Making QR Codes

Tuesday, June 25th, 2024

CodeBreakHERS

Step 1: type this into your terminal

sudo apt-get install qrencode

CodeBreakHERS

Step 2: pick a url

(e.x. google.com)

CodeBreakHERS

Step 3: creating a QR code

qrencode -o

CodeBreakHERS

Step 3: creating a QR code

~/Desktop/name.png -s 12 -l

e.x. ~/Desktop/google.png -s 12 -l

CodeBreakHERS

Step 3: creating a QR code

H -v 3 ‘url’

e.x. H -v 3 ‘google.com’

CodeBreakHERS

a complete example

```
qrencode -o ~/Desktop/google.png -s 12 -l H -v 3 'https://google.com'
```

CodeBreakHERS

Testing error correction

- Form groups and pick a QR code
- Open the QR code on your desktop
- Reproduce it using LEGOs with 1 x 1 black pieces
- Scan it with your phone to test it!
- Find a staff member when you're done for next steps

From Encoding to Error Correction

Tuesday, June 25th, 2024

CodeBreakHERS

QR codes recap

What's special about QR codes?

- Convert the input data into a sequence of bits
- Add extra information to detect and correct errors
    - We could still scan the QR code after removing some Legos!

CodeBreakHERS

Redundancy, error detection, and correction

- Codewords provide **redundancy**, which allows us to read data that has been damaged (errors)
- Interleaving: encoded data and error correcting codewords are such that damage only affects a small part of the data

Today we'll be talking about error correction!

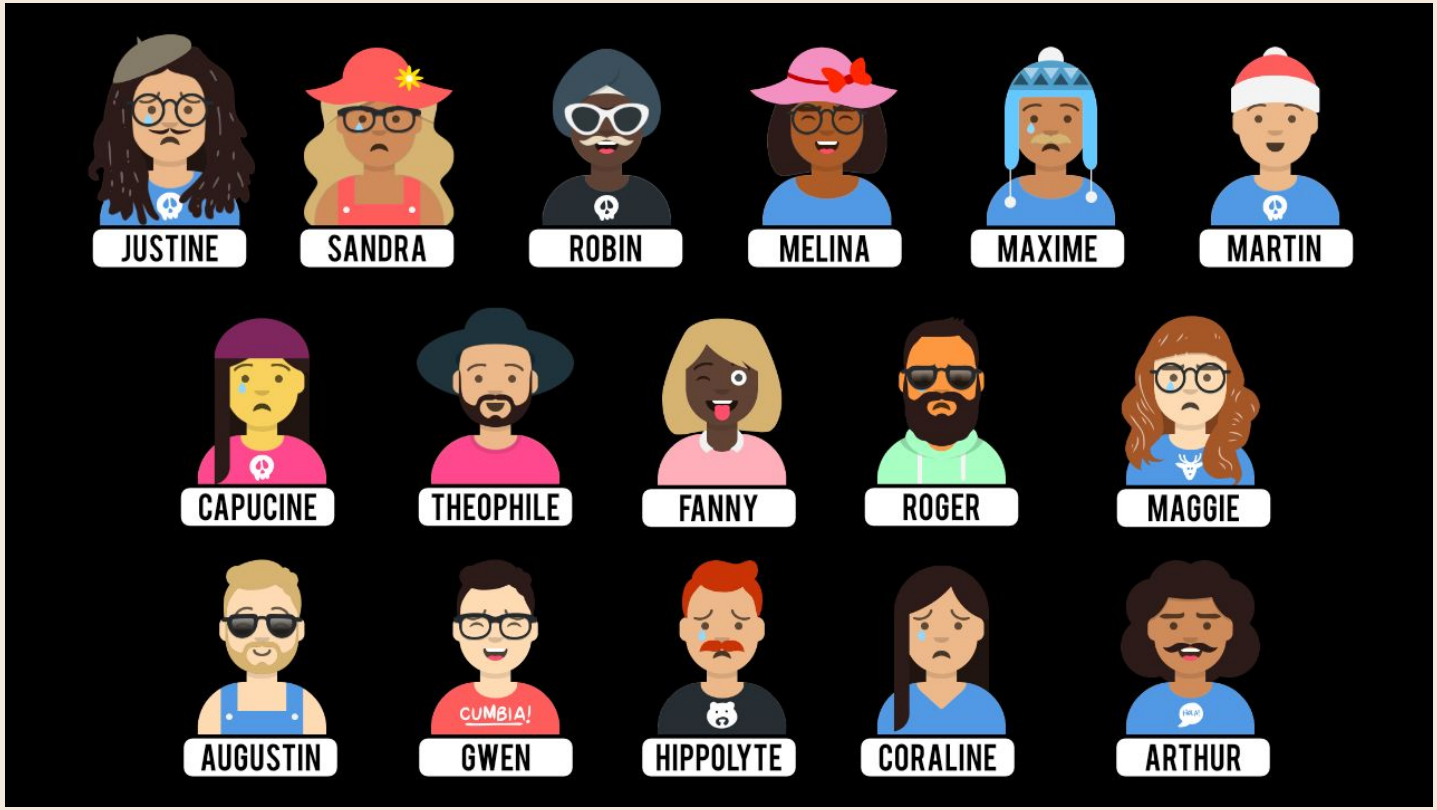
CodeBreakHERS

Guess Who

- Player 1 picks a character
- Player 2 has to guess who Player 1 picked
- What strategies can we use?

How many questions should Player 2 ask before she can be confident in her guess?

CodeBreakHERS



CodeBreakHERS

Your answers are bits of information!

1) Does this character wear a hat or head covering?
2) Does this character wear (sun)glasses?
3) Does this character have an unhappy facial expression?
4) Does this character have facial hair?

- Justine: 1111
- Sandra: 1110
- Robin: 1101
- Melina: 1100
- Maxime: 1011
- Martin: 1000
- Capucine: 1010
- Theophile: 1001
- Gwen: 0100
- Hippolyte: 0011
- Coraline: 0010
- Arthur: 0001
- Fanny: 0000
- Roger: 0111
- Maggie: 0110
- Augustin: 0101

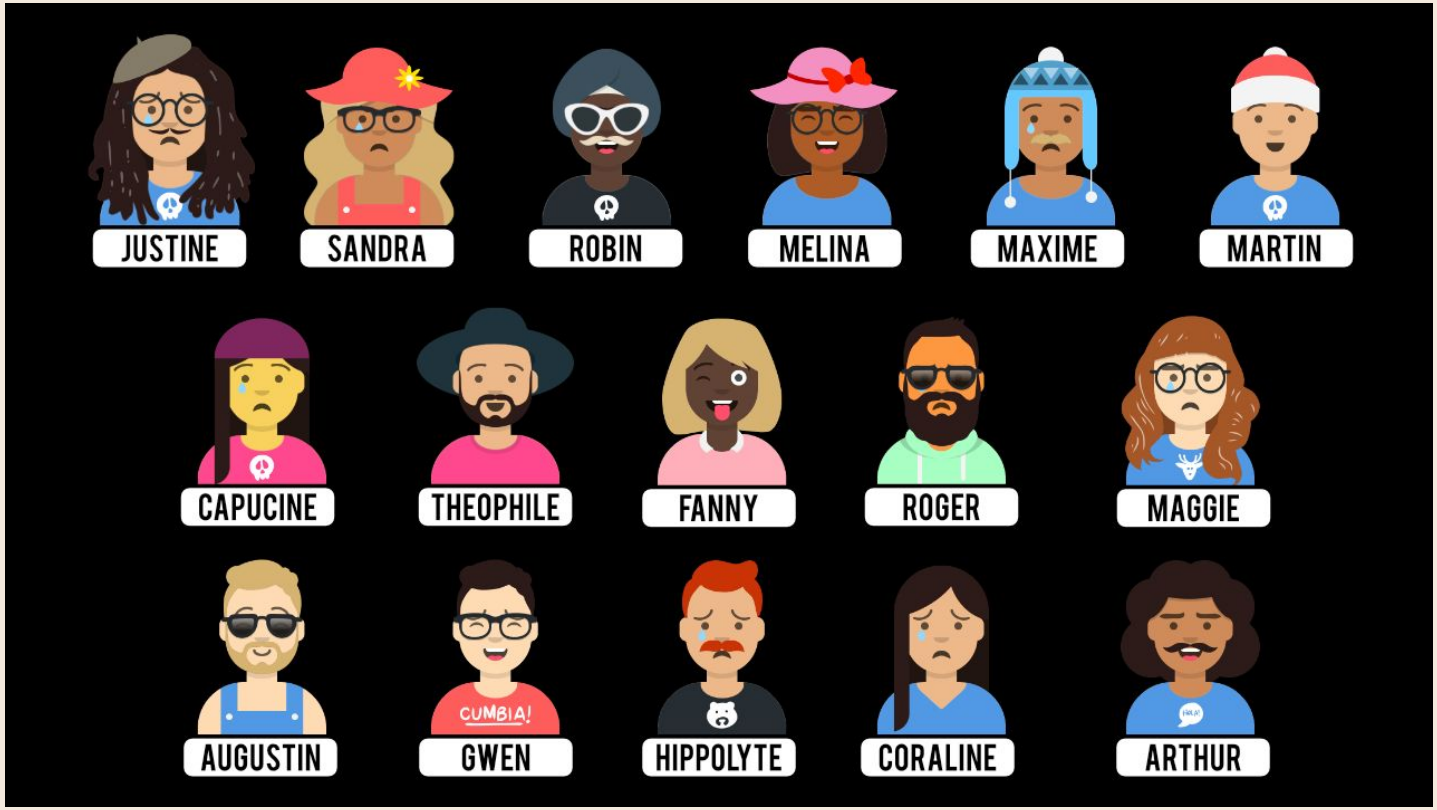
1 = yes, 0 = no

0111

CodeBreakHERS

What if there was a lie?

CodeBreakHERS



CodeBreakHERS

Transmitting data

- First game (no lies): only 4 questions
- Second game (one lie): 7 questions
  - We can detect and correct a single error bit
- Third game (two lies), 7 questions was not enough!
  - We cannot confidently detect and correct two error bits
- This is called a [7, 4] linear code, it corrects one error
- Coming up: what kinds of codewords should we use?

CodeBreakHERS

Lunch!

12:00 pm - 1:30 pm

CodeBreakHERS

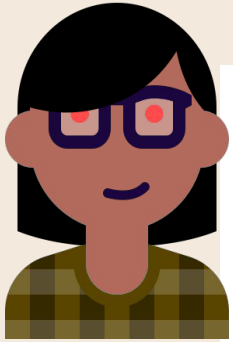
Building
Error Correcting Codes

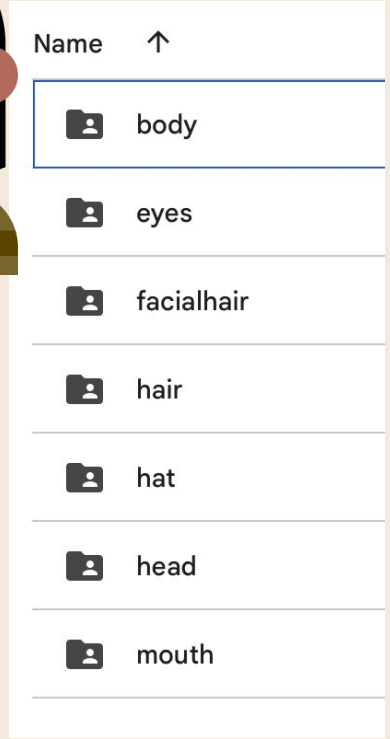
Tuesday, June 25th, 2024

CodeBreakHERS

Create your own characters

- Navigate to “Guess Who Images”
- In a group, make four characters with different traits
- Name your four characters
- Play Guess Who with one lie!
  - We’ll give you the questions to ask (or be asked)
- Your group wins if someone can correctly guess a character three times
  - In other words, you win if the characters you made are good for finding errors





CodeBreakHERS

Step 1: Make characters

- Navigate to "Guess Who Images"
- Your group should make **four** characters with different traits, and name them
- Find someone to play Guess Who

Step 2 : Play Guess Who in groups!

- Player 1 picks one of Player 2's characters, Player 2 tries to guess which of their characters was picked
- Player 2 asks the following **five** questions:
  - Does your character have green eyes?
  - Does your character have glasses?
  - Does your character wear a hat/headwear?
  - Does your character have facial hair?
  - Does your character have a blue body?
- Player 1 lies one time
- Player 2 wins if they can guess which character Player 1 picked

You beat the game if your group wins as Player 2 four times in a row!

CodeBreakHERS

What are some properties of successful codes?

Distance

- Successful codes must have the right (Hamming) distance
- The distance is the number of positions in which two codewords differ
- We just built a [5, 2] linear code

01111 01100

d = 2

What distance works?

Claim: A code can correct t errors if the minimum distance between two codes is at least $2t + 1$.

What is the smallest distance we need to correct 1 error?

Can codes have very large distances?

Singleton bound: An $[n, k]$ linear code with distance d must satisfy $d \leq n - k + 1$.

CodeBreakHERS

Thanks for listening!

CodeBreakHERS