RIVER VALLEY HIGH SCHOOL
General Certificate of Education Advanced Level
Higher 2
Preliminary Examination

COMPUTING

9569/01
Paper 1
16 Sep 2022
3 hours

Additional Materials: Answer Booklet

READ THESE INSTRUCTIONS FIRST

Write your center number, index number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

If you need additional answer paper ask the invigilator for a continuation booklet.

Answer **all** questions.
Approved calculators are allowed.

The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 100.

This document consists of **9** printed pages.

Answer **all** questions.

1. An unknown sorting algorithm is shown below.

```
01 def UnknownSort(lst):

02     def helper(lst, i, temp):
03         if i == 0:
04             lst[0] = temp
05         elif temp < lst[i-1]:
06             lst[i] = temp
07         else:
08             lst[i] = lst[i-1]
09             helper(lst, i-1, temp)

10     for i in range(1, len(lst)):
11         helper(lst, i, lst[i])
```

a) State if the sorting algorithm is an in-place sorting algorithm. Explain your answer. [2]

b) Trace the content of lst in the for loop after each iteration when the following code is executed. [3]

```
>>> lst = [5,6,7,2,4,3]
>>> UnknowSort(lst)
```

i	lst[0]	lst[1]	lst[2]	lst[3]	lst[4]	lst[5]
1						
2						
3						
4						
5						

c) State the name of the sorting algorithm. [1]

d) State the time complexity of `helper` and `UnknownSort`. [2]

e) Identity the base case(s) and the recursive calls in `UnknownSort`. [3]

An unknown search algorithm is shown below.

```
01 def UnknownSearch(lst, target):
02     def helper(lst):
03         if lst:
04             if lst[0] == target:
05                 return True
06             else:
07                 return helper(lst[1:])
08         else:
09             return False
10    return helper(lst)
```

f) Explain why `UnknownSearch` is an out-of-place search algorithm. [2]

g) State the time complexity of `UnknownSearch`. [1]

h) Modify the code to make it in-place. [4]

The unknown search algorithm can search for both sorted and unsorted list.

i) Optimise the out-of-place `UnknownSearch` function to solely performing search in a sorted list. Explain specifically how your optimisation can improve the performance. [3]

2. Draw a reduced decision table based on the following.

- If condition 1 is satisfied, execute outcome C. If condition 2 is also satisfied, execute outcome A as well. If not, execute outcome B with outcome C.
- If condition 1 is not satisfied, execute outcome A. If condition 2 is also satisfied, execute outcome C as well.
- Execute all outcomes if all conditions are not satisfied. [5]

3. The nodes of a linked list holding fruit names in **alphabetical** order are stored in the element of an array, `fruits`.

Each element of the array `fruits` comprises two parts: the data and the next pointer.

Data	NextPtr

The pointer `NextPtr` contains the array index of a node next to the current node. **Null** indicates there are no further nodes.

An integer variable, `Head`, holds the index of the head node of the linked list.

The contents of the array `fruits` are shown:

Head	3

index	Data	NextPtr
0	**NULL**	**NULL**
1	Orange	**NULL**
2	**NULL**	**NULL**
3	Apple	4
4	Banana	6
5	**NULL**	**NULL**
6	Grape	7
7	Pear	1

a) Draw the logical linked list using the information above (using boxes and arrows). [3]

b) There is a mistake in logical linked list. Correct the mistake by changing only the `NextPtr` field in the array. [2]

A queue data structure has the following operations defined. In this question, the queue primarily stores integer values.

Operation	Description
`Queue()`	Create and return a new queue instance
`Q.enqueue(item)`	Insert new value, `Item` into queue instance `Q`
`Q.dequeue()`	Remove and return the head item of queue instance `Q`
`Q.size()`	returns the number of items in queue instance `Q`

c) Write in Pseudo-code the `search(target)` function that returns `True` if the integer value `target` is found in the queue and `False` otherwise. The items in the queue must be in the same order before and after the function `search(target)` is executed. [4]

The code of an unknown function `foo` in Python is described below.

```
def foo(lst):
    result = [-1]*len(lst)
    S = myStack(len(lst))
    for i in range(len(lst)):
        while not S.isEmpty() and lst[S.peek()] > lst[i]:
            S.pop()
        if S.isEmpty():
            result[i]=-1
        else:
            result[i]=S.peek()
        S.push(i)
    return result
```

d) State the content of the `result` when the following is executed. [2]

```
lst <- [2, 4, 6, 9, 5, 3]
result = foo(lst)
```

4. A hashing algorithm is to be used to locate a record within a hash table.

a) Explain how a collision is managed differently using open addressing and closed addressing. [2]

A local e-commerce company must store and maintain huge quantities of data. The e-commerce company hashes the user's ID to locate information of the user.

b) Explain why in this context, a linear search on the user's information would perform better than a binary search. [2]

The e-commerce company keeps a record of the spending history of its users. To boost the revenue, the company decides to use the data to advertise products to the users through emails and phone calls.

c) State the 3 steps the company must take before using the data for the above purpose. [3]

d) Explain how the use of customer's data can become an ethical issue. [1]

5. Below is an extract of an article from Straits Time.

Ransomware attacks threaten nations, 137 S'pore firms fell prey in 2021: CSA

SINGAPORE - Fifty per cent more companies in Singapore fell prey to ransomware last year, as such attacks increasingly become national security threats.

Mirroring global trends, the number of firms in Singapore that had their systems locked up until a ransom was paid shot up from 89 in 2020 to 137 last year, said the Cyber Security Agency (CSA) of Singapore.

…
Hackers exploited vulnerabilities in US tech firm Accellion's file-sharing software, which is used by Singtel and many global firms. Cyber criminals later posted a ransom note addressed to Accellion demanding $250,000 worth of bitcoin. The incident shone the spotlight on supply chain risks.
…

CSA said phishing remained a popular method for hackers to gain access into systems before deploying malware in them. There were 55,000 links to phishing sites hosted here last year, a 17 per cent increase from 47,000 in 2020.
…

Source: https://www.straitstimes.com/tech/tech-news/ransomware-attacks-threaten-nations-137-spore-firms-fell-prey-in-2021-csa

a) Explain what ransomware is. [1]

b) Explain what phishing is. [1]

c) Suggest 3 steps that the company can do to prevent or reduce the impact of ransomware? [3]

6. eShop is an online shopping platform, the company engages you to design a relational database solution. A typical online shopping record would look like the following table.

Online Shopping Record				
Record No:		ESHOP2022076	**Order Date:**	23 Aug 2022
Delivery Start Date:		24 Aug 2022	**Delivery End Date:**	26 Aug 2022
Store ID:		STORE007	**Store Name:**	Challenger
Store Contact:		91234567	**Store Address:**	6 Boon Lay Ave
Customer ID:		CUST001	**Customer Name:**	Xiao Ming
Customer Contact:		98765432	**Customer Address:**	30 Lakeside Dr
Item ID	**Title**	**Comment**	**Unit Price**	**Quantity**
ITEM001	iPhone	I want gold color	$1154.00	1
ITEM007	Case	NIL	$20.00	1
ITEM010	Charging Cable	1x 1.2m red cable 1x 1.2m blue cable	$5.00	2

a) You are required to design a relational database solution for the company. Identify the tables that will give a normalized solution. Show the process of normalization. [6]

b) Based on your solution in (a), draw a fully labelled ER diagram to show how the entities are related. [4]

c) Explain the following terminologies. Hence state the advantage of relational database over flat file implementation in the respective aspect.

(i) Data privacy. [3]
(ii) Data redundancy. [3]

d) To make this commercial website more appealing, the administrator searched for some beautiful image online and include them to improve the aesthetics design. Explain why this could be a potential problem and suggest one possible alternative solution. [3]

7. As the Chief Engineer, you are leading a team to design a computerized system for the Navy of the Great CZ Empire.

All ships have a name and its displacement value.

There are two types of ships serving in the Navy:

- Transport
- Carrier

The team needs to design an object-oriented system to capture:

- Name of all ships
- Displacement tonnage of all ships (basically the weight of the ship)
- Type of cargo inside the transport ships
- Maximum number of aircrafts the carrier can carry, default as `10`

a) Draw a class diagram, with base class Ship, showing:

- appropriate sub-classes,
- inheritance,
- the properties required,
- appropriate methods, including but not limited to the constructor methods, and at least one pair of 'get' and 'set' methods for each class,
- circle the polymorphed methods.

[6]

b) Using the above example, state and explain the difference between a class and an instance. [4]

c) Describe and define another subclass that can be included on the diagram and state where it fits. [3]

d) Using the above example, explain the meaning of the term **Polymorphism**, and state one advantage of it. [3]

8. Every published book has an International Standard Book Number (ISBN). This ISBN is a 9-digit number plus a check digit which is calculated and added to the end of the number. A weighted-modulus method is used to calculate the check digit.

Take the ISBN number of `"184146208"` as an example. The following steps are used to calculate the check digit:

Digit	1	8	4	1	4	6	2	0	8
Weight	10	9	8	7	6	5	4	3	2

- The sum of product of digit and weight is calculated to be `199`.
- `199 % 11` will have a remainder of `1`.
- The check value is calculated using `11 - 1`, in this case, the check value is `10`.
- Final check digit is replaced as `"X"`.

If the check value is `11`, the final check digit will be `"0"`.
If the check value is `10`, the final check digit will be `"X"`.
Otherwise, the final check digit will be the string form of the check value.

The following pseudocode is used to calculate the check digit using a recursive algorithm.

```
01  FUNCTION ISBN_CHECKDIGIT(NUM_STR: STRING, TOTAL: INT) RETURNS STRING
02      IF LENGTH(NUM_STR) > 0:
03          WEIGHT <- __________A___________
04          TOTAL <- TOTAL + INT(NUM_STR[0]) * WEIGHT
05          CHECK_DIGIT <- __________B___________
06      ELSE:
07          CHECK_VALUE <- __________C___________
08          IF CHECK_VALUE == 11:
09              CHECK_DIGIT <- "0"
10          ELSEIF CHECK_VALUE == 10:
11              CHECK_DIGIT <- "X"
12          ELSE:
13              CHECK_DIGIT <- __________D___________
14          END IF
15      END IF
16      RETURN CHECK_DIGIT
17  END FUNCTION
```

a) Analyze the above algorithm, state the correct pseudo-code that is appropriate for the positions `A`, `B`, `C` and `D` respectively. [4]

b) State the functional call that will calculate the check digit of ISBN number `"184146208"`. [1]

c) Explain what white-box testing is. [2]

d) You are tasked to design a series of 3 test cases to perform a white-box test on the above algorithm. State the test cases and elaborate on the purpose of each test case. [6]

e) The above algorithm does not validate the NUM_STR. Propose two validation checks accompanied with test cases; and elaborate on the purpose of these checks. [2]

End of paper