

Difficulties in making secure passwords

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- ▶ Solution 2: Use hash functions.

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```
>>> hash(3904823904823094823094823098429084092842098)
681526534381889374
>>> hash(390482390482309482345)
794921925195204626
>>> hash("hello")
840651671246116861
>>> hash("pas$word1234")
7207291063912423845
```

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- ▶ Two different passwords should not hash to the same value.

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3. Collision resistance allows us to think of a hash as a *unique id number*, even though in a mathematical sense is not unique.

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- ▶ You should not be able to do better than random guessing.
- ▶ Thanks to the birthday paradox if your hash function has n output values then it will only take $\sim \sqrt{n}$ tries to find a collision (on average).

Which hash to choose?

- ▶ Not all hashes are created equal. Python's built-in hash function is not suitable for cryptography:

```
>>> hash(1)
```

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- ▶ Even cryptographic hashes are generally not based on rock-solid mathematical principles.
- ▶ This means the recommendation for which hash to use changes over time, as hashes get broken. The current standard is SHA265, although older hashes such as MD5 are still in use.

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- ▶ This way two users who happen to have the same password won't have the same hashvalue in the company's database.

Have I been pwned?

Demonstration.

How do you make a secure password?

- ▶ Common advice is to do things like:
 - ▶ Add a capital letter somewhere in the word.
 - ▶ Replace 's' with '\$' or 'a' with '@'.
 - ▶ Add two numbers on the end of the password.

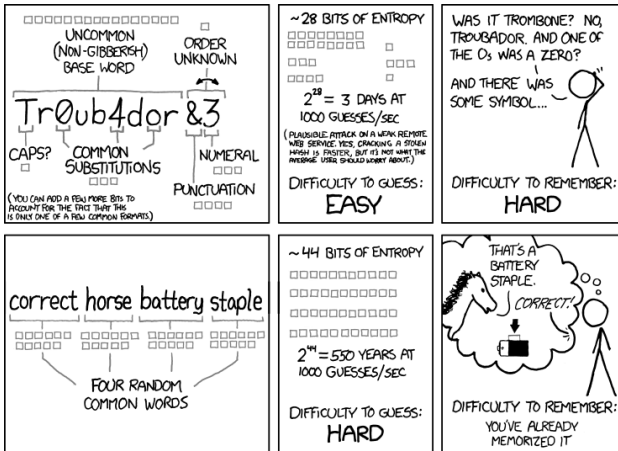
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- ▶ It does make the password hard to remember though!
- ▶ In general increasing length is better than increasing the size of character set.

How do you make a secure password?



THROUGH 20 YEARS OF EFFORT, WE'VE SUCCESSFULLY TRAINED EVERYONE TO USE PASSWORDS THAT ARE HARD FOR HUMANS TO REMEMBER, BUT EASY FOR COMPUTERS TO GUESS.

Remembering strong passwords is nearly impossible

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- ▶ Another approach: use a password manager.

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- ▶ They need to sync passwords across devices. How do they keep your passwords safe?

Hardware security modules

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- ▶ They work by encrypting all the data they store and limiting the number of attempts to access that data. [Picture.]

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 - ▶ Then they put the key cards in a blender.
 - ▶ Now the engineers couldn't access your passwords even if they wanted to. (In theory.)

Thanks for listening.