

Week 8: Lecture A

Introduction to The Web

Tuesday, October 14, 2025

Announcements

- **Project 2: AppSec** released
 - **Deadline: this Thursday** by 11:59PM

Project 2: Application Security

Deadline: Thursday, October 16 by 11:59PM.

Before you start, review the [course syllabus](#) for the Lateness, Collaboration, and Ethical Use policies.

You may optionally work alone, or in teams of **at most two** and submit **one project per team**. If you have difficulties forming a team, post on [Piazza's Search for Teammates](#) forum. Note that the final exam will cover project material, so you and your partner should collaborate on each part.

The code and other answers your group submits must be entirely your own work, and you are bound by the University's Student Code. You may consult with other students about the conceptualization of the project and the meaning of the questions, but you may not look at any part of someone else's solution or collaborate with anyone outside your group. You may consult published references, provided that you appropriately cite them (e.g., in your code comments). **Don't risk your grade and degree by cheating!**

Complete your work in the **CS 4440 VM**—we will use this same environment for grading. You may not use any **external dependencies**. Use only default Python 3 libraries and/or modules we provide you.

Helpful Resources

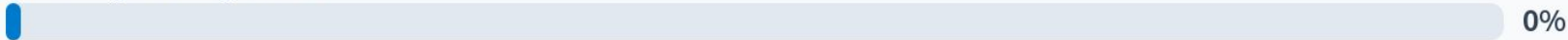
- [The CS 4440 Course Wiki](#)
- [VM Setup and Troubleshooting](#)
- [Terminal Cheat Sheet](#)
- [GDB Cheat Sheet](#)
- [x86 Cheat Sheet](#)
- [C Cheat Sheet](#)

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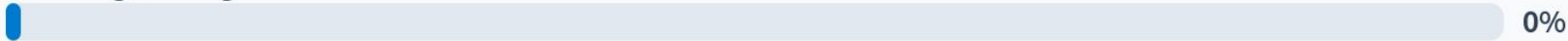
Project 2 Progress Update

Working on Targets 0-2



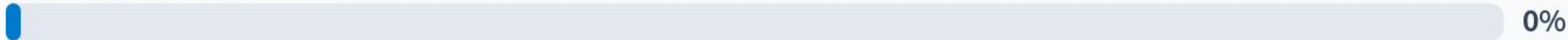
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Working on Targets 3-4



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Working on Targets 5-6



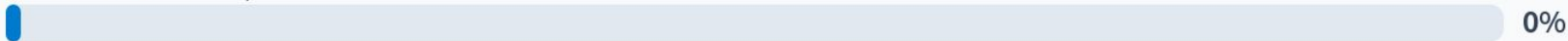
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Finished!



0%

Haven't started :(



0%



Announcements

- **Project 3: WebSec** released
 - **Deadline:** Thursday, November 6th by 11:59PM

Project 3: Web Security

Deadline: Thursday, November 6 by 11:59PM.

Before you start, review the [course syllabus](#) for the Lateness, Collaboration, and Ethical Use policies.

You may optionally work alone, or in teams of **at most two** and submit **one project per team**. If you have difficulties forming a team, post on **Piazza's Search for Teammates** forum. Note that the final exam will cover project material, so you and your partner should collaborate on each part.

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Announcements



ACM Club Callout!

In The Association for Computing Machinery:

- Find like-minded people in the field of computing, and work on projects as a Special Interest Group.
- Gain career and industry connections through lectures by professors and companies.



<- RSVP

Campus
Connect
-->



FREE Pizza!

Officer Elections!

Thurs, Oct 16, 5-6pm MEB 3515



acm.cs.utah.edu



[M uofuacm@gmail.com](mailto:uofuacm@gmail.com)

Announcements

AI and Careers Q&A Panel

When: Thursday Oct 16, 3:45–4:45 PM **Where:** Sorenson Molecular Biotech 2650 SMBB

Come explore key questions shaping the future of work with Artificial Intelligence:

- What is it really like to work with AI in today's industries?
- How is AI transforming different career paths and opportunities?
- How can students prepare now for careers that will involve AI collaboration?
- How do internships or academic research translate into real-world AI careers?

Panelists



Berton Earnshaw

Recursion Pharmaceuticals



Mary Hall

Director & Professor
Kahlert School of Computing



Ashlii Madsen

Senior Vice President
Zions Bancorporation



Abhisek Trivedi

Data Science Manager
Adobe

Suggested Topics

Come prepared with questions about:

- Landing a job in today's market
- Standing out as a new graduate
- How AI is changing careers
- Misconceptions about AI work



RSVP

Hosted by University of Utah • Networking and light refreshments to follow

Stefan Nagy

Announcements

INAUGURAL

STUDENT AI SYMPOSIUM

Student Perspectives: AI and Society

 **DATE:** Friday, November 21, 2025

 **TIME:** 8:00 AM–4:00 PM

 **LOCATION:** Marriott Library - Gould Auditorium

- A platform for students to lead conversations about AI in society.
- Invites faculty to listen and learn from student perspectives.
- Sparks meaningful discussions on AI's impact today and in the future.

LIGHTNING TALK

Share your most impactful use of AI with a 5–10 minute presentation.

RESEARCH PRESENTATION

Share your research or project in a 15–20 minute presentation.

DISCUSS THE IMPLICATIONS FOR

ETHICS

TECHNOLOGY

EDUCATION

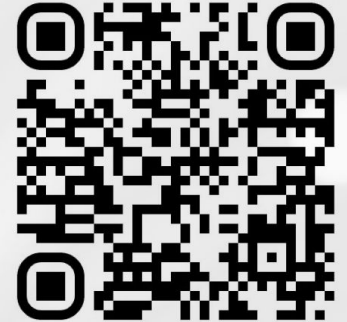
BUSINESS

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APPLY ON CANVAS

SUBMISSION DEADLINE
OCTOBER 31, 2025



Announcements



WHAT

STUDENT TEAMS OF ALL SKILL LEVELS
WITH INDUSTRY MENTORS

WHEN

Friday, October 24
4:30 PM - 12:00 AM

WHERE

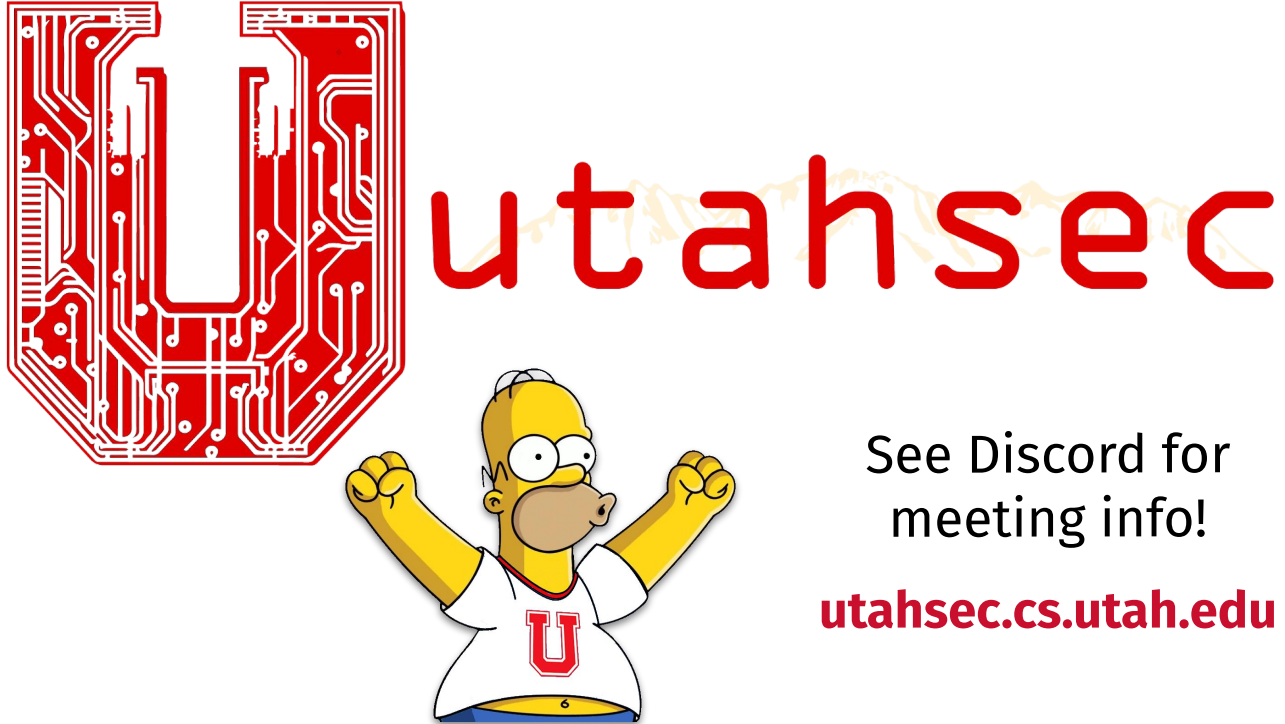
WEB 1230
72 S Central Campus Dr
Salt Lake City, UT 84112

REGISTER



SCAN THE QR CODE
FOR MORE DETAILS
AND TO REGISTER

Announcements



See Discord for
meeting info!

utahsec.cs.utah.edu

Questions?



Last time on CS 4440...

Malware
Today's Malware "Zoo"
Malware Detection and Prevention

Malware: Malicious Software

- Definition: ???



Malware: Malicious Software

- **Definition:** software (more generally, a set of instructions) that runs on a computer it **doesn't have access to** and/or does **something nefarious**
- **Goals of Malware: ???**



Malware: Malicious Software

- **Definition:** software (more generally, a set of instructions) that runs on a computer it **doesn't have access to** and/or does **something nefarious**
- **Goals of Malware:**
 - Steal private data
 - Display ads, send spam
 - Damage local machine
 - Congest a network
 - Attack other systems on the network
 - Commit online fraud
 - Gain, then grant, unauthorized access
 - Up to the attacker(s) really...



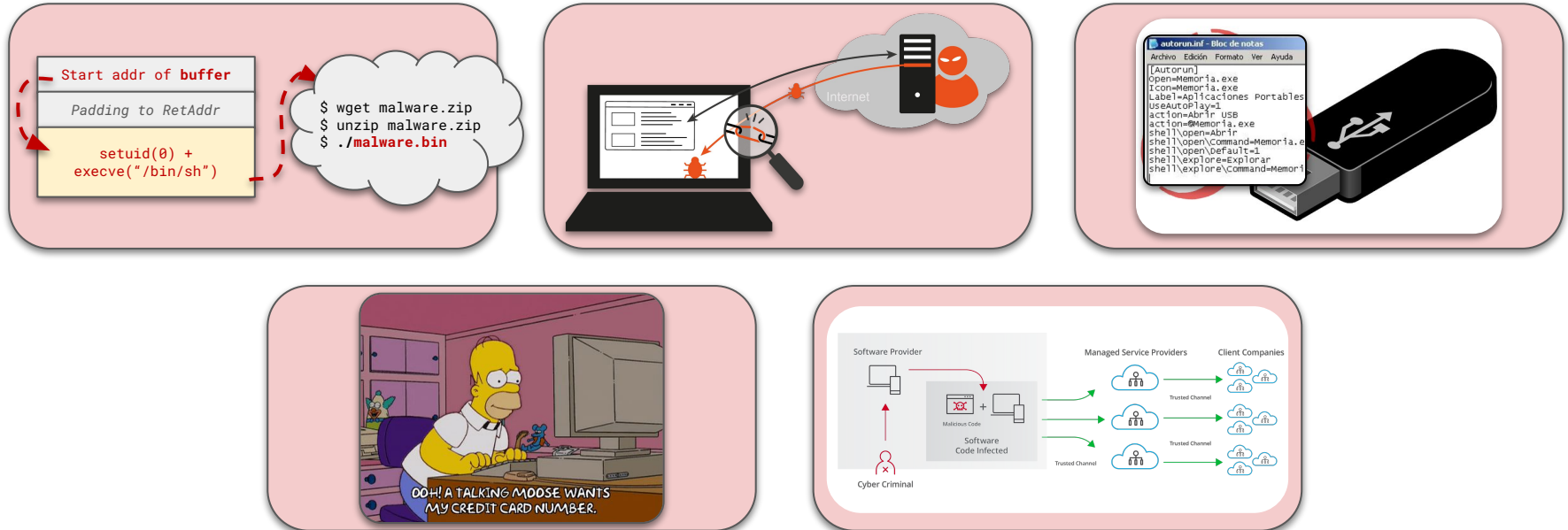
Malware Infection

- **How** does malicious software get on victim computers in the first place?



Malware Infection

- **How** does malicious software get on victim computers in the first place?



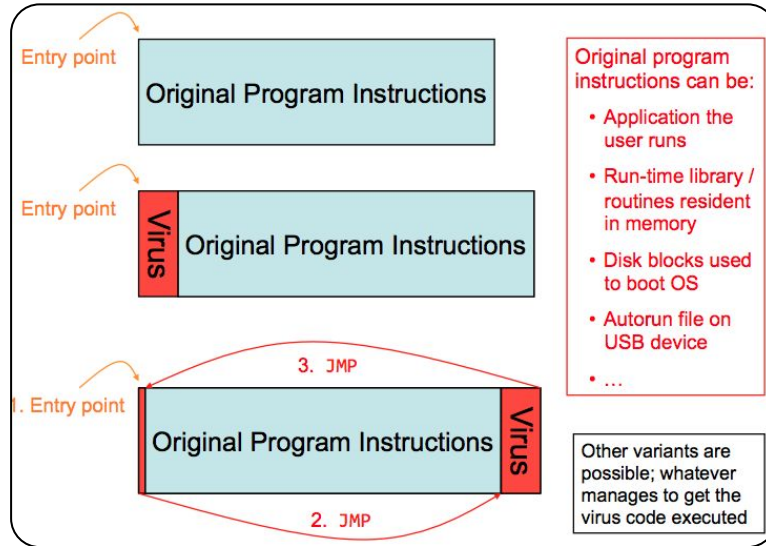
Summary: Major Malware Types

- **Virus**
 - ???

Summary: Major Malware Types

■ Virus

- Self-replicating software that **infects other programs**, mutates itself to avoid detection



Different types of computer viruses

- | | |
|--|---|
|  Polymorphic virus |  Browser hijacker |
|  Multipartite virus |  Web scripting virus |
|  Boot sector virus |  Network virus |
|  File infector |  Macro virus |
|  Overwrite virus | |

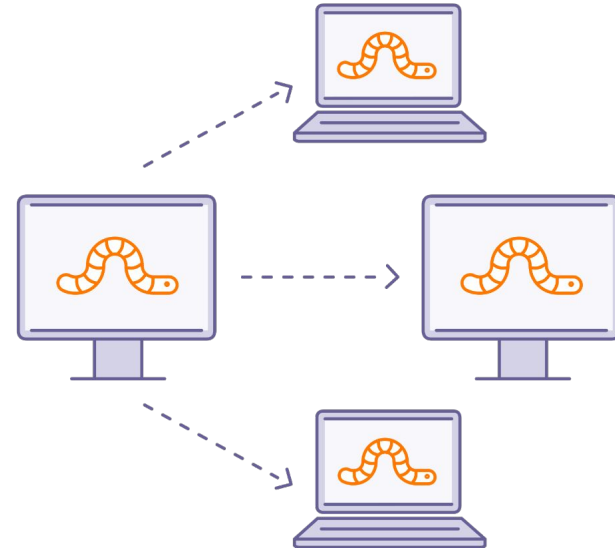
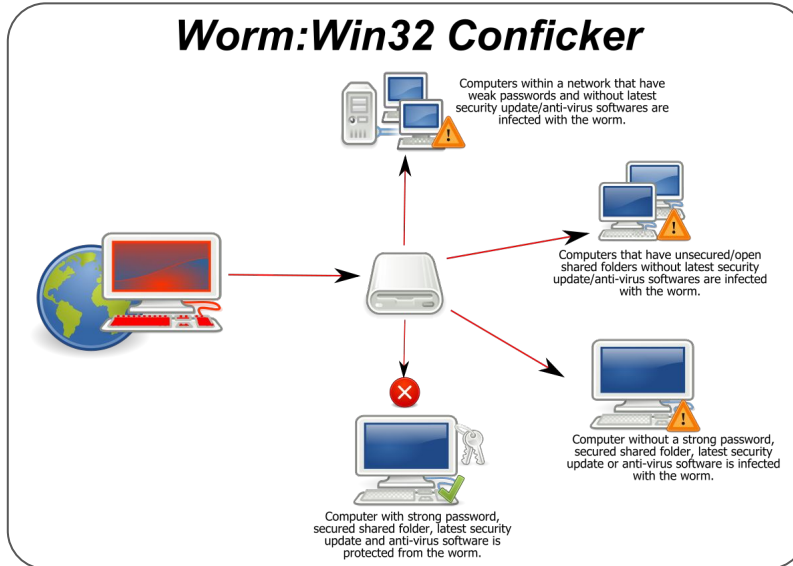
Summary: Major Malware Types

- **Worm**
 - ???

Summary: Major Malware Types

■ Worm

- Self-replicating software that **spreads** over networks to infect programs on other systems



Summary: Major Malware Types

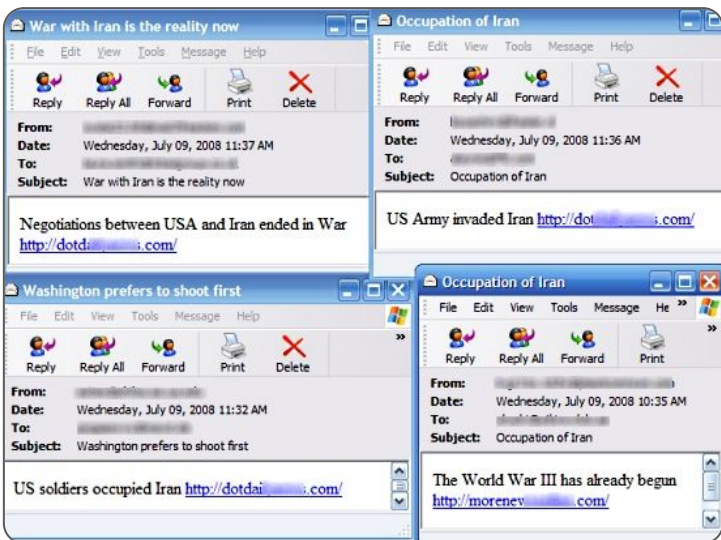
- **Trojans**

- ???

Summary: Major Malware Types

■ Trojans

- Appears to perform desirable function, but does something **malicious behind the scenes**



Summary: Major Malware Types

- **Adware**

- ???

Summary: Major Malware Types

■ Adware

- Software that incessantly **displays advertisements**; often bundled with other malware



Summary: Major Malware Types

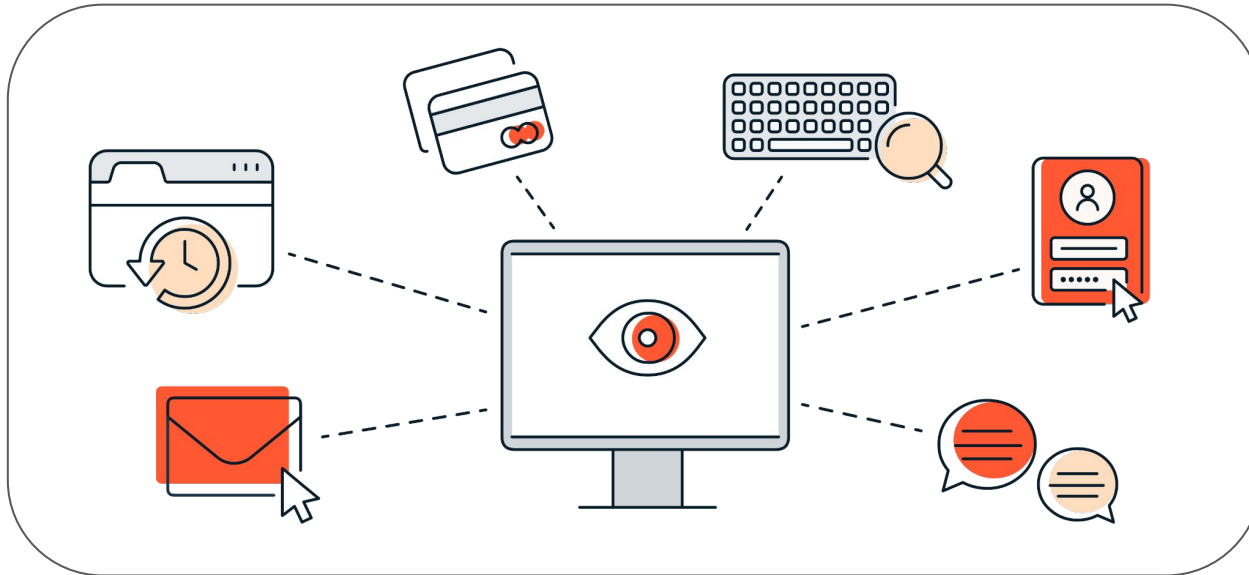
- **Spyware**

- ???

Summary: Major Malware Types

■ Spyware

- Software that tracks, collects, and exfiltrates **sensitive user information**



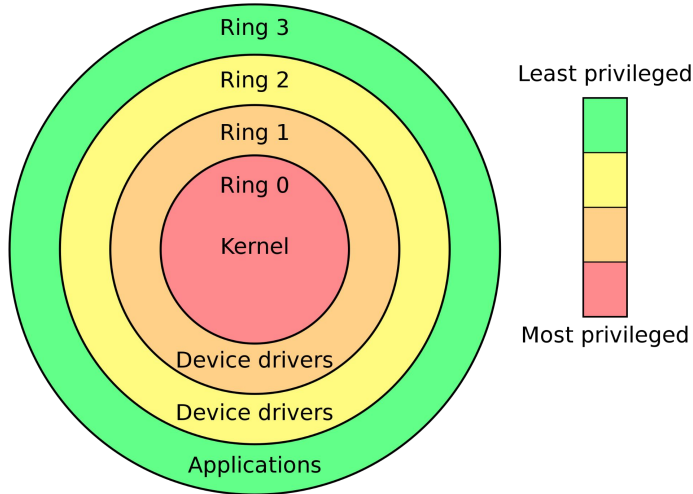
Summary: Major Malware Types

- **Rootkit**
 - ???

Summary: Major Malware Types

■ Rootkit

- Malware that uses stealth to achieve **persistent, privileged control** over a victim machine



GMER 1.0.14.14536

Type	Name	Value
Device	\Driver\BTHUSB \Device\00000097	bthport.sys (Bluetooth Bus Driver/Micr...
Device	\Driver\BTHUSB \Device\00000099	bthport.sys (Bluetooth Bus Driver/Micr...
AttachedD...	\FileSystem\Fastfat \Fat	ftmgr.sys (Microsoft Filesystem Filter ...
Library	c:\windows\system32\z [*** hidden ***] @ C:\WINDOWS\system32\services.exe [680]	0x6A300000
Library	c:\windows\system32\z [*** hidden ***] @ C:\WINDOWS\Explorer.EXE [1568]	0x6A300000
Reg	HKLM\SYSTEM\CurrentControlSet\Services\BTHPORT\Parameters\Keys\005056cdd03	
Reg	HKLM\SYSTEM\CurrentControlSet\Services\BTHPORT\Parameters\Keys\040cce23b9f5	
Reg	HKLM\SYSTEM\CurrentControlSet\Services\BTHPORT\Parameters\Keys\14109fd4869e	
Reg	HKLM\SYSTEM\ControlSet003\Services\BTHPORT\Parameters\Keys\005056cdd03	
Reg	HKLM\SYSTEM\ControlSet003\Services\BTHPORT\Parameters\Keys\040cce23b9f5	
Reg	HKLM\SYSTEM\ControlSet003\Services\BTHPORT\Parameters\Keys\14109fd4869e	

Summary: Major Malware Types

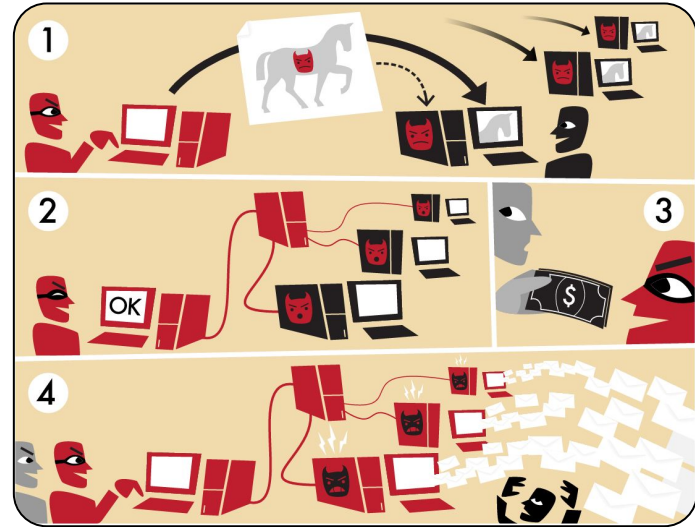
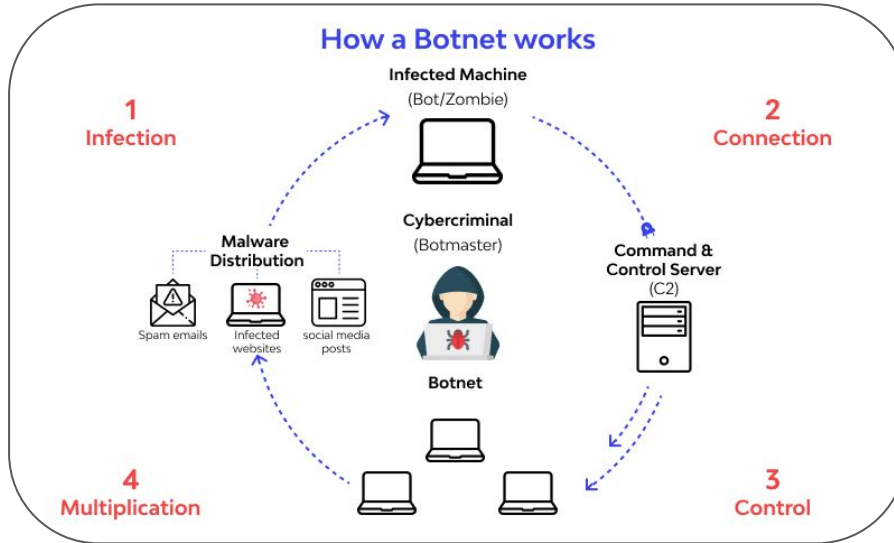
- **Botnet**

- ???

Summary: Major Malware Types

■ Botnet

- A network of **compromised “zombie” or “bot” computers** that do a botmaster’s bidding



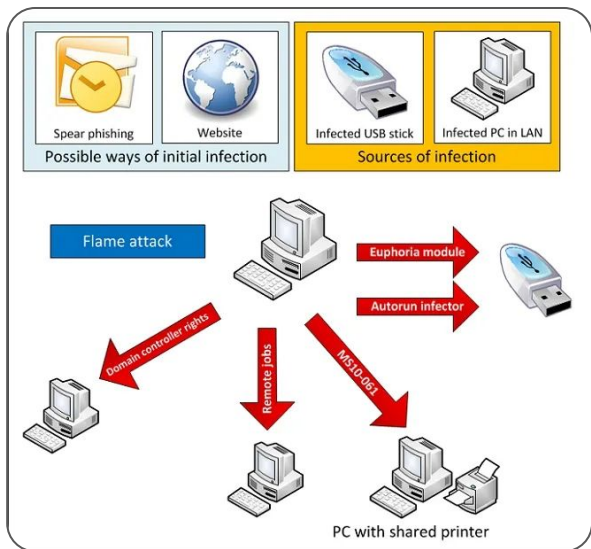
Summary: Major Malware Types

- **Advanced Persistent Threat**
 - ???

Summary: Major Malware Types

■ Advanced Persistent Threat

- Combined threats, usually targeting a specific entity; **extremely sophisticated and stealthy**



Detection

- **Anti-virus software**
 - Software for detecting, eliminate malware
 - E.g., Malwarebytes, Avast, McAfee, Symantec
- **Signature-based anti-virus:**
 - ???
- **Heuristic-based anti-virus:**
 - ???



Detection

- **Anti-virus software**

- Software for detecting, eliminate malware
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- **Signature-based anti-virus:**

- Track identifying strings (like a fingerprint)
- Difficult against mutating viruses

- **Heuristic-based anti-virus:**

- Analyze program behavior, identify unusual patterns
- E.g. network access, file deletion, modify boot sector



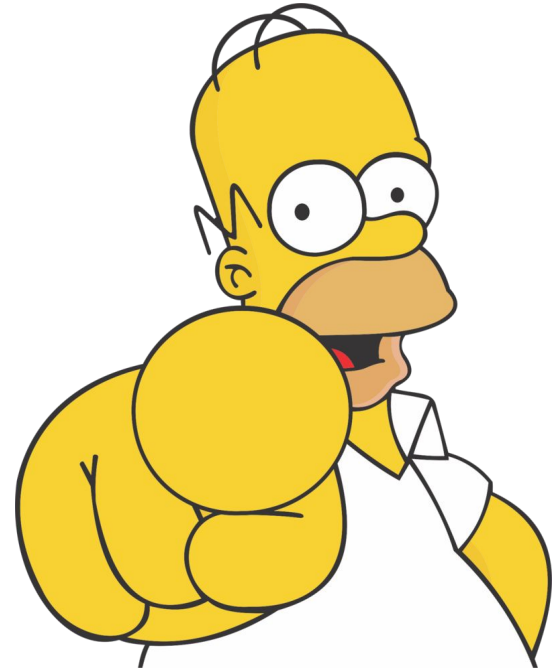
Other Defenses

■ Tripwired Hashes

- Keep hash of known system files
- Periodically re-hash and check
 - If hash changes, **file tampered**

■ Be a **security-conscious** citizen

- Strong passwords, 2-factor authentication
- Do not access suspicious files or websites
 - **Use your intuition: if it seems too good to be true, it probably is!**
- Keep software updated and use anti-virus
- **Teach others!**



Questions?



This time on CS 4440...

The Web
HTML & HTTP
HTTP Cookies
JavaScript
SQL

The Web

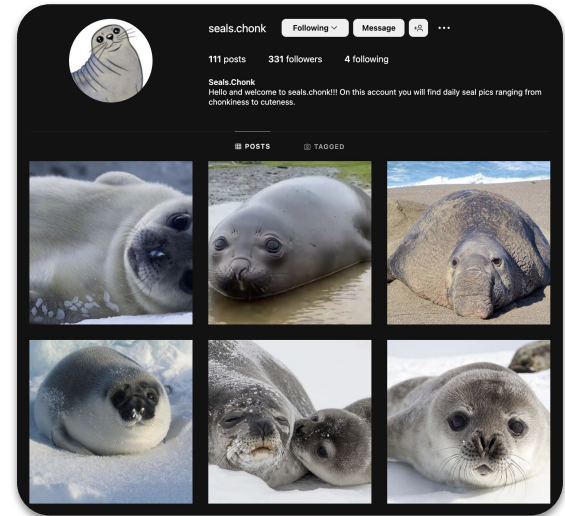
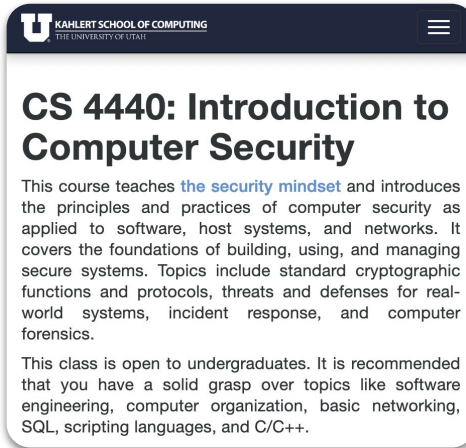
What is the Web?

- **What is it?**

What is the Web?

■ What is it?

- A venue for me to ridicule Broncos fans
- A place to view (and share) pictures of seals
- The location where I host the CS 4440 website



What is the Web?

- What **really** is it?

What is the Web?

- What **really** is it?
 - A platform for deploying applications, **portably** and **securely**



A Historical Perspective

- The web is an example of **bolt-on security**
 - Originally invented to allow physicists to share their research papers
 - Only **textual web pages**, with links to other pages;
no security model



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- Then we added **embedded media** (e.g., images)
 - **Crucial decision:** a page can embed images loaded from another web server
 - Then, **Javascript**, **dynamic HTML**, **AJAX**, **CSS**, **frames**, **audio**, **video**, and **others!**

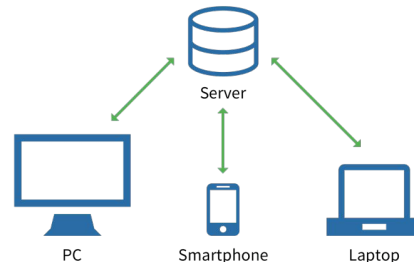


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- Today, a website is a **distributed application**

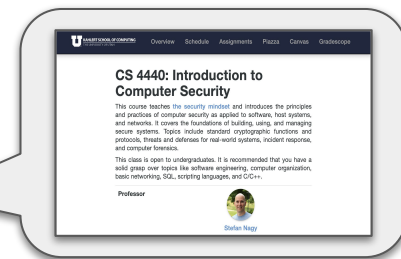


Client-Server Model



Web Security: Two Tales

- **Web Browser** (the **client** side)
 - Attacks targeting **browser security weaknesses** cause:
 - Malware installation (e.g., keyloggers, rootkits)
 - Theft of sensitive data (e.g., files, passwords)



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 - Attacks targeting **browser security weaknesses** cause:
 - Malware installation (e.g., keyloggers, rootkits)
 - Theft of sensitive data (e.g., files, passwords)
- **Web Application** (the **server** side)
 - Runs on **the site** (e.g., e-commerce, blogs)
 - Written in PHP, ASP, JSP, Ruby, etc.
 - Many attacks:
 - Cross-site **Scripting**
 - Cross-site **Request Forgery**
 - **SQL Injection**



Questions?



HTML and HTTP

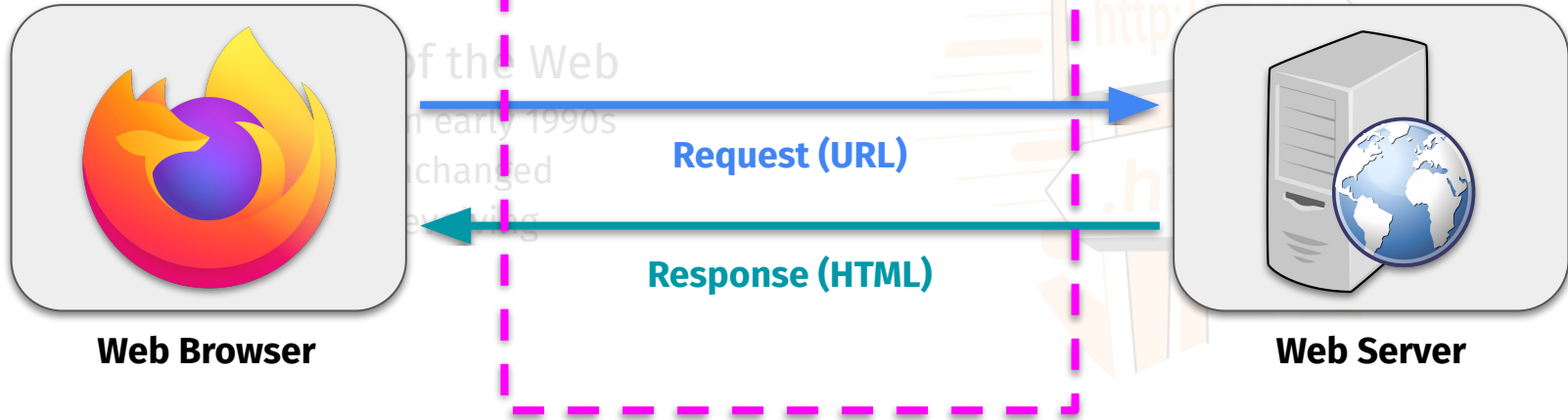
HTML and HTTP

- What are **HTML** and **HTTP**?
 - **HTML** = how we **represent** content
 - **HTTP** = how we **transfer** content
- Key components of the Web
 - Both developed in early 1990s
 - HTTP is mostly unchanged
 - HTML still evolving (albeit slowly)



HTML and HTTP

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 - **HTTP** = how we **transfer** content



HyperText Markup Language (HTML)

- Describes **content** and **formatting** of web pages
 - Rendered within browser window
- **HTML features**
 - **Static** document description language
 - Links to external pages, images by **reference**
 - User input sent to server via **forms**

```
<form action="home.html">  
  First Name:<br>  
  <input type="text" name="first_name">  
</br>  
  Last Name:<br>  
  <input type="text" name="last_name">  
</br>  
  Email:<br>  
  <input type="text" name="email">  
</br>  
  <input type="submit" name="Submit">  
</form>
```



First Name:

Last Name:

Email:

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- **HTML extensions**
 - Additional media (e.g., PDF, videos) via **plugins**
 - Embedding **programs** in other languages (e.g., **Java**) provides **dynamic content** that can:
 - Interacts with the user
 - Modify the browser user interface
 - Access the client computer environment

```
<form action="home.html">
  First Name:<br>
  <input type="text" name="first_name">
</br>
  Last Name:<br>
  <input type="text" name="last_name">
</br>
  Email:<br>
  <input type="text" name="email">
</br>
  <input type="submit" name="Submit">
</form>
```



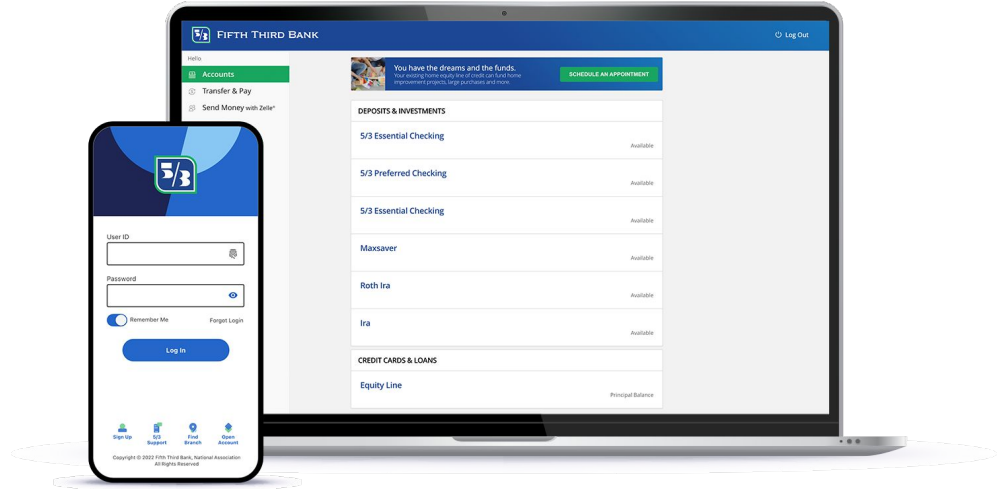
First Name:

Last Name:

Email:

HyperText Transfer Protocol (HTTP)

- **Protocol for transmitting hypermedia documents (e.g., web pages)**
 - Widely used
 - **Simple**
 - **Unencrypted**

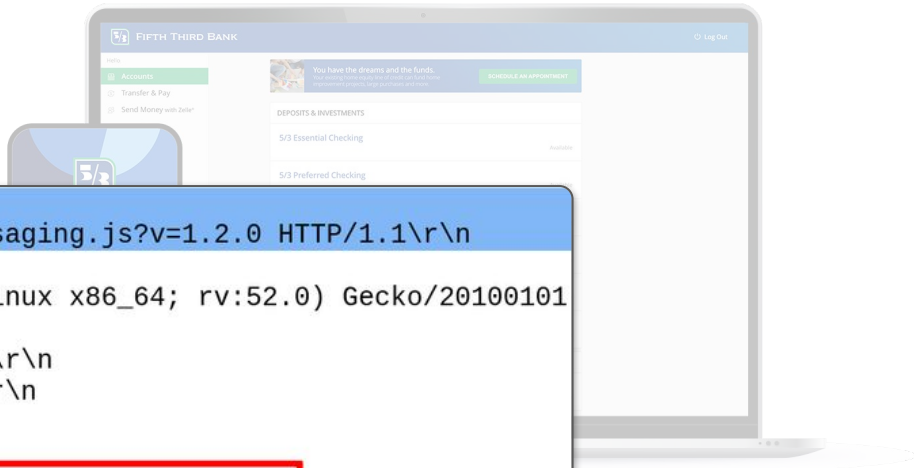


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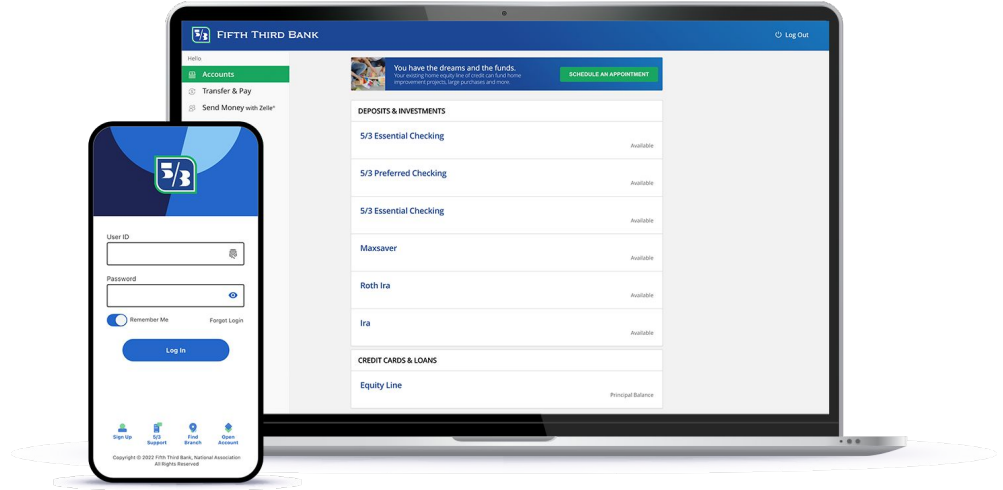
Hypertext Transfer Protocol

```
GET /libs/qimessaging/1.0/qimessaging.js?v=1.2.0 HTTP/1.1\r\n
Host: 10.0.0.6\r\n
User-Agent: Mozilla/5.0 (X11; Linux x86_64; rv:52.0) Gecko/20100101
Accept: */*\r\n
Accept-Language: en-US,en;q=0.5\r\n
Accept-Encoding: gzip, deflate\r\n
Referer: http://10.0.0.6/\r\n
Connection: keep-alive\r\n
Authorization: Basic bmFvOmNhcmVzcnVzLTlIwMDE=\r\n
  Credentials: nao:[REDACTED]\r\n
\r\n
```



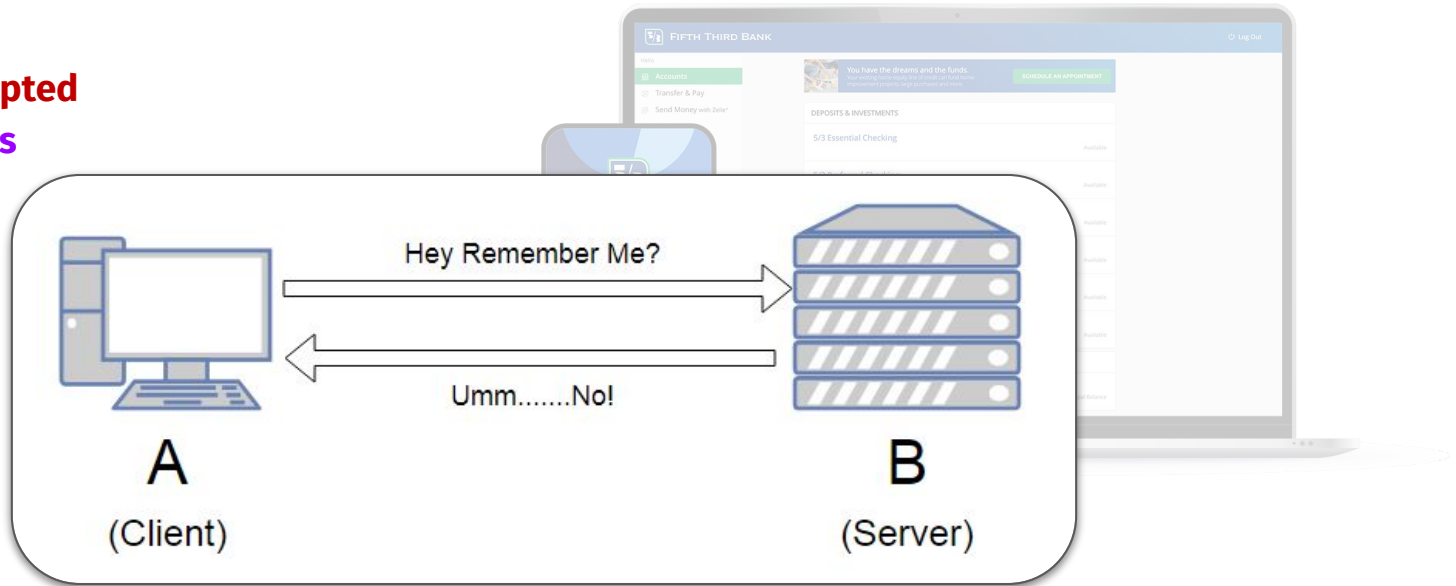
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Uniform Resource Locator (URL)

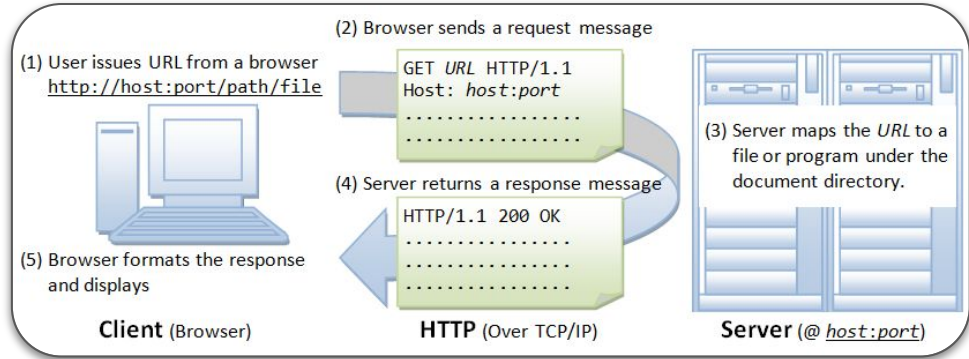
- **Reference to a web resource** (e.g., a website)
 - Specifies its **location** on a computer network
 - Specifies the mechanism for **retrieving it**
- **Example:** `http://www.cs.utah.edu/class?name=cs4440#homework`
 - **Protocol:** How to **retrieve** the web resource
 - **Path:** Identifies the **specific resource** to access (case **insensitive**)
 - **Query:** Assigns values to specified **parameters** (case **sensitive**)
 - **Fragment:** Location of a **resource subordinate** to another

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 - **HTTP**
 - **Path:** Identifies the **specific resource** to access (case **insensitive**)
 - `www.cs.utah.edu/class`
 - **Query:** Assigns values to specified **parameters** (case **sensitive**)
 - `name=cs4440`
 - **Fragment:** Location of a **resource subordinate** to another
 - `#homework`

HTTP Requests

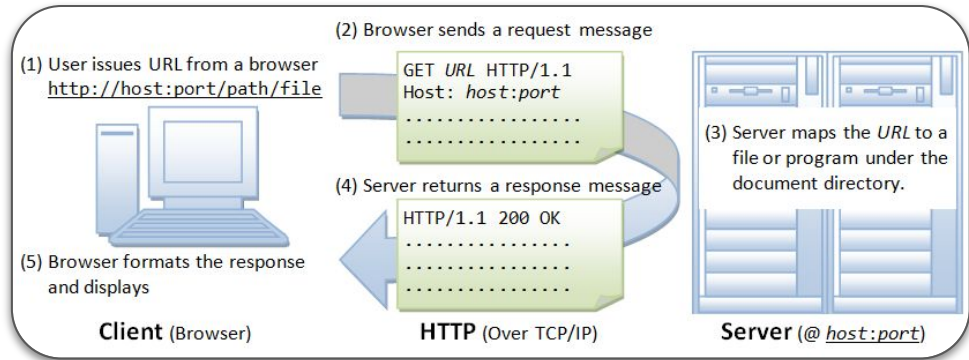
- **Browser (client):**
 1. **Open** connection
 2. Client sends **request**
 3. Server obtains **resource**
 4. Server **responds** (stateless!)
 5. Display and **close** connection



HTTP Requests

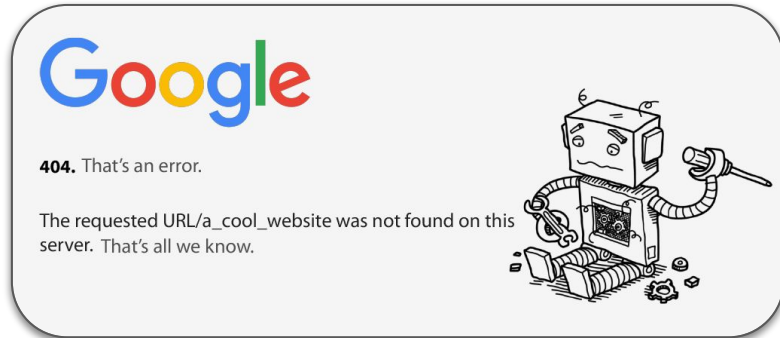
■ Browser (client):

1. **Open** connection
2. Client sends **request**
3. Server obtains **resource**
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5. Display and **close** connection



■ Server Responses:

- "200 OK"
- "304 Document moved"
- "404 Not found"
- "400 Bad request"



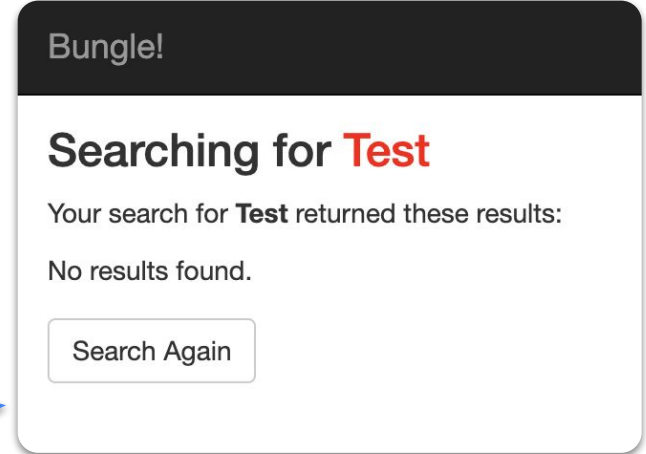
HTTP Requests

- **Two types** of HTTP requests: **GET** and **POST**
 - **GET requests:** set within the request's **URL**
- What does this example request do?

`http://cs4440.eng.utah.edu/project3/search?q=Test`

HTTP Requests

- **Two types** of HTTP requests: **GET** and **POST**
 - **GET requests:** set within the request's **URL**
- What does this example request do?
 - Sets parameter **q** to value **Test** for interface **search**



<http://cs4440.eng.utah.edu/project3/search?q=Test>

HTTP Requests

- **Two types** of HTTP requests: **GET** and **POST**
 - **POST requests:** parameters within request **body**
- What does this example request do?

```
<form action="http://cs4440.eng.utah.edu/project3/login?" method="POST">  
  <input name="username" value="attacker" type="hidden"/>  
  <input name="password" value="l33th4x" type="hidden"/>  
</form>
```

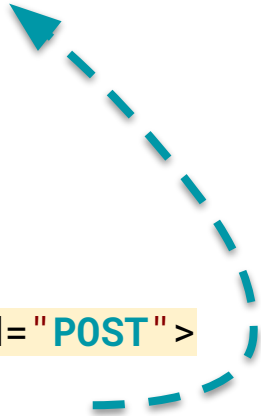
HTTP Requests

- **Two types** of HTTP requests: **GET** and **POST**
 - **POST requests:** parameters within request **body**

Logged in as **attacker**. [Log out](#)

- What does this example request do?
 - Sets **username** to value **attacker** (and type **hidden**) for interface **login**
 - Sets **password** to value **133th4x** (and type **hidden**) for interface **login**

```
<form action="http://cs4440.eng.utah.edu/project3/login?" method="POST">
  <input name="username" value="attacker" type="hidden"/>
  <input name="password" value="133th4x" type="hidden"/>
</form>
```



Questions?



Cookies

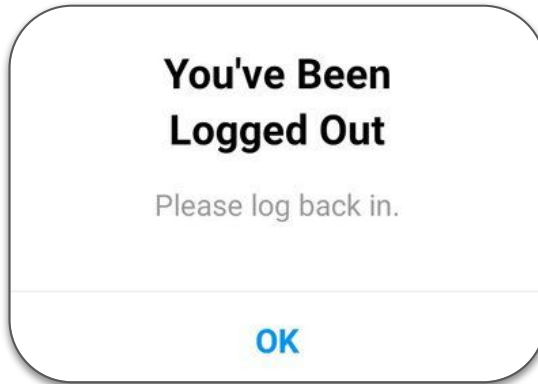
Supporting Stateful Connections

- Stateless connection is impractical—why?

The image displays two user interface elements side-by-side. On the left is a white rounded rectangle with a thin grey border. It contains the text 'You've Been Logged Out' in bold black font, followed by 'Please log back in.' in a smaller grey font, and a blue 'OK' button at the bottom. On the right is a grey rounded rectangle with a thin black border, titled 'Login' in bold black font. It contains two input fields: 'uNID: (e.g. u8675309)' and 'Password:'. Each field has a corresponding 'Forgot your uNID?' and 'Forgot your password?' link to its right. A grey 'LOGIN' button is positioned below the password field.

Supporting Stateful Connections

- **Stateless connection is impractical—why?**
 - **Performance:** cost of **re-transmitting** redundant info
 - **Convenience:** user must perform same **redundant tasks**



Login

uNID: (e.g. u8675309)

[Forgot your uNID?](#)

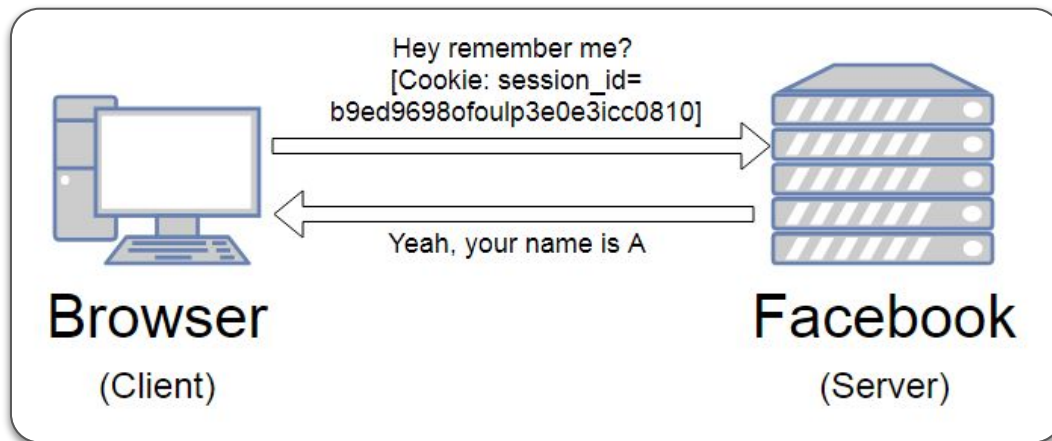
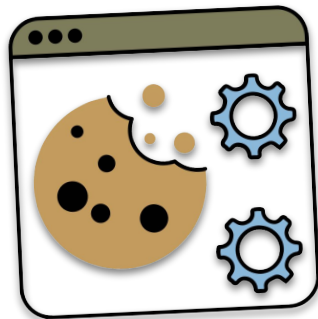
Password:

[Forgot your password?](#)

LOGIN

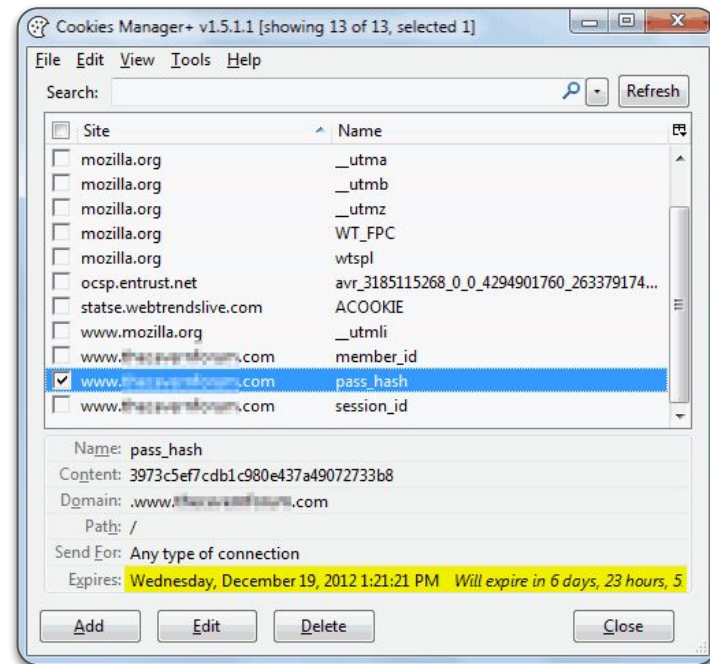
HTTP Cookies

- **Small chunks of info stored on a computer associated with a specific server**
 - When you access a website, it might store information as a cookie
 - Every time you visit that server, the cookie is re-sent to the server
 - Effectively used to **hold state information over multiple sessions**



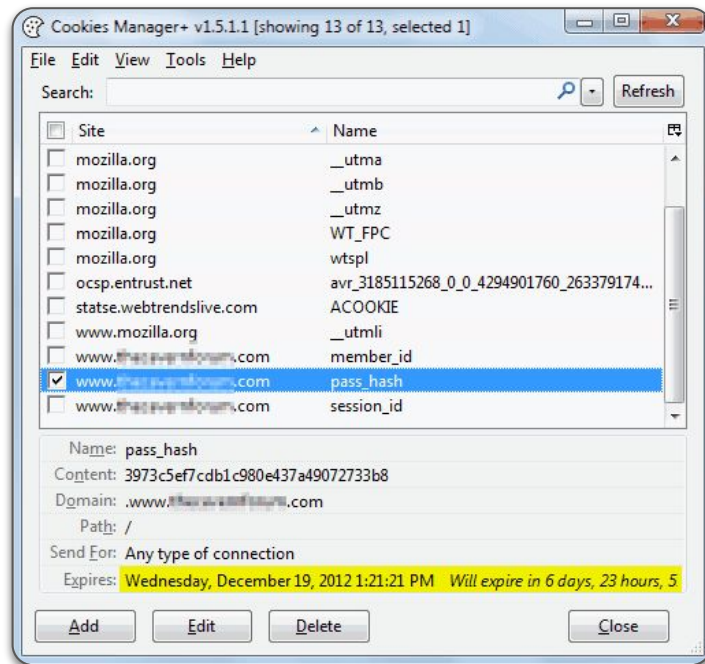
HTTP Cookies

- **Cookies expire!**
 - Date is chosen by server (e.g., **January 1st, 2036**)
 - Thus, any cookies will **stick around for a while!**



HTTP Cookies

- **Cookies expire!**
 - Date is chosen by server (e.g., **January 1st, 2036**)
 - Thus, any cookies will **stick around for a while!**
- **Every large website** that you use today makes use of cookies in some form
 - **“Necessary” cookies**
 - Core functionality like security, accessibility
 - **“Analytics” cookies**
 - Used to collect data about your browsing, or to display you targeted advertisements



HTTP Cookies

- **Cookies can hold any type of information—including sensitive information**
 - Passwords, credit card information, social security numbers, etc.
 - Session cookies, non-persistent cookies, persistent cookies

CWE-315: Cleartext Storage of Sensitive Information in a Cookie

Weakness ID: 315

Abstraction: Variant

Structure: Simple

View customized information:

Conceptual

Operational

Mapping-Friendly

Complete

▼ Description

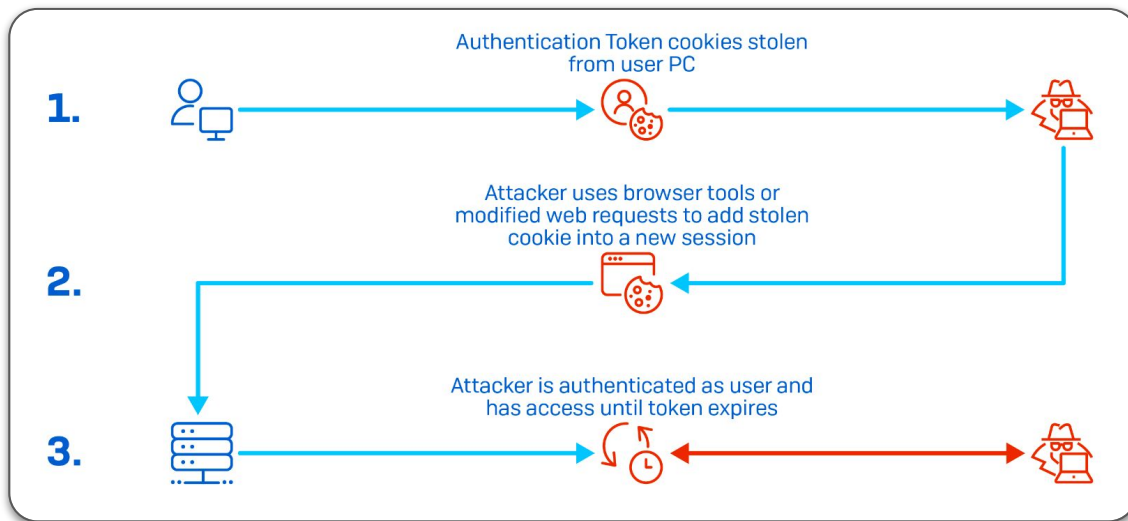
The product stores sensitive information in cleartext in a cookie.

▼ Extended Description

Attackers can use widely-available tools to view the cookie and read the sensitive information. Even if the information is encoded in a way that is not human-readable, certain techniques could determine which encoding is being used, then decode the information.

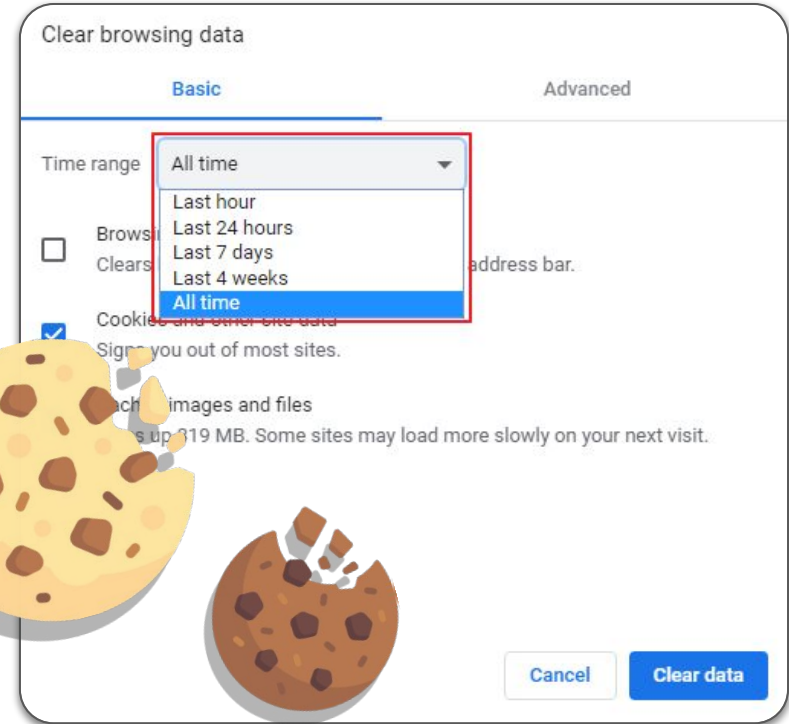
HTTP Cookies

- **Cookies are stored on your computer and can be controlled or manipulated**
 - Many sites require that you enable cookies to access the site's full capabilities
 - Their storage on your computer naturally **lends itself to cookie exploitation**



HTTP Cookies

- You can (and probably should) **clear your cookies regularly**
 - Most browsers nowadays have mechanisms to **disable cookies**
 - You can also choose to **accept** or **exclude** cookies from certain sites



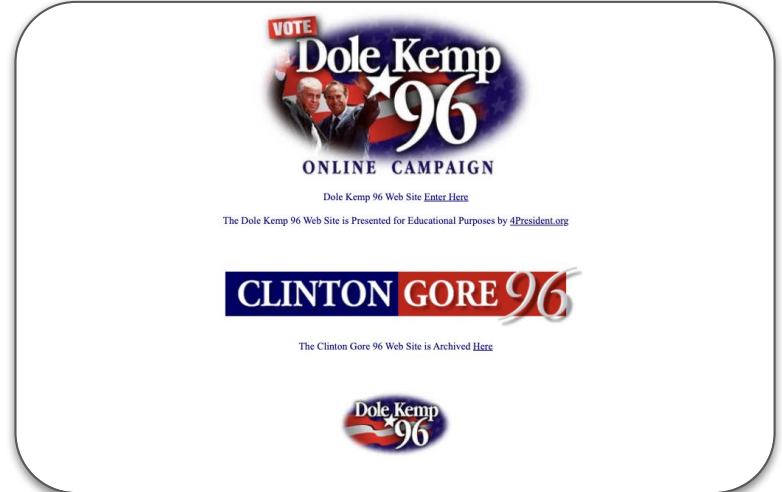
Questions?



JavaScript

From Web 1.0 to Web 2.0

- Recall that HTML is a **static language**
 - Pages are rendered only **once**
 - Ideal for **non-interactive** content
 - E.g., “About Us”, “Contact Us”, etc.



From Web 1.0 to Web 2.0

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 - Enables **richer**, more **interactive** content



From Web 1.0 to Web 2.0

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 - E.g., “About Us”, “Contact Us”, etc.
- Since **Web 1.0**, we’ve evolved to now express web pages as **programs**
 - Enables **richer**, more **interactive** content
 - E.g., the **JavaScript** language

```
1
2 <html>
3 <head>
4 <script>
5   function HelloWorld() {
6     alert("Hello World");
7   }
8 </script>
9 </head>
10 <body onload="HelloWorld()">
11
12 </body>
13 </html>
```

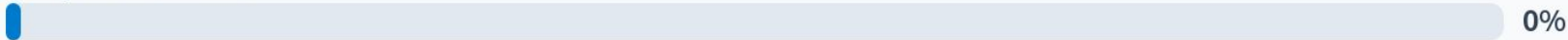
JavaScript

- **A powerful, popular web programming language**
 - Scripts embedded in web pages returned by web server
 - Scripts **executed** by browser (client-side scripting). Can:
 - **Alter contents** of a web page
 - **Track events** (mouse clicks, motion, keystrokes)
 - **Read/set cookies**
 - **Issue web requests** and read replies
- **Note:** despite the name, has *nothing* to do with Java!

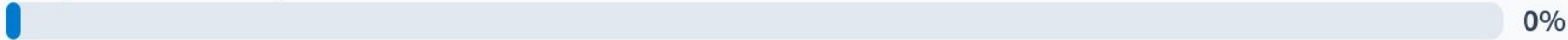


Familiarity with HTML and JavaScript?

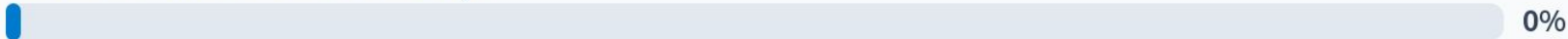
Only some HTML



Only some JavaScript



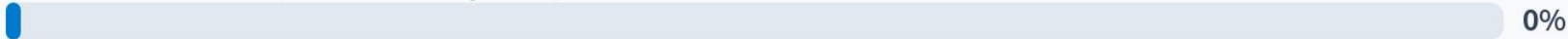
Some of both HTML and JavaScript



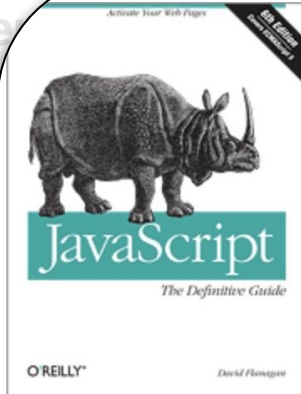
Lots of both HTML and JavaScript



None of the above (which is totally fine!)



JavaScript



JavaScript: The Definitive Guide, 6th Edition

By David Flanagan

Publisher: O'Reilly Media

Release Date: May 2011

Pages: 1096



Since 1996, *JavaScript: The Definitive Guide* has been the bible for JavaScript programmers. It's a comprehensive reference to the core language, the DOM, and the client-side JavaScript API.

The 6th edition covers HTML5 and the latest JavaScript features. It's the best web development practical guide for experienced programmers who want to master it.

"A must-have reference for expert JavaScript programmers...well-organized and detailed."
—Brendan Eich, creator of JavaScript, CTO of Mozilla

"I made a career of what I learned from *JavaScript: The Definitive Guide*."
—Andrew Hedges, Tapulous

JavaScript

A power

- Sc
- Sc



JavaScript: The Good Parts

By Douglas Crockford

Publisher: Yahoo Press

Release Date: December 2008

Pages: 172



Most programming languages contain good and bad parts, but JavaScript was developed and released as a subset of JavaScript that's truly extensible and efficient.

Considered *the* JavaScript example in the development of the language, the abundance of good ideas that make JavaScript an outstanding language, including loose typing, dynamic objects, and an expressive object literal syntax, and the downright awful ideas, like a programming model based on

—Andrew Hedges, Tapulous

JavaScript

For **Project 3**, you'll use just a **tiny subset** of this!



—Andrew Hedges, Tapulous

CS 4440 Wiki: JavaScript Cheat Sheet

CS 4440 Wiki: JavaScript Cheat Sheet

Below is an abridged cheat sheet of JavaScript fundamentals relevant to Project 3.

This page is by no means comprehensive—we encourage you to bookmark and familiarize yourself with one of the many in-depth JavaScript tutorials on the web. Some great examples are:

- [The Official JavaScript Docs](#)
- [HTMLCheetSheet's JS Cheat Sheet](#)
- [W3 Schools' JavaScript Introduction](#)

Executing JavaScript Code

In Project 3, you'll work with three fundamental ways to execute JavaScript code: **on-page scripts** wrapped in HTML code, **functions**, and **event**-driven execution.

On-page scripts:

```
<script>
  /* Code to be executed as the parent HTML code is processed. */
</script>
```

Functions:

```
function foo(){
  /* Code to be executed when this function is called. */
}
```

Table of Contents:

- [Execution](#)
 - [Scripts](#)
 - [Functions](#)
 - [Events](#)
- [Debugging](#)
 - [Alerts](#)
 - [Console](#)
- [Variables](#)
 - [Initialization](#)
 - [Data Typing](#)
- [Strings](#)
 - [Length](#)
 - [Appending](#)
 - [Substrings](#)
 - [Splitting](#)
- [Arrays](#)
 - [Indexing](#)
- [Requests](#)
 - [GET requests](#)
 - [POST requests](#)
- [Access Elements](#)
 - [DOM tree](#)
 - [Cookies](#)

Embedding JavaScript within HTML

- Code enclosed within **<script>** tags

Embedding JavaScript within HTML

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- **Defining functions**

```
<script type="text/javascript">  
    function hello() { alert("Hello world!"); }  
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Embedding JavaScript within HTML

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- **Event handlers** embedded in HTML

```

```

Embedding JavaScript within HTML

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    function hello() { alert("Hello world!"); }  
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```

- **Event handlers** embedded in HTML

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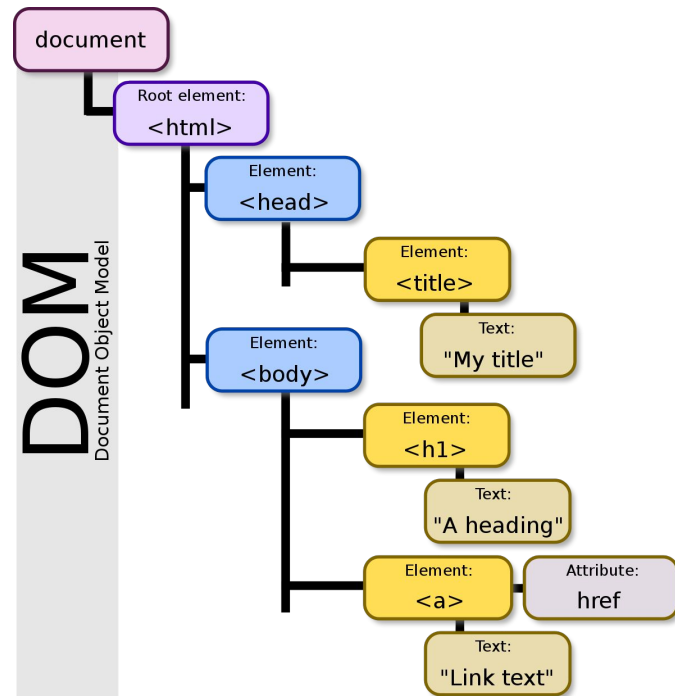
```

- **Built-in functions** can change content of a window: **click-jacking attack**

```
<a onMouseUp="window.open('http://www.evilsite.com')"  
href="http://www.trustedsite.com/">Trust me!?!</a>
```

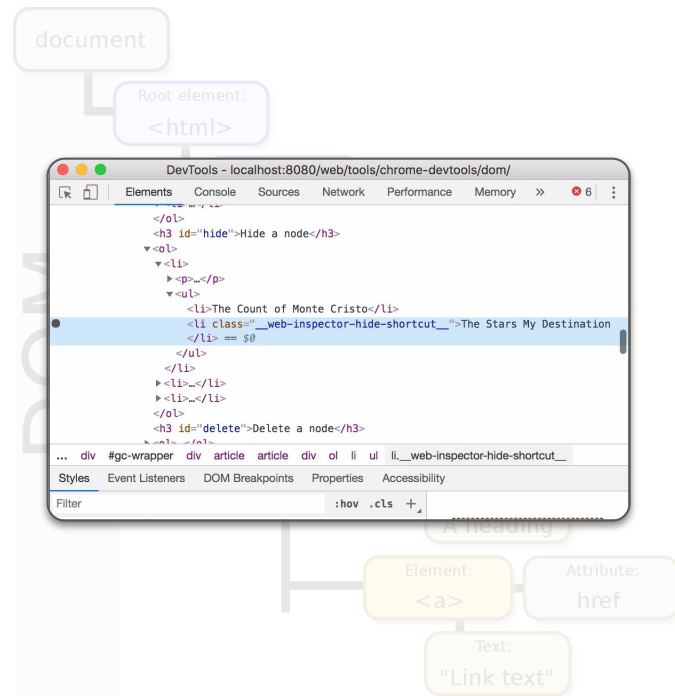
Document Object Model (DOM Tree)

- **Platform- and language-neutral interface**
 - Allows programs and scripts to dynamically **access/update** document **content**, **structure**, **style**
- Backbone of modern web browser plugins



Document Object Model (DOM Tree)

- **Platform- and language-neutral interface**
 - Allows programs and scripts to dynamically **access/update** document **content**, **structure**, **style**
- Backbone of modern web browser plugins
- You can access and update the DOM Tree yourself via browser's **web developer tools**
 - You will get familiar with this in **Project 3!**

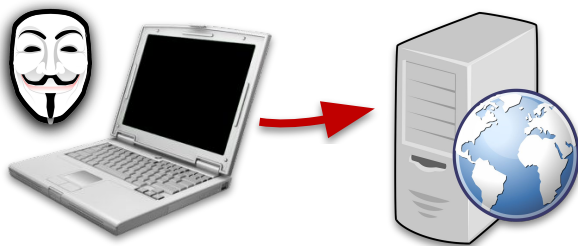


Questions?

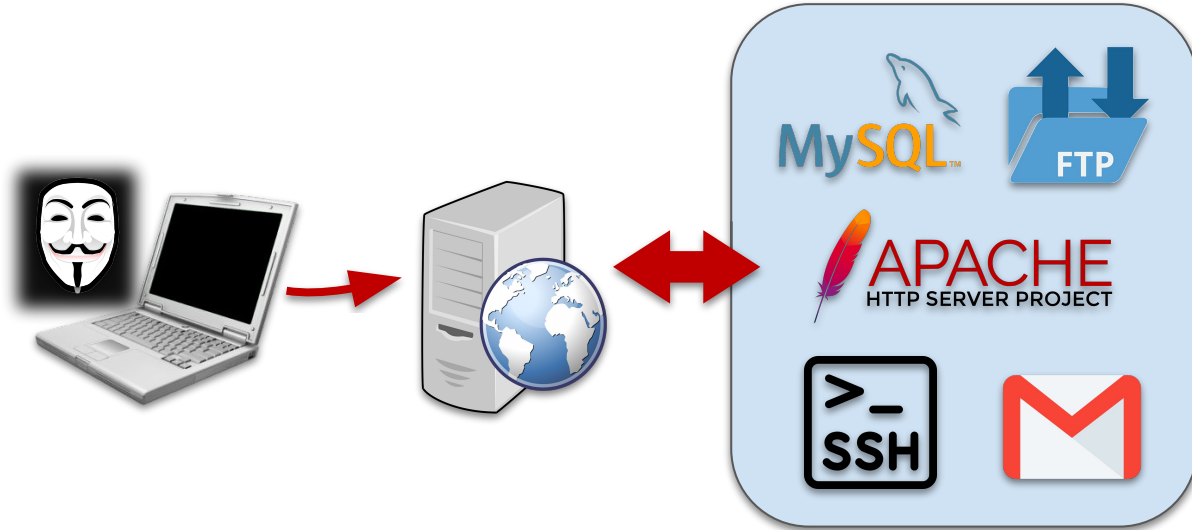


SQL

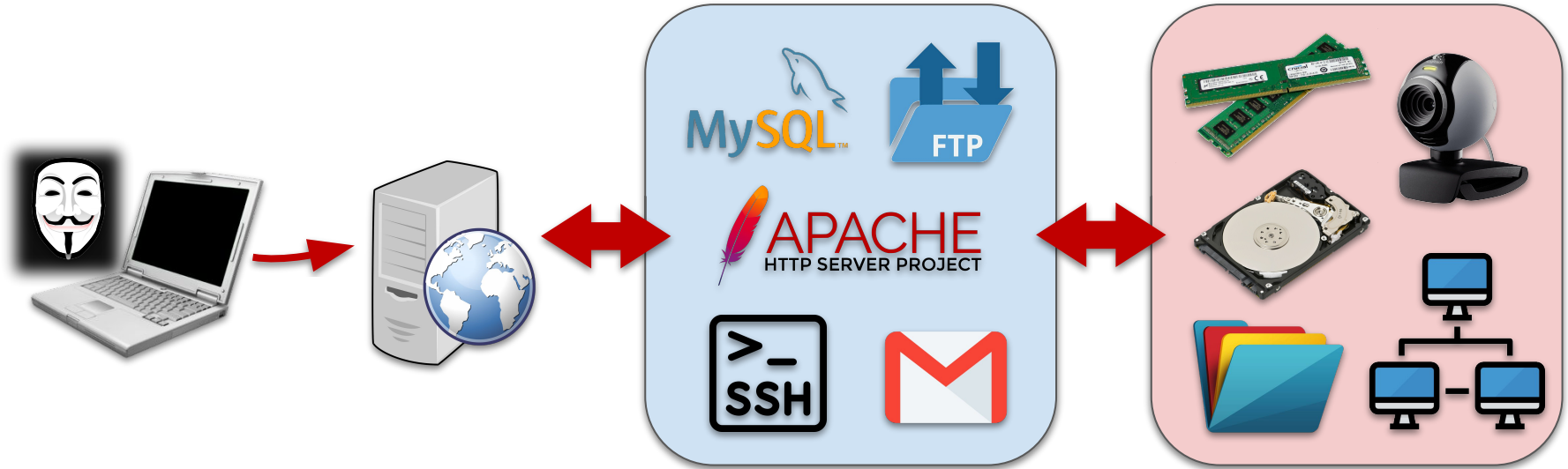
Server-side vs. Client-side Scripting



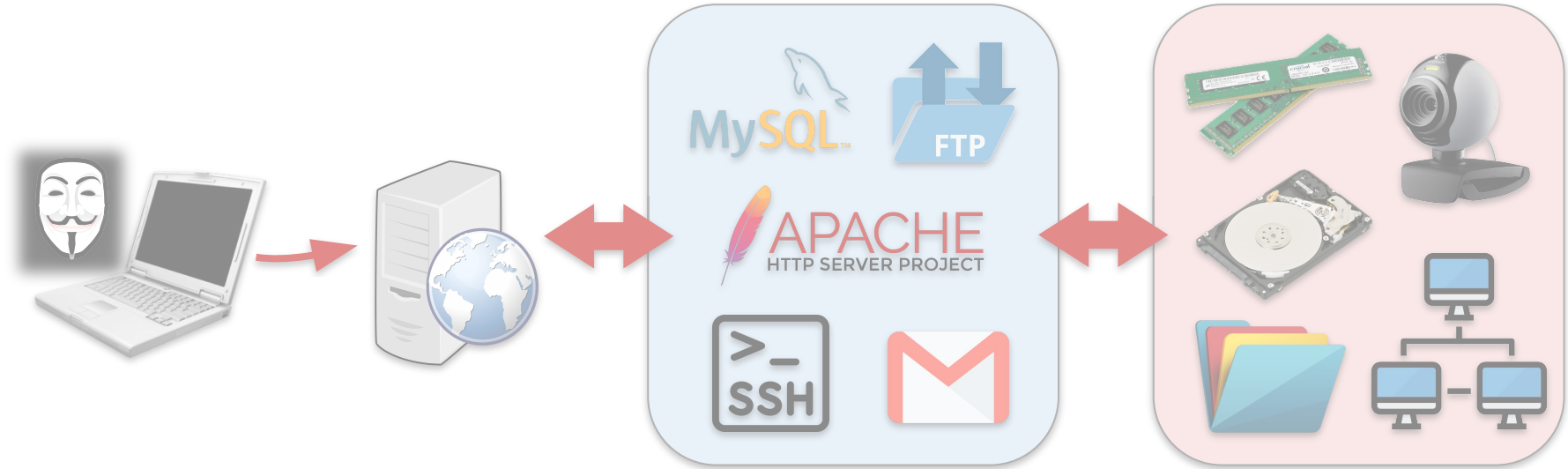
Server-side vs. Client-side Scripting



Server-side vs. Client-side Scripting



Server-side vs. Client-side Scripting



Servers are a **gateway for attackers!**

Server-side vs. Client-side Scripting

Can't we just **restrict all scripting** to be **exclusively on the client-side**?

Servers are a **gateway** for attackers!

Server-side vs. Client-side Scripting

Can't we just **restrict all scripting** to be **exclusively on the client-side**?

The **client** would need to have **all server data stored locally...**

Servers are a **gateway** for attackers!

Server-side vs. Client-side Scripting

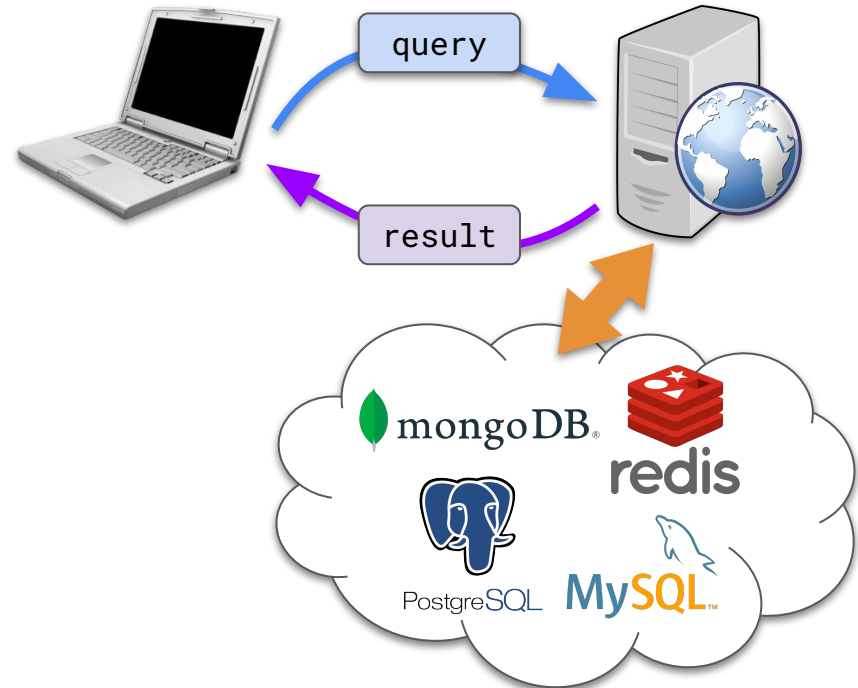
Can't we just **restrict all scripting** to be **exclusively on the client-side**?

The **client** would need to have **all server data stored locally...**

Would be inefficient and insecure!

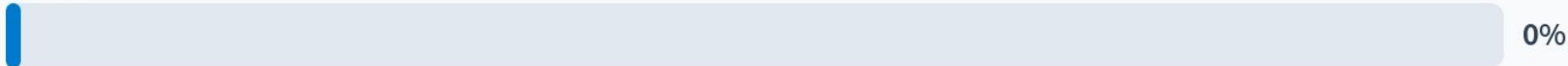
Web Databases

- **Databases:** how we store data on the server-side
 - Data **stored** by **server**
 - Data **queried** by **client**
 - Query **executed** by **server**
- A massive component of modern web applications
 - **Examples:** record keeping, user account management
- Popular DB Software:
 - MySQL, PostgreSQL
 - Redis, MongoDB



Familiarity with SQL?

Some



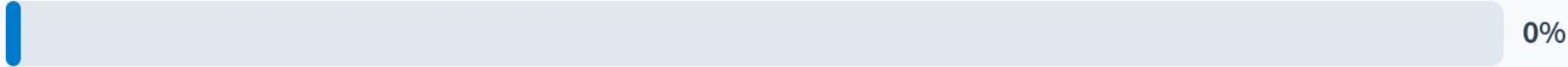
0%

Lots



0%

None of the above (which is totally fine!)



0%



Structured Query Language (SQL)

- A language to ask (“**query**”) databases questions
 - Information stored in **tables**; columns = **attributes**, rows = **records**
- Fundamental operations:
 - “**SELECT**” : express queries
 - “**INSERT**” : create new records
 - “**UPDATE**” : modify existing data
 - “**DELETE**” : delete existing records
 - “**UNION**” : combine results of multiple queries
 - “**WHERE/AND/OR**” : conditional operations
- Syntactical Tips:
 - “*****” : all
 - “**NULL**” : nothing
 - “**--**” : comment-out the rest of the line (note the space at the end)

Structured Query Language (SQL)

- A language to ask (“**query**”) databases questions
- E.g, How many users have the location **Salt Lake City**?
 - “**SELECT** **COUNT**(*) **FROM** `users` **WHERE** **location**=‘Salt Lake City’”

Structured Query Language (SQL)

- A language to ask (“**query**”) databases questions
- E.g, How many users have the location **Salt Lake City**?
 - “**SELECT** **COUNT**(*) **FROM** `users` **WHERE** **location**=‘Salt Lake City’ ”
- E.g., Is there a user with username “**bob**” and password “**abc123**”?
 - “**SELECT** * **FROM** `users` **WHERE** **username**=‘bob’ **AND** **password**=‘abc123’ ”

Structured Query Language (SQL)

- A language to ask (“**query**”) databases questions
- E.g., How many users have the location **Salt Lake City**?
 - “**SELECT** **COUNT**(*****) **FROM** **`users`** **WHERE** **location**=**`Salt Lake City`**”
- E.g., Is there a user with username “**bob**” and password “**abc123**”?
 - “**SELECT** ***** **FROM** **`users`** **WHERE** **username**=**`bob`** **AND** **password**=**`abc123`**”
- E.g., Completely delete this table!
 - “**DROP** **TABLE** **`users`**”

Example DB and SQL Queries

■ Table name: **users**

ID	username	password	passHash	location
1	Prof Nagy	c4ntgu3\$\$m3!	0x12345678	Salt Lake, UT
2	Average User	password123	0x87654321	Boulder, CO
3	Below Average	password	0x81726354	Denver, CO

- `SELECT * FROM users;`
 - **???**
- `SELECT * FROM users WHERE id = 2;`
 - **???**
- `SELECT password FROM users WHERE username = "Prof Nagy";`
 - **???**

Example DB and SQL Queries

■ Table name: **users**

ID	username	password	passHash	location
1	Prof Nagy	c4ntgu3\$\$m3!	0x12345678	Salt Lake, UT
2	Average User	password123	0x87654321	Boulder, CO
3	Below Average	password	0x81726354	Denver, CO

- `SELECT * FROM users;`
 - Will return **all users**
- `SELECT * FROM users WHERE id = 2;`
 - Will return just **Average User**
- `SELECT password FROM users WHERE username = "Prof Nagy";`
 - Will return **Prof Nagy's password**

Questions?



Food for Thought

- SQL databases and other web applications operate on **users' inputs**
 - E.g., SQL queries, HTTP GET and POST requests
 - That's how we interact with their **server-side applications**!
- **Question:** can we assume that all user input will only ever be **data**?



Next time on CS 4440...

Web Exploitation, SQL Injection, CSRF, XSS