Coursework Cover Sheet

Section A - To be completed by the student

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Semester: **5**	
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Module Code and Title: **5003CEM Advanced Algorithms**	
Assignment No. / Title: **Coursework**	% of Module Mark **67%**
Hand out date: **20 April 2022**	Due date: **9 JUNE 2023**
Penalties: No late work will be accepted. If you are unable to submit coursework on time due to extenuating circumstances you may be eligible for an extension. Please consult the lecturer.	
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Section B - To be completed by the module leader

Intended learning outcomes assessed by this work: LO1: Understand and select appropriate algorithms for solving a range of problems and reason about their complexity and efficiency. LO2: Design and implement algorithms and data structures for novel problems. LO3: Understand the intractability of certain problems and implement approaches to estimate the solution to intractable problems. LO4: Describe the issue of data consistency in non-synchronous applications. LO5. Design and implement a basic concurrent application.		
Marking scheme	Max	Mark
Total		

Lecturer's Feedback
Internal Moderator's Feedback

Contents

Programming Tasks 4
Question 1: Cake ordering System 4
Output 4
Weakness of solution 34
Code References 34
Question 2: Hash Table Collision technique average cost comparison 35
Output 36
Discussion 37
Weakness of solution 38
Code References 38
Question 3: Graph 39
Output 39
Discussion 41
Weakness of solution 42
Code References 42
Question 4: Concurrent process 43
Output 43
Discussion 45
Weakness of solution 46
Code References 46
Reflection 47
References 48
Appendix 49
Question 1 49
Question 2 60
Question 3 62
Question 4 64

Programming Tasks

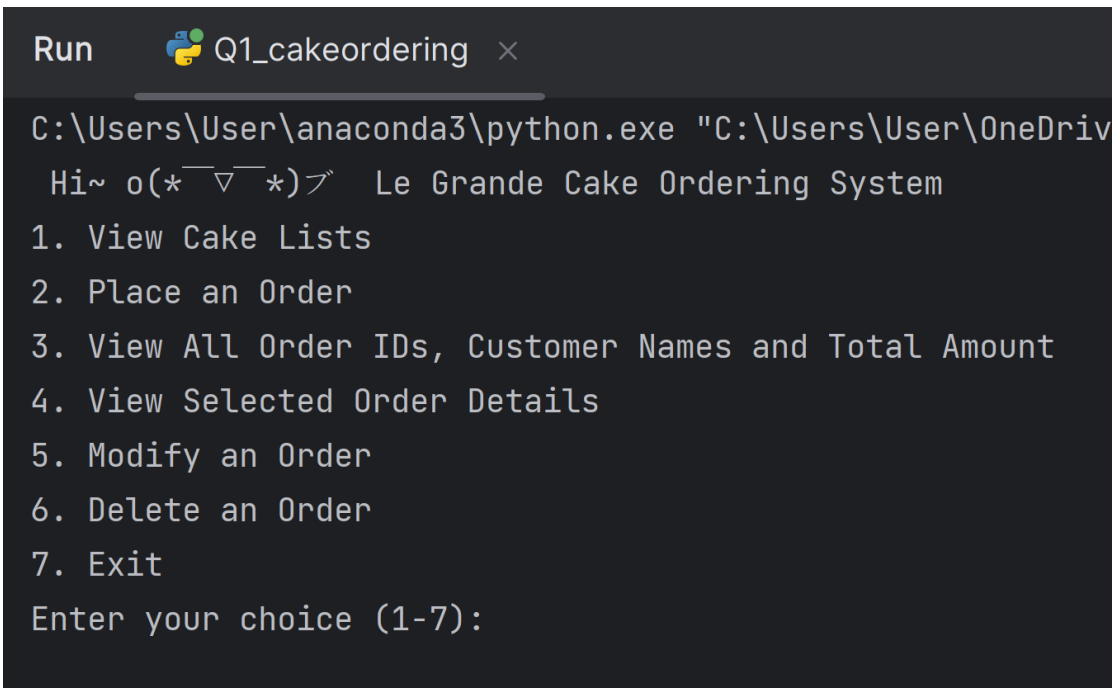
Question 1: Cake ordering System

Design and develop a Cake ordering system based on following requirements:

- The program should be menu driven, giving the user various choices of operations that allows a user to place an order for the cake(s), view list of cake order details, modify or delete a particular order if necessary.
- For every cake order, the following information will be stored:
  - Order ID (Auto assigned, no duplication), Cake Code, flavour (eg: Strawberry, chocolate), weight (Kg), Unit Price, Qty and customer information who order the cake.
  - The customer information consists of customer ID, name, address and contact number.
  - The system shall display additional information that is amount (unit price * qty) when viewing the order details.
- The program must use BST data structure to facilitate each operation.
- The system shall demonstrate a good OOP design, data validation and error handling.

Output

1. Starting Menu. Prompt user to input which function the user choose to do.



2. When user input “1” (view cake lists)

   The cake lists showing the cake code, flavour, weight, and unit price will print out in a table for the user to review. If the user wanted to return to the starting menu, then press ‘Enter’ to return. The output is shown in the second picture below.

```
Enter your choice (1-7): 1
+-------------+------------------------------+---------------+-----------------------+
|   Cake Code | Flavour                      |   Weight (kg) |   Unit Price (RM/kg) |
+=============+==============================+===============+=======================+
|           1 | Belgium Chocolate Cheesecake |             1 |                 115   |
+-------------+------------------------------+---------------+-----------------------+
|           2 | Burnt Cheesecake             |             1 |                  95   |
+-------------+------------------------------+---------------+-----------------------+
|           3 | Strawberry Shortcake         |             1 |                 120   |
+-------------+------------------------------+---------------+-----------------------+
|           4 | French Earl Grey             |             1 |                  98.5 |
+-------------+------------------------------+---------------+-----------------------+
|           5 | Lemon Tart                   |             1 |                 100.5 |
+-------------+------------------------------+---------------+-----------------------+
|           6 | Lemon Poppy Seed             |             1 |                  97.8 |
+-------------+------------------------------+---------------+-----------------------+
|           7 | Black Forest                 |             1 |                  96.7 |
+-------------+------------------------------+---------------+-----------------------+
|           8 | White Forest                 |             1 |                  96.7 |
+-------------+------------------------------+---------------+-----------------------+
|           9 | Matchamisu                   |             1 |                 130   |
+-------------+------------------------------+---------------+-----------------------+
|          10 | Tiramisu (contain alcohol)   |             1 |                 135   |
+-------------+------------------------------+---------------+-----------------------+
|          11 | Red Velvet                   |             1 |                  89   |
+-------------+------------------------------+---------------+-----------------------+
|          12 | Blueberry Cheesecake         |             1 |                 128.5 |
+-------------+------------------------------+---------------+-----------------------+

Press Enter to continue...
```

```
Press Enter to continue...
 Hi~ o(*￣▽￣*)ブ  Le Grande Cake Ordering System
1. View Cake Lists
2. Place an Order
3. View All Order IDs, Customer Names and Total Amount
4. View Selected Order Details
5. Modify an Order
6. Delete an Order
7. Exit
Enter your choice (1-7):
```

3. When user input “2” (place an order)

   Firstly, the user is required to enter the customer's details. If the name or address is empty, the programme will loop until the user enters the name and details. After the name and address are entered, the programme will only ask for the user to enter the contact number.

```
Enter your choice (1-7): 2

~~~~~ Place an Order ~~~~~
--- Customer Details ---
Enter Customer Name:
Enter Customer Address:
Customer details cannot be empty. Please try again.
Enter Customer Name: Big Naughty
Enter Customer Address:
Customer details cannot be empty. Please try again.
Enter Customer Name:
Enter Customer Address: ABC11 XYZ Street 11199 XX
Customer details cannot be empty. Please try again.
Enter Customer Name: Big Naughty
Enter Customer Address: ABC11 XYZ Street 11199 XX
Contact number:
```

   The programme will validate that the contact number must start with 0 and include 10–11 digits before proceeding to the next.

```
Contact number:
Invalid contact number. Please try again. Contact number must start with '0' and have 10-11 digits.
Contact number: abduueiek
Invalid contact number. Please try again. Contact number must start with '0' and have 10-11 digits.
Contact number: 1236463783
Invalid contact number. Please try again. Contact number must start with '0' and have 10-11 digits.
Contact number: 01373777748484
Invalid contact number. Please try again. Contact number must start with '0' and have 10-11 digits.
Contact number: 0128504432
```

The cake lists will be shown to the user as a reference so the user can place the cake order easily. The programme will ask for user input for the cake code to place the order.

```
Contact number: 0128504432

+------------+------------------------------+--------------+----------------------+
|  Cake Code | Flavour                      |  Weight (kg) |  Unit Price (RM/kg)  |
+============+==============================+==============+======================+
|          1 | Belgium Chocolate Cheesecake |            1 |                  115 |
+------------+------------------------------+--------------+----------------------+
|          2 | Burnt Cheesecake             |            1 |                   95 |
+------------+------------------------------+--------------+----------------------+
|          3 | Strawberry Shortcake         |            1 |                  120 |
+------------+------------------------------+--------------+----------------------+
|          4 | French Earl Grey             |            1 |                 98.5 |
+------------+------------------------------+--------------+----------------------+
|          5 | Lemon Tart                   |            1 |                100.5 |
+------------+------------------------------+--------------+----------------------+
|          6 | Lemon Poppy Seed             |            1 |                 97.8 |
+------------+------------------------------+--------------+----------------------+
|          7 | Black Forest                 |            1 |                 96.7 |
+------------+------------------------------+--------------+----------------------+
|          8 | White Forest                 |            1 |                 96.7 |
+------------+------------------------------+--------------+----------------------+
|          9 | Matchamisu                   |            1 |                  130 |
+------------+------------------------------+--------------+----------------------+
|         10 | Tiramisu (contain alcohol)   |            1 |                  135 |
+------------+------------------------------+--------------+----------------------+
|         11 | Red Velvet                   |            1 |                   89 |
+------------+------------------------------+--------------+----------------------+
|         12 | Blueberry Cheesecake         |            1 |                128.5 |
+------------+------------------------------+--------------+----------------------+
--- Cake Order Details ---

Enter Cake Code:
```

If the cake code entered is not valid, the programme will show the message "Invalid Cake Code. Please try again.". After entering a valid cake code (1–12), it will show the weight available for the cake and ask for input.

```
--- Cake Order Details ---

Enter Cake Code: afa
Invalid Cake Code. Please try again.

Enter Cake Code:
Invalid Cake Code. Please try again.

Enter Cake Code: 999
Invalid Cake Code. Please try again.

Enter Cake Code: 2

Available Weight (kg): 0.25, 0.5, 1.0, 1.5, 2.0, 2.5, 3,0

Enter Weight (in kg):
```

There is validation in the user input for the weight that the input weight must be in the available weight lists. Otherwise, the system will show the message "Invalid Weight. Please enter a valid weight from the options.". If the weight is available, the user is prompted to enter the quantity.

```
Available Weight (kg): 0.25, 0.5, 1.0, 1.5, 2.0, 2.5, 3,0

Enter Weight (in kg):
Invalid Weight. Please enter a valid weight from the options.

Enter Weight (in kg): 445
Invalid Weight. Please enter a valid weight from the options.

Enter Weight (in kg): qsff
Invalid Weight. Please enter a valid weight from the options.

Enter Weight (in kg): 1.1
Invalid Weight. Please enter a valid weight from the options.

Enter Weight (in kg): 0.5
Enter Quantity:
```

The quantity must be an integer that is bigger than 0, otherwise the error will print and ask for input until a valid integer is entered. Next, the system will ask the user if they want to add more cakes to the order or not.

```
Enter Weight (in kg): 0.5
Enter Quantity: two
Invalid Quantity. Please enter a positive integer.
Enter Quantity: 0
Invalid Quantity. Please enter a positive integer.
Enter Quantity:
Invalid Quantity. Please enter a positive integer.
Enter Quantity: 0.5
Invalid Quantity. Please enter a positive integer.
Enter Quantity: 2

Do you want to add another cake? (Press 'y' if yes):
```

The validation on the input for asking the user whether he or she wants to add more cakes will check on the input whether it is ‘y’ or "Y." Any input, such as ‘enter’, any integer, string, etc. other than ‘y," will be considered as do not add more cake. If an input other than ‘y" is entered, the order will be inserted into the BST, and the order details will print out as shown in the image below.

Example 1: ‘Enter’ is pressed

```
Do you want to add another cake? (Press 'y' if yes):
Total Amount: RM 95.00
Order Placed Successfully!



--------------------------------------------------------------------------------
Order ID: 2007
--- Customer Details ---
Customer ID: 1
Name: Big Naughty
Address: ABC11 XYZ Street 11199 XX
Contact Number: 0128504432

--- Cake Order Details ---
Cake Code: 2
Flavour: Burnt Cheesecake
Weight: 0.5 kg
Quantity: 2

Total Amount: RM 95.00
--------------------------------------------------------------------------------

Press Enter to continue...
```

Example 2: any alphabets (strings) is entered

```
Do you want to add another cake? (Press 'y' if yes): dfghj
Total Amount: RM 89.00
Order Placed Successfully!



--------------------------------------------------------------------------------
Order ID: 2994
--- Customer Details ---
Customer ID: 3
Name: jay park
Address: 1987 mommae 18373 xcdkd
Contact Number: 01638475023

--- Cake Order Details ---
Cake Code: 11
Flavour: Red Velvet
Weight: 1.0 kg
Quantity: 1

Total Amount: RM 89.00
--------------------------------------------------------------------------------

Press Enter to continue...
```

Example 3: any numbers is entered

```
Do you want to add another cake? (Press 'y' if yes): 1234
Total Amount: RM 95.00
Order Placed Successfully!



--------------------------------------------------------------------------------
Order ID: 8458
--- Customer Details ---
Customer ID: 4
Name: donny
Address: 937 jln pkk cr 12990 aa penang
Contact Number: 01793002631

--- Cake Order Details ---
Cake Code: 3
Flavour: Strawberry Shortcake
Weight: 0.25 kg
Quantity: 1

Cake Code: 9
Flavour: Matchamisu
Weight: 0.5 kg
Quantity: 1

Total Amount: RM 95.00
--------------------------------------------------------------------------------
```

When the user wishes to add more cakes to the order, the programme will loop on the same questions as when the first cake order is added. After the second cake is added, the programme will ask again if the user wants to add another cake or not. If not, it will print the order details.

```
--- Cake Order Details ---

Enter Cake Code: 3

Available Weight (kg): 0.25, 0.5, 1.0, 1.5, 2.0, 2.5, 3,0

Enter Weight (in kg): 0.25
Enter Quantity: 1

Do you want to add another cake? (Press 'y' if yes): y

Enter Cake Code:
```

```
Do you want to add another cake? (Press 'y' if yes): 0
Total Amount: RM 97.50
Order Placed Successfully!



--------------------------------------------------------------------------------
Order ID: 5019
--- Customer Details ---
Customer ID: 2
Name: yeon jin
Address: 9373 jalan aba 28362 pp
Contact Number: 0982456122

--- Cake Order Details ---
Cake Code: 3
Flavour: Strawberry Shortcake
Weight: 0.25 kg
Quantity: 1

Cake Code: 10
Flavour: Tiramisu (contain alcohol)
Weight: 0.5 kg
Quantity: 1

Total Amount: RM 97.50
--------------------------------------------------------------------------------
```

4. When user input “3” (view all orders)

   If there are no orders in the BST, it will show the message that “There are no orders.”

```
Press Enter to continue...
 Hi~ o(*￣▽￣*)ブ  Le Grande Cake Ordering System
1. View Cake Lists
2. Place an Order
3. View All Order IDs, Customer Names and Total Amount
4. View Selected Order Details
5. Modify an Order
6. Delete an Order
7. Exit
Enter your choice (1-7): 3

~~~~~ All Orders ~~~~~
There are no orders.

Press Enter to continue...
```

   If there are orders in the BST, it will display all the orders, including the order ID, customer name, and total amount, using in-order traversal.

```
 Hi~ o(*￣▽￣*)ブ  Le Grande Cake Ordering System
1. View Cake Lists
2. Place an Order
3. View All Order IDs, Customer Names and Total Amount
4. View Selected Order Details
5. Modify an Order
6. Delete an Order
7. Exit
Enter your choice (1-7): 3

~~~~~ All Orders ~~~~~
Order ID: 2007  Customer Name: Big Naughty  Total Amount: RM 95.00
Order ID: 2994  Customer Name: jay park Total Amount: RM 89.00
Order ID: 3053  Customer Name: wendy    Total Amount: RM 225.18
Order ID: 5019  Customer Name: yeon jin Total Amount: RM 97.50
Order ID: 8458  Customer Name: donny    Total Amount: RM 95.00

Press Enter to continue...
```

5. When user input “4” (view a specific order)

   If there are no orders in the BST, it will show the message that “There are no orders.”

```
 Hi~ o(*￣▽￣*)ブ  Le Grande Cake Ordering System
1. View Cake Lists
2. Place an Order
3. View All Order IDs, Customer Names and Total Amount
4. View Selected Order Details
5. Modify an Order
6. Delete an Order
7. Exit
Enter your choice (1-7): 4

~~~~~ Order Details ~~~~~
There are no orders.

Press Enter to continue...
```

Based on the screenshot output below, when there are orders inside the BST, it will ask for the user input the order ID, and then the programme will validate the input. If the input is empty, not an integer, or a negative integer, the programme will show the message "Invalid Order ID. Please enter a positive integer.". However, if the input is an integer, the programme will search on the integer, and if the order is not in the BST, it will show "Order not found. Please try again.".

```
 Hi~ o(*￣▽￣*)ブ  Le Grande Cake Ordering System
1. View Cake Lists
2. Place an Order
3. View All Order IDs, Customer Names and Total Amount
4. View Selected Order Details
5. Modify an Order
6. Delete an Order
7. Exit
Enter your choice (1-7): 4

~~~~~ Order Details ~~~~~

Enter Order ID (Press 0 to cancel): 29
Order not found. Please try again.

Enter Order ID (Press 0 to cancel): nfh
Invalid Order ID. Please enter a positive integer.

Enter Order ID (Press 0 to cancel): -92
Invalid Order ID. Please enter a positive integer.

Enter Order ID (Press 0 to cancel):
Invalid Order ID. Please enter a positive integer.
```

If a valid order ID is entered in the BST, the order details will print out, showing the order ID, customer details, cake order details, and the total amount. The screenshots of output below show when an order has only one cake order and multiple cake orders. After viewing the order details, the user is required to press ‘enter’ to return to the starting menu.

```
Enter Order ID (Press 0 to cancel): 2994

------------------------------------------------------------
Order ID: 2994
--- Customer Details ---
Customer ID: 3
Name: jay park
Address: 1987 mommae 18373 xcdkd
Contact Number: 01638475023

--- Cake Order Details ---
Cake Code: 11
Flavour: Red Velvet
Weight: 1.0 kg
Quantity: 1

Total Amount: RM 89.00
------------------------------------------------------------

Press Enter to continue...
```

```
Enter Order ID (Press 0 to cancel): 3053

------------------------------------------------------------
Order ID: 3053
--- Customer Details ---
Customer ID: 5
Name: wendy
Address: 5A js as street nacjdj 92991
Contact Number: 02636352571

--- Cake Order Details ---
Cake Code: 5
Flavour: Lemon Tart
Weight: 2.0 kg
Quantity: 1

Cake Code: 7
Flavour: Black Forest
Weight: 0.25 kg
Quantity: 1

Total Amount: RM 225.18
------------------------------------------------------------

Press Enter to continue...
```

If user want to terminate this function, the user is required to enter “0”. Then it will print the starting menu again and asked for user input to choose another function.

```
Enter Order ID (Press 0 to cancel): 0
 Hi~ o(*￣▽￣*)ブ  Le Grande Cake Ordering System
1. View Cake Lists
2. Place an Order
3. View All Order IDs, Customer Names and Total Amount
4. View Selected Order Details
5. Modify an Order
6. Delete an Order
7. Exit
Enter your choice (1-7):
```

6. When user input “5” (modify an order)

   If there are no orders in the BST, it will show the message that “There are no orders.”.

```
 Hi~ o(*￣▽￣*)ブ  Le Grande Cake Ordering System
1. View Cake Lists
2. Place an Order
3. View All Order IDs, Customer Names and Total Amount
4. View Selected Order Details
5. Modify an Order
6. Delete an Order
7. Exit
Enter your choice (1-7): 5
~~~~~ Modify an Order ~~~~~
There are no orders.

Press Enter to continue...
```

   Based on the screenshot output below, when there are orders inside the BST, it will ask for user input the order id, then the program will validate on the input. If the input is empty, not integer, or negative integer, the programme will show the message “Invalid Order ID. Please enter a positive integer.”. However, if the input is integer, the program will search on the integer, while the order is not in the BST, it will show that “Order not found. Please try again.”. If the user needs to end this function press ‘enter’ and it will back to the staring menu.

```
Enter your choice (1-7): 5
~~~~~ Modify an Order ~~~~~

Enter Order ID (Press 0 to cancel): 1
Order not found. Please try again.

Enter Order ID (Press 0 to cancel): one
Invalid Order ID. Please enter a positive integer.

Enter Order ID (Press 0 to cancel): -829
Invalid Order ID. Please enter a positive integer.

Enter Order ID (Press 0 to cancel):
Invalid Order ID. Please enter a positive integer.
```

```
Enter Order ID (Press 0 to cancel): 0
 Hi~ o(*￣▽￣*)ブ  Le Grande Cake Ordering System
1. View Cake Lists
2. Place an Order
3. View All Order IDs, Customer Names and Total Amount
4. View Selected Order Details
5. Modify an Order
6. Delete an Order
7. Exit
Enter your choice (1-7):
```

If a valid order ID is entered in the BST, the order details will print out, showing the order ID, customer details, cake order details, and the total amount. Next, the programme will ask the user to enter the new value for modifying the customer's details; if the user wants to remain with the same value, press 'enter' to leave it blank. After the customer's details are modified, the programme will ask if the user wants to edit any cake orders. If the input is other than 'y' or 'Y', the programme will consider that the user is not going to modify the cake order. Thus, the order will update to the BST and the updated order details will display.

Example 1: Remain unchanged

```
Enter Order ID (Press 0 to cancel): 2994

------------------------------------------------------------
Order ID: 2994
--- Customer Details ---
Customer ID: 3
Name: jay park
Address: 1987 mommae 18373 xcdkd
Contact Number: 01638475023

--- Cake Order Details ---
Cake Code: 11
Flavour: Red Velvet
Weight: 1.0 kg
Quantity: 1

Total Amount: RM 89.00
------------------------------------------------------------

--- Modify Customer's Details ---
Enter new customer name (leave blank to keep current):
```

```
--- Modify Customer's Details ---
Enter new customer name (leave blank to keep current):
Enter new customer address (leave blank to keep current):
Enter new customer contact number (leave blank to keep current):

Do you want to modify the cake items? (Press 'y' if yes): gsda
Order Modified Successfully!

Updated Order Details for Order ID 2994:

----------------------------------------------------------------------
Order ID: 2994
--- Customer Details ---
Customer ID: 3
Name: jay park
Address: 1987 mommae 18373 xcdkd
Contact Number: 01638475023

--- Cake Order Details ---
Cake Code: 11
Flavour: Red Velvet
Weight: 1.0 kg
Quantity: 1

Total Amount: RM 89.00
----------------------------------------------------------------------
```

Example 2: Changing on the customer's details and the cake code (flavour) where the weight and quantity remain unchanged.

```
--- Modify Customer's Details ---
Enter new customer name (leave blank to keep current): park jae beom
Enter new customer address (leave blank to keep current): 11 seongsudong 12889 kr
Enter new customer contact number (leave blank to keep current): 12245
Invalid contact number. Please try again. Contact number must start with '0' and have 10-11
 digits.

Enter new customer contact number (leave blank to keep current): adf
Invalid contact number. Please try again. Contact number must start with '0' and have 10-11
 digits.

Enter new customer contact number (leave blank to keep current): 01285930533
```

```
Do you want to modify the cake items? (Press 'y' if yes): y

--- Modify Cake Items ---
+-------------+------------------------------+--------------+----------------------+
|   Cake Code | Flavour                      |   Weight (kg) |   Unit Price (RM/kg) |
+=============+==============================+==============+======================+
|           1 | Belgium Chocolate Cheesecake |            1 |                115   |
+-------------+------------------------------+--------------+----------------------+
|           2 | Burnt Cheesecake             |            1 |                 95   |
+-------------+------------------------------+--------------+----------------------+
|           3 | Strawberry Shortcake         |            1 |                120   |
+-------------+------------------------------+--------------+----------------------+
|           4 | French Earl Grey             |            1 |                 98.5 |
+-------------+------------------------------+--------------+----------------------+
|           5 | Lemon Tart                   |            1 |                100.5 |
+-------------+------------------------------+--------------+----------------------+
|           6 | Lemon Poppy Seed             |            1 |                 97.8 |
+-------------+------------------------------+--------------+----------------------+
|           7 | Black Forest                 |            1 |                 96.7 |
+-------------+------------------------------+--------------+----------------------+
|           8 | White Forest                 |            1 |                 96.7 |
+-------------+------------------------------+--------------+----------------------+
|           9 | Matchamisu                   |            1 |                130   |
```

```
|           9 | Matchamisu                   |            1 |                130   |
+-------------+------------------------------+--------------+----------------------+
|          10 | Tiramisu (contain alcohol)   |            1 |                135   |
+-------------+------------------------------+--------------+----------------------+
|          11 | Red Velvet                   |            1 |                 89   |
+-------------+------------------------------+--------------+----------------------+
|          12 | Blueberry Cheesecake         |            1 |                128.5 |
+-------------+------------------------------+--------------+----------------------+

Cake Item 1:
Enter New Cake Code (Press Enter to keep current): 12

Cake details updated!

Available Weight (kg): 0.25, 0.5, 1.0, 1.5, 2.0, 2.5, 3,0

Enter New Weight (Press Enter to keep current):
The current weight is remain unchanged.

Enter New Quantity (Press Enter to keep current):
The current quantity is remain unchanged.

Order Modified Successfully!
```

```
Updated Order Details for Order ID 2994:

------------------------------------------------------------
Order ID: 2994
--- Customer Details ---
Customer ID: 3
Name: park jae beom
Address: 11 seongsudong 12889 kr
Contact Number: 01285930533

--- Cake Order Details ---
Cake Code: 12
Flavour: Blueberry Cheesecake
Weight: 1.0 kg
Quantity: 1

Total Amount: RM 128.50
------------------------------------------------------------

Press Enter to continue...
```

Example 3: Changing on the order that have multiple cakes.

```
Enter Order ID (Press 0 to cancel): 5019

------------------------------------------------------------------
Order ID: 5019
--- Customer Details ---
Customer ID: 2
Name: yeon jin
Address: 9373 jalan aba 28362 pp
Contact Number: 0982456122

--- Cake Order Details ---
Cake Code: 3
Flavour: Strawberry Shortcake
Weight: 0.25 kg
Quantity: 1

Cake Code: 10
Flavour: Tiramisu (contain alcohol)
Weight: 0.5 kg
Quantity: 1

Total Amount: RM 97.50
------------------------------------------------------------------

--- Modify Customer's Details ---
Enter new customer name (leave blank to keep current):
```

```
--- Modify Customer's Details ---
Enter new customer name (leave blank to keep current):
Enter new customer address (leave blank to keep current):
Enter new customer contact number (leave blank to keep current):

Do you want to modify the cake items? (Press 'y' if yes): y

--- Modify Cake Items ---
+-------------+------------------------------+---------------+----------------------+
|   Cake Code | Flavour                      |   Weight (kg) |   Unit Price (RM/kg) |
+=============+==============================+===============+======================+
|           1 | Belgium Chocolate Cheesecake |             1 |                  115 |
+-------------+------------------------------+---------------+----------------------+
|           2 | Burnt Cheesecake             |             1 |                   95 |
+-------------+------------------------------+---------------+----------------------+
|           3 | Strawberry Shortcake         |             1 |                  120 |
+-------------+------------------------------+---------------+----------------------+
```

```
Cake Item 1:
Enter New Cake Code (Press Enter to keep current):
The cake is remain unchanged.

Available Weight (kg): 0.25, 0.5, 1.0, 1.5, 2.0, 2.5, 3,0

Enter New Weight (Press Enter to keep current): 1
Enter New Quantity (Press Enter to keep current):
The current quantity is remain unchanged.
```

```
Cake Item 2:
Enter New Cake Code (Press Enter to keep current): 5

Cake details updated!

Available Weight (kg): 0.25, 0.5, 1.0, 1.5, 2.0, 2.5, 3,0

Enter New Weight (Press Enter to keep current):
The current weight is remain unchanged.

Enter New Quantity (Press Enter to keep current): 2
Order Modified Successfully!
```

```
Updated Order Details for Order ID 5019:

--------------------------------------------------
Order ID: 5019
--- Customer Details ---
Customer ID: 2
Name: yeon jin
Address: 9373 jalan aba 28362 pp
Contact Number: 0982456122

--- Cake Order Details ---
Cake Code: 3
Flavour: Strawberry Shortcake
Weight: 1.0 kg
Quantity: 2

Cake Code: 5
Flavour: Lemon Tart
Weight: 0.5 kg
Quantity: 2

Total Amount: RM 340.50
--------------------------------------------------

Press Enter to continue...
```

Error handling on the cake items (cake code, weight, quantity):

If a new cake code enter is not in the range. User is prompt to reinput the cake code again. If the user changes the mind to not to change the cake flavour, then it can still press enter to remain the same cake choice. Same for the weight and quantity, the system will check on the input where the weight must in the range of 0.25kg, 0.5kg, 1.0kg, 1.5kg, 2.0kg, 2.5kg, 3.0kg, and the quantity must a positive integer that more than 0.

```
Cake Item 1:
Enter New Cake Code (Press Enter to keep current): 13
Invalid cake code. Please try again.

Enter New Cake Code (Press Enter to keep current): ab
Invalid cake code. Please try again.

Enter New Cake Code (Press Enter to keep current):
The cake is remain unchanged.

Available Weight (kg): 0.25, 0.5, 1.0, 1.5, 2.0, 2.5, 3,0
```

```
Available Weight (kg): 0.25, 0.5, 1.0, 1.5, 2.0, 2.5, 3,0

Enter New Weight (Press Enter to keep current): abc
Invalid Weight. Please enter a valid weight from the options.

Enter New Weight (Press Enter to keep current): 12
Invalid Weight. Please enter a valid weight from the options.

Enter New Weight (Press Enter to keep current): 0
Invalid Weight. Please enter a valid weight from the options.

Enter New Weight (Press Enter to keep current): -3
Invalid Weight. Please enter a valid weight from the options.

Enter New Weight (Press Enter to keep current):
The current weight is remain unchanged.
```

```
Enter New Quantity (Press Enter to keep current): abb
Invalid Quantity. Please enter a positive integer.

Enter New Quantity (Press Enter to keep current): 0
Invalid Quantity. Please enter a positive integer.

Enter New Quantity (Press Enter to keep current): 9.23
Invalid Quantity. Please enter a positive integer.

Enter New Quantity (Press Enter to keep current):
The current quantity is remain unchanged.
```

7. When user input “6” (delete an order)

   If there are no orders in the BST, it will show the message that “There are no orders.”

```
 Hi~ o(*￣▽￣*)ブ  Le Grande Cake Ordering System
1. View Cake Lists
2. Place an Order
3. View All Order IDs, Customer Names and Total Amount
4. View Selected Order Details
5. Modify an Order
6. Delete an Order
7. Exit
Enter your choice (1-7): 6
~~~~~ Delete an Order ~~~~~
There are no orders.

Press Enter to continue...
```

   Based on the screenshot output below, when there are orders inside the BST, it will ask for the user's input of the order ID, and then the programme will validate the input.

```
 Hi~ o(*￣▽￣*)ブ  Le Grande Cake Ordering System
1. View Cake Lists
2. Place an Order
3. View All Order IDs, Customer Names and Total Amount
4. View Selected Order Details
5. Modify an Order
6. Delete an Order
7. Exit
Enter your choice (1-7): 6
~~~~~ Delete an Order ~~~~~
Enter Order ID (Press 0 to cancel):
```

If the input is empty, not integer, or negative integer, the programme will show the message “Invalid Order ID. Please enter a positive integer.”. However, if the input is integer, the program will search on the integer, while the order is not in the BST, it will show that “Order not found. Please try again.”.

```
~~~~~ Delete an Order ~~~~~
Enter Order ID (Press 0 to cancel): yeye
Invalid Order ID. Please enter a positive integer.

Enter Order ID (Press 0 to cancel): 0333
Order not found. Please try again.
Enter Order ID (Press 0 to cancel): -23
Invalid Order ID. Please enter a positive integer.

Enter Order ID (Press 0 to cancel): aaaa
Invalid Order ID. Please enter a positive integer.

Enter Order ID (Press 0 to cancel):
Invalid Order ID. Please enter a positive integer.

Enter Order ID (Press 0 to cancel):
```

If the user wishes to end this function, the user is required to enter "0". Then it will print the starting menu again and ask for user input to choose another function.

```
Enter Order ID (Press 0 to cancel): 0
 Hi~ o(*￣▽￣*)ブ  Le Grande Cake Ordering System
1. View Cake Lists
2. Place an Order
3. View All Order IDs, Customer Names and Total Amount
4. View Selected Order Details
5. Modify an Order
6. Delete an Order
7. Exit
Enter your choice (1-7):
```

The order details for the order ID entered will be display if the order exists in the BST. Next, the system will ask for the user is really wanted to delete the order. If the input is other than ‘y’ or ‘Y’, the programme will consider that the user is not going to delete the order.

```
~~~~~ Delete an Order ~~~~~
Enter Order ID (Press 0 to cancel): 2007

------------------------------------------------------------------------
Order ID: 2007
--- Customer Details ---
Customer ID: 1
Name: Big Naughty
Address: ABC11 XYZ Street 11199 XX
Contact Number: 0128504432

--- Cake Order Details ---
Cake Code: 2
Flavour: Burnt Cheesecake
Weight: 0.5 kg
Quantity: 2

Total Amount: RM 95.00
------------------------------------------------------------------------
Are you sure want to delete this order? (Press 'y' if yes): sdd

Deletion Cancelled.

Press Enter to continue...
```

```
Total Amount: RM 95.00
------------------------------------------------------------------------
Are you sure want to delete this order? (Press 'y' if yes):

Deletion Cancelled.

Press Enter to continue...
```

```
Total Amount: RM 95.00
------------------------------------------------------------------------
Are you sure want to delete this order? (Press 'y' if yes): 1245

Deletion Cancelled.

Press Enter to continue...
```

If the answer is ‘y’ or ‘Y’, the order will be deleted from the BST. Since there are few conditions that can take place to delete the order in BST. All the outputs below show the deletion of orders that take placed in the BST.

```
Enter your choice (1-7): 6
~~~~~ Delete an Order ~~~~~
Enter Order ID (Press 0 to cancel): 2007

----------------------------------------------------------------------
Order ID: 2007
--- Customer Details ---
Customer ID: 1
Name: Big Naughty
Address: ABC11 XYZ Street 11199 XX
Contact Number: 0128504432

--- Cake Order Details ---
Cake Code: 2
Flavour: Burnt Cheesecake
Weight: 0.5 kg
Quantity: 2

Total Amount: RM 95.00
----------------------------------------------------------------------
Are you sure want to delete this order? (Press 'y' if yes): y

Order Deleted Successfully!

Press Enter to continue...
```

The order lists after deletion:

```
Press Enter to continue...
 Hi~ o(*￣▽￣*)ブ  Le Grande Cake Ordering System
1. View Cake Lists
2. Place an Order
3. View All Order IDs, Customer Names and Total Amount
4. View Selected Order Details
5. Modify an Order
6. Delete an Order
7. Exit
Enter your choice (1-7): 3

~~~~~ All Orders ~~~~~
Order ID: 2994  Customer Name: park jae beom    Total Amount: RM 128.50
Order ID: 3053  Customer Name: wendy    Total Amount: RM 225.18
Order ID: 5019  Customer Name: yeon jin Total Amount: RM 340.50
Order ID: 8458  Customer Name: donny    Total Amount: RM 95.00

Press Enter to continue...
```

```
Enter your choice (1-7): 6
~~~~~ Delete an Order ~~~~~
Enter Order ID (Press 0 to cancel): 2994

--------------------------------------------------------------------------------
Order ID: 2994
--- Customer Details ---
Customer ID: 3
Name: park jae beom
Address: 11 seongsudong 12889 kr
Contact Number: 01285930533

--- Cake Order Details ---
Cake Code: 12
Flavour: Blueberry Cheesecake
Weight: 1.0 kg
Quantity: 1

Total Amount: RM 128.50
--------------------------------------------------------------------------------
Are you sure want to delete this order? (Press 'y' if yes): y

Order Deleted Successfully!

Press Enter to continue...
```

The order lists after deletion:

```
Enter your choice (1-7): 3

~~~~~ All Orders ~~~~~
Order ID: 3053  Customer Name: wendy    Total Amount: RM 225.18
Order ID: 5019  Customer Name: yeon jin Total Amount: RM 340.50
Order ID: 8458  Customer Name: donny    Total Amount: RM 95.00

Press Enter to continue...
```

```
Enter Order ID (Press 0 to cancel): 5019

------------------------------------------------------------------------
 ----
Order ID: 5019
--- Customer Details ---
Customer ID: 2
Name: yeon jin
Address: 9373 jalan aba 28362 pp
Contact Number: 0982456122

--- Cake Order Details ---
Cake Code: 3
Flavour: Strawberry Shortcake
Weight: 1.0 kg
Quantity: 2

Cake Code: 5
Flavour: Lemon Tart
Weight: 0.5 kg
Quantity: 2

Total Amount: RM 340.50
------------------------------------------------------------------------
 ----
Are you sure want to delete this order? (Press 'y' if yes): y

Order Deleted Successfully!
```

The order lists after deletion:

```
Enter your choice (1-7): 3

~~~~~ All Orders ~~~~~
Order ID: 3053  Customer Name: wendy    Total Amount: RM 225.18
Order ID: 8458  Customer Name: donny    Total Amount: RM 95.00

Press Enter to continue...
```

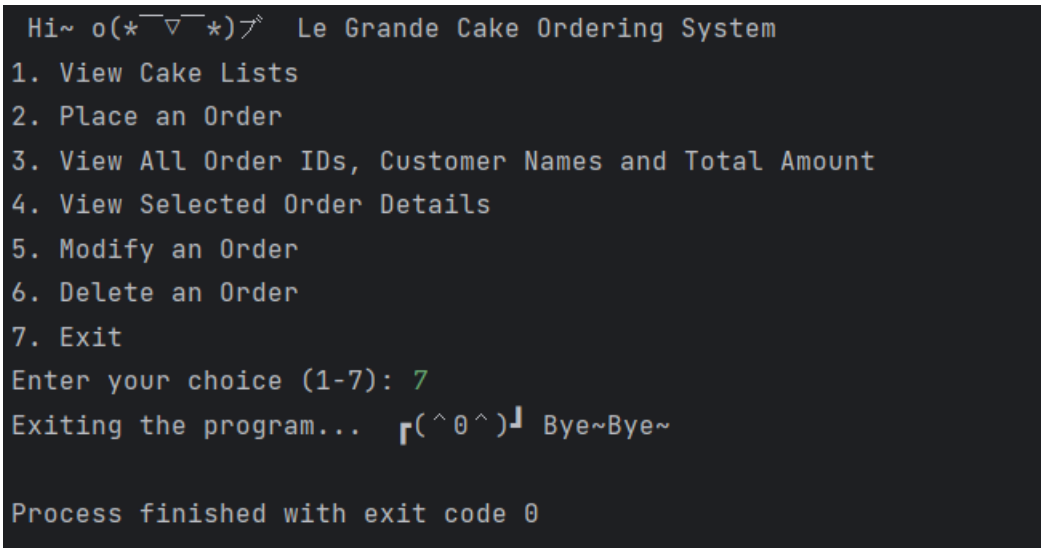
```
Enter your choice (1-7): 6
~~~~~ Delete an Order ~~~~~
Enter Order ID (Press 0 to cancel): 3053

------------------------------------------------------------------------
 ----
Order ID: 3053
--- Customer Details ---
Customer ID: 5
Name: wendy
Address: 5A js as street nacjdj 92991
Contact Number: 02636352571

--- Cake Order Details ---
Cake Code: 5
Flavour: Lemon Tart
Weight: 2.0 kg
Quantity: 1

Cake Code: 7
Flavour: Black Forest
Weight: 0.25 kg
Quantity: 1

Total Amount: RM 225.18
------------------------------------------------------------------------
```

```
Are you sure want to delete this order? (Press 'y' if yes): y

Order Deleted Successfully!

Press Enter to continue...
```

The order lists after deletion:

```
~~~~~ All Orders ~~~~~
Order ID: 8458  Customer Name: donny    Total Amount: RM 95.00

Press Enter to continue...
```

8. When user input “7” (exit the program)



9. If user input numbers out of the ranges or not integer.

   If the invalid values are inserted, the program will loop to prompt for user input until the valid choice (1 to 7) is entered.

```
 Hi~ o(*￣▽￣*)ブ  Le Grande Cake Ordering System
1. View Cake Lists
2. Place an Order
3. View All Order IDs, Customer Names and Total Amount
4. View Selected Order Details
5. Modify an Order
6. Delete an Order
7. Exit
Enter your choice (1-7): 10
Invalid choice. Please try again.

 Hi~ o(*￣▽￣*)ブ  Le Grande Cake Ordering System
1. View Cake Lists
2. Place an Order
3. View All Order IDs, Customer Names and Total Amount
4. View Selected Order Details
5. Modify an Order
6. Delete an Order
7. Exit
Enter your choice (1-7): ab
Invalid choice. Please try again.
```

```
 Hi~ o(*￣▽￣*)ブ  Le Grande Cake Ordering System
1. View Cake Lists
2. Place an Order
3. View All Order IDs, Customer Names and Total Amount
4. View Selected Order Details
5. Modify an Order
6. Delete an Order
7. Exit
Enter your choice (1-7):
Invalid choice. Please try again.

 Hi~ o(*￣▽￣*)ブ  Le Grande Cake Ordering System
1. View Cake Lists
2. Place an Order
3. View All Order IDs, Customer Names and Total Amount
4. View Selected Order Details
5. Modify an Order
6. Delete an Order
7. Exit
Enter your choice (1-7):
```

Weakness of solution

The program does not include the clear screen function after each action is completed. Therefore, the screen will be very messy if the program has run multiple times. This will made the system difficult to navigate and read. The programme should include a screen cleaning function to improve user experience.

Next, there are no validation checks in the programme for the customer's name and address inputs. The programme only validated that the customer's name and address should not be empty. This implies that the programme accepts any strings input by the user without validating its accuracy or completeness. Validation tests must be implemented to guarantee that the customer's name and address inputs fulfil the relevant parameters.

Besides that, the Customer class has no searching method in the code. As a result, there is no method to determine whether a customer is already exists in the system. Therefore, redundant customer profiles with different customer IDs are possible, which resulting in data inconsistency and confusion. For the improvement, it also can include the BST for the Customer class to insert, search, and delete the customers.

Lastly, the cake lists are already fixed in the system, it does not have the flexibility to add or remove cakes from the lists. This restricts the ability of the system to adjust to shifts in the cake selections provided. To further enhance the solution, include the function that allows for the dynamic addition and removal of cakes, enabling the system more versatility and scalability.

Code References

(Lane, 2021)

(Rastogik346, n.d.)

(Kumar, 2021)

(Bhat, n.d.)

(PranchalK, n.d.)

Question 2: Hash Table Collision technique average cost comparison

Write a program to compute and compare two collision techniques: Chaining and open addressing (linear probing) for the hash table implementations.

The program shall insert 5,000 randomly generated numbers into two separate hash table objects that use different methods (chaining and open addressing) to handle the collision. Use 6001 as the table size of the hash tables.

The program shall execute at least 10 times and calculate the maximum, minimum and average number of collisions that had happened for each technique and run. Populate the result in the following tabular formats:

Average Cost					
Chaining			Open Addressing		
Minimum	Maximum	Average	Minimum	Maximum	Average

Note: reminder to clean up the hash table before the next run.

Discuss your observation and finding.

Output

```
C:\Users\User\anaconda3\python.exe "C:\Users\User\OneDrive\Documents\YiJia\INTI\50
Total collision Chaining: 1595
Total collision Open Addressing: 14168

Total collision Chaining: 1614
Total collision Open Addressing: 11578

Total collision Chaining: 1611
Total collision Open Addressing: 13812

Total collision Chaining: 1619
Total collision Open Addressing: 13740

Total collision Chaining: 1576
Total collision Open Addressing: 13706

Total collision Chaining: 1674
Total collision Open Addressing: 14044

Total collision Chaining: 1601
Total collision Open Addressing: 12241

Total collision Chaining: 1601
Total collision Open Addressing: 12539
```

```
Total collision Chaining: 1612
Total collision Open Addressing: 12330

Total collision Chaining: 1607
Total collision Open Addressing: 14029

-------------------------------------------------------------------------------------
|                                Average cost                                       |
-------------------------------------------------------------------------------------
|              Chaining               |              Open Addressing                |
-------------------------------------------------------------------------------------
|   Min     |   Max     |     Avg     |       Min     |    Max      |     Avg      |
-------------------------------------------------------------------------------------
|   1576    |   1674    |   1611.00   |       11578   |   14168     |  13218.70    |
-------------------------------------------------------------------------------------
```

Discussion

Chaining's overall collision number ranges from 1576 to 1674, with an average of 1611. This number represents the number of collisions which took place when the chaining method was used to resolve collisions. In contrast, the total collision count for open addressing ranges from 11578 to 14168, with an average of 13218.7. The numbers signify the number of collisions that occurred when using the open addressing method. When comparing the chaining and open addressing, chaining generates less collisions. This is because of the reason that in chaining, each slot in the hash table may store numerous items in the format of linked lists, which allows effective collision handling.

However, open addressing has a higher number of collision because when a collision takes place in open addressing, the algorithm tries to discover the next available position by exploring the consecutive slots, potentially resulting in item clustering and more collisions. The amounts of collisions in open addressing can be influenced by aspects such as the load factor (the ratio of occupied spaces to total spaces) and the probing strategy employed (e.g., linear probing, quadratic probing, and so on). The arrangement and content of the input data could impact the amounts of collisions in open addressing. Particular trends in the input data can cause more collisions in open addressing than in chaining.

Chaining and open addressing both has its own strengths and weaknesses. Chaining may lead to increase in memory overhead because of the necessity for linked lists in each slot, which could contribute to higher memory utilisation. Furthermore, when long chains formed as resulting of high collision rates, performance degrades, impacting searching and inserting processes. Another disadvantage of chaining is the items in linked lists may not be stored consecutively, resulting in longer access times (Hashing - Open Addressing for Collision Handling, n.d.). Conversely, open addressing can result from increased clustering, which occurs when consecutive collisions lead items to be stored near together, which causes longer probe sequences and more collisions. High load factors can also make open addressing difficult since the amounts of collisions and probe sequences increases, affecting efficiency. Furthermore, open addressing necessitates a fixed-size database, making subsequent insertions difficult to manage without severe collisions or the requirement to enlarge the table (Hashing - Open Addressing for Collision Handling, n.d.). These problems show the importance of adopting a collision resolution approach for hash tables based on the individual requirements and characteristics of the data.

In summary, the outcomes imply that the chaining technique performs open addressing in the current scenario by having less collisions. However, considering the specific use case, the distribution of the input data, and the hash function selected, the efficiency of any collision resolution approach can change.

Weakness of solution

The programme lacks suitable error handling techniques. It does not deal with exceptions or unanticipated circumstances that may occur during the execution, for example, memory failures, division by zero, or other potential problems. The stability as well as accuracy of the approach would increase with proper error handling.

The programme uses limited evaluation metrics which means that the output shows only the total number of collisions for each collision resolution technique. It lacks other evaluation metrics, like the load factor, average chain length (for chaining), and probing sequence analysis (for open addressing). These measurements can provide additional information into the effectiveness and efficacy of the collision resolution method.

Furthermore, the system lacks test coverage. The statistic simply indicates the average number of collisions for several executes of the programme. It fails to provide extensive testing or coverage of many sides of situations, such as entering duplicate keys, or evaluating the behaviour with varied load factors. Thorough testing would aid in the detection of any flaws and other case handling concerns.

Finally, there is also a lack of code optimisations in the code. There are no performance optimisations in the code, including employing data structures like linked lists for chaining or more effective probing sequences for open addressing. Optimisations may decrease the number of comparisons, increase memory utilisation, and improve the overall performance.

Code References

(Simranjenny84, n.d.)

(EntilZha, 2015)

(Zaczyński, n.d.)

(stephengrice, 2018)

Question 3: Graph

Write a program that uses graph concept. The program shall fulfil the following requirements:

- construct a weighted directed class graph that consists of the following methods:
  - listAdjacentVertex: List all the adjacent vertex for a given vertex
  - sumHighestAdjacentVertex: sum up all the weight for all the adjacent Vertices.

- Create two different graph objects (least 6 vertexes for each graph) and call the above two functions and display the results.

Explain the method/design you had used to present the graph structure in your program.

Output

The printing adjacency list for graph 1 and its adjacent vertex with sum of the weight of the vertices.

```
C:\Users\User\anaconda3\python.exe "C:\Users\User\OneDrive\Documents\
Graph 1
(0 -(31)-> 1) (0 -(13)-> 6)
(1 -(11)-> 2) (1 -(9)-> 3) (1 -(10)-> 4)
(2 -(8)-> 0)
(3 -(5)-> 4) (3 -(14)-> 5)
(4 -(12)-> 3)
(5 -(7)-> 2) (5 -(3)-> 3)

Adjacent vertices of vertex 0 : [1, 6]
Sum of the weights of adjacent vertices of vertex 0 : 44

Adjacent vertices of vertex 1 : [2, 3, 4]
Sum of the weights of adjacent vertices of vertex 1 : 30

Adjacent vertices of vertex 2 : [0]
Sum of the weights of adjacent vertices of vertex 2 : 8

Adjacent vertices of vertex 3 : [4, 5]
Sum of the weights of adjacent vertices of vertex 3 : 19

Adjacent vertices of vertex 4 : [3]
Sum of the weights of adjacent vertices of vertex 4 : 12

Adjacent vertices of vertex 5 : [2, 3]
Sum of the weights of adjacent vertices of vertex 5 : 10
```

The printing adjacency list for graph 2 and its adjacent vertex with sum of the weight of the vertices.

```
Graph 2
(0 -(2)-> 1) (0 -(4)-> 2) (0 -(6)-> 3)
(1 -(8)-> 3) (1 -(4)-> 4)
(2 -(6)-> 0) (2 -(2)-> 4)
(3 -(5)-> 4)
(4 -(10)-> 5)


Adjacent vertices of vertex 0 : [1, 2, 3]
Sum of the weights of adjacent vertices of vertex 0 : 12

Adjacent vertices of vertex 1 : [3, 4]
Sum of the weights of adjacent vertices of vertex 1 : 12

Adjacent vertices of vertex 2 : [0, 4]
Sum of the weights of adjacent vertices of vertex 2 : 8

Adjacent vertices of vertex 3 : [4]
Sum of the weights of adjacent vertices of vertex 3 : 5

Adjacent vertices of vertex 4 : [5]
Sum of the weights of adjacent vertices of vertex 4 : 10

Adjacent vertices of vertex 5 : []
Sum of the weights of adjacent vertices of vertex 5 : 0

Process finished with exit code 0
```

Discussion

The code employs an adjacency list structure to implement a weighted directed graph. The WeightedGraph class contains methods for listing neighbouring vertices and calculating the total weights for adjacent vertices of a given vertex. An empty adjacency list of size n is initialised by allocating memory in the constructor method (__init__). It then loops through the list of edges given, adding each edge to the adjacency list. Every element in the adjacency list is a tuple (destination, weight), which represents the destination vertex and the edge weight.

The listAdjacentVertex function iterates over the adjacency list and extracts the adjacent vertices from the tuples to produce a list of adjacent vertices for a particular vertex.

The sumHighestAdjacentVertex function measures the sum of weights for every vertex's adjacent vertices. The function uses knowledge of lists to extract the weights from the tuples in the adjacency list after calling listAdjacentVertex to get the connected vertices. The function that returns the sum is then used to get the sum of all these weights.

The printWeightedGraph method is to print the graph's adjacency list representation. The function iterates over the adjacency list with nested loops, printing each vertex together with the neighbouring vertices and the weights.

Two graphs (graph1 and graph2) are created by applying the given edges in the __main__ section. The printWeightedGraph function is then used to print each graph's adjacency list representation. Finally, for every vertex within the graph, the neighbouring vertices are displayed by using the methods listAdjacentVertex and sumHighestAdjacentVertex for the sum of the weights of the adjacent vertices.

Overall, the code efficiently uses the adjacency list format and provides capabilities for connecting with the graph. It illustrates methods to build graph-related operations and delivers the basis for future graph-based algorithms and analysis.

Weakness of solution

The code is presumptively written using a specified set of edges and weights in the form of lists. It lacks a way for dynamically inputting or modifying the graph structure during execution. Edges and weights are hard-coded within the programming. This constrains the programme's flexibility and reusability because it cannot accommodate alternative input graphs without altering the algorithm.

The printWeightedGraph function only displays the graph's adjacency list representation. Although this can help with visualisation, it might not be suitable for huge or complex graphs. Additional formatting or visualisation choices, such as displaying the graph with a graph visualisation library or providing more details, would improve the output's utility.

The code focuses on building the graph and giving methods for listing neighbouring vertices and calculating the sum of adjacent vertices' weights. Other commonly used graph operations, such as graph traversal techniques (BFS, DFS), shortest path methods (Dijkstra's, Bellman-Ford), and minimal spanning tree algorithms (Kruskal, Prim), are not included. As a result, its usefulness is limited, and it may not be suitable for more complicated graph-related tasks.

Code References

(Graph Implementation in Python, n.d.)

(‘Graph Data Structure’, n.d.)

Question 4: Concurrent process

(a) Write a function to calculate and display the car loan monthly repayment. Assume flat interest rate is used. Refer to the link below to understand how to calculate the monthly repayment of a loan: https://www.comparehero.my/personal-loan/articles/heres-how-car-loans-work-and-why-interest-charges-are-higher-than-you-think

(b) Write a program to allow users to calculate monthly repayment for 3 customers. The program shall call the function define in (a) concurrently.

Observe the output of your solution. Discuss the theorical behind to support your observation in the documentation.

Output

```
Customer 1:
Please enter customer name: Justhis
Please enter the amount to loan: 74500
Please enter interest rate: 3.4
Please enter loan duration (in years): 7

Customer 2:
Please enter customer name: Jay Park
Please enter the amount to loan: 15000
Please enter interest rate: 3.97
Please enter loan duration (in years): 6

Customer 3:
Please enter customer name: Kwon Ji Yong
Please enter the amount to loan: 88000
Please enter interest rate: 4.5
Please enter loan duration (in years): 8
```

The system asked for user input to calculate the monthly repayment for 3 customers.

Output 1:

```
Calculate the monthly repayment for Justhis.
The monthly repayment for a loan of RM74500.00 with 3.40% interest rate for 7 years is RM1097.99.

Calculate the monthly repayment for Jay Park.
The monthly repayment for a loan of RM15000.00 with 3.97% interest rate for 6 years is RM257.96.

Calculate the monthly repayment for Kwon Ji Yong.
The monthly repayment for a loan of RM88000.00 with 4.50% interest rate for 8 years is RM1246.67.


Process finished with exit code 0
```

The output above shows that when the program is executed concurrently, it gives the expected output.

Output 2:

```
C:\Users\User\anaconda3\python.exe "C:\Users\User\OneDrive\Documents\YiJia\INTI\5003CEM ADVANCED ALGOR
Calculate the monthly repayment for Justhis.Calculate the monthly repayment for Jay Park.
The monthly repayment for a loan of RM74500.00 with 3.40% interest rate for 7 years is RM1097.99.


The monthly repayment for a loan of RM15000.00 with 3.97% interest rate for 6 years is RM257.96.

Calculate the monthly repayment for Kwon Ji Yong.
The monthly repayment for a loan of RM88000.00 with 4.50% interest rate for 8 years is RM1246.67.


Process finished with exit code 0
```

The output above illustrates that the monthly repayment calculations and displays for each customer are not in the expected order. This can be possible due to concurrent thread execution and the unpredictable nature of thread scheduling.

Discussion

Based on the outputs above, the first result shows that the calculations and display are executed in the appropriate sequence, with each customer's repayment data being calculated and displayed separately before going on to the next customer. The sequential execution in the threading is most likely due to the structure of the operation, which performs every calculation and output action in a deterministic order, showing the expected behaviour when each of the threads is merged in the main programme once they have finished their calculations. This means concurrent execution does not take place in this case. Thus, race conditions or synchronization problems do not occur.

However, in the second output, the statement "Calculating monthly repayment" for Justhis appears first, merging with the statement for Jay Park. After that, the system only displays the statements of calculation for Justhis, followed by extra lines of spacing and the calculation statement for Jay Park. This shows that the calculations for Justhis and Jay Park are started at almost the same time, but the output for Justhis is displayed first and the output for Jay Park is delayed. Lastly, only the statement calculating the loan and the results of the calculation for Kwon Ji Yong are displayed. This output shows the non-deterministic behaviour of concurrent execution, where the sequence in which the threads finish their calculations and the display statements are synchronised can change. This is due to the nature of thread scheduling, in which separate threads can change at different rates depending on factors such as compute speed, system resource accessibility, and the thread scheduler's decisions. The order in which threads are processed is decided by the operating system's thread scheduler, and it can change within processes as well as during the same process. Therefore, the order in which outcomes are presented could differ because of the overlapping of thread execution. This is typical behaviour for concurrent execution and does not always point to a race condition or synchronisation problem.

In conclusion, the theoretical ideas of sequential execution and concurrent execution are apparent in the observable results. Output 1 shows sequential execution in threading, in which operations are finished in an ordered manner to ensure the intended outcome. Output 2 illustrates concurrent execution in threading, in which multiple processes are carried out concurrently, which might result in changes to the sequence in which they are completed and demonstrated.

Weakness of solution

The code now determines monthly repayments for a group of customers of 3. It allows for user input to customise loan data but do not allows dynamically add new consumers. Adding user involvement via command-line inputs or a graphical user interface would improve the solution's usability and flexibility. Besides that, currently the code uses a set number of threads determined by the number of customers. If the number of customers substantially rises, this strategy might not scale properly. A thread pool or other thread management strategies might be used to efficiently handle a larger number of consumers.

Another weakness for the solution is insufficient calculation logic. The code just calculates the total repayment amount and does not take into account extra aspects like fees, insurance coverage, or other costs that may alter the overall loan repayment. Adding such components in the calculation logic would give an improved estimation of the monthly repayments.

Furthermore, threading might face the problem of synchronization or race condition when sharing the same resources. The code does not employ synchronisation methods such as mutex (lock) or semaphore to ensure thread safety while publishing results and progress. This implies that if many threads alter the shared resources such as customer list at the same time, it may result in unexpected performance or data corruption. To safeguard shared resources, it would be advantageous to use synchronisation techniques like locks or semaphores to ensure the accurate and consistent functioning of concurrent threads.

Code References

(Brownlee, 2022)

(Multithreading in Python | Set 1, n.d.)

Reflection

The main challenge that I faced in the coursework is when designing and implementing the data structure especially the binary search tree (BST) and hash table to fulfil the conditions is tough. It requires to have a deeper comprehension in data structure so that can achieve in implemented a better program to handle those situations. For example, the question 1 cake ordering system that implement using BST desires to spent a lot of time to implement the system because it has many values and data to save which requires many errors handling and testing to meet the requirements.

Besides that, the documentation after implemented all the program is also a challenge for me. This is because documentation involves a lot of explanation and elaborations on the theories, techniques used in the implementation. If does not have clear understanding on the theories or methods will not able to write the reports and discuss on the implementation for those topics especially the concurrent process.

On the other hand, this coursework provides many valuable experiences for me and have gained a lot of knowledge regarding the data structure and the algorithms that works in the computer. It allows me to practice on designing the program in data structure to solve the problem that may use in the future. I have understand more deeply in the programming, designing suitable algorithms or data structure on the situations, and problem-solving.

In conclude, although the coursework is quite challenging when solving the questions and needs to devote times in solving it. However, it was worthwhile because it helped me to improve my skills in many factors such as programming, data structures and algorithms, and also the thinking and problem-solving skills.

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Appendix

Question 1

```
import random
import re
from tabulate import tabulate


class Cake:
    def __init__(self, code, flavour, weight, unit_price):
        self.code = code
        self.flavour = flavour
        self.weight = weight
        self.unit_price = unit_price


class Customer:
    cus_id_counter = 1  # Auto-increasing variable for generating unique customer IDs

    def __init__(self, name, address, contact):
        self.customer_id = Customer.cus_id_counter
        Customer.cus_id_counter += 1
        self.name = name
        self.address = address
        self.contact_number = contact


class Order:
    def __init__(self, customer):
        self.order_id = None  # initialise the order_id to None
        self.customer = customer
        self.cake_items = []  # list to add multiple cakes into the order

    def set_order_id(self, order_id):  # mutator method to set the order id (initially None)
        self.order_id = order_id

    def add_cake(self, cake, weight, quantity):
        # Function to add cake into the list in constructor
        self.cake_items.append((cake, weight, quantity))

    def calculate_total_amount(self):
        total_amount = 0.0
        for cake, weight, quantity in self.cake_items:
            cake_price = cake.unit_price
            cake_weight = weight
            cake_quantity = quantity
            subtotal = cake_price * cake_weight * cake_quantity
            total_amount += subtotal
        return total_amount


class Node:
    def __init__(self, order):
        self.order = order
        self.left = None
```

```
        self.right = None


class OrderBST:
    def __init__(self):
        self.root = None

    def insert_order(self, order):
        if self.root is None:  # if BST empty
            self.root = Node(order)  # insert the node as root
        else:  # if not empty
            self._insert_order(self.root, order)

    def _insert_order(self, node, order):
        # recursive method to insert data
        if order.order_id < node.order.order_id:  # if the value is smaller than the current node
            if node.left is None:  # the left side of the node is empty
                node.left = Node(order)  # insert the order to left subtree as a leaf
            else:  # if the node have left subtree
                self._insert_order(node.left, order)  # traverse the node to the left until find the position
        elif order.order_id > node.order.order_id:  # if the value is bigger than the current node
            if node.right is None:
                node.right = Node(order)
            else:
                self._insert_order(node.right, order)

    def search_order(self, order_id):
        return self._search_order(self.root, order_id)

    def _search_order(self, node, order_id):
        # recursive method to search order
        if node is None or node.order.order_id == order_id:  # Return None if empty or don't have the order ID
            return node.order if node else None  # Return node.order if the order ID is found
        if order_id < node.order.order_id:  # if the order ID is smaller than the node order ID
            return self._search_order(node.left, order_id)  # move the node to left and check again
        else:  # if the order ID is larger than the node order ID
            return self._search_order(node.right, order_id)  # move the node to right and check again

    def display_all_order_ids(self):
        if self.root is None:  # if the BST is empty
            print("There are no orders.")
            return
        self._display_all_order_ids(self.root)

    def _display_all_order_ids(self, node):
        if node is not None:  # print the order IDs that are in the BST using in-order traversal
            self._display_all_order_ids(node.left)
            order = node.order
            print(f"Order ID: {order.order_id}\tCustomer Name: {order.customer.name}\t"
                  f"Total Amount: RM {order.calculate_total_amount():.2f}")
            self._display_all_order_ids(node.right)

    def view_orders_details(self, current_node, order):
        # display all the order details for selected order ID using in-order traversal
        if current_node is not None:  # if the current node is not empty
```

```
            self.view_orders_details(current_node.left, order)
            # the current node traversal from the left child to search on the order id
            if current_node.order.order_id == order.order_id:  # when the order id is matched, print the order
details
                print("\n-----------------------------------------------------------------------------------------")
                print(f"Order ID: {current_node.order.order_id}")
                print("--- Customer Details ---")
                print(f"Customer ID: {current_node.order.customer.customer_id}")
                print(f"Name: {current_node.order.customer.name}")
                print(f"Address: {current_node.order.customer.address}")
                print(f"Contact Number: {current_node.order.customer.contact_number}")
                print("\n--- Cake Order Details ---")
                for cake, weight, quantity in current_node.order.cake_items:
                    print(f"Cake Code: {cake.code}")
                    print(f"Flavour: {cake.flavour}")
                    print(f"Weight: {weight} kg")
                    print(f"Quantity: {quantity}")
                    print("")
                print(f"Total Amount: RM {current_node.order.calculate_total_amount():.2f}")
                print("-----------------------------------------------------------------------------------------")
            self.view_orders_details(current_node.right, order)
            # the current node traversal from the right child to search on the order id

    def modify_order(self, order_id, new_cake_code, new_flavour, new_weight, new_quantity,
new_unit_price,
                     new_customer_name, new_customer_address, new_contact):
        # modify the details of a specific order
        self._modify_recursive(self.root, order_id, new_cake_code, new_flavour, new_weight, new_quantity,
                               new_unit_price, new_customer_name, new_customer_address, new_contact)

    def _modify_recursive(self, current_node, order_id, new_cake_code, new_flavour, new_weight,
new_quantity,
                          new_unit_price, new_customer_name, new_customer_address, new_contact):
        # private helper method
        if current_node.order.order_id == order_id:  # when the order ID is found
            total_amount = 0.0  # assign the total amount to 0 so that can recalculate the total
            for i, (cake, weight, quantity) in enumerate(current_node.order.cake_items):
                # to update the cake lists in the order by assigning the new value
                if cake.code == new_cake_code:
                    # Update cake details base on the cake code
                    cake.code = new_cake_code
                    cake.flavour = new_flavour
                    cake.unit_price = new_unit_price
                    current_node.order.cake_items[i] = (cake, new_weight, new_quantity)
                    # update the order cake details based on new value into the tuple list
                subtotal = cake.unit_price * new_weight * new_quantity
                total_amount += subtotal
            current_node.order.total_amount = total_amount
            current_node.order.customer_name = new_customer_name
            current_node.order.customer_address = new_customer_address
            current_node.order.customer.contact_number = new_contact

        elif order_id < current_node.order.order_id:
            self._modify_recursive(current_node.left, order_id, new_cake_code, new_flavour, new_weight,
new_quantity,
```

```
                                new_unit_price, new_customer_name, new_customer_address, new_contact)
        else:
            self._modify_recursive(current_node.right, order_id, new_cake_code, new_flavour, new_weight,
new_quantity,
                                new_unit_price, new_customer_name, new_customer_address, new_contact)

    def delete_order(self, order_id):
        self.root = self._delete_order(self.root, order_id)

    def _delete_order(self, node, order_id):
        # To find the target node
        if node is None:  # if the order ID not found
            return node
        if order_id < node.order.order_id:
            node.left = self._delete_order(node.left, order_id)
        elif order_id > node.order.order_id:
            node.right = self._delete_order(node.right, order_id)
        else:  # Target found
            # Node with no child or only one child
            if node.left is None:  # The node does not have left child ( 1 right child )
                temp = node.right  # temp (pointer in C++) point to the right child
                node = None  # delete the node
                return temp  # the right child become the new node
            elif node.right is None:  # The node does not have right child ( 1 left child )
                temp = node.left
                node = None
                return temp
            # The target node has two children
            temp = self._min_value_node(node.right)  # Find the successor node (smallest in the right subtree)
            node.order = temp.order  # replaces the target node's content with the order of the successor node
            node.right = self._delete_order(node.right, temp.order.order_id)  # Delete the inorder successor
        return node

    @staticmethod  # does not depend on any instance-specific data and does not modify the state of the
object
    def _min_value_node(node):
        # to find the smallest value of order ID
        current = node
        while current.left is not None:  # loop down to find the smallest value leaf
            current = current.left
        return current


class CakeOrderingSystem:
    def __init__(self):
        self.bst = OrderBST()
        self.cake_lists = []  # List to store available cake objects

    @staticmethod
    def display_menu():
        print(" Hi~ o(*￣▽￣*)ブ  Le Grande Cake Ordering System ")
        print("1. View Cake Lists")
        print("2. Place an Order")
        print("3. View All Order IDs, Customer Names and Total Amount")
        print("4. View Selected Order Details")
```

```
        print("5. Modify an Order")
        print("6. Delete an Order")
        print("7. Exit")

    def generate_order_id(self):
        while True:
            order_id = random.randint(100, 10000)
            if not self.bst.search_order(order_id):  # so that the order ID does not duplicate
                return order_id

    def available_cake_list(self):
        # Create cake objects and add them to the cake list
        cake1 = ["1", "Belgium Chocolate Cheesecake", 1.0, 115.00]
        cake2 = ["2", "Burnt Cheesecake", 1.0, 95.00]
        cake3 = ["3", "Strawberry Shortcake", 1.0, 120.00]
        cake4 = ["4", "French Earl Grey", 1.0, 98.50]
        cake5 = ["5", "Lemon Tart", 1.0, 100.50]
        cake6 = ["6", "Lemon Poppy Seed", 1.0, 97.80]
        cake7 = ["7", "Black Forest", 1.0, 96.70]
        cake8 = ["8", "White Forest", 1.0, 96.70]
        cake9 = ["9", "Matchamisu", 1.0, 130.00]
        cake10 = ["10", "Tiramisu (contain alcohol)", 1.0, 135.00]
        cake11 = ["11", "Red Velvet", 1.0, 89.00]
        cake12 = ["12", "Blueberry Cheesecake", 1.0, 128.50]

        self.cake_lists = [cake1, cake2, cake3, cake4, cake5, cake6, cake7, cake8, cake9, cake10, cake11,
cake12]

    def view_cake_list(self):
        # print the cake lists in table
        # print("")
        self.available_cake_list()
        headers = ["Cake Code", "Flavour", "Weight (kg)", "Unit Price (RM/kg)"]
        table = tabulate(self.cake_lists, headers=headers, tablefmt="grid")
        print(table)

    def get_cake_info(self, cake_code):
        # to get the cake details for specific cake code (use in modify cake order)
        for cake in self.cake_lists:
            if cake[0] == cake_code:
                flavour = cake[1]
                unit_price = cake[3]
                return flavour, unit_price
        return None

    def place_order(self):
        print("\n~~~~~ Place an Order ~~~~~")
        print("--- Customer Details ---")
        customer_name = input("Enter Customer Name: ")
        customer_address = input("Enter Customer Address: ")
        customer_contact = None

        # Validate customer details input must be filled
        while not customer_name or not customer_address:
            print("Customer details cannot be empty. Please try again.")
```

```
    customer_name = input("Enter Customer Name: ")
    customer_address = input("Enter Customer Address: ")

while customer_contact is None:
    customer_contact = input("Contact number: ")

    # Validate contact number format
    if not re.match(r'^0\d{9,10}$', customer_contact):
        print("Invalid contact number. Please try again. "
              "Contact number must start with '0' and have 10-11 digits.")
        customer_contact = None

# create an object called new_customer for Customer class and pass the user input attributes to the class
new_customer = Customer(customer_name, customer_address, customer_contact)
# create new_order object and pass it into Order class
new_order = Order(new_customer)

new_order.set_order_id(self.generate_order_id())  # set the order id using random generated id
# by calling the set_order_id function in the Order class

print("")
self.view_cake_list()  # display the cake lists
print("\n--- Cake Order Details ---")

while True:
    cake_code = input("\nEnter Cake Code: ")
    cake = None  # initialise the cake to None
    for c in self.cake_lists:
        if c[0] == cake_code:  # the cake code entered is exists
            cake = Cake(c[0], c[1], c[2], c[3])  # create an object cake and pass it into the Cake class
            break

    if cake is None:  # not selecting any cake or invalid cake code
        print("Invalid Cake Code. Please try again.")
        continue

    weight = None  # initialise the weight to None
    print("\nAvailable Weight (kg): 0.25, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0 \n")
    while weight is None:
        try:
            weight = float(input("Enter Weight (in kg): "))
            if weight not in [0.25, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0]:
                raise ValueError
        except ValueError:
            print("Invalid Weight. Please enter a valid weight from the options.\n")
            weight = None

    quantity = None
    while quantity is None:
        try:
            quantity = int(input("Enter Quantity: "))
            if quantity <= 0:  # validate the quantity do not get the negative value or 0
                raise ValueError
        except ValueError:
            print("Invalid Quantity. Please enter a positive integer.")
```

```
                quantity = None

            new_order.add_cake(cake, weight, quantity)  # add the cake into the list that declare in the Order
class

            choice = input("\nDo you want to add another cake? (Press 'y' if yes): ")
            if choice.lower() != "y":  # any input beside of y will exit the loop to add multiple cake
                break

        # Calculate and display total amount
        total_amount = new_order.calculate_total_amount()
        print(f"Total Amount: RM {total_amount:.2f}")

        # Insert order to BST
        self.bst.insert_order(new_order)
        print("Order Placed Successfully!\n")
        self.bst.view_orders_details(self.bst.root, new_order)
        input("\nPress Enter to continue...")

    def view_all_ordersID(self):
        # display all orders in BST
        print("\n~~~~~ All Orders ~~~~~")
        self.bst.display_all_order_ids()
        input("\nPress Enter to continue...")

    def view_order_details(self):
        # display selected order in the BST
        print("\n~~~~~ Order Details ~~~~~")

        if self.bst.root is None:  # if the BST is empty
            print("There are no orders.")
            input("\nPress Enter to continue...")
            return

        while True:
            try:
                order_id = int(input("\nEnter Order ID (Press 0 to cancel): "))
                if order_id < 0:  # if negative number
                    raise ValueError
                if order_id == 0:
                    return  # Exit the function or method
            except ValueError:
                print("Invalid Order ID. Please enter a positive integer.")
                continue

            # Search the order in BST
            order = self.bst.search_order(order_id)
            if order is not None:
                # Order found
                self.bst.view_orders_details(self.bst.root, order)  # print order details
                break
            else:
                print("Order not found. Please try again.")

        input("\nPress Enter to continue...")
```

```
def modify_order(self):
    # modify the value in the order
    print("~~~~~ Modify an Order ~~~~~")

    if self.bst.root is None:  # if the BST is empty
        print("There are no orders.")
        input("\nPress Enter to continue...")
        return

    while True:
        try:
            order_id = int(input("\nEnter Order ID (Press 0 to cancel): "))
            if order_id < 0:  # if negative number
                raise ValueError
            if order_id == 0:
                return  # Exit the function2
        except ValueError:
            print("Invalid Order ID. Please enter a positive integer.")
            continue

        # Search the order in BST
        order = self.bst.search_order(order_id)
        if order is not None:  # Order found
            self.bst.view_orders_details(self.bst.root, order)  # print order details

            # Prompt the user for the new details
            print("\n--- Modify Customer's Details ---")
            new_name = input("Enter new customer name (leave blank to keep current): ")
            new_address = input("Enter new customer address (leave blank to keep current): ")
            new_contact = input("Enter new customer contact number (leave blank to keep current): ")

            if new_contact != "":
                while not re.match(r'^0\d{9,10}$', new_contact):
                    print("Invalid contact number. Please try again. "
                          "Contact number must start with '0' and have 10-11 digits.")
                    new_contact = input("\nEnter new customer contact number (leave blank to keep current): ")
                order.customer.contact_number = new_contact

            # Update the customer details
            if new_name != "":
                order.customer.name = new_name
            if new_address != "":
                order.customer.address = new_address

            # Update cake items
            choice = input("\nDo you want to modify the cake items? (Press 'y' if yes): ")
            if choice.lower() == "y":
                print("\n--- Modify Cake Items ---")
                self.view_cake_list()  # display cake lists
                for i, (cake, weight, quantity) in enumerate(order.cake_items):
                    print(f"\nCake Item {i + 1}:")
                    while True:
                        new_cake_code = input("Enter New Cake Code (Press Enter to keep current): ")
                        if new_cake_code:  # if the new cake code enter
```

```
            # Get the flavour and unit price based on the cake code
            cake_info = self.get_cake_info(new_cake_code)
            if cake_info:  # based on the cake info for that cake code update the cake details
                flavour, unit_price = cake_info
                cake.code = new_cake_code
                cake.flavour = flavour
                cake.unit_price = unit_price
                print("\nCake details updated!")
                break  # Exit the while loop
            else:
                print("Invalid cake code. Please try again.\n")
        else:
            print("The cake is remain unchanged.")
            break  # Exit the while loop is keep the same value

    print("\nAvailable Weight (kg): 0.25, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0 \n")

    # update new weight
    while True:
        new_weight = input("Enter New Weight (Press Enter to keep current): ")
        if new_weight != "":
            try:
                if new_weight in ['0.25', '0.5', '1', '1.0', '1.5', '2', '2.0', '2.5', '3', '3.0']:
                    weight = float(new_weight)  # update the new weight to weight
                    break  # Exit the loop if valid weight is entered
                else:
                    raise ValueError
            except ValueError:
                print("Invalid Weight. Please enter a valid weight from the options.\n")
        else:
            print("The current weight is remain unchanged.\n")
            break

    # update new quantity
    while True:
        new_quantity = input("Enter New Quantity (Press Enter to keep current): ")
        if new_quantity != "":
            try:
                new_quantity_int = int(new_quantity)  # covert the string entered to int
                if new_quantity_int >= 1:
                    quantity = int(new_quantity_int)  # update the new quantity to quantity
                    break  # Exit the loop if valid quantity is entered
                else:
                    raise ValueError
            except ValueError:
                print("Invalid Quantity. Please enter a positive integer.\n")
        else:
            print("The current quantity is remain unchanged.\n")
            break

    # update the cake details for the order in the list
    order.cake_items[i] = (cake, weight, quantity)

# Recalculate total amount
order.calculate_total_amount()
```

```
            print("Order Modified Successfully!")
            print(f"\nUpdated Order Details for Order ID {order_id}:")
            self.bst.view_orders_details(self.bst.root, order)
            break
        else:
            print("Order not found. Please try again.")
            continue
    input("\nPress Enter to continue...")

def delete_order(self):
    print("~~~~~ Delete an Order ~~~~~")

    if self.bst.root is None:  # if the BST is empty
        print("There are no orders.")
        input("\nPress Enter to continue...")
        return

    while True:
        try:
            order_id = int(input("Enter Order ID (Press 0 to cancel): "))
            if order_id < 0:  # if negative number
                raise ValueError
            if order_id == 0:  # Exit the loop
                return
        except ValueError:
            print("Invalid Order ID. Please enter a positive integer.\n")
            continue

        # Search the order in BST
        order = self.bst.search_order(order_id)
        if order is not None:
            # Order found
            self.bst.view_orders_details(self.bst.root, order)  # print order details
            confirm = input("Are you sure want to delete this order? (Press 'y' if yes): ")
            if confirm.lower() == "y":
                self.bst.delete_order(order_id)
                print("\nOrder Deleted Successfully!")
                break
            else:
                print("\nDeletion Cancelled.")
                break
        else:
            print("Order not found. Please try again.")

    input("\nPress Enter to continue...")

def run(self):
    while True:
        self.display_menu()
        choice = input("Enter your choice (1-7): ")
        if choice == "1":
            self.view_cake_list()
            input("\nPress Enter to continue...")
        elif choice == "2":
```

```
            self.place_order()
        elif choice == "3":
            self.view_all_ordersID()
        elif choice == "4":
            self.view_order_details()
        elif choice == "5":
            self.modify_order()
        elif choice == "6":
            self.delete_order()
        elif choice == "7":
            print("Exiting the program...  ┌( ^ 0 ^ )┘  Bye~Bye~")
            break
        else:
            print("Invalid choice. Please try again.\n")


# Create and run the Cake Ordering System
system = CakeOrderingSystem()
system.run()
```

Question 2

```
import random


class HashTable:
    def __init__(self, size):
        self.__size = size
        self.__chaining_table = [[] for _ in range(size)]  # creates an empty lists for chaining
        self.__open_addressing_table = [None] * size
        self.total_collision_chaining = 0  # variable assign to calculate the total collision
        self.total_collision_open_addressing = 0

    def __hash(self, key):
        return key % self.__size  # return the remainder of the value / size of hash table

    def insert_chaining(self, key):  # insert the hash key (remainder) using chaining
        index = self.__hash(key)
        self.__chaining_table[index].append(key)

    def insert_open_addressing(self, key):  # insert the hash key (remainder) using open addressing
        index = self.__hash(key)
        while self.__open_addressing_table[index] is not None:  # if collision occurs
            self.total_collision_open_addressing += 1  # calculate the total collision of open addressing
            index = (index + 1) % self.__size  # keep increasing the index by 1 to find the available slot to insert
        self.__open_addressing_table[index] = key  # insert the key into after found the available slot

    def calculate_total_collision_chaining(self):  # calculate the total collisions in chaining
        for n in self.__chaining_table:
            if len(n) > 1:  # if there has element(s) in the hash table
                self.total_collision_chaining += len(n) - 1  # increase the counter with the length of slot and
                # subtract 1 to exclude the first key that was inserted without collision
        return self.total_collision_chaining


def run_program():
    number_items = 5000
    table_size = 6001
    num_execute = 10  # Number of execute times

    chaining_min_collisions = float('inf')  # positive infinity value
    chaining_max_collisions = float('-inf')  # negative infinity value
    chaining_avg_collisions = 0  # to calculate the total average of chaining for 10 execution

    open_addressing_min_collisions = float('inf')
    open_addressing_max_collisions = float('-inf')
    open_addressing_avg_collisions = 0  # to calculate the total average of open addressing for 10 execution

    for _ in range(num_execute):
        items = [random.randint(0, 100000) for _ in range(number_items)]  # autogenerate 5000 random
numbers

        chaining_table = HashTable(table_size)
        open_addressing_table = HashTable(table_size)

        for item in items:  # insert the numbers into hash table
```

```
            chaining_table.insert_chaining(item)
            open_addressing_table.insert_open_addressing(item)

        # calculate the total collision of every execution for collision and open addressing
        total_collision_chaining = chaining_table.calculate_total_collision_chaining()
        print(f"Total collision Chaining: {total_collision_chaining}")
        print(f"Total collision Open Addressing: {open_addressing_table.total_collision_open_addressing}\n")

       # Update minimum and maximum collisions for chaining
       # compares the current value of min or max with total_collision_chaining,
       # then selects the smaller of the two values and assigns it back
       chaining_min_collisions = min(chaining_min_collisions, total_collision_chaining)
       chaining_max_collisions = max(chaining_max_collisions, total_collision_chaining)

        # Update minimum and maximum collisions for open addressing
        open_addressing_min_collisions = min(open_addressing_min_collisions,
open_addressing_table.total_collision_open_addressing)
        open_addressing_max_collisions = max(open_addressing_max_collisions,
open_addressing_table.total_collision_open_addressing)

        # Add the total collisions to calculate the average after every execution
        chaining_avg_collisions += total_collision_chaining
        open_addressing_avg_collisions += open_addressing_table.total_collision_open_addressing

        # Clean up hash tables after every execution
        chaining_table.chaining_table = [[] for _ in range(table_size)]
        open_addressing_table.open_addressing_table = [None] * table_size

    # Calculate average collisions
    chaining_avg_collisions /= num_execute  # average = total average / 10
    open_addressing_avg_collisions /= num_execute

    # Print results in tabular format
    print("-------------------------------------------------------------------------------------")
    print("|\t\t\t\t\t\t\t\tAverage cost\t\t\t\t\t\t\t\t|")
    print("-------------------------------------------------------------------------------------")
    print("|\t\t\t\tChaining\t\t\t\t|\t\t\t\tOpen Addressing\t\t\t\t|")
    print("-------------------------------------------------------------------------------------")
    print("|\tMin\t\t|\tMax\t\t|\t  Avg\t\t|\t\tMin\t\t|\t Max\t  | \tAvg\t\t|")
    print("-------------------------------------------------------------------------------------")

print(f"|\t{chaining_min_collisions}\t|\t{chaining_max_collisions}\t|\t{chaining_avg_collisions:.2f}\t\t|\t\t"
        f"{open_addressing_min_collisions}\t|\t{open_addressing_max_collisions}\t  |
{open_addressing_avg_collisions:.2f}\t|")
    print("-------------------------------------------------------------------------------------")


run_program()
```

Question 3

```
class WeightedGraph:
    # Constructor
    def __init__(self, edges, n):
        # allocate memory for the adjacency list
        self.adjacencyList = [[] for _ in range(n)]

        # add edges to the directed graph
        for (src, destination, weight) in edges:
            # allocate node in adjacency list from src to destination with weight
            self.adjacencyList[src].append((destination, weight))

    # Function to list all adjacent Vertices
    def listAdjacentVertex(self, vertex):
        return [adj_vertex for (adj_vertex, _) in self.adjacencyList[vertex]]

    # Function to calculate the sum of all the weight for all the adjacent Vertices of a graph
    def sumHighestAdjacentVertex(self, vertex):
        adj_list = self.listAdjacentVertex(vertex)
        if not adj_list:
            return 0
        return sum([weight for (_, weight) in self.adjacencyList[vertex]])


# Function to print adjacency list representation of a graph
def printWeightedGraph(graph):
    for src in range(len(graph.adjacencyList)):
        # print current vertex and all its neighboring vertices with weights
        for (destination, weight) in graph.adjacencyList[src]:
            print(f'({src} —({weight})—> {destination}) ', end='')
        print()


if __name__ == '__main__':
    # Edges and weights in a directed weighted graph
    edges1 = [(0, 1, 31), (0, 6, 13),
              (1, 2, 11), (1, 3, 9), (1, 4, 10),
              (2, 0, 8),
              (3, 4, 5), (3, 5, 14),
              (4, 3, 12),
              (5, 2, 7), (5, 3, 3)]
    edges2 = [(0, 1, 2), (0, 2, 4), (0, 3, 6),
              (1, 3, 8), (1, 4, 4),
              (2, 0, 6), (2, 4, 2),
              (3, 4, 5),
              (4, 5, 10)]

    # No. of vertices
    n = 6

    # construct a graph from a given list of edges
    graph1 = WeightedGraph(edges1, n)
    graph2 = WeightedGraph(edges2, n)

    # print adjacency list representation of the graph
```

```
    print("Graph 1")
    printWeightedGraph(graph1)
    for vertex in range(n):
        print("\nAdjacent vertices of vertex", vertex, ":", graph1.listAdjacentVertex(vertex))
        print("Sum of the weights of adjacent vertices of vertex", vertex, ":",
graph1.sumHighestAdjacentVertex(vertex))

    print("\n\nGraph 2")
    printWeightedGraph(graph2)
    for vertex in range(n):
        print("\nAdjacent vertices of vertex", vertex, ":", graph2.listAdjacentVertex(vertex))
        print("Sum of the weights of adjacent vertices of vertex", vertex, ":",
graph2.sumHighestAdjacentVertex(vertex))
```

Question 4

```
import threading


# calculate the monthly repayment for the customer
def calculate_monthly_repayment(customer, amount_to_loan, interest_rate, loan_duration):
    interest_rate = interest_rate / 100  # Converting interest rate from percentage to decimal
    loan_period_months = loan_duration * 12

    total_interest = amount_to_loan * interest_rate * loan_duration
    total_amount_repayable = amount_to_loan + total_interest
    monthly_repayment = total_amount_repayable / loan_period_months

    # Displaying the monthly repayment
    print(f"Calculate the monthly repayment for {customer}.")
    print(f"The monthly repayment for a loan of RM{amount_to_loan:.2f} with {interest_rate * 100:.2f}%
interest rate "
          f"for {loan_duration} years is RM{monthly_repayment:.2f}.\n")


# Main program
def main():
    # Input values for three customers
    customers = []

    # Accept user input for three customers
    for i in range(3):
        customer = {}
        print(f"Customer {i + 1}:")
        customer["customer"] = input("Please enter customer name: ")

        while True:
            try:
                customer["amount_to_loan"] = float(input("Please enter the amount to loan: "))
                if customer["amount_to_loan"] > 0:
                    break
                else:
                    print("Invalid input. Please enter a loan value that greater than 0.")
            except ValueError:
                print("Invalid input. Please enter a valid number.")

        while True:
            try:
                customer["interest_rate"] = float(input("Please enter interest rate: "))
                if customer["interest_rate"] > 0:
                    break
                else:
                    print("Invalid input. Please enter the interest rate that greater than 0.")
            except ValueError:
                print("Invalid input. Please enter a valid number.")

        while True:
            try:
                customer["loan_duration"] = int(input("Please enter loan duration (in years): "))
                if customer["loan_duration"] > 0:
```

```
                break
            else:
                print("Invalid input. Please enter a loan period that greater than 0.")
        except ValueError:
            print("Invalid input. Please enter a valid integer.")

    customers.append(customer)  # insert the 3 customer into list
    print("")

threads = []  # a list to save all the threads
for customer in customers:
    # Create a thread for each customer and start it
    thread = threading.Thread(target=calculate_monthly_repayment,
                              args=(customer["customer"], customer["amount_to_loan"], customer["interest_rate"],
                                    customer["loan_duration"]))
    thread.start()  # to start the execution of the thread
    # initially the target function in a separate thread, start() allows the threads to run concurrently
    threads.append(thread)  # insert the 3 customer thread into list

# Wait for all threads to finish then only end the program
for thread in threads:
    thread.join()


if __name__ == "__main__":
    main()
```