

Chapter 01

True / False

1. The evolution of computer science began before the development of the first computer system.

a. True

b. False

ANSWER: True

2. At its most basic level, computer science is the study of algorithms.

a. True

b. False

ANSWER: True

3. Computer science is the study of how to write computer programs.

a. True

b. False

ANSWER: False

4. Algorithms are exclusive to the field of computer science.

a. True

b. False

ANSWER: False

5. All conceivable problems can be solved algorithmically.

a. True

b. False

ANSWER: False

6. Algorithms usually contain a set of instructions to be executed in a specific order.

a. True

b. False

ANSWER: True

7. When an operation is unambiguous, we call it a primitive operation, or simply a primitive of the computing agent carrying out the algorithm.

a. True

b. False

ANSWER: True

8. Mechanical devices for performing complex calculations existed prior to the twentieth century.

- a. True
- b. False

ANSWER: True

9. The Pascaline and Leibnitz's Wheel are examples of early computers.

- a. True
- b. False

ANSWER: False

10. The first electronic programmable computer, ENIAC, was completed just after World War II.

- a. True
- b. False

ANSWER: True

11. According to Norman Gibbs's and Allen Tucker's definition of computer science, the central concept in computer science is the compiler. _____

- a. True
- b. False

ANSWER: False

12. The statement "If the mixture is too dry, then add one-half cup of water to the bowl" is an example of a(n) iterative operation. _____

- a. True
- b. False

ANSWER: False

13. The discovery by Gödel places a limit on the capabilities of computers and computer scientists. _____

- a. True
- b. False

ANSWER: True

14. The Analytical Engine was the first computing device to use the base-2 binary numbering system. _____

- a. True
- b. False

ANSWER: False

15. FORTRAN and COBOL, the first high-level (English-like) programming languages, appeared during the first generation of computing. _____

- a. True
- b. False

ANSWER: False

Completion

16. The three types of operations used to construct algorithms are sequential, _____, and iterative.

ANSWER: conditional

17. One of the most fundamentally important virtues of a(n) _____ is that if we can specify one to solve a problem, then we can automate the solution.

ANSWER: algorithm

18. Unlike the _____, Leibniz's Wheel could carry out addition, subtraction, multiplication, and division.

ANSWER: Pascaline

19. Charles Babbage gave up on his second _____ because the current technology could not support his project.

ANSWER: Difference Engine

20. Ultra-large-scale integrated circuits are _____-generation innovation in computing.

ANSWER: fifth

Multiple Choice

21. In ____ computer science, researchers study the logical and mathematical properties of problems and their solutions.

- a. theoretical
- b. scientific
- c. practical
- d. logical

ANSWER: a

22. In computer science, it is not simply the construction of a high-quality _____ that is important but also the methods it embodies.

- a. processor
- b. program
- c. memory module
- d. storage device

ANSWER: b

23. Designing programming languages and translating algorithms into these languages is known as ____ realization.

- a. programming language
- b. compiler
- c. linguistic
- d. interpreter

ANSWER: c

24. ____ operations are the “looping” instructions of an algorithm.

- a. Sequential
- b. Looping
- c. Iterative
- d. Hierarchal

ANSWER: b

25. In computer science terminology, the machine, robot, person, or thing carrying out the steps of the algorithm is called a(n) ____.

- a. computing agent
- b. algorithmic agent
- c. computing representative
- d. algorithmic representative

ANSWER: a

26. An algorithm may be too ____ to be of any use.

- a. difficult to read
- b. inefficient
- c. difficult to create
- d. offensive

ANSWER: b

27. An algorithm is a ____ collection of unambiguous and effectively computable operations that, when executed, produces a result and halts in a finite amount of time.

- a. sequential
- b. computing agent
- c. mechanical calculator
- d. well-ordered

ANSWER: d

28. An operation that is ____ is called a primitive operation of the computing agent carrying out the algorithm.

- a. primary
- b. complementary
- c. basic
- d. unambiguous

ANSWER: d

29. What is wrong with the following algorithm?
1. Set X to be 12. Increment X3. Print X4.
If $X > 0$, repeat from 2

- a. It does not produce a result.
- b. It is ambiguous.
- c. It does not halt in a finite amount of time.
- d. It is not well ordered.

ANSWER: c

30. The ____ revolution enabled us to implement algorithms that automated the drudgery of repetitive mental tasks.

- a. industrial
- b. technological
- c. computer
- d. designer

ANSWER: c

31. The history of ____ begins 3,000 years ago.

- a. computer science
- b. logarithms
- c. the Pascaline
- d. mathematics

ANSWER: d

32. In 1672, a French philosopher and mathematician designed and built one of the first mechanical calculators named the ____ that could do addition and subtraction.

- a. Pascaline
- b. Leibniz Wheel
- c. Abacus
- d. TI-85

ANSWER: a

33. The first slide rule appeared around ____.

- a. 1183
- b. 1622
- c. 1882
- d. 1945

ANSWER: b

34. In 1614, John Napier invented ____ as a way to simplify difficult mathematical computations.

- a. algorithms
- b. logarithms
- c. electronic computers

d. mechanical calculators

ANSWER: b

35. Jacquard's Loom was considered the first "computing device" because it was ____ and had memory where information was stored in a machine-readable form.

a. compact

b. electric

c. mathematically efficient

d. programmable

ANSWER: d

36. In Babbage's Analytical Engine, a mill was most like the ____ of modern-day computers.

a. RAM

b. processor

c. logic unit

d. input/output

ANSWER: c

37. The ____ was the first fully electronic, general-purpose, programmable computer.

a. EDVAC

b. EDSAC

c. ENIAC

d. Mark I

ANSWER: c

38. John Von Neumann's stored program computer lay the groundwork for modern-day computing by allowing the computer to store instructions in ____ alongside the data.

a. binary values

b. external displays

c. vacuum tubes

d. data cylinders

ANSWER: a

39. Integrated circuits, built on silicon chips, were introduced during the ____ generation of computing.

a. first

b. second

c. third

d. fourth

ANSWER: c

40. During the ____ generation of computing, the desktop machine shrunk to the size of a typewriter.

a. second

- b. third
- c. fourth
- d. fifth

ANSWER: c

Essay

41. Briefly respond to the observation that every problem can be solved algorithmically, and discuss the implications of your response.

ANSWER: While it might seem that every problem can be solved algorithmically, in the early 1930s the German logician Kurt Gödel proved that there are problems for which no generalized algorithmic solution can possibly exist. No matter how much time and effort is put into obtaining a solution to these problems, they are unsolvable and no solution will ever be found. This discovery, which staggered the mathematical world, effectively places a limit on the ultimate capabilities of computers and computer scientists.

42. Explain the term “unambiguous operation.”

ANSWER: An unambiguous operation is one that can be understood and carried out directly by the computing agent without further simplification or explanation.

43. What was the major change brought about by the second generation of computing?

ANSWER: In the late 1950s, the bulky vacuum tube of the first generation of computers was replaced by a single transistor only a few millimeters in size, and memory was now constructed using tiny magnetic cores only 1/50th of an inch in diameter, drastically changing the size and complexity of computers.

44. What were the marks of the user-friendly systems that emerged in the fourth generation of computers?

ANSWER: They included new graphical user interfaces with pull-down menus, icons, and other visual aids to make computing easier and more fun.

45. Discuss the four basic components that Babbage’s Analytical Engine possessed that equate it to a modern-day computer.

ANSWER: Babbage’s Term Modern Terminology
mill arithmetic/logic unit
store memory
operator processor
output unit input/output
His machine had four basic components: a mill to perform the arithmetic manipulation of data, a store to hold the data, an operator to process the instructions contained on punched cards, and an output unit to put the results onto separate punched cards.

46. Respond to the observation that computer science is the study of how to write computer programs. Include an example to illustrate your argument.

ANSWER: Many people are introduced to computer science when learning to write programs in a language such as C++, Python, or Java. This almost universal use of programming as the entry to the discipline can create the misunderstanding that

computer science is equivalent to computer programming. Programming is extremely important to the discipline—researchers use it to study new ideas and build and test new solutions—but like the computer itself, it is a tool. When computer scientists design and analyze a new approach to solving a problem or create new ways to represent information, they often implement their ideas as programs to test them on an actual computer system. This enables researchers to see how well these new ideas work and whether they perform better than previous methods. For example, searching a list is one of the most common applications of computers, and it is frequently applied to huge problems, such as finding one name among the approximately 20,000,000 listings in the New York City telephone directory. A more efficient lookup method could significantly reduce the time that customers must wait for directory assistance. Assume that we have designed what we believe to be a “new and improved” search technique. After analyzing it theoretically, we would study it empirically by writing a program to implement our new method, executing it on our computer, and measuring its performance. These tests would demonstrate under what conditions our new method is or is not faster than the directory search procedures currently in use. In computer science, it is not simply the construction of a quality program that is important but also the methods it embodies, the services it provides, and the results it produces. It is possible to become so enmeshed in writing code and getting it to run that we forget that a program is only a means to an end, not an end in itself.

47. Define each of the categories to which the operations used to construct algorithms belong. Provide two to three examples within each category.

ANSWER: All the operations used to construct algorithms belong to one of only three categories: Sequential operations. A sequential instruction carries out a single well-defined task. When that task is finished, the algorithm moves on to the next operation. Sequential operations are usually expressed as simple declarative sentences. • 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. Conditional operations. These are the “question-asking” instructions of an algorithm. They ask a question, and the next operation is selected on the basis of the answer to that question. • If the mixture is too dry, then add one-half cup of water to the bowl. • If the amount of the check is less than or equal to the current account balance, then cash the check; otherwise, tell the person there are insufficient funds. • If x is not equal to 0, then set y equal to $1/x$; otherwise, print an error message that says you cannot perform division by 0. Iterative operations. These are the “looping” instructions of an algorithm. They tell us not to go on to the next instruction but, instead, to go back and repeat the execution of a previous block of instructions. • 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 1.

48. Explain the achievement of the Difference Engine of Charles Babbage, and explain the challenge he faced in trying to construct the larger model.

ANSWER: In 1823, Babbage extended the ideas of Pascal and Leibniz and constructed a working model of the largest and most sophisticated mechanical calculator of its time. This machine, called the Difference Engine, could do addition, subtraction, multiplication, and division to six significant digits, and it could solve polynomial equations and other complex mathematical problems as well. Babbage tried to construct a larger model of the

Difference Engine that would be capable of working to an accuracy of 20 significant digits, but after 12 years of work, he had to give up his quest. The technology available in the 1820s and 1830s was not sufficiently advanced to manufacture cogs and gears to the precise tolerances his design required. Like Galileo's helicopter or Jules Verne's atomic submarine, Babbage's ideas were fundamentally sound but years ahead of their time. (In 1991, the London Museum of Science, using Babbage's original plans, built an actual working model of the Difference Engine. It worked exactly as Babbage had planned.)

49. Explain the significance of the Von Neumann architecture.

ANSWER: In 1946, John Von Neumann proposed a radically different computer design based on a model called the stored program computer. Until then, all computers were programmed externally using wires, connectors, and plugboards. The memory unit stored only data, not instructions. For each different problem, users had to rewire virtually the entire computer. For example, the plugboards on the ENIAC contained 6,000 separate switches, and reprogramming the ENIAC involved specifying the new settings for all these switches—not a trivial task. Von Neumann proposed that the instructions that control the operation of the computer be encoded as binary values and stored internally in the memory unit along with the data. To solve a new problem, instead of rewiring the machine, you would rewrite the sequence of instructions—that is, create a new program. Von Neumann invented programming as it is known today. The model of computing proposed by Von Neumann included many other important features found on all modern computing systems, and to honor him this model of computation has come to be known as the Von Neumann architecture.

50. List at least six of the recent developments of the fifth generation of computing.

ANSWER: Some of the recent developments in computer systems include the following:

- Massively parallel processors capable of quadrillions of computations per second
- Smartphones, tablets, and other types of handheld digital devices
- High-resolution graphics for imaging, animation, movie making, video games, and virtual reality
- Powerful multimedia user interfaces incorporating sound, voice recognition, touch, photography, video, and television
- Integrated digital devices incorporating data, television, telephone, camera, the Internet, the World Wide Web, and, struggling for relevancy, fax
- Wireless communications
- Massive cloud storage devices capable of holding 100 exabytes of data
- Ubiquitous computing, in which miniature computers are embedded into cars, cameras, kitchen appliances, home heating systems, clothing, and even our bodies