# *GIT Department of Computer Engineering*
# *CSE 222/505 - Spring 2020*
# *Homework 8*
# *Part 2*
# *Report*

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## *Problem Solution Approach*

*I design the extended graph ADT using 2-D linked-list structure. In 2-D linked-list structure . My linkedListGraph2D has inner node class which has data, rnext, rprev, cnext,cprev. In my main class which is LinkedListGraph2D has 4 node data which are firstRow, firstCol, lastRow, lastCol, and dimension value,vertice number and edge number. And finally I have an edge list which hold the edges.*

*My first method is addEdge(). That method add the edge to the two dimensional linked list. Firstly I find the address of edge. After that I change the node's data value to the 1. add to the edge list and increase the number of edge.*

*My second method is removeEdge(). That method remove a edge from the two dimensional linked list.Firstly I find the address of edge. After that I change the node's data value to the 0. remove from the edge list and decrease the number of edge.*

*My third method is addVertice(). That method add a vertex to two dimensional linked list. Firstly I add vertex to the end of the vertices. Then I create nodes between the all vertices. If there is an edge,I do not touch that node. But the node is not edge, I give 0 value to the node. which means node is not edge.*

*My fourth method is removeVertice(). Firstly remove the edges from the row which will be remove, remove from the edge list and decrease the number of edge. Then remove the row. After that, I do same process for column. Firstly remove the edges from the column which will be remove, remove from the edge list and decrease the number of edge. Then remove the column. That method remove the vertex from two dimensional linked list.*

*My fifth method is print(). That method prints the two dimensional linked list.*

*My sixth method is remove(). That method remove the edge which edge is given as a parameter. Difference between the remove and removeEdge is removeEdge takes address, but remove takes an Edge object.*

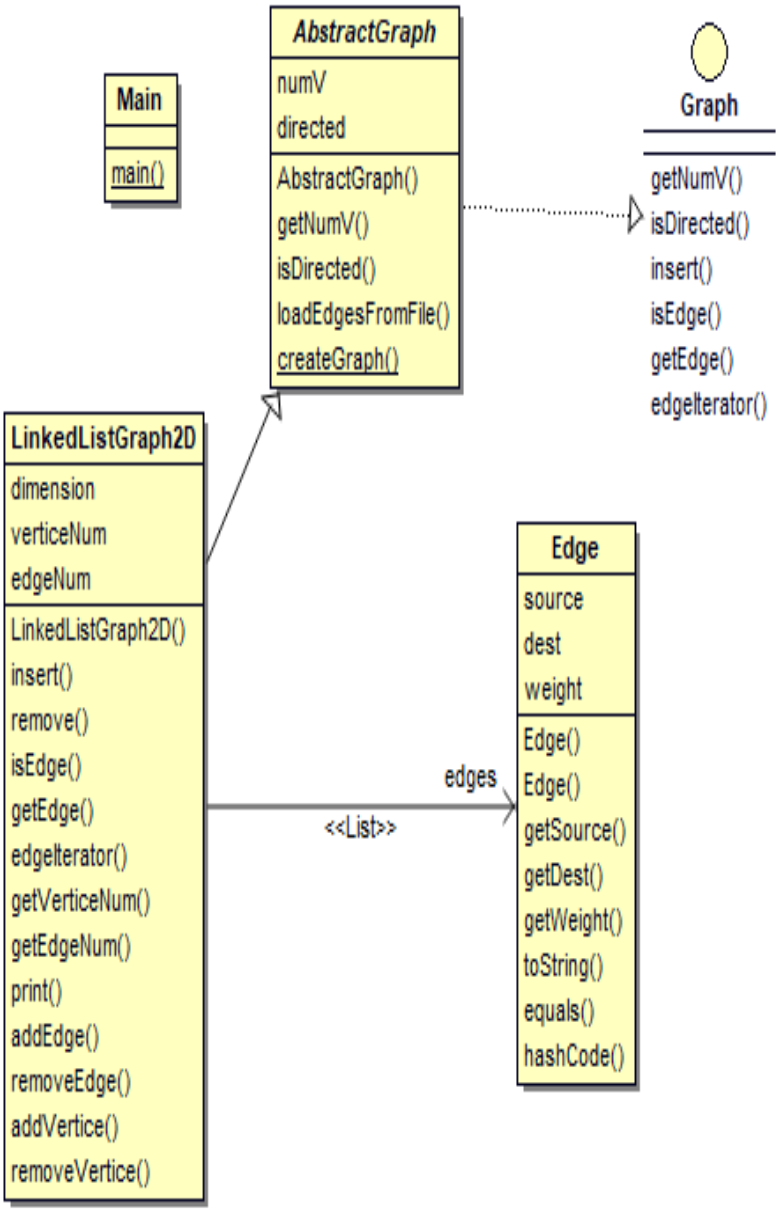
*My first override method is insert(). That method add an edge to the two dimensional linked list. Difference between the insert() and addEdge() is addEdge() takes address, but insert() takes an Edge object.*

***My second override method is isEdge(). That method checks the node is edge or not.***

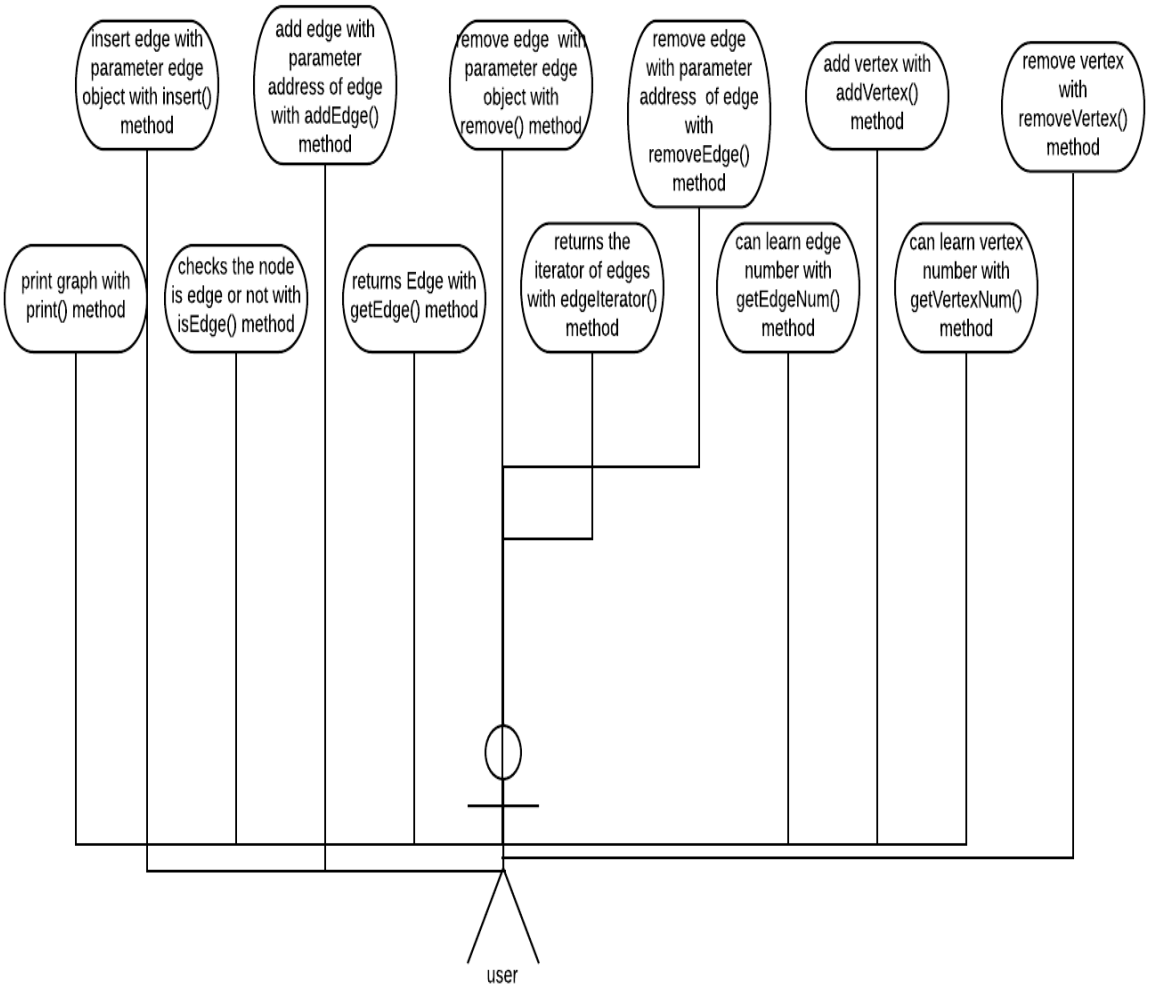
***My third override method is getEdge(). That method returns the edge.***

***My fourt override method is edgeIterator(). That method returns the edge list's iterator version.***

## *Class Diagram*



# *Use case Diagram*



# Test Cases

| Test Case ID | Test Scenario | Test Steps | Test Data | Expected Results | Actual Results | Pass/ Fail |
|---|---|---|---|---|---|---|
| T01 | Check constructor | Call constructor | (0,true) | - | - | pass |
| T02 | Check addVertice() method | Call addVertice() method | (123) | - | - | Pass |
| T03 | Check print() method | Call print() method | - | 123<br>123 | 123<br>123 | Pass |
| T04 | Check edgeIterator() method | Call edgeIterator() method | (0) | - | - | Pass |
| T05 | Check getEdgeNum() | Call getEdgeNum() | - | 0 | 0 | Pass |
| T06 | Check getVerticeNum() | Call getVerticeNum() | - | 1 | 1 | Pass |
| T07 | Check addVertice() method | Call addVertice() method | (456) | - | - | Pass |
| T08 | Check print() method | Call print() method | - | 123 456<br>123<br>456 | 123 456<br>123<br>456 | Pass |
| T09 | Check edgeIterator() method | Call edgeIterator() method | (0) | - | - | Pass |
| T10 | Check getEdgeNum() | Call getEdgeNum() | - | 0 | 0 | Pass |
| T11 | Check getVerticeNum() | Call getVerticeNum() | - | 2 | 2 | Pass |
| T12 | Check addVertice() method | Call addVertice() method | (789) | - | - | Pass |
| T13 | Check print() method | Call print() method | - | 123 456 789<br>123<br>456<br>789 | 123 456 789<br>123<br>456<br>789 | Pass |
| T14 | Check edgeIterator() method | Call edgeIterator() method | (0) | - | - | Pass |

| | | | | | | |
|---|---|---|---|---|---|---|
| T15 | Check getEdgeNum() | Call getEdgeNum() | - | 0 | 0 | Pass |
| T16 | Check getVerticeNum() | Call getVerticeNum() | - | 3 | 3 | Pass |
| T17 | Check addEdgeMethod( ) | Call addEdgeMethod( ) | (123,456) | - | - | Pass |
| T18 | Check print() method | Call print() method | - | 123 456 789<br>123 1<br>456<br>789 | 123 456 789<br>123 1<br>456<br>789 | Pass |
| T19 | Check edgeIterator() method | Call edgeIterator() method | (0) | [(123, 456): 1.0] | [(123, 456): 1.0] | Pass |
| T20 | Check getEdgeNum() | Call getEdgeNum() | - | 1 | 1 | Pass |
| T21 | Check getVerticeNum() | Call getVerticeNum() | - | 3 | 3 | Pass |
| T22 | Check addEdgeMethod( ) | Call addEdgeMethod( ) | (789,789) | - | - | Pass |
| T23 | Check print() method | Call print() method | - | 123 456 789<br>123 1<br>456<br>789 1 | 123 456 789<br>123 1<br>456<br>789 1 | Pass |
| T24 | Check edgeIterator() method | Call edgeIterator() method | (0) | [(123, 456): 1.0]<br>[(789, 789): 1.0] | [(123, 456): 1.0]<br>[(789, 789): 1.0] | Pass |
| T25 | Check getEdgeNum() | Call getEdgeNum() | - | 2 | 2 | Pass |
| T26 | Check getVerticeNum() | Call getVerticeNum() | - | 3 | 3 | Pass |
| T27 | Check addEdgeMethod( ) | Call addEdgeMethod( ) | (123,123) | - | - | Pass |
| T28 | Check print() method | Call print() method | - | 123 456 789<br>123 1 1<br>456<br>789 1 | 123 456 789<br>123 1 1<br>456<br>789 1 | Pass |
| T29 | Check edgeIterator() method | Call edgeIterator() method | (0) | [(123, 456): 1.0]<br>[(789, 789): 1.0]<br>[(123, 123): 1.0] | [(123, 456): 1.0]<br>[(789, 789): 1.0]<br>[(123, 123): 1.0] | Pass |
| T30 | Check getEdgeNum() | Call getEdgeNum() | - | 3 | 3 | Pass |

| | | | | | | |
|---|---|---|---|---|---|---|
| T31 | Check getVerticeNum() | Call getVerticeNum() | - | 3 | 3 | Pass |
| T32 | Check addEdgeMethod( ) | Call addEdgeMethod( ) | (789,123) | - | - | Pass |
| T33 | Check print() method | Call print() method | - | 123 456 789<br>123 1 1<br>456<br>789 1 1 | 123 456 789<br>123 1 1<br>456<br>789 1 1 | Pass |
| T34 | Check edgeIterator() method | Call edgeIterator() method | (0) | [(123, 456): 1.0]<br>[(789, 789): 1.0]<br>[(123, 123): 1.0]<br>[(789, 123): 1.0] | [(123, 456): 1.0]<br>[(789, 789): 1.0]<br>[(123, 123): 1.0]<br>[(789, 123): 1.0] | Pass |
| T35 | Check getEdgeNum() | Call getEdgeNum() | - | 4 | 4 | Pass |
| T36 | Check getVerticeNum() | Call getVerticeNum() | - | 3 | 3 | Pass |
| T37 | Check removeEdge() | call removeEdge() | (789,123) | - | - | Pass |
| T38 | Check print() method | Call print() method | - | 123 456 789<br>123 1 1<br>456<br>789 1 | 123 456 789<br>123 1 1<br>456<br>789 1 | Pass |
| T39 | Check edgeIterator() method | Call edgeIterator() method | (0) | [(123, 456): 1.0]<br>[(789, 789): 1.0]<br>[(123, 123): 1.0] | [(123, 456): 1.0]<br>[(789, 789): 1.0]<br>[(123, 123): 1.0] | Pass |
| T40 | Check getEdgeNum() method | Call getEdgeNum() | - | 3 | 3 | Pass |
| T41 | Check getVerticeNum() Method | Call getVerticeNum() | - | 3 | 3 | Pass |
| T42 | Check insert() method | Call insert() method | (456,456) | - | - | Pass |
| T43 | Check print() method | Call print() method | - | 123 456 789<br>123 1 1<br>456 1<br>789 1 | 123 456 789<br>123 1 1<br>456 1<br>789 1 | Pass |
| T44 | Check edgeIterator() method | Call edgeIterator() method | (0) | [(123, 456): 1.0]<br>[(789, 789): 1.0]<br>[(123, 123): 1.0]<br>[(456, 456): 1.0] | [(123, 456): 1.0]<br>[(789, 789): 1.0]<br>[(123, 123): 1.0]<br>[(456, 456): 1.0] | Pass |

| | | | | | | |
|---|---|---|---|---|---|---|
| T45 | Check getEdgeNum() method | Call getEdgeNum() | - | 4 | 4 | Pass |
| T46 | Check getVerticeNum() Method | Call getVerticeNum() | - | 3 | 3 | Pass |
| T47 | Check isEdge() method | Call isEdge() method() | (456,456) | True | True | Pass |
| T48 | Check getEdge() method with getSource() method | call getEdge() method with getSource() method | (456,456) | 456 | 456 | Pass |
| T49 | Check getEdge() method with getDest() method | call getEdge() method with getDest() method | (456,456) | 456 | 456 | Pass |
| T50 | Check isEdge() method | Call isEdge() method() | (789,123) | True | True | Pass |
| T51 | Check getEdge() method with getSource() method | call getEdge() method with getSource() method | (789,123) | 789 | 789 | Pass |
| T52 | Check getEdge() method with getDest() method | call getEdge() method with getDest() method | (789,123) | 123 | 123 | Pass |
| T53 | Check remove() method | Call remove() method | (Edge(123, 456)) | - | - | Pass |
| T54 | Check print() method | Call print() method | - | 123 456 789<br>123 1<br>456 1<br>789 1 | 123 456 789<br>123 1<br>456 1<br>789 1 | Pass |
| T55 | Check edgeIterator() method | Call edgeIterator() method | (0) | [(789, 789): 1.0]<br>[(123, 123): 1.0]<br>[(456, 456): 1.0] | [(789, 789): 1.0]<br>[(123, 123): 1.0]<br>[(456, 456): 1.0] | Pass |
| T56 | Check getEdgeNum() method | Call getEdgeNum() | - | 3 | 3 | Pass |
| T57 | Check getVerticeNum() Method | Call getVerticeNum() | - | 3 | 3 | Pass |
| T58 | Check removeVertice() method | Call removeVertice() method | (456) | - | - | Pass |

| | | | | | | |
|---|---|---|---|---|---|---|
| T59 | Check print() method | Call print() method | - | 123 789<br>123 1<br>789 1 | 123 789<br>123 1<br>789 1 | Pass |
| T60 | Check edgeIterator() method | Call edgeIterator() method | (0) | [(789, 789): 1.0]<br>[(123, 123): 1.0] | [(789, 789): 1.0]<br>[(123, 123): 1.0] | Pass |
| T61 | Check getEdgeNum() method | Call getEdgeNum() | - | 2 | 2 | Pass |
| T62 | Check getVerticeNum() Method | Call getVerticeNum() | - | 2 | 2 | Pass |
| T63 | Check removeVertice() method | Call removeVertice() method | (123) | - | - | Pass |
| T64 | Check print() method | Call print() method | - | 789<br>789 1 | 789<br>789 1 | Pass |
| T65 | Check edgeIterator() method | Call edgeIterator() method | (0) | [(789, 789): 1.0] | [(789, 789): 1.0] | Pass |
| T66 | Check getEdgeNum() method | Call getEdgeNum() | - | 1 | 1 | Pass |
| T67 | Check getVerticeNum() Method | Call getVerticeNum() | - | 1 | 1 | Pass |
| T68 | Check removeVertice() method | Call removeVertice() method | (789) | - | - | Pass |
| T69 | Check print() method | Call print() method | - | | | Pass |
| T70 | Check edgeIterator() method | Call edgeIterator() method | (0) | | | Pass |
| T71 | Check getEdgeNum() method | Call getEdgeNum() | - | 0 | 0 | Pass |
| T72 | Check getVerticeNum() Method | Call getVerticeNum() | - | 0 | 0 | Pass |

## *Run time results*

### *T02-T03-T04-T05-T06*

```
addVertice (123)

        123
123
edges:

edge number: 0
vertex number: 1
```

### *T07-T08-T09-T10-T11*

```
----------------------------------------
addVertice (456)

        123     456
123
456
edges:

edge number: 0
vertex number: 2

----------------------------------------
```

### *T12-T13-T14-T15-T16*

```
----------------------------------------
addVertice (789)

       123     456     789
123
456
789
edges:

edge number: 0
vertex number: 3

----------------------------------------
```

**T17-T18-T19-T20-T21**

```
----------------------------------------
addEdge (123,456)

        123     456     789
123             1
456
789
edges:
[(123, 456): 1.0]

edge number: 1
vertex number: 3
```

**T22-T23-T24-T25-T26**

```
----------------------------------------
addEdge (789,789)

        123     456     789
123             1
456
789                     1
edges:
[(123, 456): 1.0]
[(789, 789): 1.0]

edge number: 2
vertex number: 3

----------------------------------------
```

**T27-T28-T29-T30-T31**

```
----------------------------------------
addEdge (123,123)

        123     456     789
123     1       1
456
789                     1
edges:
[(123, 456): 1.0]
[(789, 789): 1.0]
[(123, 123): 1.0]

edge number: 3
vertex number: 3

----------------------------------------
```

## T32-T33-T34-T35-T36

```
----------------------------------------
addEdge (789,123)

        123     456     789
123     1       1
456
789     1               1
edges:
[(123, 456): 1.0]
[(789, 789): 1.0]
[(123, 123): 1.0]
[(789, 123): 1.0]

edge number: 4
vertex number: 3

----------------------------------------
```

## T37-T38-T39-T40-T41

```
----------------------------------------
removeEdge (789,123)

        123     456     789
123     1       1
456
789                     1
edges:
[(123, 456): 1.0]
[(789, 789): 1.0]
[(123, 123): 1.0]

edge number: 3
vertex number: 3

----------------------------------------
```

## T42-T43-T44-T45-T46

```
----------------------------------------
insert (456,456)

        123     456     789
123     1       1
456             1
789                     1
edges:
[(123, 456): 1.0]
[(789, 789): 1.0]
[(123, 123): 1.0]
[(456, 456): 1.0]

edge number: 4
vertex number: 3

----------------------------------------
```

## T47-T48-T49

```
----------------------------------------
isEdge(456,456) -> true
source     :456
destination:456

----------------------------------------
```

## T50-T51-T52

```
----------------------------------------
isEdge(789,123) -> false
source     :789
destination:123

----------------------------------------
```

## T53-T54-T55-T56-T57

```
----------------------------------------
remove(Edge(123,456))

        123     456     789
123     1
456             1
789                     1
edges:
[(789, 789): 1.0]
[(123, 123): 1.0]
[(456, 456): 1.0]

edge number: 3
vertex number: 3

----------------------------------------
```

## T58-T59-T60-T61-T62

```
----------------------------------------
removeVertice(456)

        123     789
123     1
789             1
edges:
[(789, 789): 1.0]
[(123, 123): 1.0]

edge number: 2
vertex number: 2

----------------------------------------
```

## T63-T64-T65-T66-T67

```
----------------------------------------
removeVertice(123)

        789
789     1
edges:
[(789, 789): 1.0]

edge number: 1
vertex number: 1

----------------------------------------
```

## T68-T69-T70-T71-T72

```
----------------------------------------
removeVertice(789)


edges:

edge number: 0
vertex number: 0
```