Dash - Captain Field Test

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Summary: 16 Questions in 21 minutes, no time to waste!

Contents

Chapter I

Introduction

- The dashes are projects available only for a limited amount of time.

- You can only access it if you are present at the school and logged in on both a school computer and to the Intranet.

- You will only have a limited amount of time to complete the dash from the moment the repo has been created.

- This time it is a little challenge in the form of a quiz.

- After the time is up, it will be evaluated by moulinette.

- If you succeed, you will earn the xp associated to the dash.

Chapter II

General instructions

This dash has to be achieved in `plaintext`.
There is no norme in this project.

The goal of this project is to submit a directory named `cft` containing all of your answer files. Each question must have its own answer file named after the question number.

```
III.0 00
0. What is a Dash?

(A) Sonic the Hedgehog
(B) Lorem ipsum dolor sit amet, consectetur adipiscing elit
(C) Meow
(D) Love, Death, and Robots
(E) An exercise done in a limited amount of time
```

```
$ cat cft/00
E
```

Chapter III

Mandatory part

III.1   01

1. Consider the following pseudocode fragment, where **x** is an integer variable that has been initialized.

```
int i ← 1
int j ← 1

while ( i < 10 )
    j ← j * i
    i ← i + 1
    if ( i == x )
        break
    end if
end while
```
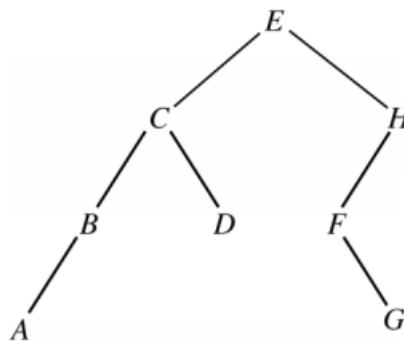
Which of the following statements is (are) true at the end of the **while** loop?

   I. (i == 10) or (i == x)

  II. If x > 10, then i == 10.

 III. If j == 6, then x == 4.

(A) None
(B) I only
(C) III only
(D) II and III only
(E) I, II, and III

III.2   02

2. In the binary search tree above, finding node *E* requires one comparison and finding
    node *A* requires four comparisons. What is the expected number of comparisons
    required to find a node chosen at random?

    (A) 1.75
    (B) 2
    (C) 2.75
    (D) 3
    (E) 3.25

III.3   03

3. A stack can be implemented with an array `A[0..N-1]` and a variable `pos`. The
    `push` and `pop` operations are defined by the following code.

```
push (x)
      A[pos] ← x
      pos ← pos - 1
end push

pop ( )
      pos ← pos + 1
      return A[pos]
end pop
```

    Which of the following will initialize an empty stack with capacity `N` for this
    implementation?

    (A) pos ← -1
    (B) pos ← 0
    (C) pos ← 1
    (D) pos ← N - 1
    (E) pos ← N

III.4   04

4. A processor with a word-addressable memory has a two-way set-associative cache. A cache line is one word, so a cache entry contains a set of two words. If there are M words of memory and C cache entries, how many words of memory map to the same cache entry?

  (A) $\dfrac{C}{2}$

  (B) $\dfrac{M}{2C}$

  (C) $\dfrac{M}{C}$

  (D) $\dfrac{2M}{C}$

  (E) $\dfrac{M}{2}$

III.5   05

5. Which of the following regular expressions will not generate a string with two consecutive 1s? (Note that ε denotes the empty string.)

  I. $(1 + \varepsilon)(01 + 0)*$
  II. $(01 + 10)*$
  III. $(0 + 1)*(0 + \varepsilon)$

  (A) I only
  (B) II only
  (C) III only
  (D) I and II only
  (E) II and III only

III.6   06

6. Consider the following recursive function.

```
int Fun ( int n )
   if ( n == 4 )
      return 2
   else
      return 2 * Fun ( n + 1 )
   end if
end Fun
```

What is the value returned by the function call `Fun ( 2 )` ?

(A) 2
(B) 4
(C) 8
(D) 16
(E) 24

III.7   07

7. If `A[0..n-1]` is an array with `n` elements and procedure `Swap` exchanges its arguments, then the following code sorts `A` in <u>descending</u> order.

```
int j ← 0
while ( j < n - 1 )
    int k ← 0
    while ( k < n - j - 1 )
        if ( A[k] < A[k + 1] )
            Swap ( A[k], A[k + 1] )
        end if
        k ← k + 1
    end while
    j ← j + 1
end while
```

If `A` initially contains `n` different elements sorted in <u>ascending</u> order, how many calls to `Swap` are made in total?

(A) n - 1
(B) n
(C) n(n - 1)/2
(D) (n - 1)(n - 2)
(E) n(n - 1)

III.8   08

8. If A, B, and C are Boolean variables, which of the following is (are) true?

   I. $A \wedge (B \vee C) = (A \wedge B) \vee (A \wedge C)$

   II. $A \vee (B \wedge C) = (A \vee B) \wedge (A \vee C)$

   III. $(A \wedge B) \vee C = C \vee (B \wedge A)$

   (A) I only
   (B) II only
   (C) I and II only
   (D) II and III only
   (E) I, II, and III

III.9   09

9. A personal identification number (PIN) that opens a certain lock consists of a sequence of 3 <u>different</u> digits from 0 through 9, inclusive. How many possible PINs are there?

   (A)   120
   (B)   360
   (C)   720
   (D)   729
   (E) 1,000

III.10   10

10. Consider the statement "Every connected graph has one or more vertices of degree 2."
Each of the five graphs below has one or more connected components. Which of the
five graphs is a counterexample to the statement?

(A)

(B)

(C)

(D)

(E)
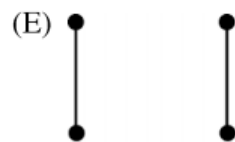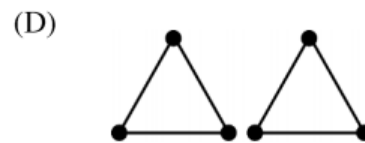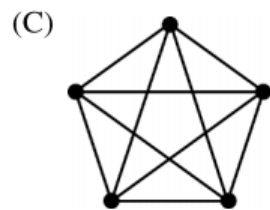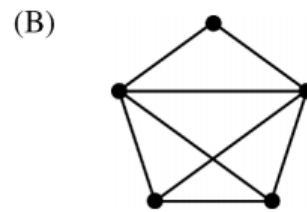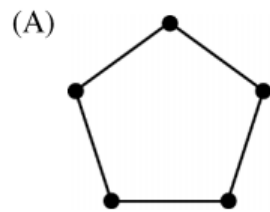
III.11   11

11. Following is a definition of a `widget` and a declaration of an array `A` that contains 10 `widgets`. The sizes of a **byte**, **short**, **int**, and **long** are 1, 2, 4, and 8 bytes, respectively. Alignment is restricted so that an n-byte field must be located at an address divisible by n. The fields in a **struct** are not rearranged; padding is used to ensure alignment. All `widgets` in `A` must have the same size.

```
struct widget
     short s
     byte b
     long l
     int i
end widget

widget A[10]
```

Assuming that `A` is located at a memory address divisible by 8, what is the total size of `A`, in bytes?

(A) 150
(B) 160
(C) 200
(D) 240
(E) 320

III.12   12

12. Consider a virtual memory system running on a RISC CPU. Page tables are not locked in memory and may be swapped to disk. An `lw` (load word) instruction reads one data word from memory; the address is the sum of the value in a register and an immediate constant stored in the instruction itself. Neither machine instructions nor page-table entries nor data words can cross a page boundary. In the worst case, how many page faults could be generated as a result of the fetch, decode, and execution of an `lw` instruction?

(A) 2
(B) 3
(C) 4
(D) 5
(E) 6

III.13   13

13. Four processes—P_1, P_2, P_3, and P_4—are scheduled to use a single processor. The following table shows the arrival time and duration of each of the four processes.

Process	Arrival Time (seconds)	Duration (seconds)
P_1	0	7
P_2	2	4
P_3	4	1
P_4	5	4

If the system uses a preemptive shortest-job-first scheduling algorithm, what is the average waiting time for the four processes, in seconds?

(A) 2
(B) 3
(C) 4
(D) 5
(E) 6

III.14   14
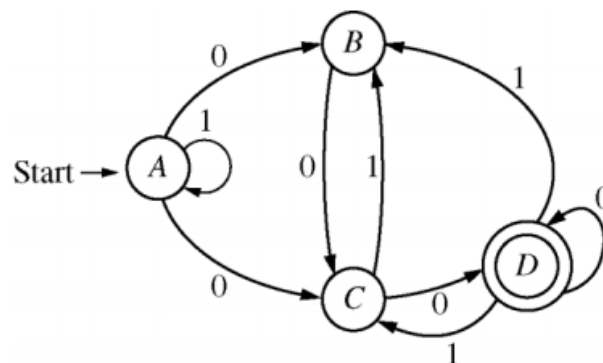
14. The figure above represents a nondeterministic finite automaton with accepting state D. Which of the following strings does the automaton accept?

(A) 001
(B) 1101
(C) 01100
(D) 000110
(E) 100100

III.15   15

15. Given that

> $B(x)$ means "x is a bear",
> $F(x)$ means "x is a fish", and
> $E(x, y)$ means "x eats y",

what is the best English translation of

$$\forall x\,[F(x) \to \forall y\,(E(y, x) \to B(y))]\,?$$

(A) All fish eat bears.

(B) Every fish is eaten by some bear.

(C) Bears eat only fish.

(D) Every bear eats fish.

(E) Only bears eat fish.

III.16   16

16. Consider the following table in a relational database.

Last Name	Rank	Room	Shift
Smith	Manager	234	Morning
Jones	Custodian	33	Afternoon
Smith	Custodian	33	Evening
Doe	Clerical	222	Morning

According to the data shown in the table, which of the following could be a candidate key of the table?

(A) {Last Name}

(B) {Room}

(C) {Shift}

(D) {Rank, Room}

(E) {Room, Shift}

III.17   Notation, Conventions, and Definitions

1. All numbers are assumed to be written in decimal notation unless otherwise indicated.

2. $\lfloor x \rfloor$ denotes the greatest integer that is less than or equal to x.

3. $\lceil x \rceil$ denotes the least integer that is greater than or equal to x.

4. $g(n) = O(f(n))$ denotes "$g(n)$ has order at most $f(n)$" and means that there exist positive constants C and N such that $g(n) \le Cf(n)$ for all $n > N$.

    $g(n) = \Omega(f(n))$ denotes "$g(n)$ has order at least $f(n)$" and means that there exist positive constants C and N such that $g(n) \ge Cf(n)$ for all $n > N$.

    $g(n) = \Theta(f(n))$ denotes "$g(n)$ has the same order as $f(n)$" and means that there exist positive constants C_1, C_2, and N such that
    $$C_1 f(n) \le g(n) \le C_2 f(n) \text{ for all } n > N.$$

5. $\exists$ denotes "there exists".

    $\forall$ denotes "for all".

    $\rightarrow$ denotes "implies".

    $\neg$ denotes "not"; "$\overline{A}$" is also used to mean "$\neg A$".

    $\vee$ denotes "inclusive or"; $+$ also denotes "inclusive or", e.g., $P + Q$ can denote "P or Q".

    $\oplus$ denotes "exclusive or".

    $\wedge$ denotes "and"; also, juxtaposition of statements can denote "and", e.g., PQ can denote "P and Q".

6. $\varnothing$ denotes the empty set.

    If A and B denote sets, then

    $A \cup B$ is the set of all elements that are in A or in B or in both;

    $A \cap B$ is the set of all elements that are in both A and B;

    $A - B$ is the set of all elements in A that are not in B;

    $A \subseteq B$ means A is a subset of B (that is, any element in A is also in B);

    $A \subset B$ means A is a proper subset of B (that is, $A \subseteq B$ and there is at least one element in B that is not in A);

    $\overline{A}$ is the set of all elements not in A that are in some specified universal set; and

    $|A|$ is the cardinality of A.

7. ϵ denotes the empty string.

   If x and y are strings, $x + y$ denotes the set $\{x\} \cup \{y\}$ and xy denotes the concatenation of x and y.

   If S and T are sets of strings, then

   $ST = \{xy \mid x \in S \text{ and } y \in T\}$ denotes the concatenation of S and T;

   $S + T$ denotes $S \cup T$;

   S^n denotes $\underbrace{SS\ldots S}_{n \text{ factors}}$;

   S^+ denotes $S \cup S^2 \cup S^3 \cup \cdots$; and

   S^* denotes $\{\epsilon\} \cup S^+$.

8. In a grammar, $\alpha \rightarrow \beta$ represents a production rule.

   Unless otherwise specified,

   (i)   symbols appearing on the left-hand side of productions are nonterminal symbols, and the remaining symbols are terminal symbols;
   (ii) the leftmost symbol of the first production is the start symbol; and
   (iii) the start symbol is permitted to appear on the right-hand side of productions.

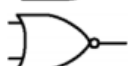9. In a logic diagram

    represents an AND gate;

    represents an inclusive OR gate;

    represents an exclusive OR gate;

    represents a NOT gate;

    represents a NAND gate; and

    represents a NOR gate.

10. In a finite automaton diagram, states are represented by circles, where final (or accepting) states are indicated by two concentric circles. The start state is labeled Start. An arc from state s to state t labeled a indicates a transition from s to t on input a.

11. Unless specified otherwise, all code segments are written in pseudocode, where $\leftarrow$ indicates assignment.

Chapter IV

Turn-in and peer-evaluation

This part describes the conditions and instructions regarding the turn-in and the peer-evaluation of the project. If your project does not require odd turn-in or peer-evaluation instructions, feel free to use the following paragraph as it is:

Turn your work in using your `GiT` repository, as usual. Only work present on your repository will be graded in defense.