Chapter 1: An Introduction to Computer Science

Invitation to Computer Science, Java Version, Third Edition

Objectives

In chapter 1, you will learn about

- One definition of computer science
- The concept of algorithms
- Organization of the reference book (for your information only)
Introduction

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

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)

- 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)

- 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 machine languages
- Applications
  - Identifying important problems and designing correct and efficient software packages to solve these problems
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 and let a computing agent to do it

- 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

- Algorithm
  - A well-ordered collection of **unambiguous and effectively computable operations** that, when executed, produces a result and halts in a finite amount of time
The Formal Definition of an Algorithm (continued)

- Unambiguous, understandable operation
  - An operation that can be understood and carried out directly by the computing agent without needing to be further simplified or explained

- Effectively computable (doable)
  - Computational process exists that allows computing agent to complete that operation successfully

The result of the algorithm must be produced after the execution of a finite number of operations

- Infinite loop
  - The algorithm has no provisions to terminate
  - A common error in the design and coding of algorithms
The Importance of Algorithmic Problem Solving

- Algorithmic solutions can be
  - Encoded into some appropriate language
  - Given to a computing agent to execute

- The computing agent
  - Would mechanically follow these instructions and successfully complete the task specified
  - Would not have to understand
    - Creative processes that went into discovery of solution
    - Principles and concepts that underlie the problem

Example

Algorithm: A well-ordered collection of unambiguous and effectively computable operations that, when executed, produces a result and halts in a finite amount of time

- A valid algorithm for shampooing your hair?
  - Wet your hair
  - Lather your hair
  - Rinse your hair
  - Repeat

- No. The problems are
  - Repeat what?
  - for how many times?
Example

- Two valid algorithms for shampooing your hair
  - Algorithm 1
    - Wet your hair
    - Lather your hair
    - Rinse your hair
    - Lather your hair
    - Rinse your hair
  - Algorithm 2
    - Wet your hair
    - Repeat the following steps until your hair is clean
      - Lather your hair
      - Rinse your hair

Organization of the Text

- The reference book is divided into six separate sections called levels

- Each level addresses one aspect of the definition of computer science

- Computer science/algorithms
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