Chapter 1: Computers: A First Look

How do computers affect us in our daily lives?

Brief History of Computing

Computers: A First Look

- In this lecture:
  - How do computers pervade our every day lives?
  - What is considered a computer and what is not?
  - Why do computers use the binary system?
  - What are some characteristics of different types of computers?
  - How are computers commonly used today?
  - How have computers evolved over the years?

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Beyond the Computer Invasion

- 6:15 AM - Timer in coffee maker turns on
- 6:30 AM - Computerized alarm clock rings
- 7:30 AM - Drive car/airbag,brakes,radio
- 8:00 AM - Check email at work
- 9:00 AM - Check in-coming voice mail
- 10:00 AM - Receive in-coming fax
- 12:00 PM - Buy gift. Electronic Kiosk
- 1:15 PM - Reserve airline ticket over Internet
- 3:00 PM - Pick up paycheck
- 5:15 PM - Stop off at ATM
- 6:30 PM - Grocery store /Checkout
- 11:30 PM - Microwave dinner

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Beyond the Computer Invasion

- The reason why computers are pervasive is that they help us…
  - perform tasks that are repetitive.
  - perform tasks that involve calculation or manipulation of numbers.
  - perform tasks that involve storage of large quantities of information.

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What Is (and Isn't) a Computer

- ***Definition:***
  - A **computer** is a device that takes data in one form, processes it, and produces a different form of information which is related to (but not the same as) the original data.

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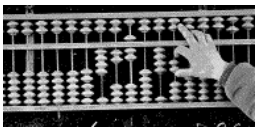
What Is (and Isn't) a Computer

- The Abacus is not a computer by our definition.
  - It is an early calculation device that only holds numbers for the person using it.



  - Abacus + Person = Computer? Issue for semantics…

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What Is (and Isn't) a Computer

- Stonehenge is a computer by our definition.
  - It takes the movement of the planets, sun and other heavenly bodies and provides information concerning eclipses and other astronomical events.

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What Is (and Isn't) a Computer

- The bathroom scale is a computer by our definition.
  - It takes in the amount of gravitational pull between a human body and the earth and provides us with the amount of pounds or kilograms.

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What Is (and Isn't) a Computer

- A calculator is a computer by our definition.
  - They range from doing simple arithmetic to powerful models that produce graphic output.

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What Is (and Isn't) a Computer

- Digital pagers and cell phones are also computers.
  - These wireless communication devices provide instant access to voice-mail, e-mail, and fax transmission.
  - Some provide built-in Internet access.

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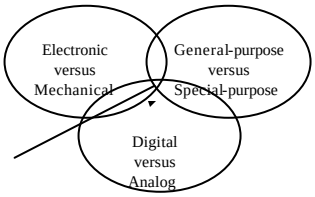
The Many Kinds of Computers

- Computers can be classified by three sets of characteristics:



Electrical, General Purpose, Digital Computer

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The Many Kinds of Computers

- Electronic Computer
  - Constructed from transistors and electrical circuits.
  - Needs an electrical source to function.
- Mechanical Computer
  - Constructed of a combination of gears, levers and/or springs.
  - Produces its own intrinsic energy. (Does not need electricity to function.)

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The Many Kinds of Computers

- General-purpose Computer
  - Was not manufactured to do any one thing.
  - Changeable to do any task.
- Special-purpose Computer
  - Manufactured to perform a predetermined task or set of tasks.

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The Many Kinds of Computers

- Digital Computer
  - One that functions in discretely varying quantities.
  - Produces or gives results that are also discretely varying.
- Analog Computer
  - One that functions in continuously varying quantities.
  - Produces or gives results that are also continuously varying.

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The General-Purpose Electronic Digital Computer

- The General-purpose electronic digital computer
  - General Purpose: Can be used in many different fields of work.
  - Electronic: Requires a source of electricity to function.
  - Digital: Made up of binary circuitry. (Each can be set to one of one two possible conditions.)
  - Controlled by humans; Presents results in a way usable by humans.

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The General-Purpose Electronic Digital Computer

- Digital computers are made up of four major components:
  - **Input units** - Humans interface with the computer through devices like the mouse and keyboard.
  - **Memory** - Stores programs and other data.
  - **Central Processing Unit** - "Brain" controls all computer operations, processes information, computes results.
  - **Output Units** - The computer displays results to the human through devices like the printer and monitor.
- We'll have more to say about these components in later lectures.

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The General-Purpose Electronic Digital Computer

- Computer **Hardware**
  - The electronics and associated mechanical parts of the computer.
- Computer **Software**
  - Consists of instructions that control the hardware and cause the desired process to happen
  - A Disk is considered hardware. A program ON the disk is considered software!

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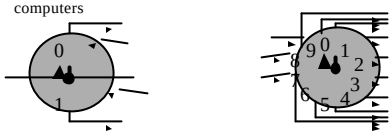
The General-Purpose Electronic Digital Computer

- Why do computers work in binary?
  - Simply, because using the binary system is cheap and reliable.
  - Building computers using any other system would be too expensive and become less reliable.
  - Future computers might break this rule; e.g. quantum computers



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Applications: Making the Computer Work for You

- Applications (Application Programs)
  - Sets of computer instructions designed to perform a particular application or task.
- Examples of popular application programs:
  - Word or WordPerfect for word processing.
  - Excel for keeping a ledger.
  - Norton's Utilities for checking disks for damage.
  - Web Browser for surfing the Internet

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Applications: Making the Computer Work for You

- Productivity Tools
  - First designed for the business setting.
  - Targeted increased speed and accuracy for office workers.
  - Now used in homes, schools, and in offices.
- Four types are included in this category:
  - Word Processing
  - Electronic Spreadsheets
  - Presentation Graphics
  - Database Management Systems
- Let's say a bit about database systems… they are used in several courses and there is a class dedicated to databases!

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Applications: Making the Computer Work for You

- Database Management Systems (DBMS)
  - DBMS are the computer programs that are used to organize small to large amounts of information in a meaningful way.
  - Allows entry, updating, and retrieval of information in a meaningful format.
    - Can add information.
    - Modify information.
    - Delete information.
    - Print information in a variety of formats.
    - Retrieve information efficiently.

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Applications: Making the Computer Work for You

- Computer Control
  - Tools used to make the computer run efficiently.
  - Used to make the computer perform certain tasks.
- Three types are listed in this category:
  - Programming Languages, Operating Systems, and Utilities.

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Applications: Making the Computer Work for You

- Programming Languages
  - Each programming language has its own vocabulary and structural rules.
  - Programmers use these languages to construct programs containing lists of instructions for the computer to perform.
  - Popular languages include:
    - Java ← We'll learn Java basics in this class
    - Visual Basic
    - C++
    - Perl

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Applications: Making the Computer Work for You

- Operating Systems
  - A collection of programs that manage and control all operations and coordinate all hardware components of the computer.
  - Some functions include:
    - Controlling the mouse pointer.
    - Sending data to the printer and screen.
    - Managing files.
    - Managing memory.
    - Controlling I/O devices.
  - Popular Operating Systems include Windows, Unix/Linux, MacOS, VMS, OS/2.
- We'll learn basic UNIX commands in this class.

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Applications: Making the Computer Work for You

- Utilities
  - Help to keep the computer running properly by:
    - Making adjustments in efficiency.
      - Faster operation.
      - More efficient memory and hard disk use.
      - Better communication connections.
    - Making repairs to damaged disks and files.
    - Identifying and eliminating viruses.

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Applications: Making the Computer Work for You

- Internet and Web Tools
  - Tools used to make easy access of the Internet possible.
  - Tools used to create a web presence.
- Three tools are listed in this category:
  - Web Browsers, Search Services, Web Page Builders.

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Applications: Making the Computer Work for You

- Web Browsers
  - Most commonly used tool to access the World Wide Web.
  - These programs allow web pages to be displayed on the computer screen that may include:
    - Text
    - Graphic images, animation and streamed video
    - Sound
    - Three-dimensional virtual reality environments
  - The two most widely used web browsers today include Microsoft Explorer and Netscape Navigator.

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Applications: Making the Computer Work for You

- Search Services
  - Tools used to help search for specific information on the WWW.
  - Many free search services exist on the WWW.
    - Type in a search criteria (key words to look for).
    - The search service will then locate pages on the web that contain that search criteria.
  - A few popular web search services include Google, Alta Vista, Excite, and DogPile.

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Applications: Making the Computer Work for You

- Web Page Builders
  - Tools used to create web pages.
  - Some word processors and presentation programs include web page design capability.
    - Type in the document as you wish it to look on the WWW.
    - Have the word processing program save it in the HTML (Hypertext Markup Language) format.
  - Stand-alone web page builders allow you to design more complex and sophisticated web sites.
- In this class we'll cover basic HTML to create a simple web page

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Roots of Computing

- Roots in Mathematical Sciences and computational devices
  - Abacus, counting device, state
  - Blaise Pascal, the Pascaline 1642
    - Manual gear system to add numbers
  - Charles Babbage
    - Difference Engine 1812, eventually built
    - Analytic Engine 1823, steam-powered more general computational device with conditional controls, too complex to build in the 19th century

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Roots of Computing…

- Herman Hollerith's Tabulating Machine
  - Former MIT lecturer, developed a machine to read punch cards
  - Inspired by a train conductor to punch tickets
  - Used in the 1890 US Census
  - Company became IBM in 1924

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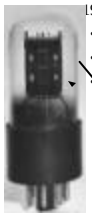
Roots of Computing…

- 1940, Conrad Zuse's Z3
  - First computing machine to use binary code, precursor to modern digital computers
- 1944, Harvard Mark I, Howard Aiken
- 1946, ENIAC, first all digital computer
  - Ushered in the "Mainframe" era of computing
  - "First Generation"
  - 18,000 vacuum tubes



Similar to a lightbulb but plate in middle controls flow of electrical current

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Roots of Computing…

- 1945: John von Neumann defines his architecture for an "automatic computing system"
  - Basis for architecture of modern computing
    - Computer accepts input
    - Processes data using a CPU
    - Stores data in memory
      - Stored program technique, storing instructions with data in memory
    - Produces output
- Led to the EDVAC and UNIVAC computers

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Roots of Computing…

1951, UNIVAC, Universal Automatic Computer

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The Second Generation: Transistors

- Invented 1947, Bell Labs: Bardeen, Shockley, Brattain
- 1958 -1964
- Transistors generate less heat
- Transistors are smaller, faster, and more reliable
- First transistors smaller than a dime
- UNIVAC II built using transistors

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The Third Generation: Integrated Circuits (IC)

- 1964 -1990
- Multiple transistors on a single chip
- IBM 360 - First mainframe to use IC
- DEC PDP-11 - First minicomputer
- End of mainframe era, on to the minicomputer era

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Integrated Circuit

- Invented at TI by Jack Kilby, Bob Noyce
- "*What we didn't realize then was that the integrated circuit would reduce the cost of electronic functions by a factor of a million to one, nothing had ever done that for anything before*" - Jack Kilby

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Minicomputer Era

- Made possible by DEC and Data General Corporation, IBM
- Medium-sized computer, e.g. DEC-PDP
- Much less expensive than mainframes, computing more accessible to smaller organizations
- Used transistors with integrated circuits

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Personal Computer Era

- First microprocessor, Intel 4004 in 1971
- MITS Altair "kit" in 1975
- Apple in 1976
- IBM PC in 1981 using 8086
- Macintosh in 1984, introduced the GUI (Graphical User Interface) we still use today
  - Some critics: Don Norman on complexity
  - Next interface delegation instead of direct manipulation?

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Today: Internetworking Era?

- Computer as communication device across networks
- World Wide Web, Internet
- Publishing, data sharing, real-time communications

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Supercomputers

- The most powerful and expensive computers
- Contain numerous very fast processors that work in parallel
  - ASCI White by IBM
    - 12 TeraFlops, size of 2 basketball courts, 8192 processors
  - At 2 TeraFlops, could do in 1 second what would take every man, woman, and child 125 years work nonstop on hand calculators
- Used by researchers and scientists to solve very complex problems
- Cost millions of dollars
- SETI @home?
  - Millions of users, >15 TeraFlops

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CPU Comparison

Increase over time!

Proc.	Year	DataBus	Trans	Mhz
4004	1971	4	2300	108Khz
8088	1979	8	29K	5
286	1982	16	134K	12
386	1985	32	855K	33
486	1989	32	1.6Mil	50-100
Pentium	1993	64	2.1Mil	166
P6	1995	64	5.5Mil	200
PII	1997	64	7.5Mil	400-500
PIII	1999	64	9.5Mil	500-800

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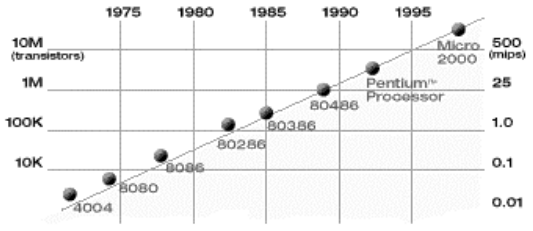
Moore's Law

1965: Computing power doubles ~ every 18 months

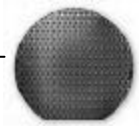


Estimate: Continue through 2010? Source: Intel Corp. 1-43

Chip Production

- Ingot of purified silicon – 1 meter long, sliced into thin wafers
- Chips are etched – much like photography
  - UV light through multiple masks
  - Circuits laid down through mask
- Process takes about 3 months

View of Cross-Section



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The Shrinking Chip

- Human Hair: 100 microns wide
  - 1 micron is 1 millionth of a meter
- Bacterium: 5 microns
- Virus: 0.8 microns
- Early microprocessors: 10-15 micron technology
- 1997: 0.35 Micron
- 1998: 0.25 Micron
- 1999: 0.18 Micron
- 2001: 0.13 Micron
- Physical limits believed to be around 0.06 Microns

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