Audio, video, and pictures

- Two steps:
  - encode the data
    - convert from “analog” (continuous) to “digital” (discrete)
  - goal: the digital data should be a close approximation of the original (analog) data
  - compress the data

- Audio and video: codecs (software or hardware used to compress and uncompress audio and video streams)

Audio: Encoding

- “Sampling”
  - more samples = better quality
    - rule of thumb: number of samples >= twice the maximum frequency (20,000 for sounds that humans can hear)
    - CD quality: 44,100 samples/second
  - each sample is encoded as a certain number of bits
    - CD: 16 bits per sample
    - stereo: two streams (sets of samples)

Audio: compression

- Many different formats: typically do both “lossy” and “lossless” compression
  - “lossy”: get rid of the unnecessary audio info (silent periods, very high and very low frequencies, etc.)
  - “lossless”: compress the remaining data (using Huffman encoding or another method)

- Examples: MP3, WMA, AAC, RA
- WAV is uncompressed audio
Pictures

- Two formats:
  - raster graphics: image is represented as colored dots called pixels
    - resolution: number of pixels in the picture (higher resolution = more pixels = higher quality)
    - examples: GIF, BMP, JPEG
  - vector graphics: images is represented in terms of lines and shapes
    - can be resized on the fly (for multiple resolutions, etc)
    - example: Flash

Colors

- Two formats:
  - RGB: Red-green-blue
  - HSB: Hue-saturation-brightness
- Three numerical values, each between 0 and 255
  - 8 bits per color
  - “True color”: > 16 million colors possible

Video

- Motion data is encoded as a series of still pictures, called frames
- Frames are played at a certain speed to re-create the motion
- Higher frame rate = better quality
  - “broadcast” (TV) quality = 30 frames/sec
  - “good” quality on the Internet = 15-20 frames/sec

Video

- Two types of compression
  - temporal: remove data that is the same in consecutive frames
    - background or stationary objects, for example
  - spatial: compress data that's repeated in the same frame
    - use run-length encoding
    - example: blocks of solid colors (sky, large objects)
### Circuits
- Recall that a computer is just a collection of circuits that interact to perform various tasks
  - memory, input, output, processing, ...
- Circuits are composed of logic gates
  - gate: device that performs an operation on one or more electrical signals

### Representing logic gates
- As an equation (boolean expression)
- As a logic diagram (circuit diagram)
- As a truth table

### Boolean algebra
- Equations/expressions in which the operands and answers have one of two values: true or false
  - true = 1
  - false = 0
- Has its own set of operators
- Can be used to express what is going on in a particular circuit

### Truth table
- A listing of all possible inputs and the resulting outputs of a circuit
  - each variable and answer is represented by a column
  - each row shows a possible combination of inputs and the resulting output(s)
Logic gates

- NOT
- AND
- OR
- XOR
- NAND
- NOR

NOT gate

- Inverter: 0 --> 1, 1 --> 0
- Expression: X = A'
- Truth table and logic diagram:

<table>
<thead>
<tr>
<th>A</th>
<th>X</th>
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<tbody>
<tr>
<td>0</td>
<td>1</td>
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<tr>
<td>1</td>
<td>0</td>
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AND gate

- Output is 1 only if all inputs are 1
- Expression: A·B
- Truth table and logic diagram:

<table>
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<th>X</th>
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<tbody>
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OR gate

- Output is always 1 unless all inputs are 0
- Expression: A+B
- Truth table and logic diagram:

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