What are Humans Made Of?

- Think about the human body.
- What components help us survive?
- What components help us function in society?
- Ignore components that help us move physically.

Computers Have Similar Needs

- Source of energy
- Environmental controls
- Superstructure holding components together
- A brain
  - To do its “reasoning”
  - “Hard-wired” memory
  - Short-term memory
  - Long-term memory
- Something to keep time
- Way to represent information
- Way to move information around
- Way to exchange information with external world
Superstructure

- System Unit
  - Monolithic or component-based

Superstructure

- Computer’s components located on motherboard.
Source of Energy

- Computers contain a **power supply**
- Converts AC line current to DC that computer needs.

Environmental Controls

- Computers generate heat and must be cooled
- System cooling
  - **Fans** that cool entire box
- Spot cooling
  - **Heat sinks**
  - **Heat pipes** (notebooks)
  - Small **local fans**
- Liquid cooling
  - Like radiator in your automobile
Processor

- The “smartest” part of the computer
- Involved in every activity.
- Can think of it as the computer’s brain,
  - Not entirely accurate
  - Memory is elsewhere, for example

"Hard-Wired" Memory

- Contains instructions that computer needs to function
- Retained when power is off
- Read-only memory (ROM)
- CMOS – powered by battery
- Flash memory – can be changed
Short-Term Memory

- Random Access Memory (RAM)
- Holds instructions and data while program is running
- Lost when machine or program is turned off

Long-Term Memory

- Internal hard drive
- Removable storage
  - CDs
  - DVDs
  - External hard drives
  - USB drives
Something to Keep Time

- **System clock**
  - Small chip that generates precisely timed electrical impulses
  - Controls timing of computer’s operations

Representing Information

- Use a coding scheme
- Numbers represent characters
- Simple example
  - | Decimal Number | Character |
    |---------------|-----------|
    | 1             | a         |
    | 2             | b         |
    | 4             | d         |
    | 214           | ?         |
Representing Information

- Computers Use the Binary system
  - Base 2 number system
  - Uses only two digits: 0 and 1
- Why binary?
  - Easy to store electrically or magnetically
  - Current flowing = 1; not flowing = 0
  - Magnetic poles: N-S = 1; S-N = 0

Binary and Decimal Systems

- Based on powers of 2 (in binary) or 10 (in decimal)

```
Decimal system:  1  0  2  5
1*10^2 = 100
1*10^1 = 10
1*1^0 = 1
(1 x 1000) + (0 x 100) + (2 x 10) + (5 x 1) = 1025

Binary system:  1  0  1  1
2^3 = 8
2^2 = 4
2^1 = 2
2^0 = 1
In binary 1011 = (1 x 8) + (0 x 4) + (1 x 2) + (1 x 1) = 11
```
Binary Numbers

<table>
<thead>
<tr>
<th>Binary</th>
<th>Decimal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>1010</td>
<td>10</td>
</tr>
<tr>
<td>1111</td>
<td>15</td>
</tr>
<tr>
<td>10000</td>
<td>16</td>
</tr>
</tbody>
</table>

“Bit” = binary digit
1000 1001 is an “8-bit” number (137 decimal)

Binary Coding Schemes

- Often use 8-bit code
  - $2^8 = 256$ characters
  - In binary, numbers between 0000 0000 and 1111 1111

<table>
<thead>
<tr>
<th>Character</th>
<th>Decimal</th>
<th>Binary</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>1</td>
<td>0001</td>
</tr>
<tr>
<td>b</td>
<td>2</td>
<td>0010</td>
</tr>
<tr>
<td>d</td>
<td>4</td>
<td>0100</td>
</tr>
<tr>
<td>?</td>
<td>214</td>
<td>1101 0110</td>
</tr>
</tbody>
</table>
Hexadecimal Numbers

- Hexadecimal (base 16)
  - 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F
  - Often used a shorthand for long binary numbers

Hexadecimal Code

<table>
<thead>
<tr>
<th>Binary</th>
<th>Hex</th>
<th>Binary</th>
<th>Hex</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000</td>
<td>0</td>
<td>1001</td>
<td>9</td>
</tr>
<tr>
<td>0001</td>
<td>1</td>
<td>1010</td>
<td>A</td>
</tr>
<tr>
<td>0010</td>
<td>2</td>
<td>1011</td>
<td>B</td>
</tr>
<tr>
<td>0011</td>
<td>3</td>
<td>1100</td>
<td>C</td>
</tr>
<tr>
<td>0100</td>
<td>4</td>
<td>1101</td>
<td>D</td>
</tr>
<tr>
<td>0101</td>
<td>5</td>
<td>1110</td>
<td>E</td>
</tr>
<tr>
<td>0110</td>
<td>6</td>
<td>1111</td>
<td>F</td>
</tr>
<tr>
<td>0111</td>
<td>7</td>
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<td></td>
</tr>
<tr>
<td>1000</td>
<td>8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Binary</th>
<th>Hex</th>
<th>Decimal</th>
</tr>
</thead>
<tbody>
<tr>
<td>0010</td>
<td>0100</td>
<td>#24</td>
</tr>
<tr>
<td>1100</td>
<td>0111</td>
<td>#C7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>36</td>
</tr>
<tr>
<td></td>
<td></td>
<td>199</td>
</tr>
</tbody>
</table>
Coding Schemes

- Can represent other things besides number and letters
- Colors are an example
  - Digital cameras
  - Image editing programs

Representing Colors

- Colors produced by adding red, green, and blue primary colors
- RGB = (Red, Green, Blue)
- 8-bit code
  - 256 intensities for each color (R, G or B)
  - 0 = least intense
  - 255 (#FF) = most intense
Representing Colors

- RGB = Red   Green   Blue
- Additive colors  (illustrate with Photoshop)
  - All colors = white; no colors = black
  - #FF 00 00  = what color?
  - #00 00 00  = what color?
  - #FF FF FF  = what color?
  - #80 80 80 = what color?

Moving Information Around

- Computer’s bus
- Pathway for data to be moved around between components
Interfaces With External World

- **Input/Output (I/O)**
- **Input**
  - Keyboards, mice, scanners, etc.
- **Output**
  - Monitors, printers, speakers

Interfaces with Outside World

- **Ports**: point of attachment for external devices (peripherals)
- **USB Port**
  - Most widely used
  - Printers, keyboards, flash drives, etc
- **Firewire**
  - Like a USB
  - More common on Macs
Interfaces with Outside World

- Bluetooth port
  - Uses radio waves to transmit data between devices
  - Short range (within 33 ft)
  - Communicate with peripherals, smart phones, etc without a cable