# Chapter 2: Algorithm Discovery and Design

## TRUE/FALSE

1. An unstructured, “free-flowing” writing style should be used for writing algorithms.

   ANS: F PTS: 1 REF: 44

2. With a natural language, different readers can interpret the same sentence in totally different ways.

   ANS: T PTS: 1 REF: 45

3. Java and C++ are examples of pseudocode languages.

   ANS: F PTS: 1 REF: 46

4. The three basic sequential operations are called addition, multiplication, and exponentiation.

   ANS: F PTS: 1 REF: 47

5. Input and output enable the computing agent to communicate with the outside world.

   ANS: T PTS: 1 REF: 49

6. The if/then/else operation allows you to select exactly one of three alternatives.

   ANS: F PTS: 1 REF: 51

7. One of the most powerful features of a computer is its ability to handle loops.

   ANS: T PTS: 1 REF: 53

8. Having an infinite loop in an algorithm is an error.

   ANS: T PTS: 1 REF: 54

9. Once an algorithm has been developed, it may itself be used in the construction of other algorithms.

   ANS: T PTS: 1 REF: 70

10. Pattern matching can only be applied to graphics and pictures.

    ANS: F PTS: 1 REF: 76

## MODIFIED TRUE/FALSE

1. <u>Natural language</u> is a set of English language constructs designed to resemble the statements in a programming language but that do not actually run on a computer. ____________________________

   ANS: F, Pseudocode

   PTS: 1 REF: 47

2. Pseudocode is a formal language with rigidly standardized syntactic rules and regulations. ____________________________

ANS: F
is not
isn't

PTS: 1 REF: 47

3. A(n) control algorithm executes its instructions in a straight line from top to bottom and then stops. ____________________________

ANS: F
sequential
straight-line

PTS: 1 REF: 51

4. The use of high-level instructions during the design process is an example of abstraction. ____________________________

ANS: T PTS: 1 REF: 79

5. The process of searching for a special pattern of symbols within a larger collection of information is called object matching. ____________________________

ANS: F, pattern

PTS: 1 REF: 76

**COMPLETION**

1. During the initial phases of design, we should be thinking and writing at a highly ______________________ level.

ANS: abstract

PTS: 1 REF: 46

2. ______________________ is sometimes called a programming language without any details.

ANS: Pseudocode

PTS: 1 REF: 47

3. ______________________ operations allow us to alter the normal sequential flow of control in an algorithm.

ANS: Control

PTS: 1 REF: 51

4. In a(n) ____________________ loop, it is possible for the loop body to never be executed.

ANS: pretest

PTS: 1 REF: 57

5. The process of finding a solution to a given problem is called ____________________ discovery.

ANS: algorithm

PTS: 1 REF: 65

**MULTIPLE CHOICE**

1. ____ is an example of a natural language.
   a. C
   b. Java
   c. English
   d. Perl

   ANS: C PTS: 1 REF: 44

2. In the line of code, “Set the value of Area to length*width”, “Area” is a ____.
   a. value
   b. variable
   c. constant
   d. primitive

   ANS: B PTS: 1 REF: 48

3. A(n) ____ is a named storage location that can hold a data value.
   a. expression
   b. variable
   c. computation
   d. constant

   ANS: B PTS: 1 REF: 48

4. ____ operations provide the computing agent with data values from the outside world that it may then use in later instructions.
   a. Ingoing
   b. Outgoing
   c. Input
   d. Output

   ANS: C PTS: 1 REF: 49

5. ____ operations send results from the computing agent to the outside world.
   a. Input
   b. Put
   c. Send
   d. Output

   ANS: D PTS: 1 REF: 49

6. A purely ____ algorithm is sometimes termed a straight-line algorithm.
   a. sequential
   b. conditional
   c. iterative
   d. control

   ANS: A PTS: 1 REF: 51

7. Together, conditional and iterative operations are called ____ operations.
   a. sequential
   b. control
   c. hierarchical
   d. dynamic

ANS: B PTS: 1 REF: 51

8. ____ statements are the "question-asking" operations of an algorithm.
   a. Primitive
   b. Iterative
   c. Sequential
   d. Conditional

ANS: D PTS: 1 REF: 51

9. A ____ is the repetition of a block of instructions.
   a. cycle
   b. nucleus
   c. matrix
   d. loop

ANS: D PTS: 1 REF: 53

10. An algorithm can fall into an infinite loop when ____.
   a. the input operations were missing
   b. the algorithm uses more than one loop
   c. the output operations were missing
   d. the continuation condition of the loop never becomes false

ANS: D PTS: 1 REF: 54

11. In a pretest loop, the continuation condition is tested at the ____ through the loop.
   a. beginning of each pass
   b. beginning of only the first pass
   c. end of each pass
   d. end of only the last pass

ANS: A PTS: 1 REF: 57

12. The ____ loop is an example of a posttest loop.
   a. do/while
   b. do
   c. while
   d. if/then/else

ANS: A PTS: 1 REF: 57

13. To create a loop that executes exactly *b* times, we create a ____.
   a. control object
   b. counting method
   c. counter
   d. variable

ANS: C PTS: 1 REF: 61

14. "Print the value of product" is an example of a(n) ____ operation.
   a. sequential
   b. conditional
   c. input
   d. output

ANS: D PTS: 1 REF: 63

15. The technique of looking at all the items in a list, starting at the beginning of the list, one at a time, until we either find what we are looking for or come to the end of the list is called ____ search.
   a. sequential
   b. control
   c. iterative
   d. random

ANS: A PTS: 1 REF: 66

16. The selection of an algorithm to solve a problem is greatly influenced by the way the input ____ for that problem are organized.
   a. words
   c. solutions

b. data

d. pseudocode

ANS: B PTS: 1 REF: 69

17. A(n) ____ is a collection of useful, prewritten algorithms.

a. primitive
b. binary
c. set
d. library

ANS: D PTS: 1 REF: 70

18. In order to implement a “find” functionality in a word processor, one would have to design a ____ algorithm.

a. pattern matching
b. natural language
c. sequential
d. do-while

ANS: A PTS: 1 REF: 76

19. Which statement exemplifies abstraction?

a. The president of General Motors views the company in terms of every worker, every supplier, and every car.
b. The president of General Motors views the company in terms of its corporate divisions and high-level policy issues.
c. A good approach to algorithm design and software development is to focus on how we might actually implement a particular operation.
d. A convenient way to view the hardware component called “memory” is to focus on the billions of electronic devices that go into constructing a memory unit.

ANS: B PTS: 1 REF: 79

20. Viewing an operation at a high level of abstraction and fleshing out the details of its implementation at a later time is known as ____ design.

a. bottom-up
b. top-down
c. increasing size
d. increasing depth

ANS: B PTS: 1 REF: 80

**SHORT ANSWER**

1. Briefly describe what pseudocode is and is not.

ANS:
Pseudocode is not a precise set of notational rules to be memorized and rigidly followed. It is a flexible notation that can be adjusted to fit your own view about how best to express ideas and algorithms.

PTS: 1 REF: 48 TOP: Critical Thinking

2. Under what circumstances would the body of a pretest loop never be executed?

ANS:
With a pretest loop, the continuation condition is tested at the beginning of each pass through the loop, and therefore it is possible for the loop body never to be executed. This would happen if the continuation condition were initially false.

PTS: 1 REF: 57 TOP: Critical Thinking

3. Briefly define the concept of iteration

   ANS:
   The powerful algorithmic concept of iteration means that instead of writing instruction 10,000 separate times, it is far better to write it only once and indicate that it is to be repetitively executed 10,000 times, or however many times it takes to obtain the answer.

   PTS: 1 REF: 67 TOP: Critical Thinking

4. What is the definition of a library in terms of algorithms?

   ANS:
   In the world of algorithms, a library is a collection of useful, prewritten algorithms, which are an important tool in the design and development of algorithms.

   PTS: 1 REF: 70 TOP: Critical Thinking

5. What is pattern matching?

   ANS:
   Pattern matching is the process of searching for a special pattern of symbols within a larger collection of information.

   PTS: 1 REF: 76 TOP: Critical Thinking

**ESSAY**

1. What is the problem with using natural language to represent algorithms?

   ANS:
   Natural language can be extremely verbose, causing the resulting algorithms to be rambling, unstructured, and hard to follow. An unstructured, “free-flowing” writing style might be wonderful for novels and essays, but it is horrible for algorithms. The lack of structure makes it difficult for the reader to locate specific sections of the algorithm because they are buried inside the text. For example, without any clues to guide us, such as indentation, line numbering, or highlighting, locating the beginning of a loop can be a daunting and time-consuming task. A second problem is that natural language is too “rich” in interpretation and meaning. Natural language frequently relies on either context or a reader’s experiences to give precise meaning to a word or phrase. This permits different readers to interpret the same sentence in totally different ways. This may be acceptable, even desirable, when writing poetry or fiction, but it is disastrous when creating algorithms that must always execute in the same way and produce identical results.

   PTS: 1 REF: 44-46 TOP: Critical Thinking

2. What is the problem with using high-level programming languages to represent algorithms?

   ANS:

As an algorithmic design language, this notation is also seriously flawed. During the initial phases of design, we should be thinking and writing at a highly abstract level. Using a programming language to express our design forces us to deal immediately with detailed language issues, such as punctuation, grammar, and syntax. These technical details clutter our thoughts and at this point in the solution process are totally out of place. When creating algorithms, a programmer should no more worry about semicolons and capitalization than a novelist should worry about typography and cover design when writing the first draft.

PTS: 1 REF: 46-47 TOP: Critical Thinking

3. What is pseudocode and why is it well-suited for representing algorithms?

ANS:
Most computer scientists use a notation called pseudocode to design and represent algorithms. This is a set of English language constructs designed to resemble statements in a programming language but that do not actually run on a computer. Pseudocode represents a compromise between the two extremes of natural and formal languages. It is simple, highly readable, and has virtually no grammatical rules. (In fact, pseudocode is sometimes called a programming language without the details.) However, because it contains only statements that have a well-defined structure, it is easier to visualize the organization of a pseudocode algorithm than one represented as long, rambling natural-language paragraphs. In addition, because pseudocode closely resembles many popular programming languages, the subsequent translation of the algorithm into a computer program is relatively simple. Pseudocode is not a formal language with rigidly standardized syntactic and semantic rules and regulations. On the contrary, it is an informal design notation used solely to express algorithms. One of the nice features of pseudocode is that you can adapt it to your own personal way of thinking and problem solving.

PTS: 1 REF: 47 TOP: Critical Thinking

4. Explain the importance of the concept of building blocks in the use of algorithms.

ANS:
The use of a “building-block” component is a very important concept in computer science. You might think that every algorithm you write must be built from only the most elementary and basic of primitives. However, once an algorithm has been developed, it may itself be used in the construction of other, more complex algorithms. This is similar to what a builder does when constructing a home from prefabricated units rather than bricks and boards. Our problem-solving task need not always begin at the beginning but can instead build on ideas and results that have come before. Every algorithm that we create becomes, in a sense, a primitive operation of our computing agent and can be used as part of the solution to other problems. That is why a collection of useful, prewritten algorithms, called a library, is such an important tool in the design and development of algorithms.

PTS: 1 REF: 70 TOP: Critical Thinking

5. Discuss in detail the application of pattern matching to the mapping of the human genome.

ANS:
One of the most interesting and exciting applications of pattern matching is assisting microbiologists and geneticists studying and mapping the human genome, the basis for all human life. The human genome is composed of a sequence of approximately 3.5 billion nucleotides, each of which can be one of only four different chemical compounds. These compounds (adenine, cytosine, thymine, guanine) are usually referred to by the first letter of their chemical names: A, C, T, and G. Thus, the basis for our existence can be rendered in a very large “text file” written in a four-letter alphabet (e.g., T C G G A C T A A C A T C G G G A T C G A G A T G …)

Sequences of these nucleotides are called genes. There are about 25,000 genes in the human genome, and they determine virtually all of our physical characteristics—sex, race, eye color, hair color, and height, to name just a few. Genes are also an important factor in the occurrence of certain diseases. A missing or flawed nucleotide can result in one of a number of serious genetic disorders, such as Down syndrome or Tay-Sachs disease. To help find a cure for these diseases, researchers are attempting to locate individual genes that, when exhibiting a certain defect, cause a specific malady. A gene is typically composed of thousands of nucleotides, and researchers generally do not know the entire sequence. However, they may know what a small portion of the gene—say, a few hundred nucleotides—looks like. Therefore, to search for one particular gene, they must match the sequence of nucleotides that they do know, called a probe, against the entire 3.5 billion-element genome to locate every occurrence of that probe. From this matching information, researchers hope to isolate specific genes. When a match is found, researchers examine the nucleotides located before and after the probe to see whether they have located the desired gene and, if so, to see whether the gene is defective. Physicians hope someday to be able to “clip out” a bad sequence and insert in its place a correct sequence.

PTS: 1 REF: 76-77 TOP: Critical Thinking