Chapter 1

The Big Picture
1.1 Computing Systems

**Hardware**  The physical elements of a computing system (printer, circuit boards, wires, keyboard…)

**Software**  The programs that provide the instructions for a computer to execute
Layers of a Computing System

- Communications
- Applications
- Operating systems
- Programming
- Hardware
- Information
Abstraction

A mental model that removes complex details

This is a key concept. Abstraction will reappear throughout the text – be sure you understand it!
Internal View
(lots of details)
Abstract View
(few details)
QUIZ

Explain the abstractions we normally apply when using the following systems:

- DVD player
- Registering for classes on DuckTrax
- Walking

In each case, explain what is the **internal view** and what is the **abstract view**.
1.2 History of computing
Early History of Computing

**Abacus** (about 1600 BC, or even 2700-2300 BC)
An early device to record numeric values  [Wikipedia page]

**Blaise Pascal**  1642
Mechanical device to add and subtract  [Pascaline]

**Gottfried Leibniz**  1672  [Wikipedia page]
Mechanical device to add, subtract, divide & multiply:  [Stepped Reckoner]
Binary number system
Anticipated many of the hardware and software concepts developed later by Babbage & Lovelace

**Joseph Jacquard**
1801:  [Jacquard’s Loom], the punched card

**Charles Babbage**
1822:  [Difference Engine] and 1837-1871:  [Analytical Engine]
Memory
Early History of Computing

Ada Lovelace, the "Enchantress of numbers"
1843: First Programmer, the loop

William Gibson & Bruce Sterling: The Difference Engine
Doron Swade: The Difference Engine and Cogwheel Brain

Alan Turing
1936: Turing Machine, Artificial Intelligence Testing (the Turing test)

Neil Stephenson: Cryptonomicon

John von Neumann
1945: Stored-program computer, a.k.a. the von Neumann architecture

Harvard Mark I, ENIAC, UNIVAC I
At the end of WWII, these early computers launched a new era in mathematics, physics, engineering and economics!
Individual work
To do by next class (Friday):

• Read Section 1.2 (The History of Computing) and write in your notebook three facts we did not mention in class

• Answer end-of-chapter questions 1 – 10 in your notebook
A (very) brief history of the hardware
First Generation Hardware (1951-1959)

**Vacuum Tubes**
Large, not very reliable, generate a lot of heat

**Magnetic Drum**
Memory device that rotated under a read/write head

**Card Readers → Magnetic Tape Drives**
Sequential auxiliary storage devices
Second Generation Hardware (1959-1965)

Transistor
Replaced vacuum tube, fast, small, durable, cheap

Magnetic Cores
Replaced magnetic drums, information available instantly

Magnetic Disks
Replaced magnetic tape, data can be accessed directly
Third Generation Hardware (1965-1971)

**Integrated Circuits (ICs)**
Replaced circuit boards, smaller cheaper, faster, more reliable

**Transistors**
Now used for memory construction

**Terminal**
An input/output device with a keyboard and screen
Fourth Generation Hardware (1971-2001)

Large-scale Integration (LSI, VLSI)
Great advances in chip technology

PCs, the Commercial Market, Workstations
Personal Computers and Workstations emerge
New companies emerge: Apple, Sun, Dell …

Laptops
Everyone has his/her own portable computer
Multi-core processors
IBM Power4, released in 2001, had 2 cores in the same chip.
Beyond the isolated computer

Parallel Computing
Computers rely on interconnected central processing and/or memory units that increase processing speed

Computer Networks
• WAN technology started in 1969 with the ARPANET
• LAN technology started in 1973 with the Ethernet

WANs and LANs \(\rightarrow\) Internet
A (very) brief history of the software
First Generation Software
(1951-1959)

**Machine Language**
Computer programs written in binary (1s and 0s)

**Assembly Languages and Assemblers**
Programs written using mnemonics, which were translated into machine language

**Programmer Changes**
Programmers divide into two groups: application programmers and systems programmers
Systems programmers write the assembler (translator).

Applications programmers use assembly language to solve problems.
Second Generation Software (1959-1965)

High-level Languages
English-like statements made programming easier: Fortran, COBOL, Lisp

Application programmers use high-level languages to solve problems

Systems programmers write the compilers (translators)
Third Generation Software
(1965-1971)

Systems Software
Operating system (OS), which decides:
• Which programs to run and when
• What resources to allocate to each program
• What utility programs to call (e.g. loaders, linkers)

Separation between Users and Hardware
Programs are created to be used by nonprogrammers, e.g. SPSS.
Fourth Generation Software
(1971-1989)

New high-level languages for structured programming
• Pascal
• C
• C++

New Application Software for Users
• Spreadsheets
• Word processors
• Database management systems (DBMS)
Fifth Generation Software
(1990- present)

Object-Oriented Design
Based on a hierarchy of data objects (e.g. Java, Python)

World Wide Web
• Allows easy global communication through the Internet
• Single-handedly invented by a physicist, along with the HTML and the first browser!!

Microsoft and the OFFICE SUITE

New Users
Today’s user needs no computer knowledge (a triumph of abstraction!)
QUIZ

Explain the abstraction applied in browsing the WWW:

• What is the internal view?
• What is the abstract view?
Computing as a Tool

Computer practitioners

Applications Programmers (use tools)

Domain-Specific Programs

Users with No Programming Background

Computing as a Discipline

Systems Programmers (build tools for others)
Areas of CS

Computing as a Discipline
Systems Programmers
Systems Areas

- Algorithms and Data Structures
- Programming Languages
- Architecture
- Operating Systems
- Software Methodology and Engineering
- Human-Computer Communication

Computing as a Tool
Applications Programmers
Applications Areas

- Numerical and Symbolic Computation
- Databases and Information Retrieval
- Artificial Intelligence and Robotics
- Graphics
- Organizational Informatics
- Bioinformatics
Who am I?

Can you list three items on my resume?
Ethical Issues

The Digital Divide

What is it? A: The unequal access that people have to computers and computer-related technology.

Is it important to try to bridge the digital divide?
A1: Yes, from an ethical and social perspective
A2: Yes, from a purely economic perspective
Practice Flashcards on the text website
What computer company was launched in a garage? (p.16)

What branch of mathematics is being used in terrorist detection? (p.20)

What is Room to Read? (p.22)

What are embedded systems? (p.23)

When and where were the first CS Departments formed? (p.26)

Did they have any computers in the 1800s?
Chapter review questions

• Describe the layers of a computer system
• Describe the concept of abstraction and its relationship to computing
• Describe the history of computer hardware and software
• Describe the changing role of the computer user
• Distinguish between systems programmers and applications programmers
• Distinguish between computing as a tool and computing as a discipline
Steampunk!
The Telectroscope, 1878-2008
Individual work
To do by next class (Monday), before starting to work on homework:

• Read Ada Lovelace’s bio, the trivia frames, chapter review questions, and ethical issues

• Answer end-of-chapter questions 11 – 38 in your notebook
Homework

Due next Fri, Jan 27:

- End-of-chapter ex. 39, 41, 47, 51, 52, 53, 54, 56, 57, 58, 59
- End-of-chapter thought question 5 (paragraph-length answer required)

The latest homework assigned is always available on the course webpage