Representation

```
def __init__(self):
   self._dictIn = {} – dictionary of dictionaries – map used to store the in vertices
   self._dictOut = {} - – dictionary of dictionaries – map used to store the out vertices
   self._dictCosts = {} – dictionary with pairs as keys – maps pairs to costs
   self._vertices = 0
   self._edges = 0
```

Specification

Class DoubleDictGraph provides the following methods:

def __init__(self)

Constructs a graph without vertices or arcs.

def vertices(self)

Returns the number of vertices.

def edges(self)

Returns the number of edges.

def is_edge(self,x, y)

Checks whether or not there is an arc between x and y.

def is_vertice(self,n)

Checks whether or not n is a vertex.

def add_vertex(self)

Adds a new vertex to the graph.

def remove_vertex(self, vertex)

Removes the vertex n from the graph.

Precondition: n is a vertex .

def add_edge(self, x, y, cost)

Adds an edge to the graph.

Precondition: x and y are existent vertices and the edge x-y doesn’t exist.

def remove_edge(self, x, y)

Removes an edge from the graph.

Precondition: x-y is an edge.

def get_vertices(self)

Returns a list of all vertices.

def get_in_degree(self, vertex)

Returns the in degree of a given vertex.

Precondition: vertex is in the graph.

def get_out_degree(self, vertex)

Returns the out degree of a given vertex.

Precondition: vertex is in the graph.

def parse_outbound(self, vertex)

Returns the list of outbound neighbors of a given vertex.

Precondition: vertex is in the graph.

def parse_inbound(self, vertex)

Returns the list of inbound neighbors of a given vertex.

Precondition: vertex is in the graph.

def get_cost(self, x, y)

Returns the cost of a given edge.

Precondition: x and y are vertices in the graph.

def modify_cost(self,x, y,newValue)

Changes the cost of a given edge.

Precondition: the edge is in the graph.

def copy(self)

Returns a deep copy of the graph.

def get_costs(self):

Returns the dictionary of costs.

External functions:

def loadGraphs(graph, filename)

Loads a graph from a text file in the memory.

def storeGraph(graph, filename)

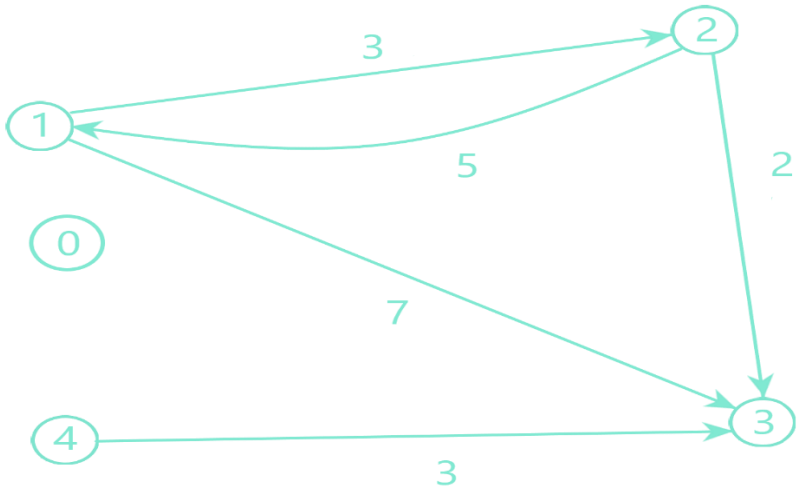
Stores a graph from memory to a text file

def generateRandomGraph(vertices, edges)

Returns a random generated graph with a given number of vertices and edges

Examples

The following graph can be obtained by applying the add_vertex() method 5 times and the add_edge method in the following way: add_edge(1,2,3) , add_edge(1,3,7) , add_edge(2,1,5), add_edge(2,3,2), add_edge(4,3,3).



For this graph the initial values will be:

self._dictIn = {

0 : {}

1 : {0 : 2}

2 : { 0 : 1}

3 : {0 : 1, 1 : 2, 2:4}

4: {}

self._dictOut = {

0 : {}

1 : {0 : 2, 1 : 3}

2 : {0 : 1, 1 : 3}

3: {}

4 : {0 : 3}

}

self._dictCosts = {

(1, 2) : 3,

(1, 3) : 7,

(2, 1) : 5,

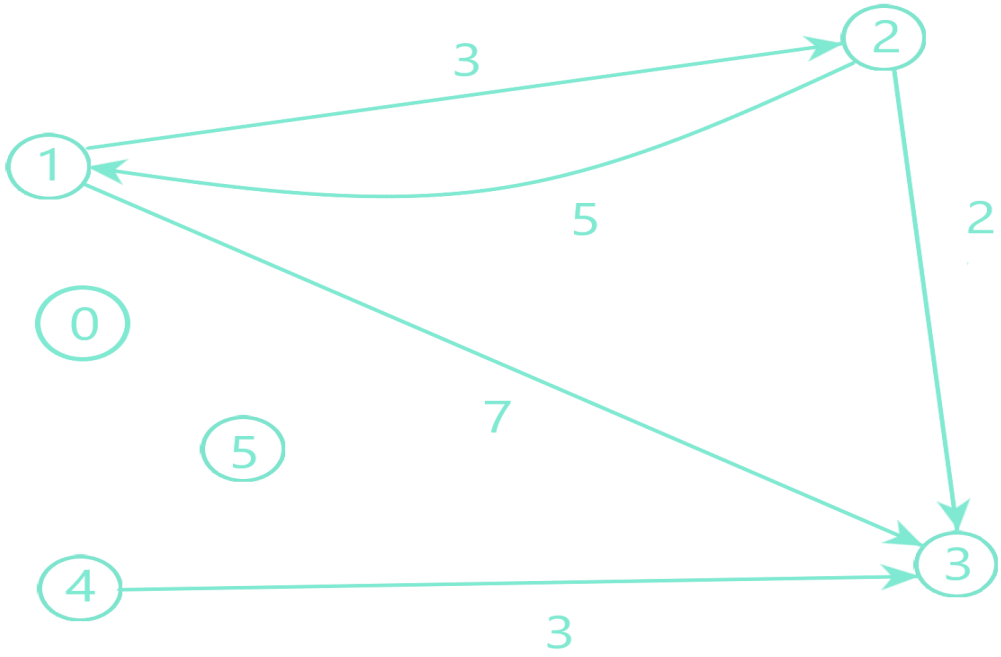
(2, 3) : 2,

(4, 3) : 3

}

self._vertices = 5
self._edges = 5

For the same graph if I call add_vertex method:



self._dictIn = {
0 : {}
1 : {0 : 2}
2 : { 0 : 1}
3 : {0 : 1, 1 : 2, 2:4}
4: {},
5: {}
}

self._dictOut = {
0 : {}
1 : {0 : 2, 1 : 3}
2 : {0 : 1, 1 : 3}
3: {}
4 : {0 : 3},
5 : {}
}

self._dictCosts = {
(1, 2) : 3
(1, 3) : 7
(2, 1) : 5
(2, 3) : 2
(4, 3) : 3
}

self._vertices = 6
self._edges = 5

Also if we call remove_vertex(1) on the previous graph we obtain the following values:

self._dictIn = {

0 : {}

1 : {}

2 : { 0 : 1, 1 : 3}

3 : {}

4: {},

}

self._dictOut = {

0 : {}

1 : {0 : 2}

2 : {}

3: {0 : 2}

4 : {},

}

self._dictCosts = {

(1, 2) : 2

(3, 2) : 3

}

self._vertices = 5
self._edges = 2