Beginning Snapshots

Chapter 0.
Chapter Objectives
Parts of the Picture

- What is Computer Science
- The History of Computing
- Introduction to Computer Systems
Chapter Objectives

- To give an overview, to demonstrate the breadth of Computer Science
- To provide the context of today’s computing by noting significant events from the past
- To describe basic components of computer systems
- To understand methods and features of programming
What is Computer Science?

It is not just writing computer programs.

Computer science includes:

- Algorithms
- Data structures
- Architecture
- Artificial intelligence
- Robotics
- Human-Computer communication
- Numerical and symbolic computation
- Operating Systems
- Programming Languages
- Software Engineering
- Ethical issues
The History of Computing

- Check out Computer History website.
- Important concepts that shaped the history of computing:
  - The mechanization of arithmetic
  - The stored Program
  - Graphical user interface
  - The computer network
Machines to Do Arithmetic

The abacus

Napier's Bones

The Pascaline

Leibniz’ calculator

The slide rule
The Stored Program

- Program: a sequence of instructions for the computer to follow. Also called “software”
- Hardware: the chips, wires, switches, etc. on which the software instructions are executed
- Primitive example: the Jacquard Loom
  - The loom was the hardware
  - The weaving pattern cards was the software
  - The “program” was “stored” on punched cards
Mechanical Computers

Charles Babbage

Difference engine computed polynomials

Analytical engine

- Provided a memory of 1000 50-digit numbers
- Had processing, storage, input, output
- Was never built – the technology of his day could not build his design

Babbage called the “Father of Computing”
Mechanical Computers

- Ada Augusta
  - Understood Babbage’s machines
  - Developed “programs”
  - Could be called the first programmer
- In the 1980’s a computer language (Ada) was named after her
Electromechanical Computers

Herman Hollerith

- Developed a punched card tabulating machine
- Used for the 1890 census
- His company was one of several which began IBM
Electromechanical Computers

- **Konrad Zuse**
  - Proposed use of vacuum tubes for switching of binary circuits
  - Hitler refused to fund his design

- **Alan Turing**
  - Computer theorist
  - Worked on the Colossus, used to decrypt German military messages, WW2

- **Grace Hopper** – coder on the Harvard Mark I
  - It used electrical relays
  - Sponsored by US Navy to compute navigational tables
Early Electronic Computers

- **ABC computer**
  - Developed by Atanasoff & Berry at Iowa State to do math & physics calculations

- **ENIAC**
  - Used 18,000 vacuum tubes, caused lights to dim in Philadelphia neighborhoods when turned on
  - Programmed by rewiring panels
Early Electronic Computers

- John von Neumann
  - Inventor of stored program concept
- Eckert and Mauchly
  - Built the UNIVAC (UNIversal Automatic Computer)
  - Used by the Census Bureau in 1950s
Second-Generation Computers

- Characterized by use of transistors in place of vacuum tubes
- During late 1950s, early 1960s, programming languages developed
  - FORTRAN (FORmula TRANslation)
  - LISP (LISt Processing)
  - COBOL (Common Business Oriented Language)
Third-Generation Computers

- Characterized by integrated circuits
- Pioneered by Jack Kilby and Robert Noyce
- IBM System/360
- First of 3rd generation computers
- Operating Systems developed
  - UNIX (1971)
  - MS-DOS (1981)
- PDP-8 first commercially successful minicomputer
- ARPANET beginning of the Internet (1969)
- ARPA Advanced Research Projects Agency
Fourth-Generation Computers

- Characterized by Very Large Scale Integrated circuits (VLSI)
- Beginning of microprocessors and personal computers
- Other events of 1970s
  - C language developed by Dennis Ritchie
  - Ethernet
  - Altair 8800 first hobby-kit computer
  - Bill Gates, Pallen write BASIC compiler for Altair
  - Steve Jobs, Steve Wosniak develop first Apple Computers
  - First super computer CRAY 1
Albuquerque

1975: speeding and driving without a license
1977: running a stop sign

Sundowner Hotel (2005), just west of Walgreen’s at Central and San Pedro
The name “Altair” came from an episode of Star Trek, or simply the name of a star ...
The Graphical User Interface (or GUI)

- Human–computer interaction was done with a difficult and cryptic command line interface
- Doug Englebart at Xerox PARC developed graphical interface, first to use a “mouse”
  - Concept went unused until Steve Jobs saw it
  - He adapted the concept for the Macintosh
- Microsoft responded with Windows operating system
- X Window system developed at M.I.T. for Unix
Networks

- Definition ⇒ two or more computers connected to exchange resources
  - Hardware resources
  - Software resources
  - Data
- Early networking
  - Timesharing, mainframe to terminals via modems
  - ARPANET connected research center computers for the Department of Defense
Networks

**The Internet**
- Grew out of the ARPANET as popularity and the number of host computers grew
- Internet service providers enable even home computers to be wired into the global digital infrastructure

**Local Area Networks (LANs)**
- Enabled by Ethernet hardware and network operating systems
- PC users share resources
Introduction to Computer Systems

Babbage’s Analytical Engine was designed with capabilities of ...

- Processing
- Storage
- Input
- Output

This is still a common feature in most modern computers
Processing

Major components of a computer
- CPU or Central Processing Unit
- Primary (internal) memory
- Secondary (external memory)
- Control Unit
- Arithmetic Logic Unit
- Input devices
- Output devices

- CPU
- Main Memory
- Control Unit
- Arithmetic and Logic Unit
- Input devices
- Output devices
- Network
- External Storage
Storage

Main Memory
- Internal, primary, random access memory (RAM)
- Stores instructions and data

Cache memory
- Smaller quantity of high speed memory

Registers
- Specific high speed memory locations used repeatedly by instructions
- Three orders of magnitude faster than RAM
Storage

Secondary, external, auxiliary storage

Needed because internal memory is volatile – loses contents when power is off

Media used

- Magnetic disks (floppy disks, hard drives)
- Optical media (CDs, DVDs)
Storage

- Binary storage
  - Storage locations are a collection of two-state values (either 0 or 1 – Binary digits)
  - These are called BITs

- Bytes
  - 8 bits make a byte
  - 1024 bytes make a kilobyte
  - Note kilo (1000) not quite accurate
  - Computer memory established in multiples of powers of 2 ... \( 2^{10} = 1024 \)
  - 1024 kilobytes = 1 Megabyte = 1,048,576 bytes
  - 1024 Megabytes = 1 Gigabyte = 1,073,741,824 bytes
Input and Output

Input devices
- Convert instructions and data into binary form
- Transmit to the CPU

Output devices
- Convert binary contents of memory into meaningful symbols for humans to view
- Outputs information as graphics, sounds, video, and even robotic movement
Input and Output

- Communication between CPU and I/O devices
- Specific or general connections to these peripheral devices called ports
- Ports connect to the computer’s bus
Operating Systems

- Required for a computer to be general purpose
- The tasks of the operating system (OS) include...
  - Interface between user and system hardware
  - Environment in which other software programs can run
- Hardware and OS together make up a platform
- Examples:
  - DOS, Windows, UNIX
Programming

- Definition ⇒ instructions for the hardware to perform
- Instructions are stored in memory
- Written in machine language
- Made up of …
  - Command or operator
  - Address of the value to be operated upon, operand
- Stored in binary form
Programming

Assembly language

- Easier to read, understand than list of binary codes
- Uses mnemonics in place of numeric codes
- Translation program called an assembler converts mnemonics into binary machine code
Programming

- High level languages
  - Instructions read like English and algebra
  - Called source code
  - Easier to read/understand than assembly language
  - Must be translated into machine language by compiler
  - Called object code
Programming

- Text editor creates source code
- Compiler creates object code
- Linker gathers portions of object code from ...
- Compiler output
- Libraries of special routines
- ... produces executable code