

# Information Security

## Networking 2: With A Single Click

Winter 2022/2023



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he/his

Recall from last time

# Lecture ground rules

- We color technologies, algorithms, etc. for your convenience
  - State-of-the-art tech, no known vulnerabilities ✓
    - This is generally safe to use!
  - Outdated tech, known issues, covered for demonstration purposes ✗
    - You should not use this!
- Coloring provides a very quick-and-dirty categorization for you
  - Want to know *why*? That's what the lecture is for 😊

Recall from last time

# Meet the players



Alice  
she/hers



Bob  
he/his

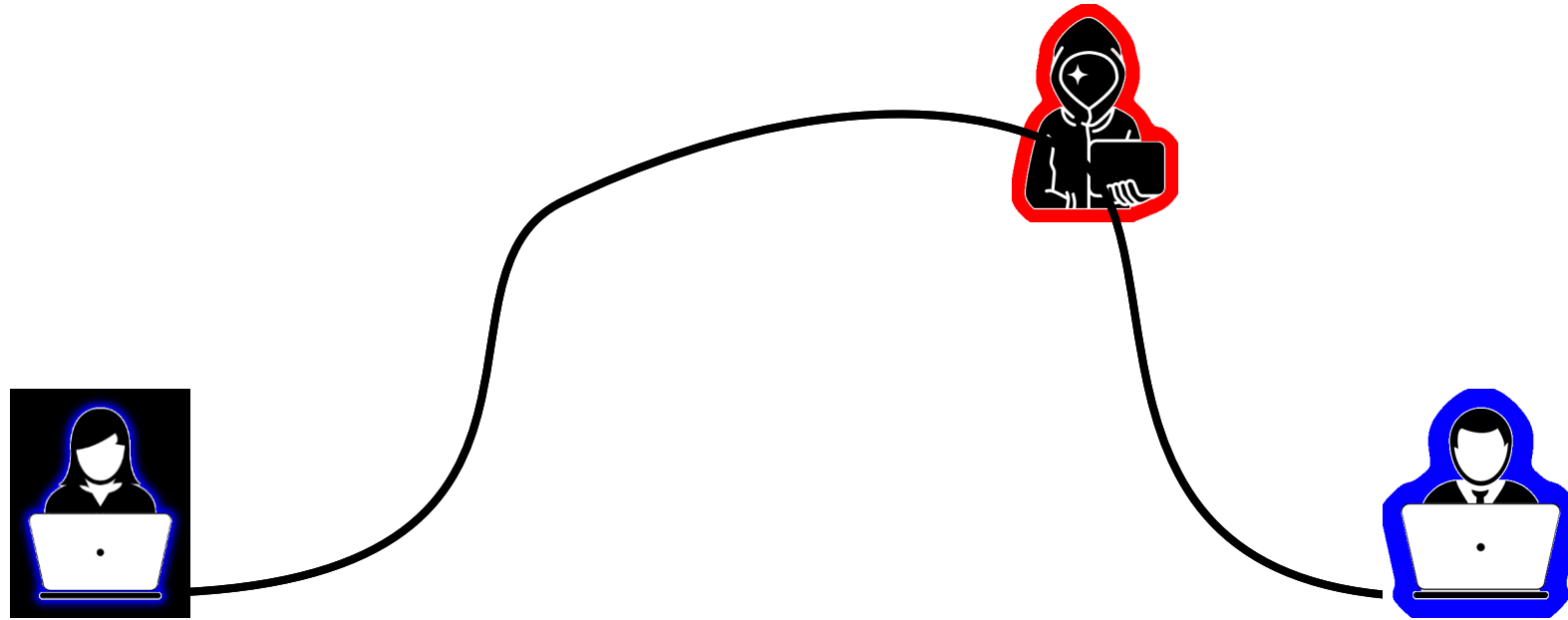


Eve  
????

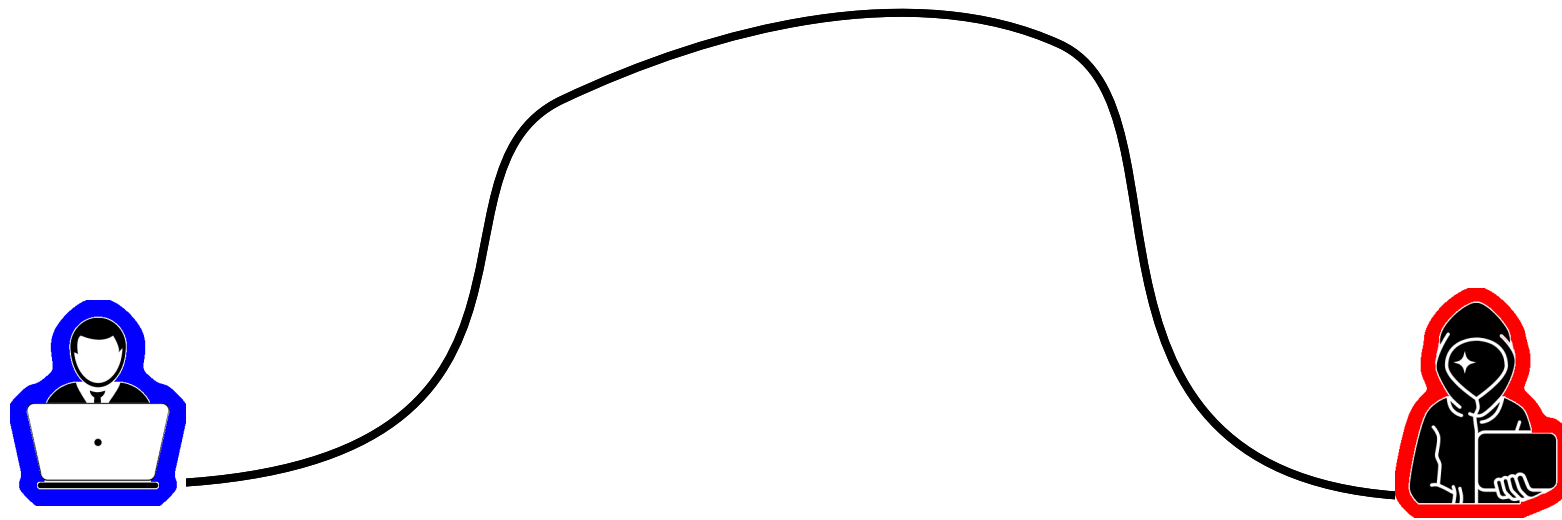


Smith  
she/hers

Last time:



This time:





From: Message Notification <fake@email.com>  
To: You <you@lawful.org>  
Subject: Urgent Message!

You have one pending message. Click to view: <https://www.evil.org/>





evil.org - Totally Legitimate Online B X +

localhost:8000/evil.org.html


## X Your Bank – Trustworthy Online Banking

Welcome to your absolutely legitimate online banking platform.

Please enter your secure password below to accept a \$500m donation from the International Monetary Fund.

Your password:  [Secure log in!](#)

We swear this money actually exists. Look, here's a picture we found on the internet to prove it:



If you do not react within 5 (five) business days, your account will be locked. Thank you.



evil.org - Totally Legitimate Online B X +

localhost:8000/evil.org.html


## X Your Bank – Trustworthy Online Banking

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Your password:  [Secure log in!](#)

We swear this money actually exists. Look, here's a picture we found on the internet to prove it:



If you do not react within 5 (five) business days, your account will be locked. Thank you.

Is Bob screwed?



The screenshot shows a web browser window with the following content:

- Browser tab: evil.org - Totally Legitimate Online Banking
- Address bar: localhost:8000/evil.org.html
- Page title: **X Your Bank – Trustworthy Online Banking** (with a person icon)
- Text: **Welcome to your absolutely legitimate online banking platform.**
- Text: Please enter your secure password below to accept a \$500m donation from the International Monetary Fund.
- Form: "Your password:" followed by a masked input field and a "Secure log in!" button.
- Text: We swear this money actually exists. Look, here's a picture we found on the internet to prove it:
- Image: A photograph of Christine Lagarde, former President of the European Central Bank.
- Text: If you do not react within 5 (five) business days, your account will be locked. Thank you.

correct horse battery staple



Is Bob screwed?

The screenshot shows a web browser window with the address bar displaying 'localhost:8000/evil.org.html'. The page has a yellow background and contains the following text:


# X Your Bank – Trustworthy Online Banking

Welcome to your absolutely legitimate online banking platform.

Please enter your secure password below to accept a \$500m donation from the International Monetary Fund.

Your password:

We swear this money actually exists. Look, here's a picture we found on the internet to prove it:



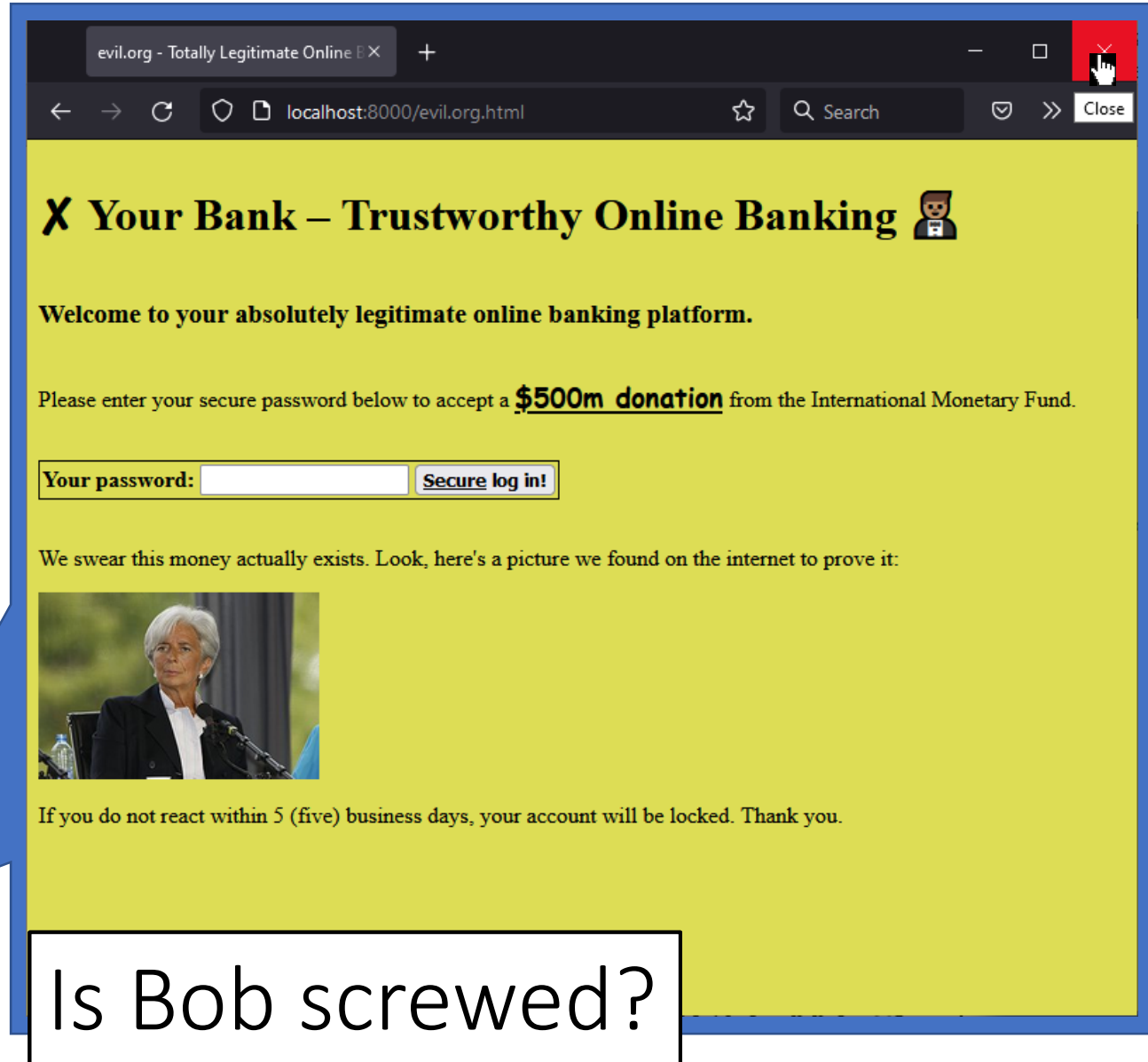
If you do not react within 5 (five) business days, your account will be locked. Thank you.

correct horse battery staple



Is Bob screwed?


Yes.



The screenshot shows a web browser window with the address bar displaying 'localhost:8000/evil.org.html'. The page content includes a title 'X Your Bank – Trustworthy Online Banking' with a small person icon, a welcome message, a request for a password to receive a '\$500m donation', a password input field, a 'Secure log in!' button, a photo of a woman, and a warning about account lockout.

evil.org - Totally Legitimate Online B X +

localhost:8000/evil.org.html


**X Your Bank – Trustworthy Online Banking** 

Welcome to your absolutely legitimate online banking platform.

Please enter your secure password below to accept a \$500m donation from the International Monetary Fund.

Your password:  [Secure log in!](#)

We swear this money actually exists. Look, here's a picture we found on the internet to prove it:




If you do not react within 5 (five) business days, your account will be locked. Thank you.

Is Bob screwed?

This sounds fishy...



The screenshot shows a web browser window with the following content:

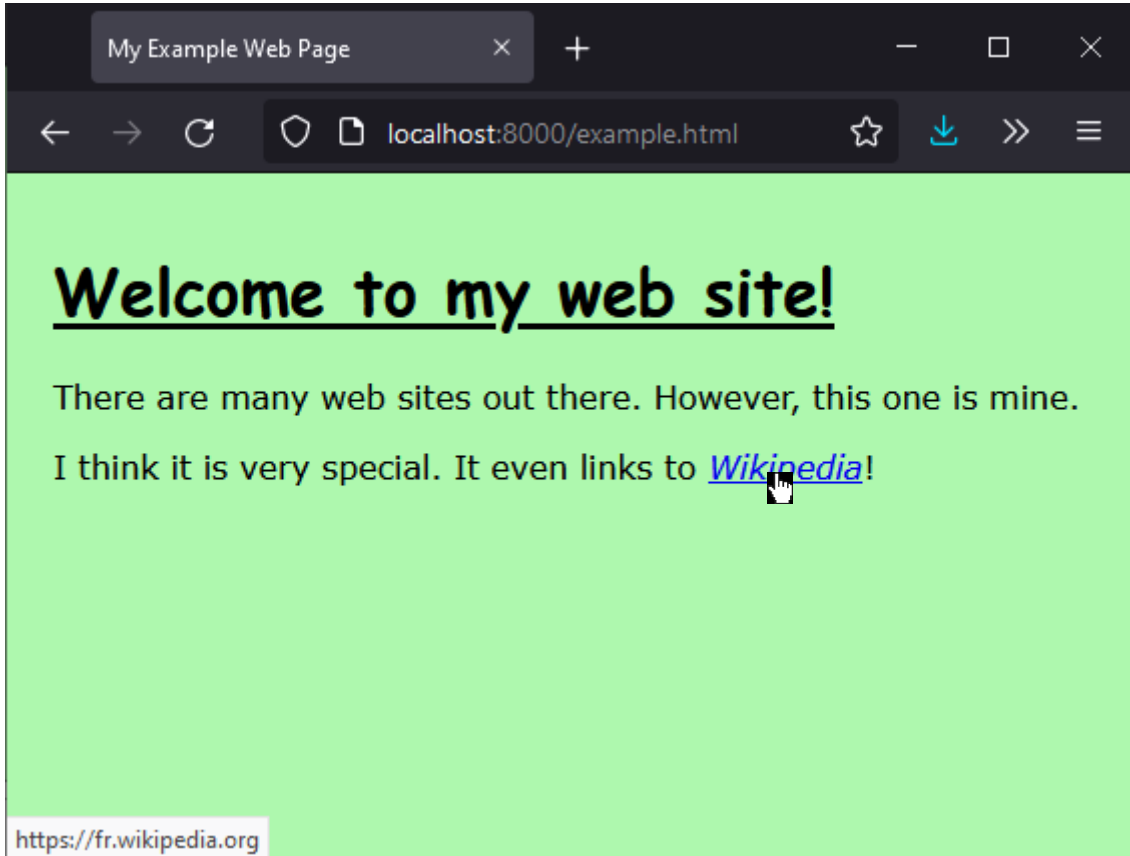
- Browser tab: evil.org - Totally Legitimate Online B X
- Address bar: localhost:8000/evil.org.html
- Page title: X Your Bank – Trustworthy Online Banking 
- Text: Welcome to your absolutely legitimate online banking platform.
- Text: Please enter your secure password below to accept a \$500m donation from the International Monetary Fund.
- Form: Your password:
- Text: We swear this money actually exists. Look, here's a picture we found on the internet to prove it:
- Image: 
- Text: If you do not react within 5 (five) business days, your account will be locked. Thank you.

This sounds fishy...

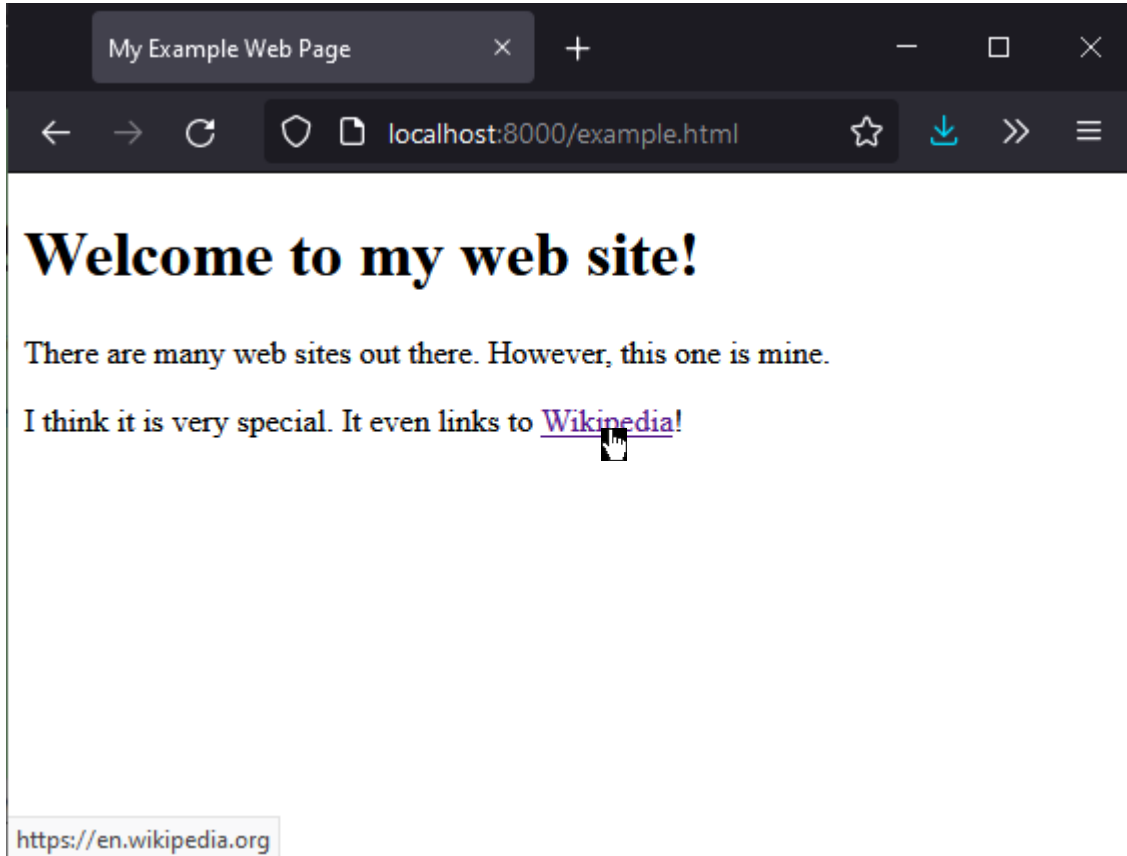


Is Bob screwed?

Maybe...



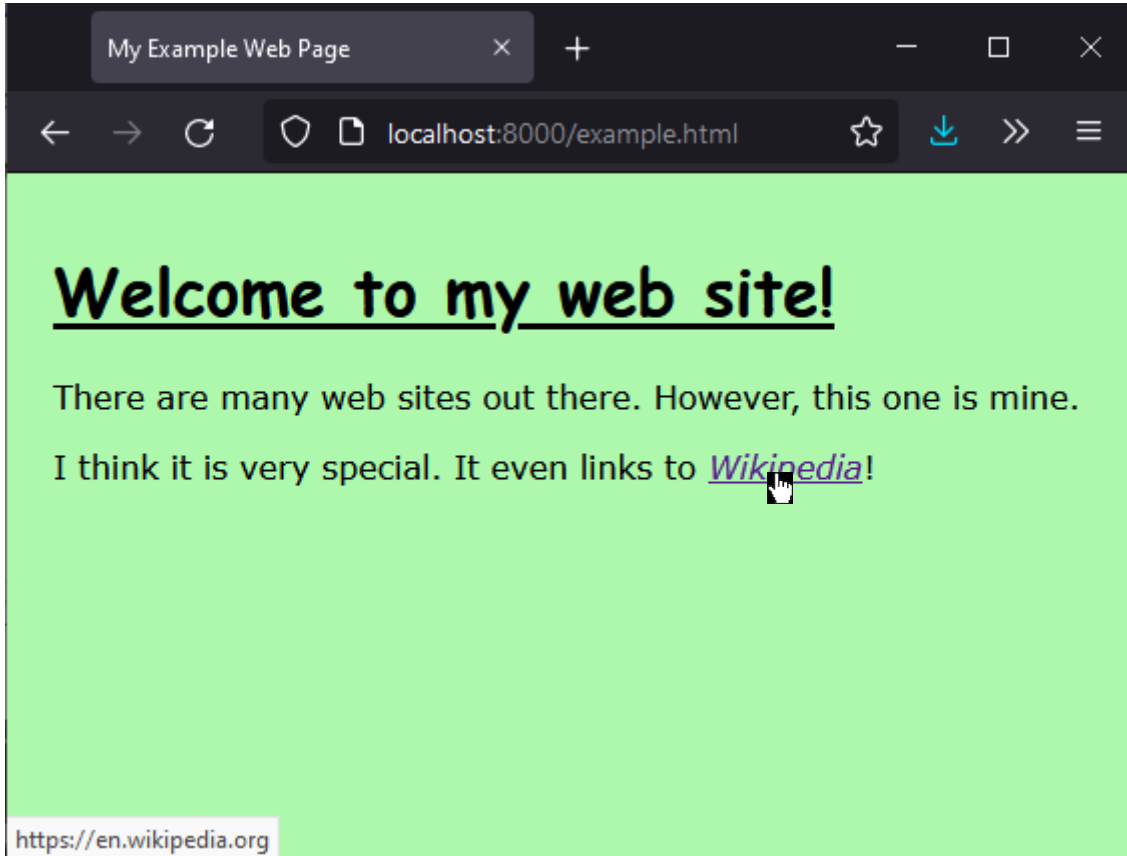
What kinds of files make up a web page?



What kinds of files make up a web page?

- **HyperText Markup Language**
- Page content and structure

```
<!doctype HTML>
<html>
  <head>
    <title>My Example Web Page</title>
  </head>
  <body>
    <h1>Welcome to my web site!</h1>
    <p>There are many web sites out there. However, this one is mine.</p>
    <p>I think it is very special. It even links to <a href="https://en.wikipedia.org/">Wikipedia</a>!</p>
  </body>
</html>
```



What kinds of files make up a web page?

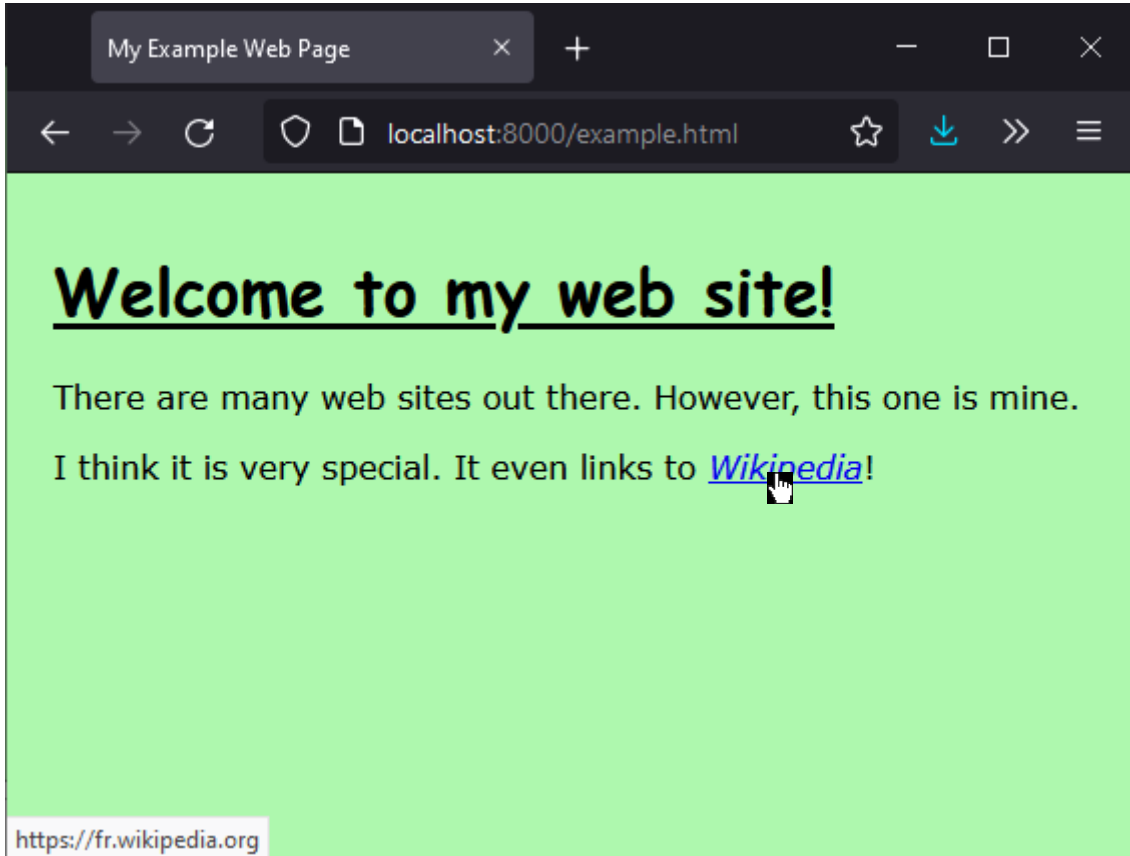
- **H**yper**T**ext **M**arkup **L**anguage
  - Page content and structure
- **C**ascading **S**tyle **S**heets
  - Page layout and formatting

```
<!doctype HTML>
<html>
  <head>
    <title>My Example Web Page</title>
    <link rel="stylesheet" href="example.css">
  </head>
  <body>
    <h1>Welcome to my web site!</h1>
    <p>There are many web sites out there. However, this one is mine.</p>
    <p>I think it is very special. It even links to <a href="https://en.wikipedia.org/">Wikipedia</a>!</p>
  </body>
</html>
```

```
html
{
  background: rgb(174, 248, 174);
  font-family: Verdana;
  padding: 15px;
}

h1
{
  font-family: "Comic Sans MS";
  text-decoration: underline;
}

a
{
  font-style: italic;
}
```



What kinds of files make up a web page?

- **H**yper**T**ext **M**arkup **L**anguage
  - Page content and structure
- **C**ascading **S**tyle **S**heets
  - Page layout and formatting
- **J**ava**S**cript
  - Dynamically modify the web page
  - Request additional data on demand
  - and many more...

```
<!doctype HTML>
<html>
  <head>
    <title>My Example Web Page</title>
    <link rel="stylesheet" href="example.css">
    <script src="example.js" defer</script>
  </head>
  <body>
    <h1>Welcome to my web site!</h1>
    <p>There are many web sites out there. However, this one is mine.</p>
    <p>I think it is very special. It even links to <a href="https://en.wiki
  </body>
</html>
```

```
html
{
  background: rgb(174, 248, 174);
  font-family: Verdana;
  padding: 15px;
}
h1
{
  font-family: "Comic Sans MS";
  text-decoration: underline;
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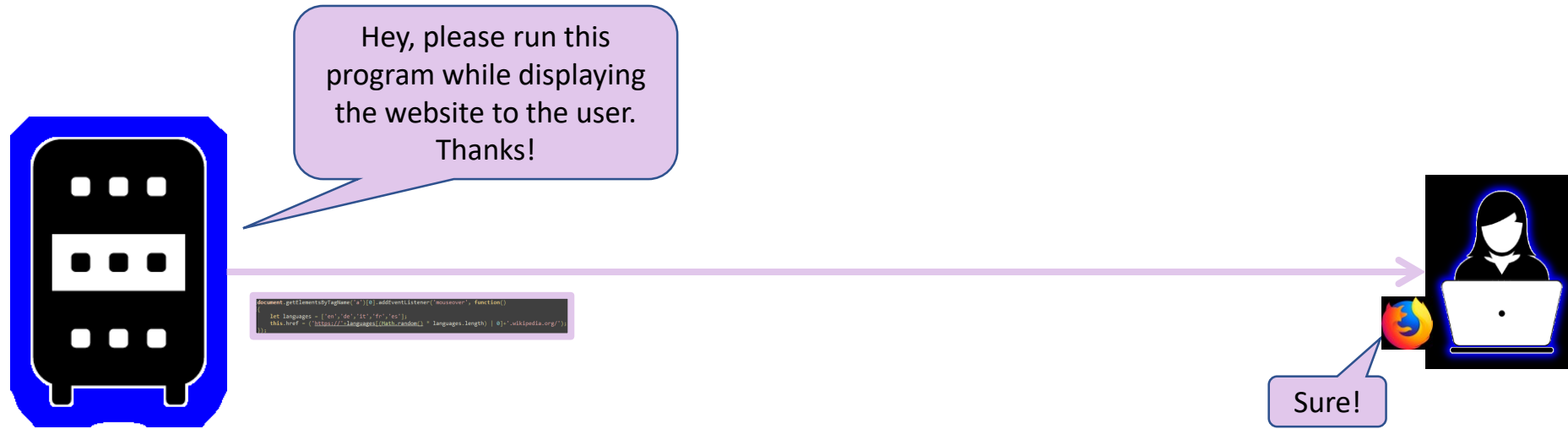
```
document.getElementsByTagName('a')[0].addEventListener('mouseover', function()
{
  let languages = ['en', 'de', 'it', 'fr', 'es'];
  this.href = ('https://' + languages[(Math.random() * languages.length) | 0] + '.wikipedia.org/');
});
```

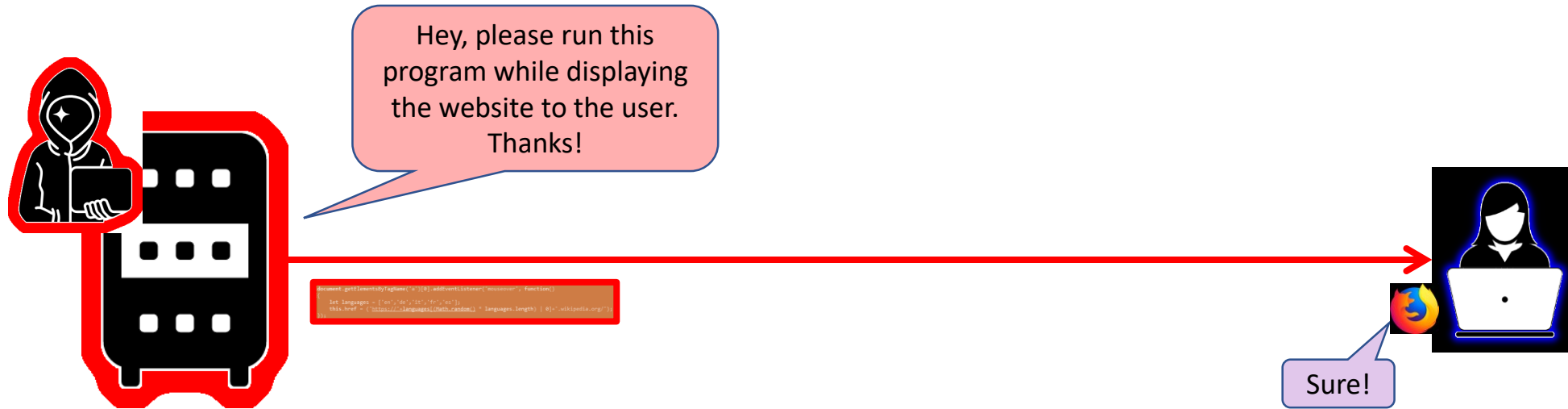


- JavaScript

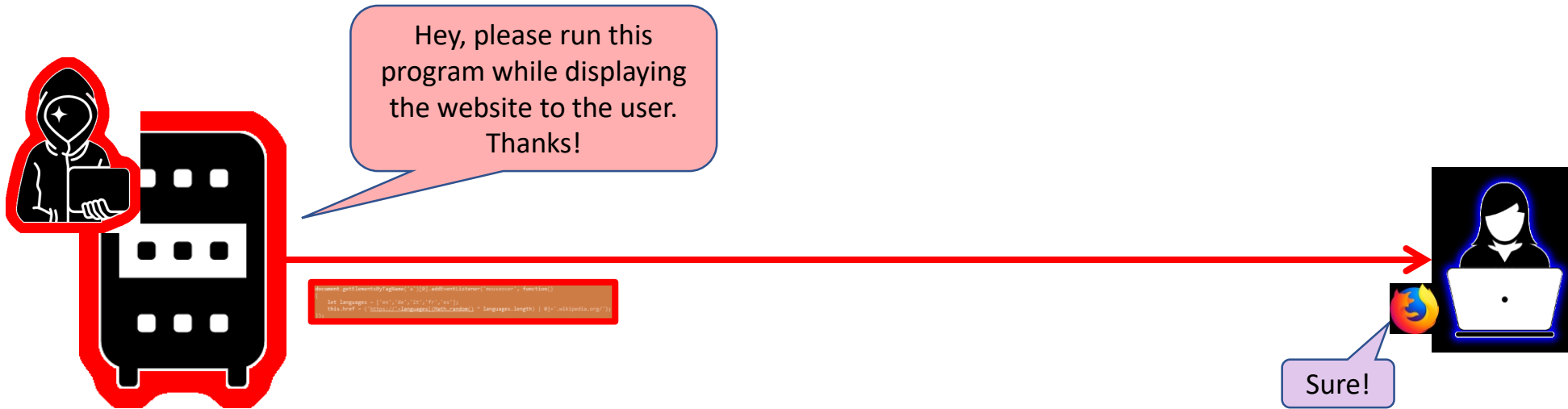
- Dynamically modify the web page
- Request additional data on demand
- and many more...



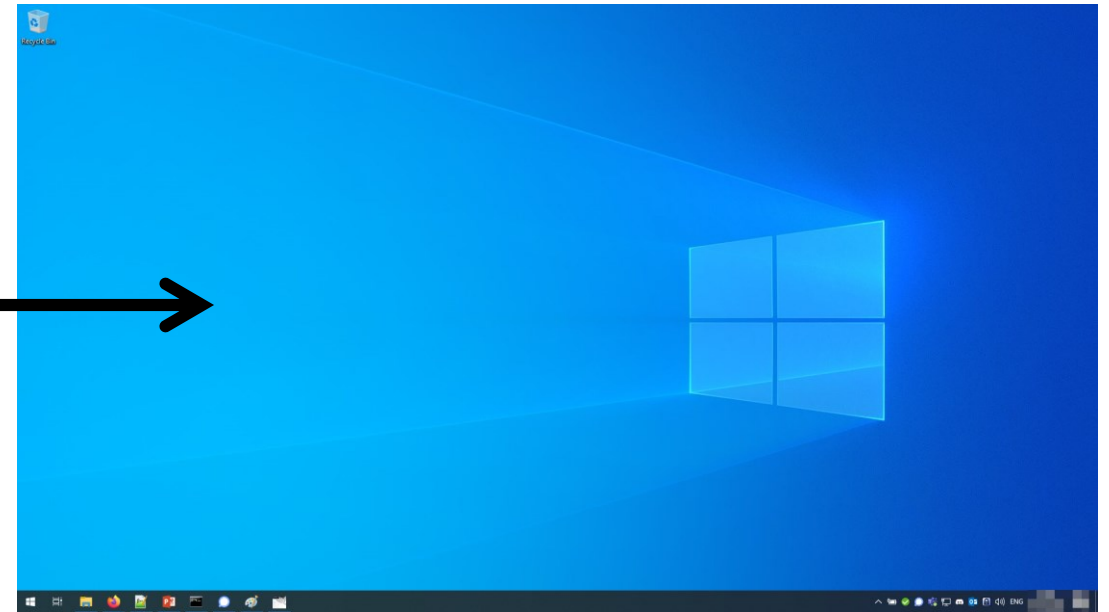
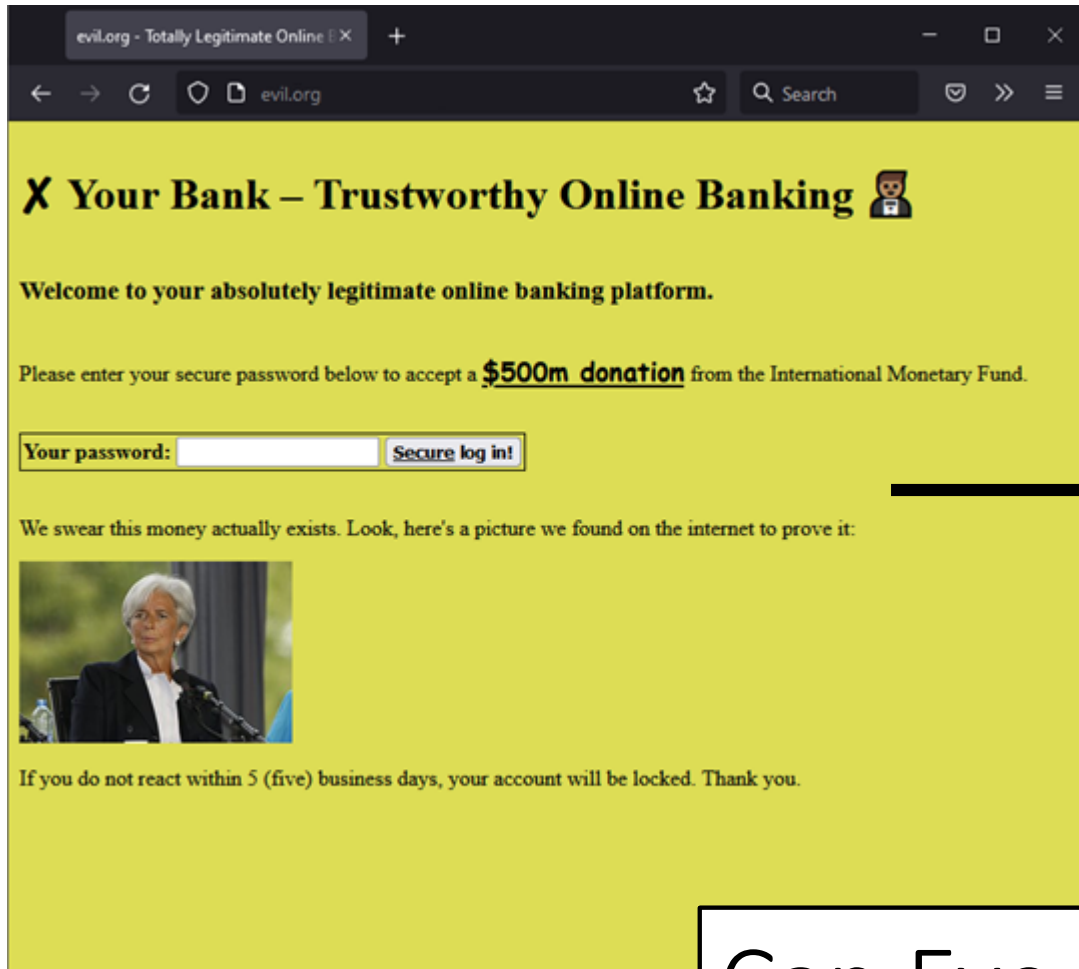




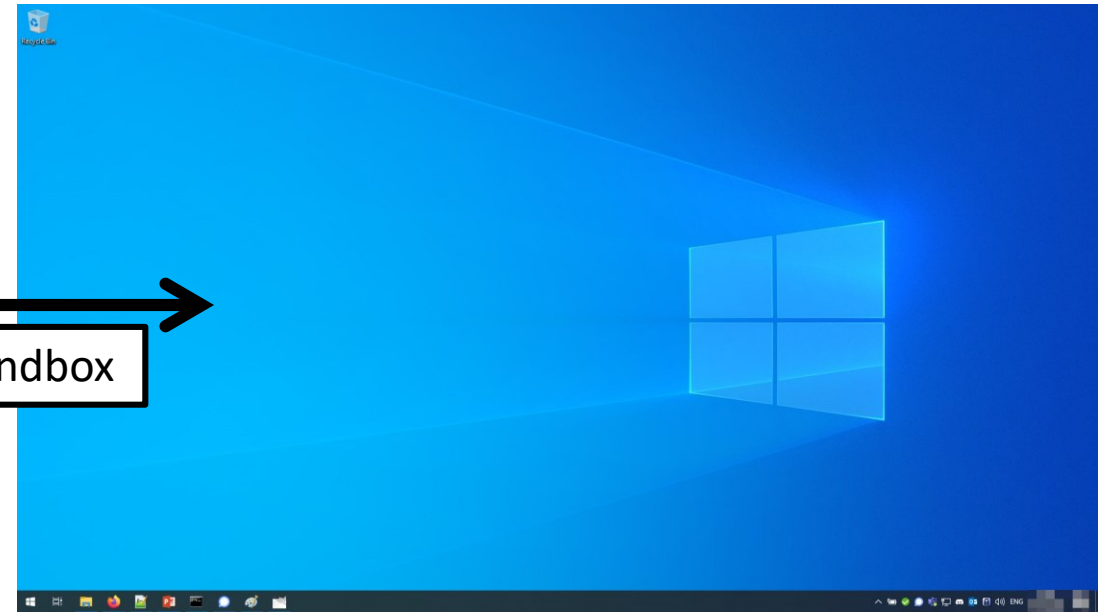
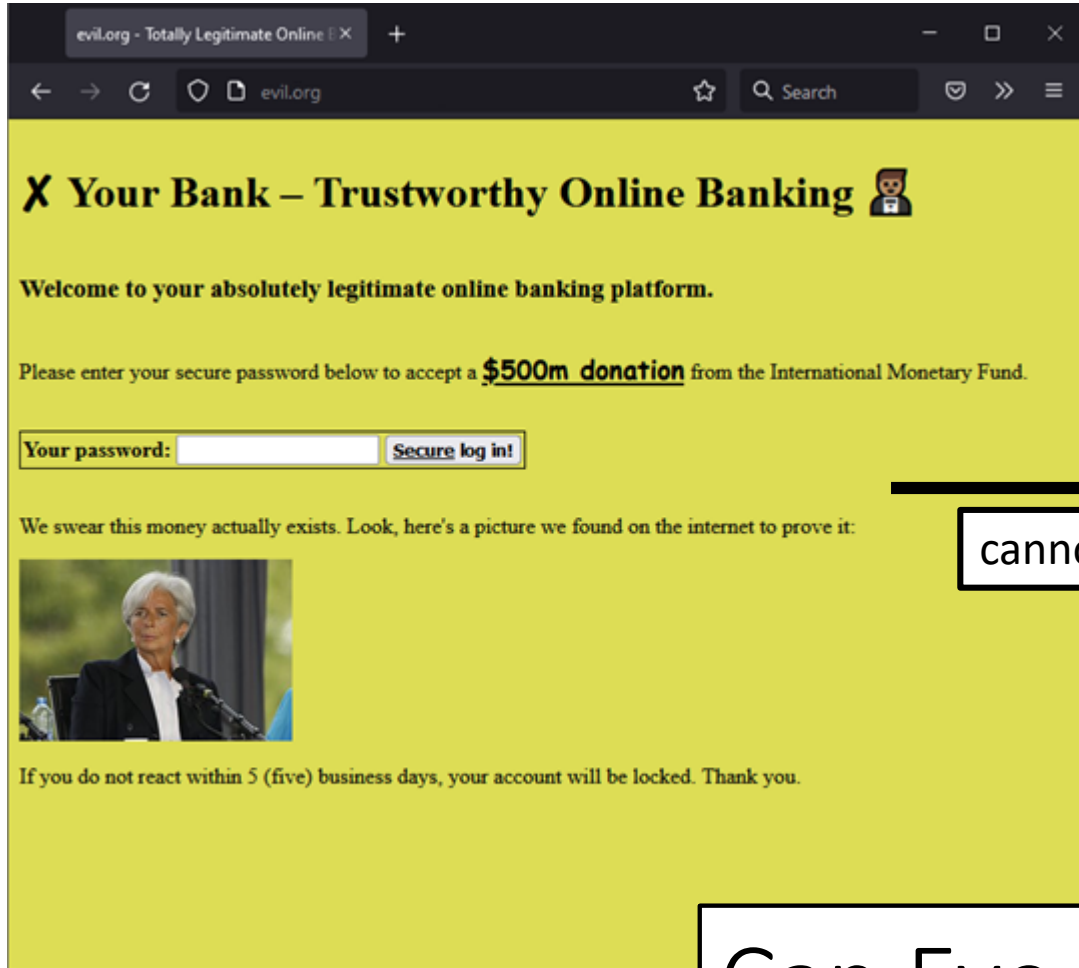
What could possibly go wrong?



What could possibly go wrong?  
Yeah, no, seriously. What could?



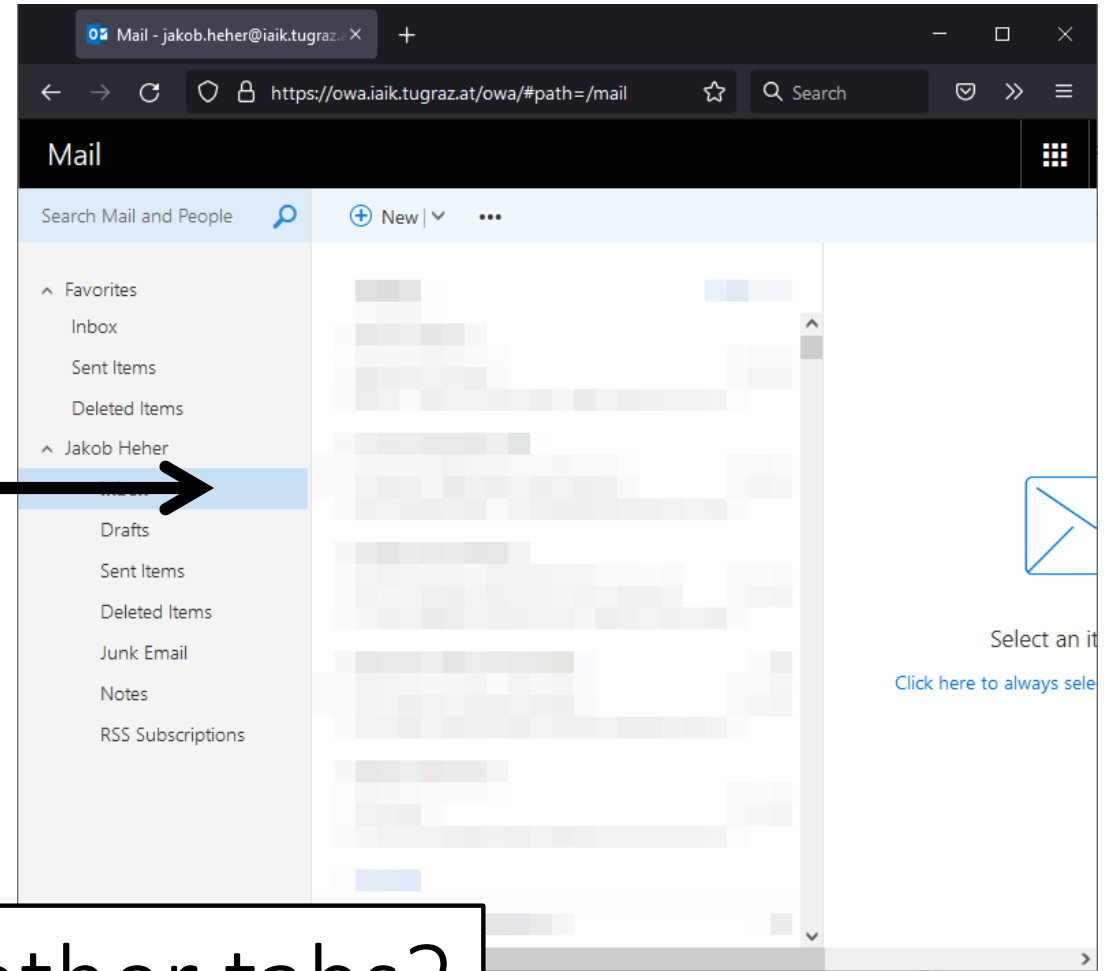
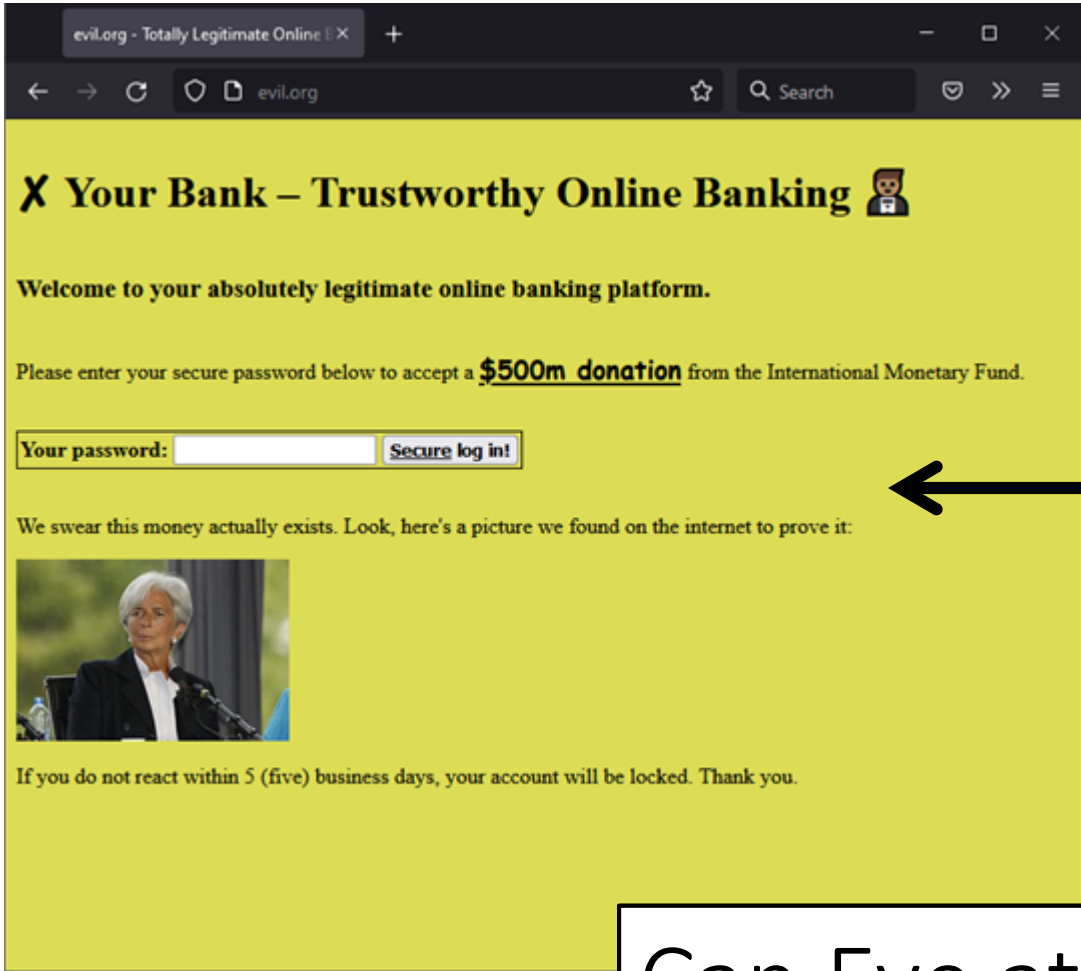
Can Eve attack the OS?



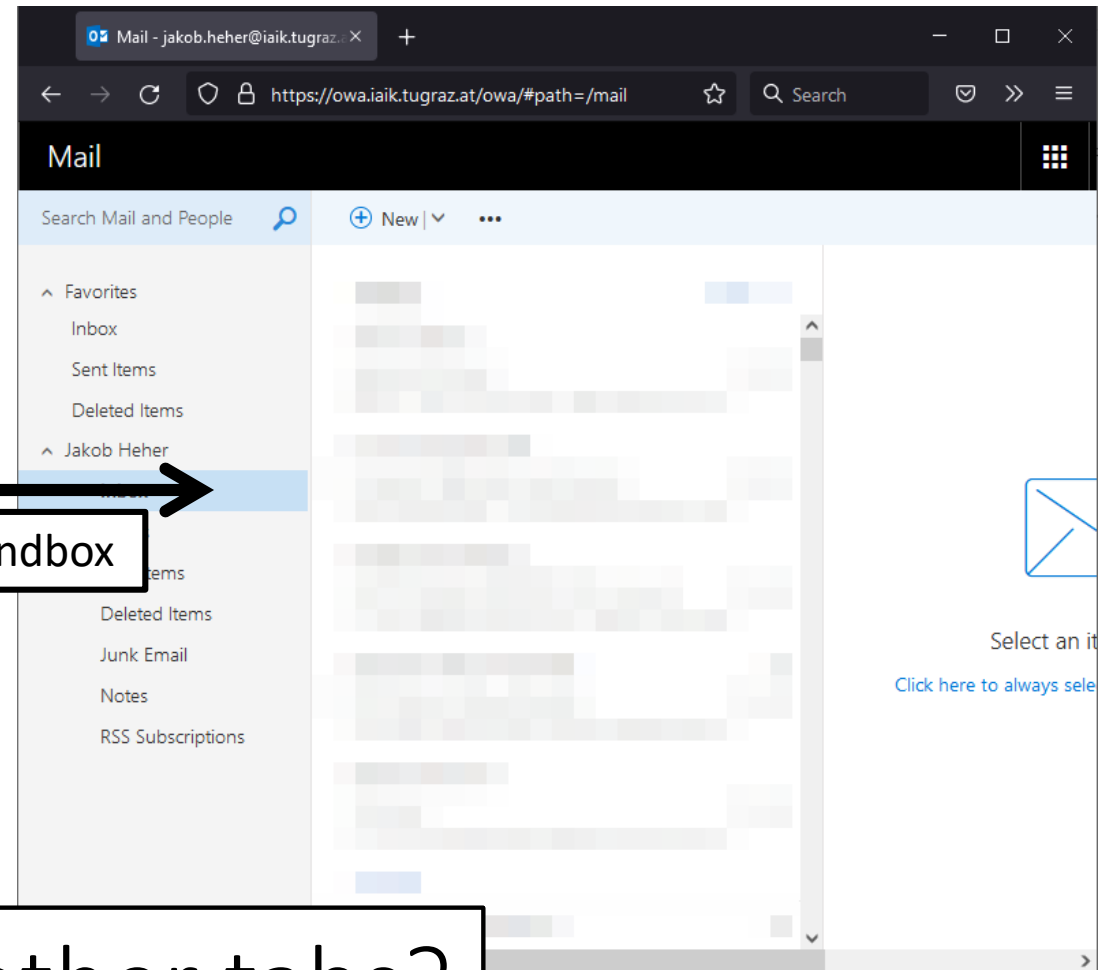
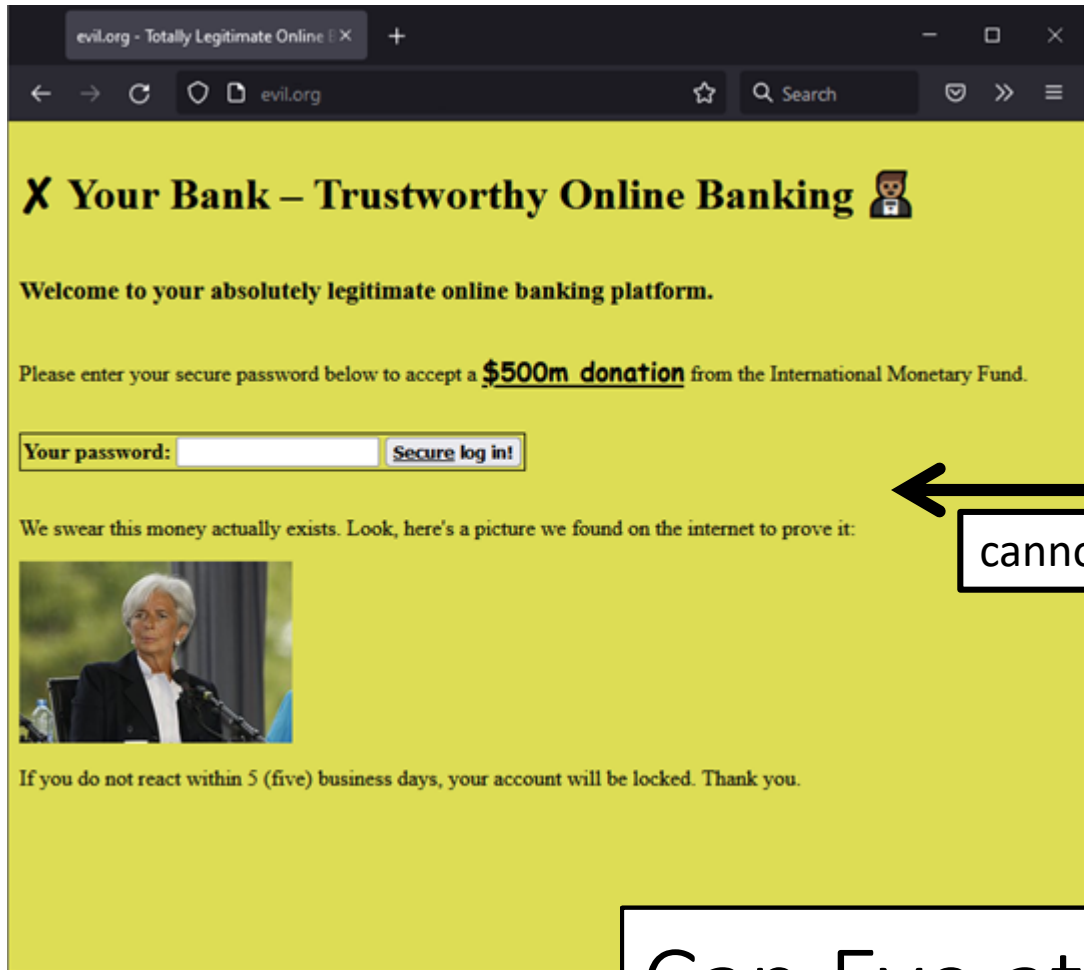
Can Eve attack the OS?

No.

(unless something has gone horribly wrong) 23



Can Eve attack other tabs?

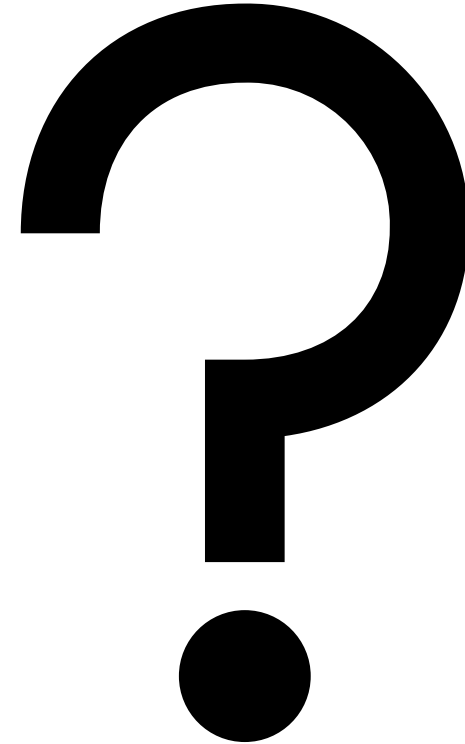
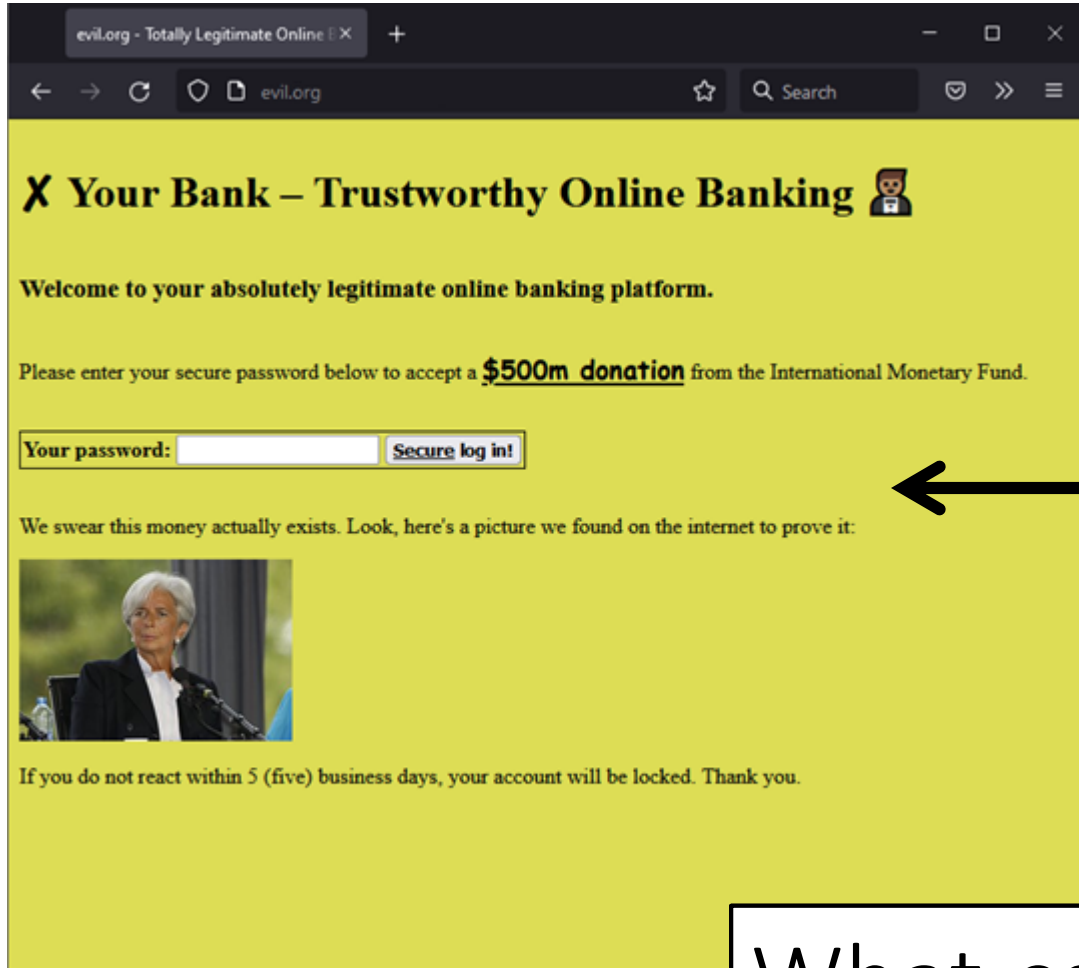


Can Eve attack other tabs?

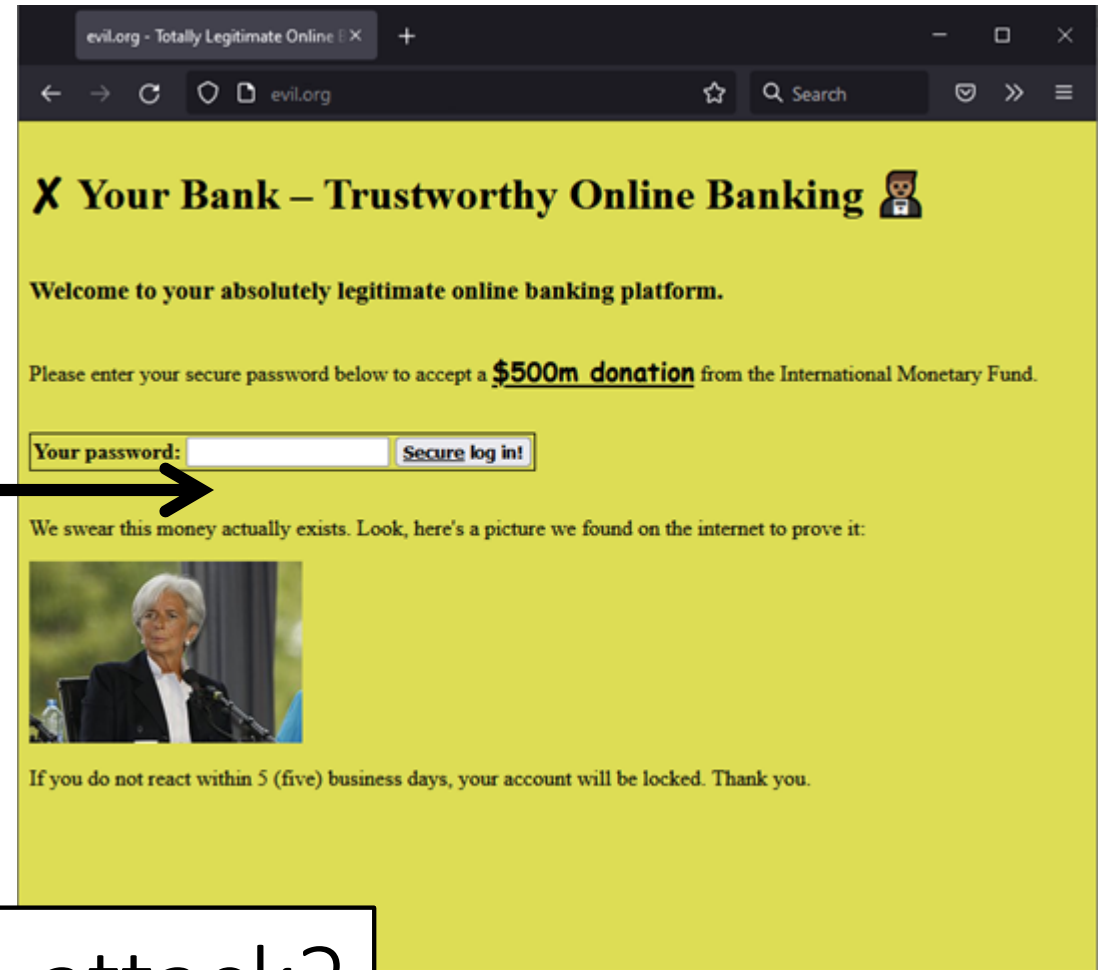
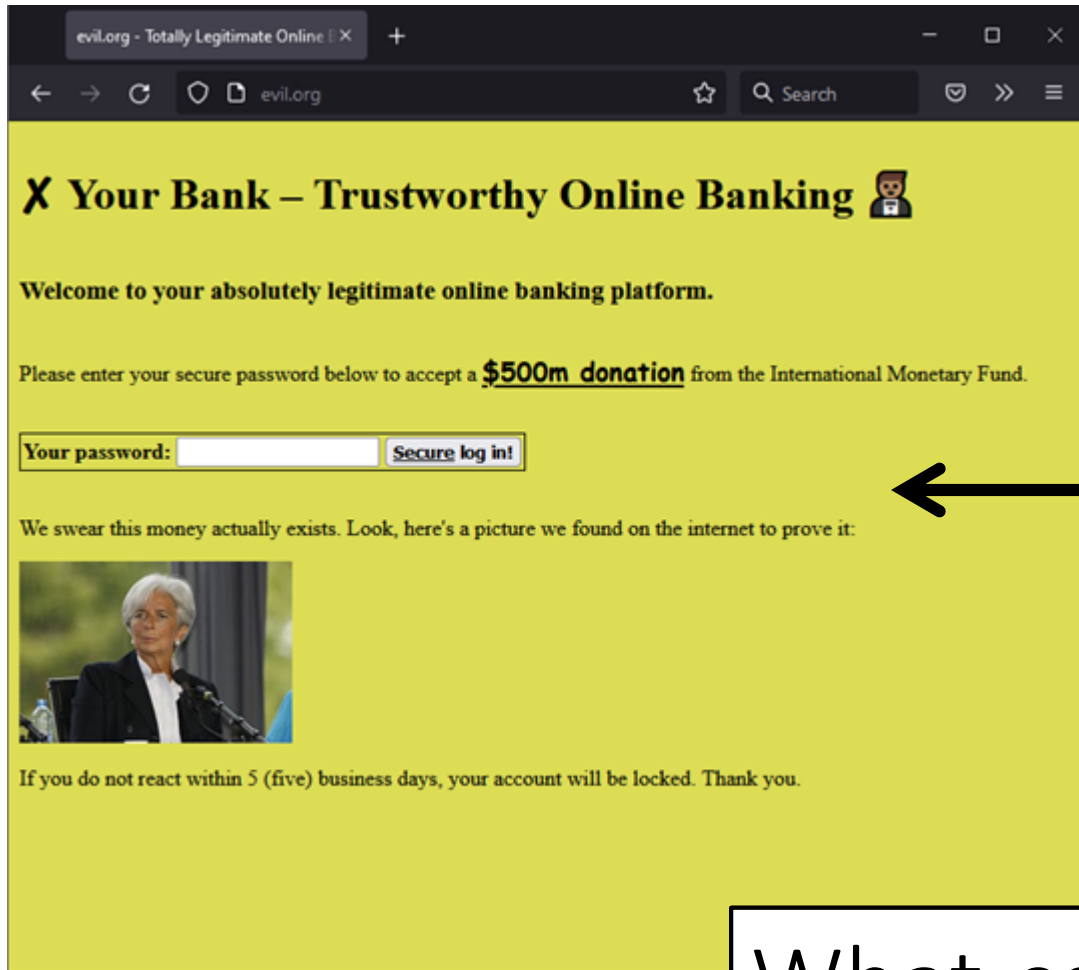
No.

(unless something has gone horribly wrong) 25





What *can* Eve attack?



What can Eve attack?  
The current tab.



evil.org - Totally Legitimate Online Banking


# X Your Bank – Trustworthy Online Banking

Welcome to your absolutely legitimate online banking platform.

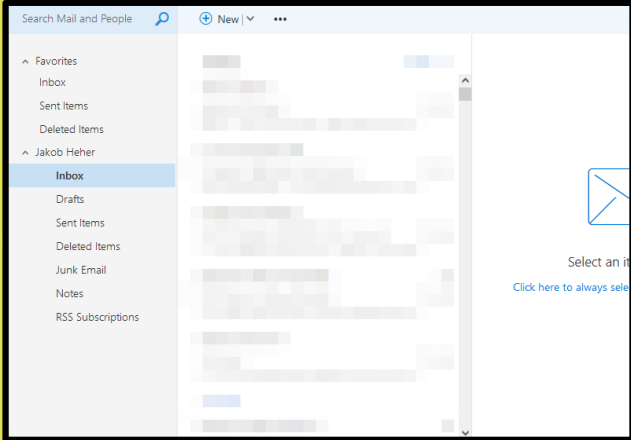
Please enter your secure password below to accept a \$500m donation from the International Monetary Fund.

Your password:  [Secure log in!](#)

We swear this money actually exists. Look, here's a picture we found on the internet to prove it:



If you do not react within 5 (five) business days, your



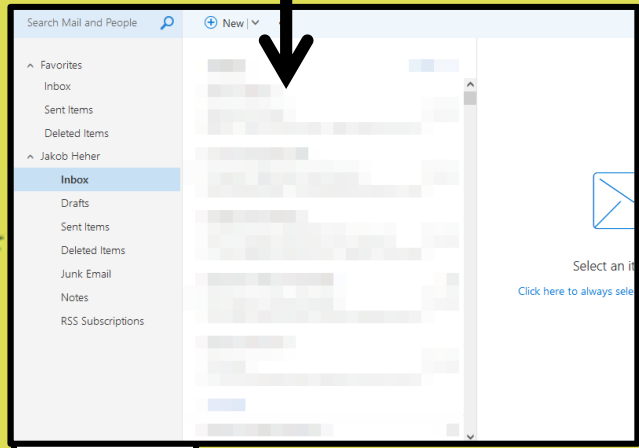
`<iframe>`

The screenshot shows a browser window with the address bar displaying 'evil.org - Totally Legitimate Online'. The page content includes a login form and a video player. A blue callout box on the left lists the origin of the main page: Scheme: http, Host: evil.org, Port: 80. A blue callout box on the right states 'All three need to match!' and shows 'http://google.com/' and 'https://google.com/' with red circles around the schemes and an equals sign between them. A white box with a black border points to the embedded frame and contains the text 'these frames have different origin'. A second blue callout box on the right lists the origin of the embedded frame: Scheme: https, Host: owa.iaik.tugraz.at, Port: 443. A white box with a black border at the bottom identifies the embedded content as '<iframe>'. The background page text includes 'Welcome to your absolutely legitimate online banking platform.', 'Please enter your secure passw', 'Your password:', 'We swear this money actually exists. Look, here', and 'If you do not react within 5 (five) business days, your'.

The screenshot shows a browser window with the address bar displaying 'evil.org - Totally Legitimate Online Banking'. The page has a yellow background and contains the following text and elements:

- Header:** 'X Your Bank – Trustworthy Online Banking' with a person icon.
- Text:** 'Welcome to your absolutely legitimate online banking platform.'
- Text:** 'Please enter your secure password below to accept a \$500m donation from the International Monetary Fund.'
- Form:** A text input field labeled 'Your password:' followed by a 'Secure log in!' button.
- Text:** 'We swear this money actually exists. Look,'
- Image:** A video player showing a woman speaking at a podium.
- Text:** 'If you do not react within 5 (five) business days, your'

no interaction with cross-origin iframe



<iframe>

evil.org - Totally Legitimate Online | X

evil.org Search


# X Your Bank – Trustworthy Online Banking

Welcome to your absolutely legitimate online banking platform.

Please enter your secure password below to accept a \$500m donation from the International Monetary Fund.

Your password:  [Secure log in!](#)

We swear this money actually exists. Look, here's a picture we found on the internet to prove it:



If you do not react within 5 (five) business days, your account will be locked. Thank you.

```
await fetch('https://secure.lawful.org/all_the_dataz.json');  
<script>
```

evil.org - Totally Legitimate Online | X

← → ↻ 🛡️ 📄 evil.org ☆ 🔍 Search 🛡️ >> ☰


# X Your Bank – Trustworthy Online Banking

Welcome to your absolutely legitimate online banking platform.

Please enter your secure password below to accept a **\$500m donation** from the International Monetary Fund.

Your password:

We have found on the internet to prove it:



If you do not react within 5 (five) business days, your account will be locked. Thank you.

```
await fetch('https://secure.lawful.org/all_the_dataz.json');
```

<script>

**❗ Cross-Origin Request Blocked: The Same Origin Policy disallows reading the remote resource at https://secure.lawful.org/all\_the\_dataz.json. (Reason: CORS header 'Access-Control-Allow-Origin' missing). [Learn More]**

- Can only send *safe* requests
- Cannot access response data

limited interaction with cross-origin URL

```
await fetch('https://secure.lawful.org/all_the_dataz.json');
```

<script>

**❗ Cross-Origin Request Blocked: The Same Origin Policy disallows reading the remote resource at https://secure.lawful.org/all\_the\_dataz.json. (Reason: CORS header 'Access-Control-Allow-Origin' missing). [Learn More]**



# What *can* Eve do?

- Send arbitrary GET requests
  - But: response data is inaccessible!

```
await fetch('https://secure.lawful.org/all_the_dataz.json');
```

- Send arbitrary POST requests

```
<form action="https://secure.lawful.org/add_admin_account" method="POST">
```

- Embed arbitrary JavaScript

```
<script src="https://secure.lawful.org/userdata.js?callback=insecure"></script>
```

- Embed arbitrary web pages as iframes

```
<iframe src="http://twitter.com/home?status=Don't%20Click:%20http://tinyurl.com/amgzs6" scrolling="no"></iframe>
```



# What *can* Eve do?

- OK, but why even involve Bob?
  - Eve can make these requests already...

```
await fetch('https://secure.lawful.org/all_the_dataz.json');
```

```
<form action="https://secure.lawful.org/add_admin_account" method="POST">
```

```
<script src="https://secure.lawful.org/userdata.js?callback=insecure"></script>
```

```
<iframe src="http://twitter.com/home?status=Don't%20Click:%20http://tinyurl.com/amgzs6" scrolling="no"></iframe>
```



# What *can* Eve do?

- OK, but why even involve Bob?
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await fetch('https://secure.lawful.org/all_the_dataz.json');
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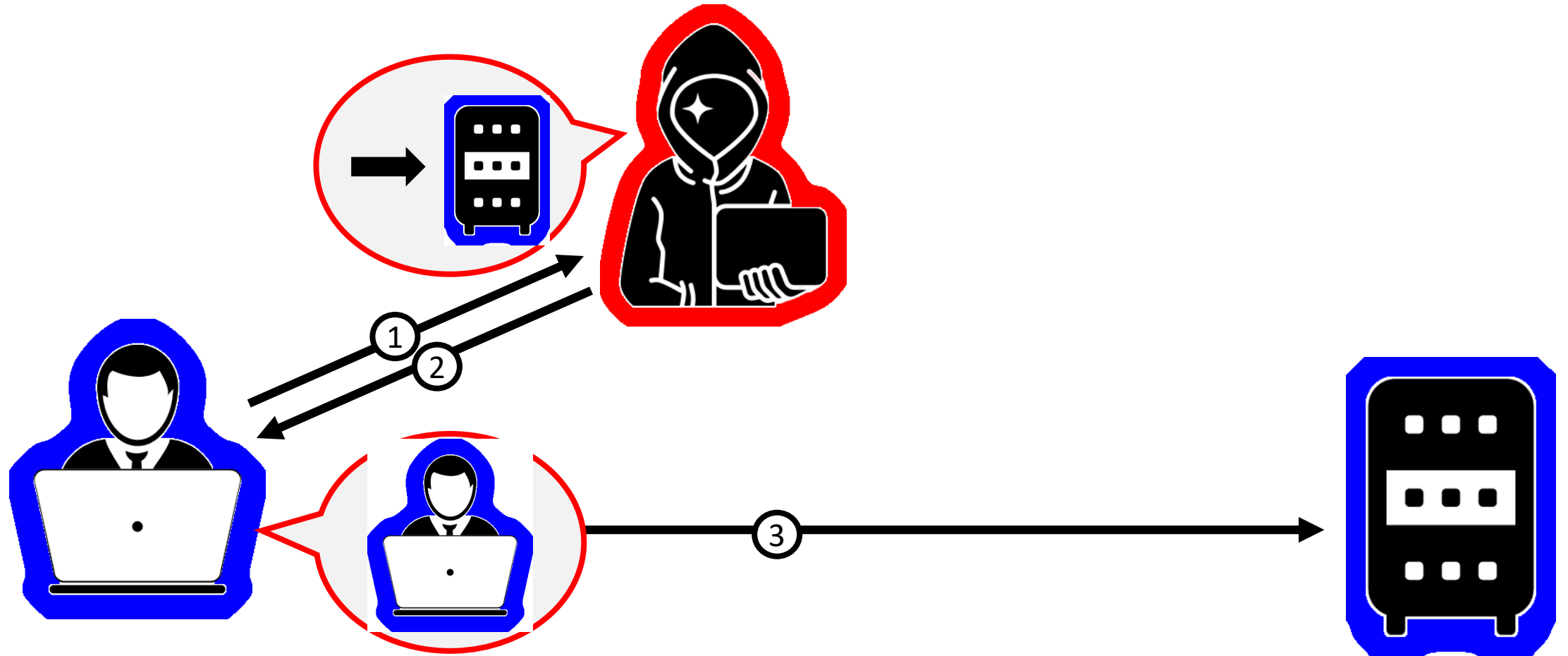
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<form action="https://secure.lawful.org/add_admin_account" method="POST">
```

```
<script src="https://secure.lawful.org/userdata.js?callback=insecure"></script>
```

```
<iframe src="http://twitter.com/home?status=Don't%20Click:%20http://tinyurl.com/amgz56" scrolling="no"></iframe>
```

- Eve cares that it's *Bob* making these requests!
  - Eve cares about *permissions* that Bob has
  - Eve cares about the action being *attributed* to Bob
- Bob's browser is **authenticated as Bob**





# Web Authentication Techniques

# How does a web server know it's you?

# IP Address



- Is the request is coming from some “secure” address range?
  - Only allow the request if this is true

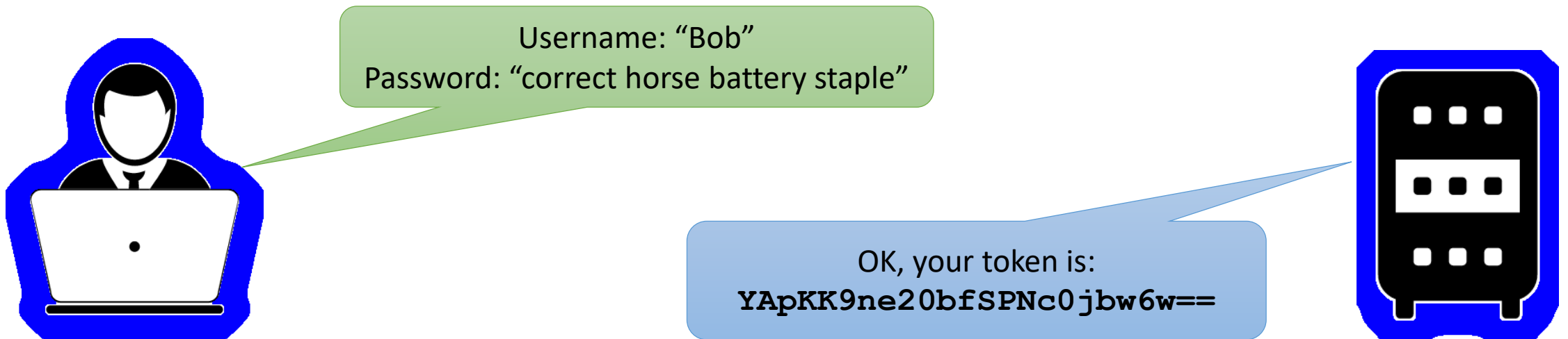
# IP Address



- Is the request is coming from some “secure” address range?
  - Only allow the request if this is true
- Eve can make arbitrary requests in our attack scenario
  - They will all be coming from Bob’s computer!
- But: Eve can’t access the response data
  - Unless we make further mistakes...

# Token-based authentication

- When Bob logs in, Bob gets a *token*
  - Some kind of “special” string



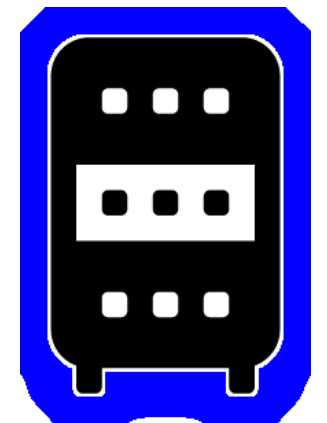


# Token-based authentication

- When Bob logs in, Bob gets a *token*
  - Some kind of “special” string
- To prove it's Bob, the browser sends the token back
  - The server can now verify it's Bob



YApKK9ne20bfSPNc0jbw6w==



# Token-based authentication

Token generation  
“What’s in the token?”

Token storage

“Where does Bob keep the token?”

In the browser, somehow...

- If Eve compromises the token, Eve wins by default
- There are different ways to ask Bob’s browser to store information...

Token storage:

# URL rewriting



- Store the token as a parameter in the URL
  - e.g. `http://genuine.org/view.php?S=YApKK9ne20bfSPNc0jbw`
- Dynamically adjust all links on the site to include the token

Token storage:

# URL rewriting



- Store the token as a parameter in the URL
  - e.g. `http://genuine.org/view.php?S=YApKK9ne20bfSPNc0jbw`
- Dynamically adjust all links on the site to include the token
- Users commonly copy links to your website
  - If Bob copies this URL and sends it to Alice, Alice will be logged in as Bob!
- Thankfully, URL rewriting has (mostly) died out...

Token storage:

# HTTP Cookies



- Server stores a string in the Bob's browser
- Bob's browser sends this string back with any<sup>\*)</sup> request
- Server can verify that it's Bob from this *cookie*

Token storage:

# HTTP Cookies



- Server stores a string in the Bob's browser
  - Bob's browser sends this string back with any<sup>\*)</sup> request
  - Server can verify that it's Bob from this *cookie*
- 
- But won't Bob's browser just send the cookie when Eve asks it to?
    - **Since 2021: No!**

Token storage:

# HTTP Cookies



- HTTP cookies come with a variety of *attributes*:
  - **SameSite**: do not send this for requests started by a different origin
  - **Secure**: only send this over HTTPS
  - **HttpOnly**: not accessible from JavaScript
  - *and others...*
- This attribute lets us protect against Eve's shenanigans!

Token storage:

# HTTP Cookies



- HTTP cookies come with a variety of *attributes*:
  - **SameSite**: do not send this for requests started by a different origin
    - ✓ **SameSite=Strict**: Never send this with a cross-origin request
    - ✓ **SameSite=Lax**: Don't send this with cross-origin requests, except top-level navigation
    - ✗ **SameSite=None**: Send this with any request, even cross-origin



Token storage:

# HTTP Cookies




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  - **SameSite**: do not send this for requests started by a different origin
    - ✓ **SameSite=Strict**: Never send this with a cross-origin request
    - ✓ **SameSite=Lax**: Don't send this with cross-origin requests, except top-level navigation
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- What's *top-level navigation*?
  - Navigation that changes the URL bar
  - Important: this can only ever be a HTTP **GET** request
  - Bob is also leaving the site, so Eve can no longer interact with him

Token storage:

# HTTP Cookies



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  - **SameSite**: do not send this for requests started by a different origin
    - ✓ **SameSite=Strict**: Never send this with a cross-origin request
    - ✓ **SameSite=Lax**: Don't send this with cross-origin requests, except top-level navigation
    - ✗ **SameSite=None**: Send this with any request, even cross-origin  Default before 2021
- What's *top-level navigation*?
  - Navigation that changes the URL bar
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Token storage:

# HTTP Cookies



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    - **SameSite**: do not send this for requests started by a different origin
      - ✓ **SameSite=Strict**: Never send this with a cross-origin request
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      - X **SameSite=None**: Send this with any request, even cross-origin
- Default since 2021!
- What's *top-level navigation*?
    - Navigation that changes the URL bar
    - Important: this can only ever be a HTTP **GET** request
    - Bob is also leaving the site, so Eve can no longer interact with him

# What *can* Eve do?

- Send arbitrary GET requests
  - But: response data is inaccessible!

```
await fetch('https://secure.lawful.org/all_the_dataz.json');
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- Send arbitrary POST requests

```
<form action="https://secure.lawful.org/add_admin_account" method="POST">
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- Embed arbitrary JavaScript

```
<script src="https://secure.lawful.org/userdata.js?callback=insecure"></script>
```

- Embed arbitrary web pages as iframes

```
<iframe src="http://twitter.com/home?status=Don't%20Click:%20http://tinyurl.com/amgzs6" scrolling="no"></iframe>
```



# What *can* Eve do?

- Navigate Bob to arbitrary URLs

```
window.location = 'https://secure.lawful.org/create_admin_account.php?user=eve&password=evulz'
```

## CON recap

- A HTTP **GET** request retrieves a resource
- HTTP **GET** requests should not modify resources
  - Making the same **GET** request multiple times should be safe
- Method functionality is by convention
  - Nothing is stopping you from deleting a file when a **GET** request is made...



# What *can* Eve do?

- Navigate Bob to arbitrary URLs

```
window.location = 'https://secure.lawful.org/create_admin_account.php?user=eve&password=evulz';
```

- Cross-Site Request Forgery
  - Significantly harder with the **SameSite=Lax** default
  - With the **None** default, forging POST forms was possible
- Badly-designed websites might still be vulnerable
  - Never let **GET** have side effects!
  - Never trust URL parameters, even from trusted users!



Token storage:

# JavaScript localStorage



- Persistent key/value store in the browser
- Each origin has its own **localStorage**
- Not sent anywhere by default
  - JavaScript explicitly reads the token and sends it when necessary
  - Eve's site can't do this, because it has its own **localStorage**
- Eve can embed a genuine page in an **<iframe>**!
  - The genuine JavaScript runs in the **<iframe>**
  - It has the ability to access **localStorage**

evil.org - Totally Legitimate Online | X

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# X Your Bank – Trustworthy Online Banking

Welcome to your absolutely legitimate online banking platform.

Please enter your secure password below to accept a **\$500m donation** from the International Monetary Fund.

Your password:  [Secure log in!](#)

We swear this money actually exists. Look,



If you do not react within 5 (five) business days, your


no interaction with cross-origin iframe

<iframe>



Save The Animals! × + - □ ×


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Pet the kitten! Ignore the kitten!

Save The Animals! × + - □ ×

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Thanks for petting the kitten!

C:\Users\jakob.heher\example\_web\kitten.html - Notepad++ [Administrator]

File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?



kitten.html

```
1 <html>
2   <head>
3     <title>Save The Animals!</title>
4     <style>
5       body { position: relative; }
6       img { height: 200px; }
7       iframe {
8         position: absolute; opacity: 0;
9         left: -40px;
10        top: 145px;
11      }
12    </style>
13  </head>
14  <body>
15    
16    <div><button>Pet the kitten!</button> <button>Ignore the kitten!</button></div>
17    <iframe src="http://lawful.org:8000/create_admin_account.html?username=Eve&password=evulz"></iframe>
18  </body>
19  <script type="text/javascript">
20    document.body.addEventListener('click', (e) =>
21    {
22      console.log(e,e.target);
23      if (e.target.closest('iframe'))
24        document.getElementsByTagName('div')[0].innerText = 'Thanks for petting the kitten!';
25    });
26  </script>
27 </html>
28
```

C:\Users\jakob.heher\example\_web\kitten.html - Notepad++ [Administrator]

File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?




kitten.html

```
1 <html>
2   <head>
3     <title>Save The Animals!</title>
4     <style>
5       body { position: relative; }
6       img { height: 200px; }
7       iframe {
8         position: absolute; opacity: 0.8;
9         left: -40px;
10        top: 145px;
11      }
12    </style>
13  </head>
14  <body>
15    
16    <div><button>Pet the kitten!</button> <button>Ignore the kitten!</button></div>
17    <iframe src="http://lawful.org:8000/create_admin_account.html?username=Eve&password=evulz"></iframe>
18  </body>
19  <script type="text/javascript">
20    document.body.addEventListener('click', (e) =>
21    {
22      console.log(e,e.target);
23      if (e.target.closest('iframe'))
24        document.getElementsByTagName('div')[0].innerText = 'Thanks for petting the kitten!';
25    });
26  </script>
27 </html>
28
```

Save The Animals! × + - □ ×

← → ↻ 🔒 evil.org:8000/kitten.html ☆ >> ≡



Username:

Password:

ignore the kitten!

# What *can* Eve do?

- Embed arbitrary web pages as iframes

```
<iframe src="http://twitter.com/home?status=Don't%20Click:%20http://tinyurl.com/amgzs6" scrolling="no"></iframe>
```

- Clickjacking

- For cookies: significantly harder with the **SameSite=Lax** default
  - **localStorage** is unprotected – the genuine JavaScript still runs
- Countermeasure: **X-Frame-Options** HTTP header
    - Prevents the page from being embedded in an attacker page



# Token-based authentication

## Token generation

“What’s in the token?”

### Stateful validation

- The server remembers the token, and can recognize it
- The token itself is just a “meaningless” random string

### Stateless validation

- The server doesn’t remember the token
- The token can be cryptographically validated somehow

## Token storage

“Where does Bob keep the token?”

In the browser, somehow...


- If Eve compromises the token, Eve wins by default
- There are different ways to ask Bob’s browser to store information...

Token generation:

# Random Session Token



- Server picks a random, “meaningless” session token
- Server remembers that this session token belongs to Bob
- Now Bob is authenticated by this session token
  
- Potential problems:
  - Tokens must be unpredictable (good randomness!)
  - Tokens must be chosen by the server
    - Don’t just create a session for unknown tokens! (**Session Fixation** attacks)
- Not infinitely scalable...



If we’re talking  
millions of users...



Token generation:

# JSON Web Tokens



- Cryptographically signed *claim* (e.g., “I am Bob”)
- Signed by the server
- Server can verify the claim without needing to remember tokens!
  - Might be a different server! (e.g., Login server signs, front-end verifies)

```
const token = base64urlEncoding(header) + '.' + base64urlEncoding(payload) + '.' + base64urlEncoding(signature)
```

- Impossible to “expire” or “invalidate” this token
  - Need to build expiration into the payload!

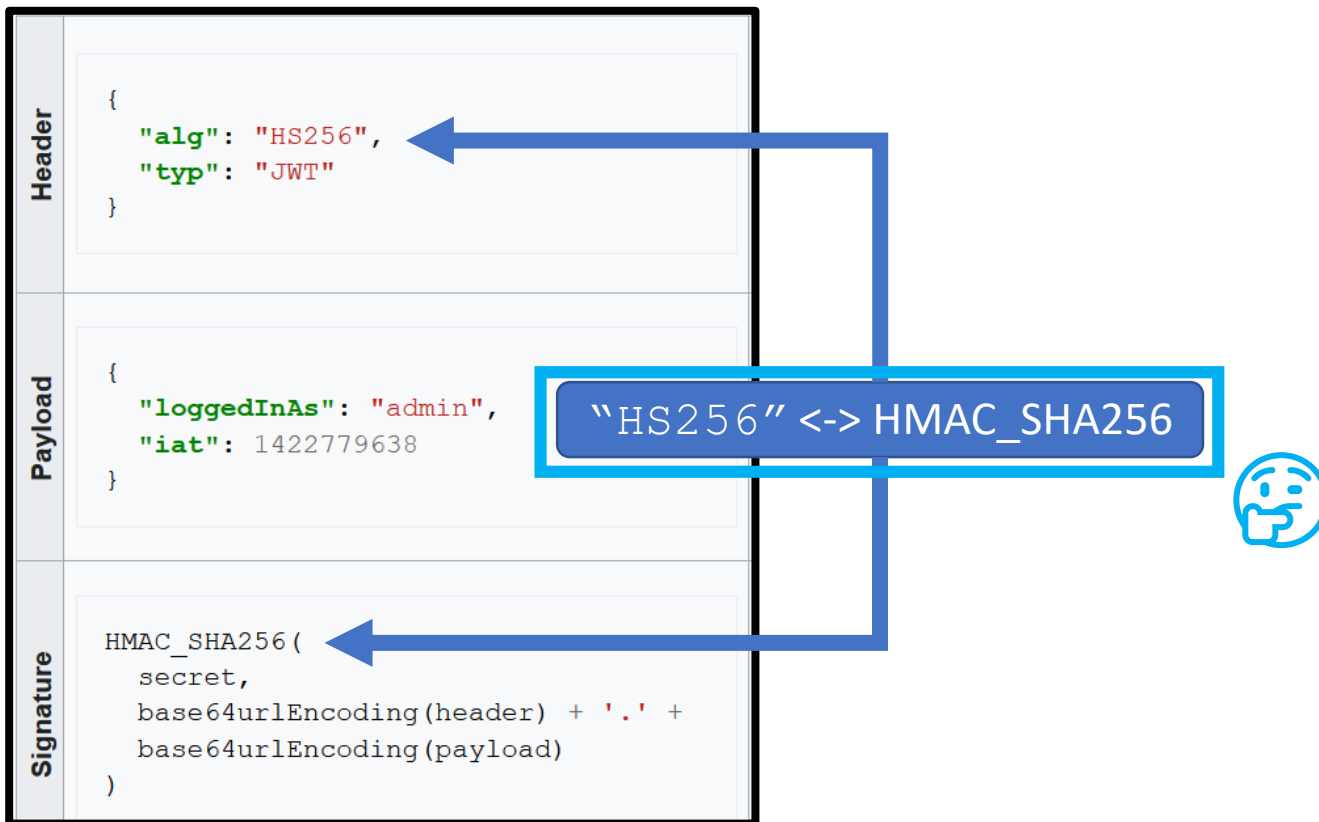
Token generation:

# JSON Web Tokens



- Server can verify the claim without needing to remember tokens!

```
const token = base64urlEncoding(header) + '.' + base64urlEncoding(payload) + '.' + base64urlEncoding(signature)
```



Token generation:

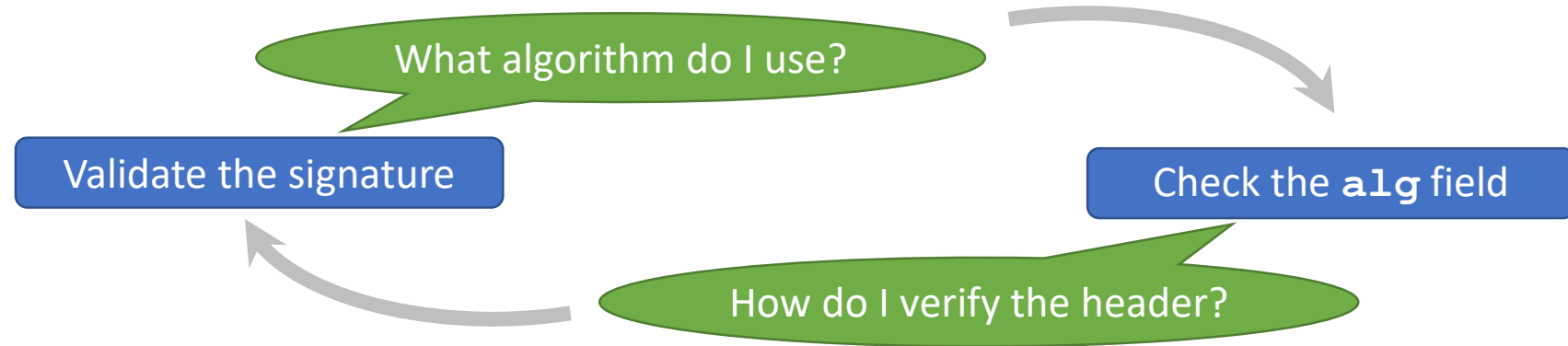
# JSON Web Tokens



- Server can verify the claim without needing to remember tokens!

```
const token = base64urlEncoding(header) + '.' + base64urlEncoding(payload) + '.' + base64urlEncoding(signature)
```

Header	<pre>{   "alg": "HS256",   "typ": "JWT" }</pre>
Payload	<pre>{   "loggedInAs": "admin",   "iat": 1422779638 }</pre>
Signature	<pre>HMAC_SHA256(   secret,   base64urlEncoding(header) + '.' +   base64urlEncoding(payload) )</pre>



Token generation:

# JSON Web Tokens



- Server can verify the claim without needing to remember tokens!

```
const token = base64urlEncoding(header) + '.' + base64urlEncoding(payload) + '.' + base64urlEncoding(signature)
```

- **Never** trust the **alg** field
  - You should already know what algorithm your tokens use!
- Potential shenanigans:
  - **alg: "none"**
  - **alg: "hs256" <-> alg: "rs256"**



Symmetric crypto



Public key crypto

Taking the gloves off:

# Cross-Origin Resource Sharing



- Sometimes we actually *want to* let cross-origin JavaScript access data!
  - Example: **timeshare.company.org** queries **ical.company.org**



```
await fetch('http://ical.company.org/employee_time.ics');
```



**!** Cross-Origin Request Blocked: The Same Origin Policy disallows reading the remote resource (Reason: CORS header 'Access-Control-Allow-Origin' missing). [\[Learn More\]](#)

Taking the gloves off:

# Cross-Origin Resource Sharing



- Sometimes we actually *want to* let cross-origin JavaScript access data!
  - Example: `timeshare.company.org` queries `ical.company.org`



- The **Access-Control-Allow-Origin** HTTP header is required
  - Sent by the (potential) “victim” resource

**X Access-Control-Allow-Origin: \***

This is okay for public data APIs

- Allows *any* origin (including `evil.org`!) to get response data

**✓ Access-Control-Allow-Origin: `https://timeshare.company.org`**

- Allows *only the specified origin* to get response data
- Need multiple origins? Check the **Origin** header on the incoming request!

Will be `https://timeshare.company.org`