CSC 443: Web Programming

LECTURE 19: WEB SECURITY

Our current view of security

- until now, we have assumed:
  - valid user input
  - non-malicious users
  - nothing will ever go wrong
- this is unrealistic!

The real world

- in order to write secure code, we must assume:
  - invalid input
  - evil users
  - incompetent users
  - everything that can go wrong, will go wrong
  - everybody is out to get you
  - botnets, hackers, script kiddies, KGB, etc. are out there
- **the security mindset:** assume nothing; trust no one

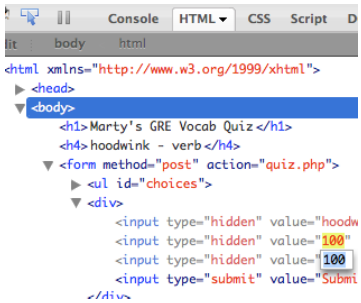
Attackers' goals

- Why would an attacker target my site?
- **Read private data** (user names, passwords, credit card numbers, grades, prices)
- **Change data** (change a student's grades, prices of products, passwords)
- **Spoofing** (pretending to be someone they are not)
- **Damage or shut down the site**, so that it cannot be successfully used by others
- **Harm the reputation or credibility** of the organization running the site
- **Spread viruses** and other malware

Tools that attackers use

Assume that the attacker knows about web dev and has the same tools you have:

- Firebug
- extensions e.g. Web Dev Toolbar
- port scanners, e.g. nmap
- network sniffers, e.g. Wireshark, EtherDetect, Firesheep



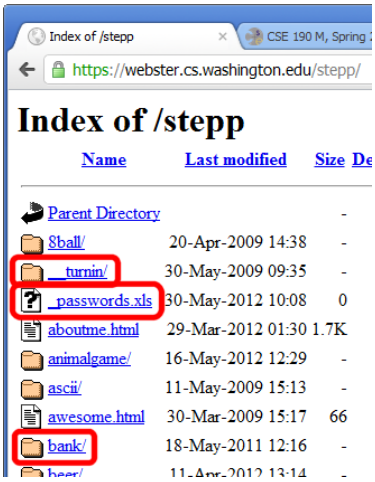
Some kinds of attacks

- **Denial of Service (DoS)**: Making a server unavailable by bombarding it with requests.
- **Social Engineering**: Tricking a user into willingly compromising the security of a site (e.g. phishing).
- **Privilege Escalation**: Causing code to run as a "privileged" context (e.g. "root").
- **Information Leakage**: Allowing an attacker to look at data, files, etc. that he/she should not be allowed to see.
- **Man-in-the-Middle**: Placing a malicious machine in the network and using it to intercept traffic.
- **Session Hijacking**: Stealing another user's session cookie to masquerade as that user.
- **Cross-Site Scripting (XSS)** or HTML Injection: Inserting malicious HTML or JavaScript content into a web page.
- **SQL Injection**: Inserting malicious SQL query code to reveal or modify sensitive data.

Information leakage

when the attacker can look at data, files, etc. that he/she should not be allowed to see

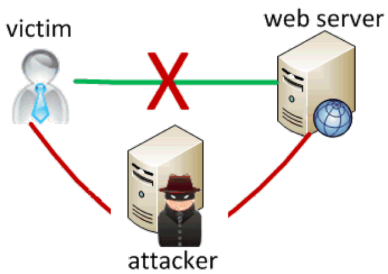
- files on web server that should not be there
  - or have too generous of permissions (read/write to all)
- directories that list their contents (indexing)
  - can be disabled on web server
- guess the names of files, directories, resources
  - see `loginfail.php`, try `loginsuccess.php`
  - see `user.php?id=123`, try `user.php?id=456`
  - see `/data/public`, try `/data/private`



Man-in-the-middle attack

when the attacker listens on your network and reads and/or modifies your data

- works if attacker can access and compromise any server/router between you and your server
- also works if you are on the same local area network as the attacker
- often, the attacker still sends your info back and forth to/from the real server, but he silently logs or modifies some of it along the way to his own benefit
- e.g. listens for you to send your user name / password / credit card number / ...



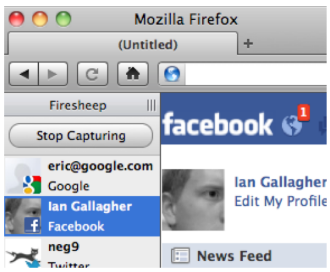
Secure HTTP (HTTPS)

- HTTPS: encrypted version of HTTP protocol
- all messages between client and server are encrypted so men in the middle cannot easily read them
- servers can have **certificates** that verify their identity

Session hijacking

when the attacker gets a hold of your session ID and masquerades as you

- exploit sites that use HTTPS for only the initial login:
  - HTTPS: browser → server (POST login.php)
  - HTTPS: browser ← server (login.php + **PHPSESSID cookie**)
  - ***HTTP***: browser → server (GET whatever.php + ***PHPSESSID cookie***)
  - ***HTTP***: browser ← server (whatever.php + ***PHPSESSID cookie***)
- attacker can listen to the network, get your session ID cookie, and make requests to the same server with that same session ID cookie to masquerade as you!
  - example: Firesheep



HTML injection

a flaw where a user is able to inject arbitrary HTML content into your page

- This flaw often exists when a page accepts user input and inserts it bare into the page.
- What kinds of silly or malicious content can we inject into the page? Why is this bad?

Injecting HTML content

```
8ball.php?question=<em>lolololol</em>
```

- injected content can lead to:
  - annoyance / confusion
  - damage to data on the server
  - exposure of private data on the server
  - financial gain/loss
  - end of the human race as we know it
- why is HTML injection bad? It allows others to:
  - disrupt the flow/layout of your site
  - put words into your mouth
  - possibly run malicious code on your users' computers

Cross-site scripting (XSS)

a flaw where a user is able to inject and execute arbitrary JavaScript code in your page

```
8ball.php?question=<script type='text/javascript'>alert('pwned');</script>
```

- JavaScript is often able to be injected because of a previous HTML injection
  - masquerade as the original page and trick the user into entering sensitive data
  - steal the user's cookies
  - masquerade as the user and submit data on their behalf (submit forms, click buttons, etc.)
  - ...

Securing against HTML injection / XSS

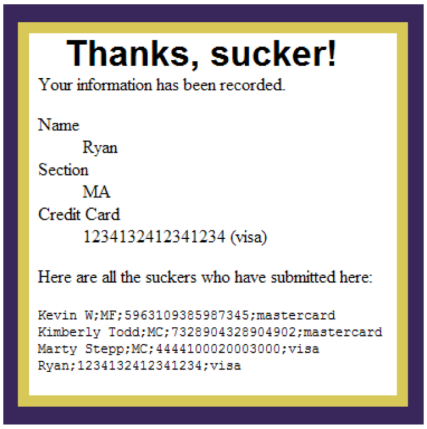
- one idea: disallow harmful characters
  - HTML injection is impossible without < >
  - can strip those characters from input, or reject the entire request if they are present
- another idea: allow them, but **escape** them

htmlspecialchars	returns an HTML-escaped version of a string

```
$text = "<p>hi 2 u & me</p>";
$text = htmlspecialchars($text);    # "&lt;p&gt;hi 2 u &amp; me&lt;/p&gt;"
```

Another XSS example

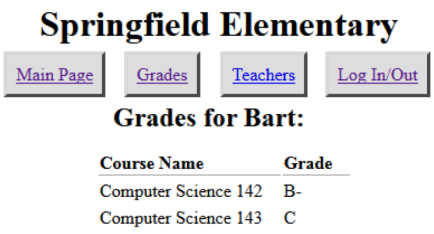
- example: Lab 4, Buy-a-Grade (buyagrade.html)
- Recall that the user submits his name, section, and credit card number to the server, which are then displayed on the page.
- How can we inject HTML/JavaScript into the page? Be creative...
- What could we do to steal the user's sensitive information?



SQL injection

a flaw where the user is able to inject arbitrary SQL into your query

- This flaw often exists when a page accepts user input and inserts it bare into the query.
- example: simpsons grade lookup (start.php)
- What kinds of SQL can we inject into the query? Why is this bad?



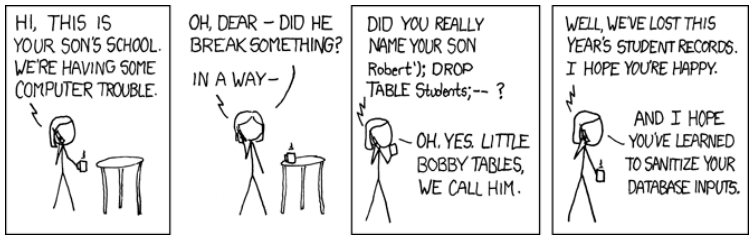
A SQL injection attack

- The query in the Simpsons PHP code is:

```
$query = "SELECT * FROM students
WHERE username = '$username' AND password = '$password'";
```
SQL

- Are there malicious values for the user name and password that we could enter?
- Password: ' OR '1'='1
- This causes the query to be executed as:`$query = "SELECT * FROM students WHERE username = '$username' AND password = '' OR '1'='1'";`
  - What will the above query return? Why is this bad?

Too true...



- injected SQL can:
  - change the query to output others' data (revealing private information)
  - insert a query to modify existing data (increase bank account balance)
  - delete existing data (`; DROP TABLE students; --`)
  - bloat the query to slow down the server (`JOIN a JOIN b JOIN c ...`)
  - ...

Securing against SQL injection

- similar to securing against HTML injection, escape the string before you include it in your query

quote	returns a SQL-escaped version of a string

```php
$username = $db->quote($_POST["username"]);
$password = $db->quote($_POST["password"]);
$query = "SELECT name, ssn, dob FROM users
WHERE username = $username AND password = $password";
```

- replaces ' with \', etc., and surrounds with quotes