Chapter 1: An Introduction to Computer Science

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Ali Seydi Keçeli

Tuğba Erdoğan

Objectives

In this chapter, you will learn about

- The definition of computer science
- Algorithms
- A brief history of computing

Introduction

- Common misconceptions about computer science
  - Computer science is the study of computers
  - Computer science is the study of how to write computer programs
  - Computer science is the study of the uses and applications of computers and software

The Definition of Computer Science

- Gibbs and Tucker definition of computer science
  - The study of algorithms
    - Formal and mathematical properties
    - Hardware realizations
    - Linguistic realizations
    - Applications

The Definition of Computer Science (continued)

- Computer scientist designs and develops algorithms to solve problems
- Operations involved in designing algorithms
  - Formal and mathematical properties
    - Studying the behavior of algorithms to determine whether they are correct and efficient
  - Hardware realizations
    - Designing and building computer systems that are able to execute algorithms

The Definition of Computer Science (continued)

- Linguistic realizations
  - Designing programming languages and translating algorithms into these languages
- Applications
  - Identifying important problems and designing correct and efficient software packages to solve these problems

The Definition of Computer Science (continued)

- Algorithm
  - Dictionary definition
    - Procedure for solving a mathematical problem in a finite number of steps that frequently involves repetition of an operation
    - A step-by-step method for accomplishing a task
  - Informal description
    - An ordered sequence of instructions that is guaranteed to solve a specific problem

The Definition of Computer Science (continued)

- An algorithm is a list that looks like
  - STEP 1: Do something.
  - STEP 2: Do something.
  - STEP 3: Do something.
  - . .
  - . .
  - . .
  - STEP N: Stop. You are finished.

The Definition of Computer Science (continued)

- Categories of operations used to construct algorithms
  - Sequential operations
    - Carry out a single well-defined task; when that task is finished, the algorithm moves on to the next operation
    - Examples:
      - Add 1 cup of butter to the mixture in the bowl
      - Subtract the amount of the check from the current account balance
      - Set the value of x to 1

The Definition of Computer Science (continued)

- Conditional operations
  - Ask a question and then select the next operation to be executed on the basis of the answer to that question
  - Examples
    - If the mixture is too dry, then add one-half cup of water to the bowl

The Definition of Computer Science (continued)

- Conditional operations examples (continued):
  - If the amount of the check is less than or equal to the current account balance, then cash the check; otherwise, tell the person that the account is overdrawn
  - If x is not equal to 0, then set y equal to 1/x; otherwise, print an error message that says we cannot divide by 0

The Definition of Computer Science (continued)

- Iterative operations
  - Tell us to go back and repeat the execution of a previous block of instructions
  - Examples
    - Repeat the previous two operations until the mixture has thickened
    - While there are still more checks to be processed, do the following five steps
    - Repeat steps 1, 2, and 3 until the value of y is equal to 11

The Definition of Computer Science (continued)

- If we can specify an algorithm to solve a problem, we can automate its solution

- Computing agent
  - The machine, robot, person, or thing carrying out the steps of the algorithm
  - Does not need to understand the concepts or ideas underlying the solution

The Formal Definition of an Algorithm (continued)

- A primitive operation (or a primitive) of the computing agent
  - Operation that is unambiguous for computing agent
  - Primitive operations of different individuals (or machines) vary
  - An algorithm must be composed entirely of primitives
- Effectively computable
  - Computational process exists that allows computing agent to complete that operation successfully

The Early Period: Up to 1940

- 3,000 years ago: Mathematics, logic, and numerical computation
  - Important contributions made by the Greeks, Egyptians, Babylonians, Indians, Chinese, and Persians
- 1614: Logarithms
  - Invented by John Napier to simplify difficult mathematical computations
- Around 1622: First slide rule created

The Early Period: Up to 1940 (continued)

- 1672: The Pascaline
  - Designed and built by Blaise Pascal
  - One of the first mechanical calculators
  - Could do addition and subtraction
- 1674: Leibnitz's Wheel
  - Constructed by Gottfried Leibnitz
  - Mechanical calculator
  - Could do addition, subtraction, multiplication, and division

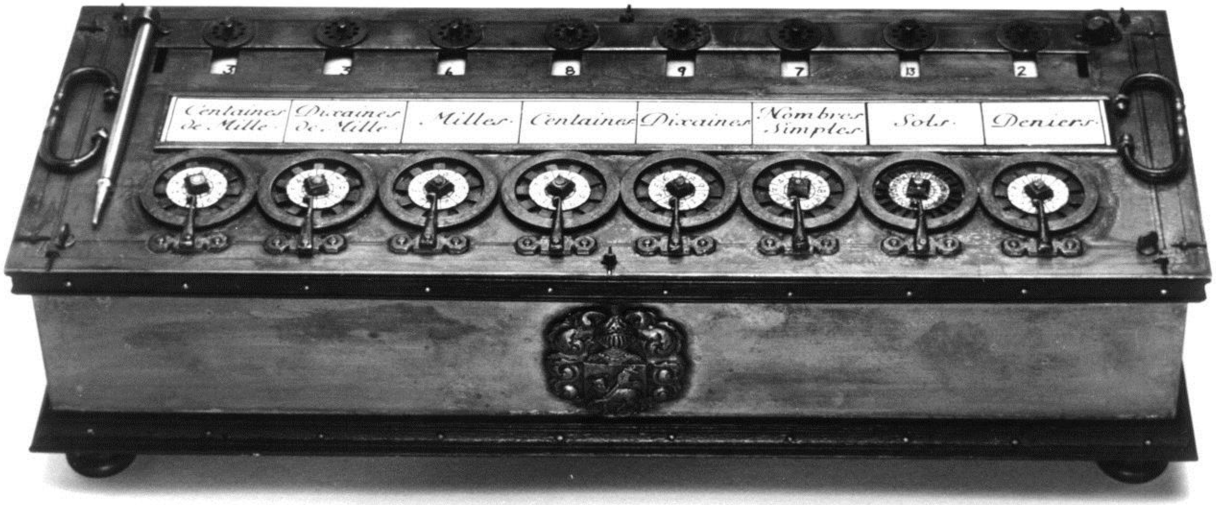


Figure 1.4

The Pascaline: One of the Earliest Mechanical Calculators

The Early Period: Up to 1940 (continued)

- 1801: The Jacquard loom
  - Developed by Joseph Jacquard
  - Automated loom
  - Used punched cards to create desired pattern
- 1823: The Difference Engine
  - Developed by Charles Babbage
  - Did addition, subtraction, multiplication, and division to 6 significant digits
  - Solved polynomial equations and other complex mathematical problems

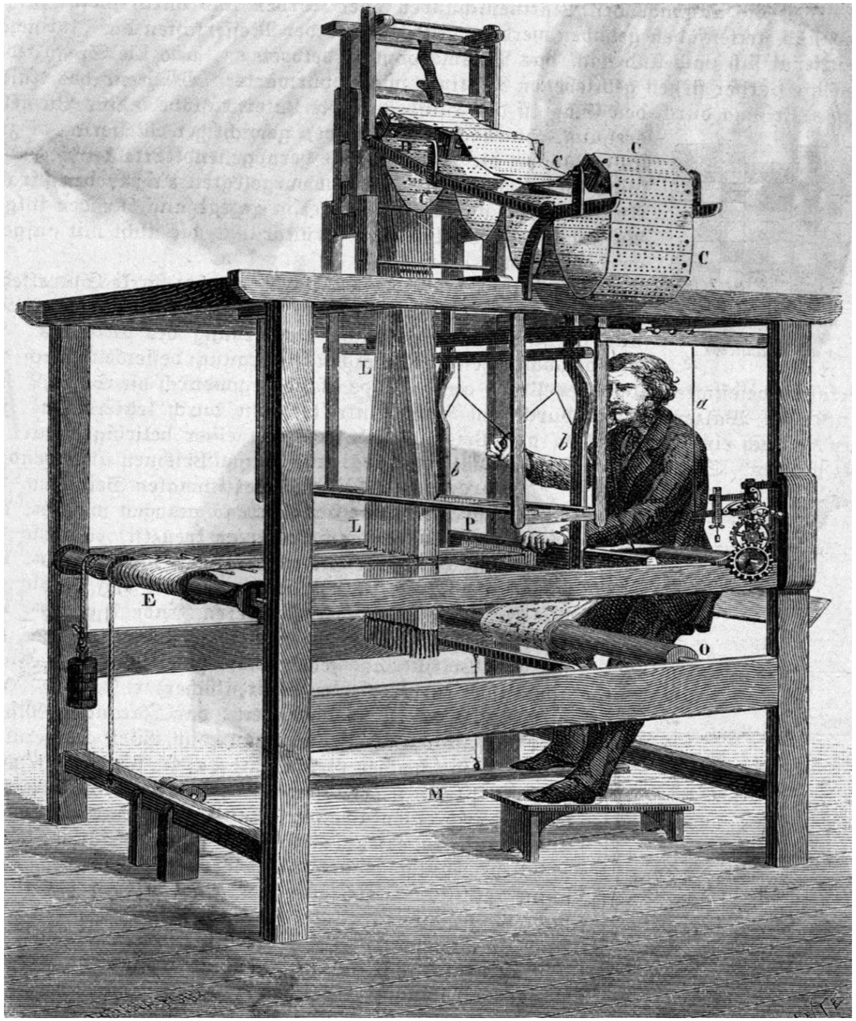


Figure 1.5
Drawing of the Jacquard Loom

The Early Period: Up to 1940 (continued)

- 1830s: The Analytic Engine
  - Designed by Charles Babbage
  - More powerful and general-purpose computational machine
  - Components were functionally similar to the four major components of today’s computers
    - Mill (modern terminology: arithmetic/logic unit)
    - Store (modern terminology: memory)
    - Operator (modern terminology: processor)
    - Output (modern terminology: input/output)

The Early Period: Up to 1940 (continued)

- 1890: U.S. census carried out with programmable card processing machines
  - Built by Herman Hollerith
  - These machines could automatically read, tally, and sort data entered on punched cards

The Birth of Computers: 1940-1950

- Development of electronic, general-purpose computers
  - Did not begin until after 1940
  - Was fueled in large part by needs of World War II
- Early computers
  - Mark I
  - ENIAC
  - ABC system
  - Colossus
  - Z1

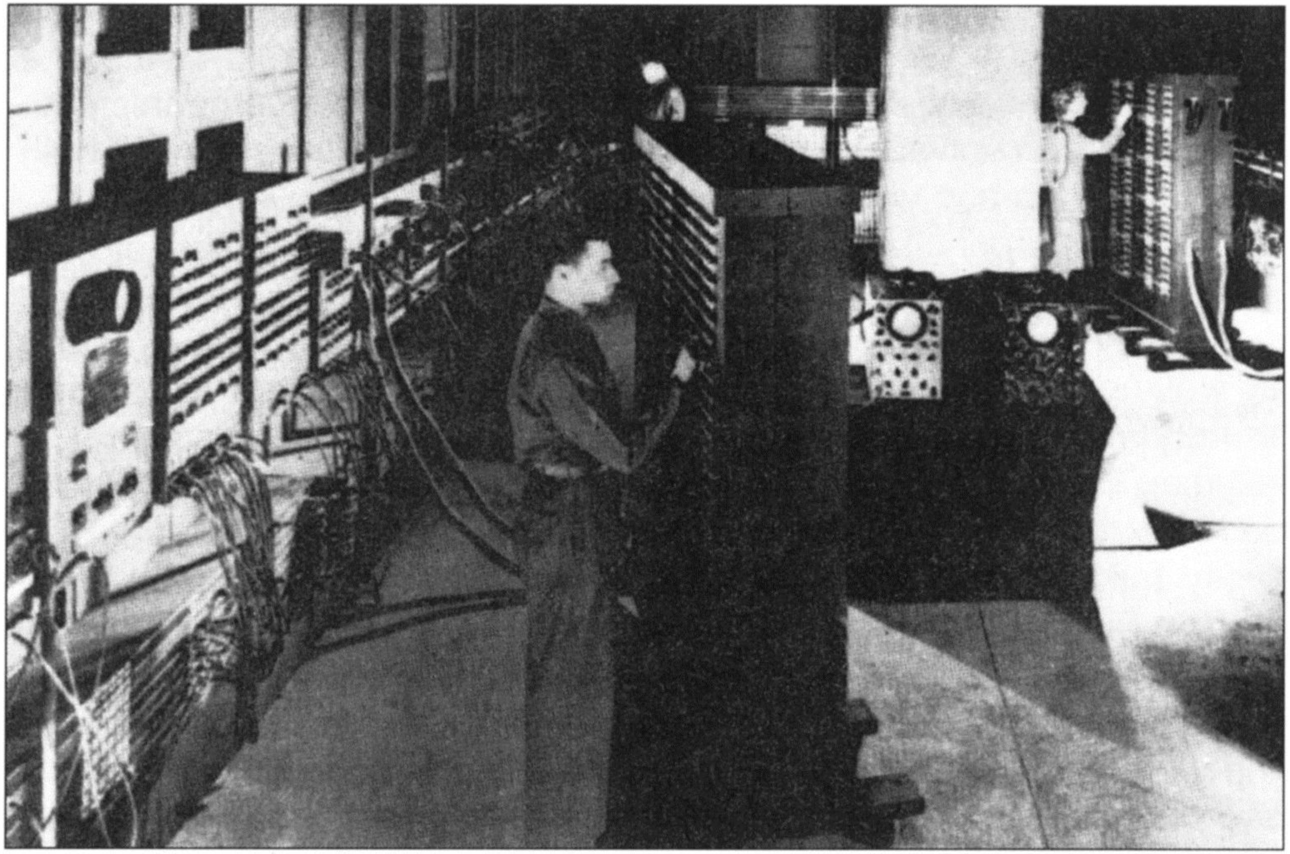


Figure 1.6
Photograph of the ENIAC Computer

The Birth of Computers: 1940-1950 (continued)

- Stored program computer model
  - Proposed by John Von Neumann in 1946
  - Stored binary algorithm in the computer's memory along with the data
  - Is known as the Von Neumann architecture
  - Modern computers remain, fundamentally, Von Neumann machines
  - First stored program computers
    - EDVAC
    - EDSAC

The Modern Era: 1950 to the Present

- First generation of computing (1950-1957)
  - Vacuum tubes used to store data and programs
  - Each computer was multiple rooms in size
  - Computers were not very reliable

The Modern Era: 1950 to the Present (continued)

- Second generation of computing (1957-1965)
  - Transistors and magnetic cores replaced vacuum tubes
  - Dramatic reduction in size
    - Computer could fit into a single room
  - Increase in reliability of computers
  - Reduced cost of computers
  - High-level programming languages
    - The programmer occupation was born

The Modern Era: 1950 to the Present (continued)

- Third generation of computing (1965-1975)
  - Integrated circuits rather than individual electronic components were used
  - Further reduction in size and cost of computers
    - Computers became desk-sized
    - First minicomputer developed
  - Software industry formed

The Modern Era: 1950 to the Present (continued)

- Fourth generation of computing (1975-1985)
  - Reduced to the size of a typewriter
  - First microcomputer developed
  - Desktop and personal computers common
  - Appearance of
    - Computer networks
    - Electronic mail
    - User-friendly systems (graphical user interfaces)
    - Embedded systems

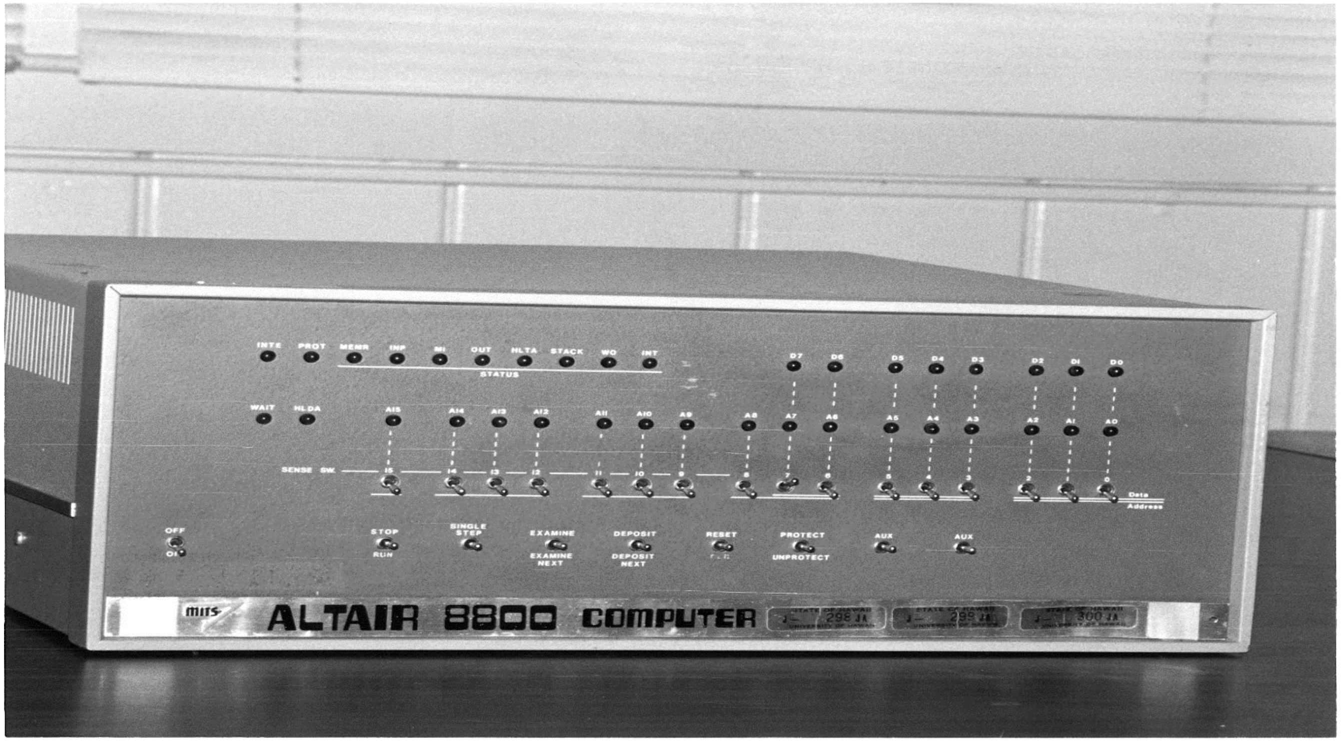


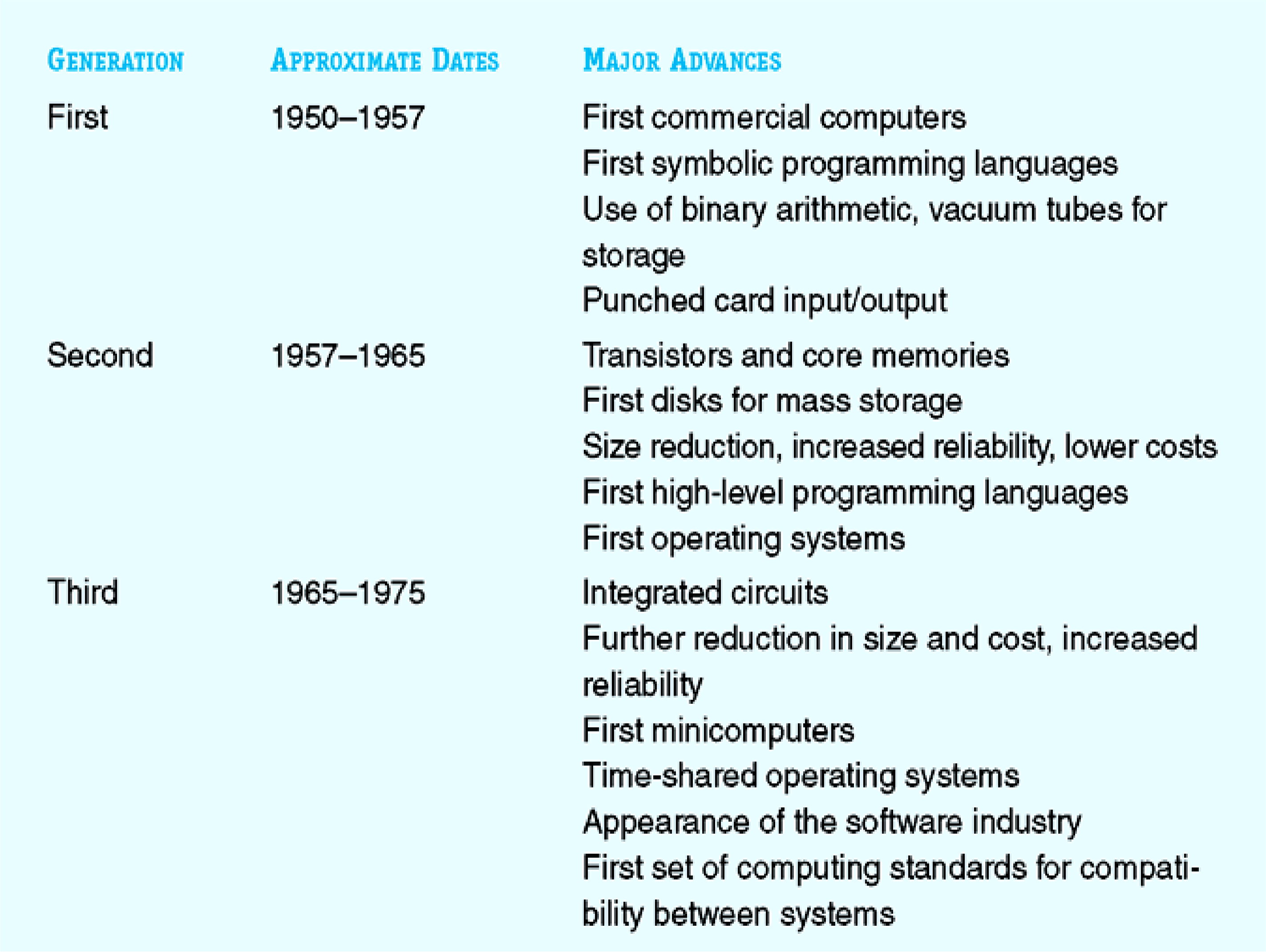
Figure 1.7
The Altair 8800, the World's First Microcomputer

The Modern Era: 1950 to the Present (continued)

- Fifth generation of computing (1985-?)
  - Recent developments
    - Massively parallel processors
    - Handheld devices and other types of personal digital assistants (PDAs)
    - High-resolution graphics
    - Powerful multimedia user interfaces incorporating sound, voice recognition, touch, photography, video, and television

The Modern Era: 1950 to the Present (continued)

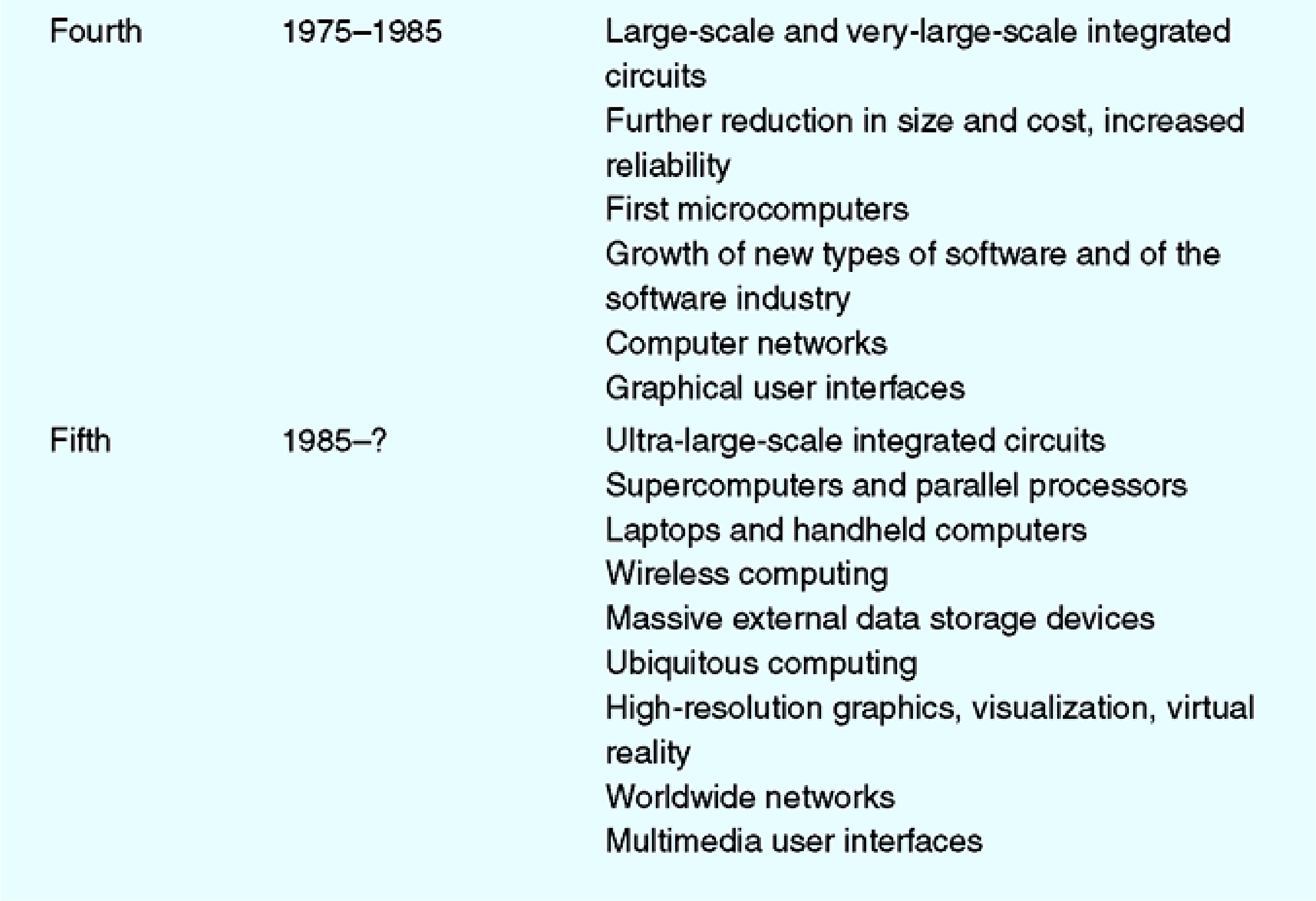
- Recent developments (continued)
  - Integrated global telecommunications incorporating data, television, telephone, fax, the Internet, and the World Wide Web
  - Wireless data communications
  - Massive storage devices
  - Ubiquitous computing



Generation	Approximate Dates	Major Advances
First	1950–1957	First commercial computers First symbolic programming languages Use of binary arithmetic, vacuum tubes for storage Punched card input/output
Second	1957–1965	Transistors and core memories First disks for mass storage Size reduction, increased reliability, lower costs First high-level programming languages First operating systems
Third	1965–1975	Integrated circuits Further reduction in size and cost, increased reliability First minicomputers Time-shared operating systems Appearance of the software industry First set of computing standards for compatibility between systems

Figure 1.8

Some of the Major Advancements in Computing



Fourth	1975–1985	Large-scale and very-large-scale integrated circuits Further reduction in size and cost, increased reliability First microcomputers Growth of new types of software and of the software industry Computer networks Graphical user interfaces
Fifth	1985–?	Ultra-large-scale integrated circuits Supercomputers and parallel processors Laptops and handheld computers Wireless computing Massive external data storage devices Ubiquitous computing High-resolution graphics, visualization, virtual reality Worldwide networks Multimedia user interfaces

Figure 1.8
Some of the Major Advancements in Computing

Summary

- Computer science is the study of algorithms
- An algorithm is a well-ordered collection of unambiguous and effectively computable operations that, when executed, produces a result and halts in a finite amount of time
- If we can specify an algorithm to solve a problem, then we can automate its solution
- Computers developed from mechanical calculating devices to modern electronic marvels of miniaturization