Problem 3: Coordinate Connection

Problem Number: P3

Suppose you have many coordinates you want to connect. You want to connect them in such a way that there exists a path between two coordinates! Simple right?

However, you have to be careful because you are on a strict budget and want to minimize costs as much as possible. The cost of connecting two coordinates $(x_1, y_1), (x_2, y_2)$ is their distance $\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$.

Given the set of coordinates, find the minimum cost to connect the coordinates together!

Input:

The input stars with one line $t \leq 100$, denoting the number of test cases.

Each test case starts with a single $n, 1 \leq n \leq 100$, representing the number of coordinates.

Followed after is n lines of (unique) coordinates (x, y) where $-100 \leq x, y \leq 100$.

Output:

For each test case, output the minimum cost to connect the coordinates, up to 3 decimal places.

Sample Input	Sample Output
1 3 0 0 -1 1 1 0	2.414

Explanation: The cheapest way to connect the coordinates is to connect $(0,0)$ to $(-1,1)$, which costs 1.414, and to connect $(0,0)$ to $(1,0)$ which costs 1. That way, all the coordinates are connected!

Hint: This in an MCST problem.

Problem 4: Vertex Cost????

Problem Number: P4

When talking about the shortest paths before, we only took the sum of the edges as the cost.

What if we also add to the total cost the number of vertices in the path as well? For example if you travel from vertex 0 to 2 by taking edges (0,1,3) and (1,2,1), your total cost is 3+1+(3 vertices)=7.

Given this new cost function, find the value of the shortest path from vertex u to vertex v now. Assume that the graph is undirected as well. You are guaranteed a shortest path exists.

Input:

The input stars with one line $t \leq 100$, denoting the number of test cases.

Each test case starts with four integers V, E, u, v, where $2 \leq V \leq 100$, $1 \leq E \leq 5000$, and $0 \leq u, v < V$.

V represents the number of vertices (labeled 0 to V-1)

E represents the number of edges

u is the source, and v is the goal.

Then the input is followed by E lines, which are represented by (m, n, e), which represents that there is an edge between m and n and costs e. $0 \leq m, n < V$ and $0 \leq e < 10^5$.

Output:

For each test case, output minimum path cost from u to v.

Sample Input	Sample Output
1 4 4 0 3 0 3 3 0 1 1 1 2 0 2 3 1	5

Explanation: The shortest path is of length 5 because while going directly to 3 has cost 3+2 vertices=5, the other path, which takes edges (0,1,1), (1,2,0), and (2,3,1) costs a total of 2 with just the edges alone, but visits 4 vertices, so the total cost is 2+4=6.

Hint: This is a shortest paths problem.

P5: Floyd-Warshall Algorithm

Problem Number: P5

So far, we have been solving **SINGLE** source shortest path problems. A different problem is to identify the shortest path (cost) between all pairs of vertices in the graph. This is known as the All-Pair Shortest Paths algorithm.

This is a Dynamic Programming Problem, but your task is to simply implement the solution (Floyd-Warshall Algorithm) given a directed, connected graph. It is recommended you use an adjacency matrix to represent your graph.

Input:

The input stars with one line $t \leq 100$, denoting the number of test cases.

Each test case starts with two integers V, E, where $2 \leq V \leq 100$, $1 \leq E \leq 100$.

V represents the number of vertices (labeled 0 to V-1)

E represents the number of edges

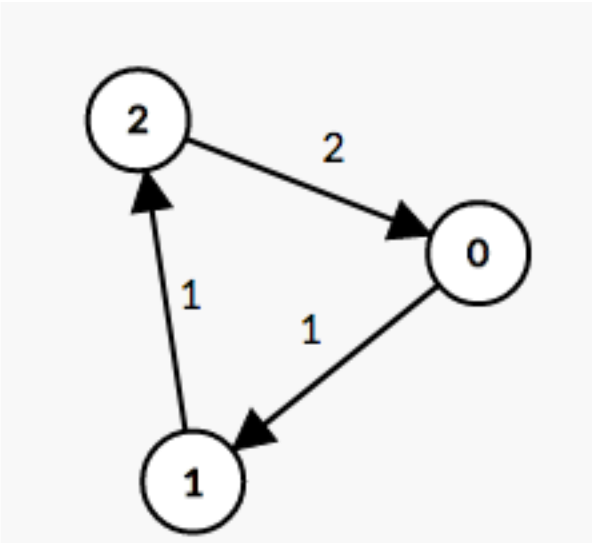
Then the input is followed by E lines, which are represented by (m, n, e), which represents that there is an edge from m to n and costs e. $0 \leq m, n < V$ and $0 \leq e < 10^5$.

Output:

For each test case, output the shortest paths in proper order. Follow the example below:

Sample Input	Sample Output
1 3 3 0 1 1 1 2 1 2 0 2	The shortest path from 0 to 0 is 0 The shortest path from 0 to 1 is 1 The shortest path from 0 to 2 is 2 The shortest path from 1 to 0 is 3 The shortest path from 1 to 1 is 0 The shortest path from 1 to 2 is 1 The shortest path from 2 to 0 is 2 The shortest path from 2 to 1 is 3 The shortest path from 2 to 2 is 0

The graph of the sample test case is as follows:


2
2
0
1
1
1