Browser Fingerprinting and Digital Privacy

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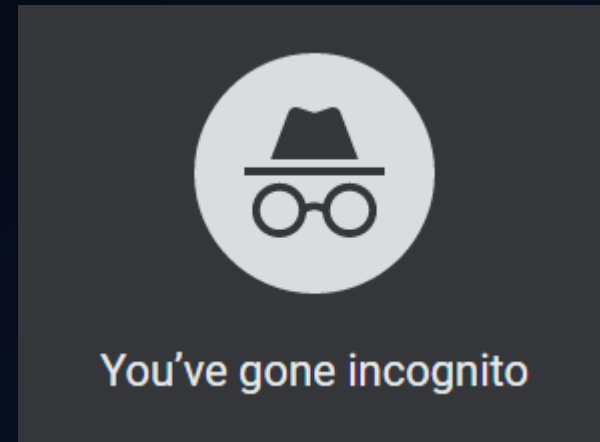University of Minnesota Morris

Privacy and Security

User Activity

- Banking

- Politics

- Shopping

- Communication

- Media

- Data

Incognito Mode

You've gone incognito

www.google.com

- Browsing history

- Internet tracking

What is a Browser?

Browsers:

- Browser Wars

- User Agent Header

- Header's elements

```
Mozilla/5.0 (X11; Ubuntu; Linux x86_64; rv:85.0)
        Gecko/20100101 Firefox/85.0
```

What is a Browser Fingerprint?

Definition:

- ID created from data about the 'Web Client'

- Modern Fingerprint:
  - Peter Eckersley
  - User Agent Header

First Fingerprint:

- Jonathan Mayer

- 2009

- Navigator objects
  - Plugins

What is a Browser Fingerprint?

Attributes:

- User Agent Header

- Screen Resolution

- Language

- Time Zone

- APIs

Fingerprint
3f22247763891c1f143cfd3b0d5eb58e

Device Signature

userAgent = Mozilla/5.0 (X11; Ubuntu; Linux x86_64; rv:85.0)
Gecko/20100101 Firefox/85.0
webdriver = false
language = en-US
colorDepth = 24
screenResolution = 768,1366
availableScreenResolution = 741,1294
timezoneOffset = 360
timezone = America/Chicago
sessionStorage = true
localStorage = true
platform = Linux x86_64
plugins =
touchSupport = 0,false,false
fonts = Arial,Arial Narrow,Bitstream Vera Sans Mono,Bookman Old
Style,Century Schoolbook,Courier,Courier New
audio = 35.73833402246237
deviceMemory = not available
hardwareConcurrency = 4
canvas = canvas winding:yes,canvas
fp:data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAB9AAAADICAYAAACwGnoBAA
AgA
webglVendorAndRenderer = Intel Open Source Technology Center~Mesa DRI
Intel(R) HD Graphics 3000 (SNB GT2)
webgl =
data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAASwAAACWCAYAAABkW7XSAAARc
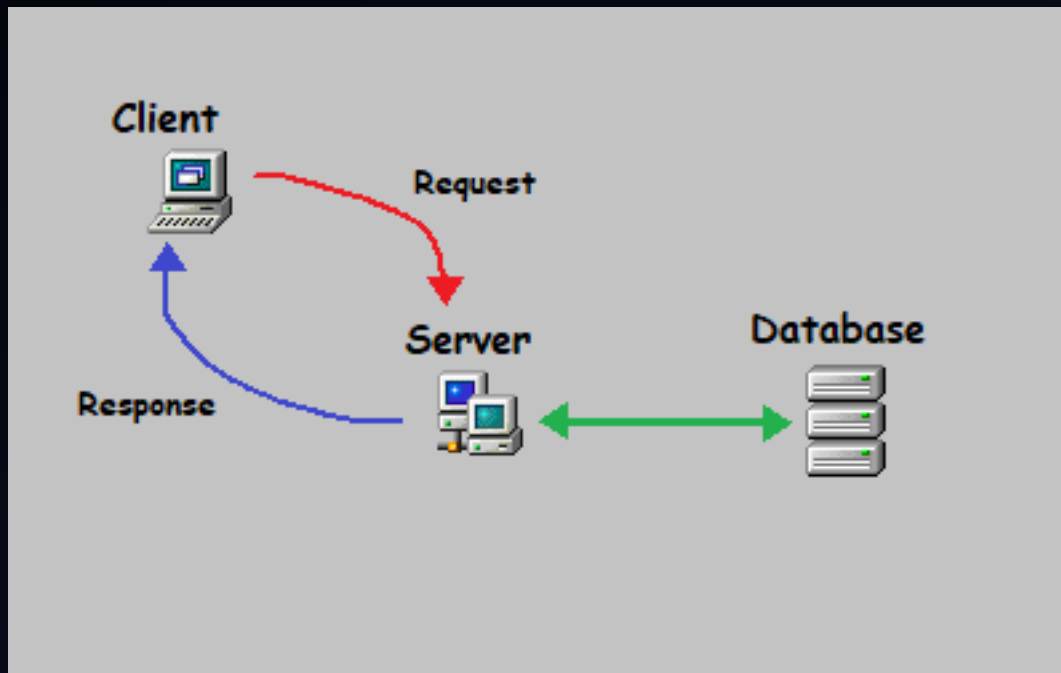klEQVR4nO3c/2vbi37f8eefsR82uD

Show Details

Fingerprint in Cookie
No fingerprint cookie

Outline

- **The Structure and Attribute Collection Practices**

- Available Countermeasures

- Security and Usability Focused Platform

- Conclusions

The Underlying Structure

Client-Server & Request-Response

- Structure:
  - Client
  - Server
  - Database

- Data Transmission
  - Request Packets
  - Response Packets

Attribute Collection

How its Done:

- JavaScript

- Querying

- API
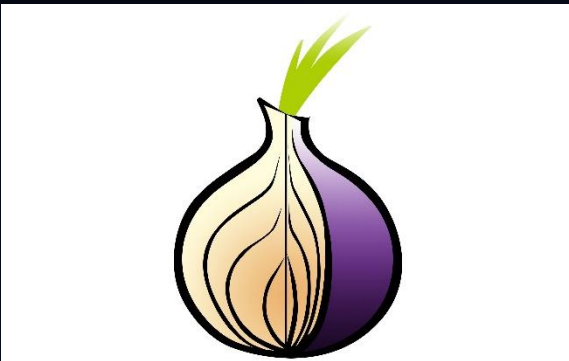 - Canvas
  - WebGL

- Cookies

Client – Server

- Scripts
  - Response

- Sessions
  - Cookies
  - Persistent fingerprint

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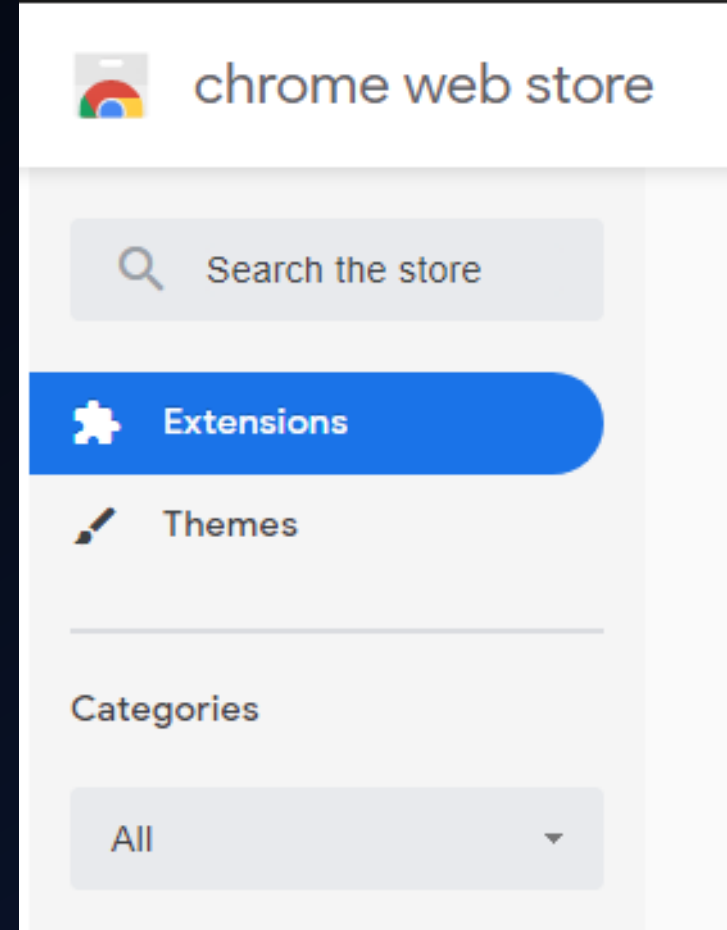
Available Countermeasures

- Browsers
  - Tor
  - Brave

- Extensions

chrome web store

Search the store

Extensions

Themes

Categories

All

https://1000logos.net/tor-logo

https://www.computerworld.com/article/3292619/the-brave-browser-basics-what-it-does-how-it-differs-from-rivals.html

https://chrome.google.com/webstore/category/extensions?utm_source=chrome-ntp-icon

Available Countermeasures

Script Blocking

- Ad-BlockPlus

- Disconnect

- Ghostery

- NoScript

- Privacy Badger

- uBlock

Attribute Blocking

- CanvasBlocker

- Canvas Defender

Available Countermeasures

Attribute Switching

- User Agent Switcher

- Random Agent Spoofer

Attribute Blurring

- FPGuard

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Security and Usability Focused Platform

Non-unique Fingerprint

- User Experience

- Clustering Algorithm

- A. Gómez-Boix, D. Frey, Y.-D. Bromberg, and B. Baudry. 2019

A. Gómez-Boix, D. Frey, Y.-D. Bromberg, and B. Baudry. 2019
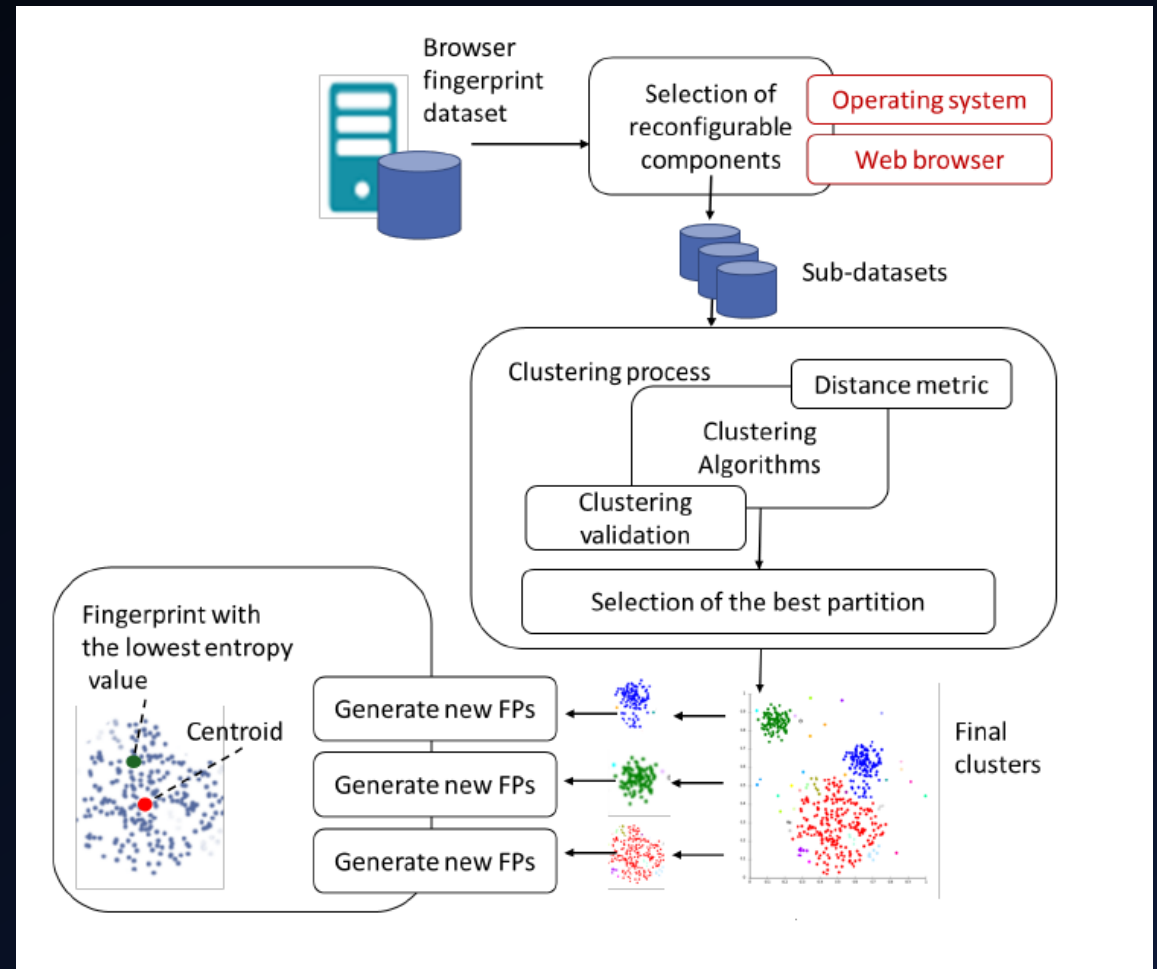
Security and Usability Focused Platform

Distance:

$$D(F_1, F_2) = \sum_{i=1}^{n} w_i * d\left(F_{1a_i}, F_{2a_i}\right)$$

Identifiability:
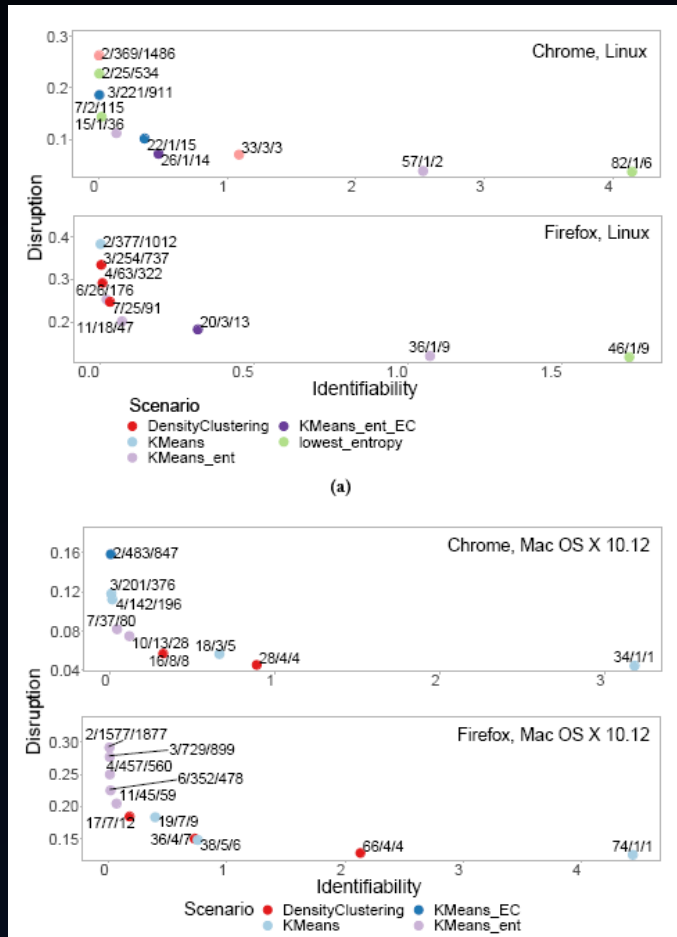
$$I = \sum_{k=1}^{K} \frac{1}{u(c_k)}$$

Disruption:

$$R = \sum_{k=1}^{K} \sum_{i \in c_k} \left(d\left(FP_i, FP^{\{k\}}\right) * \frac{u(FP_i)}{U}\right)$$
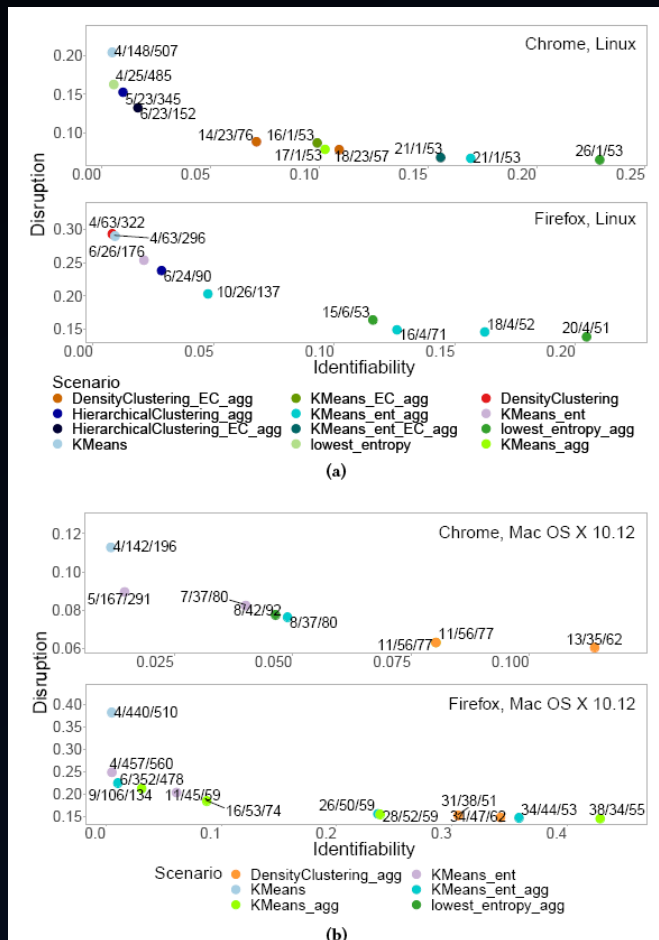
Fingerprint Generation:

- Algorithms:
  - K-Means Clustering
  - Density Based Clustering Algorithm
  - Agglomerative Hierarchical Clustering

- Centroid of the clusters

- Lowest Entropy

Security and Usability Focused Platform

Dataset	# of FPs	Number of devices	% of unique	Ident.
Linux, Chrome	1,176	4,117	67.6	921.05
Linux, Firefox	804	2,316	61.3	594.31
Mac OS X 10.12, Chrome	1,047	1,769	73.6	871.24
Mac OS X 10.12, Firefox	3,202	3,832	88.6	2,991.81

Images from: A. Gómez-Boix, D. Frey, Y.-D. Bromberg, and B. Baudry. 2019

Security and Usability Focused Platform

Images from: A. Gómez-Boix, D. Frey, Y.-D. Bromberg, and B. Baudry. 2019

Security and Usability Focused Platform

Experiment Results:

- Reduced Identifiability

- Fingerprint Protection Platform

  - Browser

  - Website

  - Software Containers

Larger Scope

- Scalability

Outline

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- Available Countermeasures

- Security and Usability Focused Platform

- **Conclusions**

Conclusion

- De-anonymization

- Tracking

- Solutions:
  - FPP
  - Browser Extensions
  - User actions

Sources:

- H. F. Alan and J. Kaur. 2019

- A. Gómez-Boix, D. Frey, Y.-D. Bromberg, and B. Baudry. 2019

- A. Gómez-Boix, P. Laperdrix, and B. Baudry. 2018

- A. J. Kaizer and M. Gupta. 2016

- P. Laperdrix, N. Bielova, B. Baudry, and G. Avoine. 2020.

- W. L. Robison. 2018

Thank you

QUESTIONS?