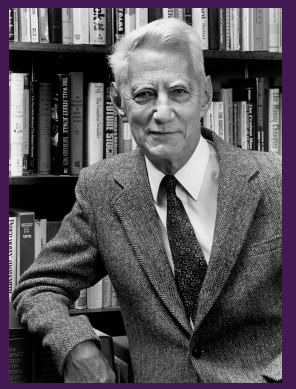

CS121: Our Digital World

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Blown to Bits

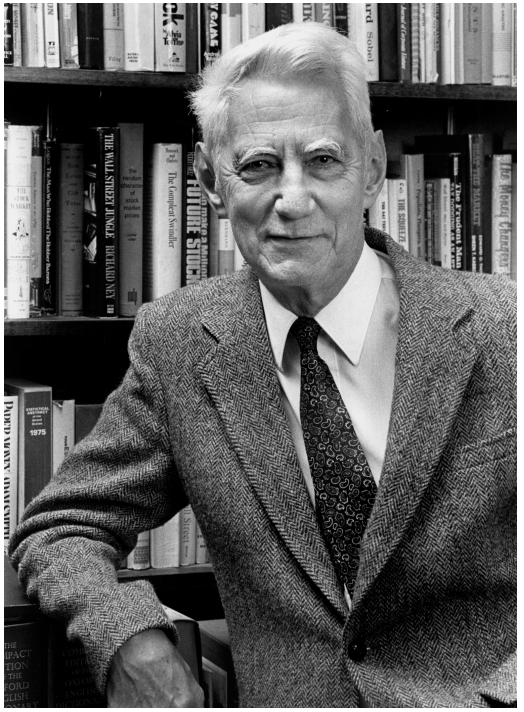
Chapter 1

Questions

- What is a bit and what does it mean to say (Koan 1) that "it's all just bits"?
- Give examples of the different kinds of things that today are represented by binary data?
- Describe Moore's Law.
- Give an example of how the digital explosion is "neither good nor bad" but has both positive and negative implications.

Who Invented Bits?

- Claude Shannon



Koan 1

It's all Just Bits

Bits are Universal & Ubiquitous

- All different kinds of information can be represented as sequences of bits:
  - Numbers
  - plain text
  - formatted documents
  - Colors
  - Images
  - Sound
  - Video
  - software applications
- This universality is the basis of the digital revolution, which allows us to create share, and manipulate all these kinds of information on our computers.

Bits don't have Intrinsic Meaning

- Because bits can be used to represent anything, bits have no intrinsic meaning. The meaning of a sequence of bits depends on how you interpret them. Given a sequence of bits, you can't necessarily tell if it stands for a number, a document, an image, a sound file, etc.

- However:
  - Analysis can give you a clue. If the high-order bit of each byte is 0, this suggests that the sequence is ASCII characters, so the bits may be a document of some sort. If some of the substrings look like HTML tags (e.g. <html>, <body>, <h1>, etc.), it's probably an HTML document.
  - Many file types have initial bytes that serve as a header saying "I am this type of file".
  - Many file types have extensions (e.g., .txt, .html, .doc, etc.) to help humans and programs determine how to interpret them.

Binary Digits (bits)

- Binary digits (bits) correspond naturally to electronic circuits where 1 represents 'on' and 0 represents 'off'. In computers, binary sequences are used to represent all kinds of data: text, numbers, images, sounds, ..., everything.

A Little Bit About Bits

- A byte is an 8-bit sequence. Historically an 8-bit byte was used to represent a single character in computer memory.
- The length of a binary sequence -- a sequence of 0s and 1s -- determines the number of different sequences that can be generated and therefore the number of different things that can be represented by such a sequence.
- For example, with 1 bit, you can have two different sequences, 0 or 1, which can stand for two different colors, say, 0 stands for white and 1 for black. With 2 bits, you can have four different sequences, 00, 01, 10, or 11, which can represent four different colors, white, black, red, green. And so on.

Bits and Bytes

- In general, an n-bit sequence can represent how many things?
- Answer:
- Test your knowledge here:
  - http://www.cs.trincoll.edu/~ram/q/110/powers-of-2.html

Koan 2

Perfection is Normal

Bits can be Easily Copied

- The fact that bits are easily copyable means that we can easily share electronic information on the Web.
- But this has huge implications for:
  - Privacy
  - Security
  - Intellectual Property

Stolen Pictures

Error Detection & Correction

- Computer Scientists have developed schemes to insure accurate data representation and communication.
- Example: Parity Bit Error Detection
- Suppose you are sending a stream of data to a server. By adding a parity bit, you enable to the server to detect some basic transmission errors

Parity Bit Error Detection

- For example, if the server expects that every byte will contain an even number of 1s and it detects a byte such as 0001 0101 with an odd number of 1s, it can tell that an error occured. Perhaps the user meant to send 0000 0101 but one of the bits was flipped from 0 to 1 during transmission.
- A parity bit is a bit that is added as the leftmost bit of a bit string to ensure that the number of bits that are 1 in the bit string are even or odd.
- To see how this works, suppose our data are stored in strings containing 7 bits.

Parity Bit Error Detection

- In an even parity scheme the eighth bit, the parity bit, is set to 1 if the number of 1s in the 7 data bits is odd, thereby making the number of 1s in the 8-bit byte an even number. It is set to 0 if the number of 1s in the data is even.
- In an odd parity scheme the eighth bit, the parity bit, is set to 1 if the number of 1s in the 7 data bits is even, thereby making the number of 1s in the 8-bit byte an odd number. It is set to 0 if the number of 1s in the data is odd.
- Test yourself: http://www.cs.trincoll.edu/~ram/q/110/parity-error-detection.html

Koan 3

Want in the Midst of Plenty

Devices Change

Devices Change

Devices Change

Devices Change

Koan 4

Processing is Power

Moore's Law

- The observation that the number of transistors that could be packed onto a integrated circuit seemed to double ever two years or so.
- Someone offers you a summer job and offers you two payment schemes: (1) $10 per hour for 40 hours per week for 30 days or (2) One cent on day 1, two cents and day two, four cents on day three and on (doubling each day) for 30 days. Which play would you choose?
  - Answer

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- http://en.wikipedia.org/wiki/Parity_bit