

SQL Injection and Cookies

Question 1 *Boogle* ()

Boogle is a social networking website that's looking into expanding into other domains. Namely, they recently started a map service to try their hand at fusing that with social media. The URL for the main website is <https://www.boogle.com>, and they want to host the map service at <https://maps.boogle.com>.

- (a) For each of the following webpages, determine whether the webpage has the same origin as <http://boogle.com/index.html>.
- i. <https://boogle.com/index.html>
 - ii. <http://maps.boogle.com>
 - iii. <http://boogle.com/home.html>
 - iv. <http://maps.boogle.com:8080>

Solution:

- i. False. <https://boogle.com/index.html> and <http://boogle.com/index.html> do not have the same origin, since their protocols (https) and (http) are different.
- ii. False. <http://maps.boogle.com> and <http://boogle.com/index.html> do not have the same origin, since their domains (maps.boogle.com) and (boogle.com) are different. The same-origin policy performs string matching on the protocol, domain, and port.
- iii. True. The paths are not checked in the same-origin policy.
- iv. False. <http://maps.boogle.com:8080> and <http://boogle.com/index.html> do not have the same origin, because their ports (8080) and (80) are different. Note that if the port is not specified, the port defaults to 80 for http and 443 for https.

- (b) Describe how to make a cookie that will be sent to only Boogle's map website and its subdomains.

Solution: Set the domain parameter of the cookie to `.maps.boogle.com`

- (c) How can Boogle ensure that cookies are only transmitted encrypted so eavesdroppers on the network can't trivially learn the contents of the cookies?

Solution: Set the secure flag on each cookie.

- (d) Boogle wants to be able to host websites for users on their servers. They decide to host each user's website at [https://\[username\].boogle.com](https://[username].boogle.com). Why might this not be a good idea?

Solution: A malicious user could set cookies that would be sent to other users' sites as well as the entire .boogle.com domain. Also, any cookies meant for boogle.com will go to the malicious user.

- (e) Propose an alternate scheme so that Boogle can still host other users websites with less risk, and explain why this scheme is better.

Note: It is okay if the user sites interfere with each other, as long as they cannot affect official Boogle websites.

Solution: Boogle should create a new domain exclusively for user hosted content, like [https://\[username\].boogleusercontent.com](https://[username].boogleusercontent.com). This way, user sites cannot set cookies that will affect all boogle domains due to the cookie setting policy. This is known as a cookie tossing attack, and is one of the reasons why github hosts user sites on github.io instead of github.com (see <https://blog.github.com/2013-04-09-yummy-cookies-across-domains/>).

Question 2 *Second-order linear... err I mean SQL injection* ()

Alice likes to use a startup, NotAmazon, to do her online shopping. Whenever she adds an item to her cart, a POST request containing the field `item` is made. On receiving such a request, NotAmazon executes the following statement:

```
cart_add := fmt.Sprintf("INSERT INTO cart (session, item) " +
                        "VALUES ('%s', '%s')", sessionToken, item)
db.Exec(cart_add)
```

Each item in the cart is stored as a separate row in the `cart` table.

- (a) Alice is in desperate need of some pancake mix, but the website blocks her from adding more than 72 bags to her cart ☹. Describe a POST request she can make to cause the `cart_add` statement to add 100 bags of pancake mix to her cart.

Solution: Note that Alice can see her own cookies so knows what `sessionToken` is. She can perform some basic SQL injection by sending a POST request with the `item` field set to:

```
pancake mix'), ($sessionToken, 'pancake mix'), ... ; --
```

Where `$sessionToken` is the string value of her `sessionToken` and `($sessionToken, 'pancake mix')` repeats 99 times. A similar attack could also be done by modifying the `sessionToken` itself

When a user visits their cart, NotAmazon populates the webpage with links to the items. If a user only has one item in their cart, NotAmazon optimizes the query (avoiding joins) by doing the following:

```
cart_query := fmt.Sprintf("SELECT item FROM cart " +
                          "WHERE session='%s' LIMIT 1", sessionToken)
item := db.Query(cart_query)
link_query = fmt.Sprintf("SELECT link FROM items WHERE item='%s'", item)
db.Query(link_query)
```

After part(a), Alice recognizes a great business opportunity and begins reselling all of NotAmazon's pancake mix at inflated prices. In a panic, NotAmazon fixes the vulnerability by parameterizing the `cart_add` statement.

- (b) Alice claims that parameterizing the `cart_add` statement won't stop her pancake mix trafficking empire. Describe how she can still add 100 bags of pancake mix to her cart. Assume that NotAmazon checks that `sessionToken` is valid before executing any queries involving it.

Solution: Alice can send a malicious POST request like part (a). Even though her input won't change the SQL statement from (a), it will still store her string

in the database. Now, if she visits her cart we'll execute the optimized query. Note that `link_query` doesn't have any injection protections, so her input will maliciously change the SQL statement. The `item` field in her POST request should be something like:

```
pancake mix'; INSERT INTO cart (session, item) VALUES
($sessionToken, 'pancake mix'), ... ; --
```

Moral of the story: Securing external facing APIs/queries is not enough.

Question 3 *Session Fixation*

()

A *session cookie* is used by most websites in order to manage user logins. When the user logs in, the server sends a randomly-generated session cookie to the user's browser. The server also stores the cookie value in a database along with the corresponding username. The user's browser sends the session cookie to the server whenever the user loads any page on the site. The server then looks the session cookie up in the database and retrieves the corresponding username. Using this, the server can know which user is logged in.

Some web application frameworks allow cookies to be set by the URL. For example, visiting the URL

`http://foobar.edu/page.html?sessionid=42.`

will result in the server setting the `sessionid` cookie to the value "42".

- (a) Can you spot an attack on this scheme?
- (b) Suppose the problem you spotted has been fixed as follows: `foobar.edu` now establishes new sessions with session IDs based on a hash of the tuple (`username`, `time of connection`). Is this secure? If not, what would be a better approach?

Solution:

- (a) The main attack is known as *session fixation*. Say the attacker establishes a session with `foobar.edu`, receives a session ID of 42, and then tricks the victim into visiting `http://foobar.edu/browse.html?sessionid=42` (maybe through an `img` tag). The victim is now browsing `foobar.edu` with the attacker's account. Depending on the application, this could have serious implications. For example, the attacker could trick the victim to pay his bills instead of the victim's (as intended).

Another possibility is for the attacker to fix the session ID and then send the user a link to the log-in page. Depending on how the application is coded, it might so happen that the application allows the user to log-in but reuses the previous (attacker-set) session ID. For example, if the victim types in his username and password at `http://foobar.edu/login.html?sessionid=42`, then the session ID 42 would be bound to his identity. In such a scenario, the attacker could impersonate the victim on the site. This is uncommon nowadays, as most login pages reset the session ID to a new random value instead of reusing an old one.

- (b) The proposed fix is not secure since it solves the wrong problem - it doesn't fix either issue. In fact, it makes things weaker by significantly reducing the *entropy* of the session cookie.

The correct fix is for the server to generate cookie values afresh, rather than setting them based on the session ID provided via URL parameters. Also, the server shouldn't allow cookies to be set by the URL. This makes the attackers

job more difficult as they have to do some form of XSS in order to manipulate the client's cookie vs. just clicking on a link.