Central processing unit

- “Brains” of the computer
- 2 parts
  - control unit: executes computer programs, step by step
  - ALU (arithmetic/logic unit): mathematical and logical calculations (if $x$ is true, do $y$)
- a.k.a “processor”

Data storage

- Memory: temporary storage inside the computer
  - RAM, e.g.
- “Secondary” storage device: long-term storage
  - hard drive
  - CD/DVD drives
  - tape drive
  - floppy drive
Hard drive

Input/output devices

- Input: keyboard, mouse, CD/DVD drive, USB drive, etc.
- Output: monitor, printer, speakers, CD writer, etc.

Today: How data is stored in computers

Data types to store

- Text (characters)
- Numbers (integer, decimal)
- Audio
- Video
- Pictures
- Programs
- Formatting
- ...
The math part: Number systems

- We use a decimal system
  - digits: 0, 1, 2, ..., 9
  - aka base-10
  - all numbers are combinations of the digits 0-9
- Number systems are *positional*
  - e.g.: $1428 = 1 \times 10^3 + 4 \times 10^2 + 2 \times 10^1 + 8 \times 10^0$

Base $n$

- Contains digits 0, 1, ..., $n-1$
- Examples:
  - base 3: 0, 1, 2
  - base 5: 0, 1, 2, 3, 4
  - base 11: ???
    - any bases higher than 10 use letters
    - base 11: 0, 1, ..., 9, A
    - base 16: 0, 1, ..., F
  - 456 could be in base 7, 8, 9, ...

Converting from base $n$ to base 10

- Procedure: multiply each digit in the number by the base raised to the proper positional power, then add all of the products together
- Example: 1476
  - base 12 to base 10: $1 \times 12^3 + 4 \times 12^2 + 7 \times 12^1 + 6 \times 12^0 = 2394$
  - base 8 to base 10: $1 \times 8^3 + 4 \times 8^2 + 7 \times 8^1 + 6 \times 8^0 = 830$
  - base 4 to base 10: ???
    - (can't do it! base 4 only has digits 0-3)

Powers of 2 bases

- Binary: base 2 {0,1}
- Octal: base 8 {0,1,...,7}
- Hexadecimal: base 16 {0,1,...,9,A,B,C,D,E,F}
Examples

- Convert $1101010$ to decimal:
  - $1\times2^6 + 1\times2^5 + 1\times2^3 + 1\times2^1 = 106$

- Convert $456$ from octal to decimal:
  - $4\times8^2 + 5\times8^1 + 6\times8^0 = 302$

- Convert $4AC$ from hexadecimal to decimal:
  - $4\times16^2 + 10\times16^1 + 12\times16^0 = 1196$
The architecture of a computer

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    = 1* 10³ + 4 * 10² + 2 * 10¹ + 8 * 10⁰
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