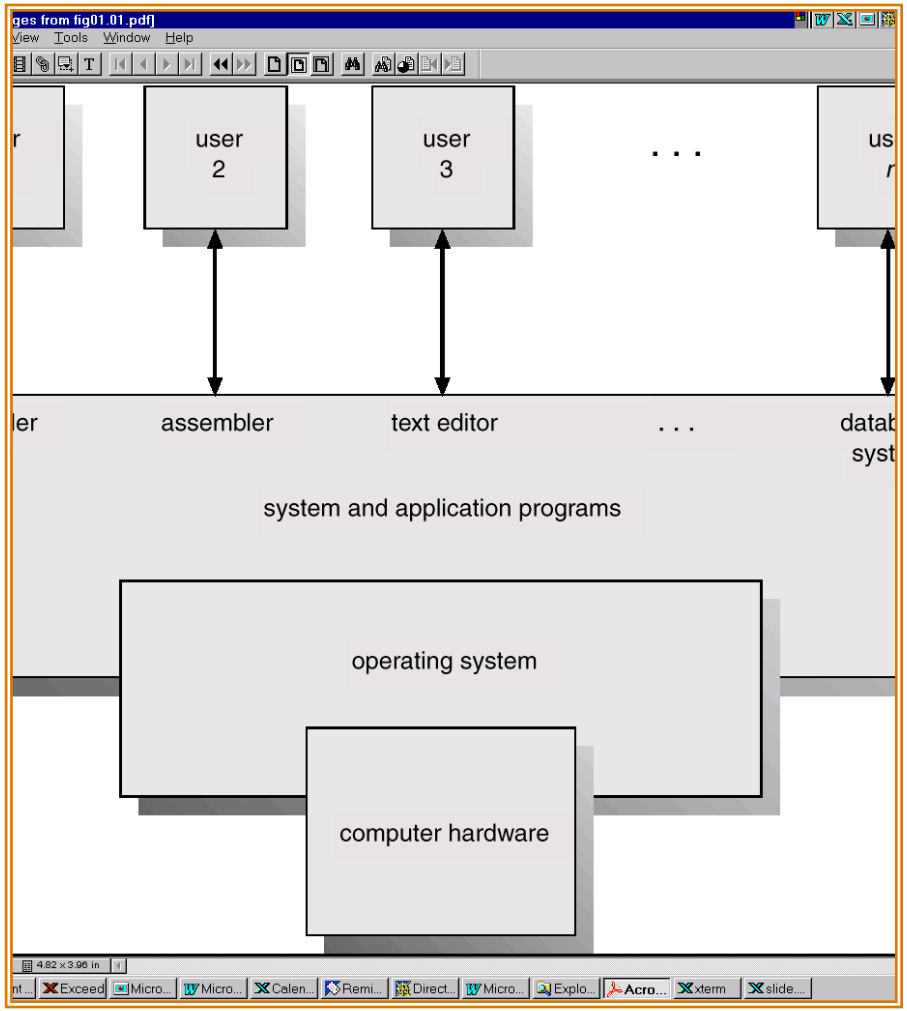
Computer Architecture and Binary Encodings

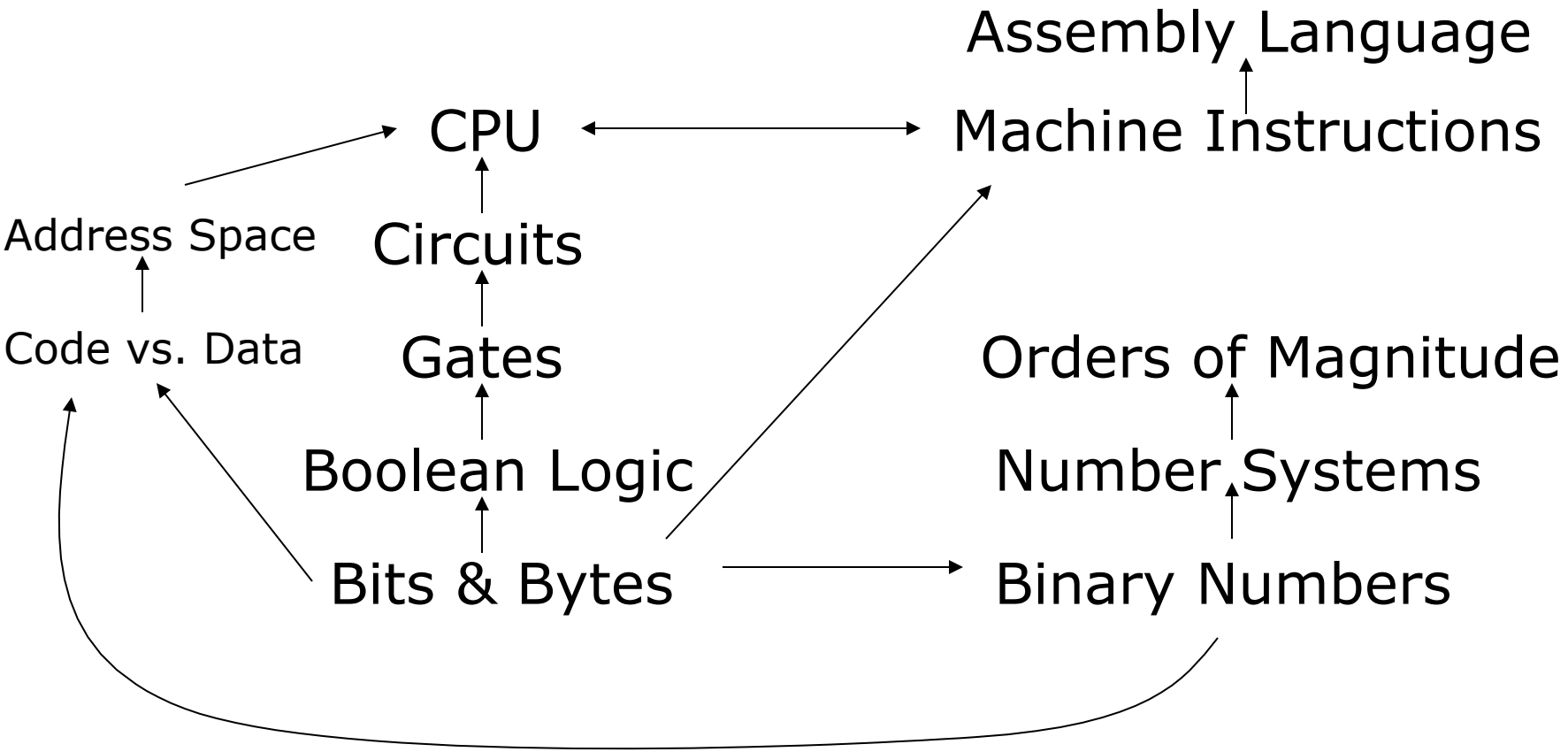
Computers of Different Shapes

Computer System Components



1. Hardware – provides basic computing resources (CPU, memory, I/O devices, network)
2. Operating system – controls and coordinates the use of the hardware among the various application programs for the various users
3. Applications programs – define the ways in which the system resources are used to solve the computing problems of the users (compilers, database systems, video games, business programs)
4. Users (people, machines, other computers)

How Do Computers Work?



Data Representation

- All data stored in and manipulated by a *digital* computer are represented by patterns of bits:
  - Numbers
  - Text characters
  - Sound
  - Images and videos
  - Anything else…
- **Bit**
  - Binary Digit = a symbol whose meaning depends on the application at hand
- Binary: takes on values of ‘0’ or ‘1’
  - Or equivalently, “FALSE” or “TRUE”, “OFF” or “ON”

Bytes

- A sequence of bits
- 8 bits = 1 byte

Kilobyte (KB)	1024 or 2^{10} bytes	1,024 bytes	Thousands of bytes
Megabyte (MB)	1024^2 or 2^{20} bytes	1,048,578 bytes	Millions of bytes
Gigabyte (GB)	1024^3 or 2^{30} bytes	1,073,741,824 bytes	Billions of bytes
Terabyte (TB)	1024^4 or 2^{40} bytes	1,099,511,627,776 bytes	Trillions of bytes

How binary works?

Number System

$$DIGIT * BASE^{POSITION\ \#}$$

$$
\begin{array}{lcll}
4*10^{2} & = & 4*100 & = & 400. \\
6*10^{1} & = & 6*10 & = & 60. \\
2*10^{0} & = & 2*1 & = & 2. \\
1*10^{-1} & = & 1*.1 & = & 0.1 \\
5*10^{-2} & = & 5*.01 & = & +\ 0.05 \\
 & & & & \hline \\
 & & & & 462.15
\end{array}
$$

Binary Number System

$DIGIT * BASE^{POSITION\#}$

110

Fours	*Twos*	*Ones*
2^2	2^1	2^0
1	**1**	**0**

$1*2^2 = 1*4 = 4$

$1*2^1 = 1*2 = 2$

$0*2^0 = 0*1 = 0$

=6 decimal

Convert Decimal to Binary

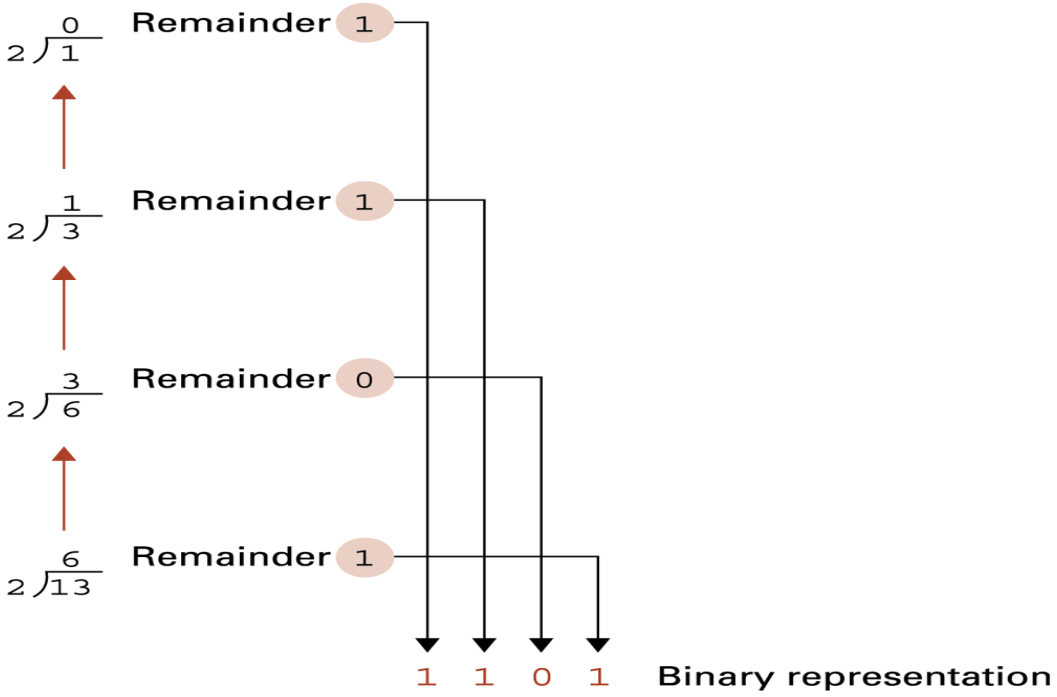
- 13 = 8 + 4 + 1 = 1101
- What if we have a big number?

Convert Decimal to Binary

Step 1. Divide the value by two and record the remainder.

Step 2. As long as the quotient obtained is not zero, continue to divide the newest quotient by two and record the remainder.

Step 3. Now that a quotient of zero has been obtained, the binary representation of the original value consists of the remainders listed from right to left in the order they were recorded.



Try it!

- 1011001 to decimal
- 10110010 to decimal
- 15 to binary
- 30 to binary
- 31 to binary

Computer Anatomy

- Motherboard
- Power Supply
- CPU Heatsink/Fan
- CPU (Central Processing Unit)
- RAM (Random Access Memory)
- Hard Drive
- Optical Drive
- Graphic Card
- Sounds Card
- Computer Case