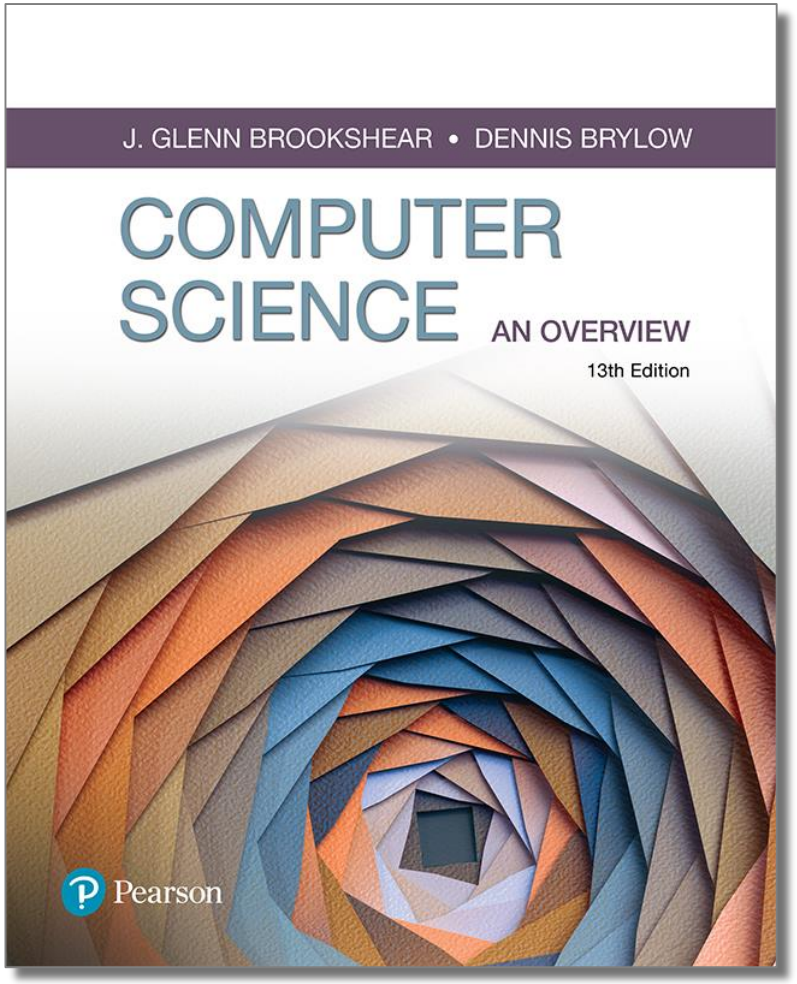
Computer Science An Overview

13th Edition



Chapter 0

Introduction

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Chapter 0: Introduction

- 0.1 The Role of Algorithms
- 0.2 The History of Computing
- 0.3 An Outline of Our Study
- 0.4 The Overarching Themes of Computer Science
  - Algorithms
  - Abstraction
  - Creativity
  - Data
  - Programming
  - Internet
  - Impact

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0.1 The Role of Algorithms

- **Algorithm:** A set of steps that defines how a task is performed
- **Program:** A representation of an algorithm
- **Programming:** The process of developing a program
- **Software:** Programs and the algorithms they represent
- **Hardware:** The machinery

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Figure 0.2
The Euclidean algorithm for finding the greatest common divisor of two positive integers

Description: This algorithm assumes that its input consists of two positive integers and proceeds to compute the greatest common divisor of these two values.

Procedure:

Step 1. Assign M and N the value of the larger and smaller of the two input values, respectively.

Step 2. Divide M by N, and call the remainder R.

Step 3. If R is not 0, then assign M the value of N, assign N the value of R, and return to step 2; otherwise, the greatest common divisor is the value currently assigned to N.

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History of Algorithms

- The study of algorithms was originally a subject in mathematics.
- Early examples of algorithms
  - Long division algorithm
  - Euclidean Algorithm
- **Gödel's Incompleteness Theorem**: Some problems cannot be solved by algorithms.

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0.2 The History of Computing

- Early computing devices
  - Abacus: positions of beads represent numbers
  - Gear-based machines (1600s-1800s)
    - Positions of gears represent numbers
    - Blaise Pascal, Wilhelm Leibniz, Charles Babbage

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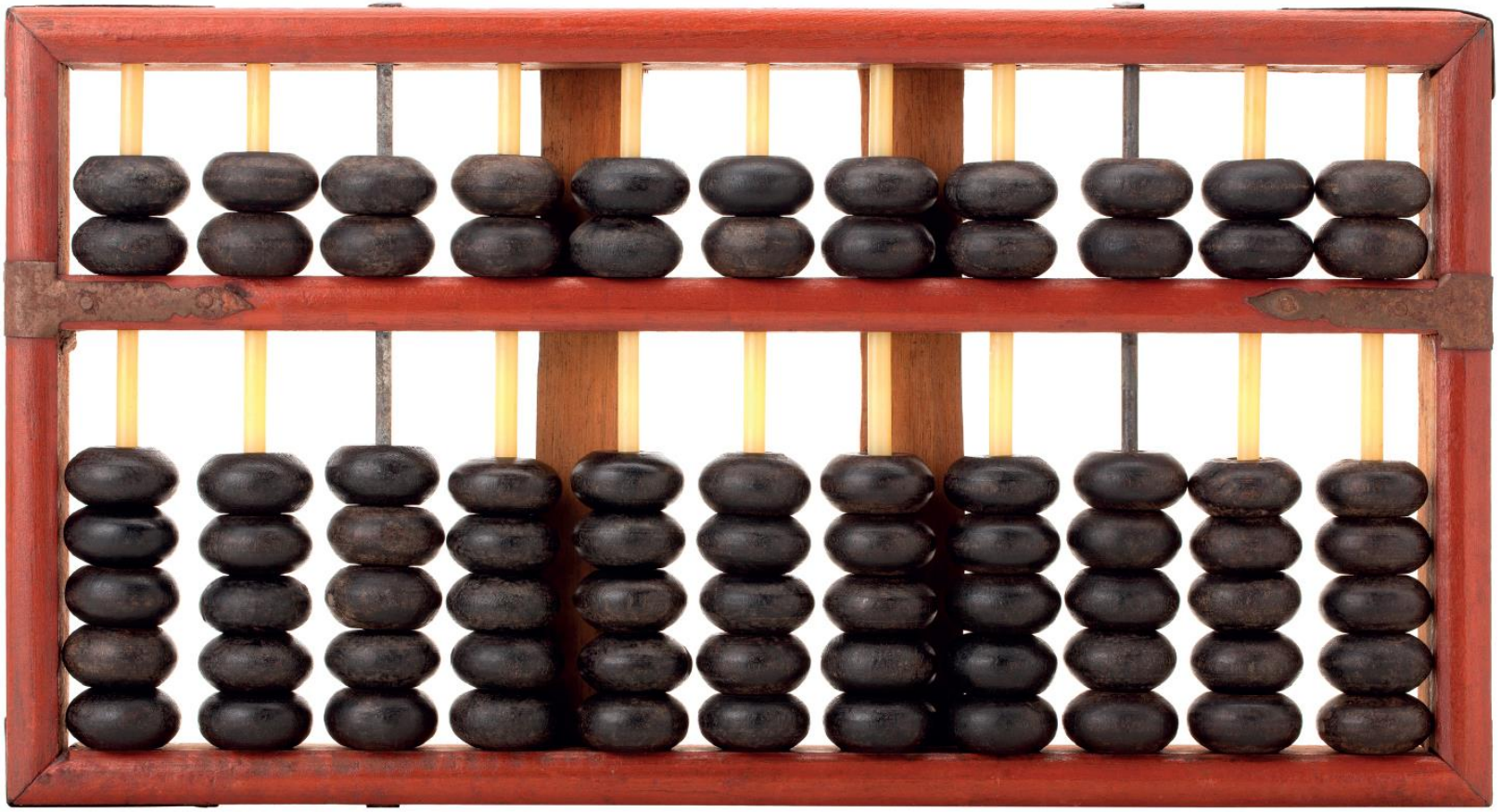
Figure 0.3
Chinese Wooden Abacus



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Early Data Storage

- Punched cards
  - First used in Jacquard Loom (1801) to store patterns for weaving cloth
  - Storage of programs in Babbage's Analytical Engine
  - Popular through the 1970's
- Gear positions

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Early Computers

- Based on mechanical relays
  - 1940: Stibitz at Bell Laboratories
  - 1944: Mark I: Howard Aiken and IBM at Harvard
- Based on vacuum tubes
  - 1937-1941: Atanasoff-Berry at Iowa State
  - 1940s: Colossus: secret German code-breaker
  - 1940s: ENIAC: Mauchly & Eckert at U. of Penn.

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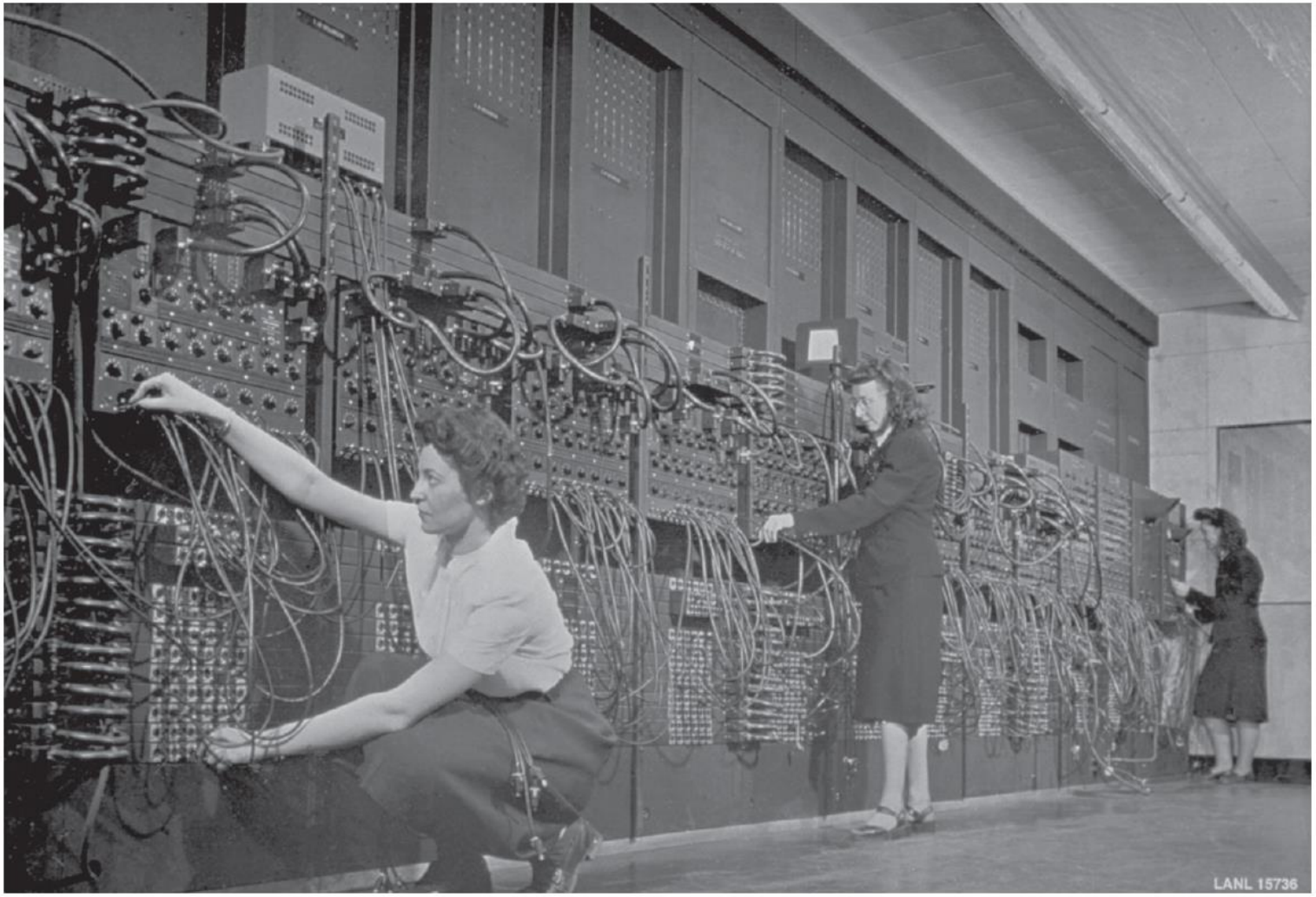
Figure 0.4
Three women operating the ENIAC's main control panel



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Personal Computers

- Hobbyists built homemade computers
- Apple Computer established in 1976.
- IBM introduced the PC in 1981.
  - Accepted by business
  - Became the standard hardware design for most desktop computers
  - Most PCs use software from Microsoft

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End of the 20th Century

- Internet revolutionized communications
  - World Wide Web
  - Search Engines
- Miniaturization of computing machines
  - Embedded (GPS, in automobile engines)
  - Smartphones

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0.3 An Outline of Our Study

- Chapter 1: Data Storage
- Chapter 2: Data Manipulation
- Chapter 3: Operating Systems
- Chapter 4: Networks and the Internet
- Chapter 5: Algorithms
- Chapter 6: Programming Languages

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An Outline of Our Study (continued)

- Chapter 7: Software Engineering
- Chapter 8: Data Abstractions
- Chapter 9: Database Systems
- Chapter 10: Computer Graphics
- Chapter 11: Artificial Intelligence
- Chapter 12: Theory of Computation

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0.4 The Overarching Themes of Computer Science

- Computing technology is fundamental to being a part of the modern world
- This course will include applications and consequences of computer science
- Seven “Big Ideas” that unite computer science:
  - Algorithms, Abstraction, Creativity, Data, Programing, Internet and Impact

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Algorithms

- Computer Science is the science of algorithms
- Draws from other subjects, including
  - Mathematics
  - Engineering
  - Psychology
  - Business Administration
  - Linguistics

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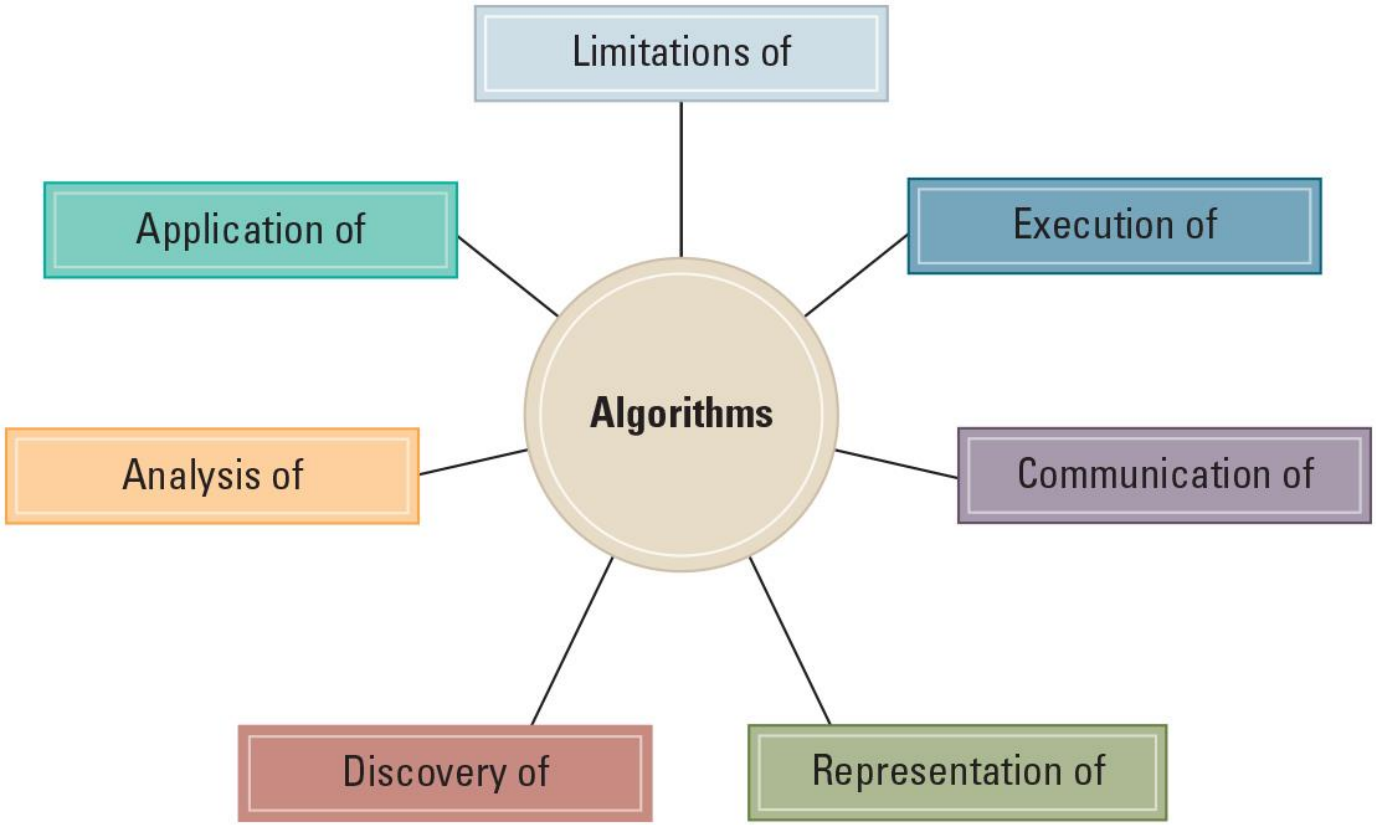
Figure 0.5
The central role of algorithms in computer science



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Given the Central Role of Algorithms

- Which problems can be solved by algorithmic processes?
- How can characteristics of different algorithms be analyzed and compared?
- How can algorithms be applied to produce intelligent behavior?
- How does the application of algorithms affect society?

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Abstraction

- **Abstraction:** The distinction between the external properties of an entity and the details of the entity's internal composition
- **Abstract tool:** A "component" that can be used without concern for the component's internal properties

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Creativity

- Computer science is inherently creative
  - Discovering and applying algorithms is a human activity
  - Extends existing forms of expression
  - Enables new modes of digital expression
- Creating large software systems is like conceiving a grand new sculpture

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Data

- Computers can represent any information that can be discretized and digitized
- Algorithms process and transform data
  - Search for patterns
  - Create simulations
  - Generate knowledge and insight
- Data is driving modern discovery

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Questions about Data

- How do computers store data about common digital artifacts?
  - Numbers, text, images, sounds, and video
- How do computers approximate data about analog artifacts in the real world?
- How do computers detect and prevent errors in data?
- What are the ramifications or an ever-growing and interconnected universe of digital data?

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Programming

- **Programming** is broadly referred to as:
  - Translating human intentions into executable algorithms
- Computer hardware is capable of only simple algorithmic steps
- Abstractions in a **programming language** allow humans to reason and encode solutions to complex problems

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Questions about Programming

- How are programs built?
- What kind of errors can occur in programs?
- How are errors in programs found and repaired?
- What are the effects of errors in modern programs?
- How are programs documented and evaluated?

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Internet

- Profound impact in the way information is:
  - Stored
  - Retrieved
  - Shared
- Privacy
- Security

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Impact

- Social, ethical, legal impacts including:
  - Security concerns
  - Issues of software ownership and liabilities
  - Social impact of database technology
  - Consequences of artificial intelligence

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Impact explored through "Social Issues" questions

- Social Issues questions are meant to increase awareness of:
  - Various stakeholders
  - Alternatives
  - Short term and long term consequences
- Character-based ethics
  - "Who do I want to be?"
  - Become more aware, insightful, and sensitive to the issues involved

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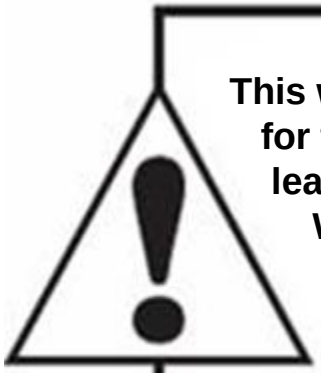

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