

CSE 484/M584: Computer Security (and Privacy)

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Admin

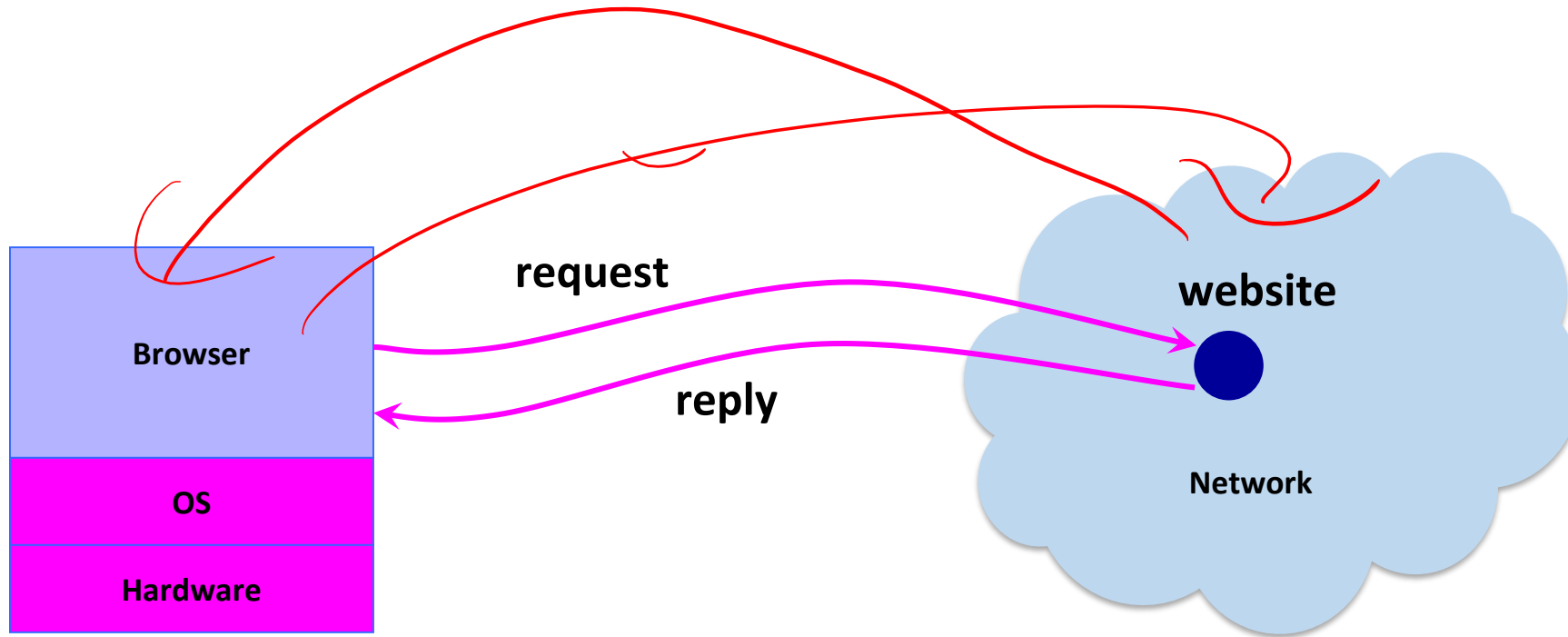
- Lab 2 (Cryptolab) due today

Next Major Topic!

Browser Security and Web Application Security



Big Picture: Browser and Network



Two Sides of Web Security

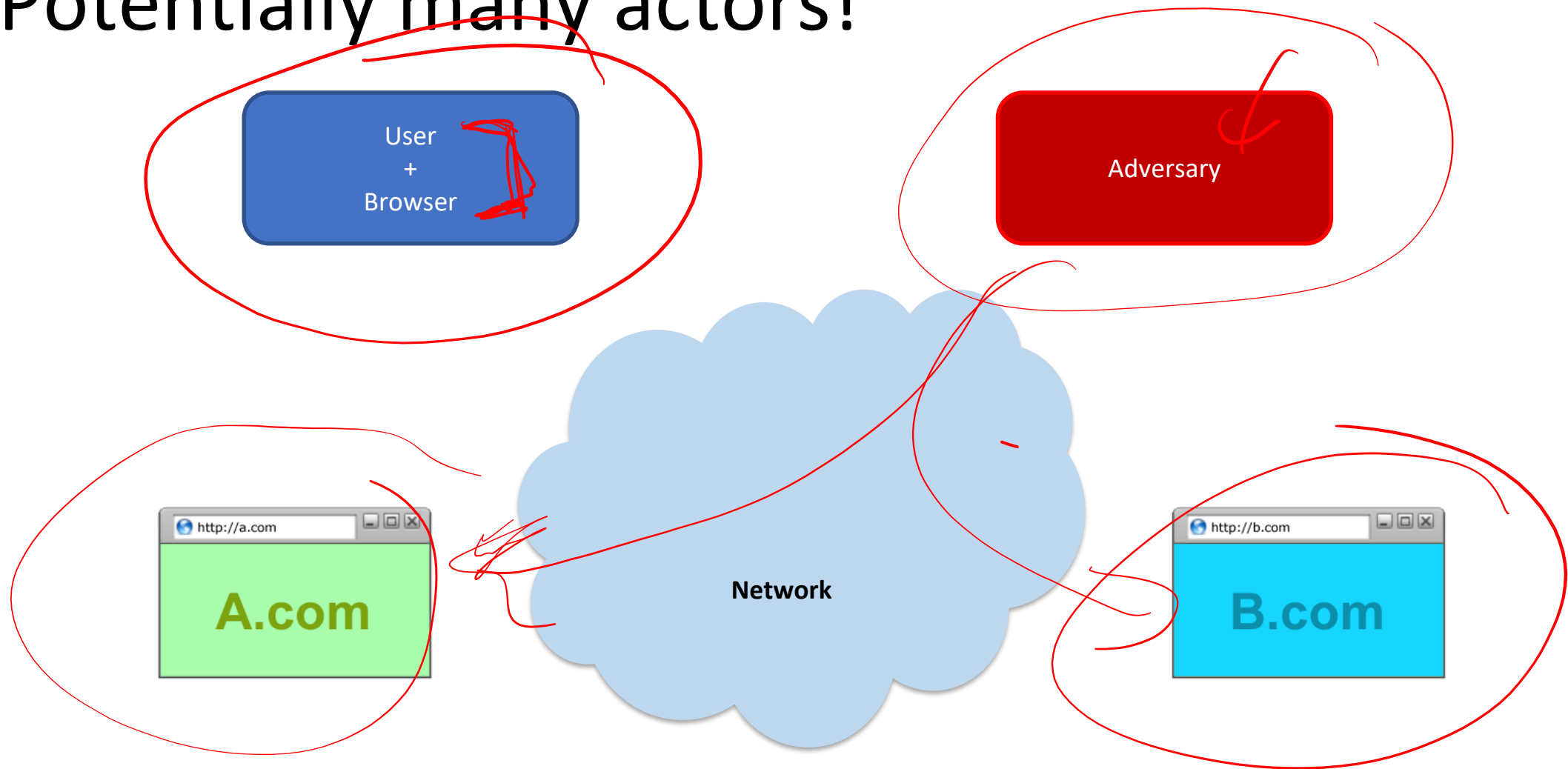
(1) Web browser

- Responsible for securely confining content presented by visited websites

(2) Web applications

- Online merchants, banks, blogs, email...
- Mix of server-side and client-side code
 - Server-side code written in Go, PHP, JavaScript, C++ etc.
 - Client-side code written in JavaScript (... sort of)
- Client cannot be trusted: server must treat input carefully.
 - Many potential bugs: XSS, XSRF, SQL injection.

Potentially many actors!

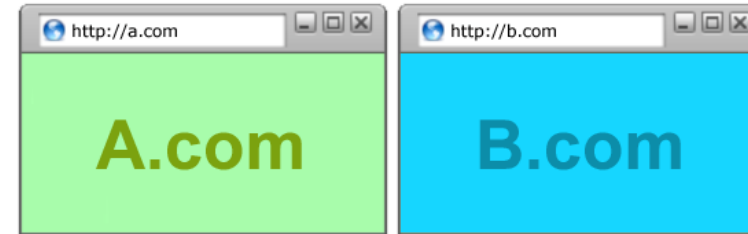


Browser: All of These Should Be Safe

- Safe to visit an evil website



- Safe to visit two pages
 - Simultaneously
 - Sequentially



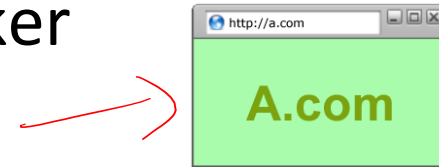
- Safe delegation



Browser Security Model

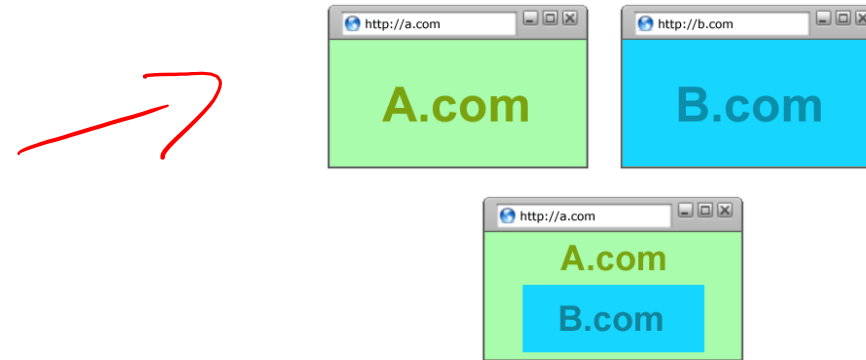
Goal 1: Protect local system from web attacker

→ Browser Sandbox



Goal 2: Protect/isolate web content from other web content

→ Same Origin Policy



Browser Sandbox



Goals: Protect local system from web attacker; *protect websites from each other*

- E.g., safely execute JavaScript provided by a website
- No direct file access, limited access to OS, network, browser data, content from other websites
- Tabs and iframes in their own processes
- Implementation is browser and OS specific*

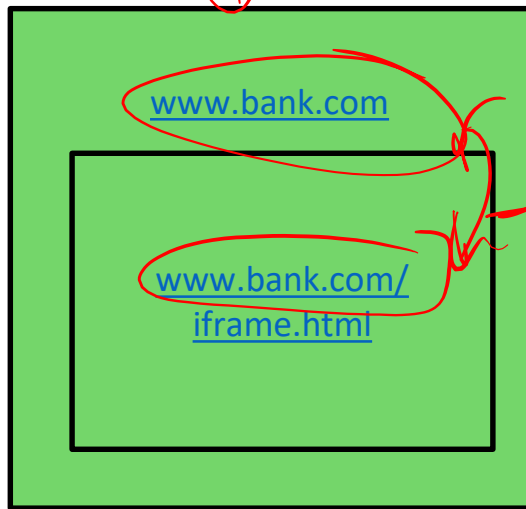
*For example

	High-quality report with demonstration of RCE	High-quality report demonstrating controlled write	High-quality report of demonstrated memory corruption	Baseline
Sandbox escape / Memory corruption / RCE in a non-sandboxed process [1], [2]	Up to \$250,000	Up to \$90,000	Up to \$35,000	Up to \$25,000

From Chrome Vulnerability Rewards Program

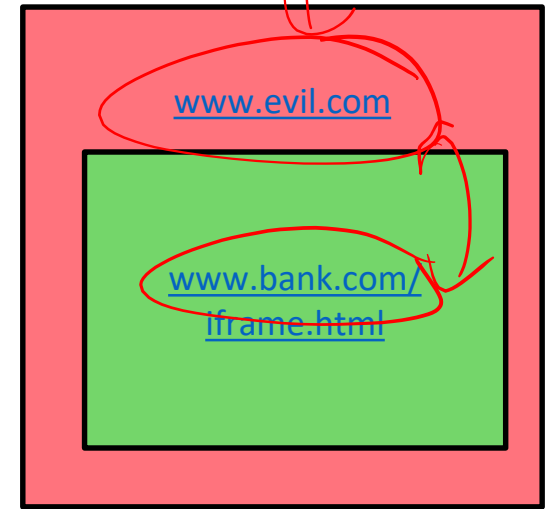
Same-Origin Policy

Only code from same origin can **access HTML elements** on another site (or in an iframe).



www.bank.com (the parent) **can** access HTML elements in the iframe (and vice versa).

```
<html> <body>
<iframe
  src="http://www.bank.com/iframe.html">
</iframe>
</body> </html>
```



www.evil.com (the parent) **cannot** access HTML elements in the iframe (and vice versa).

Same Origin Policy

(Website origin = (scheme, domain, port))

http https
↓

example.com 80/443
↓

Goal: Protect/isolate web content from other web content

Same Origin Policy

Website origin = (scheme, domain, port)

Compare: http://www.example.com/dir/page.html

Compared URL	Outcome	Reason
http://www.example.com/dir/page2.html	Success	Same scheme, host and port
http://www.example.com/dir2/other.html	Success	Same scheme, host and port
http://username:password@www.example.com/dir2/other.html	Success	Same scheme, host and port
http://www.example.com:80/dir/other.html	Success	Most modern browsers implicitly assign the protocol's default port when omitted. [6] [7]
http://www.example.com:81/dir/other.html	Failure	Same scheme and host but different port
https://www.example.com/dir/other.html	Failure	Different scheme
http://en.example.com/dir/other.html	Failure	Different host
http://example.com/dir/other.html	Failure	Different host (exact match required)
http://v2.www.example.com/dir/other.html	Failure	Different host (exact match required)
data:image/gif;base64,R0lGODlhAQABAAAAACwAAAAAAQABAAA=	Failure	Different scheme

Browser Cookies

GET

- HTTP is stateless protocol
- Browser cookies are used to introduce state
 - Websites can store small amount of info in browser
 - Used for authentication, personalization, tracking...
 - Cookies are often secrets

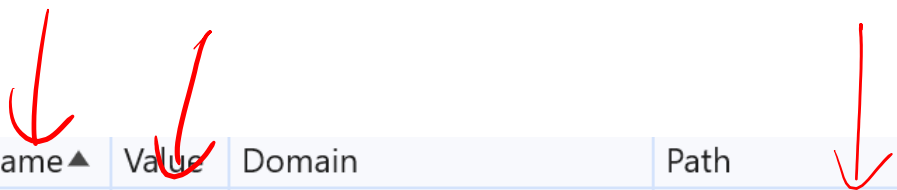


Browser cookies

- Want to set a cookie?
 - `document.cookie="name=value; ";`
 - Yes its that simple
- More commonly, in the HTTP Header response

Set-Cookie: <cookie-name>=<cookie-value>; Domain=<domain-value>; Secure

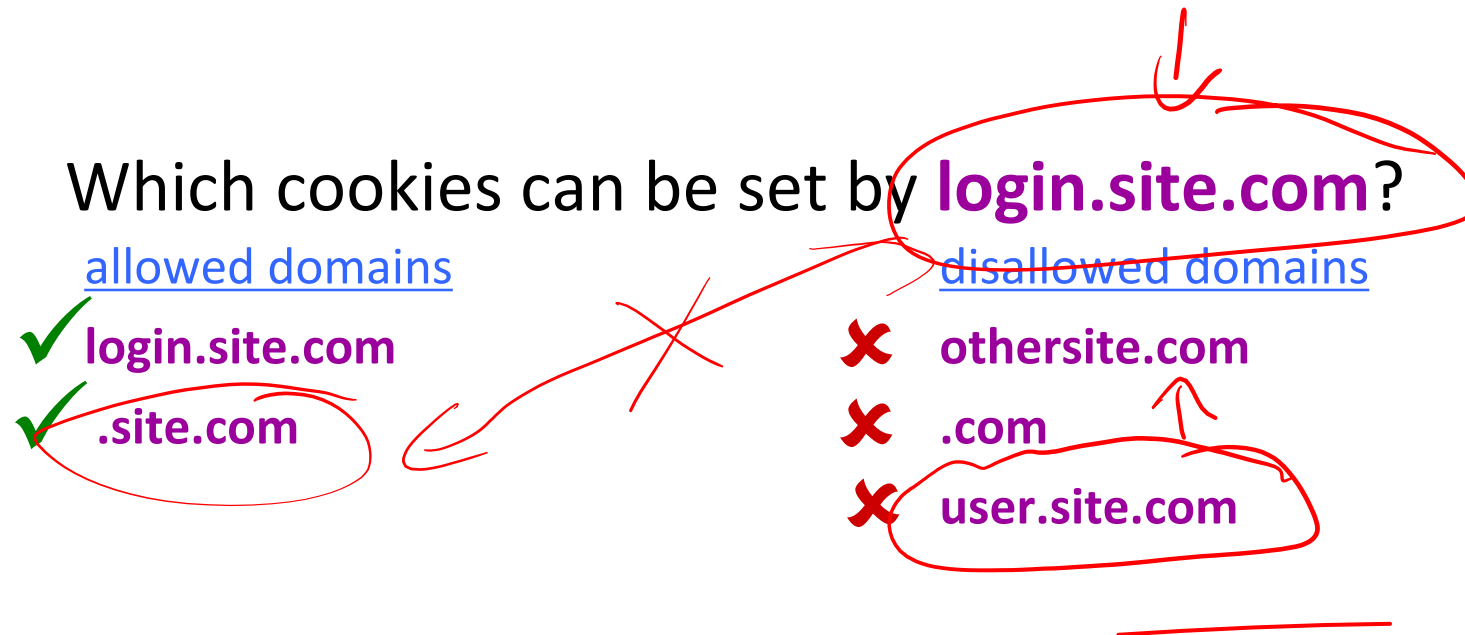
Browser cookies



Name▲	Value	Domain	Path	Expires / Max...	Size	HttpOnly	Secure	SameSite	Partition Key Site	Cross Site	Priority
rpin	384	homes.cs.washington.edu	/~dkohlbre/cew	Session	7						Medium

Name ▲	Value	Domain	Path	Expires / Max-Age	Size	HttpOnly	Secure	SameSite	Partitio...	Cross Site	Priority
csrftoken	5SGI ...	my.uw.edu	/	2025-10-27T22:5...	41			Lax			Medium
sessionid	hrc [REDACTED]	my.uw.edu	/	Session	41	✓		Lax			Medium

Same Origin Policy-ish: Cookie Writing



login.site.com can set cookies for all of **.site.com (domain suffix)**, but not for another site or top-level domain (TLD)

Same-Origin Policy: Scripts

- When a website **includes a script**, that script **runs in the context of the embedding website**.



The code from <http://otherdomain.com> **can** access HTML elements and cookies on <http://otherdomain.com>.

- If code in script sets cookie, under what origin will it be set?
- What could possibly go wrong...?

Foreshadowing:

SOP Does Not Control Sending

- A webpage can **send** information to any site
- Can use this to send out secrets...

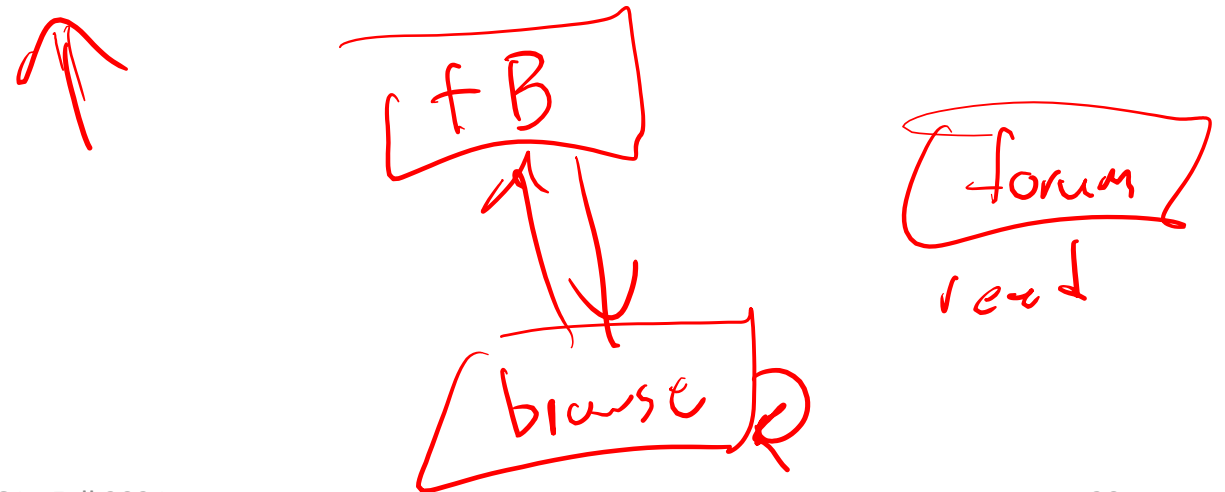
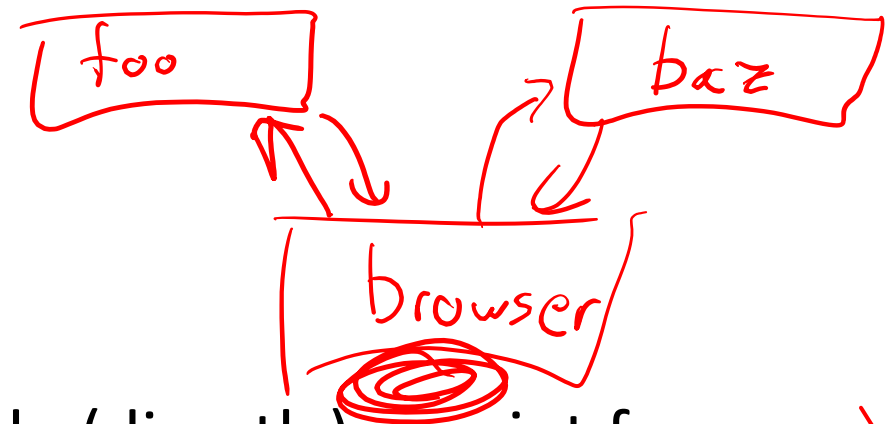
Considerations:

- Why would website foobar.com include (directly) a script from baz.com?

- E.g. `<script src="https://baz.com/ascript.js"/>`

- If they do, what could happen if baz is compromised, or decides to be malicious?

- Gradescope!



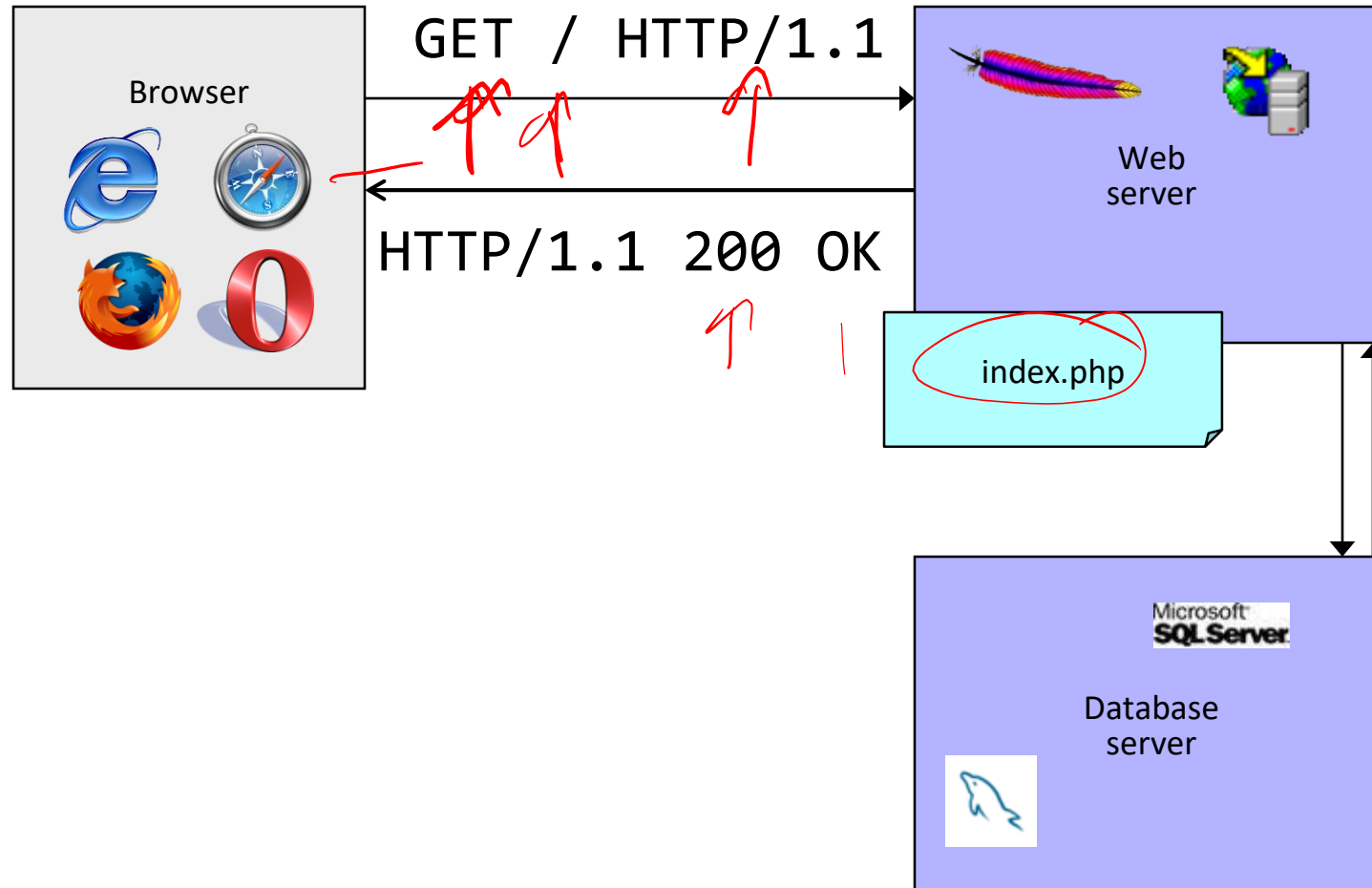
Example: Cookie Theft

- Cookies often contain authentication token
 - Stealing such a cookie == accessing account
- If you can run JS inside the victim page
 - You can just send the cookie wherever you want!
 - How do we get this to happen...?
- Aside: Cookie theft via network eavesdropping
 - Cookies included in HTTP requests
 - One of the reasons HTTPS is important!

Web Application Security:

How (Not) to Build a Secure Website

Dynamic Web Application



Cross-Site Scripting (XSS)

PHP: Hypertext Processor

- Server scripting language
- Can intermingle static HTML and code

```
<input value=<?php echo $myvalue; ?>>
```

- Can embed variables in double-quote strings

```
    $user = "world"; echo "Hello $user!";  
or    $user = "world"; echo "Hello" . $user . "!";
```

- Form data in global arrays `$_GET`, `$_POST`, ...

Demo!

Echoing / “Reflecting” User Input

Classic mistake in server-side applications

<http://naive.com/search.php?term=“Can I go back to campus yet?”>

search.php responds with

```
<html> <title>Search results</title>
```

```
<body>You have searched for <?php echo $_GET[term] ?>...  
</body>
```

Echoing / “Reflecting” User Input

naive.com/hello.php?name=

User

Welcome, dear User

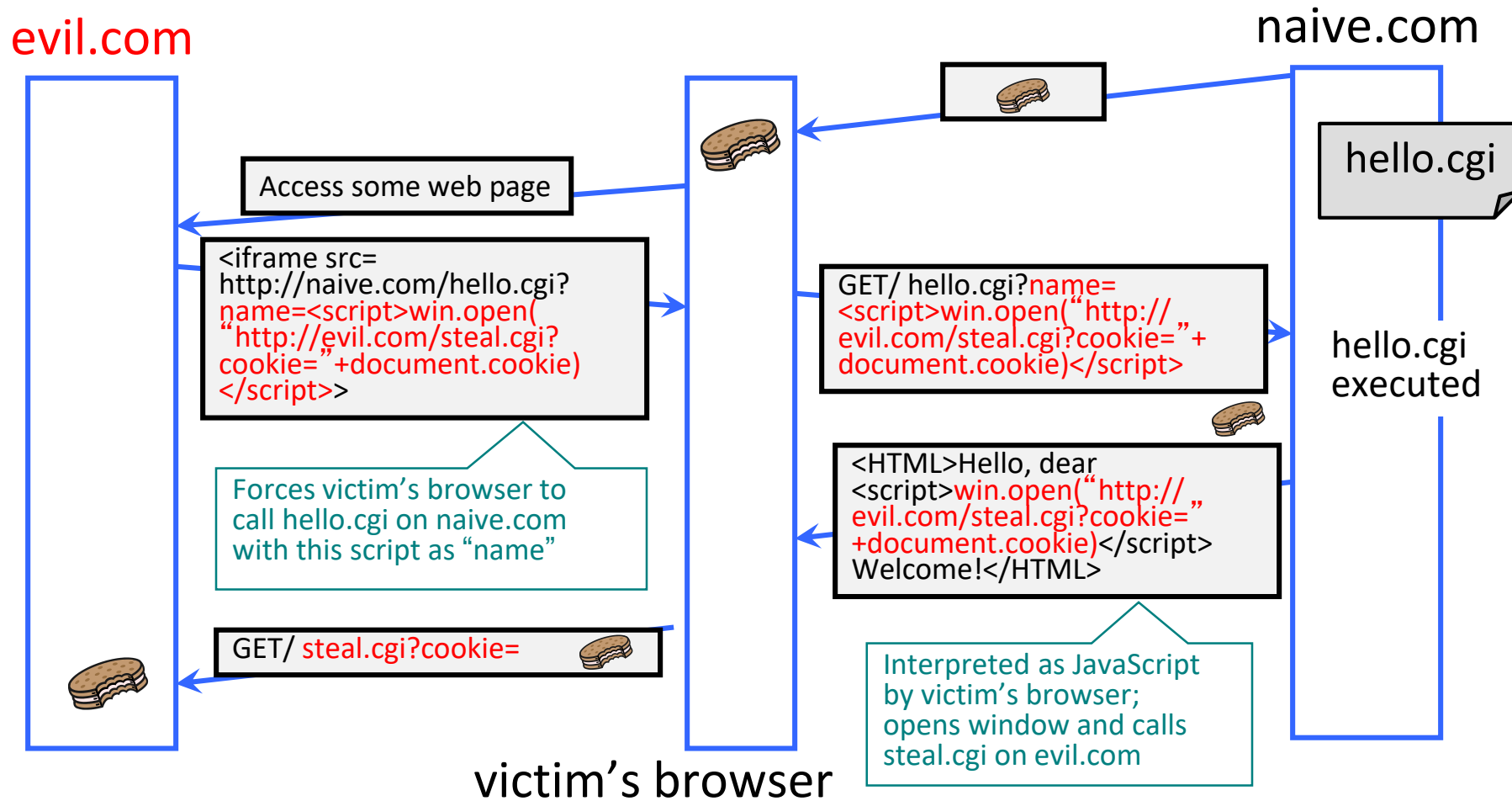
naive.com/hello.php?name=<img

src='http://upload.wikimedia.org/wikipedia/en/thumb/3/39/YoshiMarioParty9.png/210px-YoshiMarioParty9.png'>

Welcome, dear



Cross-Site Scripting (XSS)



Basic Pattern for Reflected XSS

Injected script can manipulate website to **show bogus information, leak sensitive data, cause user's browser to attack other websites**. This violates the "spirit" of the same origin policy

