Lecture 1: Zeros and Ones

A "data structure" is a way to organize data in order to achieve some goal or tradeoff. It's an engineering problem.

But deep down, remember that every piece of data stored on a computer is 0s and 1s.
- Memory (what you'll be working with in your Java programs): 0s and 1
- Files you save on your hard drive: 0s and 1s
- Stuff you download from the internet, including websites you visit: 0s and 1s.
- So let's take a look at some 0s and 1s.

Questions for the semester:
- How do we make sense of this? How do we go from this, to text, images, and video, websites, and the code that you are going to write this semester?
- What can we do to make this all more useful?

Explore grouping!
- In general a group of n bits can carry 2^n different messages.
    - Look at the argument by induction.
- Hexadecimal: Base 2^4
    - Let's take a look at this!
    - On
- Why grouping leads to base Base 2^n
- Bytes - addressable unit.
    - So is this really Base 256 = 2^8 ?
- Colors: 3 bytes
    - Show in a color picker (6 hex digits for 24 bit color)
        - https://htmlcolorcodes.com/color-picker/
- Base 64 encoding (show my audio files)
- Integers, Signed, and Floating Point Values
- UUID - 128 bits

Clip from The Martian
- https://www.youtube.com/watch?v=-LjPJ8ThnuU
- Takeaways:
    - You can communicate anything in binary.
    - To make it easier, he used grouping (hexadecimal then ascii)
    - Common to find ways to increase the amount of information sent.
        - How do we measure information content anyway?

Character Standards
- Original ASCII (1960s)
- UTF standard (unicode) - up to 32 bits (16 in Java chars, but strings can contain more)

- Almost every script available
    - Latin (with all the accents), Han (includes traditional, simplified), Devanagari, Arabic, Greek, Cyrillic, Hebrew
    - Did you know you could write a Java variable using greek script? An actual alpha or beta. But I wouldn't recommend it.
- Emojis:
    - Show the different ways to render emojis, the underlying data has nothing to do with how they are rendered!
        - Cultural/Political arguments over how to render emojis (Elon musk post): https://x.com/elonmusk/status/1826014723940429871

Primitives in Java:
- Int, float: 4 bytes
- Long, double: 8 bytes
- Short, Char (2 bytes, 16-bit)
- Byte (1 byte of course, 8 bits, 265 possible values)

References/Pointers:
- Refer to an address in memory
- Every time you have a variable in java that contains an object, it's holding a reference, not the object itself
    - That's why it can be null - if you have a bad reference
    - NullPointerException - you'll all run into this at some point during the semester.
- 64-bit system (why upgrade from 32)
    - 32 Bits means 2^32 addresses, or around 4Gb of memory only
    - 64 Bits is… a lot more. The power of exponential growth!