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1 // Kruskal's Implementation using priority_queue
2 //Complexity : O(E logE)   E is the no of edges
3 #include<bits/stdc++.h>
4 using namespace std;
5
6 //declaring all class those we are using
7 class Graph;
8 class MinHeap;
9 class UnionFind;
10
11 //Create a structure that represent a node in which there are source, destination and
    its weight
12 struct node
13 {
14     int source;
15     int dest;
16     int weight;
17 };
18
19 //class Graph for creating a graph
20 class Graph
21 {
22 private:
23     int rows=6,column=6; //No of rows and columns (no need)
24 public:
25
26     int totalCost=0;
27     void addEdge(int,int,int); //add an edge to the adj Matrix
28     void kruskal(); //Perform Kruskal's Algorithm
29
30 };
31
32 //Class that contains minHeap
33 class MinHeap
34 {
35 private:
36     struct node minHeap[500];
37     int length;
38 public:
39     void addNode(int ,int ,int);
40     void heapify(int);
41     void buildHeap();
42     void printHeap();
43     void deleteMin();
44     struct node ExtractMin();
45     int isEmpty();
46 };
47 //Class for performing disjoint set
48 class UnionFind
49 {
50 private:
51     int parent[6];
52     int ParentLength=6;
53
54 public:
55     void initializeParent();
56     int findParent(int ); //find the parent of any node
57     void unionSet(int ,int ); //perform union of two sets
58     void printParent();
59 };
60 Graph graph1;
61 MinHeap minHeap1;
62 UnionFind unionFind1;
63
64 void Graph::addEdge(int source,int dest,int weight)
65 {
66     minHeap1.addNode(source,dest,weight);
67 }
68 void MinHeap::addNode(int source,int dest,int weight)

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69     {
70         minHeap[length].dest=dest;
71         minHeap[length].source=source;
72         minHeap[length].weight=weight;
73         length++;
74     }
75 }
76 void MinHeap::heapify(int parent)
77 {
78     int leftChild=2*parent+1;
79     int rightChild=2*parent+2;
80     int smallest=parent;
81     if(leftChild<length && minHeap[leftChild].weight<minHeap[parent].weight)
82     {
83         smallest=leftChild;
84     }
85     if(rightChild<length && minHeap[rightChild].weight<minHeap[smallest].weight)
86     {
87         smallest=rightChild;
88     }
89     if(smallest!=parent)
90     {
91         swap(minHeap[smallest],minHeap[parent]);
92         heapify(smallest);
93     }
94 }
95 void MinHeap::buildHeap()
96 {
97     for(int i=(length-1)/2;i>=0;i--)
98     {
99         heapify(i);
100     }
101 }
102 void MinHeap::deleteMin()
103 {
104     if(isEmpty())
105     {
106         cout<<"Empty\n";
107     }
108     else{
109         swap(minHeap[length-1],minHeap[0]);
110         length--;
111         heapify(0);
112     }
113 }
114 int MinHeap::isEmpty()
115 {
116     if(length==0)
117     {
118         return 1;
119     }
120     else
121     {
122         return 0;
123     }
124 }
125 void MinHeap::printHeap()
126 {
127     cout<<"--Min Heap -- "<<endl;
128     for(int i=0;i<length;i++)
129     {
130         //cout<<minHeap[i].source<<" "<<minHeap[i].dest<<" "<<minHeap[i].weight<<endl;
131         cout<<minHeap[i].weight<<" ";
132     }
133     cout<<endl;
134 }
135 struct node MinHeap::ExtractMin()
136 {
137     return minHeap[0];

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138     };
139
140     void UnionFind::initializeParent()
141     {
142         for(int i=0;i<ParentLength;i++)
143         {
144             parent[i]=-1;
145         }
146     }
147
148     int UnionFind::findParent(int index)
149     {
150         //cout<<"inside find Parent \n";
151         if(parent[index]==-1)
152         {
153             return index;
154         }
155         else
156         {
157             return findParent(parent[index]);
158         }
159     }
160     void UnionFind::unionSet(int u,int v)
161     {
162         int parentU=findParent(u);
163         int parentV=findParent(v);
164         parent[parentV]=parentU;
165     }
166     void UnionFind::printParent()
167     {
168         cout<<"Parent array -----"<<endl;
169         for(int i=0;i<ParentLength;i++)
170         {
171             cout<<parent[i]<<" ";
172         }
173         cout<<endl;
174     }
175     //kruskal's perform
176     void Graph::kruskal()
177     {
178         cout<<"-----Inside
179         Kruskal-----"<<endl;
180         if(minHeap1.isEmpty())
181         {
182             cout<<"empty\n";
183             return;
184         }
185         struct node temp;
186         temp=minHeap1.ExtractMin();
187         minHeap1.deleteMin();
188         int u =temp.source;
189         int v = temp.dest;
190         cout<<"Source="<<u<<" destination = "<<v<<" weight = "<<temp.weight<<endl;
191         int parentU=unionFind1.findParent(u);
192         int parentV= unionFind1.findParent(v);
193         cout<<"ParentU = "<<parentU<<" ParentV = "<<parentV<<endl;
194         if(parentU!=parentV)
195         {
196             cout<<"not cycle\n";
197             unionFind1.unionSet(u,v);
198             totalCost+=temp.weight;
199             unionFind1.printParent();
200             minHeap1.printHeap();
201             kruskal();
202         }
203         else
204         {
205

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206         kruskal();
207     }
208 }
209 int main()
210 {
211     //graph1.initializeAdjMatrix();
212
213     graph1.addEdge(0,1,7);
214     graph1.addEdge(0,2,9);
215     graph1.addEdge(0,5,14);
216     graph1.addEdge(1,2,10);
217     graph1.addEdge(1,3,15);
218     graph1.addEdge(2,3,11);
219     graph1.addEdge(2,5,2);
220     graph1.addEdge(3,4,6);
221     graph1.addEdge(4,5,9);
222
223     minHeap1.buildHeap();
224     minHeap1.printHeap();
225     unionFind1.initializeParent();
226     graph1.kruskal();
227     cout<<"total cost="<<graph1.totalCost<<endl;
228 }
229
```