

Browser fingerprinting

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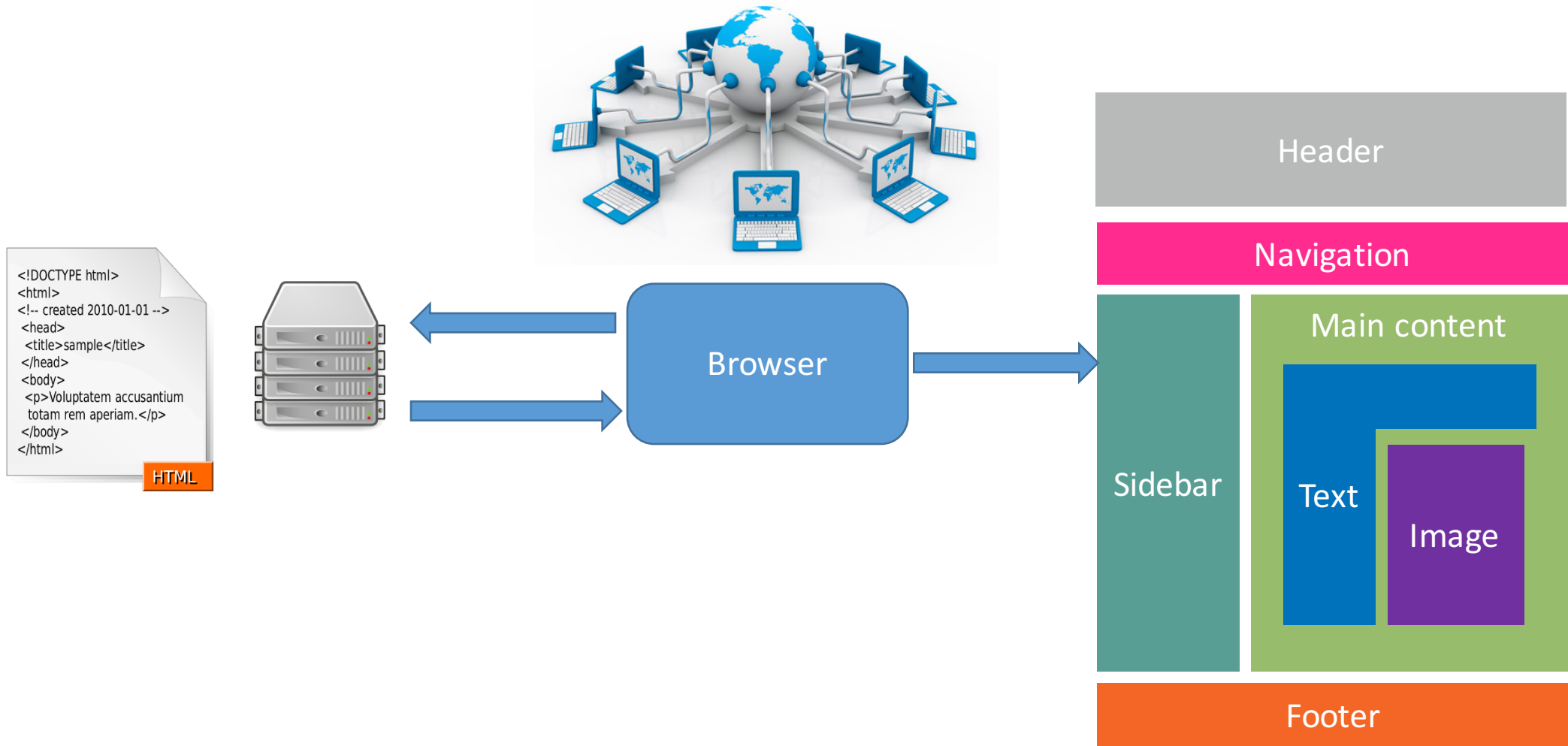
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Security and ethical aspects of data

Université Côte d'Azur

Outline

- A brief history of Web browsers
- What is browser fingerprinting?
- From basic to advanced fingerprinting



I. Internet in 1995

HTTP User agent

NCSA_Mosaic/2.0
(Windows 3.1)

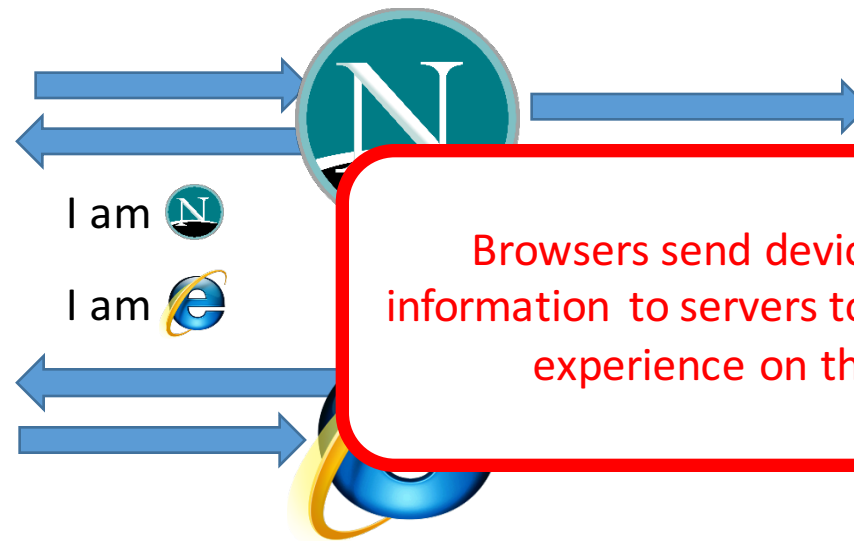
```
<!DOCTYPE html>
<html>
<!-- created 2010-01-01 -->
<head>
<title>sample</title>
</head>
<body>
<p>Voluptatem accusantium
totam rem aperiam.</p>
</body>
</html>
```

HTML

Mozilla/1.22
(compatible; MSIE
2.0; Windows 95)

```
<!DOCTYPE html>
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<!-- created 2010-01-01 -->
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</head>
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<p>Voluptatem accusantium
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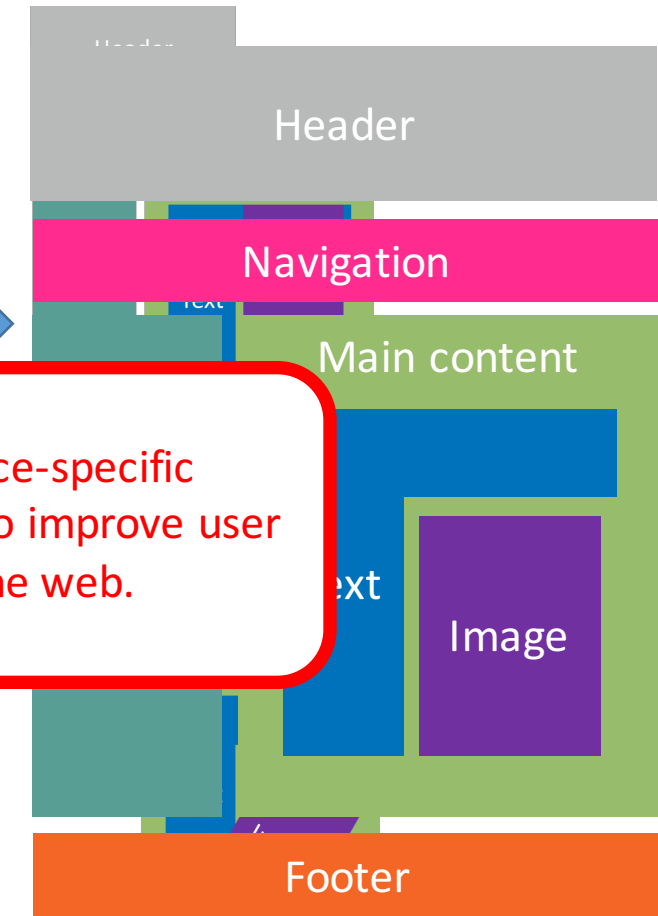
HTML



Browsers send device-specific information to servers to improve user experience on the web.

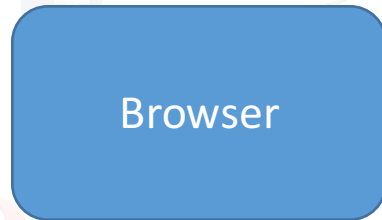
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HTML



- Every website announces with **what browser** it is recommended to visit the website





1995	2017
Browser: Netscape Language: Fr	Browser: Chrome v53 OS: Linux Screen: 1920x1080 Language: Fr Timezone: GMT+1 Graphic card: GTX 1080Ti ...

A bigger and richer web

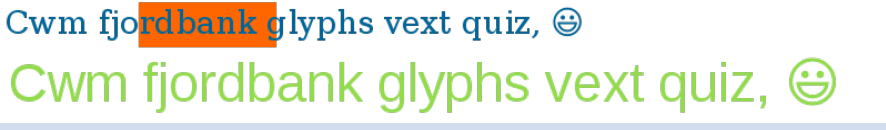


- Audio
- Video
- 3D rendering
- Real-time communications
- Web payments
- Virtual reality

...

What happens when we start collecting all the information available in a web browser?

Example of a browser fingerprint

Attribute	Value
User agent	Mozilla/5.0 (X11; Fedora; Linux x86_64; rv:55.0) Gecko/20100101 Firefox/55.0
HTTP headers	text/html, application/xhtml+xml, application/xml;q=0.9,*/*;q=0.8 gzip, deflate, br en-US,en;q=0.5
Plugins	Plugin 0: QuickTime Plug-in 7.6.6; libtotem-narrow-space-plugin.so; Plugin 1: Shockwave Flash; Shockwave Flash 26.0 r0; libflashplayer.so.
Fonts	Century Schoolbook, Source Sans Pro Light, DejaVu Sans Mono, Bitstream Vera Serif, URW Palladio L, Bitstream Vera Sans Mono, Bitstream Vera Sans, ...
Platform	Linux x86_64
Screen resolution	1920x1080x24
Timezone	-480 (UTC+8)
OS	Linux 3.14.3-200.fc20.x86 32-bit
WebGL vendor	NVIDIA Corporation
WebGL renderer	GeForce GTX 650 Ti/PCIe/SSE2
Canvas	



Maverick
Ocean Front Villas
mandarin tea
Regency
Sassafras & Ginger
Dollhouse
Athletics Dept.

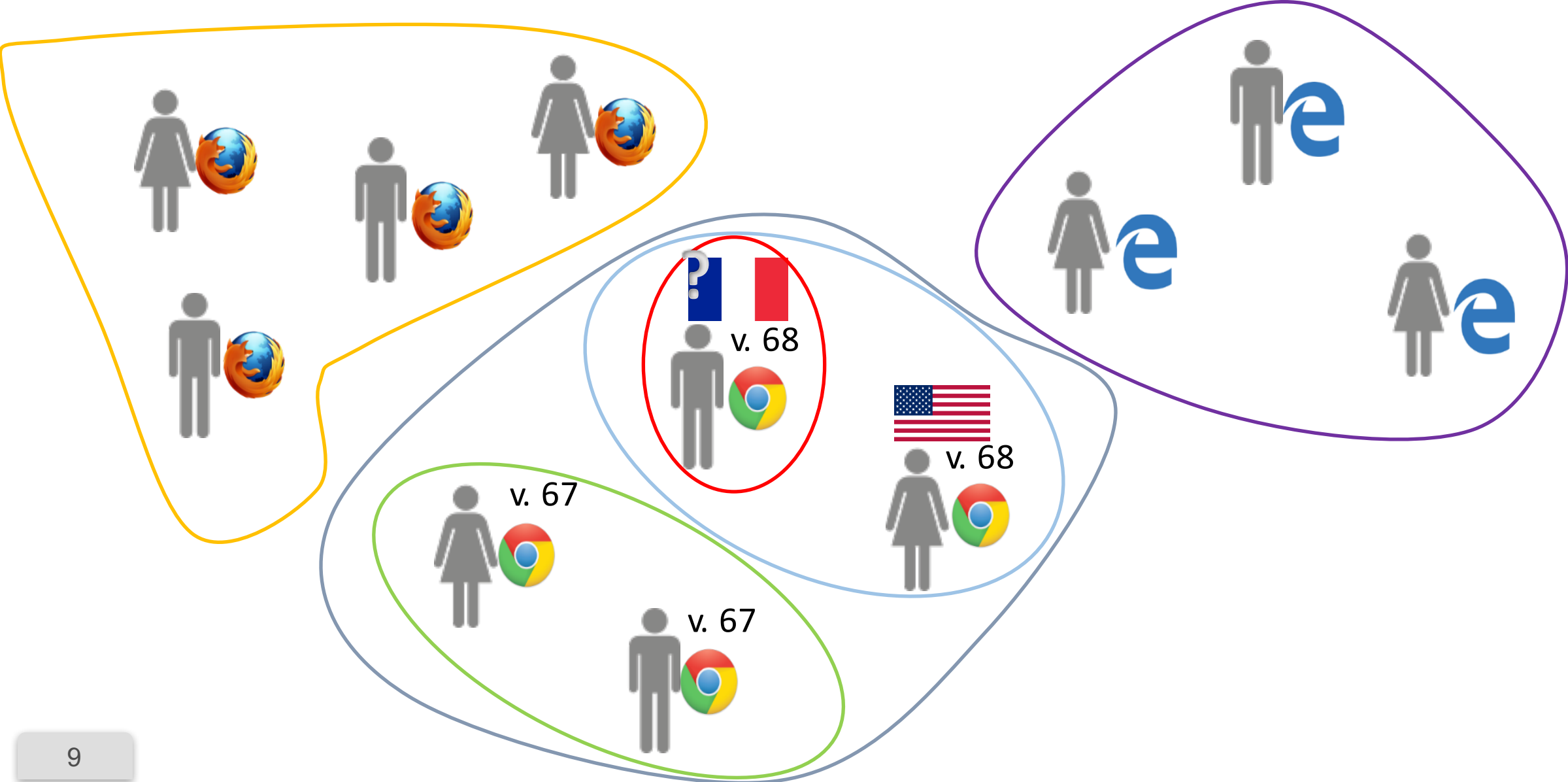


I. Definition of browser fingerprinting

Definitions

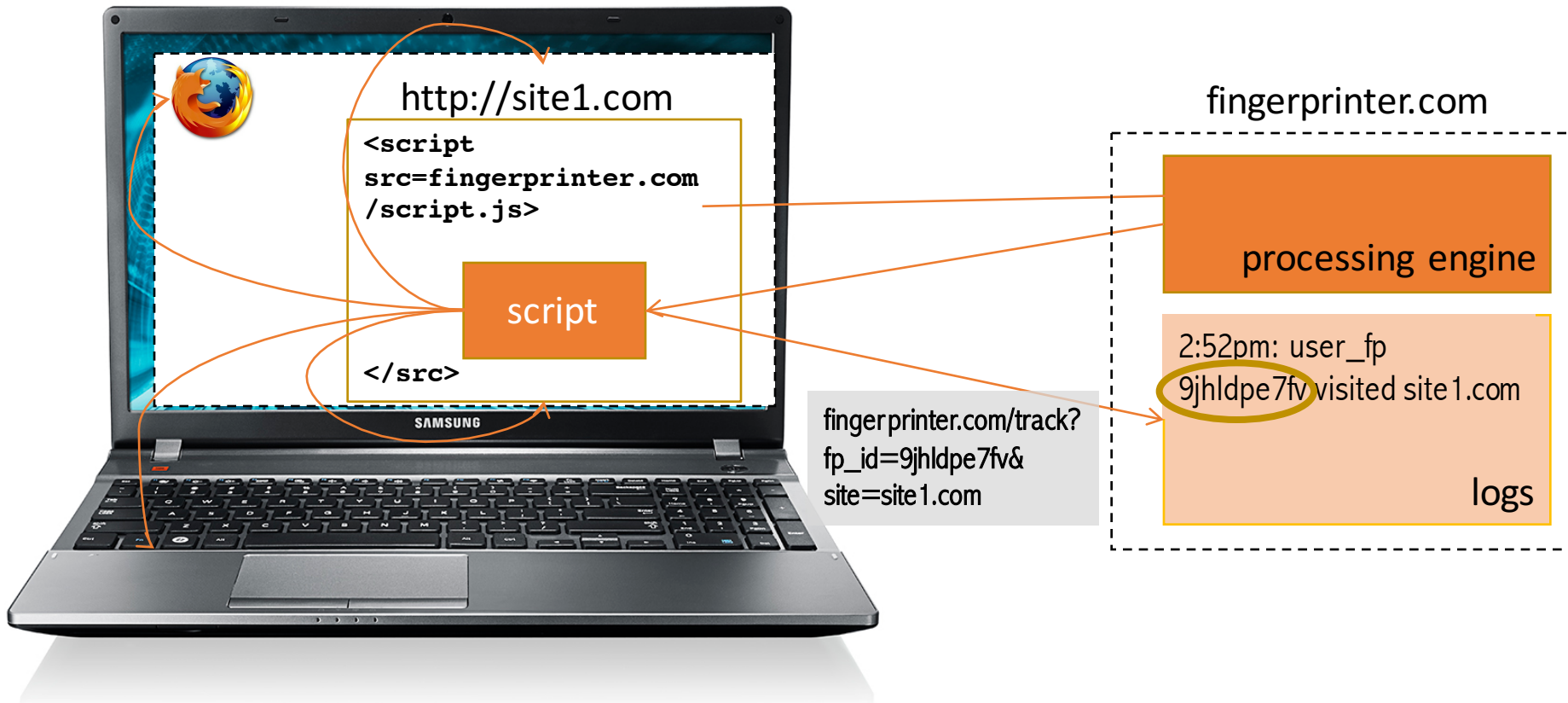
- A **browser fingerprint** is a set of information related to a user's device from the hardware to the operating system to the browser and its configuration.
- Browser **fingerprinting** refers to the process of collecting information through a web browser to build a fingerprint of a device.

How can we be identified by a browser fingerprint?



Browser fingerprinting used for tracking

Browser and operating system properties are used to **track repeated visits** to a site.



Comparison of the emoji on different devices and OSs



(a) Windows 7



(b) Windows 10



(c) Linux



(d) iOS



(e) Firefox OS



(f) Android 4.3 and before



(g) Android 4.4



(h) Android 5.0



(i) Android on an LG device



(j) Android on a Samsung device



(k) Android on an HTC device



(l) Emoji not supported

<https://hal.inria.fr/hal-01285470/document>

Two studies have investigated the diversity of browser fingerprints.



470,161 fingerprints
94.2% were unique

118,934 fingerprints
89.4% were unique

Tracking is possible

Am I Unique?



<https://amiunique.org> (Am I Unique)

The screenshot shows the homepage of the Am I Unique website. At the top, there is a teal header with the text "Am I Unique?". Below the header is a dark sidebar with navigation links: Home, My fingerprint, Global statistics, FAQ, Privacy policy, Links, About, and View on GitHub. The main content area has a white background with the following text: "Learn how identifiable you are on the Internet", "Help us investigate the diversity of web browsers", and a large dark button labeled "View my browser fingerprint". Below the button, there is a disclaimer: "By clicking on this button, only anonymous data will be collected and a cookie will be stored in your browser for four months. You can find more details in the Privacy Policy." Further down, it says "Spread the word! Share AmlUnique! Try it on all your devices!" followed by social media icons for email, Facebook, Twitter, Google+, Pinterest, Reddit, and a QR code. At the bottom, there is a link "What is browser fingerprinting? Learn more" and a footer: "Any questions? Send us an email at contact@amiunique.org".

- Website launched in November 2014
- Collected 660,000+ fingerprints so far
- Browser extension available to see the evolution of your own browser fingerprint

Fingerprinting



- Panopticlick [Eckersley, PET'2010]

Your browser fingerprint **appears to be unique** among the 2,419,678 tested so far.

Currently, we estimate that your browser has a fingerprint that conveys **at least 21.21 bits of identifying information.**

- Information needed to **uniquely identify a browser**
 - n – number of connected devices: **5 000 000 000**
 - $\log_2 n$ – number of bits for a unique id: **33 bits**
- **Idea: distinguish user's browsers** by accessing browser features and using their probability distributions

Cwm fjordbank glyphs vext quiz, 😊

Cwm fjordbank glyphs vext quiz, 😊

How to compare datasets: Anonymity sets

- User-agent on Desktop vs Mobile devices

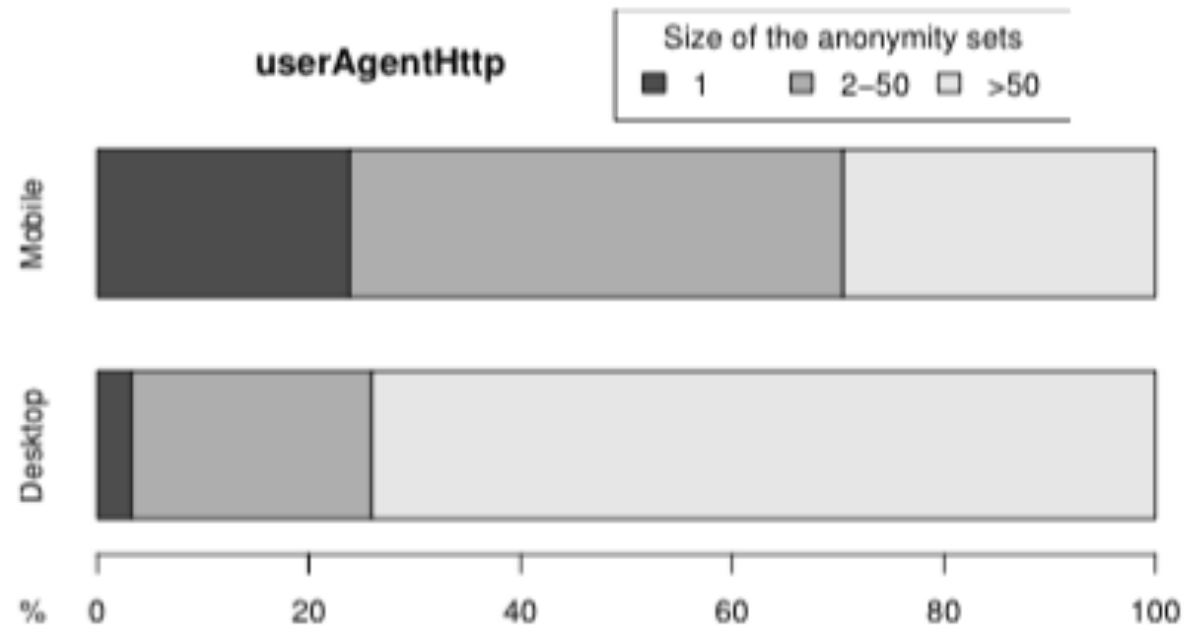


Fig. 4. Comparison of anonymity set sizes on the user-agent between desktop and mobile devices

I. Example of values collected on AmlUnique

Some user-agents

- Mozilla/5.0 (Windows NT 6.1; WOW64; rv:34.0) Gecko/20100101 Firefox/34.0
- Mozilla/5.0 (iPhone; CPU iPhone OS 8_1_2 like Mac OS X) AppleWebKit/600.1.4 (KHTML, like Gecko) Version/8.0 Mobile/12B440 Safari/600.1.4
- Mozilla/5.0 (Android; Mobile; rv:27.0) Gecko/27.0 Firefox/27.0
- Mozilla/5.0 (Macintosh; Intel Mac OS X 10_10_2) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/39.0.2171.95 Safari/537.36
- Mozilla/5.0 (X11; Ubuntu; Linux i686; rv:34.0) Gecko/20100101 Firefox/34.0

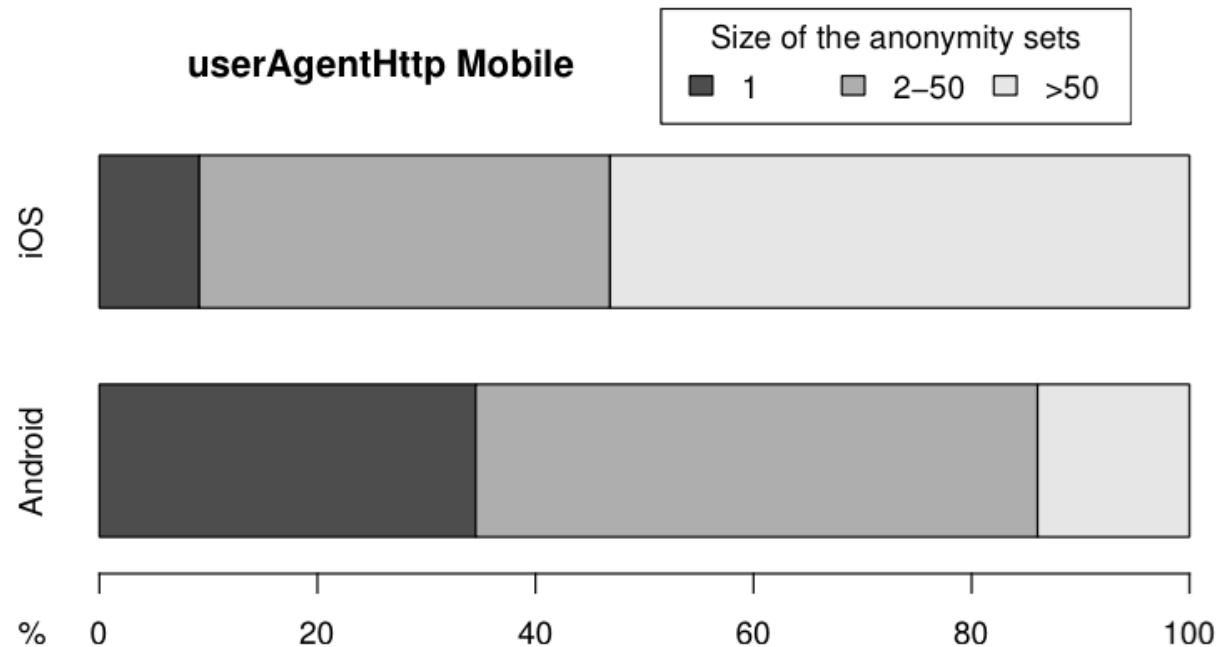
I. Example of values collected on AmlUnique

Other custom user-agents

- godzilla/5.0 (X122; BSD; rv:500.0) Gecko/20100101
- pouet
- “54. When a warlike prince attacks a powerful state, his generalship shows itself in preventing the concentration of the enemy's forces. He overawes his opponents, and their allies are prevented from joining against him.”
- Deepnet Explorer 1.5.3; Smart 2x2; Avant Browser; .NET CLR 2.0.50727; InfoPath.1)
- NSA
- Game Boy Advance
- eat it

Anonymity sets for mobile devices

- User-agent on Android vs iOS devices



› Fig. 5. Comparison of anonymity set sizes on the user-agent between Android and iOS devices

What if I disable JavaScript?

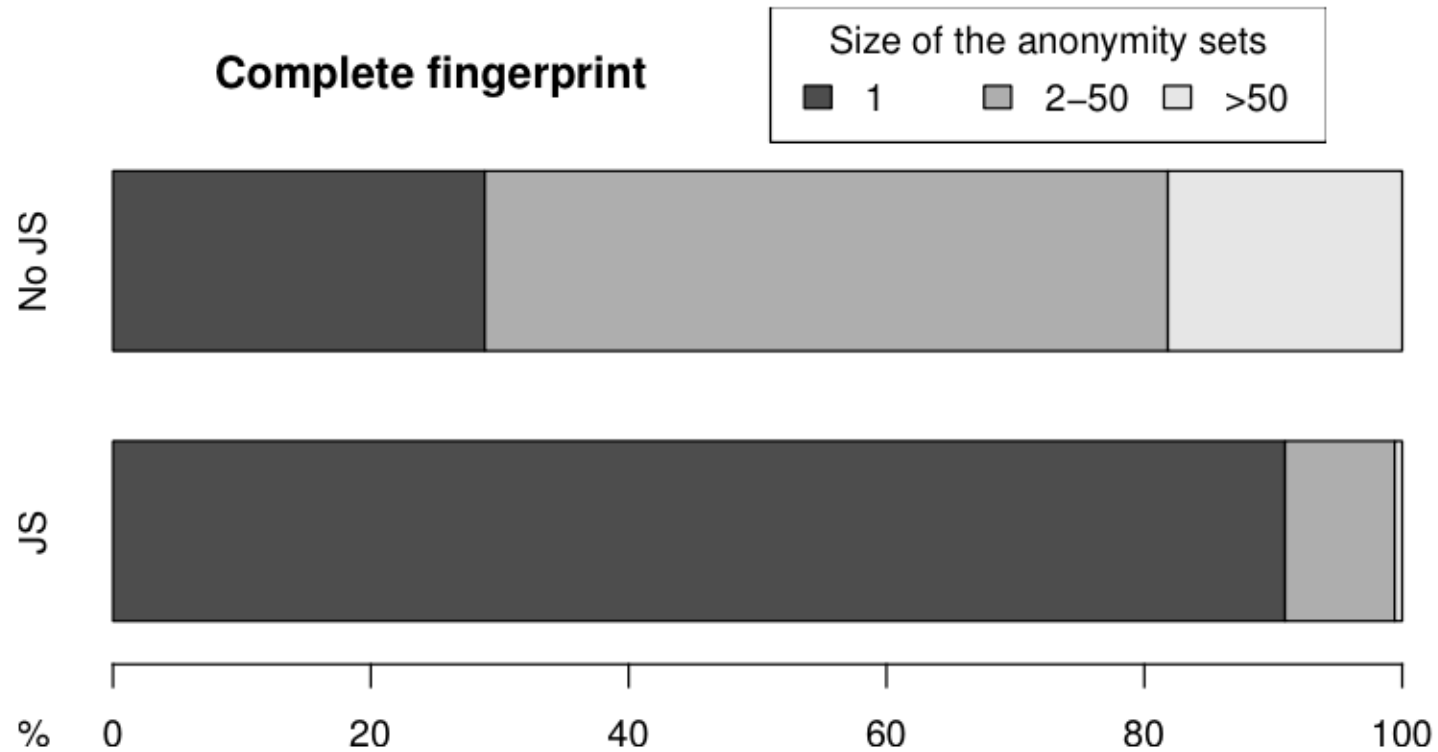


Fig. 9. Comparison of anonymity set sizes on the complete fingerprint between devices with and without JavaScript

- Servers can easily collect information about a device to form what is called a **browser fingerprint**.
- There is so much diversity that users can be **tracked** online if their fingerprint is **unique**.
- Test your device on <https://amiunique.org>



Browser Fingerprinting: A survey

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BENOIT BAUDRY, KTH Royal Institute of Technology, Sweden

GILDAS AVOINE, Univ Rennes, INSA Rennes, CNRS, IRISA, France

With this paper, we survey the research performed in the domain of browser fingerprinting, while providing an accessible entry point to newcomers in the field. We explain how this technique works and where it stems from. We analyze the related work in detail to understand the composition of modern fingerprints and see how this technique is currently used online. We systematize existing defense solutions into different categories and detail the current challenges yet to overcome.

CCS Concepts: • **Security and privacy** → **Web application security; Browser security; Privacy protections;**

Additional Key Words and Phrases: Browser fingerprinting, user privacy, web tracking

1 INTRODUCTION

The web is a beautiful platform and browsers give us our entry point into it. With the introduction of HTML5 and CSS3, the web has become richer and more dynamic than ever and it has now the foundations to support an incredible ecosystem of diverse devices from laptops to smartphones and tablets. The diversity that is part of the modern web opened the door to device fingerprinting, a simple identification technique that can be used to collect a vast list of device characteristics