University of Malta

Faculty of Information and Communication Technology

CPS-2004 Object -Oriented Assignment

Coursework 2021-2022

Faculty of ICT

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FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

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CPS2004
Course Code

Object-Oriented Programming Assignment
Title of work submitted

21/01/2022
Date

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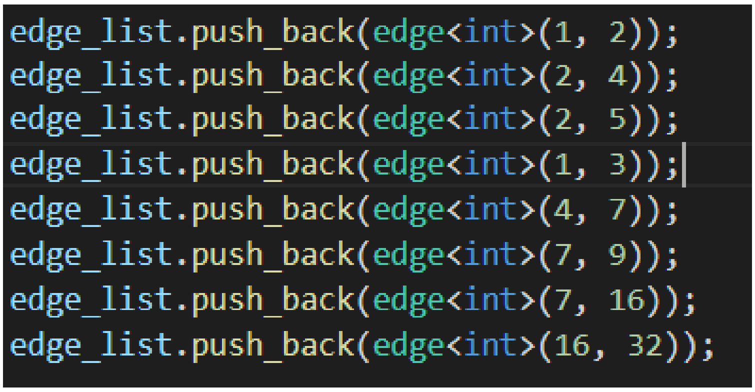
DAG (in C++)

Implementation of the code

The first task consisted of building a templatized directed acyclic graph data structure (DAG). A DAG consists of nodes which are connected by edges. The edge class creates an edge which returns a source node and a target node. The vertex class consists of multiple functions which are used to create the nodes in the graph, and populate the aforementioned source and target nodes. The dag class is used to build the final DAG. This is done through the use of an edge list. The edge list contains all the edges that will be used in our graph. For example, the first edge is looking for the source node '1'. The program will attempt to find said node in the graph that we are building. However, since the graph is currently empty, it will fail and add the node '1' to the graph itself. This is also repeated with the target node '2'. After this step if there is any other node in the graph which is using node '1' as a source node, the program will find it in the graph already and use the one in the graph. If any nodes are to be removed this can also be done via the remove_vertex() function. The main method used will print out the DAG and the edge list. In some cases, one or multiple nodes are removed and in this case the DAG and edge list will be outputted again without the nodes that were removed.

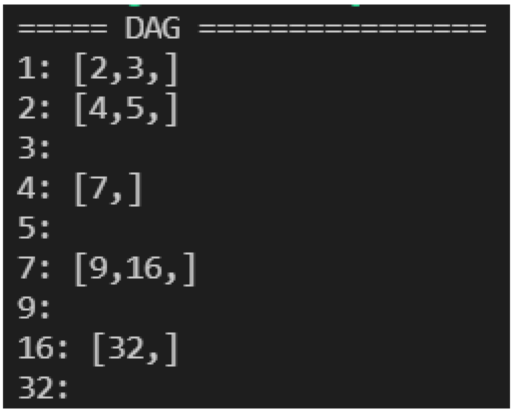
Test Cases

For the testing the following edge list was used:



```
edge_list.push_back(edge<int>(1, 2));
edge_list.push_back(edge<int>(2, 4));
edge_list.push_back(edge<int>(2, 5));
edge_list.push_back(edge<int>(1, 3));
edge_list.push_back(edge<int>(4, 7));
edge_list.push_back(edge<int>(7, 9));
edge_list.push_back(edge<int>(7, 16));
edge_list.push_back(edge<int>(16, 32));
```

The DAG outputted like so:



```
===== DAG ================
1: [2,3,]
2: [4,5,]
3:
4: [7,]
5:
7: [9,16,]
9:
16: [32,]
32:
```

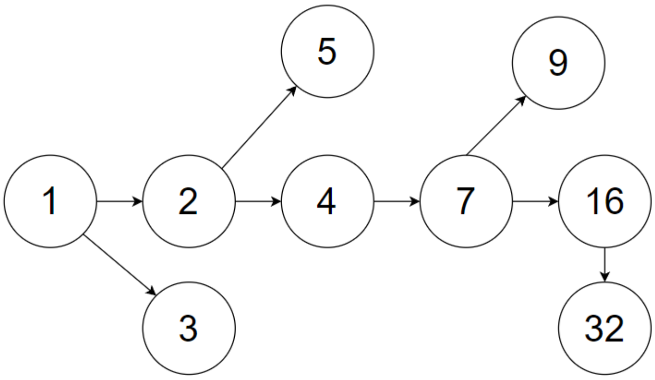
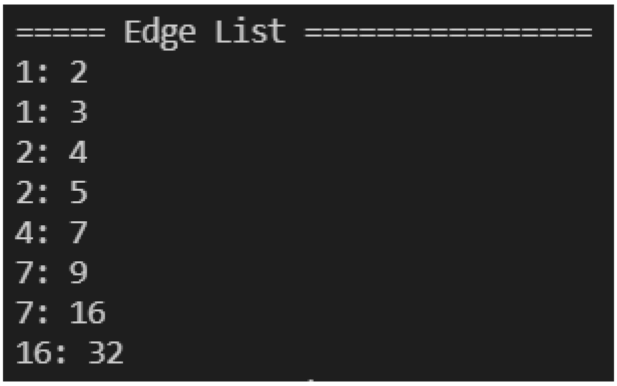


Fig.2: Output of DAG with a diagram of the graph on the right

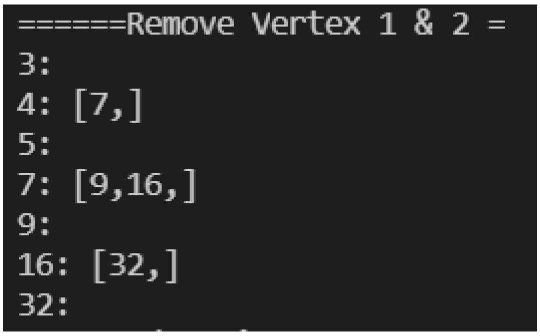
Along with the edge list as seen below:



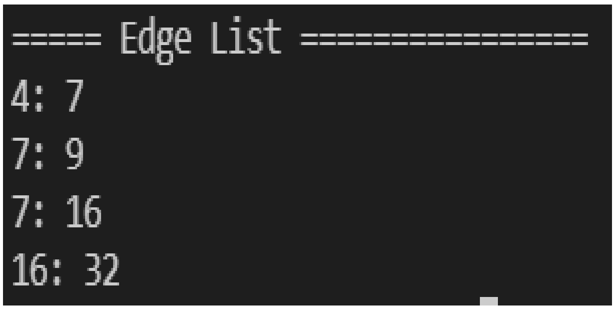
```
===== Edge List ================
1: 2
1: 3
2: 4
2: 5
4: 7
7: 9
7: 16
16: 32
```

Fig.3: The Edge List

The first two nodes were removed from the DAG and the outputs changed, however the main issue is that disconnected nodes were not completely removed.



```
======Remove Vertex 1 & 2 =
3:
4: [7,]
5:
7: [9,16,]
9:
16: [32,]
32:
```



```
===== Edge List ================
4: 7
7: 9
7: 16
16: 32
```

Fig.4: The DAG after removing nodes 1 and 2

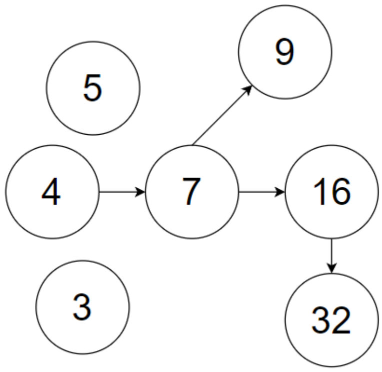


Fig.5: Diagram of the graph for the without nodes 1 & 2

UML

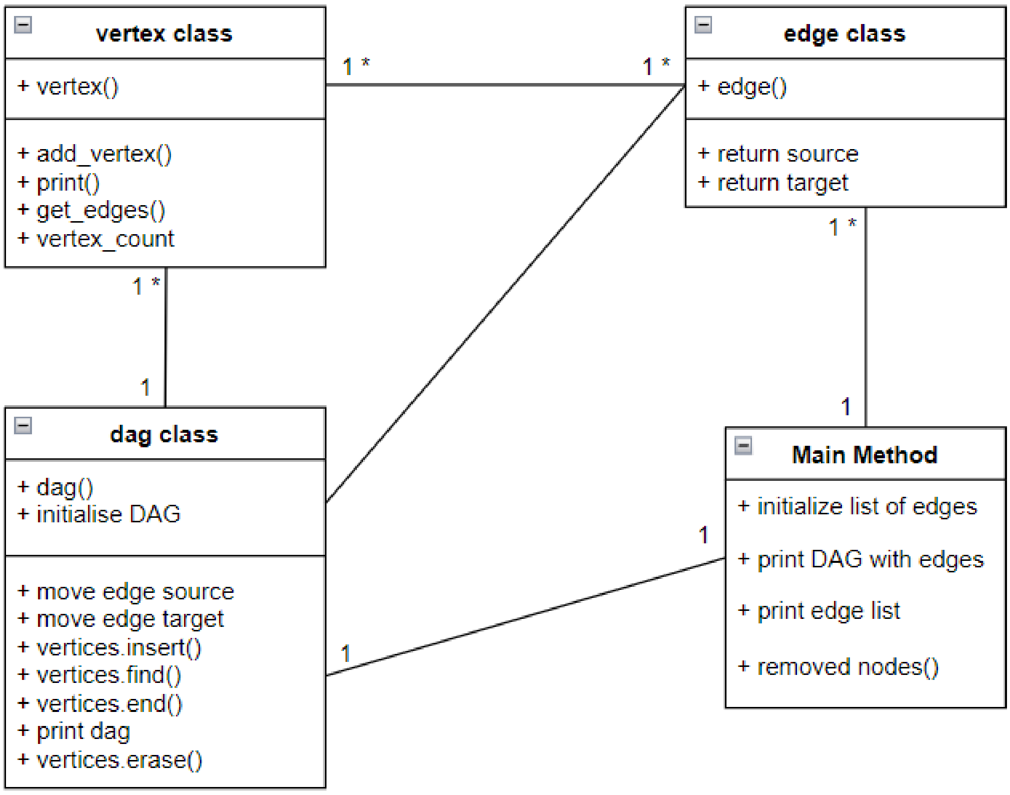


Fig.6: UML Diagram of Task 1

Possible Improvements:

Disconnected Nodes removal could make the output look cleaner.

- This was attempted in the DAG class however it caused bugs and errors and therefore it was left out

A function to check whether a cycle is present in the graph or not could have been added.

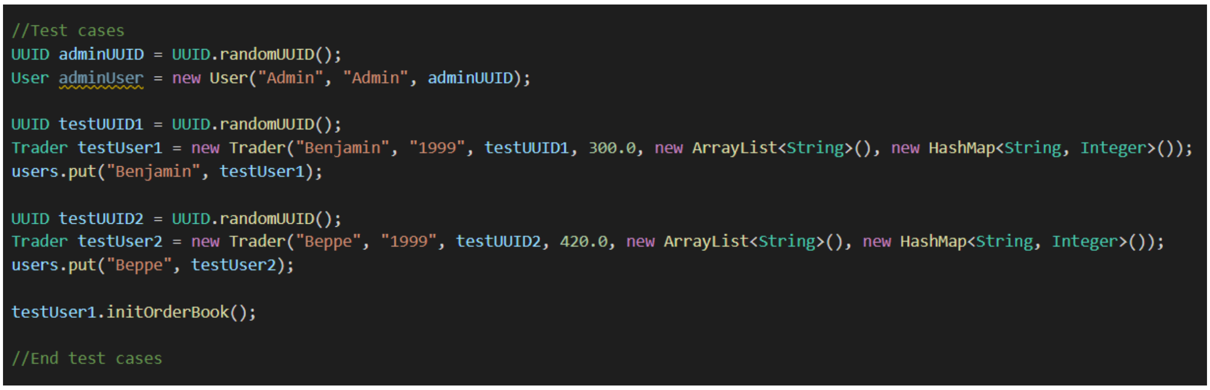
Crypto Exchange (in Java)

Implementation of the Code

The second task consisted of building a simple crypto exchange platform. The users that would use said crypto exchange would be Traders or Administrators. The Traders would have to register into the system and be approved by the Administrator. Upon running the program, the user would have 3 options: Register an account, Log in to an existing account, or Exit the system. If the user is an Administrator, then they have the option to approve any accounts waiting for approval, or log out of the system. If the user is an approved Trader, then they have the following options: View their Orderbooks, Buy Crypto, Sell Crypto, View any previous Crypto Transactions, Deposit Money into their account, View their balance, or log out of their account. The Trader and Administrator classes are subclasses to the User superclass since the user’s details such as username, password and ID are required for the Trader and Administrator’s functions to work and they are in the User() object.

Test Cases

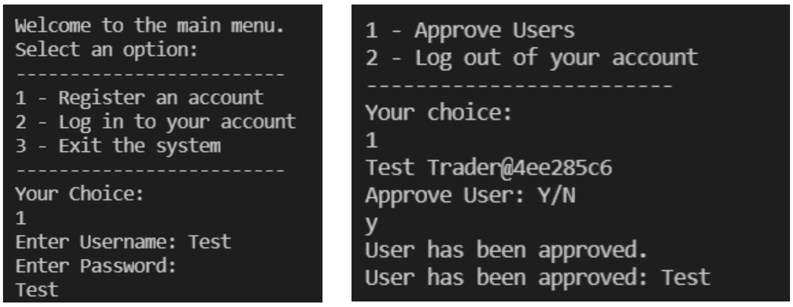
For the test cases three users were created, 2 Traders and 1 Admin.



```java
//Test cases
UUID adminUUID = UUID.randomUUID();
User adminUser = new User("Admin", "Admin", adminUUID);

UUID testUUID1 = UUID.randomUUID();
Trader testUser1 = new Trader("Benjamin", "1999", testUUID1, 300.0, new ArrayList<String>(), new HashMap<String, Integer>());
users.put("Benjamin", testUser1);

UUID testUUID2 = UUID.randomUUID();
Trader testUser2 = new Trader("Beppe", "1999", testUUID2, 420.0, new ArrayList<String>(), new HashMap<String, Integer>());
users.put("Beppe", testUser2);

testUser1.initOrderBook();

//End test cases
```

Fig.7: The users which were used for the Test Cases

In order to test out the Admin user, a user was registered so it culd be approved by the Admin.

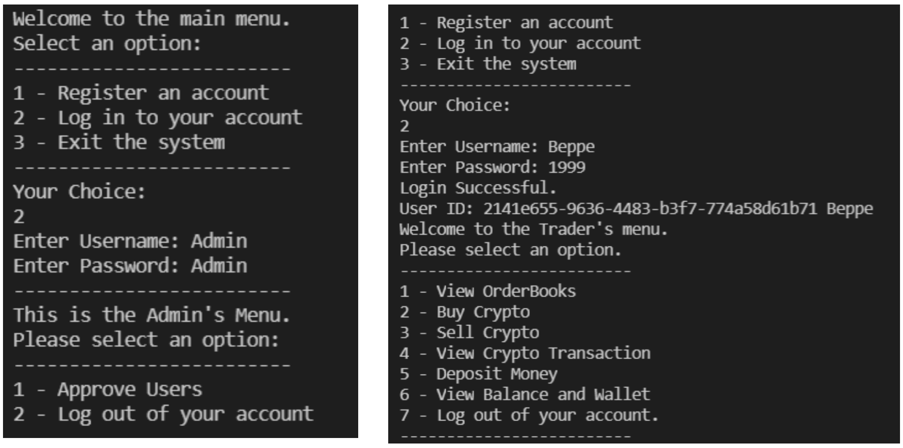


```
Welcome to the main menu.
Select an option:
------------------------
1 - Register an account
2 - Log in to your account
3 - Exit the system
------------------------
Your Choice:
1
Enter Username: Test
Enter Password:
Test
```

```
1 - Approve Users
2 - Log out of your account
-------------------------
Your choice:
1
Test Trader@4ee285c6
Approve User: Y/N
y
User has been approved.
User has been approved: Test
```

Fig.8: Test user being regiestered and approved

The following menus are shown when logging into an Admin account (Left) or Trader account (right):

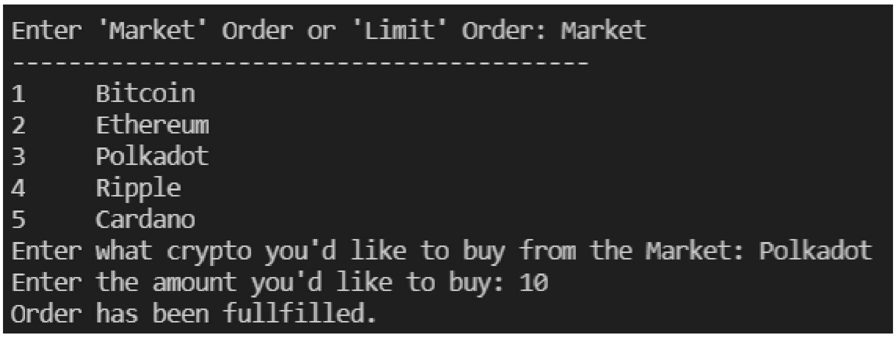


```
Welcome to the main menu.
Select an option:
------------------------
1 - Register an account
2 - Log in to your account
3 - Exit the system
------------------------
Your Choice:
2
Enter Username: Admin
Enter Password: Admin
------------------------
This is the Admin's Menu.
Please select an option:
------------------------
1 - Approve Users
2 - Log out of your account
```

```
1 - Register an account
2 - Log in to your account
3 - Exit the system
------------------------
Your Choice:
2
Enter Username: Beppe
Enter Password: 1999
Login Successful.
User ID: 2141e655-9636-4483-b3f7-774a58d61b71 Beppe
Welcome to the Trader's menu.
Please select an option.
------------------------
1 - View OrderBooks
2 - Buy Crypto
3 - Sell Crypto
4 - View Crypto Transaction
5 - Deposit Money
6 - View Balance and Wallet
7 - Log out of your account.
------------------------
```

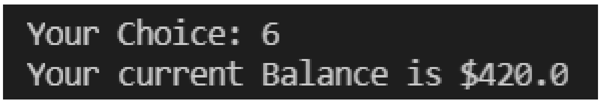
Fig.9: Logging into an Admin account (left) and Trader account (right).

The user ‘Beppe’ bought 10 of Polkadot and the order was successful since he had sufficient funds:



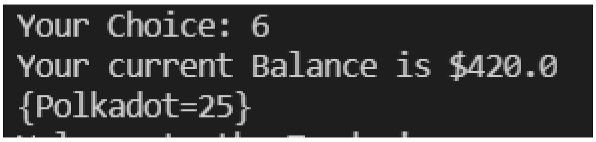
```
Enter 'Market' Order or 'Limit' Order: Market
----------------------------------------
1     Bitcoin
2     Ethereum
3     Polkadot
4     Ripple
5     Cardano
Enter what crypto you'd like to buy from the Market: Polkadot
Enter the amount you'd like to buy: 10
Order has been fullfilled.
```

Fig.10: User ‘Beppe’ buying 10 of Polkadot



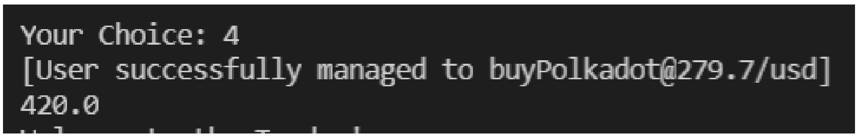
```
Your Choice: 6
Your current Balance is $420.0
```

Fig.11: User Beppe’s Balance



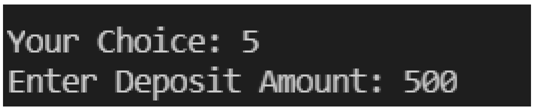
```
Your Choice: 6
Your current Balance is $420.0
{Polkadot=25}
```

Fig.12: User Beppe’s Balance after buying 10 Polkadot

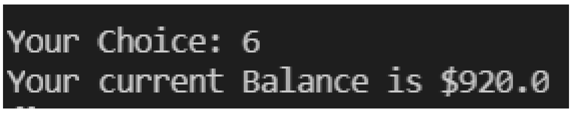


```
Your Choice: 4
[User successfully managed to buyPolkadot@279.7/usd]
420.0
```

Fig.13: The successful transaction of the purchase



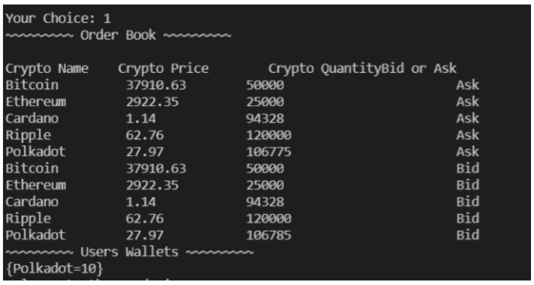
```
Your Choice: 5
Enter Deposit Amount: 500
```



```
Your Choice: 6
Your current Balance is $920.0
```

Fig.14: Depositing money into the account (left), and the balance after the addition of the money (right)

If at any point the user wishes to view their Order Book, the following is outputted:



```
Your Choice: 1
~~~~~~~~~ Order Book ~~~~~~~~~

Crypto Name    Crypto Price       Crypto QuantityBid or Ask
Bitcoin         37910.63      50000                       Ask
Ethereum        2922.35       25000                       Ask
Cardano         1.14          94328                       Ask
Ripple          62.76         120000                      Ask
Polkadot        27.97         106775                      Ask
Bitcoin         37910.63      50000                       Bid
Ethereum        2922.35       25000                       Bid
Cardano         1.14          94328                       Bid
Ripple          62.76         120000                      Bid
Polkadot        27.97         106785                      Bid
~~~~~~~~~ Users Wallets ~~~~~~~~~
{Polkadot=10}
```

Fig.15: Viewing the Order Book

This can be used to abide by the FATF regulations so that any fraudelemt activity can be investigated by the authorities and scenarios recreated.

UML

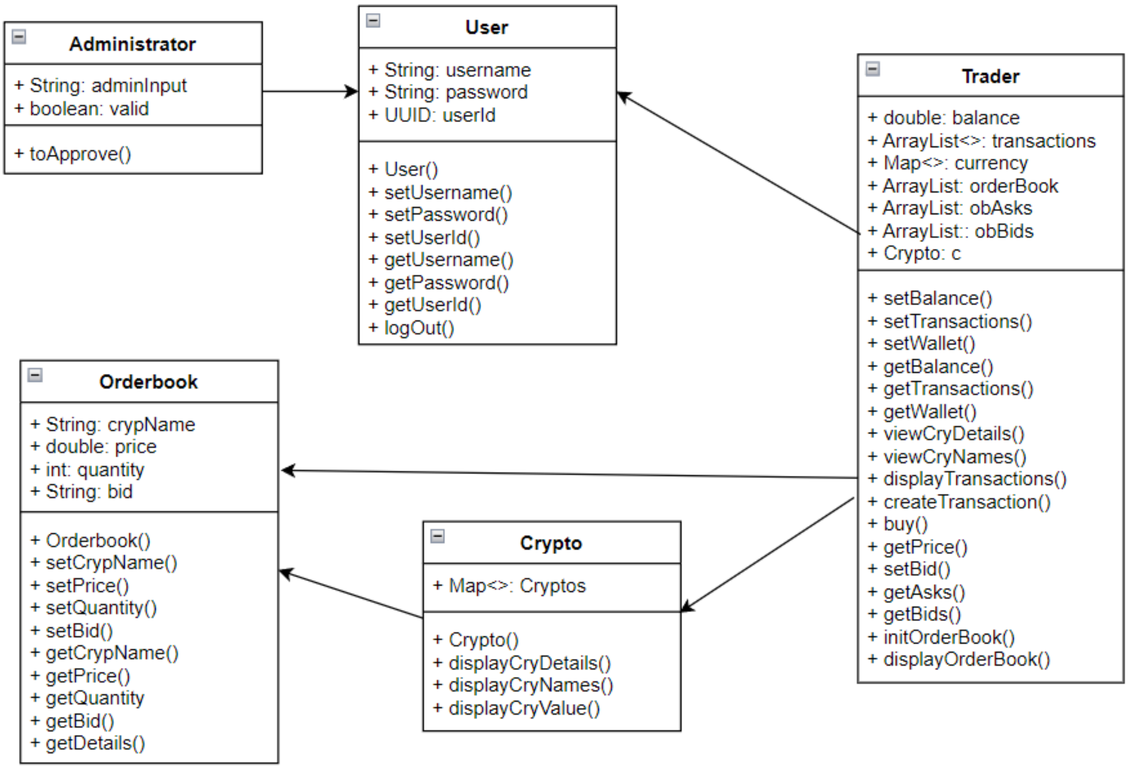
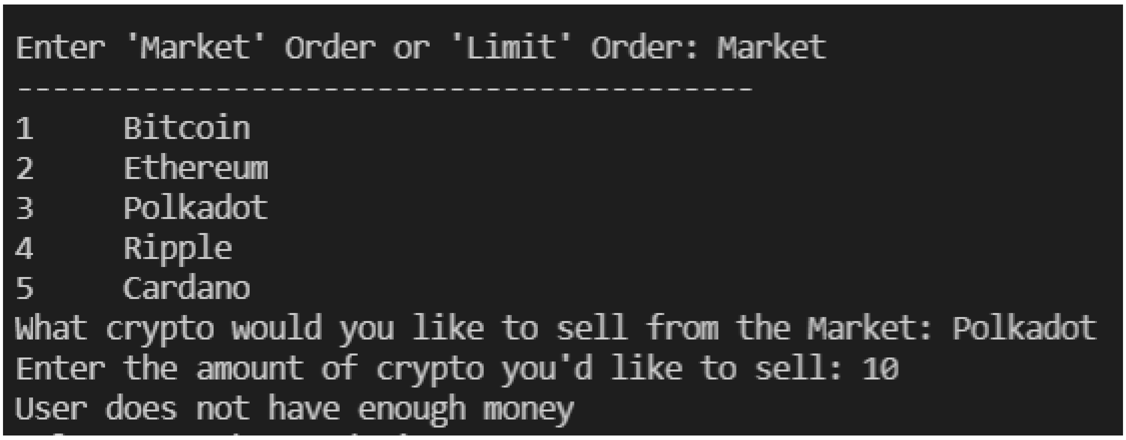


Fig.16: UML Diagram for Task 2

Possible Improvements:

As can be seen in the test cases above, the user’s balance wasn’t being updated whenever a purchase occurred, however whenever money was deposited, the balance was updated.

The sell function wasn’t properly working as whenever the user tried to sell the crypto that they had bought, it perceived it as the user trying to buy it instead of selling it as seen below:



```
Enter 'Market' Order or 'Limit' Order: Market
-----------------------------------------
1     Bitcoin
2     Ethereum
3     Polkadot
4     Ripple
5     Cardano
What crypto would you like to sell from the Market: Polkadot
Enter the amount of crypto you'd like to sell: 10
User does not have enough money
```

Fig.17: Failure to sell the 10 Polkadot the user Beppe had bought

Due to time constraints and the deadline these errors couldn’t be fixed. If they were to be fixed all requirements for the task would have been met.

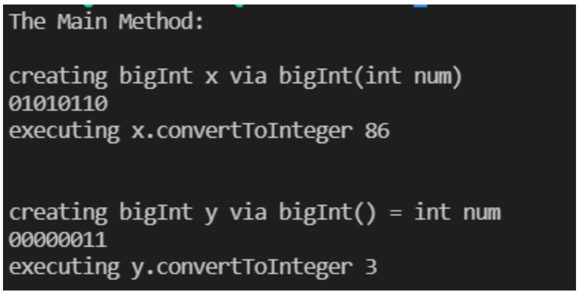
Big Integers (in C++)

Implementation of the Code

The third task consisted of writing a templated library that supports integers from 1-bit to 2048-bits. The libraray needed to only support unsigned integers with 2^n bits which through the use of the function powerOf2(), this is achieved. All binary integer operators (+, -, <<, >>) needed to be implemented and overloaded in the library. This is done through the use of operator+(), operator-(), operator<<(), and operator>>(). The operators *, /, % were implemented too: operator*(), operator/(), and operator%(). Since vector<bool> is being used, the minimum number of bits possible are being used to store a number which increases the efficiency of the code and since the operations are binary operations this also makes the code more efficient. The functions Integer_to_Binary, reverseBinary, printNum(), and onesComp() are all helper functions to be able to use the operators implemented, print the numbers, or even calculate one's compliment which is used in the operator-() function. The convertToInteger() function is used to convert the vector<bool> into an integer which is then used to display said integer during testing.

Test Cases

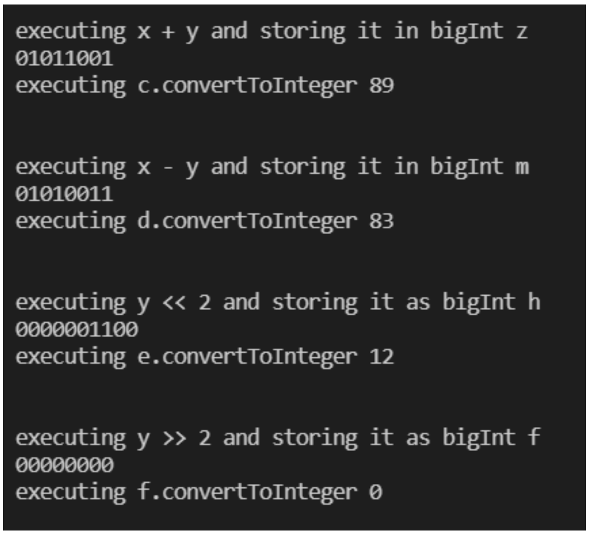
For testing the numbers used were 86 stored in x, and 3 stored in y. As can be seen, the numbers are converted to binary and are stored as vector<bool>. When outputting the number the convertToInteger() function is used to convert it back to int.



```
The Main Method:

creating bigInt x via bigInt(int num)
01010110
executing x.convertToInteger 86


creating bigInt y via bigInt() = int num
00000011
executing y.convertToInteger 3
```

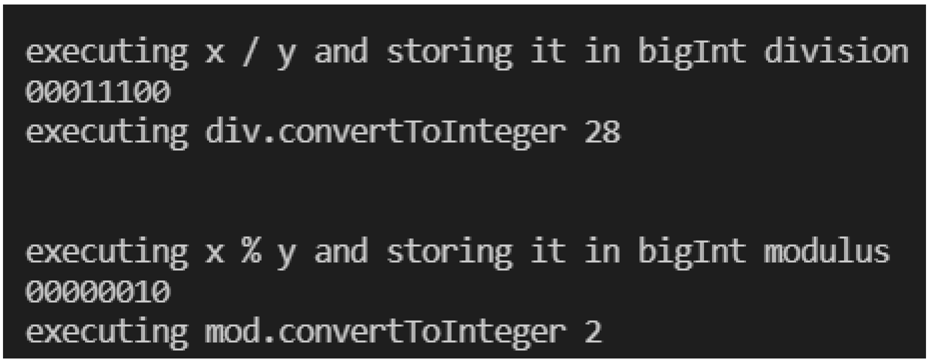
Fig.18: Numbers x(86) and y = 3 being declared

The operators =, -, <<, and >> were tested as seen below. The output was stored in various variables and then converted to integer.



```
executing x + y and storing it in bigInt z
01011001
executing c.convertToInteger 89


executing x - y and storing it in bigInt m
01010011
executing d.convertToInteger 83


executing y << 2 and storing it as bigInt h
0000001100
executing e.convertToInteger 12


executing y >> 2 and storing it as bigInt f
00000000
executing f.convertToInteger 0
```

Fig.19: Operators +, -, <<, and >> being used.



```
executing x / y and storing it in bigInt division
00011100
executing div.convertToInteger 28


executing x % y and storing it in bigInt modulus
00000010
executing mod.convertToInteger 2
```

Fig.20: Operators / and % being used.

UML

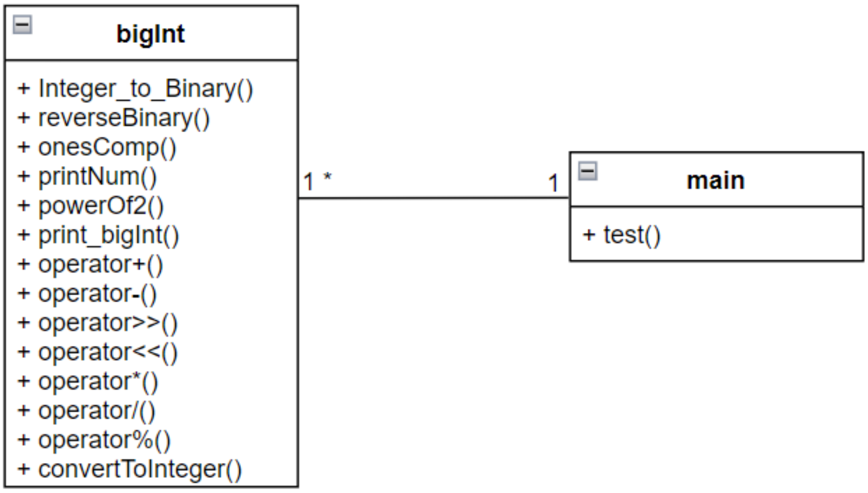
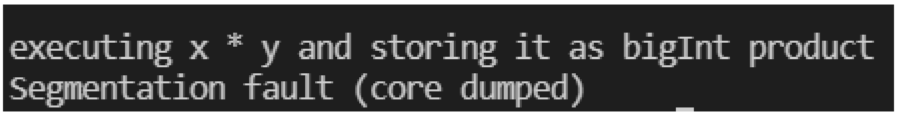


Fig.21: UML Diagram of Task 3

Possible Improvements

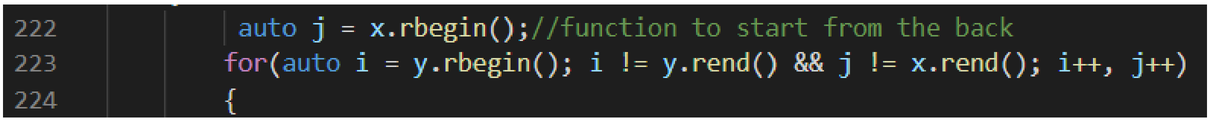
The operator*() function tends to cause a segmentation fault and as such this could be fixed in the future.



```
executing x * y and storing it as bigInt product
Segmentation fault (core dumped)
```

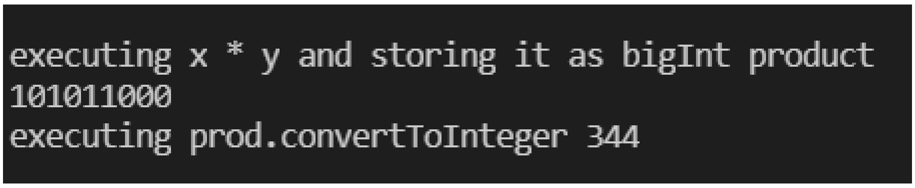
Fig.22: Segmentation fault cause by the operator*() function

A fix for this segmentation fault was found below however it affected the multiplication calculation and as such wasn't used.



```
222         auto j = x.rbegin();//function to start from the back
223        for(auto i = y.rbegin(); i != y.rend() && j != x.rend(); i++, j++)
224        {
```

Fig.23: Line 223 with the fixed segmentation fault



```
executing x * y and storing it as bigInt product
101011000
executing prod.convertToInteger 344
```

Fig.24: The calculation of 86 * 3 is incorrect