Digitized Media

Digital encoding of information means the data is stored in discrete units -- effectively numbers. Once we have digital date, we can use it to represent any form of digital media.

Recall from Monday's Lecture…

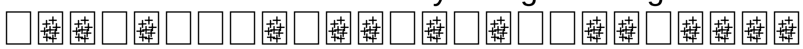
- Digital data is discrete – either "on" or "off"
- With 1 piece of data (e.g., a light switch), you can represent 2 pieces of information (e.g., the light is either "on" or "off").
- We call a single piece of data with two states a *bit*.
- If we look at a bunch of bits at the same time, we can represent more pieces of information.

BITS	NUMBER OF PIECES OF INFORMATION	EXAMPLES
1	2	0, 1
2	4	00, 01, 10, 11
3	8	000, 001, 010, 011, …

FIT 100

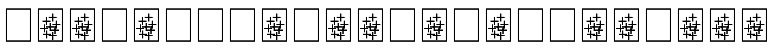
Encoding The Number

❖ Information is often stored by charge or magnetic field



Schematic diagram of magnetic spots, say on a disk

❖ Its presence or absence can be detected, leading to a natural association with 1 and 0 to the states, motivating the use of binary numbers



0 1 1 0 1 0 0 0 1 0 1 1 0 1 0 1 0 0 1 1 0 1 1 1

Byte 0 Byte 1 Byte 2

Binary is counting on your fists instead of your fingers

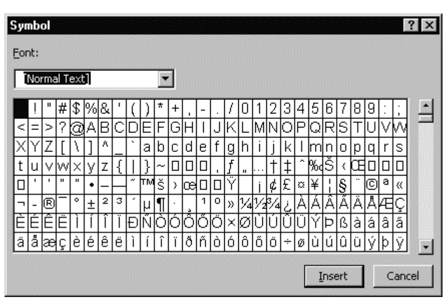
FIT 100

Some Information is Discrete: Character Encodings

❖ Keyboard characters are encoded into a byte or two

❖ ASCII is one of many encodings of the characters

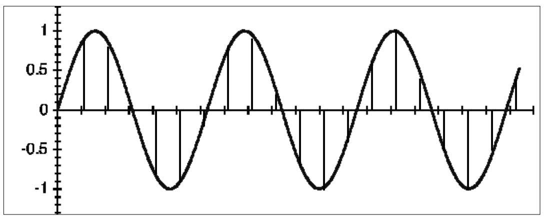
❖ A byte (8 bits) permits 256 things to be represented



ASCII, pronounced AS·key, stands for American Standard Code for Information Interchange

FIT 100 But Not All Information is Discrete…

- The physical world is analog -- sound comes from pushing air with a certain energy at a certain rate, etc
- By measuring a phenomenon one derives a value (number) of the phenomenon at that moment
- Sampling -- taking many measurements at uniform intervals -- gives a series of numbers, the digital form

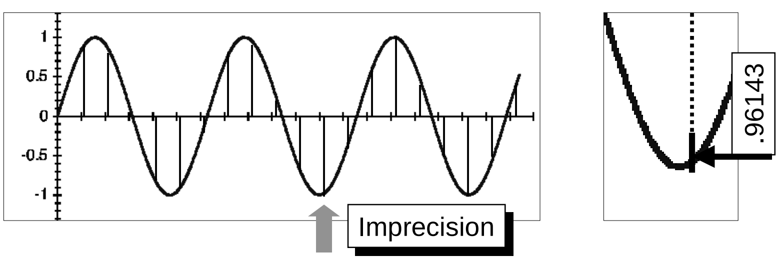


Digital audio:
44,100 sample/s
2 bytes/sample
2 channels, L&R
176,400 B/s
635 MB/hour

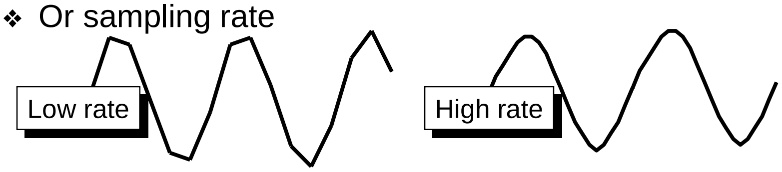
.0 .8 .7 .0 -.8 -.9 -.2 .8 .9 .2 -.7 -1 -.4 .6 1 .4 -.5 -1 -.5 .4 …

FIT 100 Digital Data

- Digital samples capture the basic structure of analog data, but it can be inaccurate due to limited precision

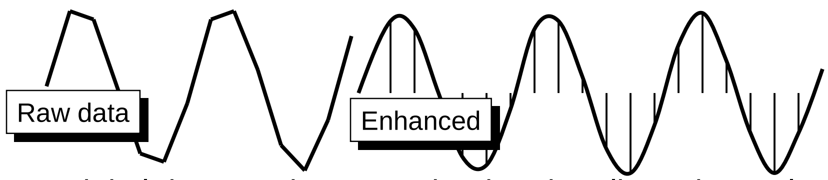


- Or sampling rate



FIT 100 Two Advantages of Digital Data

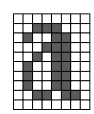
- A computer can “compute on” digital data, enhancing it to remove noise, artifacts of imprecision, etc.



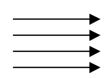
- Digital data can be transmitted and replicated exactly
  - The numbers are the complete representation of data
  - Assuring each number is duplicated or transmitted accurately, means the data is exact

.0 .8 .7 .0 -.8 -.9 -.2 .8 .9 .2 -.7 -1 -.4 .6 1 .4 -.5 -1 -.5 .4 …
.0 .8 .7 .0 -.8 -.9 -.2 .8 .9 .2 -.7 -1 -.4 .6 1 .4 -.5 -1 -.5 .4 …
.0 .8 .7 .0 -.8 -.9 -.2 .8 .9 .2 -.7 -1 -.4 .6 1 .4 -.5 -1 -.5 .4 …
.0 .8 .7 .0 -.8 -.9 -.2 .8 .9 .2 -.7 -1 -.4 .6 1 .4 -.5 -1 -.5 .4 …
.0 .8 .7 .0 -.8 -.9 -.2 .8 .9 .2 -.7 -1 -.4 .6 1 .4 -.5 -1 -.5 .4 …

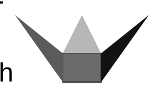
FIT 100 Picture Elements (Pixels)



- The phosphor on the screen naturally displays the on/off property of binary
  - Suitable for one color (B&W) video
  - The bits in memory are streamed out on the screen in “raster” order, like a standard TV

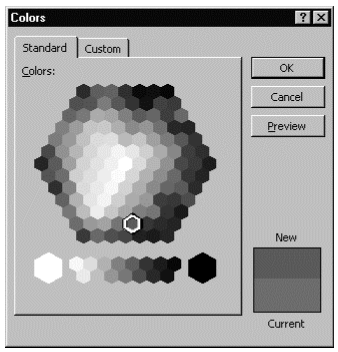


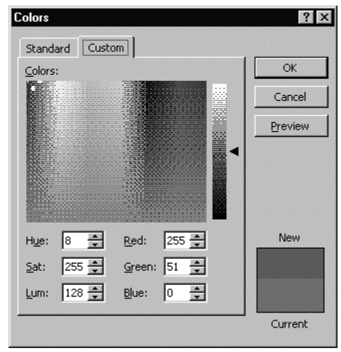
- For a color display, three (basic) colors of light must be displayed: red, green and blue (RGB)
  - Requires three different numbers, e.g. one byte each
  - Range of colors is determined by the intensity of each component
  - When all three values are at their maximum, the color is white, and when they are at their minimum the color is black



Color Control

- Select the color palette from an application and play
- Notice when values are equal -- gray results





Bits As A Medium

- Question: What does this string of bits represent?

0 1 1 0 1 0 0 0 1 0 1 1 0 1 0 1 0 0 1 1 0 1 1 1

FIT 100 Bits As A Medium

- The way that bits represent information is determined by how we interpret the bits …

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0 1 1 0 1 0 0 0 1 0 1 1 0 1 0 1 0 0 1 1 0 1 1 1
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- As separate bytes these are: 104, 181, 56
- As ASCII these bytes are: h, □, 7
- As a 24 bit integer these bytes are: 6,862,136
- As a color value the bytes are
- The bytes can be interpreted in an unlimited number of ways

FIT 100 Summary

- Digital representation can be faithfully replicated and transmitted
- It's common to "compute" on a digital representation
- The binary digits (bits) 0 and 1 are a natural way to interpret the presence or absence of a phenomenon
- Binary numbers and arithmetic are like decimal except the are limited to the two numerals 0 and 1
- Bits are bits -- what they mean depends on how we interpret their meaning … sometimes they are numbers, sometimes letters, sometimes sound, sometimes color, ...