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VCE Specialist Mathematics ½

Logic & Algorithms I [2.4]

Homework

Homework Outline:

Compulsory Questions	Pg 2- Pg 14
Supplementary Questions	Pg 17- Pg 26

Section A: Compulsory Questions

Sub-Section [2.4.1]: Write and Understand Basic Algorithms

Question 1

Construct an algorithm that triples any input given.

Question 2

Construct an algorithm that halves any input given and adds 1.

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Question 3

Construct an algorithm that subtracts 5 from an input and then multiplies by 3.

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Sub-Section [2.4.2]: Understanding and Evaluating Algorithms that have Conditional Statements and Represent Hybrid Functions as Algorithms

Question 4

a. Turn the following function into an algorithm.

$$f(x) = \begin{cases} x & x \geq 0 \\ -x & x < 0 \end{cases}$$

b. Evaluate the final output:

$a \leftarrow 1$
$b \leftarrow 1$
if $a + b < 7$
  $b \leftarrow b - 2$
  $a \leftarrow a + 3.$
end if
print a, b.

Question 5 Tech-Active.

Following is an algorithm for calculating the Australian tax.

Step 1: Input income.

Step 2a: If income ≤ 18200, then tax $\leftarrow 0$.

Step 2b: Else If income ≤ 37000, then tax $\leftarrow 0.19 \times$ income $- 3458$.

Step 2c: Else If income ≤ 90000, then tax $\leftarrow 0.325 \times$ income $- 8453$.

Step 2d: Else If income ≤ 180000, then tax $\leftarrow 0.37 \times$ income $- 12503$.

Step 2e: Else If tax $\leftarrow 0.45 \times$ income $- 26903$.

Step 3: Print tax.

a. Calculate tax for 200000.

b. Calculate tax for 45888.

c. Calculate tax for 90001.

Question 6

a. Using a flowchart, describe an algorithm of the following hybrid function.

$$f(x) = \begin{cases} 1 & x > 0 \\ 0 & x < 0 \\ \frac{1}{2} & x = 0 \end{cases}$$

b. Write an algorithm for the following hybrid function.

$$f(x) = \begin{cases} 1 & x > 3 \\ 0 & x = 3 \\ -1 & x < 3 \end{cases}$$

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Sub-Section [2.4.3]: Understand and Evaluate Algorithms with Loops

Question 7

Check whether the following algorithm has any problems. If there is a problem, state the problem; if there is no problem, give the final output of the algorithm.

Step 1: $A \leftarrow 60$

Step 2: $A \leftarrow 2A - 50$

Step 3: Repeat 2 while $A > 60$.

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Question 8

Evaluate the final output.

$a \leftarrow 1$
$b \leftarrow 1$
while $a + b < 7$
    $b \leftarrow b - 2$
    $a \leftarrow a + 3$.
end while
print a, b.

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Question 9

a. Evaluate the final output:

$c \leftarrow 0$
for a from 1 to 2
    for b from 1 to 2
        $c \leftarrow c - ab$
    end for
end for
print c.

b. Construct an algorithm that outputs the largest multiple of 5 that is less than or equal to 100.

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Sub-Section [2.4.4]: Write and Evaluate Functions using Pseudocode

Question 10

Using pseudocode, define a function for finding each of the following:

a. Finding the area of the triangle given base and height.

b. Finding the surface area of a sphere given radius.

c. Define a function for modulus.

Question 11

Evaluate the following algorithm:

a. $A \leftarrow [\ ]$
for n from 1 to 6
if $n =$ even then
append 1 to A.
else
append 0 to A.

b. $A \leftarrow [\ ]$
for n from 1 to 5
$B \leftarrow 2n + 1$
append B to A.

c. $A \leftarrow [1, 1]$
for n from 1 to 5
    $x \leftarrow A[n] + A[n + 1]$
    append x to A.

Question 12

Using pseudocode, construct an algorithm for the following:

a. Find the biggest possible product from any 2 numbers from the list $= (23, 5, 2, 56, 34)$.

NOTE: Cannot multiply numbers by themselves.

b. Find the smallest possible sum of 2 numbers from the same list as **part a**.

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Sub-Section: Final Boss

Question 13

Consider the sequence $1, 4, 7, 10, 13, 16, 19 \ldots 3(n-1)+1$.

Using pseudocode, write an algorithm for:

a. Calculate the sum of the even terms in the sequence up to the n^{th} term.

b. Calculate the product of the odd terms in the sequence up to the n^{th} term.

c. Construct a table of values to demonstrate each algorithm when $n = 5$.

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Section B: Supplementary Questions

Sub-Section [2.4.1]: Write and Understand Basic Algorithms

Question 14

Construct an algorithm that multiplies any input given by 10.

Question 15

Construct an algorithm that adds any input given by 5.

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Question 16

Construct an algorithm that subtracts any input given by 5 and multiplies by 2.

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Sub-Section [2.4.2]: Understanding and Evaluating Algorithms that have Conditional Statements and Represent Hybrid Functions as Algorithms

Question 17

Using a flowchart, describe an algorithm of the following hybrid function.

$$f(x) = \begin{cases} 3x - 5 & x \geq 0 \\ x - 1 & x < 0 \end{cases}$$

Question 18

Using a flowchart, describe an algorithm of the following hybrid function.

$$f(x) = \begin{cases} 1 & x \geq 0 \\ 0 & x < 0 \end{cases}$$

Question 19

Turn the following function into an algorithm.

$$f(x) = \begin{cases} x^2 & x \geq 1 \\ -2x + 1 & x < 1 \end{cases}$$

Question 20

Turn the following function into an algorithm.

$$f(x) = max\{n \in \mathbb{R} | n \leq x\}$$

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Sub-Section [2.4.3]: Understand and Evaluate Algorithms with Loops

Question 21

Check whether the following algorithm has any problems. If there is a problem, state the problem; if there is no problem, give the final output of the algorithm.

Step 1: $A \leftarrow 30$
Step 2: $A \leftarrow 3A - 20$
Step 3: Repeat 2 while $A > 65$.

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Question 22

Evaluate the following algorithm:

for a from 1 to 10
  if $a =$ even, then
    print "yes"
else
    print "no"
end for.

Question 23

Check whether the following algorithm has any problems. If there is a problem, state the problem; if there is no problem, give the final output of the algorithm.

Step 1: $A \leftarrow 60$
Step 2: $A \leftarrow 2A - 50$
Step 3: Repeat 2 while $A \leq 130$.

Question 24

Evaluate the following output:

$a \leftarrow 5$
$b \leftarrow 10$
if $a - b < 5$
  $a \leftarrow a - 5$
  $b \leftarrow b - 10$
end if
print a, b.

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Sub-Section [2.4.4]: Write and Evaluate Functions using Pseudocode

Question 25

$A \leftarrow [\ ]$
for n from 1 to 5
  append n to A.
  if $n = 1$, then
    return
else
  $A = \sqrt{n^2 + A[n-1]}$
  if $A =$ integer
    print "$A[n-1], n, A$ is a perfect triangle."
end for.

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Question 26

a. Roger decides to invest $1000 at an interest rate of 10% compounded monthly. Construct an algorithm that computes the number of years needed for Roger's investment to double.

b. Jacob decides to invest $500 at an interest rate of 15% compounded annually. Construct an algorithm that computes the number of years needed for Jacob's investment to increase by 50%.

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Question 27

Using pseudocode, write an algorithm to find all the primes less or equal to 100.

Question 28

Using pseudocode, construct an algorithm for the following:

Find the shortest distance between any 2 ***different*** coordinates from the list of coordinates.

$$Y \text{ coord} = [1, 35, 5, 41, 5]$$
$$X \text{ coord} = [123, 2, 74, 213, 2]$$

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