



YISHUN INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAM
Higher 2

CANDIDATE
NAME

CG

INDEX NO

COMPUTING

Paper 1 Written

9569/01

15 Sep 2020

3 hours

Additional Materials: Nil

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class clearly on the cover page.

Write in dark blue or black pen on the writing paper provided.

You may use an HB pencil for any diagrams, graphs, tables or rough working.

Do not use staples, paper clips, glue or correction fluid.

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**

- 1 A list of data items is stored in a hash table using an array `Values`. The following pseudocode describes an algorithm for searching the table using the hashing function `Hash`.

```
01   Index <- Hash(Key)
02   WHILE Values[Index] <> Key
03       Index <- Index + 1
04   ENDWHILE
05   Return Values[Index]
```

- (a) Explain when "`Values[Index] <> Key`", in line 02, will be True and explain the purpose for the code in line 03. [2]
- (b) Describe the two problems with this algorithm. [2]
- (c) Without writing any program code, describe the modifications required to overcome each of the problems stated in (a). [4]

(a) any 2 below:

- When there is a hashing collision for `Key1` and `Key2`, ie `Hash(Key1) = Hash(Key2) = index`, then although `Key2` exists in the table, it will be located at another index position.
- `Values[Index]` could be null indicating that the item `Key` does not exist in the table.
- the array at `Index` position could be occupied other item but not the `Key` since `Key` is not in the table.

[0] `Values[Index]` not the same as `Key` (or any equivalent statements).

(b) [2] Any 2 below:

- When `Index` increases, it will become larger than the table size; index out of range error
- The initial part of the table is not search, those indices $< \text{Hash}(\text{Key})$
- the algorithm does not return 'Not Found' when `Key` is not in the table

*[0] infinite while loop

(c) [4] any 2 below:

- When searching till the end of the table, ie `Index == len(table)`, set `Index` to the beginning (ie 0) and search the front portion to the initial `Index` position.

- Use a counter to check if all elements in the table has been searched once, ie `counter==len(table)`, break from the loop and declare item Key is not in the table.
- While searching through the table, if any element is null, ie `Values[index]=="`, return that the item Key is not found in the table.

2 A list of data items is stored in the array `seq`. The following function `qsort` takes the array `seq` as its parameter and returns a new array `lst`.

```
def qsort(seq):
    pivot = seq[0]
    small, large, lst = [], [], []
    for i in range (1, len(seq)):
        if seq[i] < pivot:
            small.append(seq[i])
        if seq[i] >= pivot:
            large.append(seq[i])
    lst = small + [pivot] + large
    return lst
```

(a) State the output from the function when the following is executed:

```
>>> seq1 = [5,2,1,8,9,6,4,7,3,0]
```

```
>>> qsort(seq1) [1]
```

(b) State what is meant by a recursive function. [2]

(c) Write a recursive function for the Quick Sort algorithm by modifying the given function `qsort`. [3]

(d) Explain whether the Quick Sort algorithm in **(c)** is performing an "in-place" or "non in-place" sorting and whether it is stable or unstable. [4]

(e) State and explain the efficiencies of the Quick Sort algorithm in **(c)** in the worst case scenario, using the Big-O notation for the time complexity. [2]

(a)

[2] Any 2 from:

- a function that is defined in terms of itself.
- a function that calls itself with one or more similar but smaller problems.
- a function that can repeat itself several times until one or more terminating case(s) is reached.

(b)

[1] '6' is shifted until the array becomes [1,2,5,6,8,9]

[1] '6' compares with '9' and swap; '6' compares with '8' and swap; '6' compares with '5' and no swap; '5' compares with '2' and no swap; '2' compares with '1' and no swap.

(c)

```
def insertionSort(arr,i=1):  
    if i==len(arr):  
        return arr    #[1] base case  
    else:  
        return insertionSort(sortInner(arr,i),i+1) #[1] recursive call
```

```
def sortInner(seq,j):  
    if j==0:  
        return seq  
    else:  
        if seq[j]<=seq[j-1]:  
            seq[j],seq[j-1]=seq[j-1],seq[j]  
        return sortInner(seq,j-1)
```

(d)

[2] In-place; no external memory/array is used.

[2] Unstable; same value swap, give an illustration.

(e)

[1] Worst case scenario when the array is in decreasing order

[1] Efficiency = $O(n^2)$

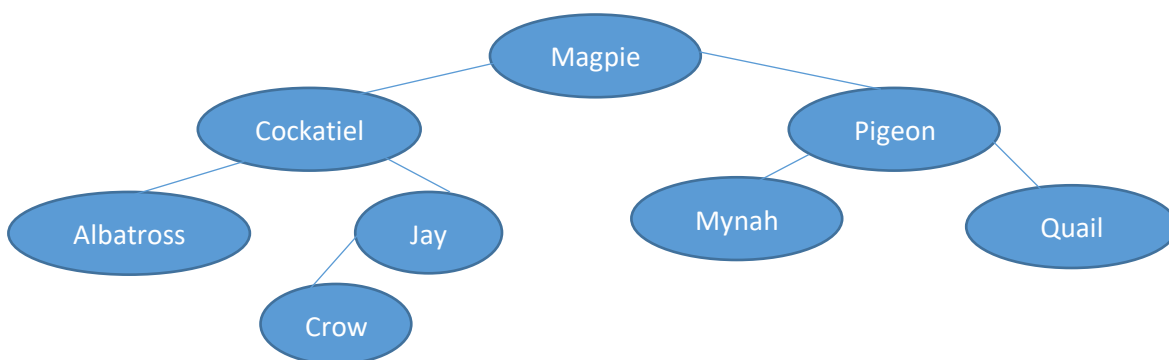
- 3 A wildlife information application is being developed to store and display information about birds. The application uses a binary search tree to store the name of the bird.

(a) The binary search tree has its data inserted in the following order.

Magpie
Cockatiel
Jay
Pigeon
Mynah
Crow
Albatross
Quail

Draw the binary search tree.

[4]



[1] correct root
[1] correct left subtree elements
[1] correct right subtree elements
[1] correct arrangement for both subtrees

(b) The binary search tree in part (a) can be implemented using object-oriented programming that involves the use of two pointers and an array.

- (i) Describe the purpose of the two pointers in the implementation of the binary search tree class. [2]

The two pointers are the start and nextfree pointers which indicates the index position of the root node of the binary tree in the tree array, and the index position of the next available empty node for insertion respectively.

- (ii) Describe the purpose of the array in the implementation of the binary search tree class. [1]

The array is used to store the tree node objects, where each tree node stores the name, left and right pointers.

- (c) (i) List the nodes, in order, that are visited for an in-order traversal. [2]

Albatross, Cockatiel, Crow, Jay, Magpie, Mynah, Pigeon, Quail

- (ii) State the property exhibited by the list of items produced in part (c)(i). [1]

They are in alphabetical/sorted in ascending order.

- (d) Describe an algorithm, using pseudocode, which uses a stack to perform an in-order traversal for the tree. [5]

```
s ← Stack() //initialize empty stack [1]
current ← self.start //initialize current index to be the
start/root index [1]
WHILE True //loop
    IF current is not Null:
        s.push(current) #push node's index num into
stack if condition is met [1]
//traverse left ST
        current ← self.tree[current].get_left_ptr()

    elif s: //if current is Null, check that stack is
non-empty before popping
        current ← s.pop() #pop from stack and print [1]
        print(self.tree[current].get_data())
//traverse right ST
        current ← self.tree[current].get_right_ptr()
```

```
//correct use of current index and correct order of
traversal [1]

else:

    break
```

- 4 *HoLi Tea* is a popular chain selling a wide variety of bubble tea. Each drink is categorised by the flavor (e.g. brown sugar, peppermint, lemon ...), the type of tea leaves used (e.g. green tea, red tea, black tea ...), the pearl options (e.g. black pearl, white pearl, or no pearl) and the price.

There are two variants of bubble tea: Milk Tea and Fruit Tea. Each milk tea has a specific type of milk used (e.g. fresh milk, condensed milk) and some milk tea come with pudding. Some fruit tea include cultured milk.

The owner of *HoLi Tea* intends to use object-oriented programming language to store and process the information on the types of drink in the self-ordering web application system.

The base class `BUBBLE_TEA` has a method to display the properties of the bubble tea.

- (a) (i) Draw a UML class diagram showing: [6]

- any derived classes and inheritance from the base class
- the properties needed in the base, and any derived classes
- suitable methods to support the system with at least one getter and one setter method

correct base class with all 4 attributes [1]

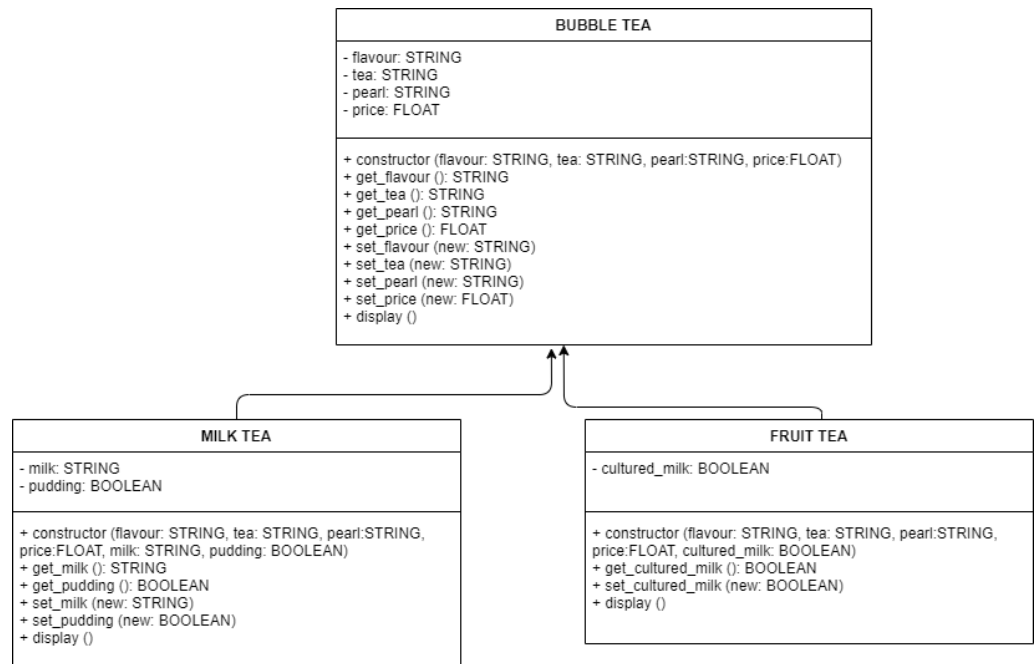
at least one set of get/set [1]

correct inheritance direction for arrow [1]

correct sub classes (milk and fruit tea) [1]

correct attributes for both milk and fruit tea [1]

at least one set of get/set methods for sub classes [1]



- (ii) Explain why inheritance is an important feature of object-oriented programming. [2]

Inheritance allows code reusability since the attributes and methods from the parent class can be extended to the base classes without the need to rewrite the codes, reducing time needed for implementation and minimizing errors.

- (iii) Explain why polymorphism is useful in object-oriented programming. [2]

Polymorphism is useful in OOP since it promotes code generalization where the same method name invokes different methods with different behaviours that applies to that class of objects, allowing objects with different internal structure to share the same external interface.

HoLi Tea has a loyalty programme to reward their regular customers. Members are entitled to a 20% discount for their purchases and a free drink on their birthday. To pay tribute to the frontline workers during the COVID-19 pandemic, all frontline workers are entitled to a 20% discount for their purchases, and those who are also members will receive a free drink on any day.

- (b) (i) Create a decision table showing all the possible conditions and actions.

[5]

Conditions	Member	Y	Y	Y	Y	N	N	N	N
	Frontline workers	Y	Y	N	N	Y	Y	N	N
	Birthday	Y	N	Y	N	Y	N	Y	N
Actions	20% discount				X	X	X		
	Usual price							X	X
	Free drink	X	X	X					

(ii) Simplify your decision table by removing redundancies.

[3]

Conditions	Member	Y	Y	Y	N	N
	Frontline workers	Y	N	N	Y	N
	Birthday	-	Y	N	-	-
Actions	20% discount			X	X	
	Usual price					X
	Free drink	X	X			

- 5 YI restaurant serves a variety of local dishes at reasonable prices and plans to provide food delivery services to its customers via a web application. A customer places an online order and an employee will be assigned by the system to deliver the order to the customer. The customer can choose to pay online when ordering or make cash payment upon delivery. Customers can choose more than one dish in the same online order and each order has a unique ID.

At the time of ordering, the application records the following data:

- Customer name, delivery address and email, if the customer has not made a booking before
- Customer ID
- Order date
- Order time

- Payment mode
- Dish and quantity

The following shows an example of the order receipt which will be sent to the customer's email address.

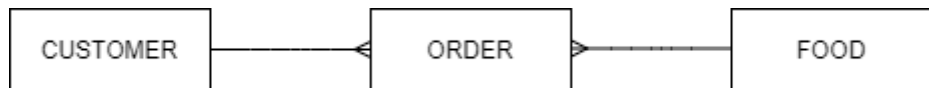
ORDER RECEIPT			
OrderID:	YI150920123		
Customer ID:	C1234		
Name:	Annabelle Dallas		
Email:	annabelledallas@gmail.com		
Address:	5 Yishun Ring Rd, Singapore 768675		
Date:	15/09/2020		
Time:	14:11:30		
Payment Mode:	Online		
Dish	Quantity	Unit Price	Price
NASI LEMAK SET	2	4.50	9.00
CURRY CHICKEN SET	1	5.00	5.00
CHICKEN RICE SET	1	4.50	4.50
Subtotal:			18.50
Delivery:			4.00
Total:			22.50

The restaurant assigns a unique ID to each employee and maintains its employees' information, such as their name, contact number and bank account number. The restaurant keeps a record of the employees' delivery assignments, the date and time when the order is successfully delivered to the customer.

(a) The company wants to model this application using a relational database.

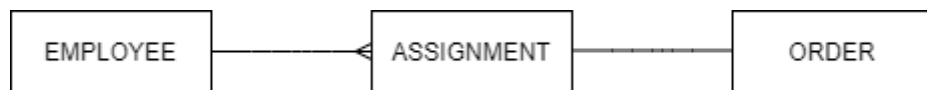
(i) The database needs three tables to store the data for the customers' food order: CUSTOMER, ORDER and FOOD.

Draw an Entity-Relationship (E-R) diagram showing the three tables and the relationships between them. [2]

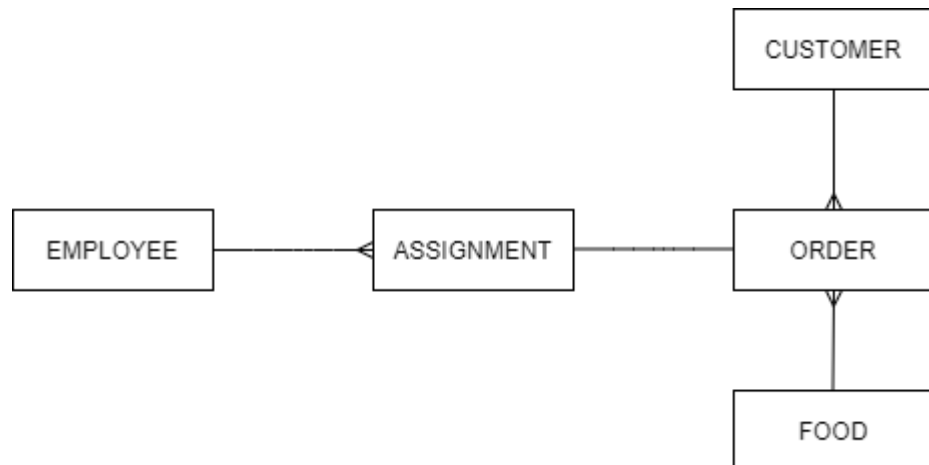


- (ii) The database needs three tables to store the data for the employees' delivery assignment: `EMPLOYEE`, `ORDER` and `ASSIGNMENT`.

Draw an Entity-Relationship (E-R) diagram showing the three tables and the relationships between them. [2]



- (iii) Draw the overall Entity-Relationship (E-R) diagram showing the five tables and the relationships between them. [1]



- (b) A table description can be expressed as:

TableName (Attribute1, Attribute2, Attribute3, ...)

The primary key is indicated by underlining one or more attributes.

Foreign keys are indicated using a dashed underline.

Write table descriptions for the five tables.

[6]

CUSTOMER (CustomerID, Name, Email, Address)

FOOD (Dish, UnitPrice)

EMPLOYEE (EmployeeID, Name, ContactNo, BankAccNo)

ORDER (OrderID, CustomerID*, Dish*, Quantity, OrderDate, OrderTime, PaymentMode)

ASSIGNMENT (EmployeeID*, OrderID*, DeliveredDate, DeliveredTime)

(c) Describe a method to protect data from loss or corruption.

[2]

Regular backing up of data can safeguard against sudden loss/corruption: ensure integrity of data is preserved, and that data can be restored at the soonest
Uninterrupted power supply to ensure that the data server is well powered and maintained to prevent sudden power/data losses.

(d) Explain how Singapore's Personal Data Protection Act (PDPA) protects the personal data of the customer and employee stored in the database.

[2]

<https://sso.agc.gov.sg/Act/PDPA2012>

PDPA governs the collection, use and disclosure of personal data by organizations in a manner that recognises both the right of the individuals to protect their personal data and the needs of organizations to collect, use or disclose personal data for purposes that a reasonable person would consider appropriate in the circumstances.

Assign a data protection officer to oversee the administration and compliance to PDPA by the company. Has clear protocols to obtain consent from the customers and to inform them on how the data is to be used before collecting, using or disclosing the customers' personal data.

(e) Describe the impact of such food delivery applications on the society and economy.

[4]

Social:

- loss of inclusivity for citizens who have difficulties using online services, e.g. elderly who may not be familiar with using such applications, etc.
- hawkers who may not be technically savvy and not know how to use these applications to offer their services may lose businesses

Economy:

- Spur rapid digitization of services (F&B), result in job losses as app reduces the need for call staff in food delivery. However, this also creates more opportunities for delivery businesses.

- (f) As there is an increase in demand for food delivery, the restaurant wishes to enhance the food delivery services to cater to the larger volume of orders and to include more features in the application such as real time location tracking of the food order and customers' review of the dishes, yet ensuring that the application maintains fast performance. The restaurant is now considering using a NoSQL DBMS instead of a relational database.

State and explain **two** reasons why NoSQL DBMS may be more suitable for the proposed scenario. [4]

(any two with substantial elaboration that is contextualized to scenario)

NoSQL has more flexibility compared to RDBMS and hence more suitable for this proposed scenario where the requirements and schema changes. NoSQL allows need fields to be added easily whereas for relational DBMS, it has to be reconstructed.

NoSQL allows for horizontal scaling whereas RDBMS can only be scaled vertically, since the proposed scenario involved increased demand, the ability to scale horizontally allows for multiple data servers to be located at different parts of the nation.

Better performance for simple queries compared to RDBMS since all related data is stored in a document with a hierarchical storage system which makes it more efficient for query, hence suitable for the proposed scenario which demands speed.

NoSQL provides high availability which is crucial for an essential service that should be up all the time to cater to the needs of the customers. This is done through the use of multiple servers.

- 6 A Web Developer is designing an online Sales portal for a company. The customer needs to submit an online form to register before ordering through the portal.

- (a) Explain the difference between data validation and data verification. [2]
- (b) Describe two validation checks that the above form should perform for the customer's inputs. [2]
- (c) Describe, with a specific example, how the customer's input is being verified. [2]

The web developer intends to use **CAPTCHA** for the above form

- (d) Explain what this added feature helps to verify. [2]

- (e) Describe the required server scripting to process the customer's input on his email address and password. [4]
- (f) Describe the differences between a web application and a native application. Explain how the developer should decide between designing a web or native application. [4]

(a) [1] Validation is about checking the input data to ensure it conforms with the data requirements of the system

[1] Verification is performed to ensure that the data entered exactly matches the original source.

(<https://www.bbc.co.uk/bitesize/guides/zdvrd2p/revision/1>)

(b) [2] Any 2 below:

- First and Last Name or Security answer not null
- symbol '@' in the email
- password min 8 characters, 1 number

(c) [1] Enter email and password twice to [1] ensure same entry.

(d) [1] A CAPTCHA test is designed to determine if an online user is really a human and not a bot. [1] It works on the assumption that only human can interpret the image provide.

(e) email - [1] check uniqueness [1] send a verification email to the user.

password - [1] check on length and with 1 no.

[1] hash the password and store in database

(f) [1] Web App - runs on browser, no need to install

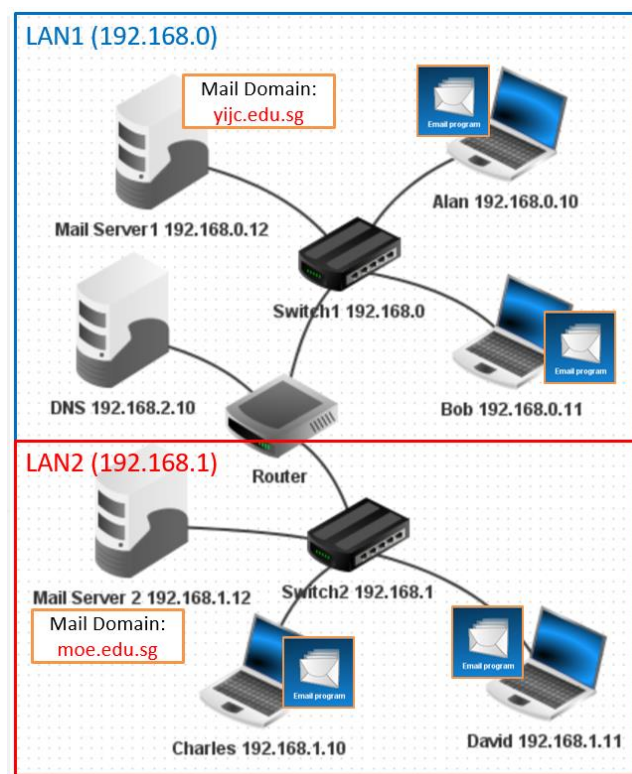
[1] Native App - need to install, OS specific, uses device's features eg gps, bluetooth, camera ...

[1] whether need to use device's feature or not;

[1] easier to develop and maintain, no need go thru AppStore

(<https://clearbridgemobile.com/mobile-app-development-native-vs-web-vs-hybrid/>)

- 7 The College's local area network (LAN) is connected to the MOEHQ's LAN over the internet.



A college's staff, Alan, sends an email to Charles who works in the MOEHQ.

With reference to the above network diagram,

- (a) describe the function of the Domain Name System (DNS) server. [1]
- (b) explain how the router identifies that the MOE's Mail server is residing in another network. [1]
- (c) describe in detail how Alan's email is delivered and kept in the MOE's Mail server. [2]
- (d) describe how Charles eventually receive Alan's email. [2]
- (e) Charles forwards Alan's email to his colleague, David. Describe how David could receive the email even when he is away from the office. [2]

(a)(i) [1] When an email is sent to yjc.edu.sg or moe.edu.sg, the DNS will provide the ip address of the mail server.

(ii) [1] The subnet mask configuration in the router helps to distinguish the 2 networks as 192.168.0 and 192.168.1

(iii) [1] Alan's laptop to yijc mail server to router, DNS provide the ip address on the moe mail server, [1] from router to moe server. [-1] router to Charles' laptop.

(iv) [1] The email client on Charles' laptop connects to the moe mail server and [1] download the email.

(b) [1] Remote access via dial-in or VPN and connect to the network, [1] use the email client to connect to the moe server to download the email.

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