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DUNMAN HIGH SCHOOL Preliminary Examination Year 6

COMPUTING

9597

(Higher 2)

Paper 1

**27 August 2018
3 hours 15 minutes**

Additional Materials: Data files

READ THESE INSTRUCTIONS FIRST

Type in the `EVIDENCE.docx` document the following:

- Candidate details
- Programming language used

Answer **all** questions.

All tasks must be done in the computer laboratory. You are not allowed to bring in or take out any pieces of work or materials on paper or electronic media or in any other form.

All tasks and required evidence are numbered. The marks is given in brackets [] at the end of each task.

Copy and paste required evidence of program code and screenshots into the appropriate cells in `EVIDENCE.docx`.

Data files

Q1 – `LOG.TXT`

Q3 – `ACHIEVEMENTS.TXT`

1. The file `LOG.TXT` contains the access log entries of an organisation's website from 0000 to 1800 hours on 1 August 2018.

The entries have the following format:

1. **host** (domain name or IP address) making the request.
2. **timestamp** in the format "DAY MON DD HH:MM:SS YYYY", where **DAY** is the day of the week, **MON** is the name of the month, **DD** is the day of the month, **HH:MM:SS** is the time of day using a 24-hour clock, and **YYYY** is the year. The timezone is -0400.
3. **request** in quotes.
4. **HTTP reply status code**.
5. **bytes in the reply**.

Task 1.1

Determine the top 5 hosts which accessed the website during this period, in descending frequency order.

Sample output:

Top 5 hosts:

1	139.230.35.135	187
2	ns2.sharp.co.jp	95
3	194.157.109.130	62
3	ix-dfw12-08.ix.netcom.com	62
4	piwebaly.prodigy.com	55
5	205.163.36.61	30

Evidence 1

Program code. [9]

Evidence 2

Screenshot. [1]

Task 1.2

Determine the host which returned the largest reply size and the largest reply size.

Sample output:

slip4086.sirius.com 12345

Evidence

Program code. [4]

Evidence 4

Screenshot. [1]

2. A media access control (MAC) address is a unique identification code hardwired to and used to identify individual devices on the network, and is often expressed using hexadecimal notation eg. `4c:21:d0:15:e3:ea`.

Task 2.1

Using top down design, write iterative program code to convert a given MAC address to decimal notation. For MAC address `4c:21:d0:15:e3:ea`, its converted decimal notation will be `76:33:208:21:227:234`.

Evidence 5

Program code. [4]

Evidence 6

Screenshot. [1]

Task 2.2

Write recursive program code to convert a given MAC address to decimal notation. Use the same MAC address `4c:21:d0:15:e3:ea` to test your program code.

Evidence 7

Program code. [4]

Evidence 8

Screenshot. [1]

Task 2.3

Write program code to perform input validation for a MAC address. Test your program with suitable test data.

Evidence 9

Program code. [3]

Evidence 10

Screenshots. [2]

3. A blockchain is a linked list of blocks where each block has the following structure:

Class: Block		
Attributes		
Identifier	Data Type	Description
Data	String	Block data
PrevHash	String	Hash of previous block
CurrHash	String	Hash of Data and PrevHash
Next	Integer	The next block pointer

The structure of the blockchain is as follows:

Class: Blockchain		
Attributes		
Identifier	Data Type	Description
ChainData	Array[1:20] of Block	An array used to store the 20 blocks.
Start	Integer	Index for the genesis block.
NextFreeBlock	Integer	Index for the next available empty block.

The initial value of `Start` is 1 and the initial value of `NextFreeBlock` is 1.

The first block of the blockchain is called the genesis block and its `PrevHash` value is 983.

The blockchain is used to store the achievement data of students in computing and infocomm programmes. This ensures the integrity and verifiability of students' portfolios which will be useful in internships, higher education and career opportunities.

Task 3.1

Write program code to declare and initialise an empty blockchain of 20 unused blocks. Also write the `Display` method to show all contents of the blockchain.

Evidence 11

Program code.

[8]

Evidence 12

Screenshot.

[2]

Task 3.2

The following hashing algorithm computes the `CurrHash` value of each block:

- Compute the sum of ASCII values for the characters in the achievement data string.
- Multiply this sum by the k^{th} prime number, where k is the length of the achievement data string.
- Multiply this with the decimal equivalent of the `PrevHash` value of the current block.
- Convert this value to its uppercase hexadecimal equivalent.
- Prepend the appropriate number of 'F' to this result to form a 23-character resultant string. This will be the current block's `CurrHash` value.

For example, for the achievement data string

`Splash Awards 2018:Robert Goh,Mary Tan,Choo Ah Beng:First`

Its `CurrHash` value will be `FFFFFFFFFFFFFFFF4D32A036`

(sum of ASCII value * 57th prime number * `PrevHash` = $4898 * 269 * 983$)

Write program code for a `ComputeHash` function to calculate the `CurrHash` value of a block. Verify your function with the following 2 achievement data strings:

`Splash Awards 2018:Robert Goh,Mary Tan,Choo Ah Beng:First`

`Splash Awards 2018:Lim Ah Huat,Alice Wong,Tan Ah Lian:Honorable Mention`

Evidence 13

Program code.

[18]

Evidence 14

Screenshot for the 2 achievement data strings.

[2]

Task 3.3

Write program code to insert the data in `ACHIEVEMENTS.TXT` into the blockchain and display the contents of the updated blockchain.

Evidence 15

Program code.

[4]

Evidence 16

Screenshot.

[1]

Task 3.4

Lim Ah Huat aspires to save the world by studying computer science in NUS School of Computing. As it is now the toughest course to get admitted to, he hopes to improve his chances of admission by showcasing his achievements in the various computing and infocomm related programmes he has participated in. He claimed that he is a good team player and is a strong self-directed learner with excellent aptitude for Computing.

How can the university admission panel verify his achievements using the existing

blockchain? You should describe briefly in program comments this strategy and implement the associated program code.

Evidence 17

Program code.

[5]

Evidence 18

Screenshot.

[1]

Task 3.5

Another student Tan Ah Seng claimed that he also has computing or infocomm related participation, and changes one of the achievement data string from

Splash Awards 2018:Lim Ah Huat,Alice Wong,Tan Ah Lian:Honorable Mention

to

Splash Awards 2018:Lim Ah Huat,Alice Wong,Tan Ah Seng:Honorable Mention

Using program comments, briefly explain the impact to the blockchain. Write program code to refute Mr Tan's claim.

Evidence 19

Program code.

[3]

Evidence 20

Screenshot.

[1]

4. Vector and matrix manipulation are used extensively in machine learning programs. We will look at how common vector and matrix operations are implemented using first principles

Addition and subtraction

$$[a, b, c] + [d, e, f] = [a+d, b+e, c+f]$$

$$[a, b, c] - [d, e, f] = [a-d, b-e, c-f]$$

Scalar multiplication i.e. product of a constant and a vector

$$k * [a, b, c] = [k*a, k*b, k*c]$$

Dot product (for 2 vectors of the same dimension)

$$[a, b, c] \cdot [d, e, f] = a*d + b*e + c*f$$

Distance (between 2 vectors $[a, b, c]$ and $[d, e, f]$ of the same dimension)

$$\sqrt{(a-d)^2 + (b-e)^2 + (c-f)^2}$$

Task 4.1

Using OOP techniques, create a class `Vector` to implement the operations add, subtract, scalar multiplication, dot product and distance.

Exercise your class methods with the following vectors and constant:

$v1 = [1, 3, 5]$, $v2 = [2, 4, 6]$, $k = 5$

Evidence 21

Program code.

[12]

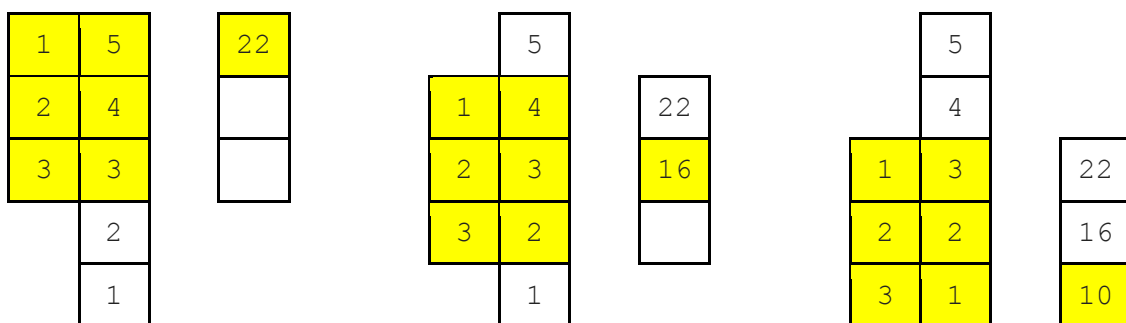
Evidence 22

Screenshots.

[2]

Task 4.2

In some situations, it may be necessary to perform operations on vectors of different dimensions eg for a convolution layer in deep learning. The following diagram illustrates this process for a 3-element vector $[1, 2, 3]$ and a 5-element vector $[5, 4, 3, 2, 1]$. The result will be a 3-element vector.



Write program code to implement the convolution process for vectors. Display the result to the screen.

Evidence 23

Program code.

[5]

Evidence 24

Screenshot.

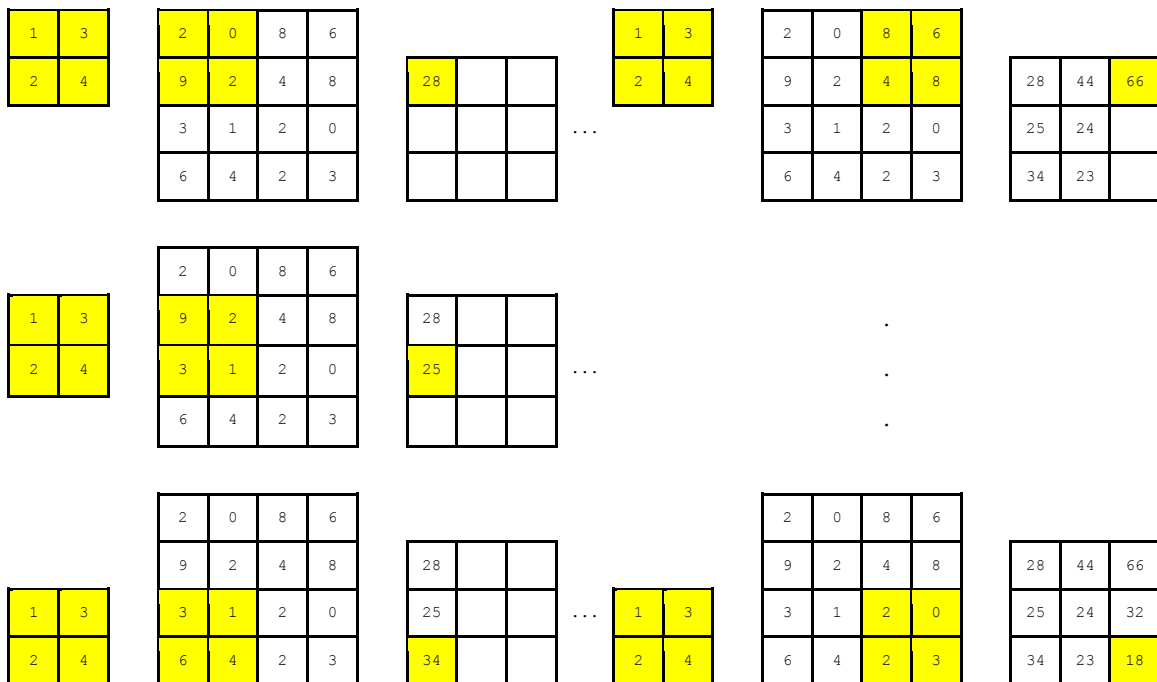
[1]

Task 4.3

An example of the inner product for a matrix (2D array) is as follows:

$$\begin{array}{|c|c|} \hline 1 & 3 \\ \hline 2 & 4 \\ \hline \end{array} \circ \begin{array}{|c|c|} \hline 0 & 3 \\ \hline 5 & 1 \\ \hline \end{array} = 1*0 + 3*3 + 2*5 + 4*1 = 23$$

Write program code to implement the convolution process for matrices which uses the dot product for matrices. An example is shown below. Display the result to the screen.

**Evidence 25**

Program code.

[8]

Evidence 26

Screenshot.

[2]

*** THE END ***