NortonLifeLock™

DECEMBER 12TH - 2019

BakingTimer: Privacy Analysis of Server-Side Request Processing Time

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Motivation

Cookies were originally introduced as a way to provide state awareness to websites, but nowadays they are not limited to store the login information or the current state of user. In several cases, third-party **cookies are deliberately used for web tracking**.

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But even if the most famous, cookies are not the only technique capable of retrieving the users' browsing history. In fact, history sniffing techniques can do it without relying on **any specific code in a third-party website**, but only on code executed in one site.

Threat Model

Alice

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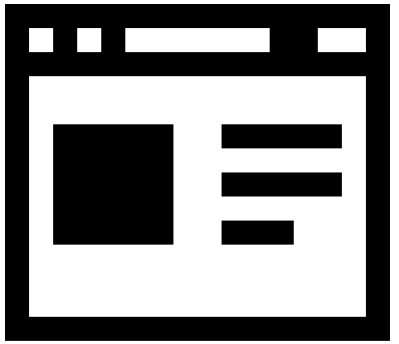

Shopping

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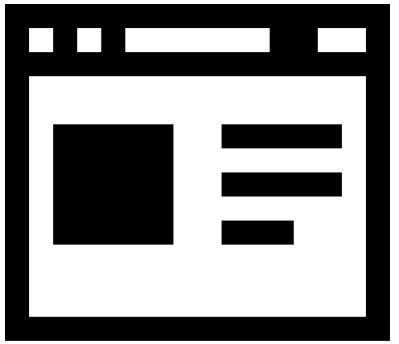

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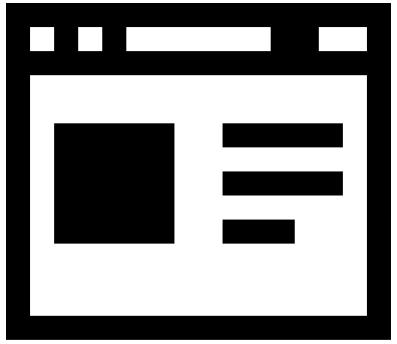

News

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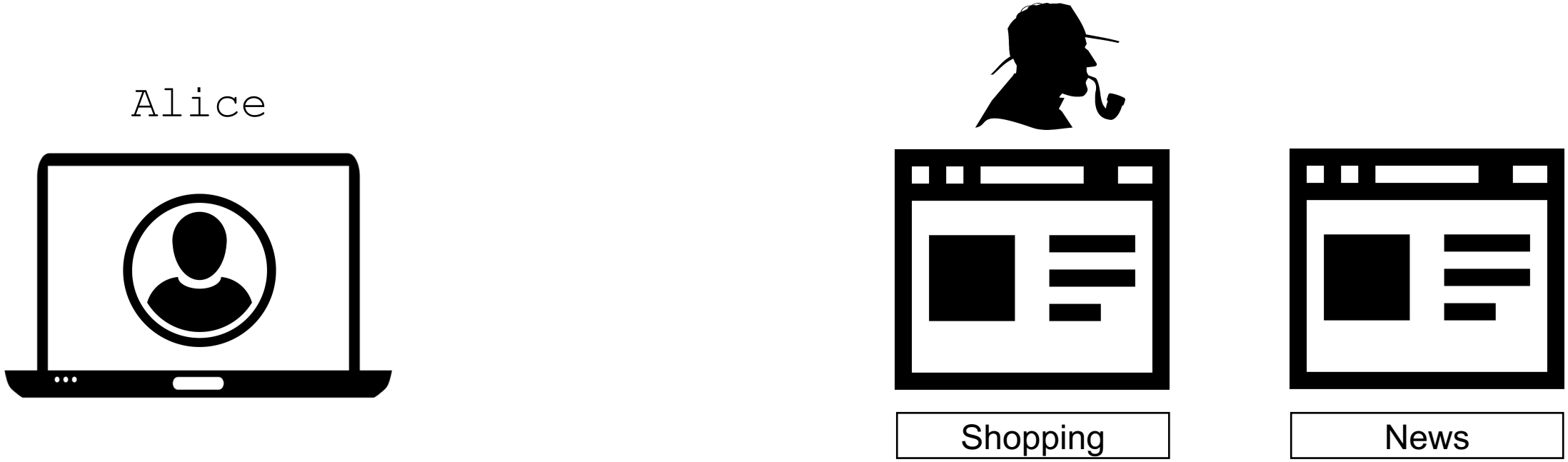

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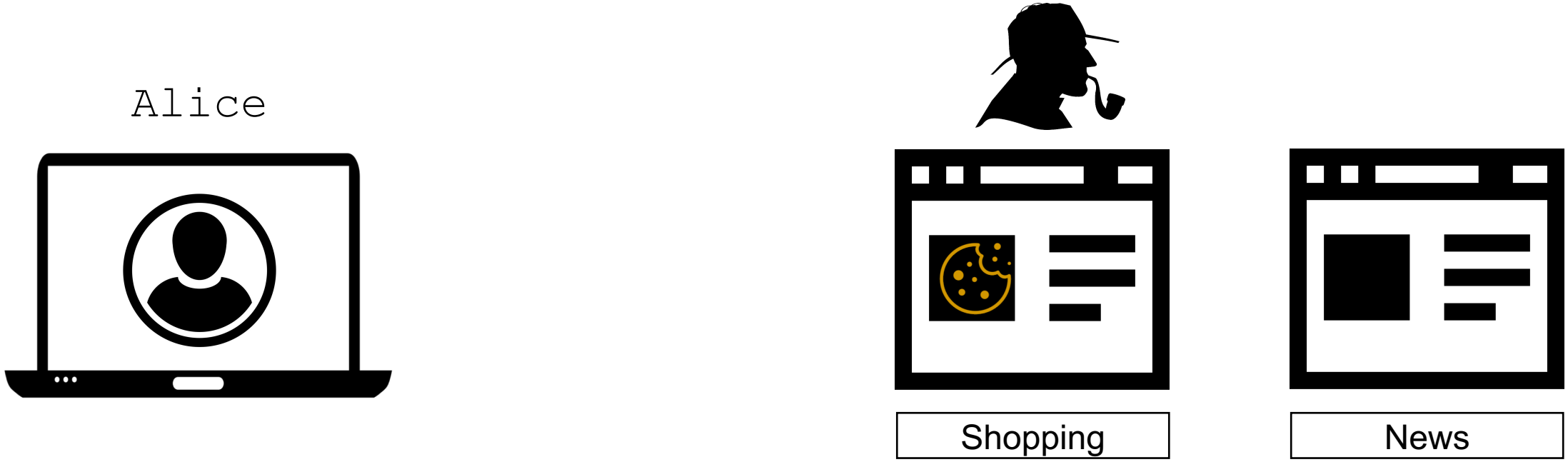

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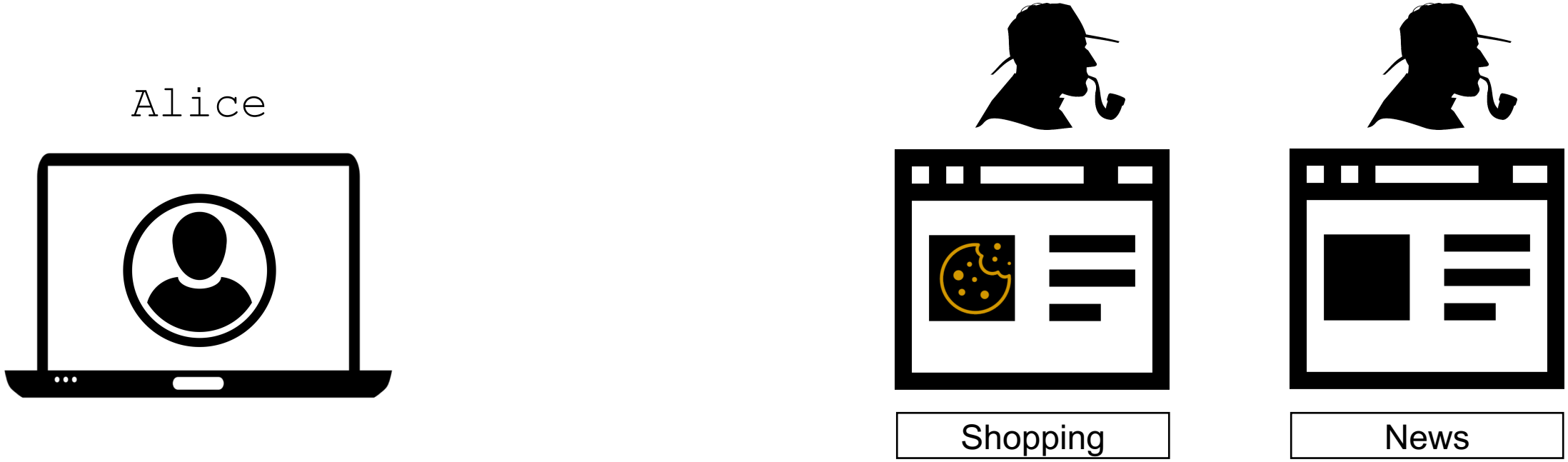

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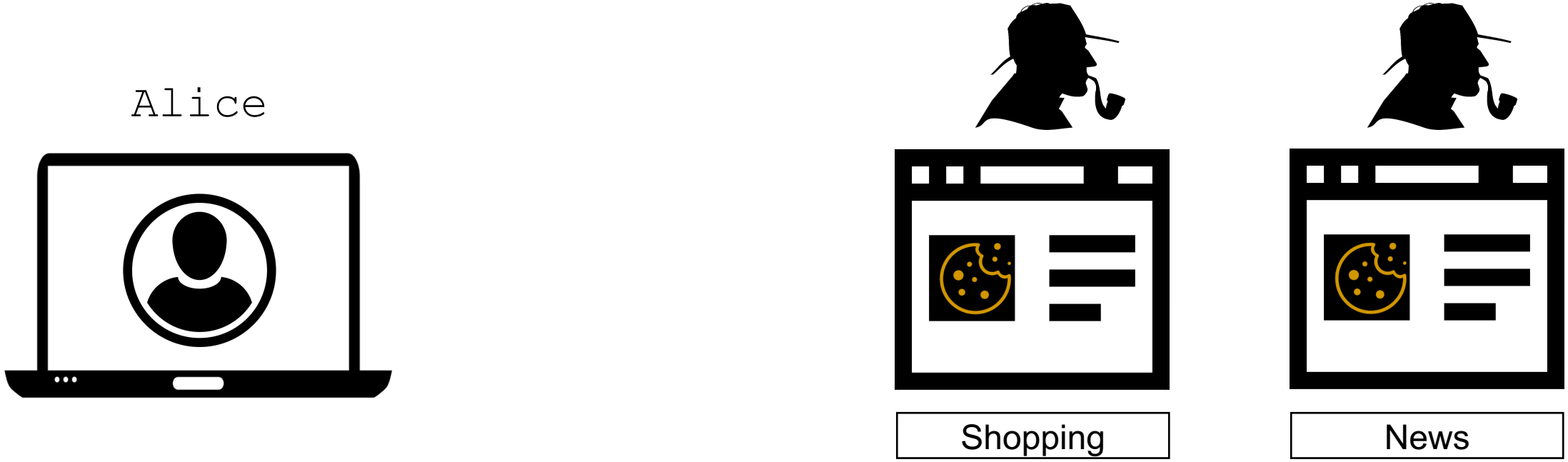

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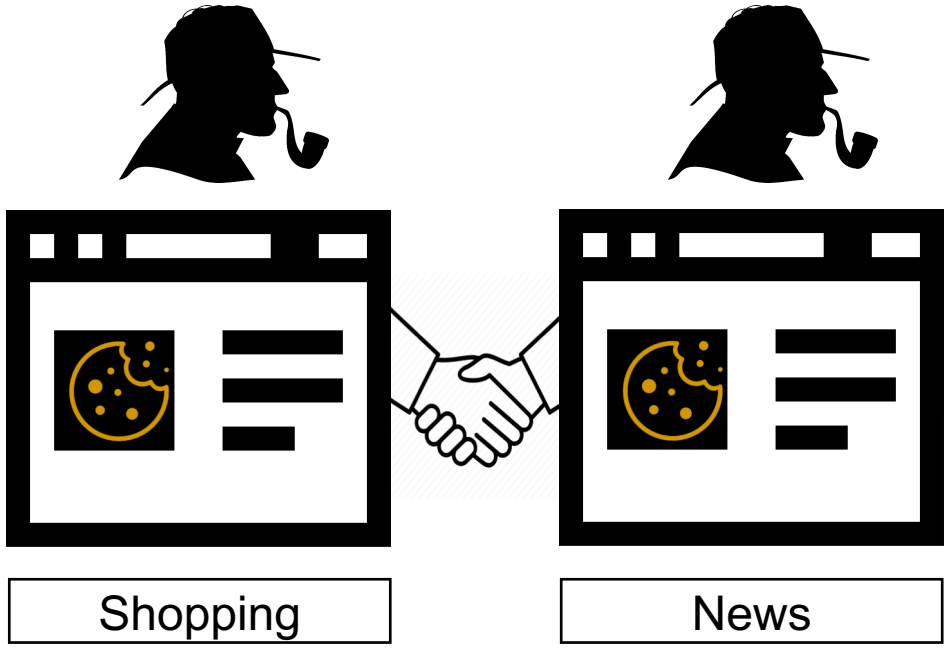

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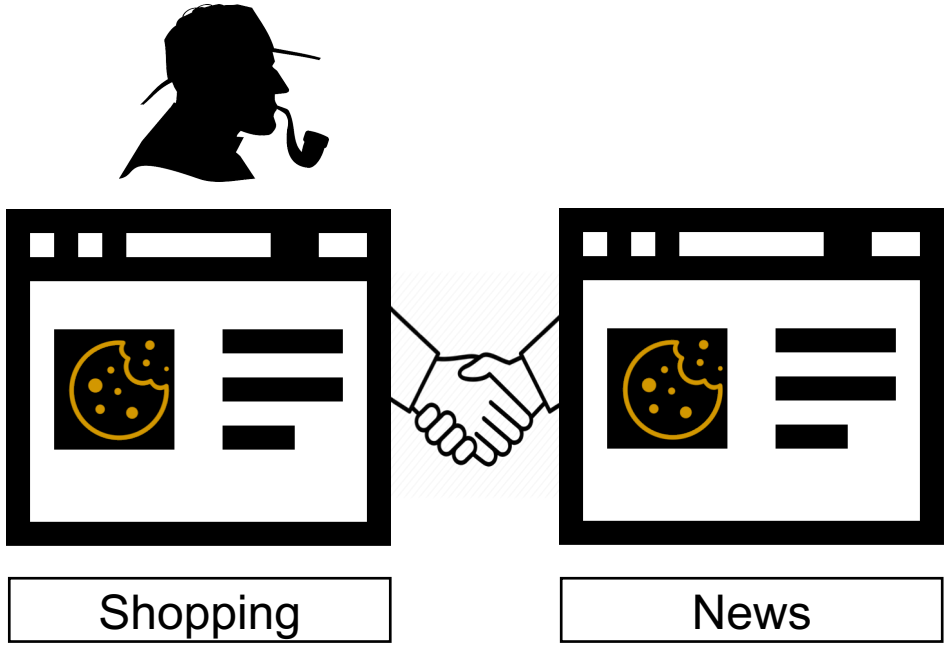

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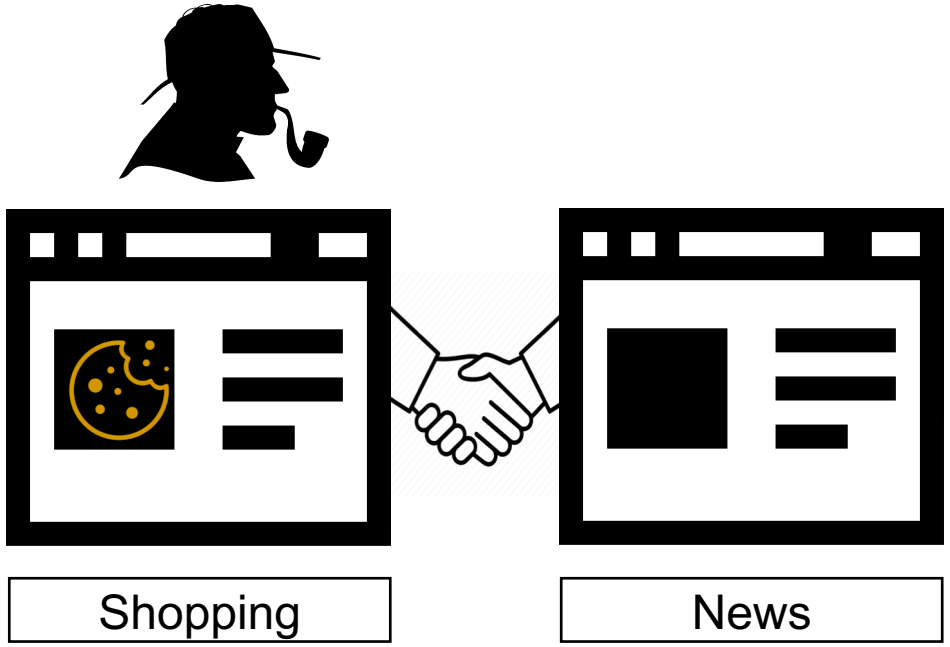

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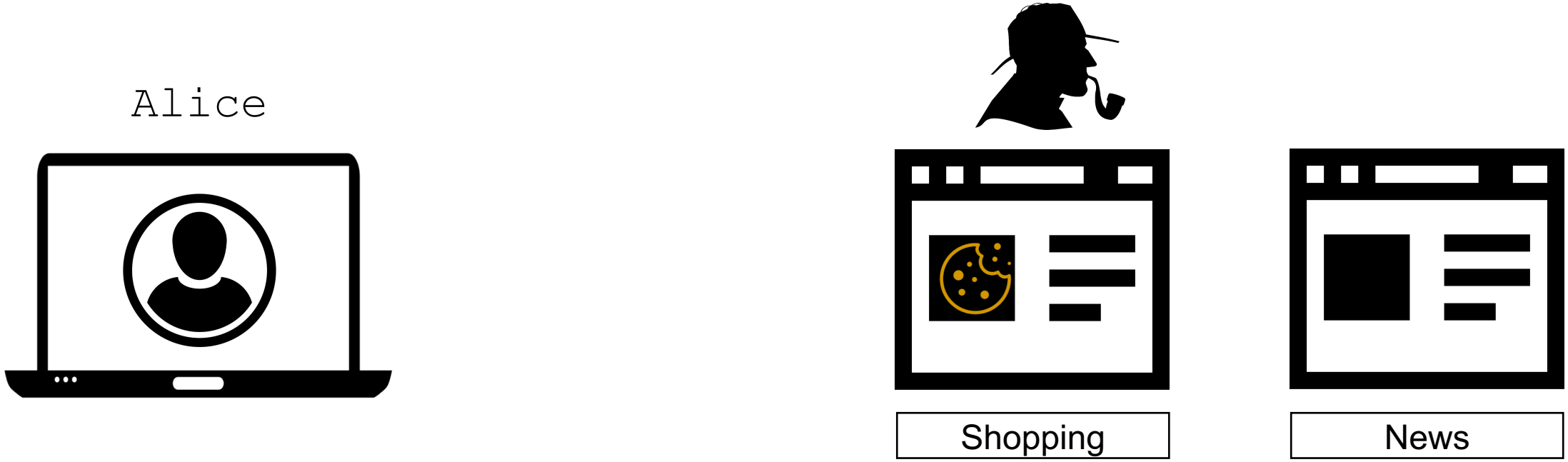

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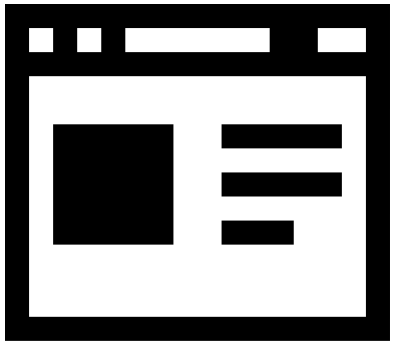

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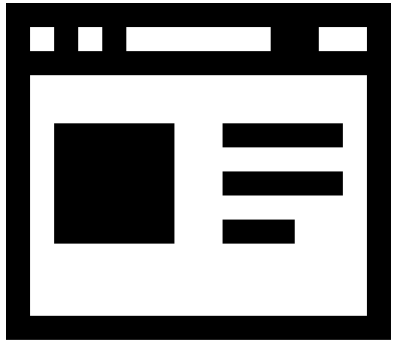

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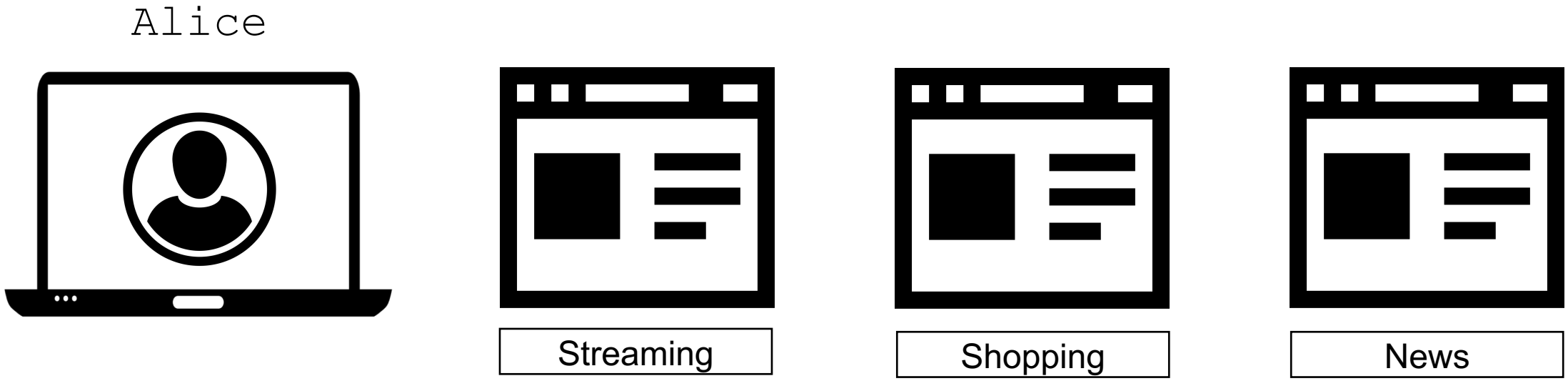

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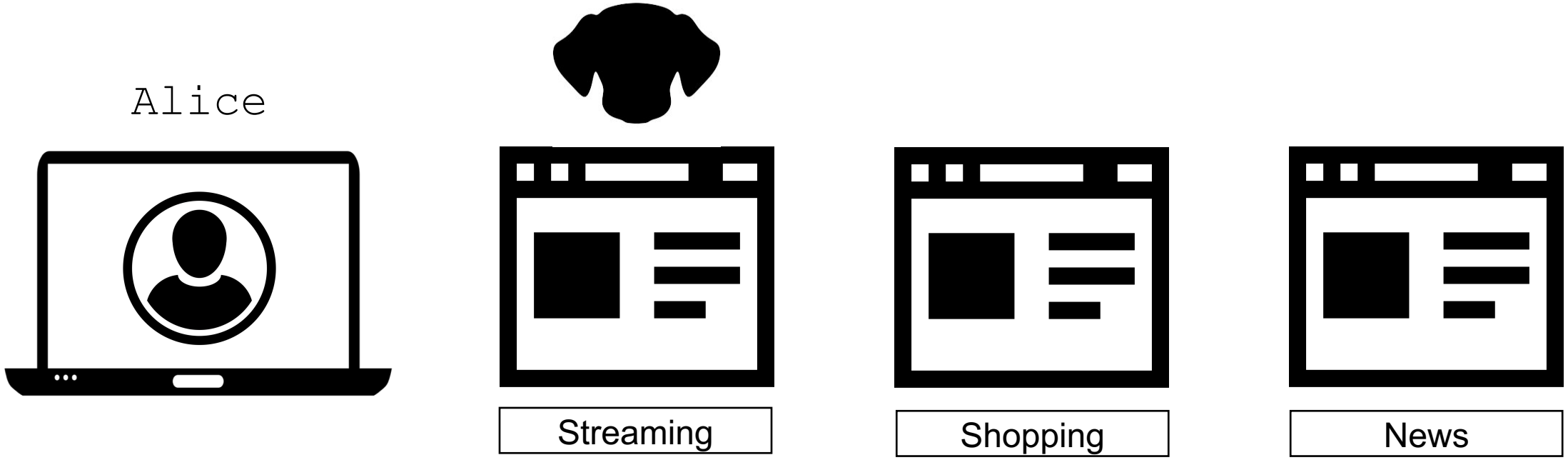

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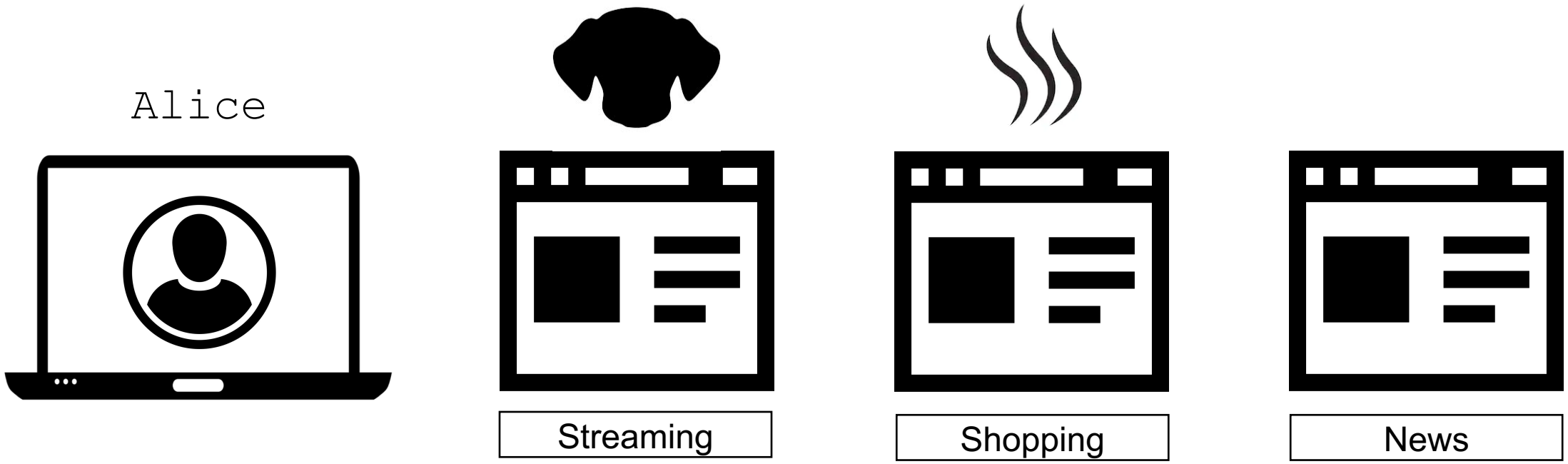

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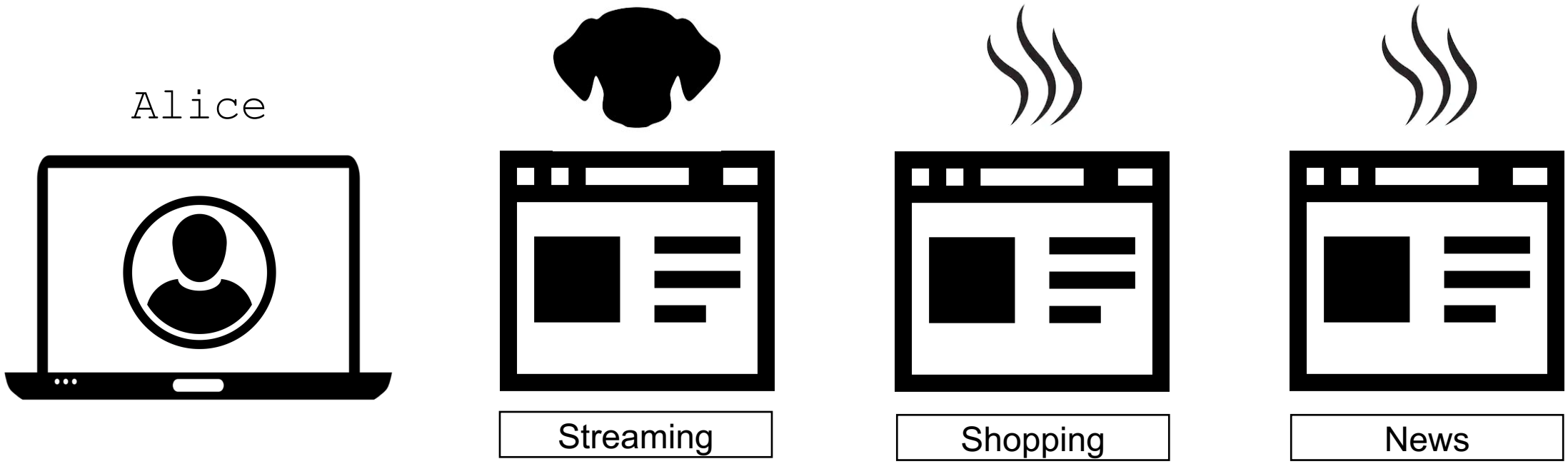

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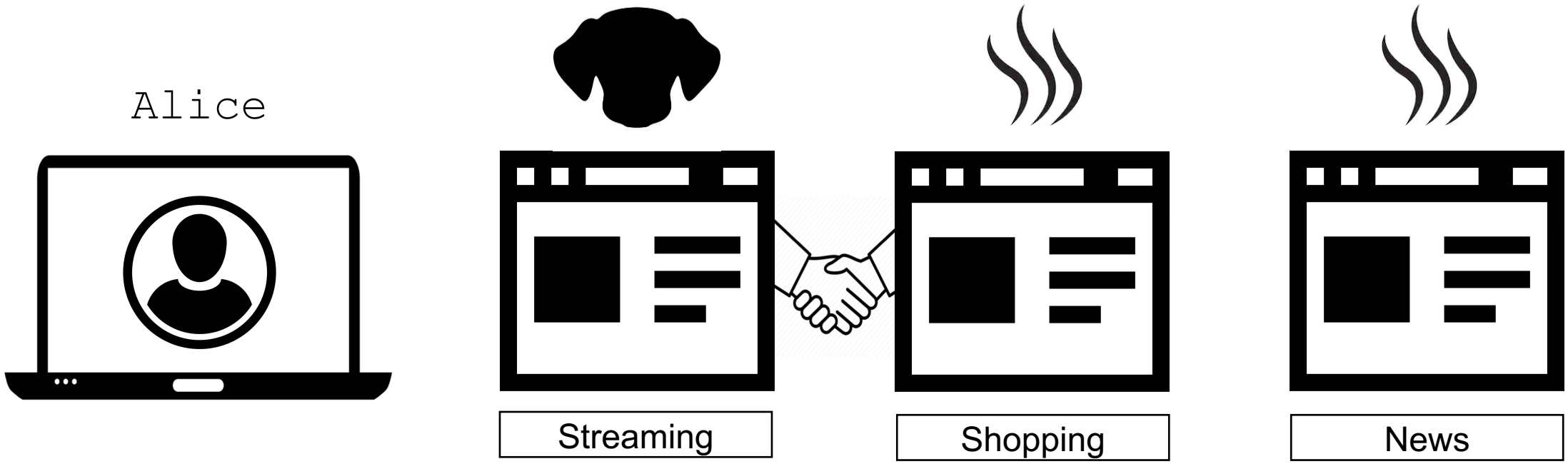

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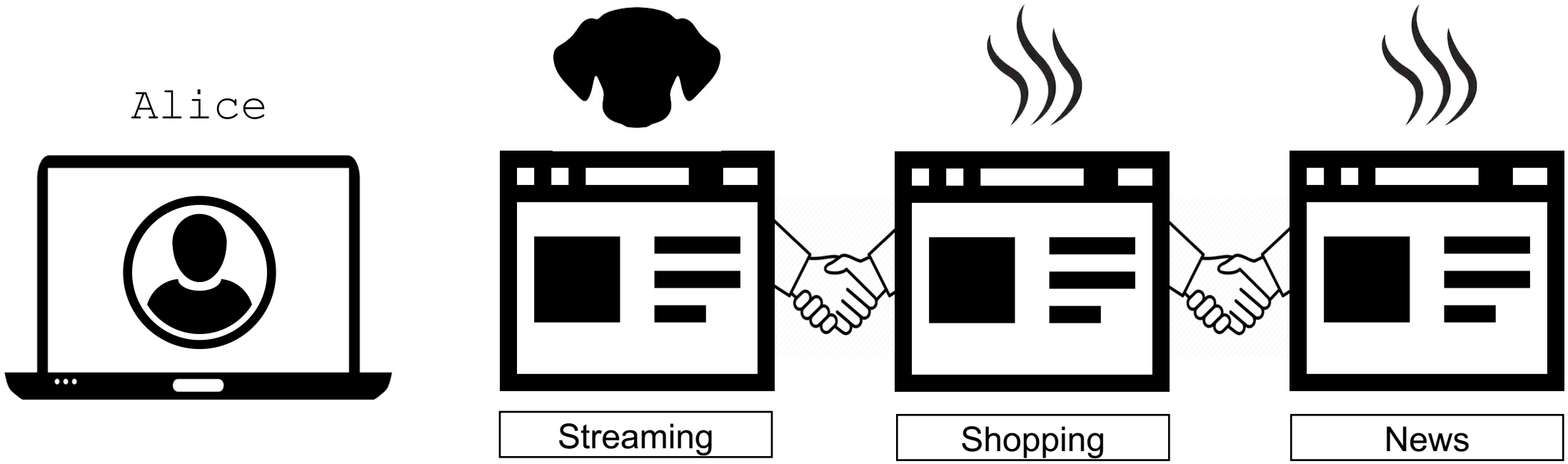

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We present a new timing side-channel attack, that relies on the **presence of first party cookies** set by the target websites to perform history sniffing.

Our system is based on the analysis of how servers **process HTTP requests**, and by using this information, is able to detect both if the user previously visited the website and whether she is currently logged in.

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The main observation behind our approach is that, when the browser sends a cookie along with a request, it is reasonable to assume that the **server will check its value**.

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Then, it may use the value to retrieve the associated user session and load additional data from the database, or that it will simply **execute a different path** with respect to a request that does not contain any cookie.

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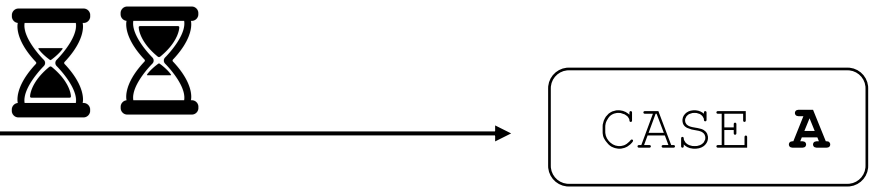

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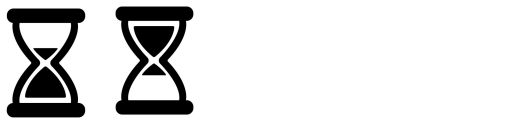

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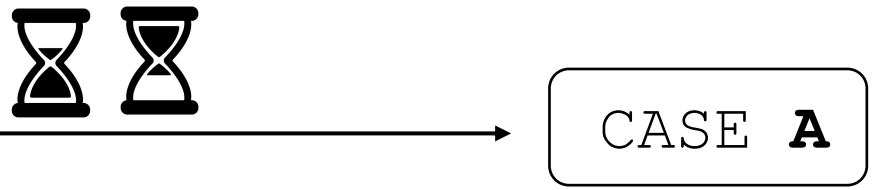

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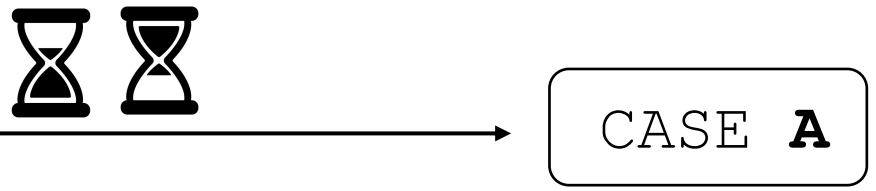

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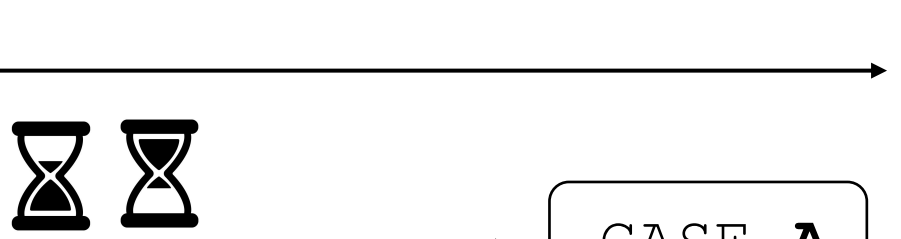

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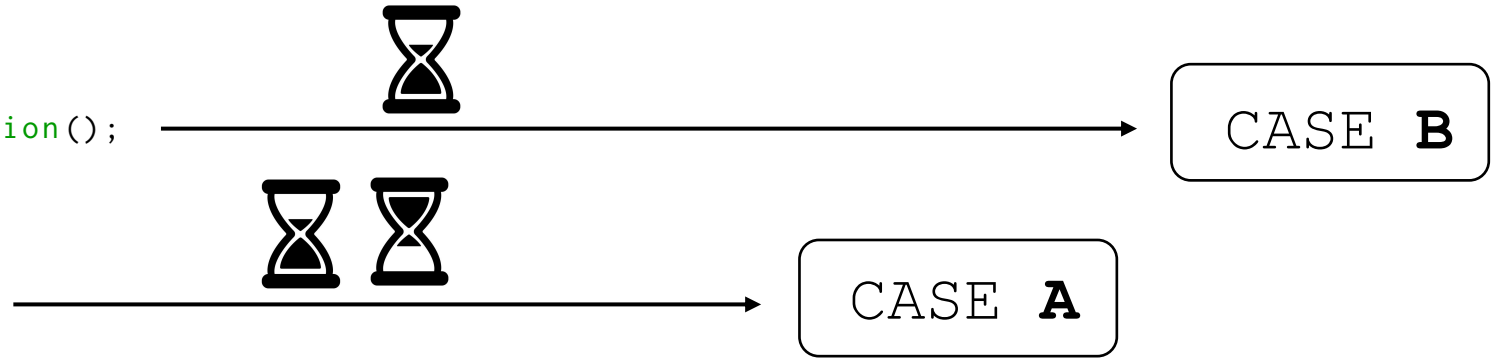

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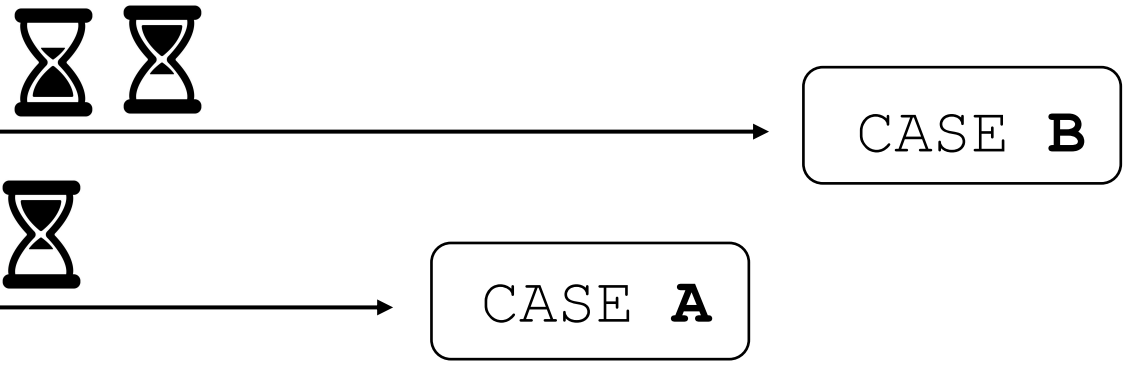

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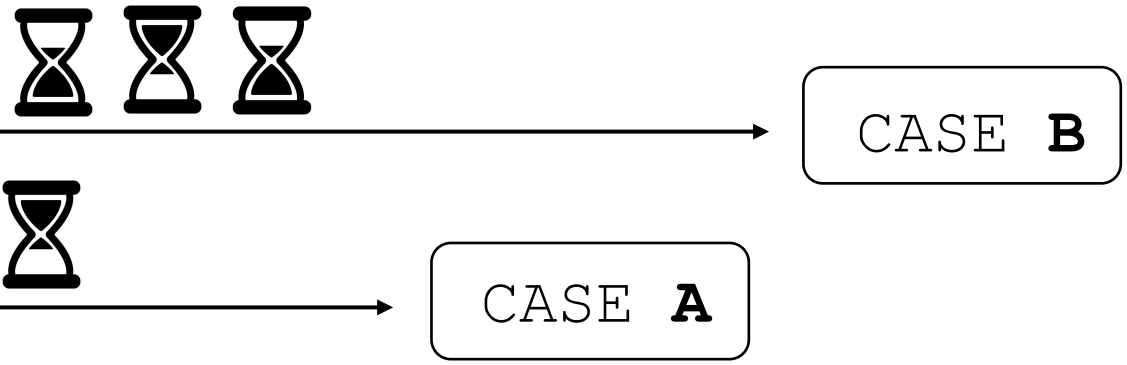

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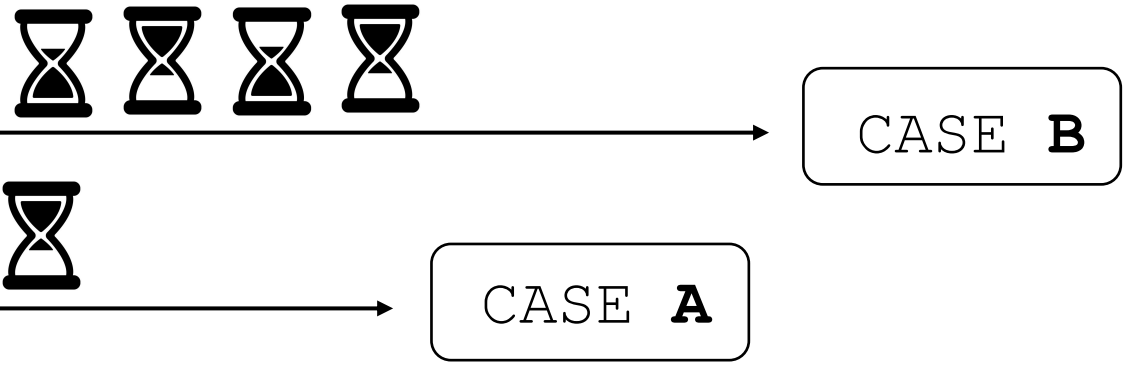

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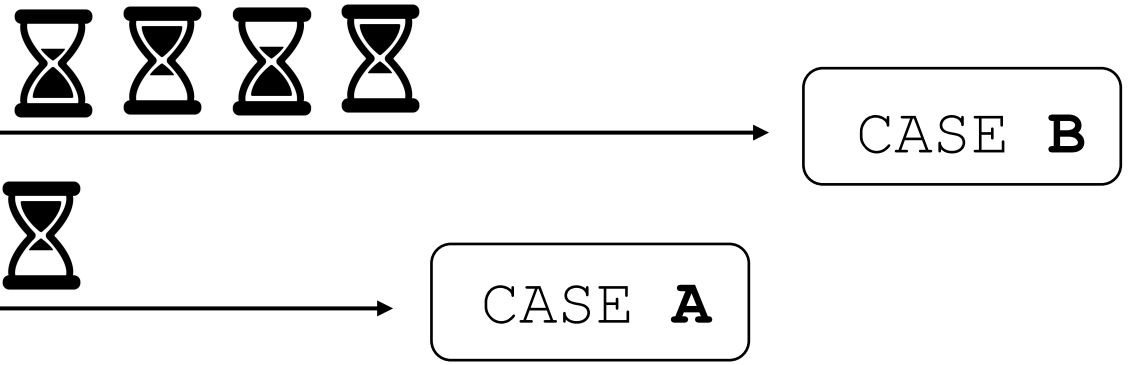

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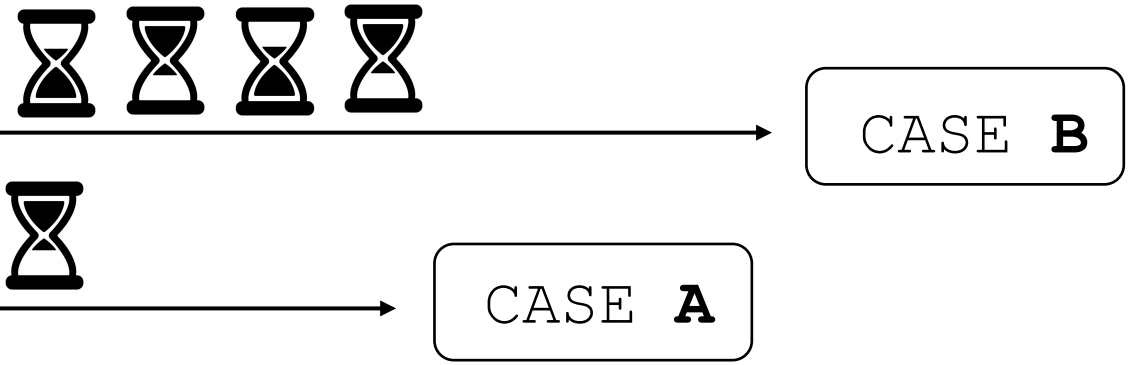

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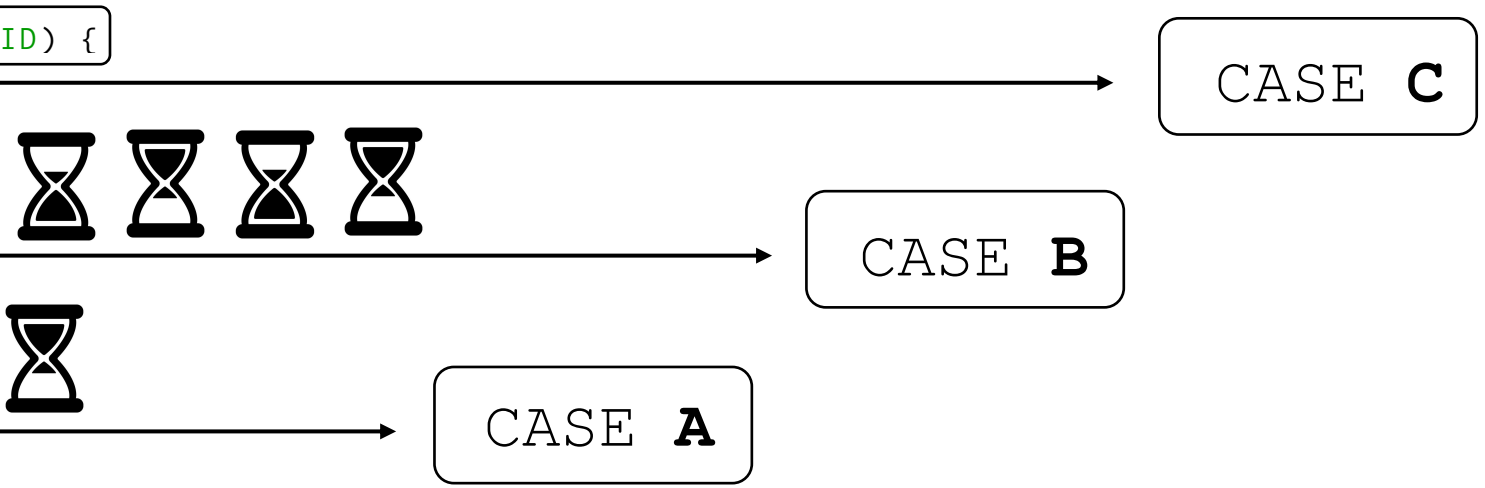

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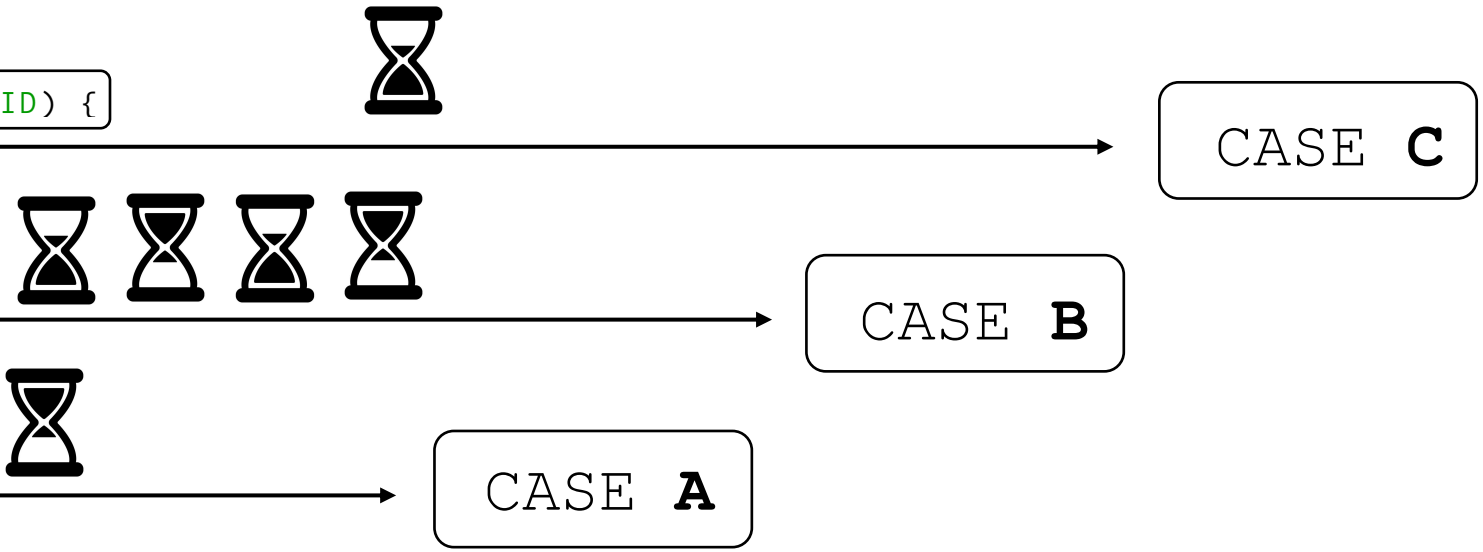

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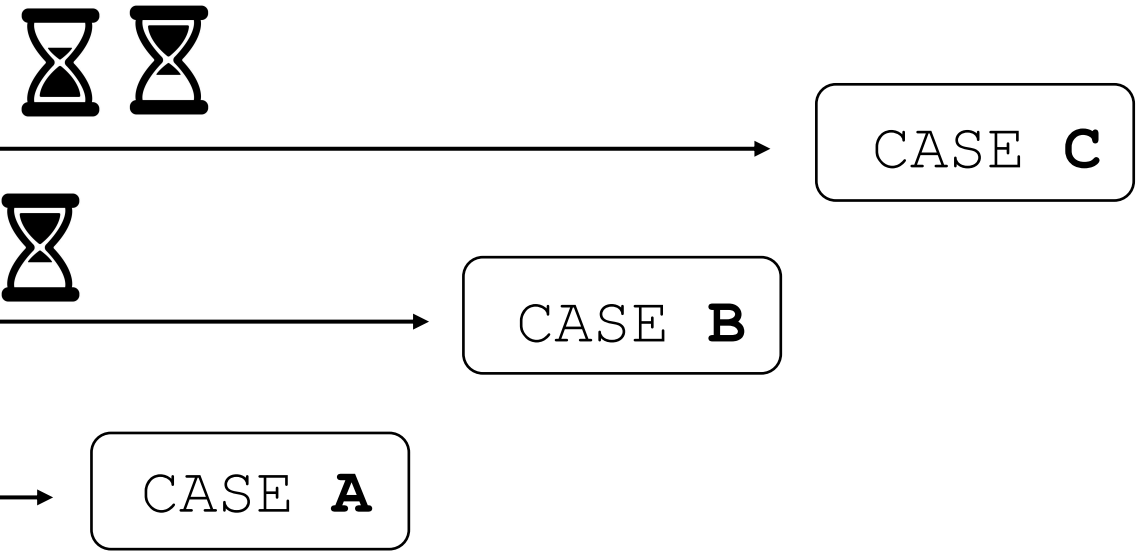

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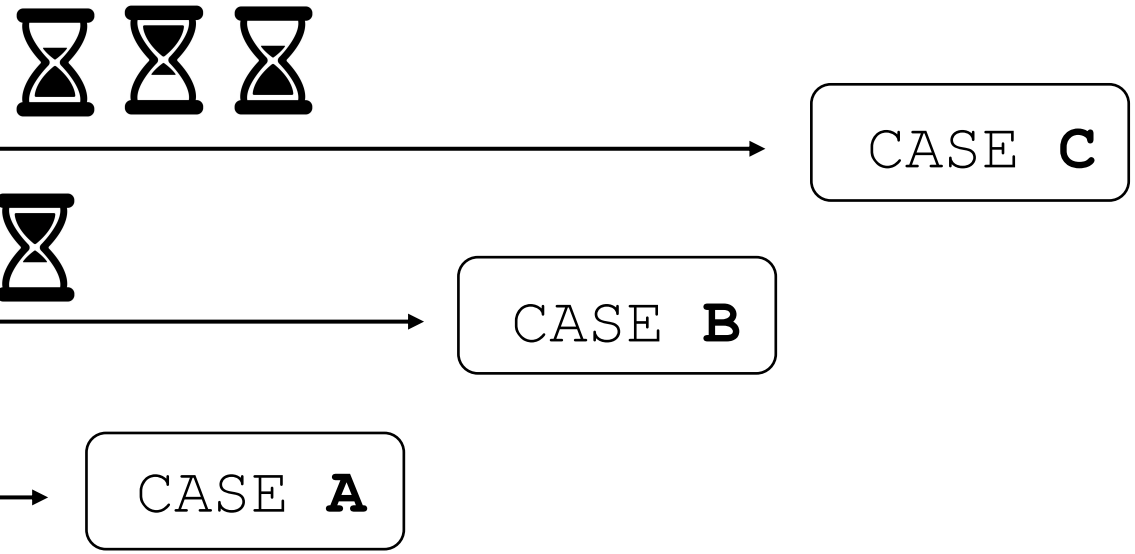

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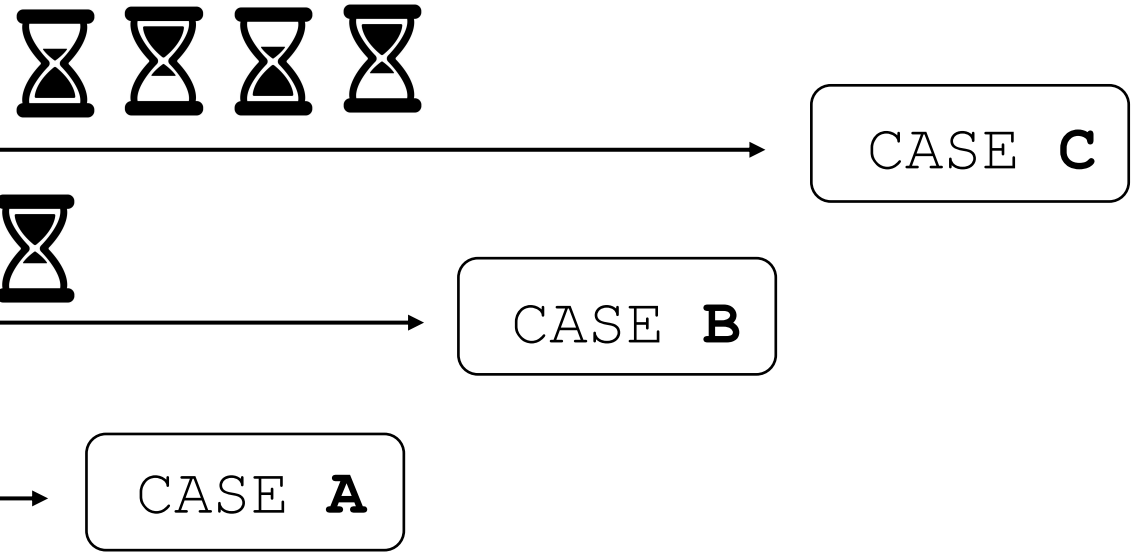

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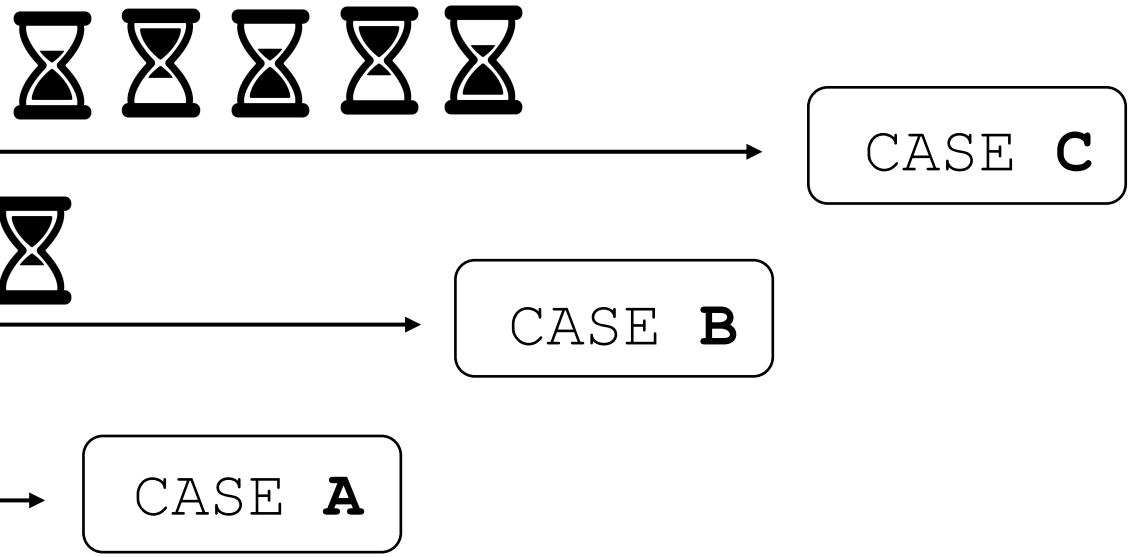

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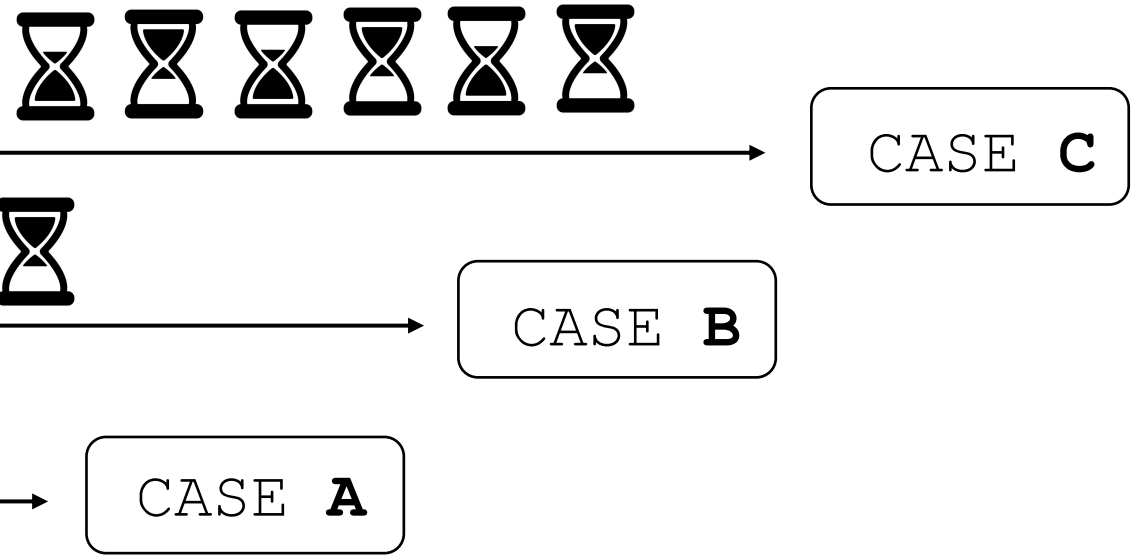
    if (isset($_COOKIE[["userID"]) {

        if ($_POST["userID"] == $userID) {
            getUserData();
        }

    } else {
        saveNavigation();
    }

} else {
    askConsent();
}
?>
```



BakingTimer

REQUEST 1 + REQUEST 2

BakingTimer

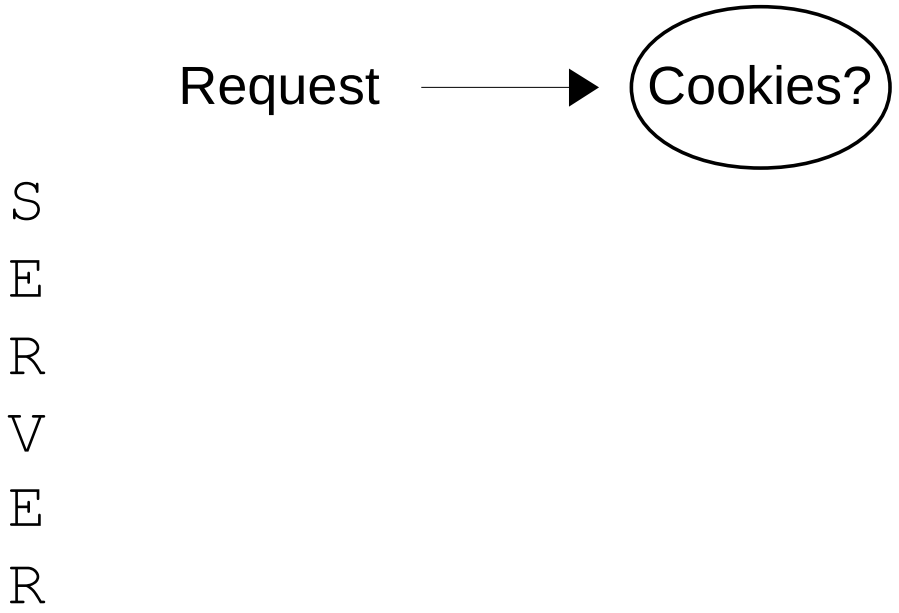
REQUEST 1

BakingTimer

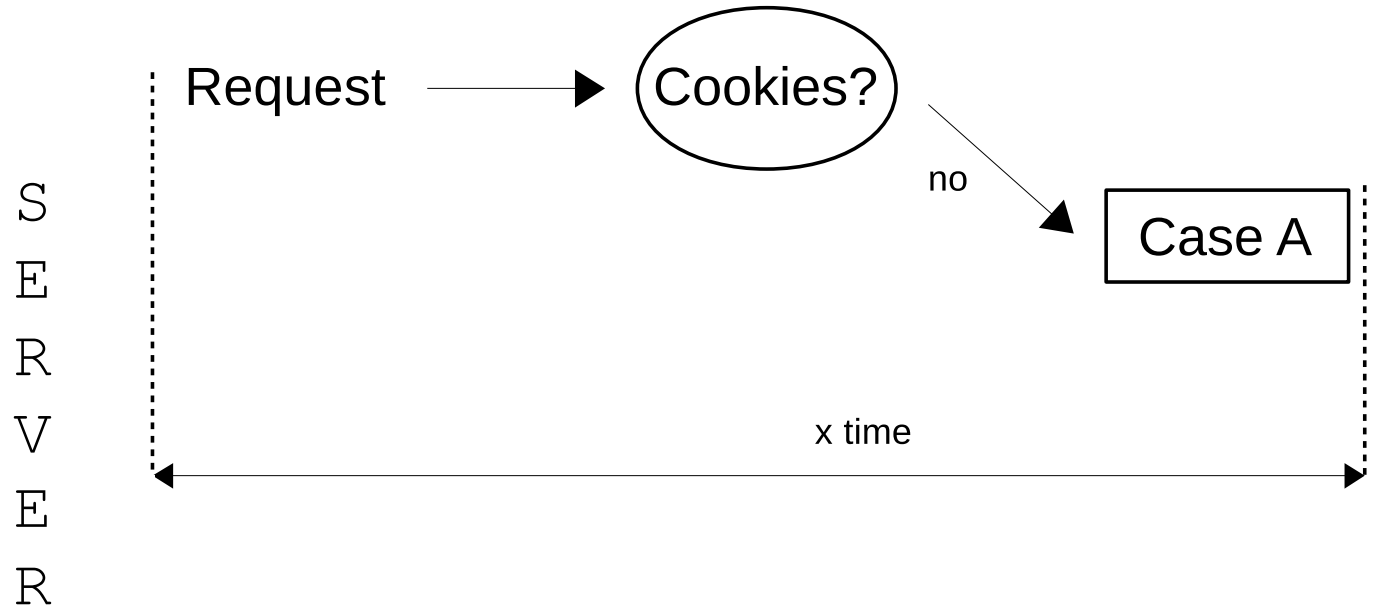
REQUEST 1

```
xmlHttpRequest.withCredentials = FALSE;
```

BakingTimer



BakingTimer



BakingTimer

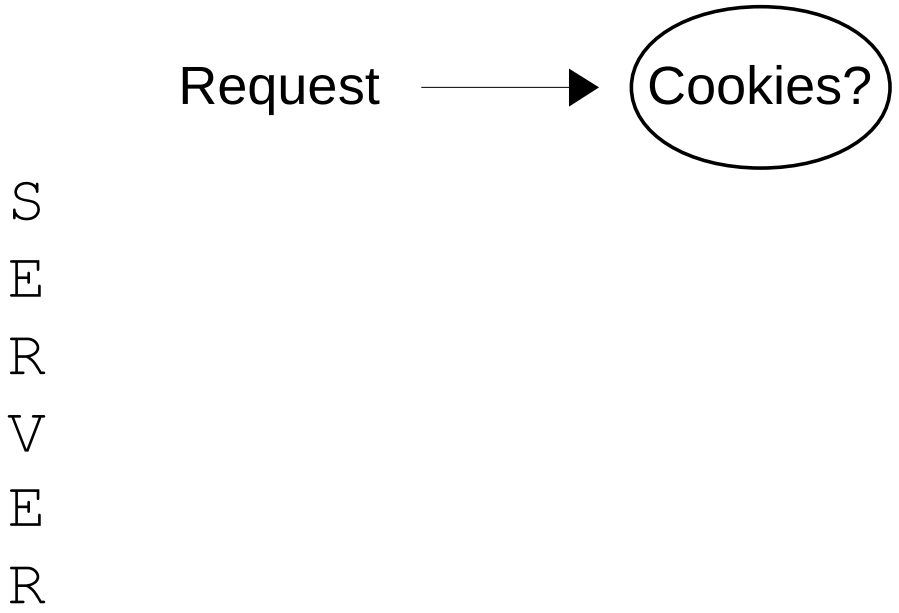
REQUEST 2

BakingTimer

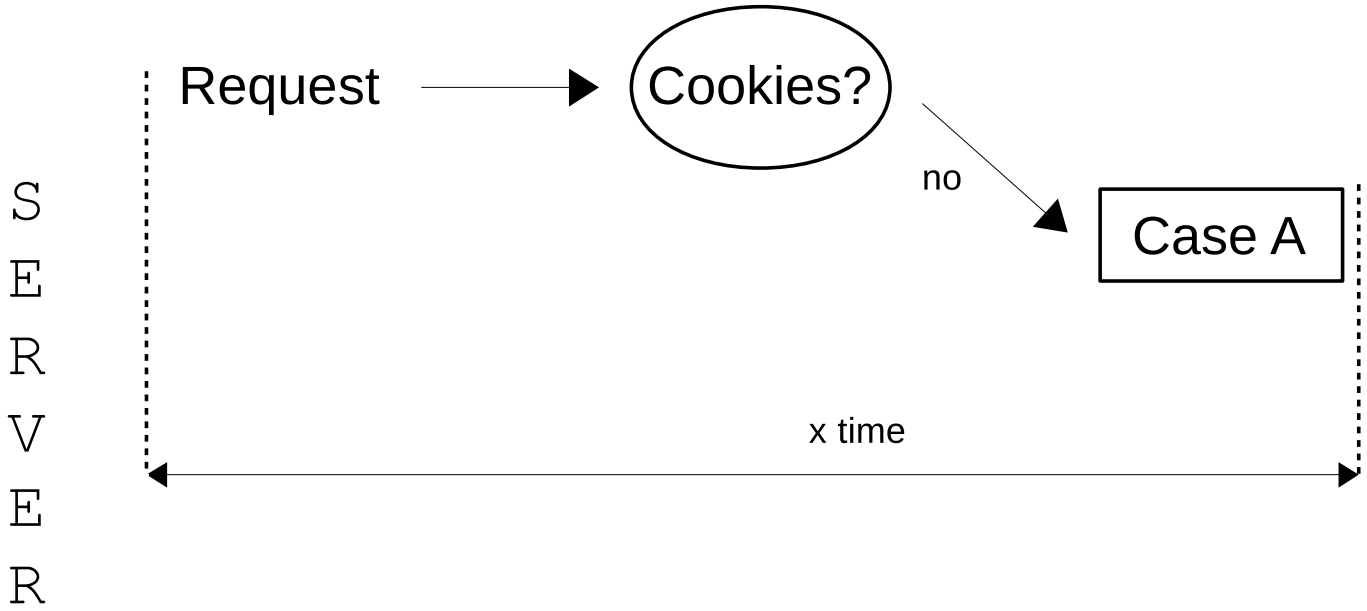
REQUEST 2

```
xmlHttpRequest.withCredentials = TRUE;
```

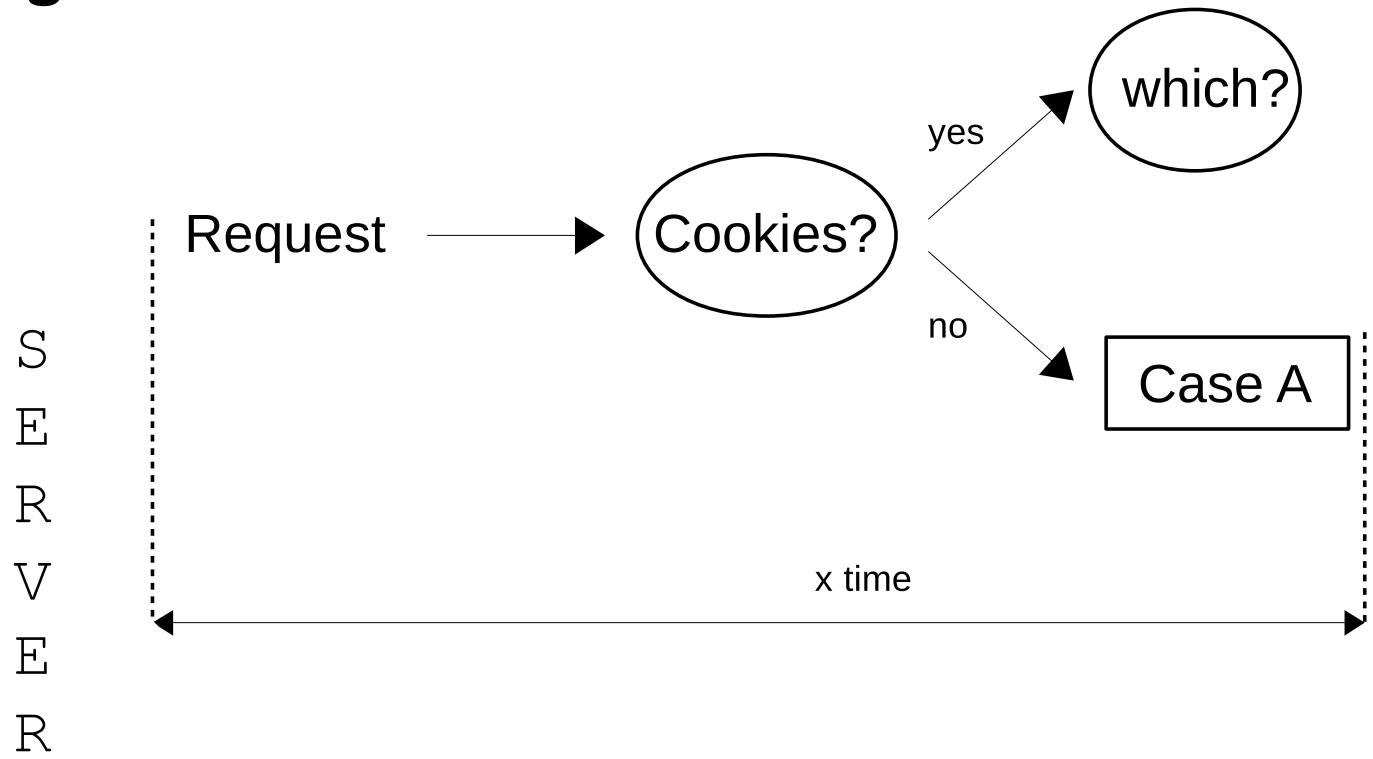
BakingTimer



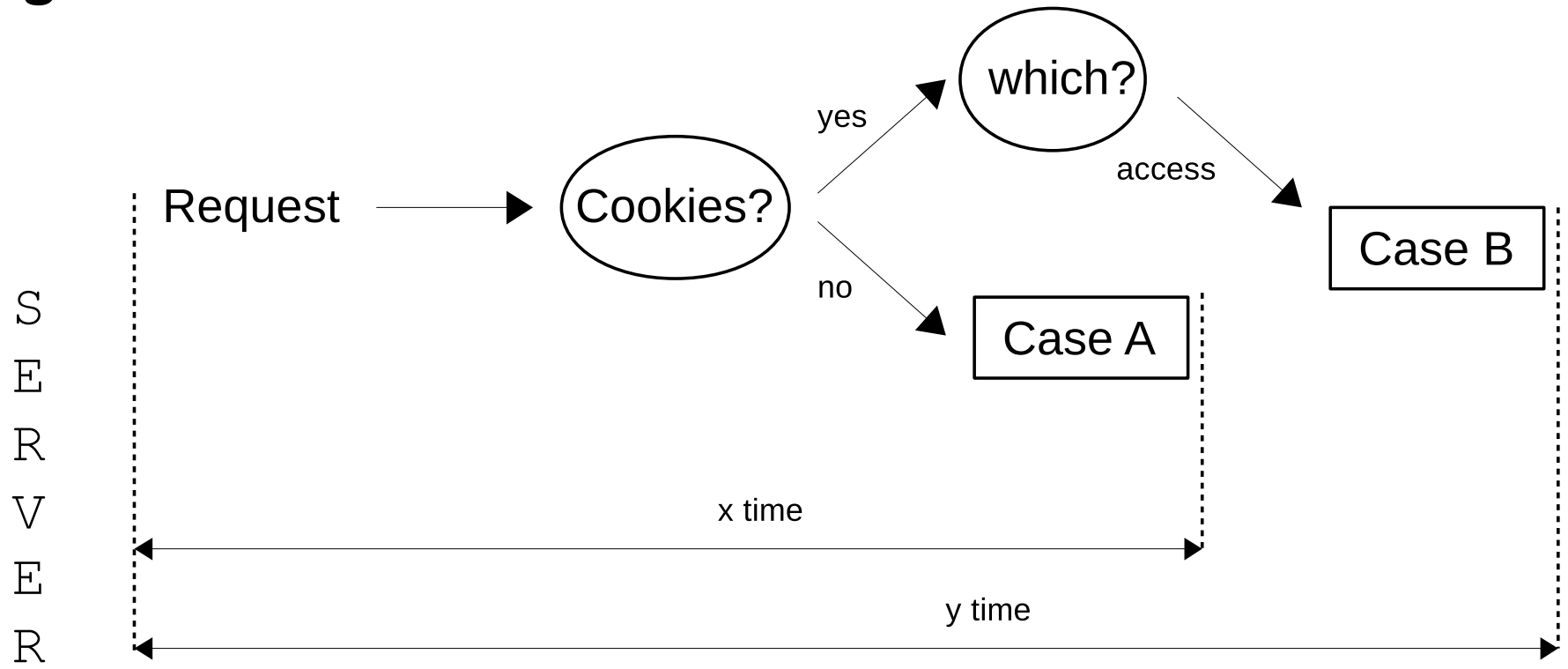
BakingTimer



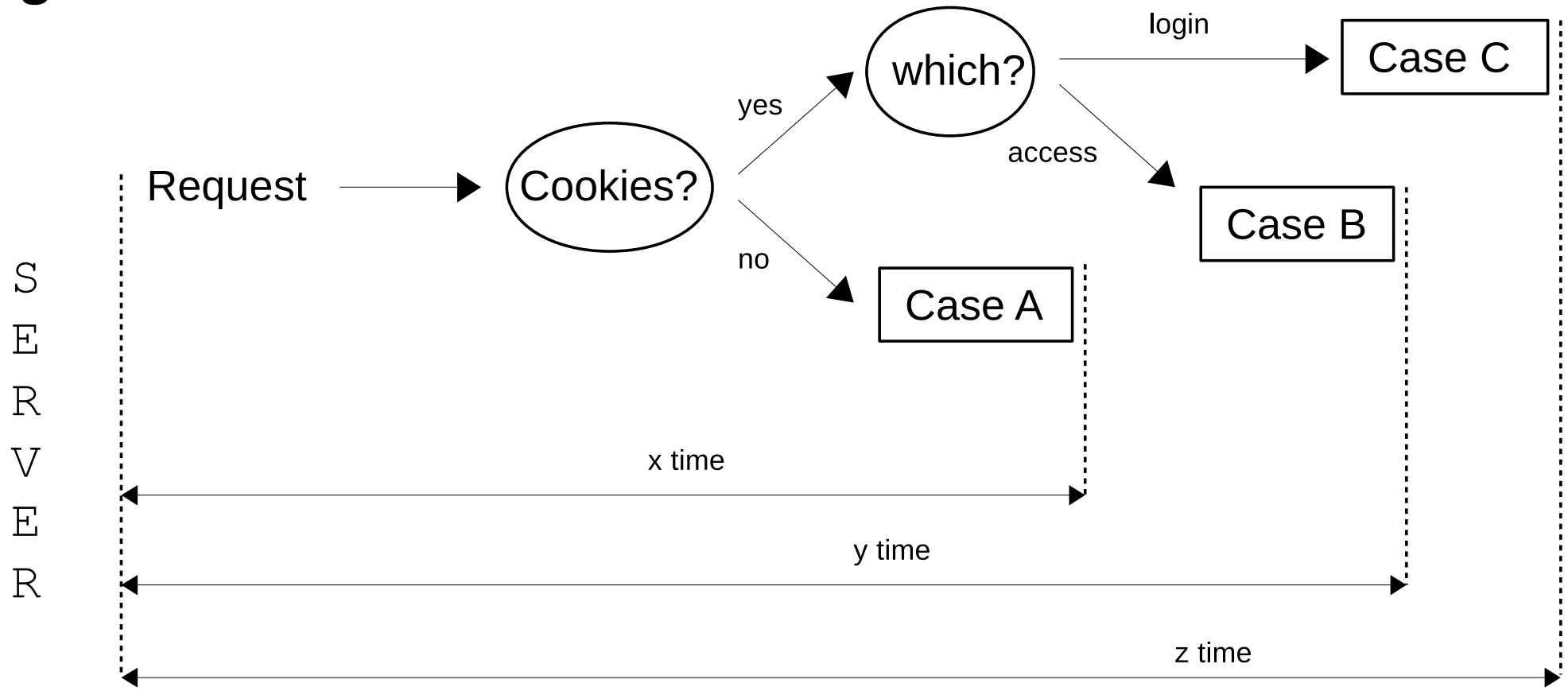
BakingTimer



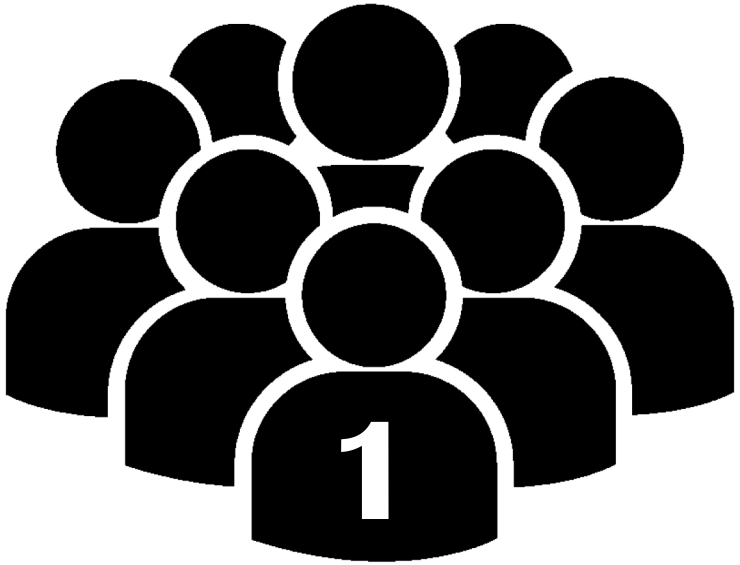
BakingTimer

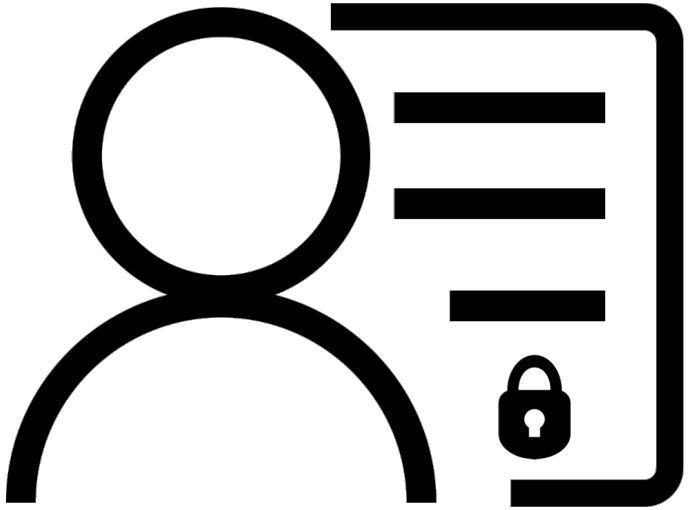


BakingTimer



Experiment Dataset





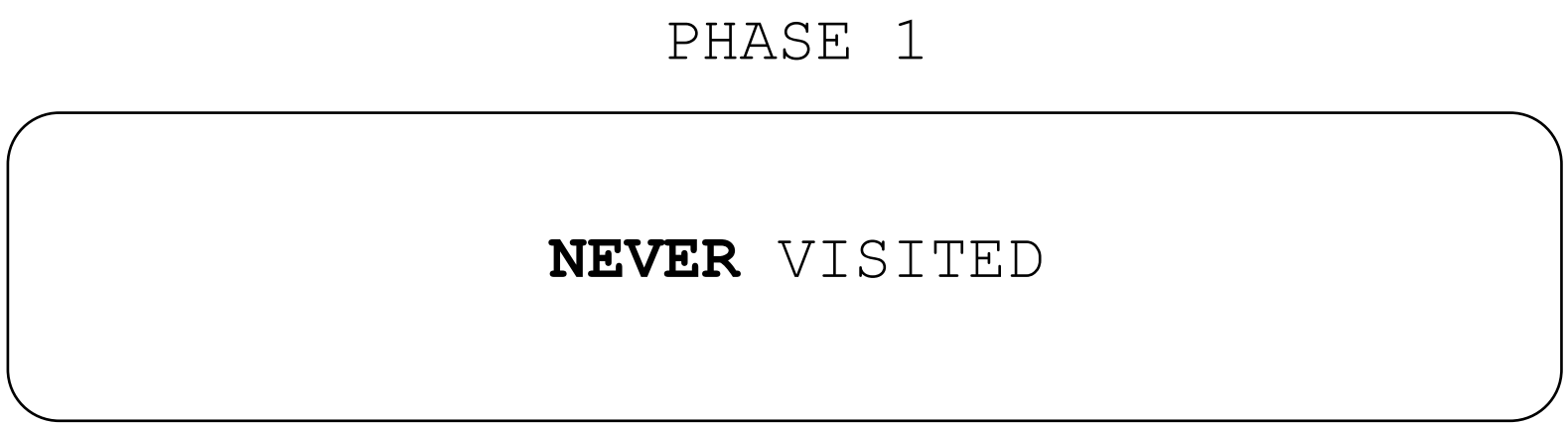
Access Detection

PHASE 1 + PHASE 2

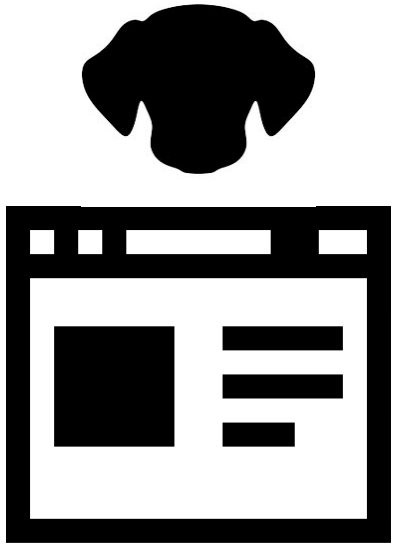
Access Detection

PHASE 1

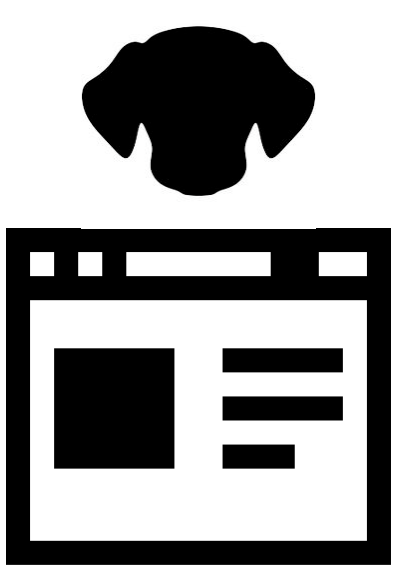
Access Detection

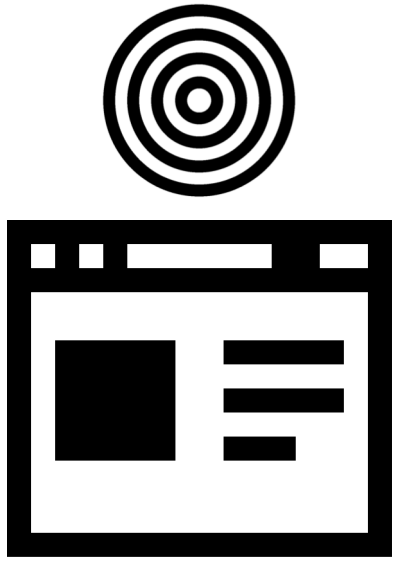


Access Detection

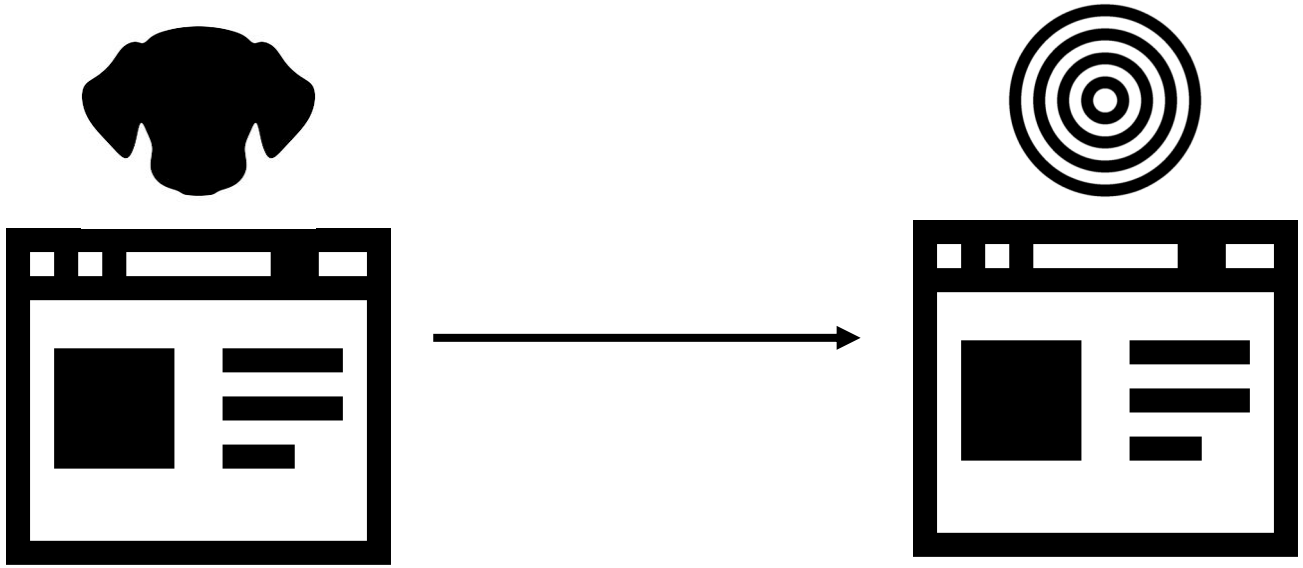


Access Detection

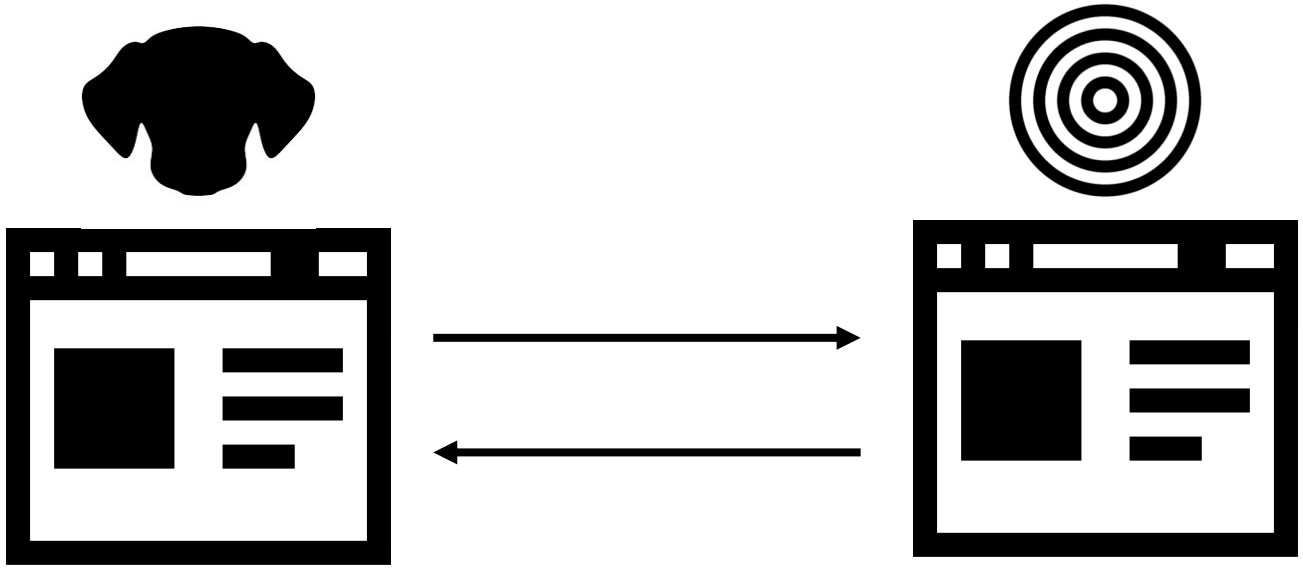




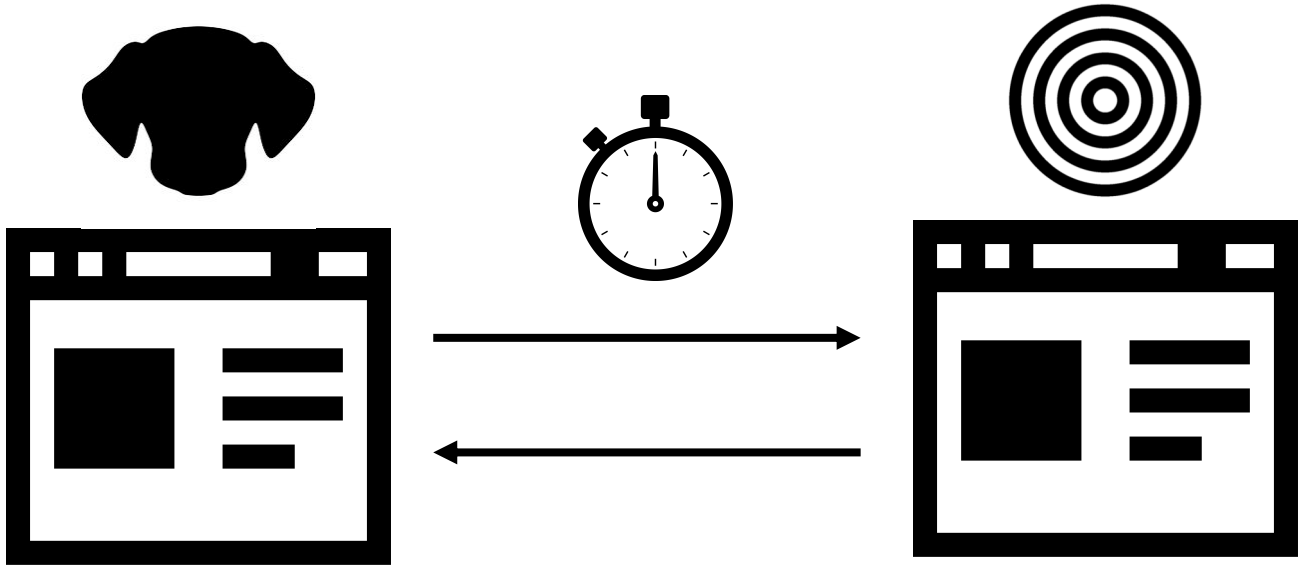
Access Detection



Access Detection



Access Detection



Access Detection

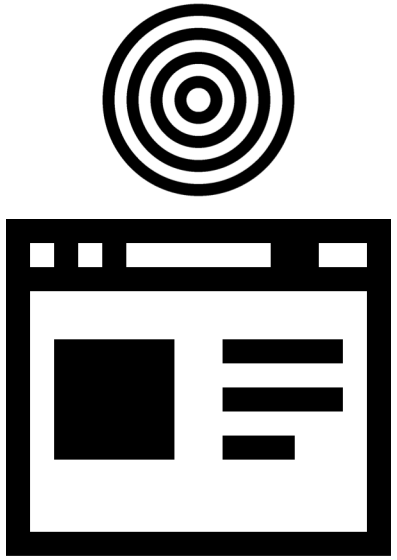
PHASE 2

Access Detection

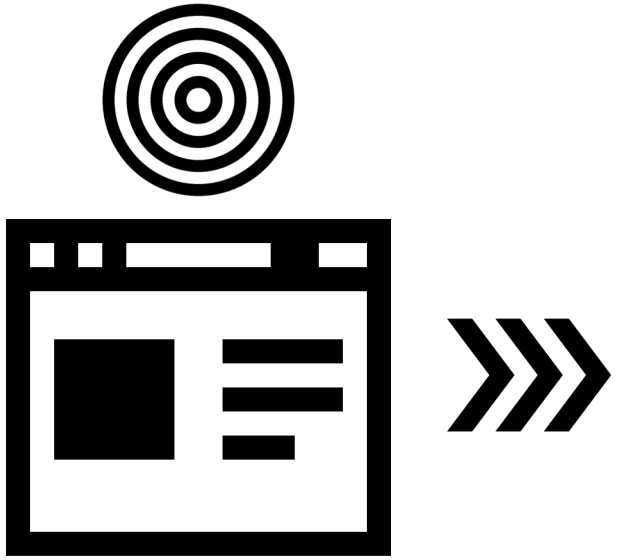
PHASE 2

PREVIOUSLY VISITED

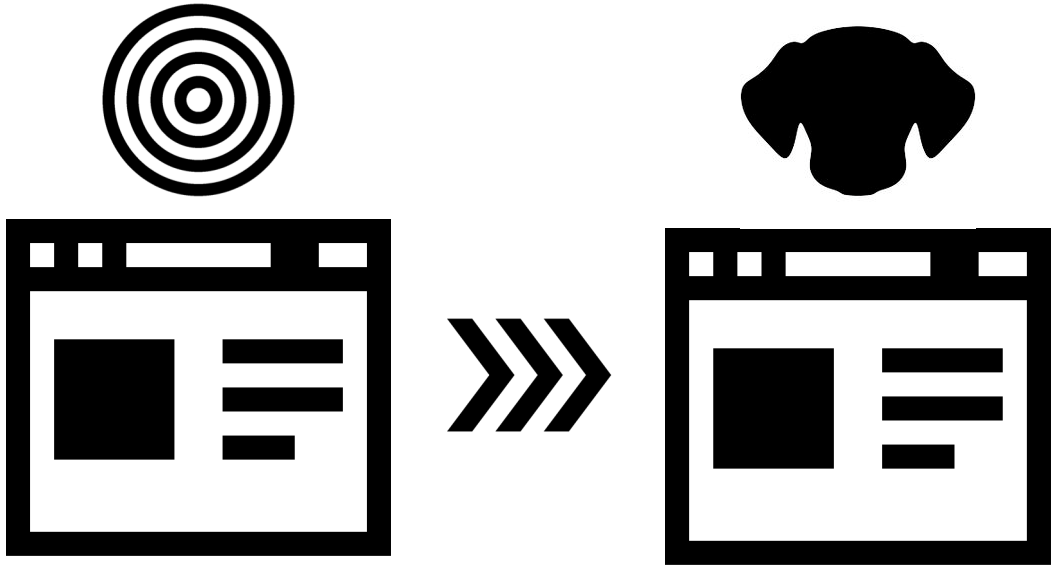
Access Detection



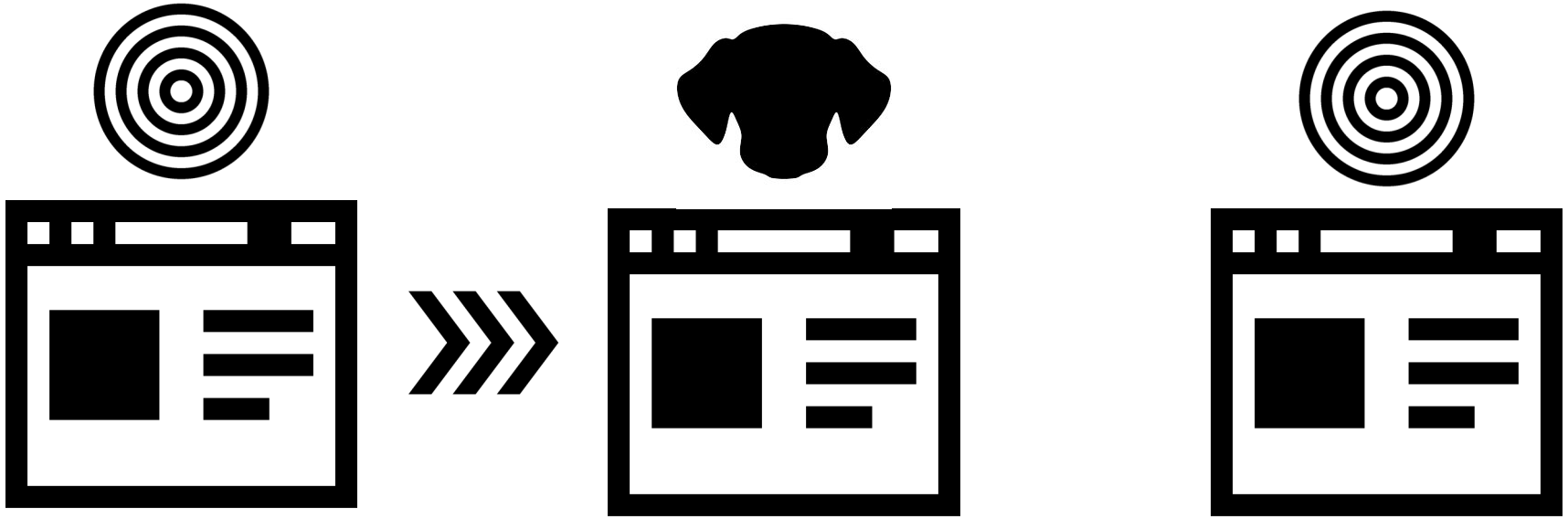
Access Detection



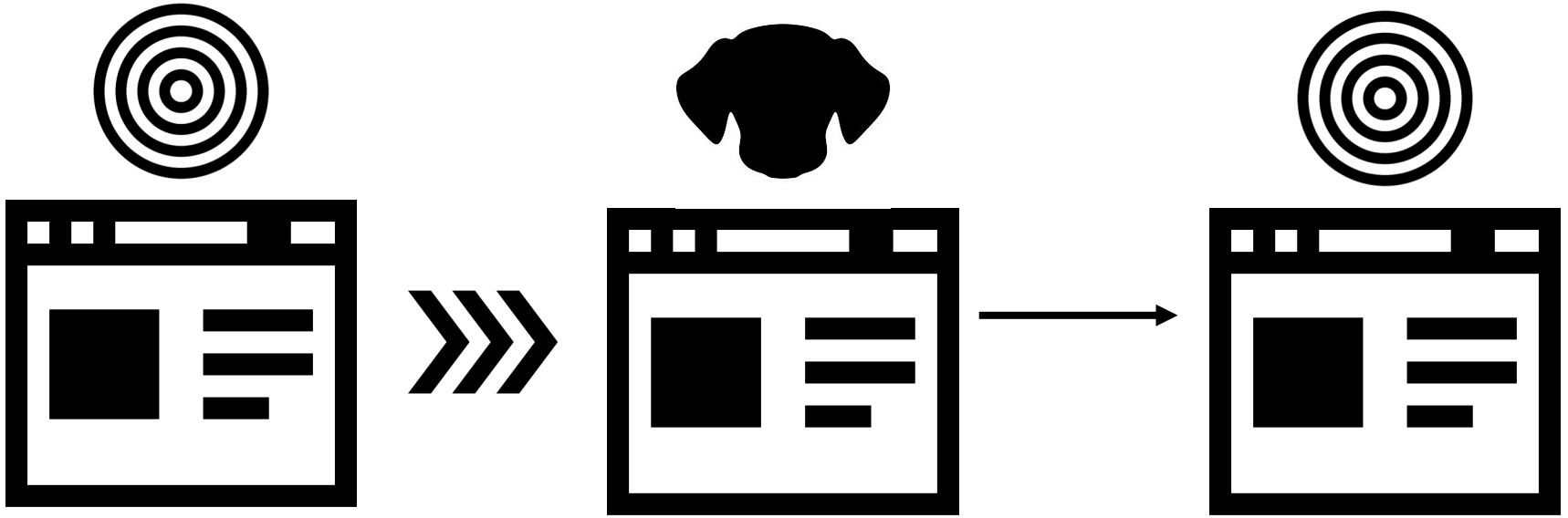
Access Detection



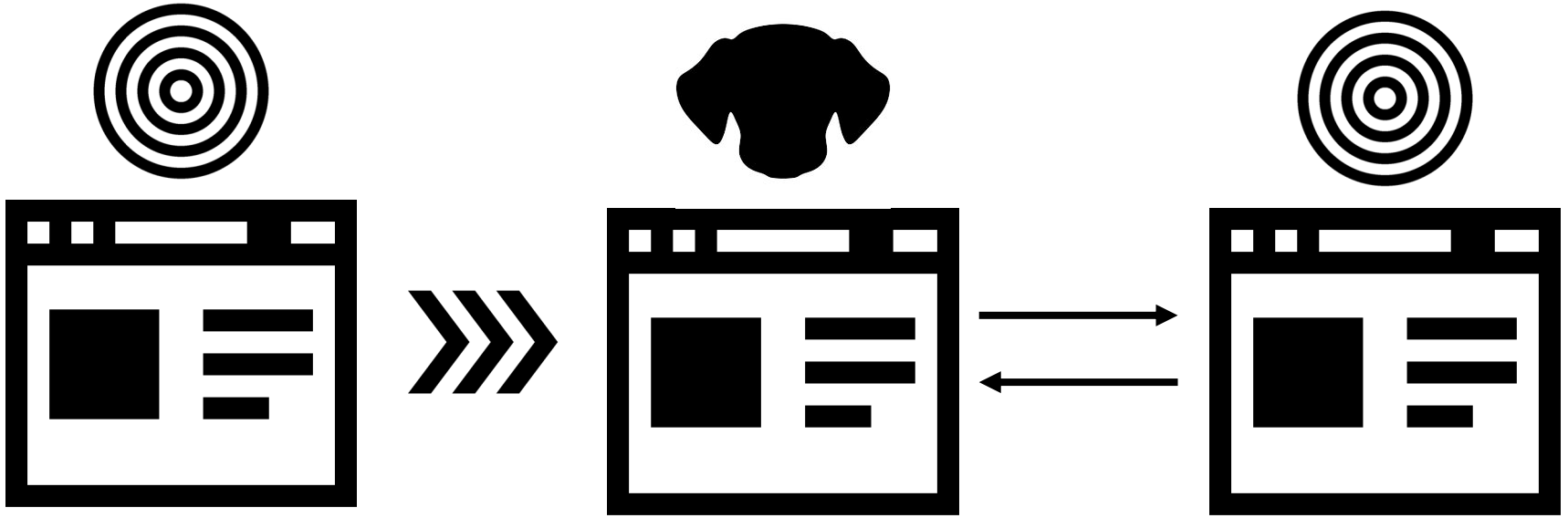
Access Detection



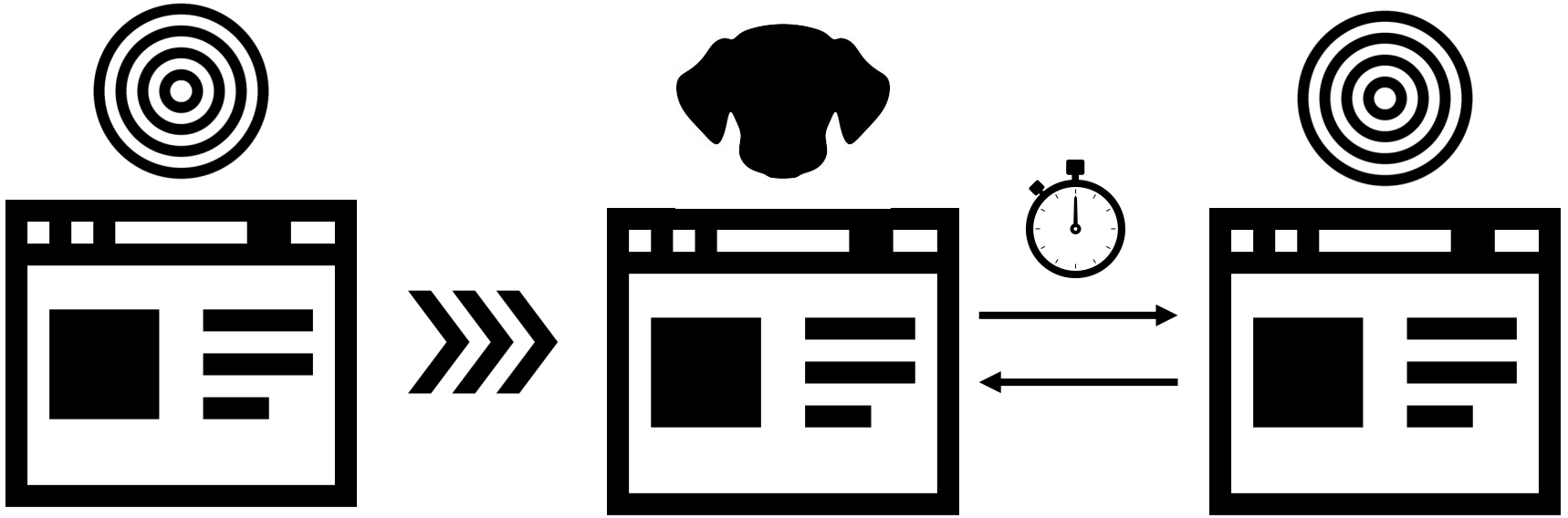
Access Detection



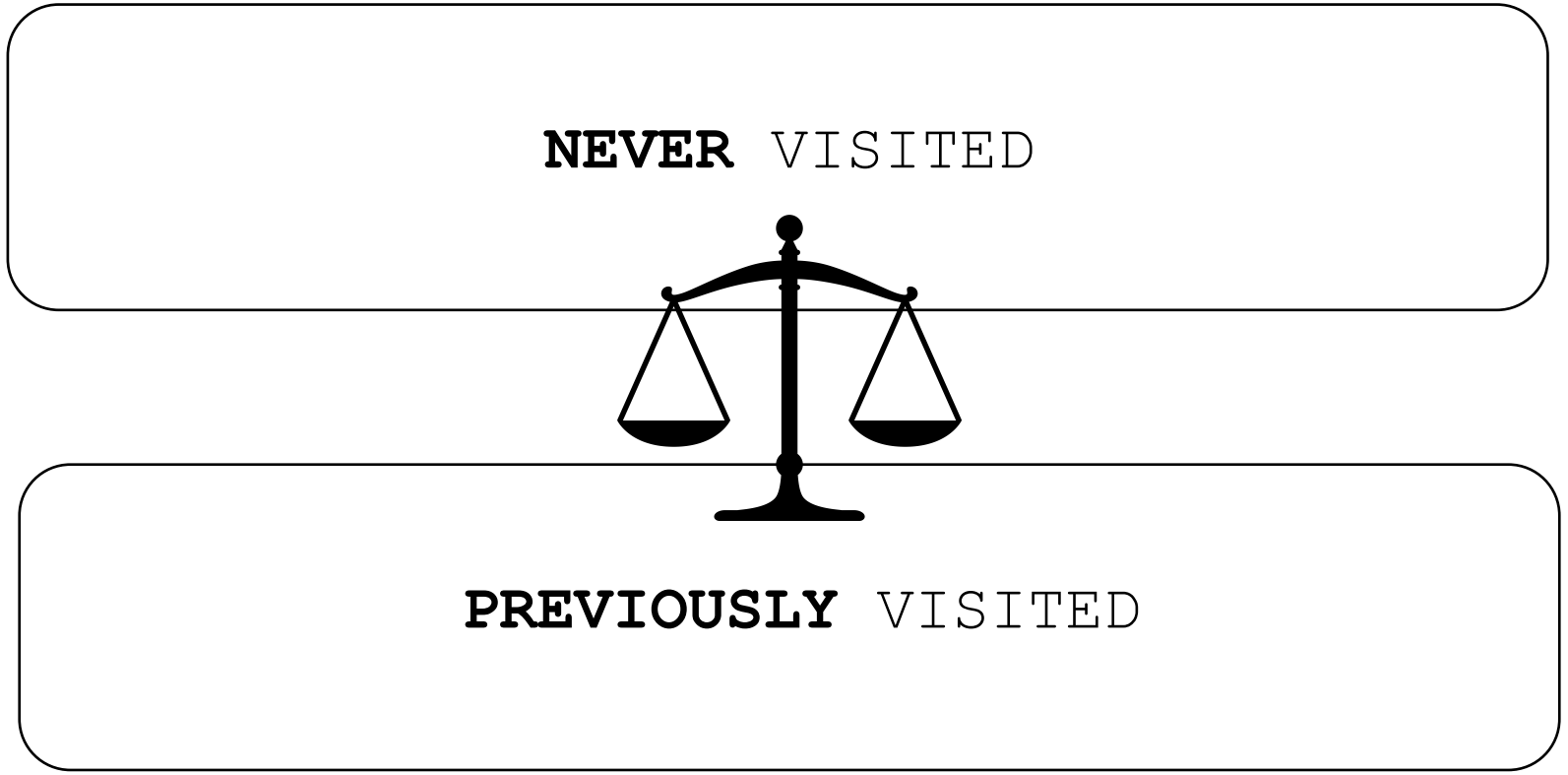
Access Detection



Access Detection



Access Detection



Access Detection

More than **half of the websites analyzed** were vulnerable to our attack. More concretely, around 70% with private personal information, and around 40% of highly accesible.

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More than **half of the websites analyzed** were vulnerable to our attack. More concretely, around 70% with private personal information, and around 40% of highly accesible.

We compared the mean and standard deviation of the number of cookies, and results show that highly accessed websites have a higher number of cookies. This hints that **slower servers or less optimized code** seem the resposible of the difference.

Login Detection

We can also check if the **user is logged in**. In our dataset, we found highly accesible website such as World of Warcraft (WoW) or Gucci, and websites related to private personal information such as LGBTchat or Dynamic Catholic.

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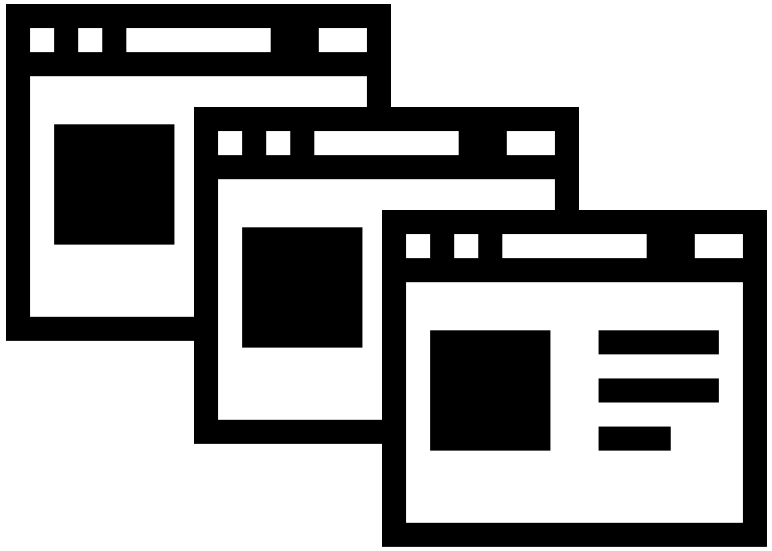
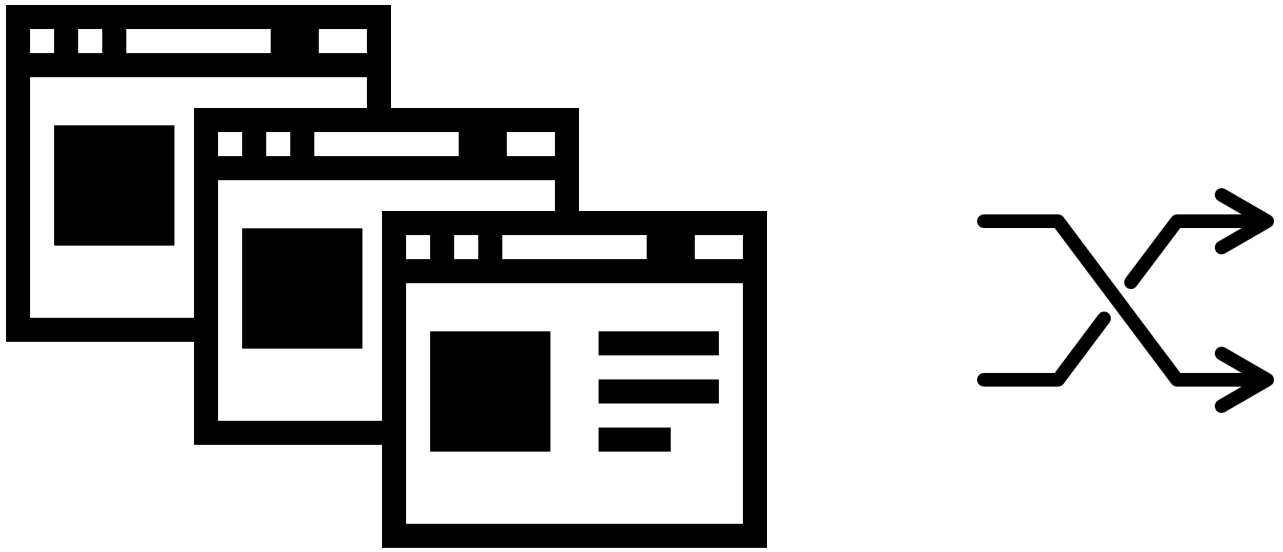
Curiously, some websites do not properly delete all cookies related to the login, what we call **persistant login**. In this cases, it is possible to detect a previous logged-in state even if not logged at that moment (e.g., Microsoft/MSN and Openload).

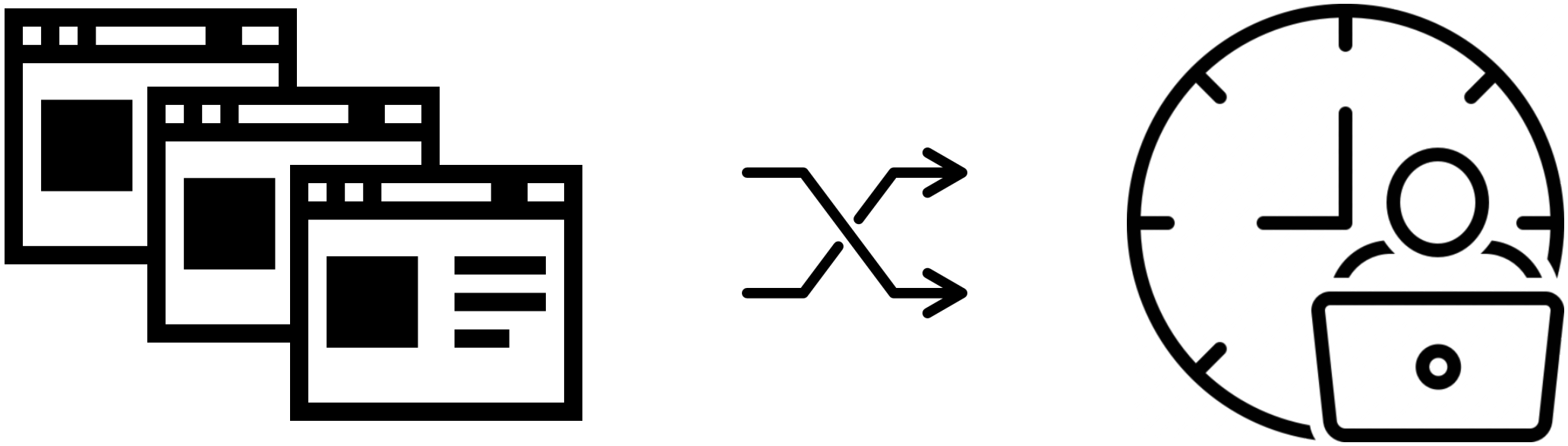
Stability Test



Stability Test



Stability Test



Countermeasures

Regular defenses for server-side timing attacks include, a random delays in the response time, or fixed response times for sensitive requests. But are difficult and impractical to implement in reality due to **performance issues**.

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Another option would be cookies with the **SameSite attribute**, that can indicate that they do not want to be send in third-party requests. However, as long as one of the cookies involved does not indicate it, the attack would still work.

NortonLifeLock™

Thank You!

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