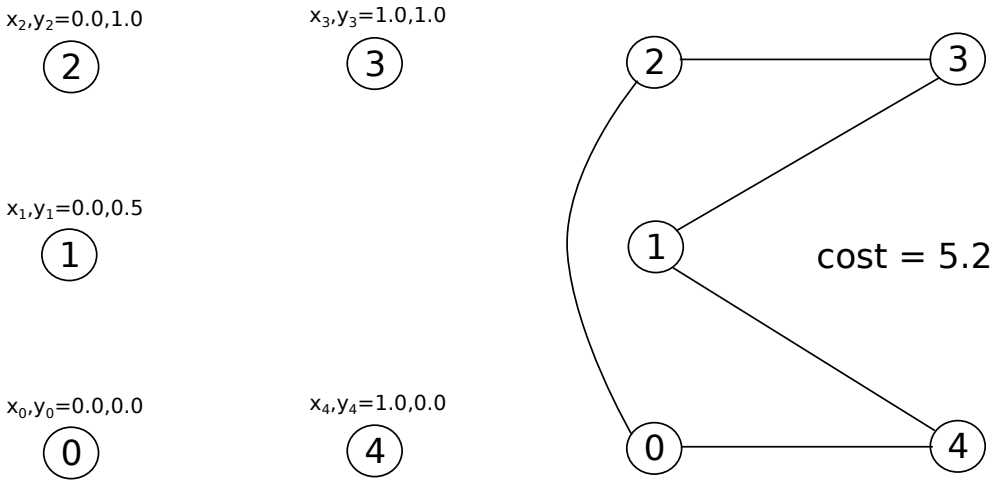
Discrete Optimization Assignment 2

Traveling Salesman Problem

1 Problem Statement

In this assignment, you will design an algorithm to solve the Traveling Salesman Problem (TSP). All traveling salespeople start from their homes, travel to several cities to sell their goods, and complete the day by returning home. To minimize their costs, traveling salespeople should visit all of the cities using the shortest total travel distance. This amounts to finding an ordering of all of the cities that minimizes the sum of the distances traveled when moving from one city to another. The following figure illustrates a small TSP and a feasible solution to that problem. The cities are labeled from 0 to 4.



2 Assignment

Write an algorithm to solve the traveling salesman problem. The problem is mathematically formulated in the following way. Given a list of locations $N = \{0, \ldots, n-1\}$ and coordinates for each location (x_i, y_i) (where, $i \in N$), let v_i be a variable denoting the visitation order, and let $dist(l_1, l_2)$ be the Euclidean distance between two locations. Then, the traveling salesman problem is formalized as the following optimization problem:

Minimize:

$$\sum_{i \in N} dist(v_i, v_{i+1}) + dist(v_n, v_0)$$

subject to:

v_i's are a permutation of N

3 Input and Output Data Format

The input file contains $n + 1$ lines. The first line contains one integer n, which is the number of cities. Each remaining line represents a point (x_i, y_i), where x_i and y_i are coordinates of a city i.

Input format:

n	
x_0	y_0
x_1	y_1
$\cdots$	
x_{n-1}	y_{n-1}

The output contains a solution and consists of two lines. The first line contains the objective value obj. This is the length of the TSP cycle. The next line is a list of n values, one for each of the v_i variables. This line encodes the solution.

Output Format:

obj
$v_0 \;\; v_1 \;\; v_2 \;\; \cdots \;\; v_{n-1}$

It is essential that the value order in the solution output matches the value order of the input. Otherwise, the grader will misinterpret the output.

Examples (based on the figure)

Input:

```
5
0   0
0   0.5
0   1
1   1
1   0
```

Output:

```
5.2
0  4  1  3  2
```

This output represents the following cycle: $0 \to 4 \to 1 \to 3 \to 2 \to 0$

4 Instructions

For now, please start to work on your computer locally. For uploading to the test system, see the file "instructions.pdf".