

Programming Assignment-3

(Chapter 4, Question 10)

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Results obtained for randomly generated test cases (left) and brute force technique (right)

```
Random test cases generated with following values for nodes (vertices): [426, 209, 357, 865, 227, 760, 935, 692, 919, 122]
MST 1 COST : 21371
MST CHANGED because of new edge added
UPDATED MST
Name:
Type: Graph
Number of nodes: 426
Number of edges: 425
Average degree: 1.9953
MST UPDATED cost : 21285
MST costs found for graph with n= 426 nodes
-----
MST 1 COST : 10834
MST CHANGED because of new edge added
UPDATED MST
Name:
Type: Graph
Number of nodes: 209
Number of edges: 208
Average degree: 1.9904
MST UPDATED cost : 10799
MST costs found for graph with n= 209 nodes
-----
MST 1 COST : 17197
MST CHANGED because of new edge added
UPDATED MST
Name:
Type: Graph
Number of nodes: 357
Number of edges: 356
Average degree: 1.9944
MST UPDATED cost : 17180
MST costs found for graph with n= 357 nodes
-----
MST 1 COST : 43912
MST CHANGED because of new edge added
UPDATED MST
Name:
Type: Graph
Number of nodes: 865
Number of edges: 864
Average degree: 1.9977
MST UPDATED cost : 43818
MST costs found for graph with n= 865 nodes
```

```
Random test cases generated with following values for nodes (vertices): [12, 8, 6, 14, 7, 10, 11, 13, 9, 4]
MST 1 COST 427
MST 2 COST 333
MST CHANGED for graph with n= 12 nodes and verified using brute force
Updated MST Cost 333
Name:
Type: Graph
Number of nodes: 12
Number of edges: 11
Average degree: 1.8333
-----
MST 1 COST 221
MST 2 COST 188
MST CHANGED for graph with n= 8 nodes and verified using brute force
Updated MST Cost 188
Name:
Type: Graph
Number of nodes: 8
Number of edges: 7
Average degree: 1.7500
-----
MST 1 COST 172
MST 2 COST 111
MST CHANGED for graph with n= 6 nodes and verified using brute force
Updated MST Cost 111
Name:
Type: Graph
Number of nodes: 6
Number of edges: 5
Average degree: 1.6667
-----
MST 1 COST 746
MST 2 COST 709
MST CHANGED for graph with n= 14 nodes and verified using brute force
Updated MST Cost 709
Name:
Type: Graph
Number of nodes: 14
Number of edges: 13
Average degree: 1.8571
-----
MST 1 COST 245
MST 2 COST 221
MST CHANGED for graph with n= 7 nodes and verified using brute force
```

Pseudocode

- Generate 10 random test cases with n nodes for a graph.
- Create a graph G using *networkx* library.

graph=nx.cycle_graph(5)

- Determine the minimum spanning tree (MST) T and its cost.
- Add an edge $e=(u,v)$ with weight w in G

graph.add_edge(1,5,weight=1)

- Find the cycle C formed by adding the new edge $e=(u,v)$ to T
- Find the edge e^* in cycle C that has maximum weight w^*
- Is $w < w^*$
 - If yes, then new MST $T^*=T-e^*+e$ is the MST for graph $G+e$
 - If not, then $T^*=T$ is the MST of $G+e$

Validation of correctness of randomly generated test cases (n=1,2....15)

```
Random test cases generated with following values for nodes (vertices): [12, 8, 6, 14, 7, 10, 11, 13, 9, 4]
MST 1 COST 427
MST 2 COST 333
MST CHANGED for graph with n= 12 nodes and verified using brute force
Updated MST Cost 333
Name:
Type: Graph
Number of nodes: 12
Number of edges: 11
Average degree: 1.8333
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MST 1 COST 221
MST 2 COST 188
MST CHANGED for graph with n= 8 nodes and verified using brute force
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Number of nodes: 14
Number of edges: 13
Average degree: 1.8571
-----
MST 1 COST 245
MST 2 COST 221
MST CHANGED for graph with n= 7 nodes and verified using brute force
```

Validation of correctness of randomly generated test cases (n=1,2....15)(Continuation)

```
MST 1 COST 245
MST 2 COST 221
MST CHANGED for graph with n= 7  nodes and verified using brute force
Updated MST Cost 221
Name:
Type: Graph
Number of nodes: 7
Number of edges: 6
Average degree:  1.7143
-----
MST 1 COST 387
MST 2 COST 352
MST CHANGED for graph with n= 10  nodes and verified using brute force
Updated MST Cost 352
Name:
Type: Graph
Number of nodes: 10
Number of edges: 9
Average degree:  1.8000
-----
MST 1 COST 495
MST 2 COST 415
MST CHANGED for graph with n= 11  nodes and verified using brute force
Updated MST Cost 415
Name:
Type: Graph
Number of nodes: 11
Number of edges: 10
Average degree:  1.8182
-----
MST 1 COST 526
MST 2 COST 458
MST CHANGED for graph with n= 13  nodes and verified using brute force
Updated MST Cost 458
Name:
Type: Graph
Number of nodes: 13
Number of edges: 12
Average degree:  1.8462
-----
MST 1 COST 364
MST 2 COST 321
MST CHANGED for graph with n= 9  nodes and verified using brute force
Updated MST Cost 321
```

Validation of correctness of randomly generated test cases (n=1,2....15)(Continuation)

```
MST 1 COST 364
MST 2 COST 321
MST CHANGED for graph with n= 9  nodes and verified using brute force
Updated MST Cost 321
Name:
Type: Graph
Number of nodes: 9
Number of edges: 8
Average degree:  1.7778
-----
MST 1 COST 100
MST 2 COST 58
MST CHANGED for graph with n= 4  nodes and verified using brute force
Updated MST Cost 58
Name:
Type: Graph
Number of nodes: 4
Number of edges: 3
Average degree:  1.5000
-----
```

Validation of performance

- Time complexity to check if current MST has been updated after adding new edge to graph G is $O(|V|)$ where $|V|$ is the number of nodes (vertices)
- Time complexity to update old MST is $O(|V|)$ where $|V|$ is the number of nodes (vertices)

