Authentication

User Accounts

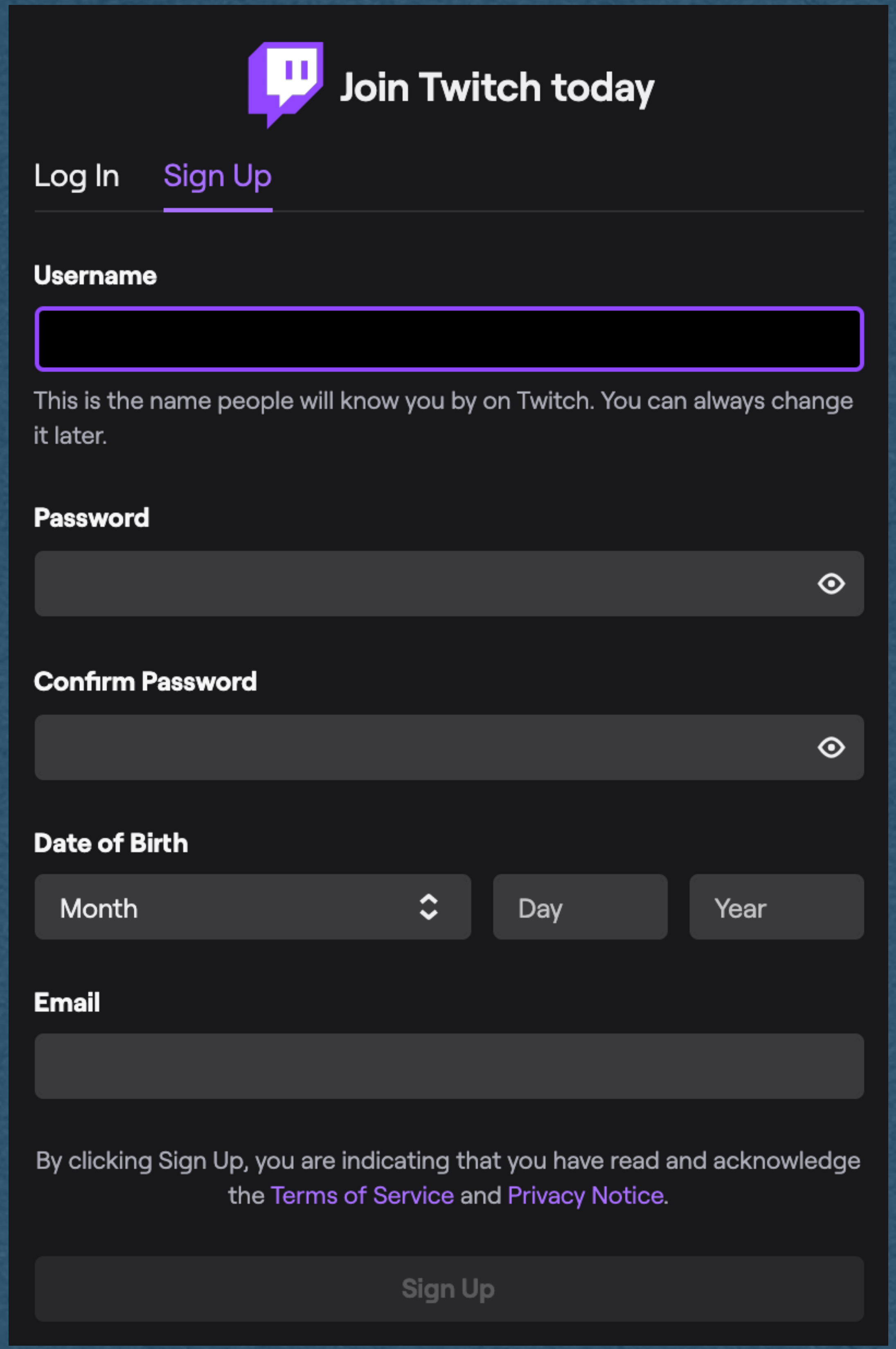
- Everything we've built so far treats every user the same and delivers the same content to all visitors
    - Only exception was setting a cookie to count visits
- For many features of a web app we want to remember a user across multiple visits and verify their identity

User Accounts

- Registration
  - Users can create an account on your app
  - Choose a username and password
- Authentication
  - Verify that a user is [likely] a registered account holder by providing their username/password
  - Log them into your app
  - Serve content specific to them

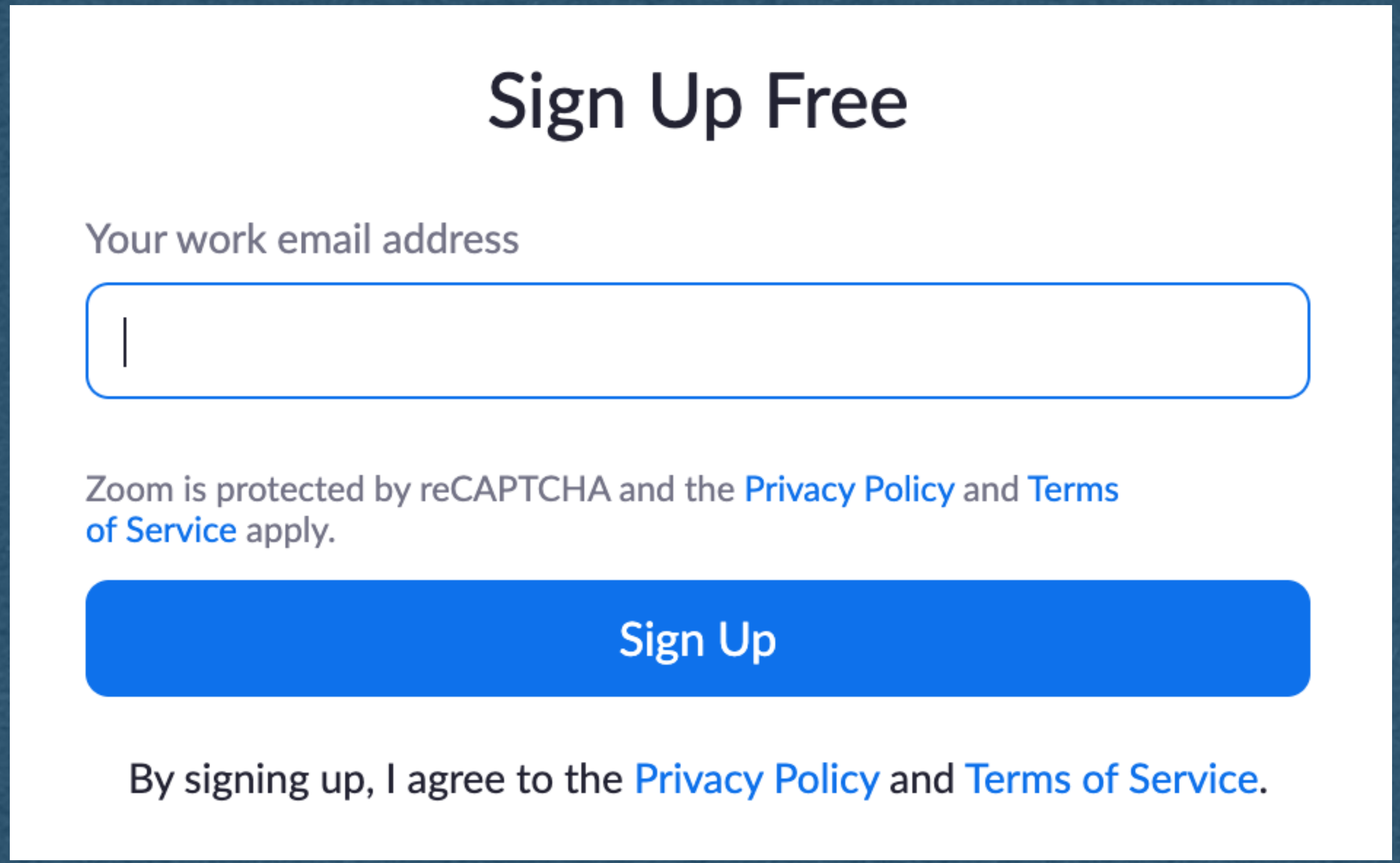
User Accounts

- Registration
  - Can be a simple web form
  - At a minimum, provide a username and password
- Common to affiliate an account with a valid email address
  - And verify that email
  - Limits the number of bots that register



This is the name people will know you by on Twitch. You can always change it later.

By clicking Sign Up, you are indicating that you have read and acknowledge the Terms of Service and Privacy Notice.



Zoom is protected by reCAPTCHA and the Privacy Policy and Terms of Service apply.

By signing up, I agree to the Privacy Policy and Terms of Service.

Authentication

- On the server
  - Store each username/password in a database
  - This data must persist so the users can log in even after a server restart
  - What if this database is compromised?
    - Perhaps by a SQL injection attack

Authentication

- **NEVER** store passwords as plain text
- Not even the admins of a website should know the passwords of their users
- We do this by **hashing** the passwords and storing only the hashes

Hash Function

- A function that converts one value into another with certain properties
  - Typically a fixed length value
- Used to build hash tables
  - Among other applications
- Hash functions might not add any security!

Cryptographic Hash Function

- A hash function that is meant for secure purposes
- Goal of being a one-way function
  - Easy to compute a hash value from plain text
  - Very difficult to compute the plain text of a given hash
- Hashes can be shared without compromising the plain text

password

↓

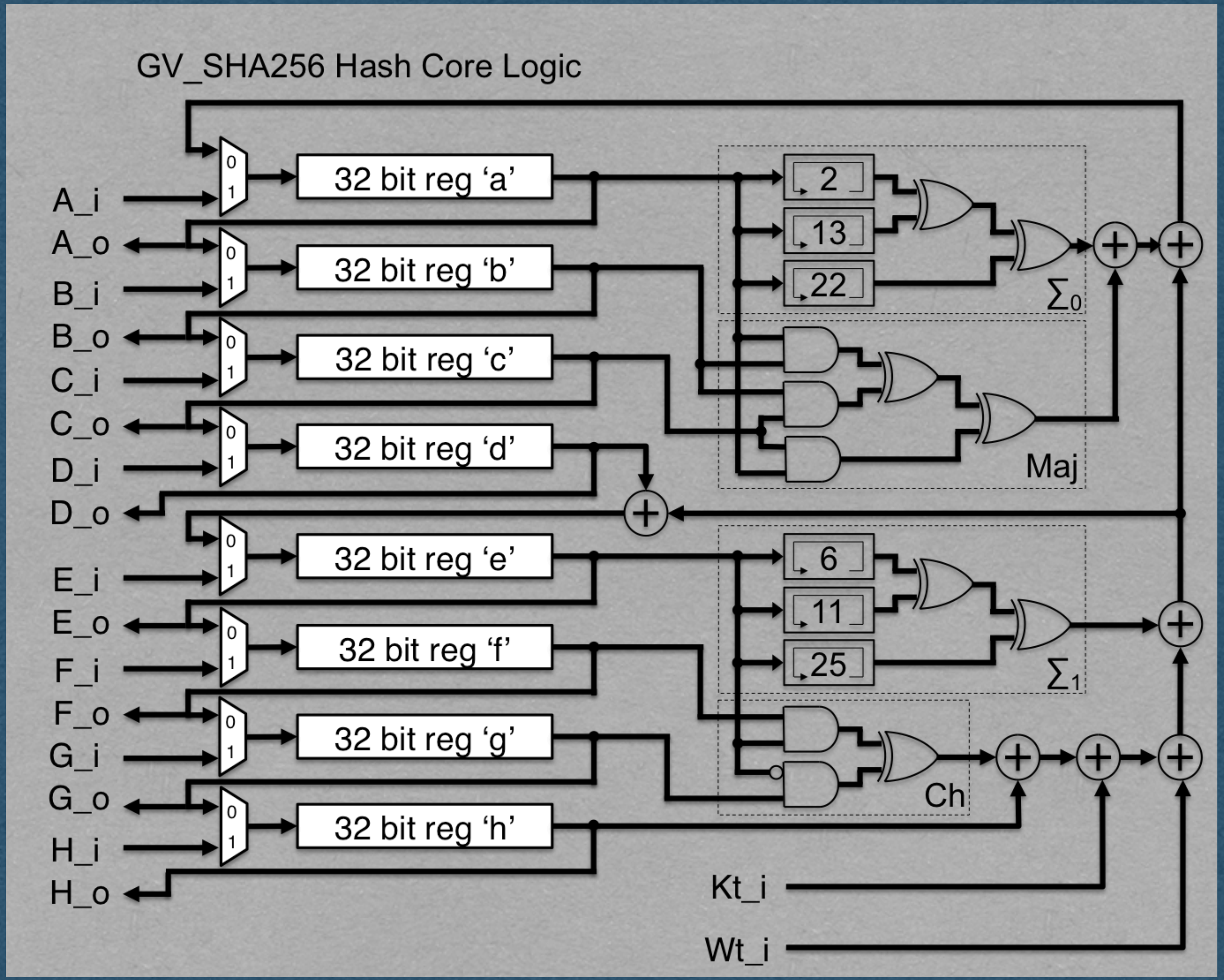
5e884898da28047151d0e56f8dc6292773603d0d6aabbdd62a11ef721d1542d8

Cryptographic Hash Function

- Only a cryptographic hash of your password is stored
- By only storing the hash of a password:
  - Even the admins of a site can’t read your password!
- SHA256 is a commonly used cryptographic hash function
  - https://www.xorbin.com/tools/sha256-hash-calculator

SHA256

- Runs input through multiple rounds of bit-level manipulation
- Easy (Fast) to compute
- Very difficult to compute in reverse



Ref: opencores.org

Brute Force Attack

- Storing SHA256 hashes is not always secure!
  - Surprisingly common misconception
- Hashes are easy to compute, but hard to reverse
- To attack a hash:
  - Hash every possible password
  - If the hashes match, you know the password

Entropy

- Entropy is a measure of uncertainty
    - Number of guesses required to guarantee a hash is matched
- Examples:
    - If you know the plain text is a single lowercase letter the entropy is 26
    - If it’s two lowercase letters, the entropy is 26^2 = 676
    - If it’s two letters that can be upper or lower case, 52^2 = 2704
- Tend to measure the “bits of entropy”
    - The log base 2 of these values
- Typically consider >=80 bits of entropy to be secure

Dictionary Attack

- More advanced version of the brute force attack
- Use common words with common replacements
  - a -> @
  - O -> 0
  - i -> !
- Real words are easier to remember
  - Attackers take advantage of this
- Lists of common passwords are freely available
  - Start with these

Rainbow Table

- A table containing the start and end of "chains" of hashes
- Repeatedly rehash the start to reach the end
- To attack a hash:
  - Rehash until you reach the end of a chain
  - Rehash the beginning of the chain to find the value before the hash
- Takes a long time to compute a large table
- Effectively trades space for time once the table is computed

Salting

- Salt hashes to prevent attacks like rainbow tables
- A salt is a randomly generated string that is stored in plain text with the hash
- The salt is appended to the plain text before hashing
  - Nearly all hashes in the rainbow table will not use this salt
- The salt does not add entropy since it is stored in the clear

Authentication

- Registration
  - User provides username/password
  - Generate a random salt
  - Append the salt to the password and compute a secure hash of this value
  - Store the username/salt/hash in your database

Authentication

- Authentication
  - User provides username/password
  - Lookup the salt/hash for the given username
  - Append the salt to the provided password and compute the SHA256 hash
  - If this hash matches the stored hash, the user is verified
  - If this hash does not match the stored hash, the user is not logged in

Authentication

- The bcrypt library implements hashing, salting, and other security related functions
- Available in many different languages
- It is highly recommended that you use this library in your assignment

Redirects

Redirects

- To redirect the user to a different page:
  - Respond with a 300-level status code
  - Ex. Redirect HTTP requests to HTTPS requests
  - Ex. Respond with 301 Moved Permanently when the server is updated with new paths, redirect the old paths to the new paths instead of maintaining both
  - Ex. Response with 302 Found to redirect temporarily (Avoids browsers caching the new path)

```
HTTP/1.1 301 Moved Permanently
Content-Length: 0
Location: /new-path
```

Redirects

- A redirect response must contain a Location header
  - This is the path of the redirect
- The client will make a second HTTP request for the Location path and load the page with the new response

```
HTTP/1.1 301 Moved Permanently
Content-Length: 0
Location: /new-path
```

Redirects

- If the Location is not a full url, it will be treated as a relative path
- New request is made with the same protocol/host/port as the original request
- Example:
  - First request was for "http://cse312.com:8080/old-path"
  - Second request is "http://cse312.com:8080/new-path"

```
HTTP/1.1 301 Moved Permanently
Content-Length: 0
Location: /new-path
```

Redirects

- If the location is a full url, the user can be redirected to a different server
- Example:
  - First request was for "http://cse312.com:8080/old-path"
  - Second request is "https://google.com/"

```
HTTP/1.1 301 Moved Permanently
Content-Length: 0
Location: https://google.com/
```

Redirects

- Add a Content-Length of 0 since there are no bytes to read from the body
  - This is technically optional. The lack of a Content-Length header should imply a length of 0
  - However, this confuses Firefox.. so we'll add the header

```
HTTP/1.1 301 Moved Permanently
Content-Length: 0
Location: /new-path
```