GEM1501 Problem Solving With Computers

26/2/2004

Examination Questions Midterm

You have 45 minutes to complete the exam. Use a B2 pencil to fill up the provided MCQ form. Leave Section A blank. Fill up Sections B and C.
After finishing, place the MCQ sheet on top of the question sheet and leave both on the table, when you exit the room.

Question 1: What do cooking recipes and computer programs have in common?

1 [A] Both are typically executed by humans.

1 [B] Both are describing a process as a sequence of simple steps.

1 [C] Both are typically executed by computers.

1 [D] Both always describe how physical items, such as ovens, cars, machines, etc are used for making things.

Answer: [B]

Question 2: The first complex algorithm was written by

2 [A] Euclid in the 4th century B.C.

2 [B] Mohammed al-Khowârizmî in the 6th century A.D.

2 [C] Lady Lovelace in the 19th century

2 [D] John von Neumann in the 20th century

Answer: [A]

Question 3: Which of the following kinds of problems can best be solved using the algorithmic method?

3 [A] Problems of human-to-human relations such as marriage problems.

3 [B] Legal problems such as finding defense arguments in a criminal court case.

3 [C] Problems of proving a mathematical theorem in algebra.

3 [D] Problems whose solution process can be described as a sequence of simple steps.

Answer: [D]

Question 4: Consider the following program.
Input: A number N
Output: A number X

1. Make a note of a counter and set it to 3. Make a note of a number X and set it to N.
2. Repeat the following until the counter is 0.
   (a) Replace X by $X \times X$.
   (b) Reduce the counter by 1.
3. Output the number X

What value does this program compute?

4 [A] 4^N

4 [B] $4 \times N$

4 [C] N^8

4 [D] N^3

Answer: [C]

Question 5: Consider the Towers of Hanoi game. In order to move a tower of 4 rings from one peg to another, following the rules of the game, requires

5 [A] 15 ring moves,

5 [B] 7 ring moves,

5 [C] 12 ring moves,

5 [D] 32 ring moves.

Answer: [A]

Question 6: The following program implements the so-called bubblesort algorithm.
Input: A list of numbers.
Output: The list sorted in ascending order.

1. do the following $N-1$ times:
   (a) point to the first element;
   (b) do the following $N-1$ times:
      i. compare the element pointed to with the next element;
      ii. if the element pointed to is larger than the next element, exchange them;
      iii. point to the next element.

Which of the following statements is always correct?
After the first iteration of the loop at line (1),

6 [A] the element at the beginning of the list is the smallest element of the list.

6 [B] the element at the beginning of the list is the largest element of the list.

6 [C] the element at the end of the list is the largest element of the list.

6 [D] the element at the end of the list is the smallest element of the list.

Answer: [C]

Question 7: Which of the following statements on the history of programming languages is correct? The first high-level programming languages appeared

7 [A] in the late 1970s.

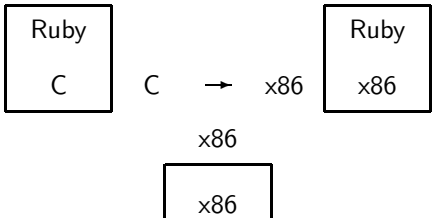
7 [B] in the late 1960s.

7 [C] in the early 1950s.

7 [D] in the last years of the 19th century.

Answer: [C]

Question 8: Consider the following T-diagram.



Which one of the following statements is correct?

8 [A] The compiler from Ruby to C is interpreted on an x86 machine.

8 [B] The Ruby interpreter is compiled from C to x86 code.

8 [C] The compiler from C to x86 is interpreted on an Ruby machine.

8 [D] The Ruby interpreter is compiled from x86 code to C.

Answer: [B]

Question 9: Consider the following program, which goes in an infinite loop for any input:

1. Take note of a value X and set X to 10.
2. Do the following until X is 0.
   (a) Increase X by 1.

Which of the following statements is true:

9 [A] This program is partially correct for any specification and any input.

9 [B] This program is totally correct for any specification and some input.

9 [C] This program is not partially correct for any specification and some input.

9 [D] This program is totally correct for any specification and any input.

Answer: [D]

Question 10: The following subroutine computes 2^{2^N} for a given number N.
Subroutine compute(N)

1. if N is 1 then return 2;
2. otherwise return compute($N-1$) $\times$ compute($N-1$)

How many multiplications are needed to compute $2^{2^4} = 256$ according to this algorithm?

10 [A] 7

10 [B] 4

10 [C] 31

10 [D] 13

Answer: [A]

Question 11: What category of algorithmic solutions best characterizes the approach taken in the previous question?

11 [A] Search and traversal

11 [B] Divide-and-conquer

11 [C] Greedy algorithm

11 [D] Dynamic planning

Answer: [B]

Question 12: The following subroutine computes 2^{2^N} more efficiently:
Subroutine compute(N)

1. if N is 1 then return 2;
2. otherwise:
   (a) make note of the result X of compute($N-1$);
   (b) return $X \times X$.

How many multiplications are needed to compute $2^{2^4} = 256$ according to this algorithm?

12 [A] 10

12 [B] 7

12 [C] 5

12 [D] 3

Answer: [D]

Question 13: Assume that a given algorithm has a runtime C that depends on the size N of its input according to the following two formulas:

- $C(1) = 0$
- $C(N) = C(N-1) + 2$ if $N > 1$

Which of the following functions $C(N)$ describes the runtime of the algorithm?

13 [A] $C(N) = N - 1$

13 [B] $C(N) = (N-1)^2$

13 [C] $C(N) = \log_2 N$

13 [D] $C(N) = 2(N-1)$

Answer: [D]

Question 14: Let us say we have an algorithm that carries out N^2 operations for an input of size N. Let us say that a computer takes 1 microsecond (1/1000000 second) to carry out one operation. How long does the algorithm run for an input of size 3000?

14 [A] 90 seconds

14 [B] 9 seconds

14 [C] 0.9 seconds

14 [D] 0.09 seconds

Answer: [B]

Question 15: What is the worst-case time complexity of the mergesort algorithm with respect to an input of size N?

15 [A] $O(N \ \log N)$

15 [B] $O(N^2)$

15 [C] $O(N)$

15 [D] $O(\log N)$

Answer: [A]

Question 16: What is the worst-case time complexity of the following algorithm, with respect to the input N?

1. Do the following $N - 10$ times:
   (a) Do the following $N/2$ times:
      i. Display the string "strange"

16 [A] $O(N)$

16 [B] $O(N\ logN)$

16 [C] $O(logN)$

16 [D] $O(N^2)$

Answer: [D]

Question 17: What is the worst-case time complexity of the following algorithm, with respect to the input N?

1. Do the following N times:
   (a) Do the following 1000 times:
      i. Display the string "remarkable"

17 [A] $O(N\ logN)$

17 [B] $O(logN)$

17 [C] $O(N)$

17 [D] $O(N^2)$

Answer: [C]