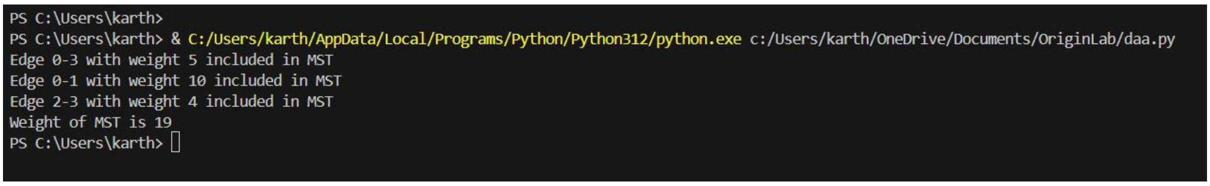
10. Boruvka's Algorithm

Code:

```
class Graph:
    def __init__(self, vertices):
        self.V = vertices
        self.graph = []
    def add_edge(self, u, v, w):
        self.graph.append([u, v, w])
    def find(self, parent, i):
        if parent[i] == i:
            return i
        return self.find(parent, parent[i])
    def union(self, parent, rank, x, y):
        xroot = self.find(parent, x)
        yroot = self.find(parent, y)
        if rank[xroot] < rank[yroot]:
            parent[xroot] = yroot
        elif rank[xroot] > rank[yroot]:
            parent[yroot] = xroot
        else:
            parent[yroot] = xroot
            rank[xroot] += 1
    def boruvka_mst(self):
        parent = []
        rank = []
        for node in range(self.V):
            parent.append(node)
            rank.append(0)
        num_trees = self.V
        mst_weight = 0
        while num_trees > 1:
            cheapest = [-1] * self.V
            for u, v, w in self.graph:
                u_set = self.find(parent, u)
                v_set = self.find(parent, v)
                if u_set != v_set:
                    if cheapest[u_set] == -1 or cheapest[u_set][2] > w:
                        cheapest[u_set] = [u, v, w]
                    if cheapest[v_set] == -1 or cheapest[v_set][2] > w:
                        cheapest[v_set] = [u, v, w]
            for node in range(self.V):
                if cheapest[node] != -1:
                    u, v, w = cheapest[node]
                    u_set = self.find(parent, u)
                    v_set = self.find(parent, v)
                    if u_set != v_set:
                        mst_weight += w
                        self.union(parent, rank, u_set, v_set)
                        print(f"Edge {u}-{v} with weight {w} included in MST")
                        num_trees -= 1
        print(f"Weight of MST is {mst_weight}")
g = Graph(4)
g.add_edge(0, 1, 10)
g.add_edge(0, 2, 6)
g.add_edge(0, 3, 5)
g.add_edge(1, 3, 15)
g.add_edge(2, 3, 4)
g.boruvka_mst()
```

output:



```
PS C:\Users\karth>
PS C:\Users\karth> & C:/Users/karth/AppData/Local/Programs/Python/Python312/python.exe c:/Users/karth/OneDrive/Documents/OriginLab/daa.py
Edge 0-3 with weight 5 included in MST
Edge 0-1 with weight 10 included in MST
Edge 2-3 with weight 4 included in MST
Weight of MST is 19
PS C:\Users\karth> 
```

time complexity:

f(n)=o(elogv)