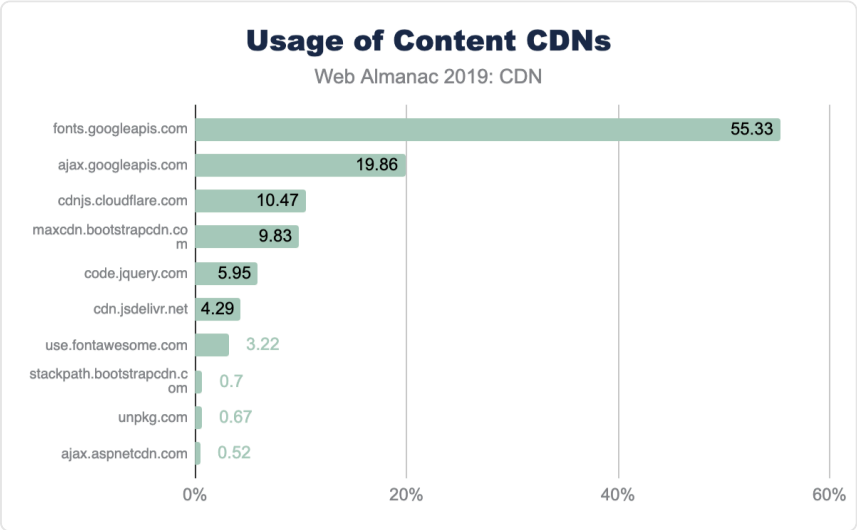
HTML◇◇◇◇◇◇◇Vary◇◇◇◇◇◇◇◇◇◇◇◇User-Agent◇◇◇◇◇◇◇◇◇◇◇◇

◇◇Vary◇Origin◇◇◇◇◇◇◇◇◇◇Vary◇Range◇◇◇Vary◇Host◇◇◇Vary◇*◇◇◇◇◇ Vary◇◇◇◇◇◇◇◇◇◇



◇ 26. CDN◇◇◇◇◇◇s-maxage◇◇◇◇

◇◇◇◇40◇◇◇◇◇◇◇◇CDN◇◇◇◇◇◇◇◇


Usage of Content CDNs
Web Almanac 2019: CDN
fonts.googleapis.com
55.33
ajax.googleapis.com
19.86
cdnjs.cloudflare.com
10.47
maxcdn.bootstrapcdn.com
9.83
code.jquery.com
5.95
cdn.jsdelivr.net
4.29
use.fontawesome.com
3.22
stackpath.bootstrapcdn.com
0.7
unpkg.com
0.67
ajax.aspnetcdn.com
0.52
0%
20%
40%
60%

◇ 27.◇◇◇◇◇◇◇◇◇◇CDN◇◇◇◇

◇◇◇◇◇◇◇◇◇◇

Andy Davies

Andy Davies Using WebPageTest Twitter @AndyDavies[476] https://andydavies.me[477]

Colin Bendell

Colin Cloudinary[478] CTO High Performance Images[479] @colinbendell[480] https://bendell.ca[481]

476. *https://twitter.com/andydavies*
477. *https://andydavies.me*
478. *https://cloudinary.com/*
479. *https://www.oreilly.com/library/view/high-performance-images/9781491925799/*
480. *https://twitter.com/colinbendell*
481. *https://bendell.ca/*

◇ IV ◇ 18

Page Weight

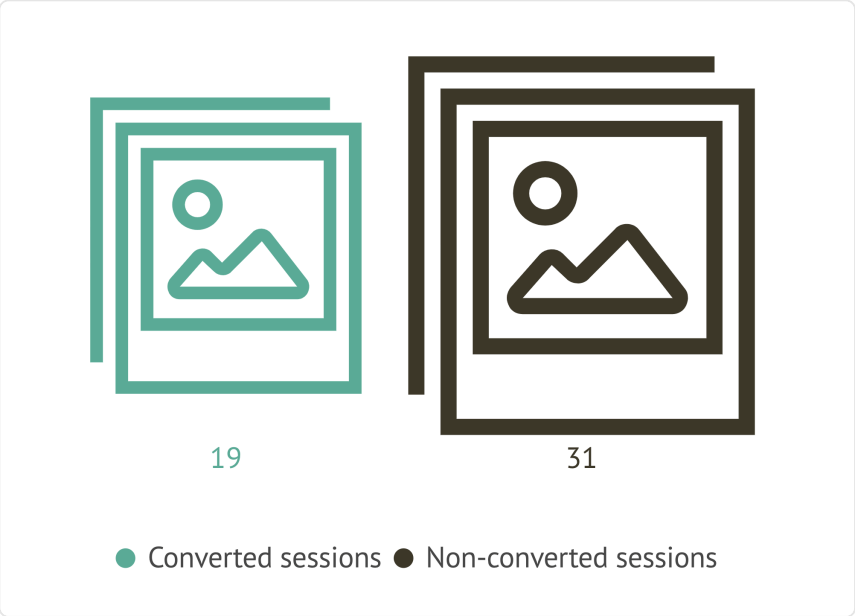
Tammy Everts ◇ Katie Hempenius ◇◇◇◇◇◇◇◇◇◇
Paul Calvano ◇◇◇◇◇◇◇◇◇
Sakae Kotaro ◇◇◇◇◇◇◇◇◇◇◇

◇◇

◇◇Web◇◇◇◇◇◇◇◇◇◇1900KB◇◇74◇◇◇◇◇◇◇◇◇◇◇

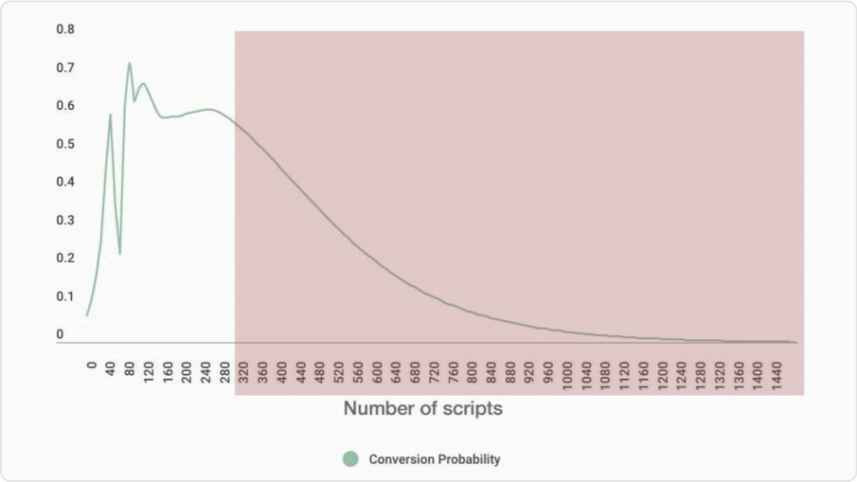
◇◇◇

◇◇◇



◇ *1.◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇*

3. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇


0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0 40 80 120 160 200 240 280 320 360 400 440 480 520 560 600 640 680 720 760 800 840 880 920 960 1000 1040 1080 1120 1160 1200 1240 1280 1320 1360 1400 1440
Number of scripts
Conversion Probability

◇ 2. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇

◇◇◇◇◇◇◇	◇◇ (KB)	HTML (KB)	JS (KB)	CSS (KB)	◇◇ (KB)	◇◇◇◇◇◇ (KB)
90	6226	107	1060	234	4746	49
75	3431	56	668	122	2270	25
50	1745	26	360	56	893	13
25	800	11	164	22	266	7
10	318	6	65	5	59	4

◇ 3. ◇◇◇◇◇◇◇

◇◇◇◇

◇◇◇◇◇◇◇	◇◇ (KB)	HTML (KB)	JS (KB)	CSS (KB)	◇◇ (KB)	◇◇◇◇◇◇ (KB)
90	+376	-50	+46	+36	+648	+2
75	+304	-7	+34	+21	+281	0
50	+179	-1	+27	+10	+106	0
25	+110	-1	+16	+5	+36	0
10	+72	0	+13	+2	+20	+1

*◇ 5. 2018◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇JavaScript◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇	GIF (KB)	ICO (KB)	JPG (KB)	PNG (KB)	SVG (KB)	WEBP (KB)
10	0	0	3.08	0.37	0.25	2.54
25	0.03	0.26	7.96	1.14	0.43	4.89
50	0.04	1.12	21	4.31	0.88	13
75	0.06	2.72	63	22	2.41	33
90	2.65	13	155	90	7.91	78

◇ 9. ◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇100◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇2◇◇◇◇◇◇◇◇◇◇◇◇1024◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

MP4◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇WebM◇ MPEG-TS◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

??????

??????	MP4 (KB)	WebM (KB)	MPEG-TS (KB)
10	0.27	0.29	34
25	1.05	0.29	121
50	39	17	286
75	514	288	476
90	2142	896	756

14. ??????????????????????????

??

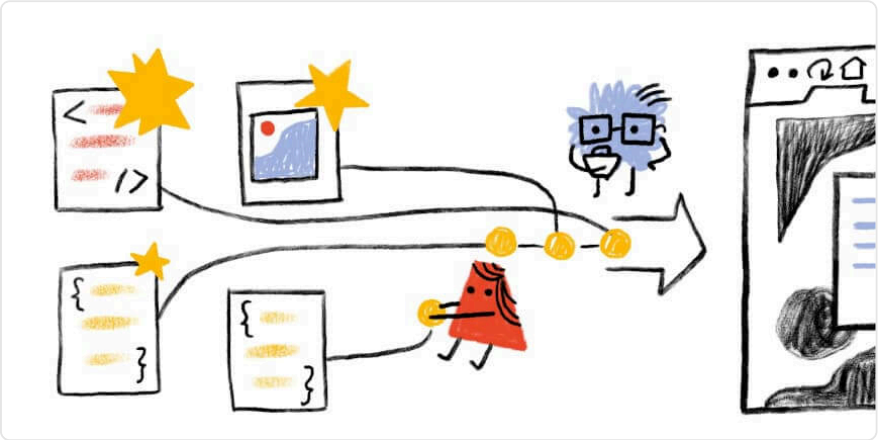
??1??????????????10????????? Brotli??3??

Katie Hempenius

Katie HempeniusChrome

◇ IV ◇ 19

◇◇◇◇◇◇◇



Katie Hempenius *◇◇◇◇◇◇◇◇◇*
Andy Davies, Barry Pollard, ◇ Yoav Weiss ◇◇◇◇◇◇◇◇
Sakae Kotaro ◇◇◇◇◇◇◇◇◇◇

◇◇

◇◇◇◇◇◇◇[491] ◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

```
<link rel="prefetch" href="shopping-cart.js">
```

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇3%◇◇◇◇◇◇◇◇◇◇◇◇◇◇HTTP◇◇◇[498]◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇IE11◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇dns-prefetch◇◇preconnect◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇HTTPS◇◇◇◇◇◇◇◇◇◇◇◇◇preconnect◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇

88%

4. as

88%as as
92% 3% 3%
CSP

API
2

[503] high,low,auto API
HTML
<image>,<link>,<script>,<iframe>

```
<carousel>
<img src="cat1.jpg" importance="high">
<img src="cat2.jpg" importance="low">
<img src="cat3.jpg" importance="low">
</carousel>
```

5. HTML

503. https://wicg.github.io/priority-hints/

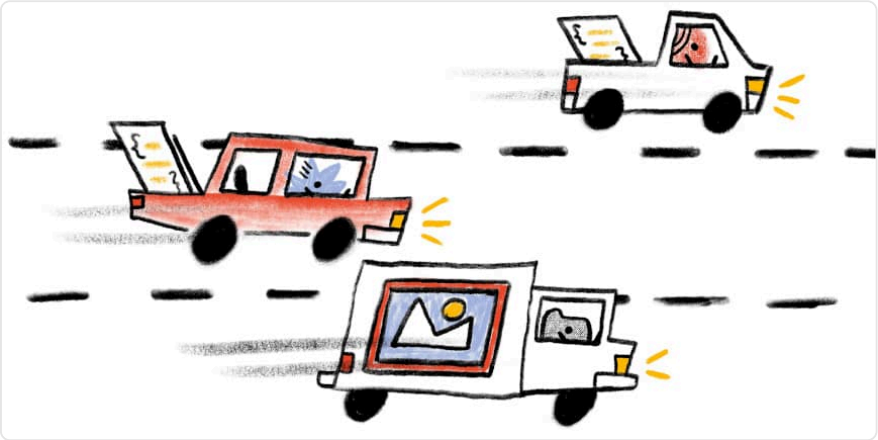
◇◇◇◇◇◇◇

◇◇

Katie Hempenius

Katie Hempenius◇Chrome◇◇◇◇◇◇◇

◇ IV ◇ 20
HTTP/2



Barry Pollard ◇◇◇◇◇◇◇◇◇
Daniel Stenberg, Robin Marx, ◇ *Andrew Galloni* ◇◇◇◇◇◇◇◇
Sakae Kotaro ◇◇◇◇◇◇◇◇◇◇

◇◇

HTTP/2◇◇◇◇20◇◇◇◇◇◇Web◇◇◇◇◇◇◇◇◇◇

HTTP/2?

HTTP Web HTTP TCP GET /index.html HTTP

HTTP HTTP/1.0 HTTP HTTP 1 HTTP

HTTP TCP TCP 6

HTTPS TCP HTTP/1.1 TCP

HTTP HTTP HTML JS CSS gzip brotli HTTP HTTPS

Web HTTP 1 HTTP HTTP HTTP

2009 Google SPDY[507] HTTP SPDY HTTP HTTPS

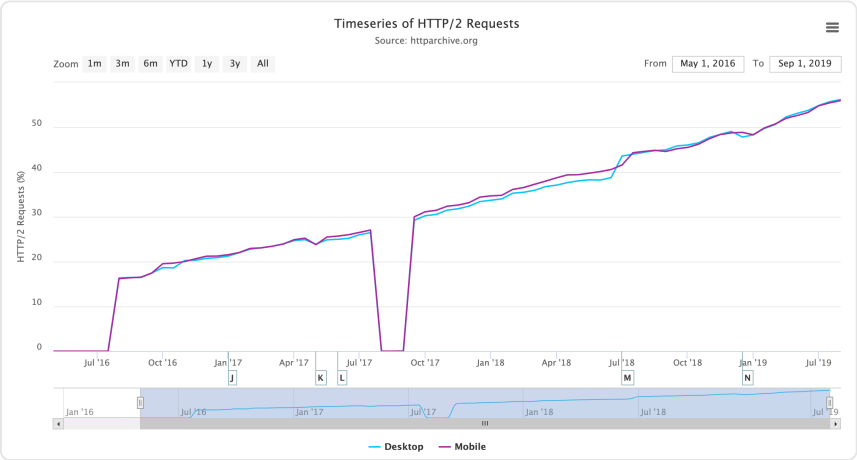
Google Chrome Web Google YouTube Gmail 1 Google HTTP

507. https://www.chromium.org/spdy

◇◇SPDY◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

□□□□□□□□□□□□□□□□□□□

□□□□□□□□□□□HTTP/2□□□□□□□□□□□□□□□□□□□



◇ 2. ◇◇◇◇◇HTTP/2◇◇◇◇(◇◇: HTTP Archive[514])

◇◇◇◇HTTP/2◇◇◇◇◇

/ HTTP ArchiveHTTP/2Chrome

HTTP ArchiveHTTP over QUIC[515]HTTP/3HTTP/2

HTTP/2Google HTTP/2HTTP/2HTTP/2 1google.com obscuresite.com

Firefox Mozilla[516]

	0.09%	0.08%	0.08%
HTTP/1.0	0.09%	0.08%	0.09%
HTTP/1.1	62.36%	63.92%	63.22%
HTTP/2	37.46%	35.92%	36.61%

4. HTTP

HTTP/2 4 36

HTTP/2HTTPS HTTPS HTTPS HTTPS HTTP/2

515. https://www.chromium.org/quic
516. https://telemetry.mozilla.org/new-pipeline/dist.html#!cumulative=0&measure=HTTP_RESPONSE_VERSION

◇◇◇◇◇	◇◇◇◇◇◇	◇◇◇◇	◇◇
	0.09%	0.10%	0.09%
HTTP/1.0	0.06%	0.06%	0.06%
HTTP/1.1	45.81%	44.31%	45.01%
HTTP/2	54.04%	55.53%	54.83%

◇ 5. HTTPS◇◇◇◇◇◇◇HTTP◇◇◇◇◇◇◇◇◇

Web◇HTTPS◇◇◇◇◇◇◇◇HTTP/2◇◇HTTPS◇◇◇◇◇◇◇◇◇

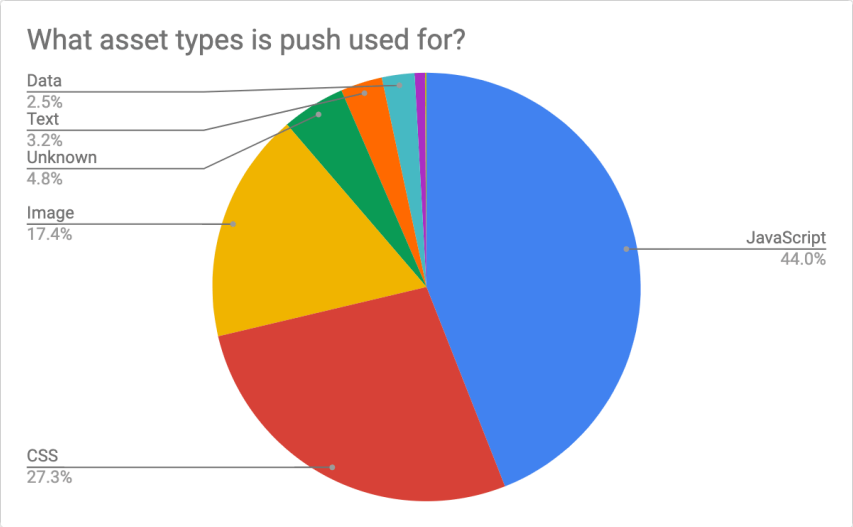
nginx◇◇◇

◇◇◇2◇◇◇

◇◇◇

◇◇◇

◇◇◇


What asset types is push used for?
Data
2.5%
Text
3.2%
Unknown
4.8%
Image
17.4%
JavaScript
44.0%
CSS
27.3%

◇ 13.◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇13◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

```
link: </assets/jquery.js>; rel=preload; as=script; nopush
```

◇◇◇◇◇HTTP◇◇◇◇◇5◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇

CDN	◇◇◇◇◇◇◇◇◇?	◇◇◇◇◇◇	◇◇◇◇	◇◇
Not using CDN	Unknown	57.81%	60.41%	59.21%
Cloudflare	Pass	23.15%	21.77%	22.40%
Google	Fail	6.67%	7.11%	6.90%
Amazon CloudFront	Fail	2.83%	2.38%	2.59%
Fastly	Pass	2.40%	1.77%	2.06%
Akamai	Pass	1.79%	1.50%	1.64%
	Unknown	1.32%	1.58%	1.46%
WordPress	Pass	1.12%	0.99%	1.05%
Sucuri Firewall	Fail	0.88%	0.75%	0.81%
Incapsula	Fail	0.39%	0.34%	0.36%
Netlify	Fail	0.23%	0.15%	0.19%
OVH CDN	Unknown	0.19%	0.18%	0.18%

◇ 14. ◇◇◇◇CDN◇◇HTTP/2◇◇◇◇◇◇◇◇◇◇◇◇

◇14◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

HTTP/3◇◇TCP◇HTTP/2◇◇◇

◇◇◇

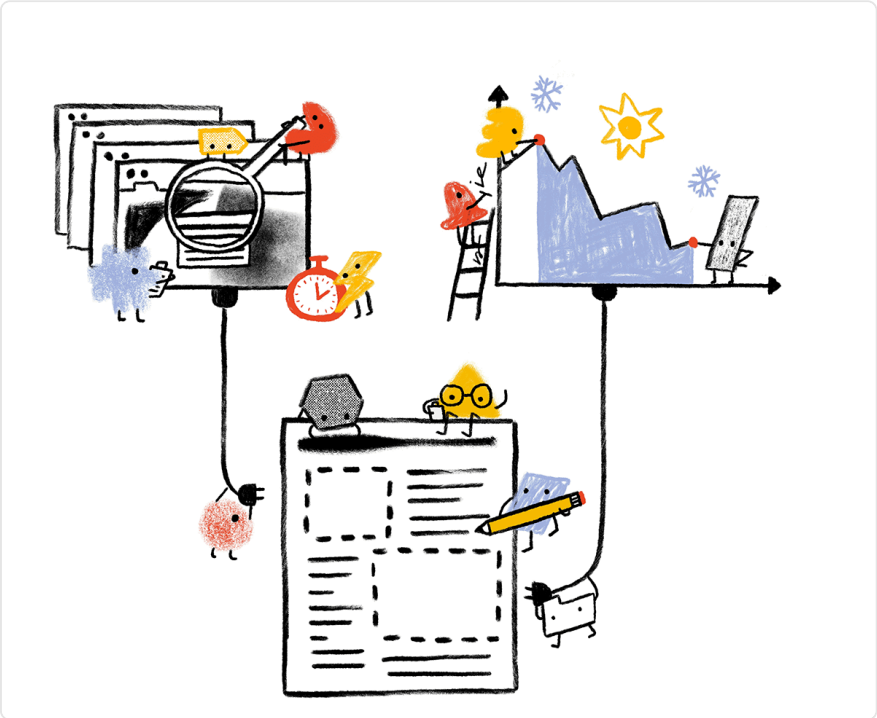
Barry Pollard

Barry Pollard Manning HTTP/2 in Action[534] @tunetheweb[535] www.tunetheweb.com[536]

534. *https://www.manning.com/books/http2-in-action*
535. *https://twitter.com/tunetheweb*
536. *https://www.tunetheweb.com*

◇◇◇◇ A

◇◇◇



◇◇

Web Almanac◇◇HTTP Archive[537]◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇HTTP Archive◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇◇

◇◇◇◇

```
GROUP BY
  percentile,
  client
ORDER BY
  percentile,
  client
```

◇◇◇◇◇◇◇◇JavaScript◇◇◇[545]◇◇◇◇◇◇◇◇

◇◇◇◇◇

HTTP Archive◇◇Web◇◇◇◇◇

◇◇	◇◇◇◇◇◇	◇◇◇◇
◇◇◇◇	Linux VM	Emulated Moto G4
◇◇◇◇◇◇◇◇◇◇	Mozilla/5.0 (X11; Linux x86_64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/75.0.3770.100 Safari/537.36 PTST/190704.170731	Mozilla/5.0 (Linux; Android 6.0.1; Moto G (4) Build/MPJ24.139-64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/65.0.3325.146 Mobile Safari/537.36 PTST/190628.140653
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◇[556]◇◇◇◇◇◇◇◇◇◇

Wappalyzer

Wappalyzer[557]◇◇◇◇◇◇◇◇◇◇

Archive◇Lighthouse◇◇◇◇

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Andy Davies

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Chen Hui Jing

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Artur Janc

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Cheng Xi

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Aymen Loukil

◇◇◇, ◇◇◇◇◇

Colin Bendell

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Barry Pollard

◇◇◇, ◇◇◇◇◇◇◇◇◇◇, ◇◇◇, ◇◇◇, ◇◇◇◇◇

Daniel Stenberg

◇◇◇◇◇

Boris Schapira

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Dave Crossland

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Brian Kardell

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David Fox

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Carlos Araya

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Doug Sillars

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Carlos Torres

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Eric A. Meyer

◇◇◇, ◇◇◇◇◇

Catalin Rosu

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Eric Portis

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Erik Nygren

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Jeff Posnick

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Gabriel De Gennaro

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John Fox

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Giacomo Pignoni

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John Teague

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Heng Yeow

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Jonathan Wold

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Henri Helvetica

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José M. Pérez

◇◇◇, ◇◇◇◇◇, ◇◇◇

Houssein Djirdeh

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Justin Ahinon

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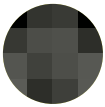

JABANE Mohamed Ayoub

◇◇◇

Justin Welenofsky

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Jared White

◇◇◇◇◇◇◇◇◇◇

Kari Larson

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Jason Haralson

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Katie Hempenius

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Laura Eberly

◇◇◇◇◇

M.Sakamaki

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Malek Hakim

◇◇◇◇◇

Mark Nottingham

◇◇◇◇◇◇◇◇◇

Mark Zeman

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Martin Splitt

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Mathias Bynens

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Matt Ludwig

◇◇◇◇◇

Matthew Phillips

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Mike Geyser

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Morten Rand-Hendriksen

◇◇◇◇◇◇◇◇◇

Natasha Kosoglov

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Nektarios Paisios

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Nicolas Hoffmann

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Noah Blon

◇◇◇◇◇◇◇◇◇

Patrick Hulce

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Patrick Meenan

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Paul Calvano

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Pavel Evdokimov

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Rachel Costello

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Raghu Ramakrishnan

◇◇◇

Raghvendra Kumar

◇◇◇

Renee Johnson

◇◇◇

Rick Viscomi

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Robin Marx

◇◇◇◇◇

Rory Hewitt

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Sakae Kotaro

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Sam Dutton

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Scott Helme

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Sergey Chernyshev

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Simon Pieters

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Susie Lu

◇◇◇◇◇

Sébastien Allemand

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TJ Monserrat

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Tammy Everts

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Tom Steiner

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Tommy Hodgins

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Yoav Weiss

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Una Kravets

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Yohan Totting

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Vamsee Jasti

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Yvo Schaap

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Vincent Terrasi

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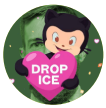

Zach Leatherman

◇◇◇, ◇◇◇◇◇◇◇◇◇◇

Weston Ruter

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