

FPRandom: Randomizing core browser objects to break advanced device fingerprinting techniques

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Outline

- 1) What is fingerprint-based tracking?
- 2) Randomizing core browser objects
 - a. Generating instability
 - b. Example n°1: Ordering of JavaScript properties
 - c. Example n°2: Canvas fingerprinting
- 3) Evaluation and conclusion



AmlUnique.org

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- Global statistics
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Learn how identifiable you are on the Internet
Help us investigate the diversity of web browsers

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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](#).

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What is browser fingerprinting? [Learn more](#)

Any questions? Send us an email at contact@amiunique.org

- Launched in November 2014
- 400,000+ fingerprints collected so far

Example of a fingerprint

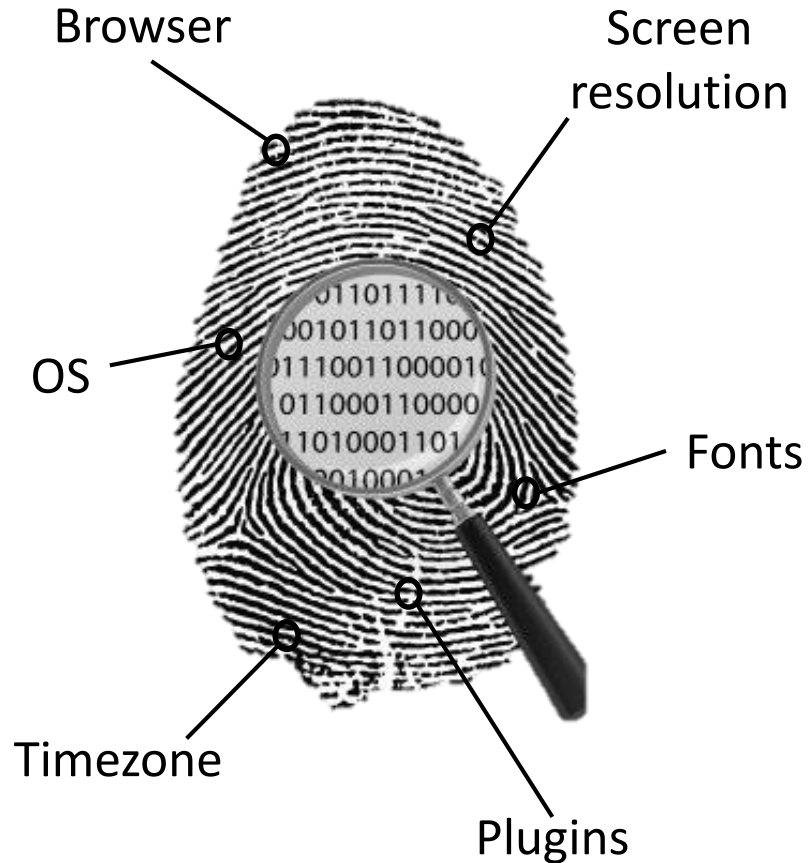
Attribute	Value
User agent	Mozilla/5.0 (X11; Fedora; Linux x86_64; rv:54.0) Gecko/20100101 Firefox/54.0
HTTP headers	text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8 gzip, deflate, br en-US,en;q=0.5
Plugins	Plugin 1: QuickTime Plug-in 7.6.6; libtotem-narrow-space-plugin.so; Plugin 2: Shockwave 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 4.11.5-200.fc25.x86_64
WebGL vendor	NVIDIA Corporation
WebGL renderer	GeForce GTX 650 Ti/PCIe/SSE2
Canvas	Cwm fjordbank glyphs vext quiz, ☺ Cwm fjordbank glyphs vext quiz, ☺



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



Can we be tracked?



PanoptiClick

How Unique – and Trackable – Is Your Browser?

- 94.2% of collected fingerprints are unique (2010)

Am I Unique?

- 89.4% of collected fingerprints are unique (2016)
- Smartphones are also prone to fingerprinting

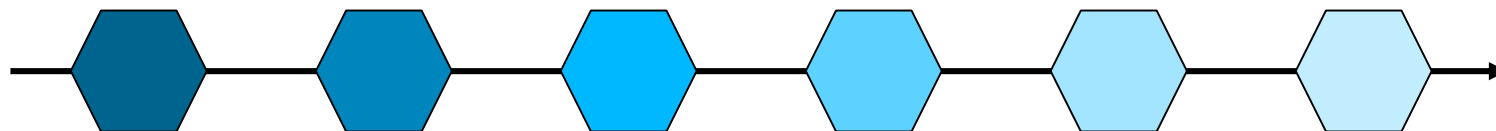
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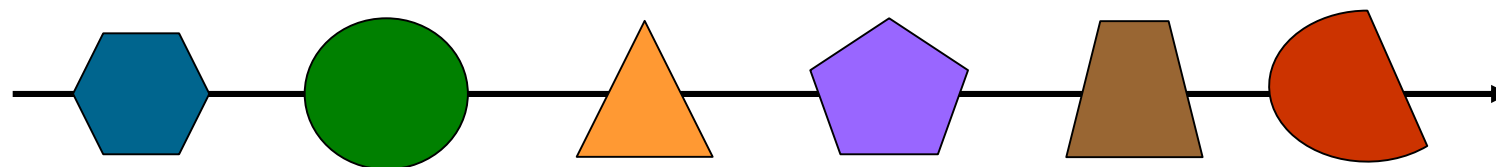
Proposed defense: making attributes unstable for tracking

- Most attributes in a fingerprint are predictable and do not drastically change over time

- Normal evolution behavior

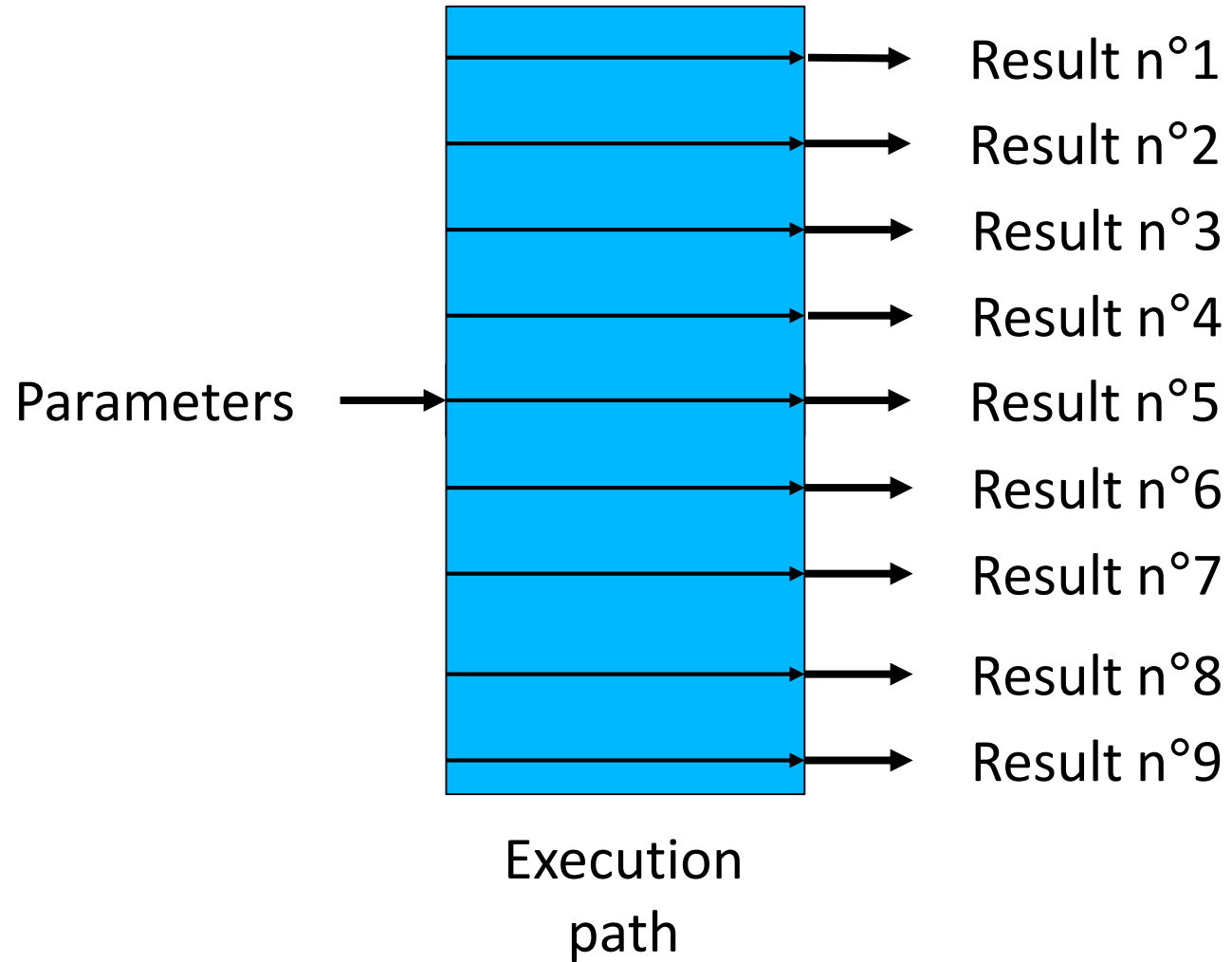


- Desired evolution behavior



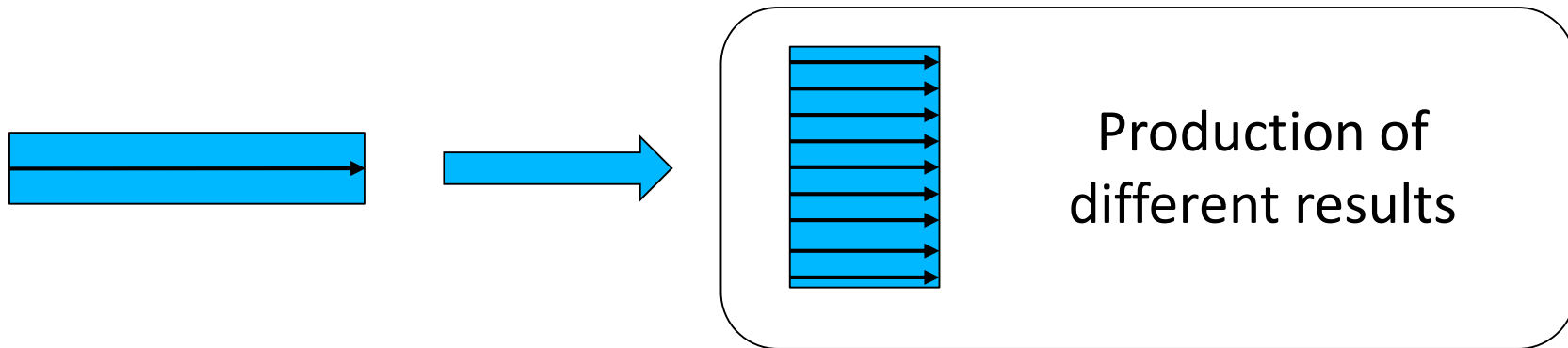
How?

Creation of multiple execution paths

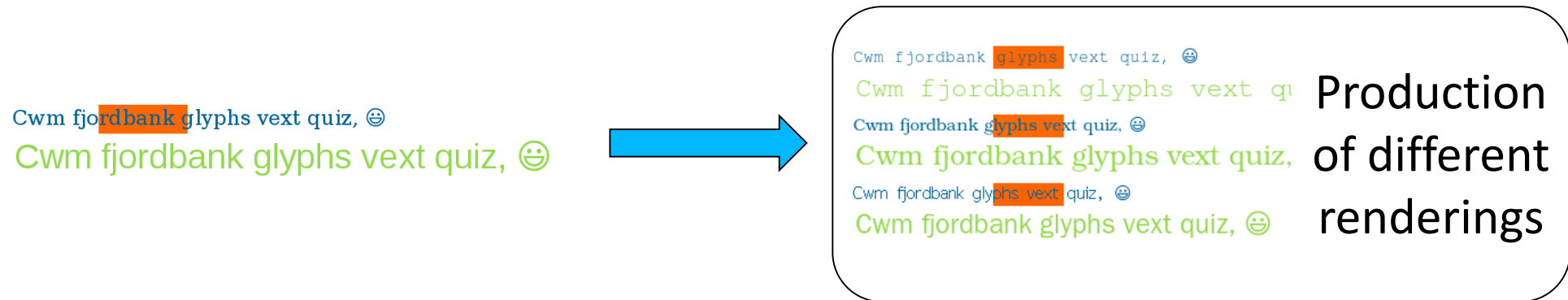


Two approaches

1. Remove the determinism of specific browser functions



2. Alter the rendering of multimedia elements



Example n°1: Ordering of JavaScript properties

- Special JavaScript objects have their own enumeration order.
- *Navigator* object

- Firefox

“vibrate;javaEnabled;getGamepads;mozGetUserMedia;requestMediaKeySystemAccess;registerProtocolHandler;registerContentHandler;taintEnabled;permissions;mimeType;plugins;doNotTrack;oscpu;vendor;vendorSub;productSub[...]”

- Chrome

“vendorSub;productSub;vendor;maxTouchPoints;hardwareConcurrency;cookieEnabled;appName;appVersion;platform;product;userAgent;language;languages;onLine;doNotTrack;geolocation;mediaDevices;plugins[...]”



Browser can be unmasked

Example n°1: Ordering of JavaScript properties

- The JavaScript language follows the ECMAScript specification.
- Section 13.7.5.15



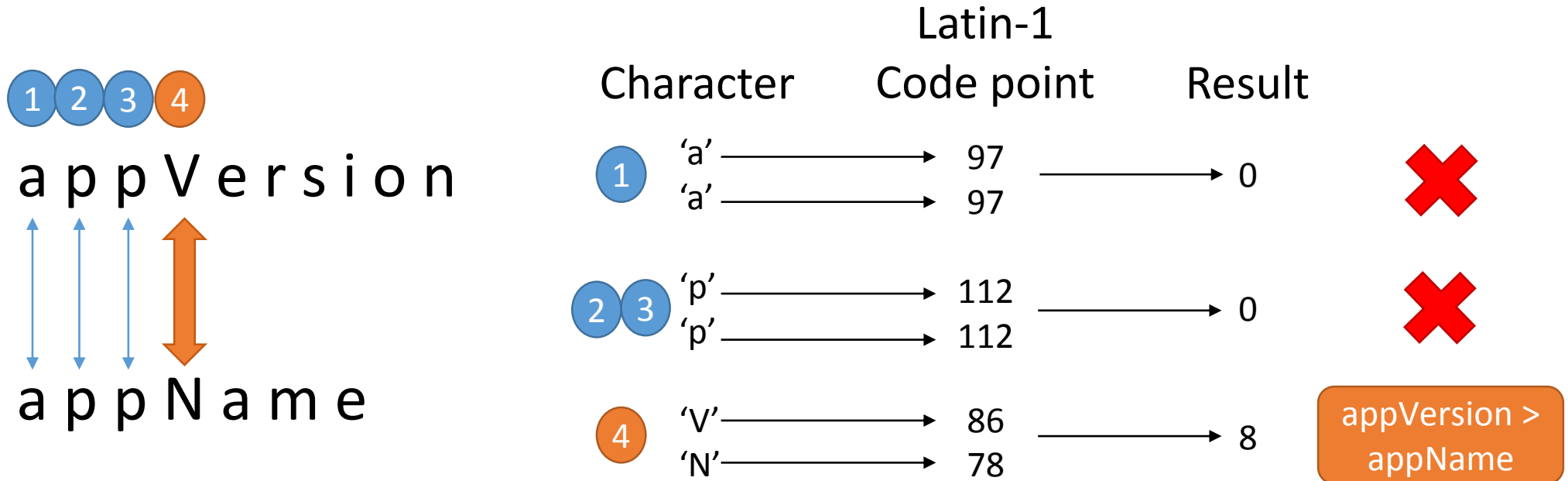
“mechanics and order of enumerating the properties is not specified”



Provide protection by randomizing the enumeration order

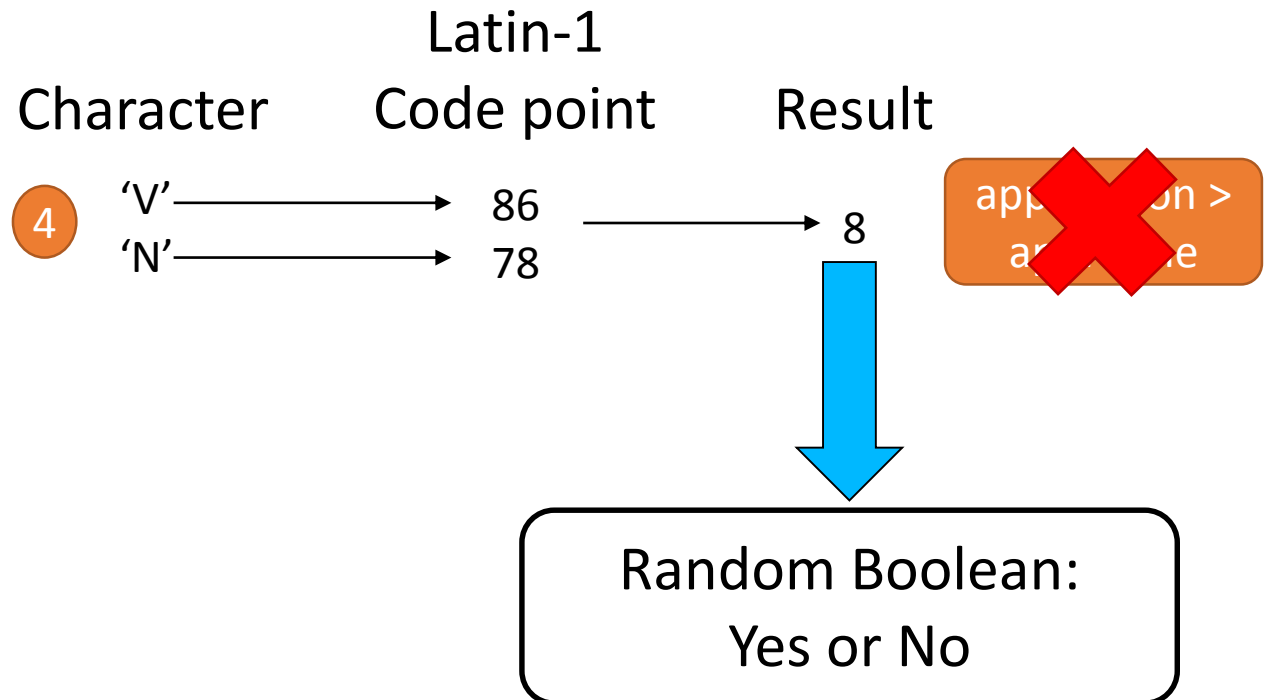
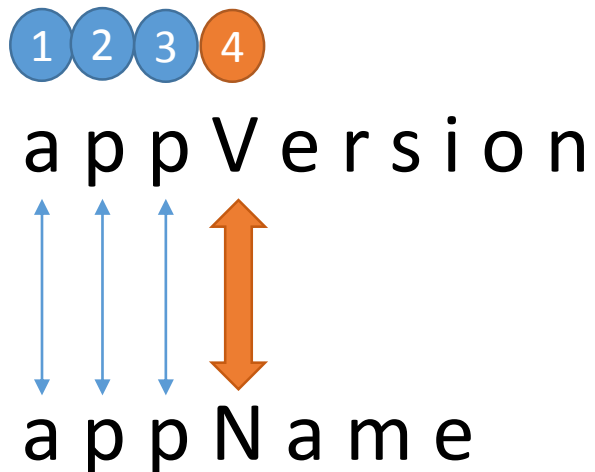
Example n°1: Ordering of JavaScript properties

- First change
 - We activate the “JS_MORE_DETERMINISTIC” flag.



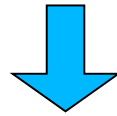
Example n°1: Ordering of JavaScript properties

- Second change
 - We change the string comparison function.



Example n°1: Ordering of JavaScript properties

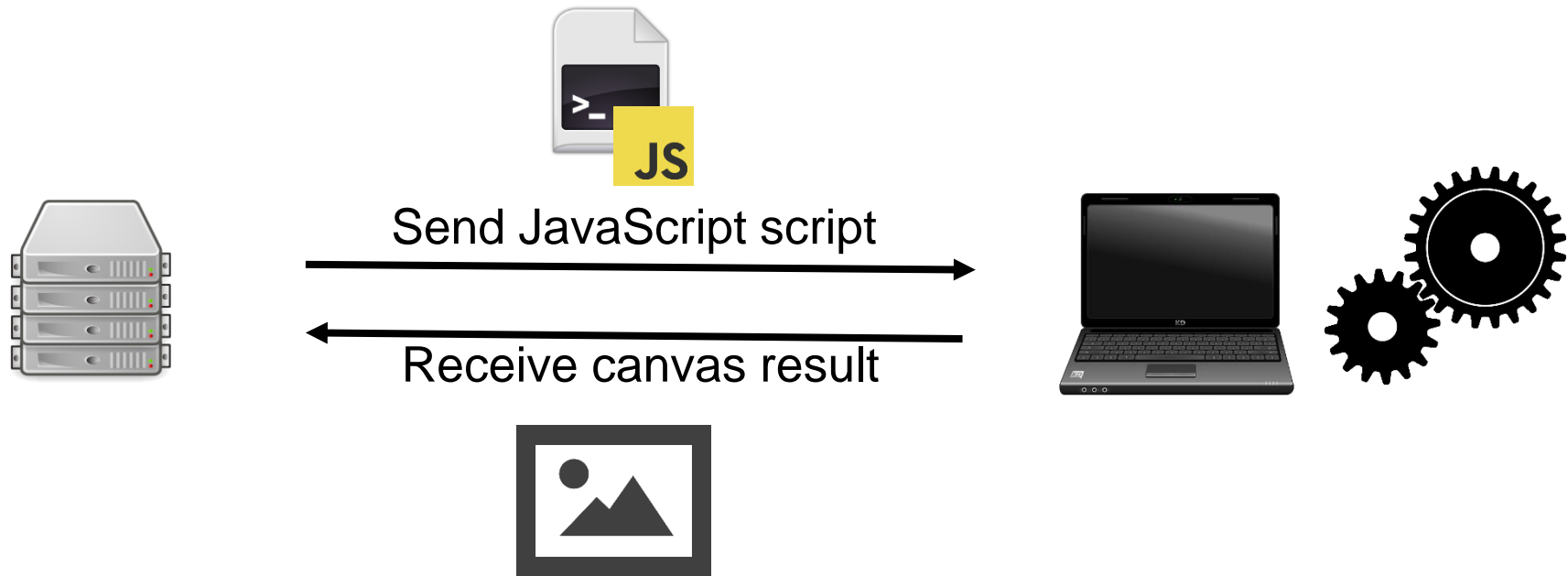
- Generation of a Boolean for every possible combination of the Latin-1 character set
- Creation of a random enumeration order for each session



Prevent trackers from using this technique by creating unstable orders

Example n°2: Canvas fingerprinting

- Canvas API to draw shapes and render strings
- Depends on both hardware and software



Example n°2: Canvas fingerprinting

```
canvas = document.createElement("canvas");
canvas.height = 60;
canvas.width = 400;
canvasContext = canvas.getContext("2d");
canvas.style.display = "inline";
canvasContext.textBaseline = "alphabetic";
```

1

```
canvasContext.fillStyle = "#f60";
canvasContext.fillRect(125, 1, 62, 20);
```

2

```
canvasContext.fillStyle = "#069";
canvasContext.font = "11pt no-real-font-123";
canvasContext.fillText("Cwm fjordbank glyphs vext quiz, \ud83d\ude03", 2, 15);
```

3

```
canvasContext.fillStyle = "rgba(102, 204, 0, 0.7)";
canvasContext.font = "18pt Arial";
canvasContext.fillText("Cwm fjordbank glyphs vext quiz, \ud83d\ude03", 4, 45);
canvasData = canvas.toDataURL();
```




Cwm fjordbank glyphs vext quiz, 😊

Cwm fjordbank glyphs vext quiz, 😊

Example n°2: Canvas fingerprinting


- Two changes
 - Apply very small modifications when parsing a new color

```
canvas.Context.fillStyle = "rgba(102, 204, 0, 0.7)";  
                           "rgba(103, 203, 0, 0.7)";
```



- Chose a random font

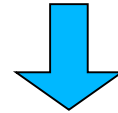
```
canvas.Context.font = "18pt Arial";  
                     "18pt Times New Roman";
```



Example n°2: Canvas fingerprinting

Cwm fjordbank glyphs vext quiz, 😊

Cwm fjordbank glyphs vext quiz, 😊



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Cwm fjordbank glyphs vext quiz, 😊

Cwm fjordbank glyphs vext quiz, 😊

Prevent trackers from using this technique by
creating random canvas renderings

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Evaluation

- 25% increase in execution time for modified functions
- User study
 - Very small impact on the user experience
 - Improvements needed on the selection of fonts
- Crawl of the top 1,000 Alexa websites
 - No visible breakage
 - No noticeable change in loading times

Conclusion

- With FPRandom, we break the stability of the following attributes: the enumeration order of special JS objects, Canvas fingerprinting and AudioContext fingerprinting.
- Two different approaches
 - Remove the determinism of specific browser functions by exploiting the JavaScript specification
 - Alter the rendering of multimedia elements
- Future work: modify additional APIs to preemptively improve user's privacy