A Balanced Introduction to Computer Science, 2/E

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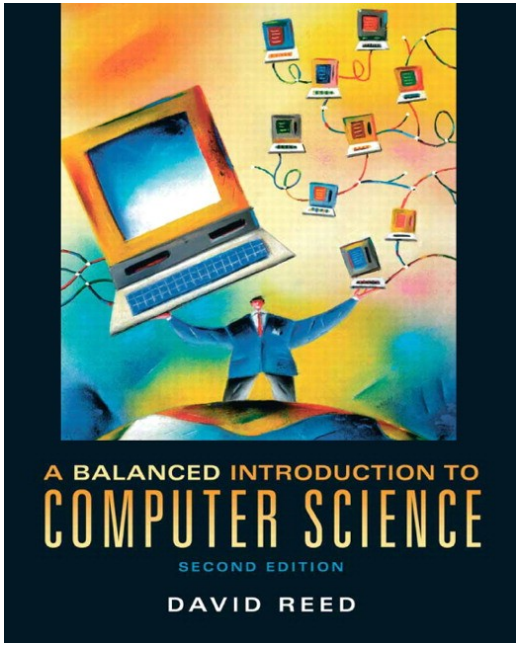
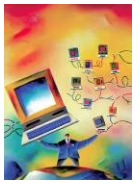


Chapter 1

Computer Basics

What is a Computer?



a *computer* is a device that receives, stores, and processes information

different types of computers have different characteristics

- *supercomputers:* powerful but expensive; used for complex computations (e.g., weather forecasting, engineering design and modeling)
- *desktop computers:* less powerful but affordable; used for a variety of user applications (e.g., email, Web browsing, document processing)
- *laptop computers:* similar functionality to desktops, but mobile
- *palmtop computers:* portable, but limited applications and screen size

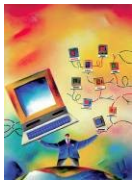
Supercomputer
Cray® 20-XMP™

Desktop Computer
Dell Dimension™ 4400

Laptop Computer
Apple iBook

Palmtop
Palm™ m130

Desktop Specifications



purchasing a computer can be confusing

- sales materials contain highly technical information and computer jargon

the following specs describe two computer systems for sale in January, 2007

- Desktop 1 is a low-end system, inexpensive but with limited features
- Desktop 2 is a high-end system, uses the latest technology so expensive

	Desktop System 1	Desktop System 2
CPU	2.53GHz Intel® Celeron® D Processor	2.93GHz Intel® Core™ 2 Duo Processor
Memory		
Cache	512KB Cache	4MB Cache
RAM	512MB RAM	4GB RAM
Hard Drive	160GB hard drive	500GB hard drive
Floppy Drive		3.5" 1.44MB diskette drive
CD-ROM/DVD	CD-RW/DVD Drive	CD-RW/DVD-RW Drive
Input/Output		
Keyboard	Multi-function Keyboard	Multi-function Keyboard
Pointing Device	Optical Wheel Mouse	Optical Wheel Mouse
Screen	15" LCD Flat Panel Display	20" LCD Flat Panel Display
Speakers	Speakers	5-piece sound system
Modem	56K Modem	56K Modem
Network Adapter	10/100 Ethernet Adapter	10/100/1000 Ethernet Adapter
Software		
Operating System	Microsoft Windows XP Home Edition	Microsoft Windows XP Home Edition
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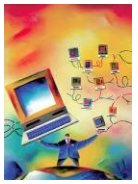
Hardware vs. Software



the term *hardware* refers to the physical components of a computer system

- e.g., monitor, keyboard, mouse, hard drive

the term *software* refers to the programs that execute on the computer

- e.g., word processing program, Web browser

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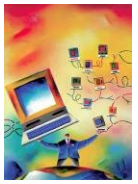
hardware components

software components

Common Desktop Hardware

von Neumann Architecture

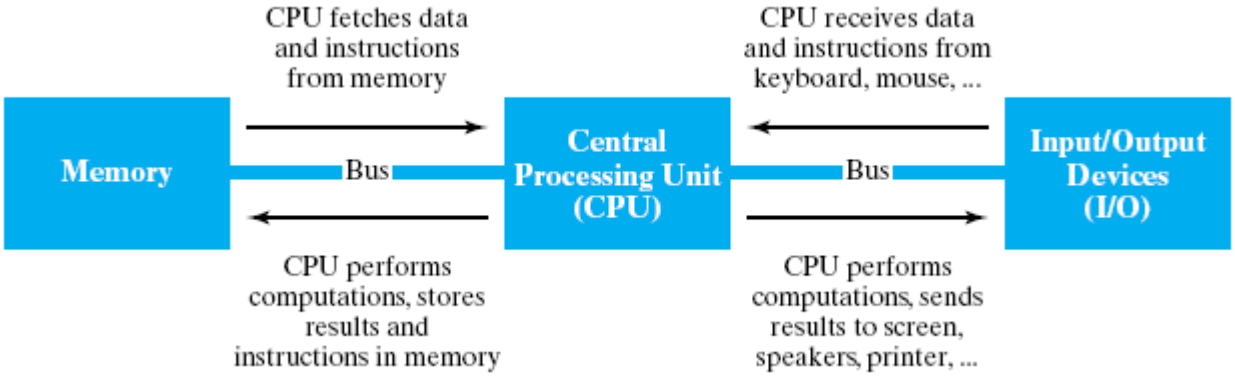


although specific components may vary, virtually all modern computers have the same underlying structure

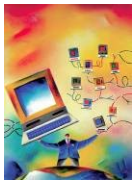
- known as the *von Neumann architecture*
- named after computer pioneer, John von Neumann, who popularized the design in the early 1950's

the von Neumann architecture identifies 3 essential components

1. *Input/Output Devices (I/O)* allow the user to interact with the computer
2. *Memory* stores information to be processed as well as programs (instructions specifying the steps necessary to complete specific tasks)
3. *Central Processing Unit (CPU)* carries out the instructions to process information



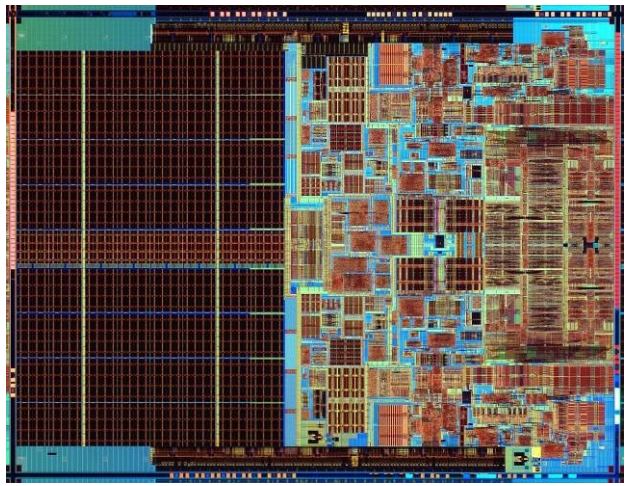
Central Processing Unit (CPU)



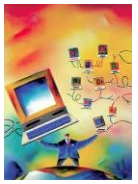
the CPU is the "brains" of the computer, responsible for controlling its inner workings

- made of *circuitry* – electronic components wired together to control the flow of electrical signals
- the circuitry is embedded in a small silicon chip, 1-2 inches square
- despite its small size, the CPU is the most complex part of a computer
  (CPU circuitry can have 100's of millions of individual components)

- commercial examples: Intel Core 2 Duo, AMD Athlon, Motorola PowerPC G4



CPU (cont.)



the CPU works by repeatedly fetching a program instruction from memory and executing that instruction

- individual instructions are very simple (e.g., add two numbers, or copy this data)
- complex behavior results from incredible speed
  - a 2.53 GHz Celeron D processor can execute 2.53 billion instructions per second
  - a 2.93 GHz Core 2 Duo processor can execute 2.93 billion instructions per second

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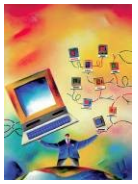
Memory



memory is the part of the computer that stores data and programs

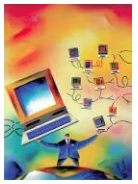
modern computers are *digital* devices, meaning they store and process information as *binary digits (bits)*

- bits are commonly represented as either 0 or 1
- bits are the building block of digital memory

  by grouping bits together, large ranges of values can be represented

1 bit	→ 2 values	0 1
2 bits	→ 4 values	00 01 10 11
3 bits	→ 8 values	000 001 010 011 100 101 110 111
4 bits	→ 16 values	0000 0001 0010 0011 0100 0101 0110 0111 1000 1001 1010 1011 1100 1101 1111
5 bits	→ 32 values	00000 00001 00010 00011 00100 00101 00110 00111 01000 01001 01010 …
6 bits	→ 64 values	000000 000001 000010 000011 000100 000101 000110 000111 001000 …
7 bits	→ 128 values	0000000 0000001 0000010 0000011 0000100 0000101 0000110 0000111 …
8 bits	→ 256 values	00000000 00000001 00000010 00000011 00000100 00000101 00000110 …
9 bits	→ 512 values	000000000 000000001 000000010 000000011 000000100 000000101 …
10 bits	→ 1,024 values	0000000000 0000000001 0000000010 0000000011 0000000100 0000000101 …
.		
.		
.		
N bits	→ 2^N values	

Memory (cont.)



memory capacity is usually specified in bytes

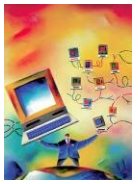
- a *byte* is a collection of 8 bits – so can represent a range of $2^8 = 256$ values
- large collections of bytes can be specified using prefixes

byte	$\rightarrow$ 8 bits		
kilobyte (KB)	$\rightarrow 2^{10}$ bytes	=	1,024 bytes (= 8,192 bits)
megabyte (MB)	$\rightarrow 2^{20}$ bytes	=	1,048,576 bytes (= 8,388,608 bits)
gigabyte (GB)	$\rightarrow 2^{30}$ bytes	=	1,073,741,824 bytes (= 8,589,934,592 bits)
terabyte (TB)	$\rightarrow 2^{40}$ bytes	=	1,099,511,627,776 bytes (= 8,796,093,022,208 bits)

since a byte is sufficient to represent a single character, can think of memory in terms of text

- a kilobyte can store a few paragraphs (roughly 1 thousand characters)
- a megabyte can store a book (roughly 1 million characters)
- a gigabyte can store a small library (roughly 1 billion characters)
- a terabyte can store a book repository (roughly 1 trillion characters)

Memory (cont.)



modern computers use a combination of memory types, each with its own performance and cost characteristics

main memory (or *primary memory*) is fast and expensive

- data is stored as electric signals in circuitry, used to store active data
- memory is volatile – data is lost when the computer is turned off
- examples: Random Access Memory (RAM), cache

secondary memory is slower but cheaper

- use different technologies (magnetic signals on hard disk, reflective spots on CD)
- memory is permanent – useful for storing long-term data
- examples: hard disk, floppy disk, compact disk (CD), flash drive

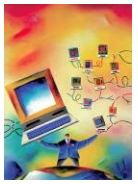
RAM chips

Hard disk

Floppy disk

Compact disk (CD)

Memory (cont.)



higher-end computers tend to have

- more main memory to allow for quick access to more data and programs
- more secondary memory to allow for storing more long-term data

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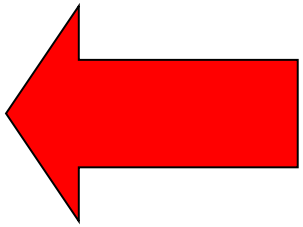
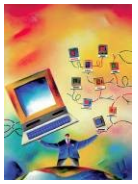


Input/Output (I/O)



input devices allow the computer to receive data and instructions from external sources

- examples: keyboard, mouse, track pad, microphone, scanner

output devices allow the computer to display or broadcast its results

- examples: monitor, speaker, printer

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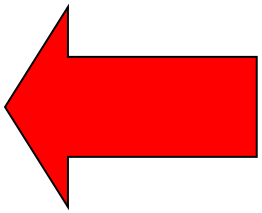
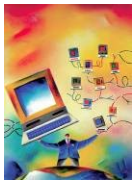


Software



recall: *hardware* refers to the physical components of computers
software refers to the programs that execute on the hardware

a software program is a sequence of instructions for the computer (more specifically, for the CPU) to carry out in order to complete some task

- e.g., word processing (Microsoft Word, Corel WordPerfect)
- e.g., image processing (Adobe Photoshop, Macromedia Flash)
- e.g., Web browsing (Internet Explorer, Mozilla Firefox)

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