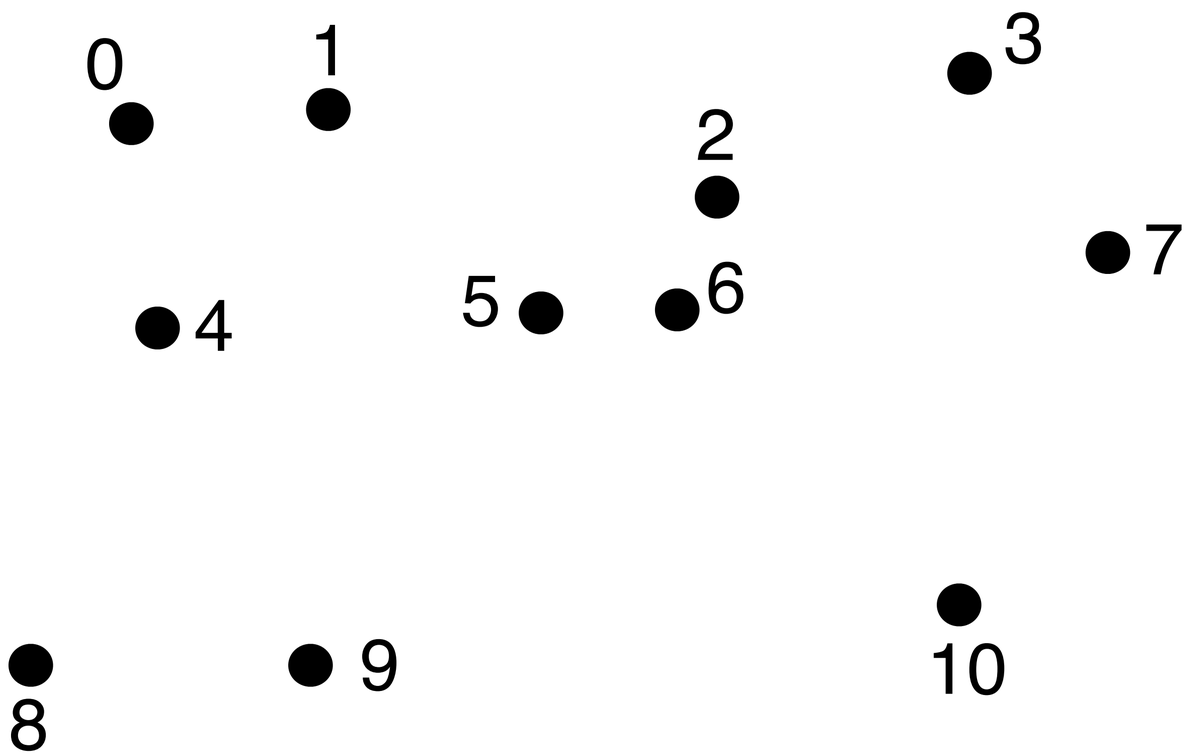
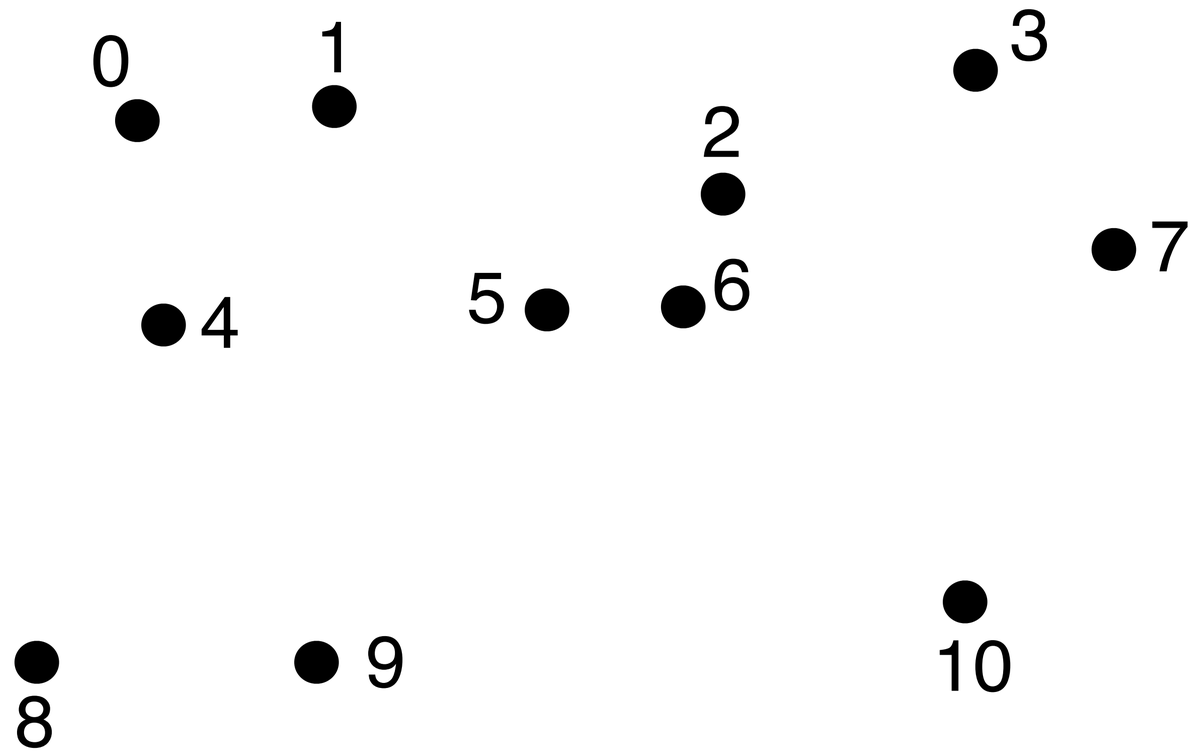
Discrete Optimization

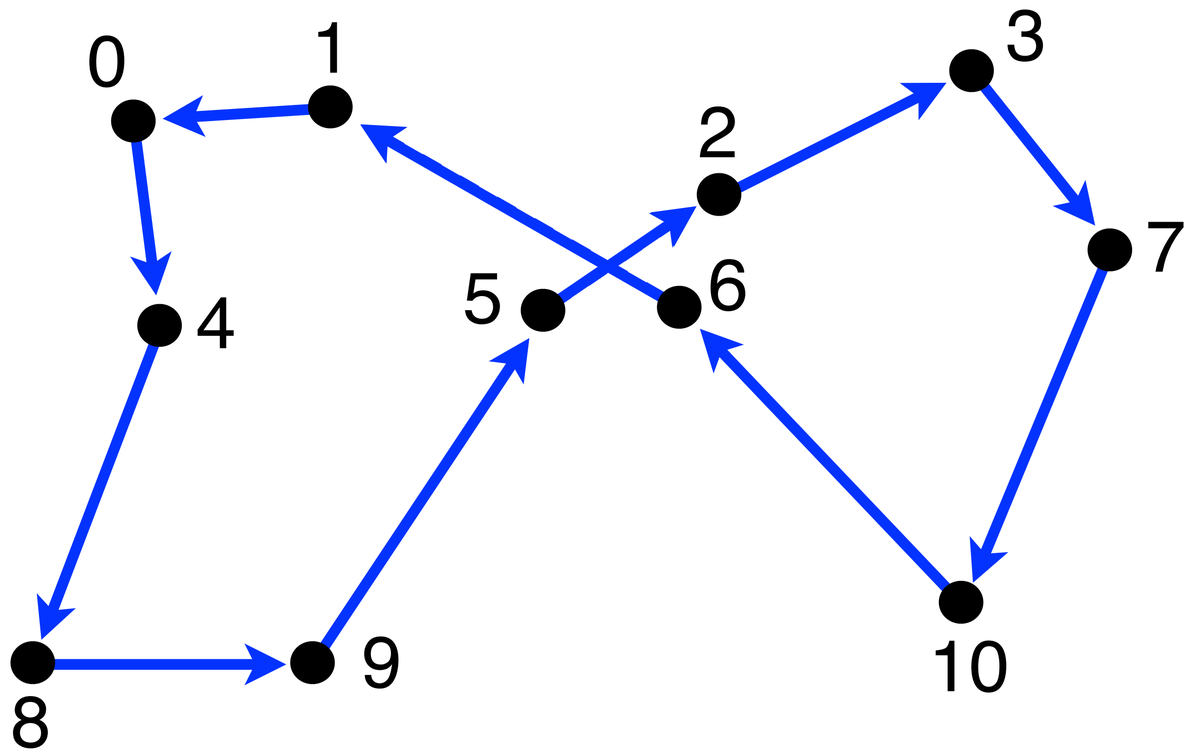
Assignments: Traveling Salesman

Traveling Salesman Problem (TSP)



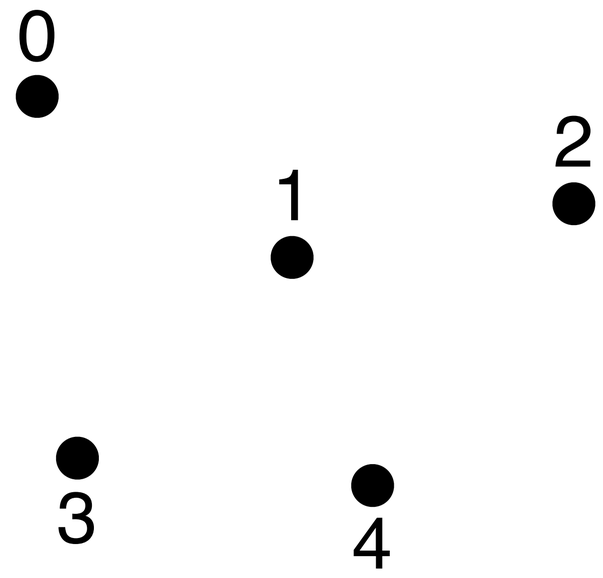
Traveling Salesman Problem (TSP)





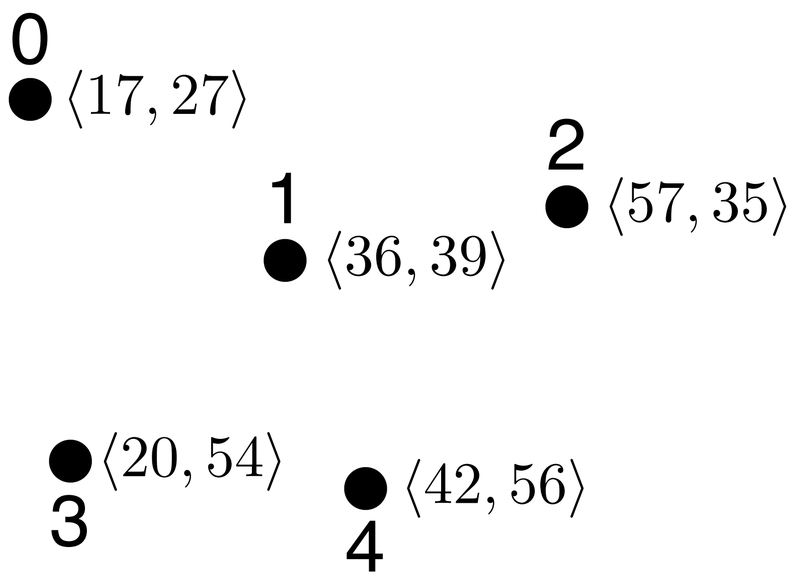
0 4 8 9 5 2 3 7 10 6 1

Euclidean TSP - A Concise Description



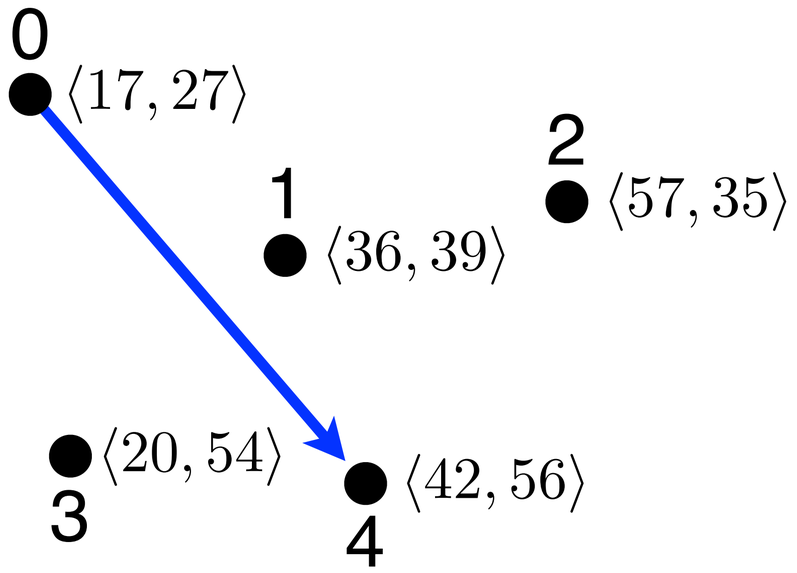
$$d_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2}$$

Euclidean TSP - A Concise Description



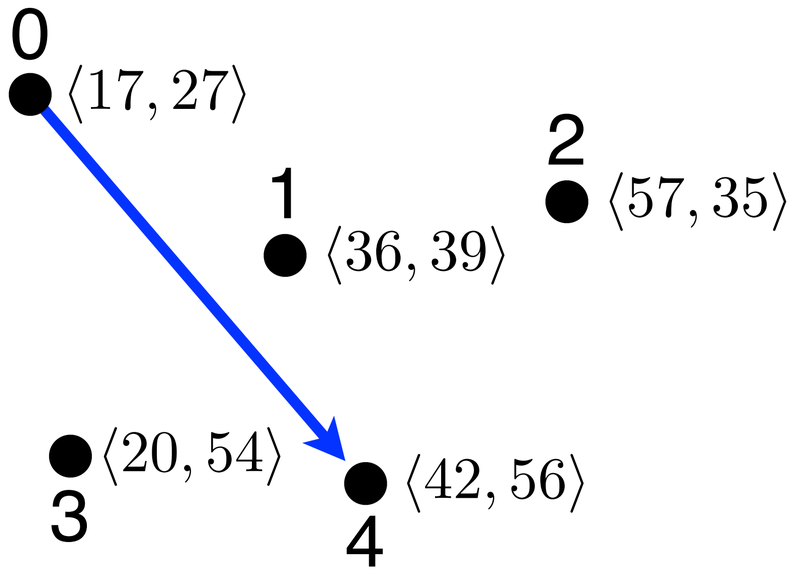
$$d_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2}$$

Euclidean TSP - A Concise Description



$$d_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2}$$

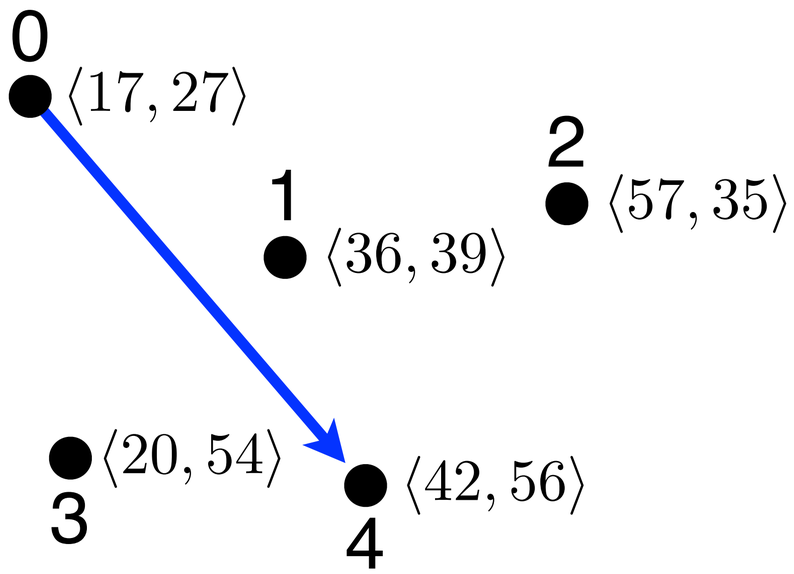
Euclidean TSP - A Concise Description



$$d_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2}$$

$$d_{04} = \sqrt{(17 - 42)^2 + (27 - 56)^2} = 38.288...$$

Euclidean TSP - A Concise Description



Point List
$\langle 17, 27 \rangle$
$\langle 36, 39 \rangle$
$\langle 57, 35 \rangle$
$\langle 20, 54 \rangle$
$\langle 42, 56 \rangle$

$$d_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2}$$

$$d_{04} = \sqrt{(17 - 42)^2 + (27 - 56)^2} = 38.288...$$

Traveling Salesman Problem

- *n* Nodes
- Points list
- V_i the visitation order

$$\text{minimize:} \quad \sum_{i \in 0 \ldots n-2} \sqrt{(x_{v_i} - x_{v_{i+1}})^2 + (y_{v_i} - y_{v_{i+1}})^2} + \sqrt{(x_{v_{n-1}} - x_{v_0})^2 + (y_{v_{n-1}} - y_{v_0})^2}$$

subject to:

v_i are a permutation of N

Traveling Salesman Problem

minimize:
$$\sum_{i \in 0 \ldots n-2} \sqrt{(x_{v_i} - x_{v_{i+1}})^2 + (y_{v_i} - y_{v_{i+1}})^2} + \sqrt{(x_{v_{n-1}} - x_{v_0})^2 + (y_{v_{n-1}} - y_{v_0})^2}$$

subject to:

v_i are a permutation of N

Input

```
|N|
x_1 y_1
x_2 y_2
...
x_|N| y_|N|
```

Output

```
obj opt
v_1 v_2 v_3 ... v_n
```

Traveling Salesman Problem

minimize:
$$\sum_{i \in 0 \ldots n-2} \sqrt{(x_{v_i} - x_{v_{i+1}})^2 + (y_{v_i} - y_{v_{i+1}})^2} + \sqrt{(x_{v_{n-1}} - x_{v_0})^2 + (y_{v_{n-1}} - y_{v_0})^2}$$

subject to:

v_i are a permutation of N

Input

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

Output

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

Traveling Salesman Problem

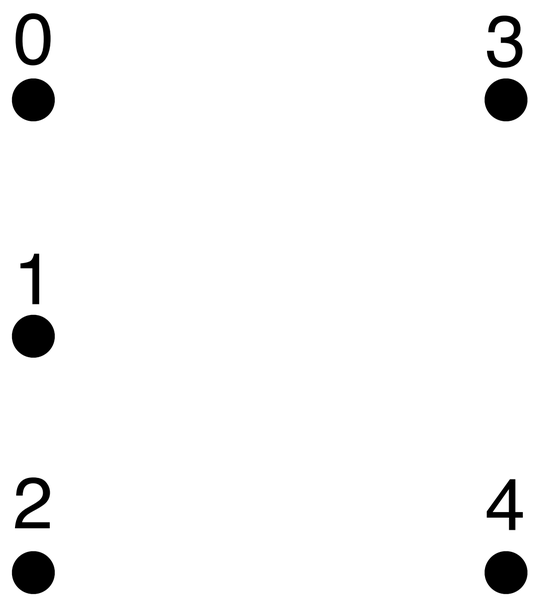
Input

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

Output

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

Traveling Salesman Problem



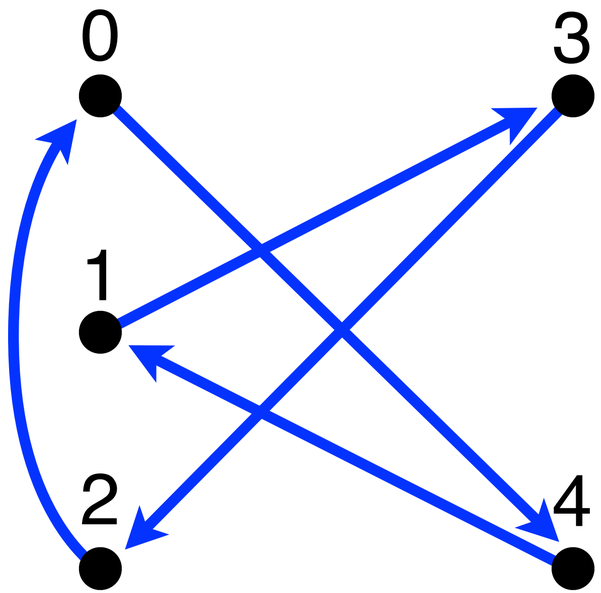
Input

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

Output

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

Traveling Salesman Problem



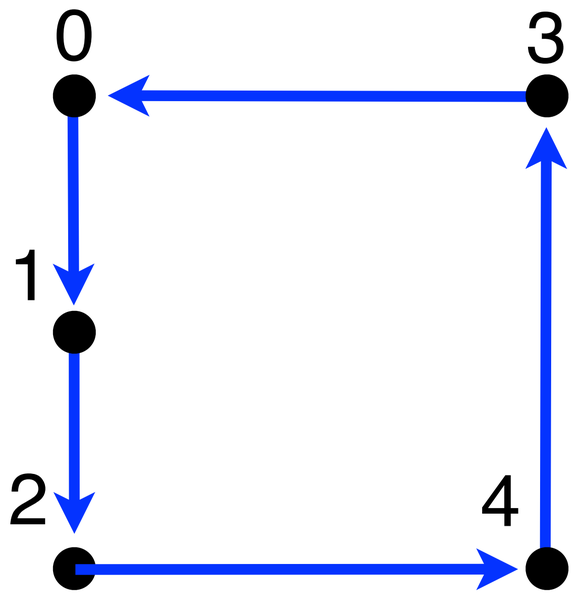
Input

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

Output

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

Traveling Salesman Problem



Input

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

Output

```
4.0 0
0 1 2 4 3
```

Assignment Tips

- *FAST* neighborhood computation
- Symmetries
- Do you need every edge
- Complete search / Lower bounds
- Look at the solution

Have Fun!