RAJSHAHI UNIVERSITY OF ENGINEERING AND TECHNOLOGY

Course No: CSE 2201

Course Title: Sessional Based on CSE-2201

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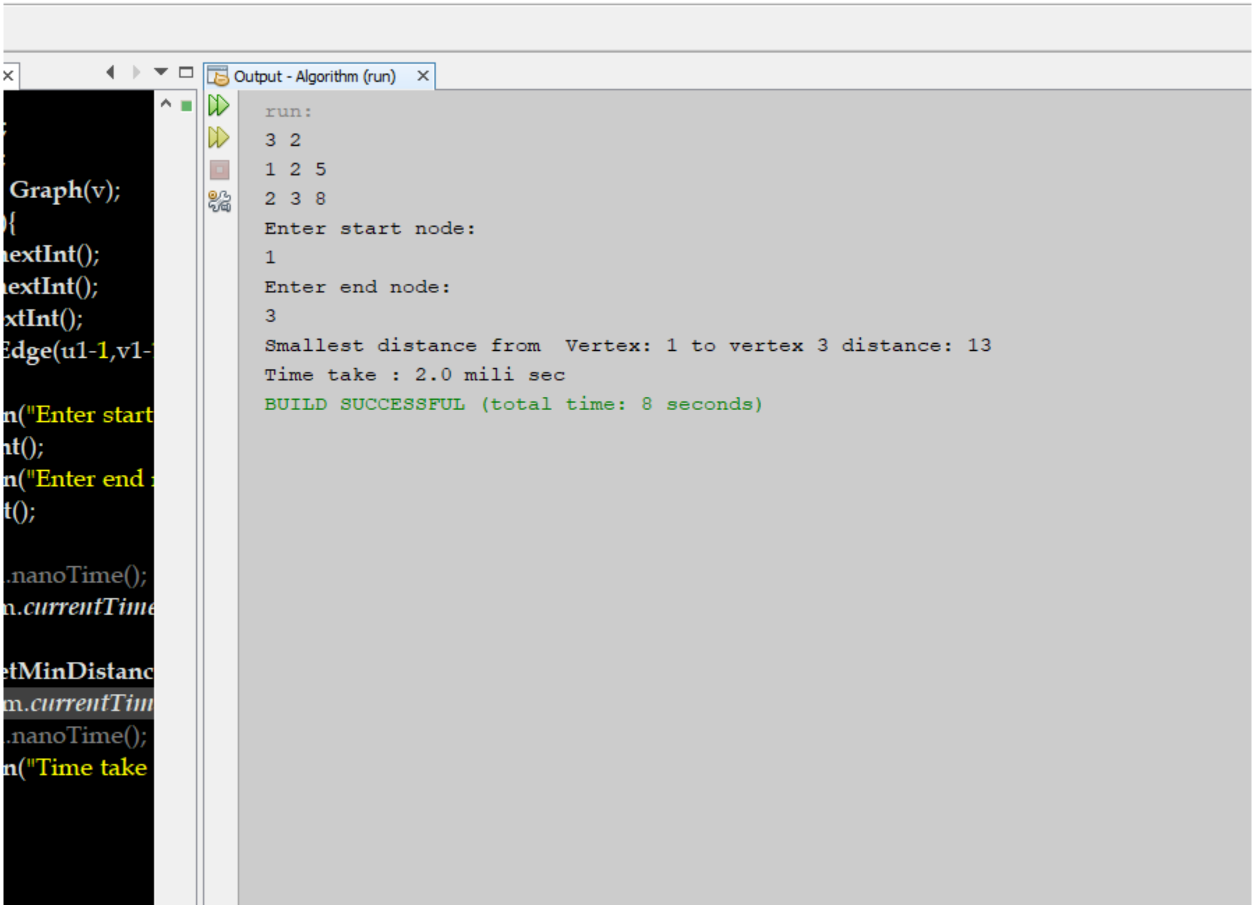
Problem Name: Dijkstra Algorithm

Source Code (Using BinaryHeap + Adjacency List) :

```
package algorithm;

import java.util.LinkedList;
import java.util.Scanner;

public class dijkstra_heap_1803078{

    static class Edge{

        int source;
        int destination;
        int weight;

        public Edge(int source,int destination,int weight){
            this.source=source;
            this.destination=destination;
            this.weight=weight;
        }
    }

    static class HeapNode{

        int vertex;
        int distance;
    }

    static class Graph{

        int vertices;
        LinkedList<Edge>[] adjacencylist;

        Graph(int vertices){
            this.vertices=vertices;
            adjacencylist=new LinkedList[vertices];
            for(int i=0;i<vertices;i++){
                adjacencylist[i]=new LinkedList<>();
            }
        }

        public void addEdge(int source,int destination,int weight){
            Edge edge=new Edge(source,destination,weight);
            adjacencylist[source].addFirst(edge);
            edge=new Edge(destination,source,weight);
            adjacencylist[destination].addFirst(edge); //for undirected graph
        }

        public void dijkstra_GetMinDistances(int sourceVertex,int end){
            int INFINITY=Integer.MAX_VALUE;
            boolean[] SPT=new boolean[vertices];

            HeapNode[] heapNodes=new HeapNode[vertices];
            for(int i=0;i<vertices;i++){
                heapNodes[i]=new HeapNode();
                heapNodes[i].vertex=i;
                heapNodes[i].distance=INFINITY;
            }

            heapNodes[sourceVertex].distance=0;

            MinHeap minHeap=new MinHeap(vertices);
            for(int i=0;i<vertices;i++){
                minHeap.insert(heapNodes[i]);
            }
            while(!minHeap.isEmpty()){

                HeapNode extractedNode=minHeap.extractMin();

                int extractedVertex=extractedNode.vertex;
                SPT[extractedVertex]=true;

                LinkedList<Edge> list=adjacencylist[extractedVertex];
                for(int i=0;i<list.size();i++){
                    Edge edge=list.get(i);
                    int destination=edge.destination;

                    if(SPT[destination]==false){

                        int
newKey=heapNodes[extractedVertex].distance+edge.weight;
                        int currentKey=heapNodes[destination].distance;
                        if(currentKey>newKey){
                            decreaseKey(minHeap,newKey,destination);
                            heapNodes[destination].distance=newKey;
                        }
                    }
                }
            }

            printDijkstra(heapNodes,sourceVertex,end);
        }
        public void decreaseKey(MinHeap minHeap,int newKey,int vertex){

            int index=minHeap.indexes[vertex];

            HeapNode node=minHeap.mH[index];
            node.distance=newKey;
            minHeap.bubbleUp(index);
        }

        public void printDijkstra(HeapNode[] resultSet,int sourceVertex,int end){
            System.out.println("Smallest distance from  Vertex: "+(sourceVertex+1)+"
to vertex "+end+" distance: "+resultSet[end-1].distance);

        }
    }

    static class MinHeap{

        int capacity;
        int currentSize;
        HeapNode[] mH;
        int[] indexes;

        public MinHeap(int capacity){
            this.capacity=capacity;
            mH=new HeapNode[capacity+1];
            indexes=new int[capacity];
            mH[0]=new HeapNode();
            mH[0].distance=Integer.MIN_VALUE;
            mH[0].vertex=-1;
            currentSize=0;
        }

        public void insert(HeapNode x){
            currentSize++;
            int idx=currentSize;
            mH[idx]=x;
            indexes[x.vertex]=idx;
            bubbleUp(idx);
        }

        public void bubbleUp(int pos){
            int parentIdx=pos/2;
            int currentIdx=pos;
            while(currentIdx>0&&mH[parentIdx].distance>mH[currentIdx].distance){
                HeapNode currentNode=mH[currentIdx];
                HeapNode parentNode=mH[parentIdx];
                indexes[currentNode.vertex]=parentIdx;
                indexes[parentNode.vertex]=currentIdx;
                swap(currentIdx,parentIdx);
                currentIdx=parentIdx;
                parentIdx=parentIdx/2;
            }
        }

        public HeapNode extractMin(){
            HeapNode min=mH[1];
            HeapNode lastNode=mH[currentSize];

            indexes[lastNode.vertex]=1;
            mH[1]=lastNode;
            mH[currentSize]=null;
            sinkDown(1);
            currentSize--;
            return min;
        }

        public void sinkDown(int k){
            int smallest=k;
            int leftChildIdx=2*k;
            int rightChildIdx=2*k+1;

    if(leftChildIdx<heapSize()&&mH[smallest].distance>mH[leftChildIdx].distance){
                smallest=leftChildIdx;
            }

    if(rightChildIdx<heapSize()&&mH[smallest].distance>mH[rightChildIdx].distance){
                smallest=rightChildIdx;
            }
            if(smallest!=k){

                HeapNode smallestNode=mH[smallest];
                HeapNode kNode=mH[k];

                indexes[smallestNode.vertex]=k;
                indexes[kNode.vertex]=smallest;
                swap(k,smallest);
                sinkDown(smallest);
            }
        }

        public void swap(int a,int b){
            HeapNode temp=mH[a];
            mH[a]=mH[b];
```

```
            mH[b]=temp;
        }

        public boolean isEmpty(){
            return currentSize==0;
        }

        public int heapSize(){
            return currentSize;
        }
    }

    public static void main(String[] args){
        Scanner ob=new Scanner(System.in);

        int v=ob.nextInt();
        int e=ob.nextInt();
        Graph graph=new Graph(v);
        for(int i=0;i<e;i++){
            int u1=ob.nextInt();
            int v1=ob.nextInt();
            int c=ob.nextInt();
            graph.addEdge(u1-1,v1-1,c);
        }
        System.out.println("Enter start node: ");
        int start=ob.nextInt();
        System.out.println("Enter end node: ");
        int end=ob.nextInt();

        //long t1=System.nanoTime();
        double t11=System.currentTimeMillis();

        graph.dijkstra_GetMinDistances(start-1,end);
        double  t22=System.currentTimeMillis();
        //long t2=System.nanoTime();
        System.out.println("Time take : "+(t22-t11)+" mili sec");

    }
}
```

Sample Input and Output:



```
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n("Time take
```
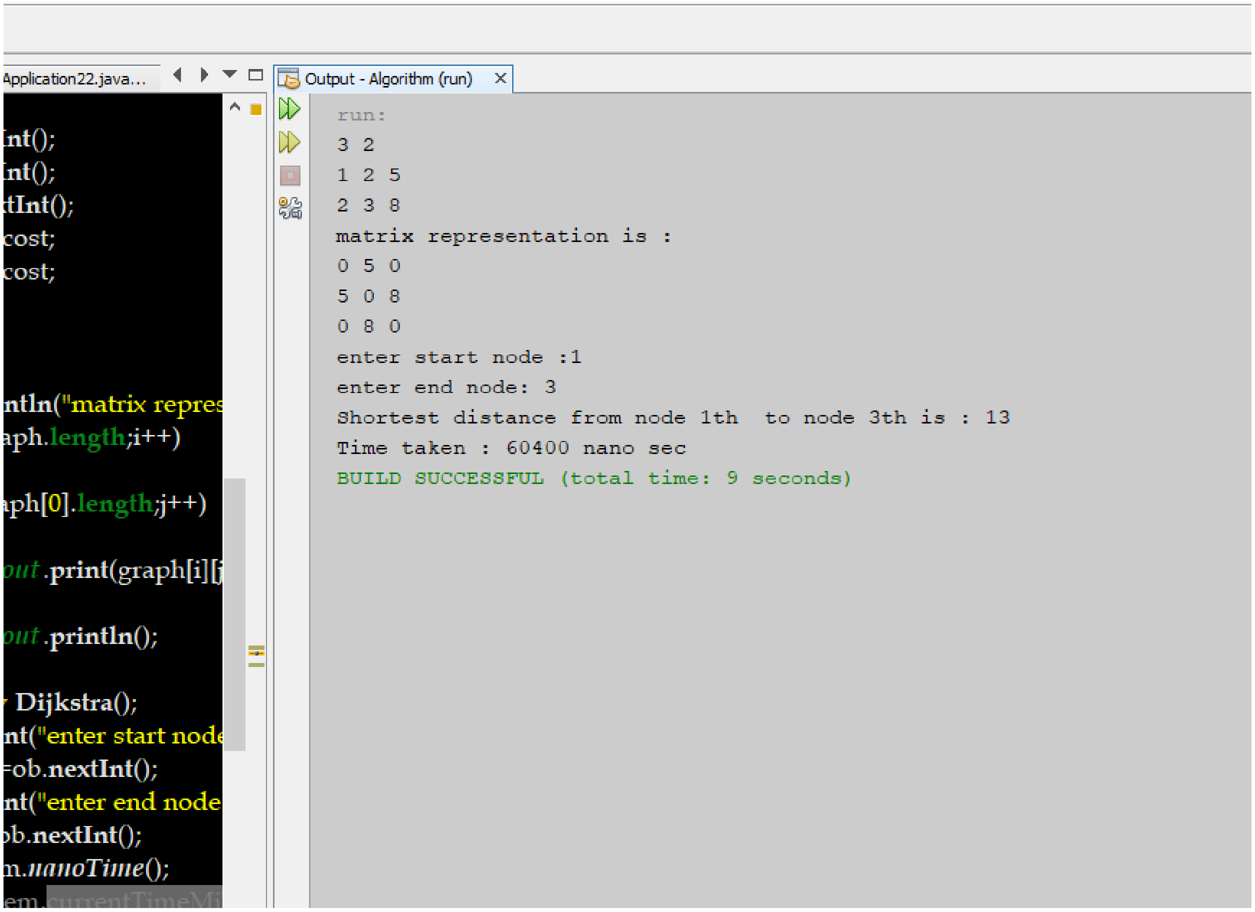

```
run:
3 2
1 2 5
2 3 8
Enter start node:
1
Enter end node:
3
Smallest distance from  Vertex: 1 to vertex 3 distance: 13
Time take : 2.0 mili sec
BUILD SUCCESSFUL (total time: 8 seconds)
```

Source Code (Using Priority Queue + Adjacency Matrix) :

```
package algorithm;

import java.util.Scanner;

public class Dijkstra{
    public static void dijkstra(int[][] graph,int source,int start_node,int end_node){
        int count=graph.length;
        boolean[] visitedVertex=new boolean[count+1+1];
        int[] distance=new int[count];
        for(int i=1;i<count;i++){
            visitedVertex[i]=false;
            distance[i]=Integer.MAX_VALUE;
        }


        distance[source]=0;
        for(int i=1;i<count;i++){
            int u=findMinDistance(distance,visitedVertex);
            visitedVertex[u]=true;
            for(int v=1;v<count;v++){

    if(!visitedVertex[v]&&graph[u][v]!=0&&(distance[u]+graph[u][v]<distance[v])){
                    distance[v]=distance[u]+graph[u][v];
                }
            }
        }
        System.out.println("Shortest distance from node "+start_node+"th  to node "+
end_node+"th is : "+distance[end_node]);

    }

    private static int findMinDistance(int[] distance,boolean[] visitedVertex){
        int minDistance=Integer.MAX_VALUE;
        int minDistanceVertex=-1;
        for(int i=1;i<distance.length;i++){
            if(!visitedVertex[i]&&distance[i]<minDistance){
                minDistance=distance[i];
                minDistanceVertex=i;
            }
        }
        return minDistanceVertex;
    }

    public static void main(String[] args){
        Scanner ob=new Scanner (System.in);
        int v=ob.nextInt();
        int e=ob.nextInt();
    int graph[][]=new int[v+1][v+1];


        for(int j=0;j<e;j++)
        {
```

```
        int v1=ob.nextInt();
        int v2=ob.nextInt();
        int cost=ob.nextInt();
        graph[v1][v2]=cost;
        graph[v2][v1]=cost;

        }

        System.out.println("matrix representation is : ");
        for(int i=1;i<graph.length;i++)
        {
        for(int j=1;j<graph[0].length;j++)
        {
            System.out.print(graph[i][j]+" ");
        }
            System.out.println();
        }
        Dijkstra T=new Dijkstra();
        System.out.print("enter start node :");
        int start_node =ob.nextInt();
        System.out.print("enter end node: ");
        int end_node=ob.nextInt();
        long t11=System.nanoTime();
        //long t1=System.currentTimeMillis();
        T.dijkstra(graph,start_node,start_node,end_node);
        //long t2=System.currentTimeMillis();
        long t22=System.nanoTime();
        System.out.println("Time taken : "+(t22-t11)+" nano sec");
    }
}
```

Sample output:



```
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cost;



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aph.length;i++)

aph[0].length;j++)

out.print(graph[i][j

out.println();

 Dijkstra();
nt("enter start node
=ob.nextInt();
nt("enter end node
ob.nextInt();
n.nanoTime();
em.currentTimeMi
```
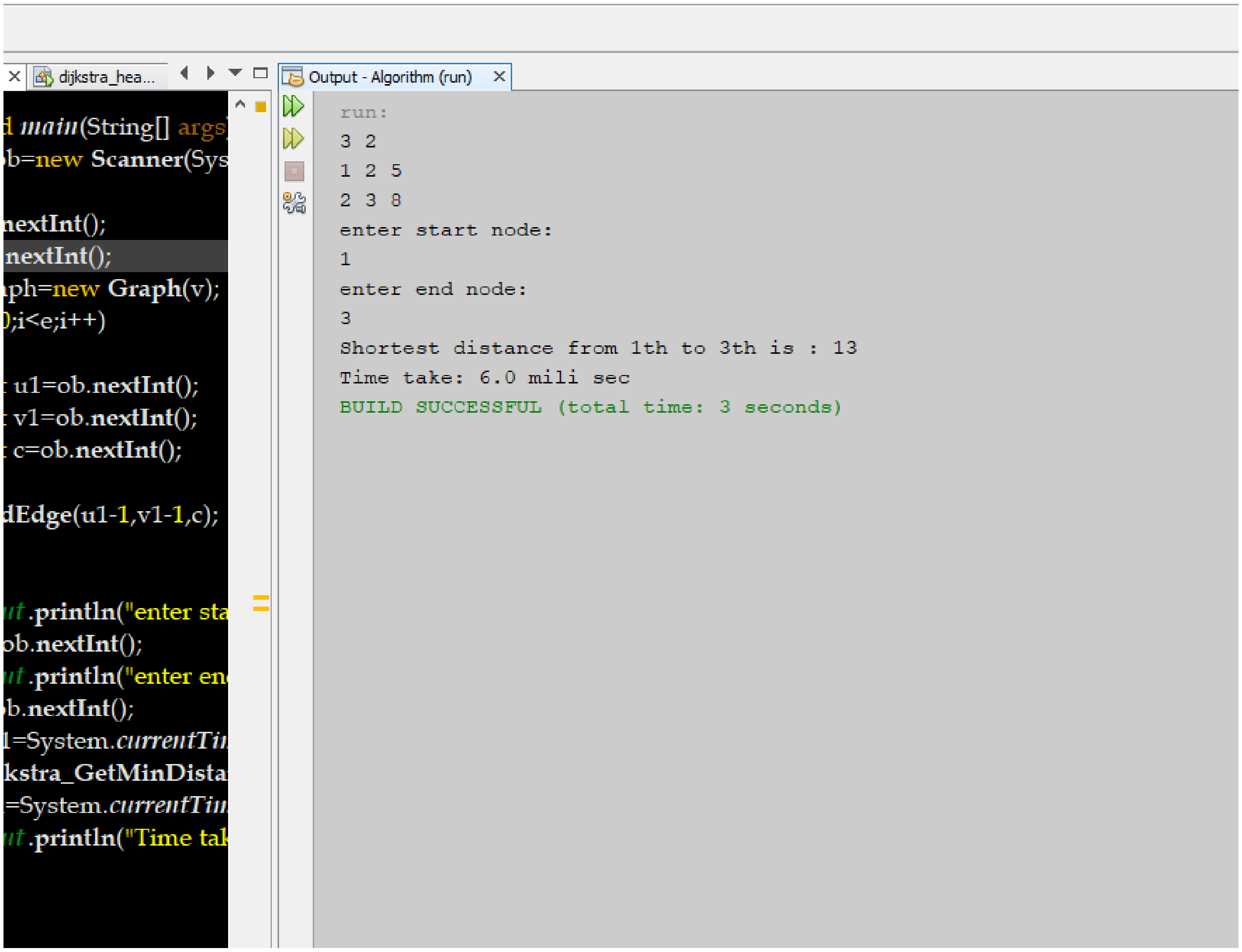

```
run:
3 2
1 2 5
2 3 8
matrix representation is :
0 5 0
5 0 8
0 8 0
enter start node :1
enter end node: 3
Shortest distance from node 1th  to node 3th is : 13
Time taken : 60400 nano sec
BUILD SUCCESSFUL (total time: 9 seconds)
```

Source Code (Using Priority Queue + Adjacency List) :

```
package algorithm;

import javafx.util.Pair;
import java.util.Comparator;
import java.util.LinkedList;
import java.util.PriorityQueue;
import java.util.Scanner;

public class Dijksta_PQ{

    static class Edge{

        int source;
        int destination;
        int weight;

        public Edge(int source,int destination,int weight){
            this.source=source;
            this.destination=destination;
            this.weight=weight;
        }
    }

    static class Graph{

        int vertices;
        static LinkedList<Edge>[] adjacencylist;

        Graph(int vertices){
            this.vertices=vertices;
            adjacencylist=new LinkedList[vertices];

            for(int i=0;i<vertices;i++){
                adjacencylist[i]=new LinkedList<>();
            }
        }

        public void addEdge(int source,int destination,int weight){
            Edge edge=new Edge(source,destination,weight);
            adjacencylist[source].addFirst(edge);

            edge=new Edge(destination,source,weight);
            adjacencylist[destination].addFirst(edge);
        }



        public void dijkstra_GetMinDistances(int sourceVertex,int start,int end){

            boolean[] SPT=new boolean[vertices];

            int[] distance=new int[vertices];


            for(int i=0;i<vertices;i++){
                distance[i]=Integer.MAX_VALUE;
            }

            PriorityQueue<Pair<Integer,Integer>> pq=new
PriorityQueue<>(vertices,new Comparator<Pair<Integer,Integer>>(){

                public int compare(Pair<Integer,Integer> p1,Pair<Integer,Integer>
p2){

                    int key1=p1.getKey();
                    int key2=p2.getKey();
                    return key1-key2;
                }
            });

            distance[0]=0;
            Pair<Integer,Integer> p0=new Pair<>(distance[0],0);

            pq.offer(p0);

            while(!pq.isEmpty()){

                Pair<Integer,Integer> extractedPair=pq.poll();

                int extractedVertex=extractedPair.getValue();
                if(SPT[extractedVertex]==false){
                    SPT[extractedVertex]=true;
                    LinkedList<Edge> list=adjacencylist[extractedVertex];
                    for(int i=0;i<list.size();i++){
                        Edge edge=list.get(i);
                        int destination=edge.destination;

                        if(SPT[destination]==false){

                            int
newKey=distance[extractedVertex]+edge.weight;
                            int currentKey=distance[destination];
                            if(currentKey>newKey){
                                Pair<Integer,Integer> p=new
Pair<>(newKey,destination);
                                pq.offer(p);
                                distance[destination]=newKey;
                            }
                        }
                    }
                }
            }
            printDijkstra(distance,sourceVertex,start,end);
        }

        public void printDijkstra(int[] distance,int sourceVertex,int start,int end){

            System.out.println("Shortest distance from "+start+"th to "+end+"th is :
"+distance[end-1]);

        }

        public static void main(String[] args){
            Scanner ob=new Scanner(System.in);

            int v=ob.nextInt();
            int  e=ob.nextInt();
            Graph graph=new Graph(v);
            for(int i=0;i<e;i++)
            {
                int u1=ob.nextInt();
                int v1=ob.nextInt();
                int c=ob.nextInt();

            graph.addEdge(u1-1,v1-1,c);
            }

            System.out.println("enter start node:");
            int start=ob.nextInt();
            System.out.println("enter end node:");
```

```
                                int end=ob.nextInt();
                                double  t1=System.currentTimeMillis();
                                graph.dijkstra_GetMinDistances(start-1,start,end);
                                double t2=System.currentTimeMillis();
                                System.out.println("Time take: "+(t2-t1)+" mili sec ");

                      }
            }
}
```

Sample output:



```
d main(String[] args
b=new Scanner(Sys

nextInt();
nextInt();
ph=new Graph(v);
);i<e;i++)

t u1=ob.nextInt();
t v1=ob.nextInt();
t c=ob.nextInt();

dEdge(u1-1,v1-1,c);


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ob.nextInt();
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b.nextInt();
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=System.currentTim
ut.println("Time tak
```
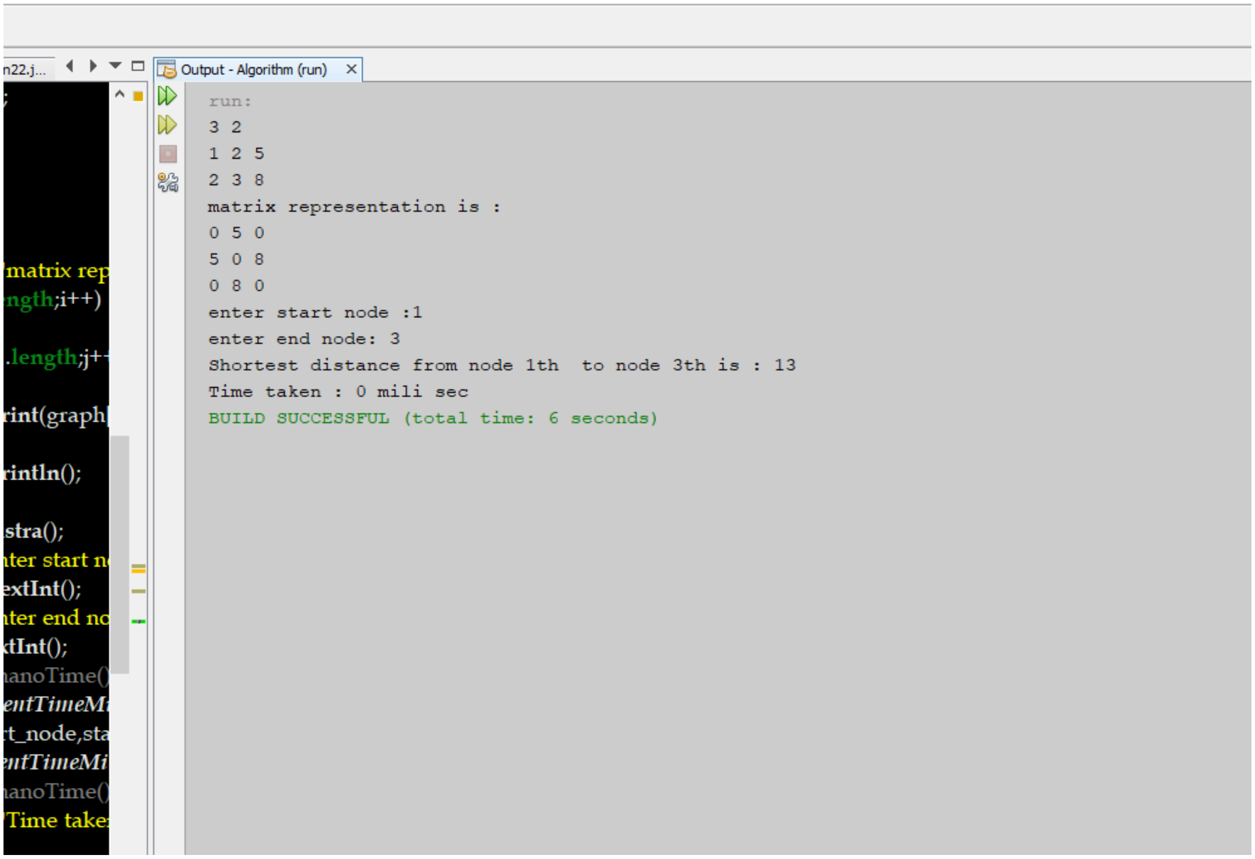

```
run:
3 2
1 2 5
2 3 8
enter start node:
1
enter end node:
3
Shortest distance from 1th to 3th is : 13
Time take: 6.0 mili sec
BUILD SUCCESSFUL (total time: 3 seconds)
```

Source Code (Using Unsorted + Adjacency Matrix) :

```
package algorithm;

import java.util.Scanner;

public class Dijkstra{

    public static void dijkstra(int[][] graph,int source,int start_node,int end_node){
        int count=graph.length;
        boolean[] visitedVertex=new boolean[count+1+1];
        int[] distance=new int[count];
        for(int i=1;i<count;i++){
            visitedVertex[i]=false;
            distance[i]=Integer.MAX_VALUE;
        }


        distance[source]=0;
        for(int i=1;i<count;i++){
            int u=findMinDistance(distance,visitedVertex);
            visitedVertex[u]=true;
            for(int v=1;v<count;v++){

    if(!visitedVertex[v]&&graph[u][v]!=0&&(distance[u]+graph[u][v]<distance[v])){
                    distance[v]=distance[u]+graph[u][v];
                }
            }
        }
        System.out.println("Shortest distance from node "+start_node+"th  to node "+
end_node+"th is : "+distance[end_node]);

    }

    private static int findMinDistance(int[] distance,boolean[] visitedVertex){
        int minDistance=Integer.MAX_VALUE;
        int minDistanceVertex=-1;
        for(int i=1;i<distance.length;i++){
            if(!visitedVertex[i]&&distance[i]<minDistance){
                minDistance=distance[i];
                minDistanceVertex=i;
            }
        }
        return minDistanceVertex;
    }

    public static void main(String[] args){
        Scanner ob=new Scanner (System.in);
        int v=ob.nextInt();
        int e=ob.nextInt();
    int graph[][]=new int[v+1][v+1];


        for(int j=0;j<e;j++)
        {
        int v1=ob.nextInt();
        int v2=ob.nextInt();
        int cost=ob.nextInt();
        graph[v1][v2]=cost;
        graph[v2][v1]=cost;

        }

        System.out.println("matrix representation is : ");
        for(int i=1;i<graph.length;i++)
        {
        for(int j=1;j<graph[0].length;j++)
        {
            System.out.print(graph[i][j]+" ");
        }
            System.out.println();
        }
        Dijkstra T=new Dijkstra();
        System.out.print("enter start node :");
        int start_node =ob.nextInt();
        System.out.print("enter end node: ");
        int end_node=ob.nextInt();
        //long t11=System.nanoTime();
       long t1=System.currentTimeMillis();
        T.dijkstra(graph,start_node,start_node,end_node);
        long t2=System.currentTimeMillis();
        //long t22=System.nanoTime();
        System.out.println("Time taken : "+(t2-t1)+" mili sec");
    }
}
```

Sample output:



```
run:
3 2
1 2 5
2 3 8
matrix representation is :
0 5 0
5 0 8
0 8 0
enter start node :1
enter end node: 3
Shortest distance from node 1th  to node 3th is : 13
Time taken : 0 mili sec
BUILD SUCCESSFUL (total time: 6 seconds)
```

Performance table:(for vertex=100)

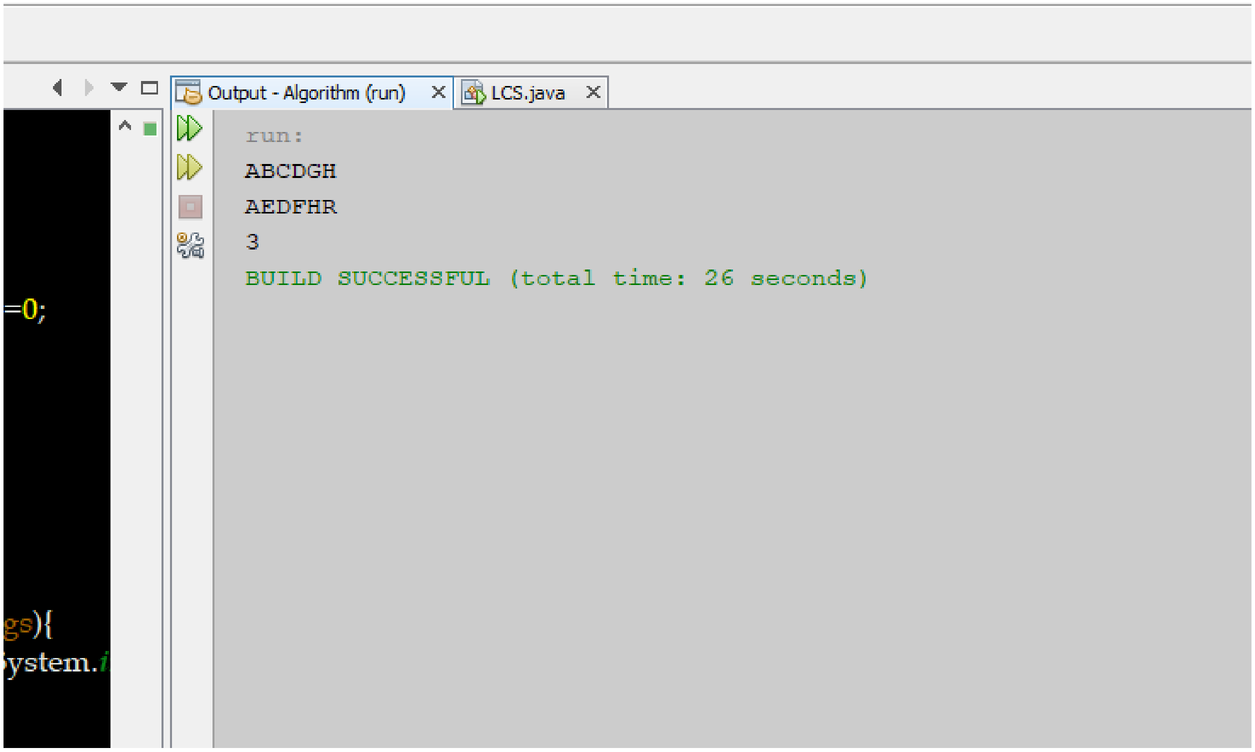
Priority Queue Data Structure	Adjacency list	Adjacency matrix
Binary Heap	0.12 mili sec	2.103 mili sec
Unsorted Array	1.001 mili sec	2.989 mili sec

Problem: Longest Common Subsequence (Dynamic programming)

Source Code:

```
package algorithm;

import java.util.Scanner;

public class LCS_1803078 {
    public static void main(String[] args){
        Scanner ob=new Scanner(System.in);
        String A=ob.next();
        String B=ob.next();
        int m=A.length(), n=B.length();
        int[][] ans=new int[m+1][n+1];
        for(int i=0;i<m;i++){
            ans[i][0]=0;

        }
        for(int j=0;j<n;j++){
            ans[0][j]=0;

        }
        for(int i=1;i<=m;i++){
            for(int j=1;j<=n;j++){
                if(A.charAt(i-1)==B.charAt(j-1)){
                    ans[i][j]=ans[i-1][j-1]+1;
                }else{
                    ans[i][j]=Math.max(ans[i-1][j],ans[i][j-1]);
                }
            }
        }
        System.out.println(ans[m][n]);
    }
}
```

Output:



```
run:
ABCDGH
AEDFHR
3
BUILD SUCCESSFUL (total time: 26 seconds)
```