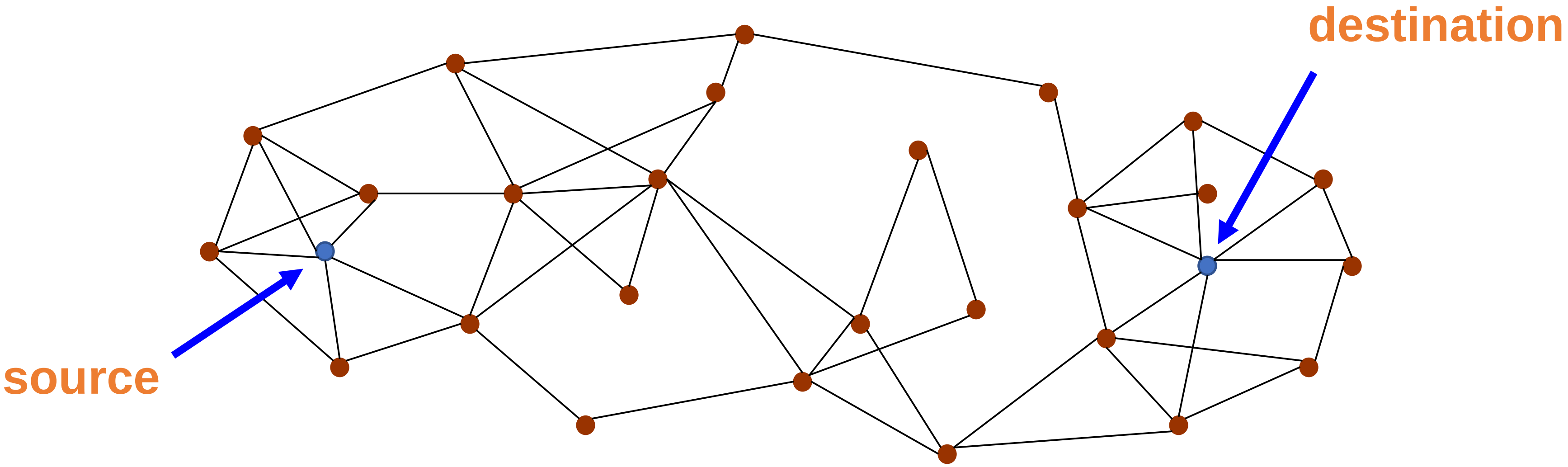
# Data Structure Programming Project #1

郭建志

# Background

- Large-scale geographic routing
- Every node only has the local information (i.e., its neighbors' information) and the destination's information

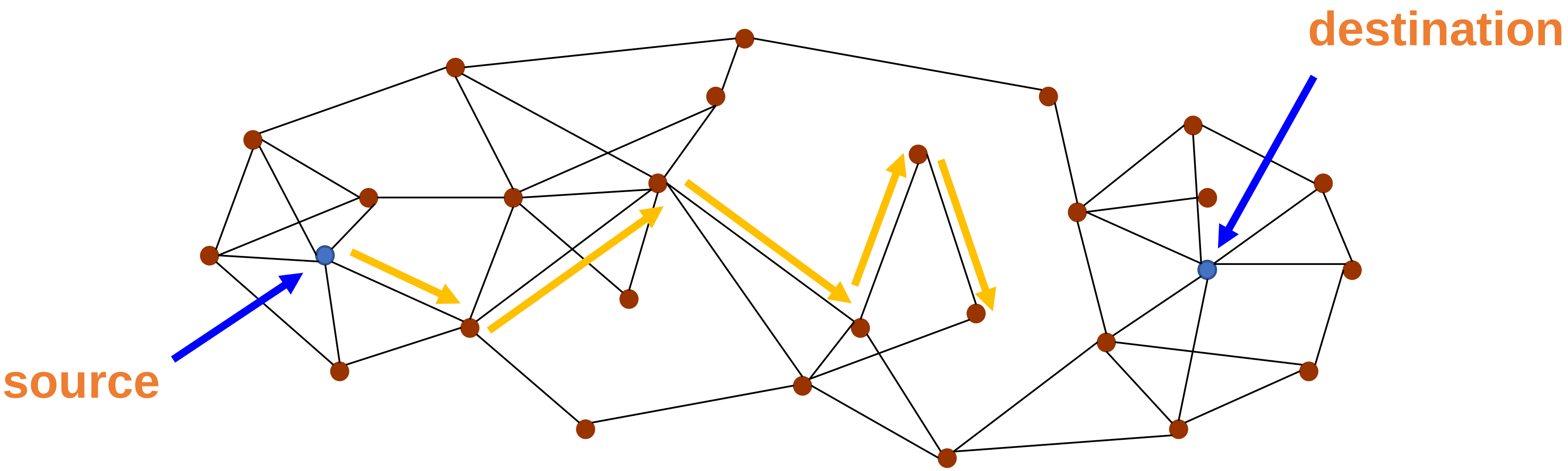


# Background

- Large-scale geographic routing
- Every node only has the local information (i.e., its neighbors' information) and the destination's information
- So, how should a source route a packet to a designated destination?

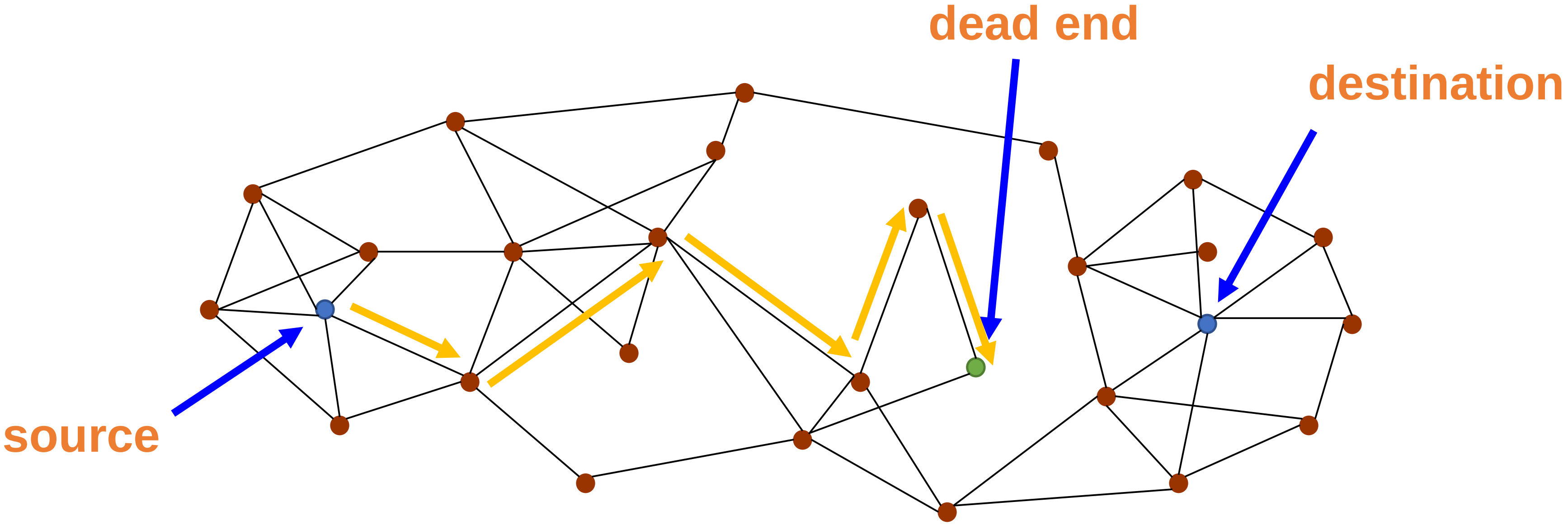
# Naïve Routing Scheme: Greedy

- Forward the packet towards the neighboring node that is closer to the destination



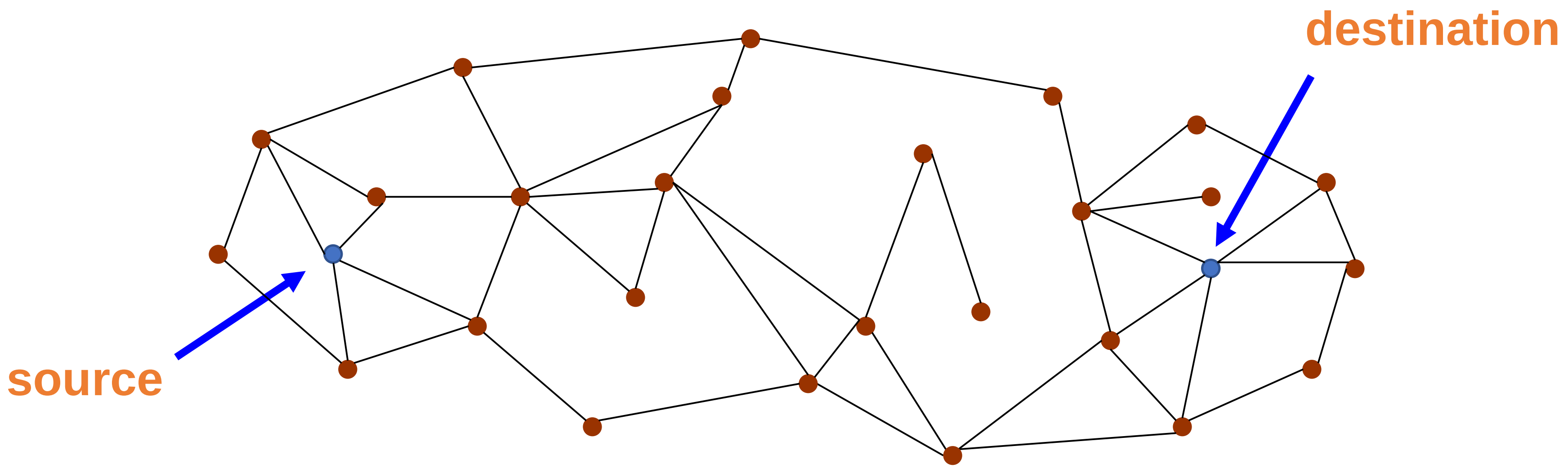
# Naïve Routing Scheme: Greedy

- Forward the packet towards the neighboring node that is closer to the destination
- However, the packet may be stuck at the dead end



# Face Routing

- Generate a planar subgraph: no crossing links
- Right-hand rule
- Change faces



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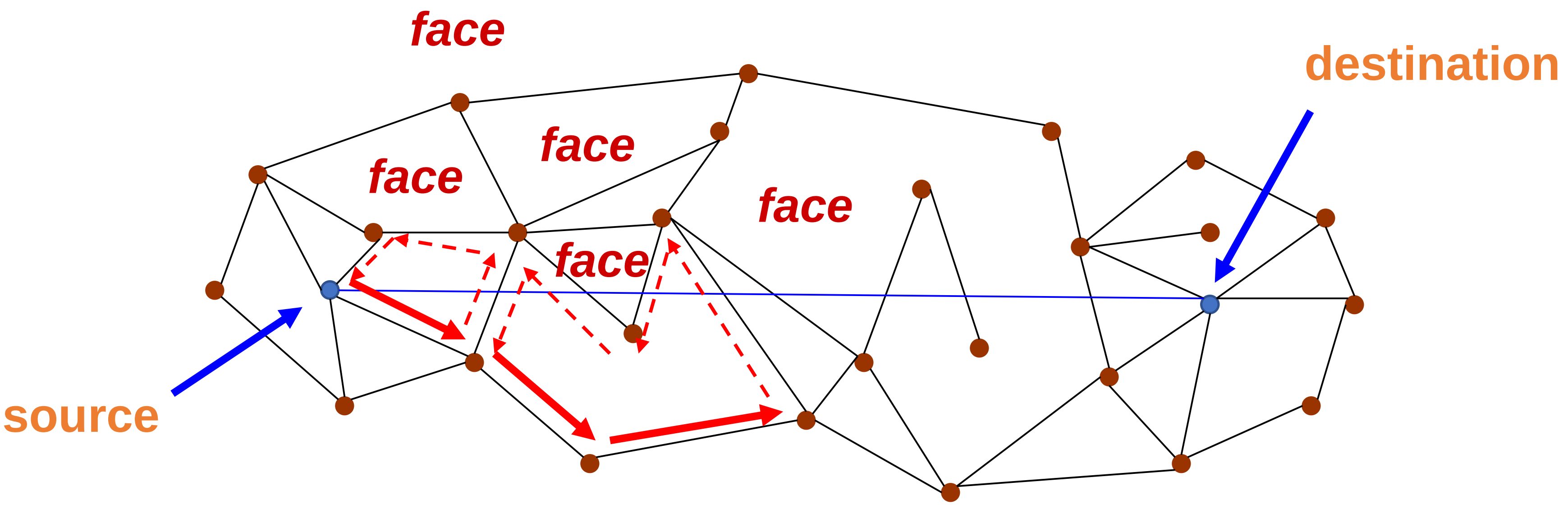
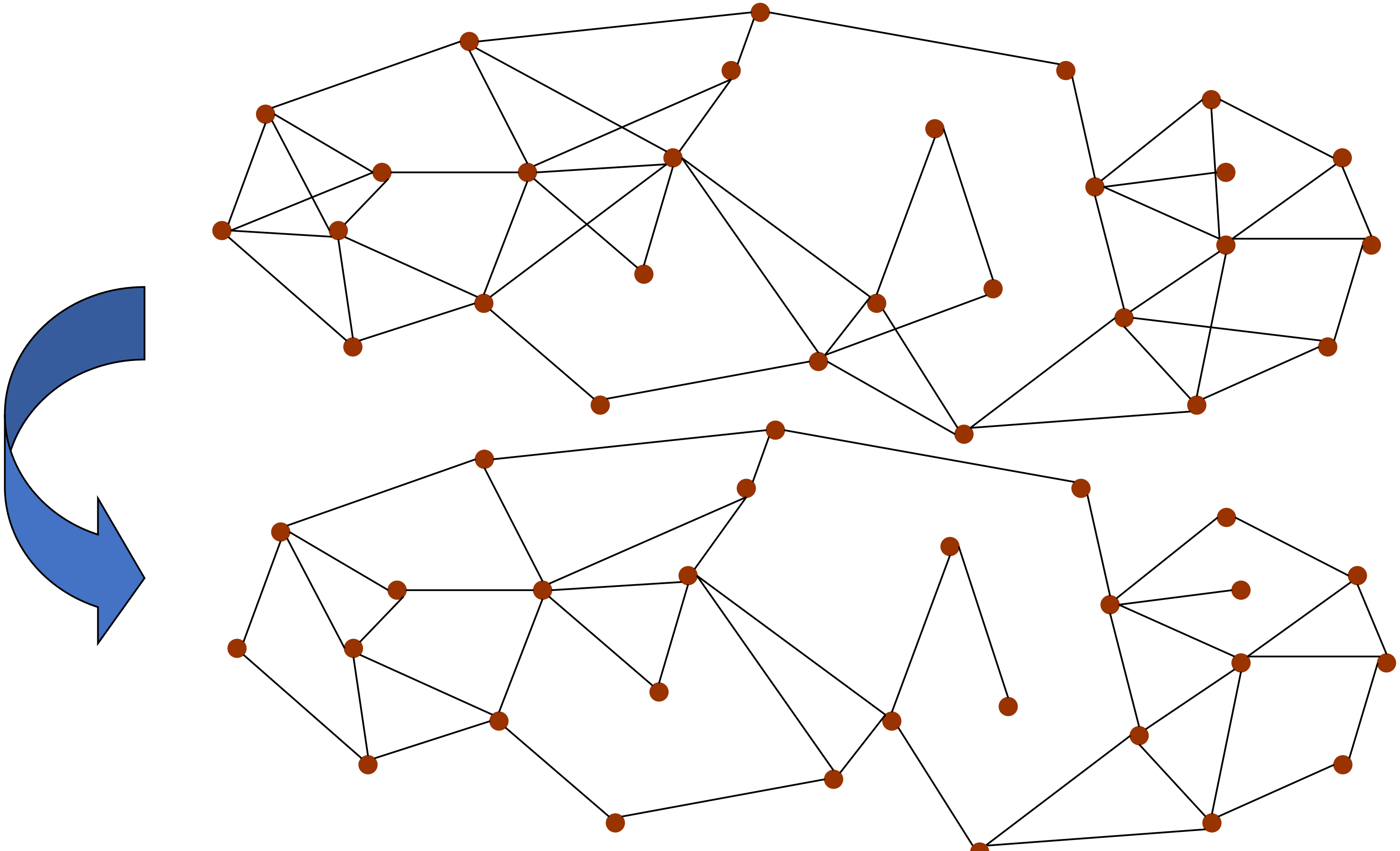


# Programming Project #1: Generate a Planar Subgraph

- Generate a planar subgraph: no crossing links



# Programming Project #1: Generate a Planar Subgraph

- Input:
  - Number of nodes
  - Nodes with non-negative coordinates (x, y) (the input graph is connected when we add links if dist(u,v) ≤ 1)
- Procedure:
  - Add a link between any two nodes u, v as dist(u,v) ≤ 1
  - Remove some links to generate a planar graph
- Output:
  - The edges before and after planarization
- The grade is proportional to the number of remaining edges

Input file:

```
5
0    1.5    2.3
1    1.2    2.6
2    1.3    1.2
...
```

Output file:

```
12
0    0    1
1    1    2
2    1    3
...
8
0    0    1
2    1    3
4    3    4
```

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| … | | |

Output file:

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| 1 | 1 | 2 |
| 2 | 1 | |
| … | | |
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- Implement a designated algorithm to remove the links

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```

# Programming Project #1: Generate a Planar Subgraph

- Output:
  - The edges before and after planarization
- **Notice that:**
  - The first node ID should be smaller than the second one for each link
  - The links should be sequentially indexed in ascending order of the first node ID
  - If there is a tie, the two links are indexed in ascending order of the second node ID
  - The IDs of remaining links after planarization should be identical to the ones before the planarization

Input file: node.txt

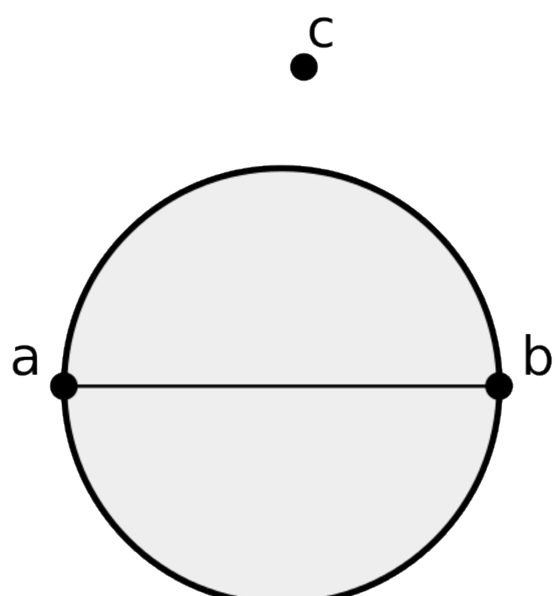
```
5
0    1.5    2.3
1    1.2    2.6
2    1.3    1.2
...
```

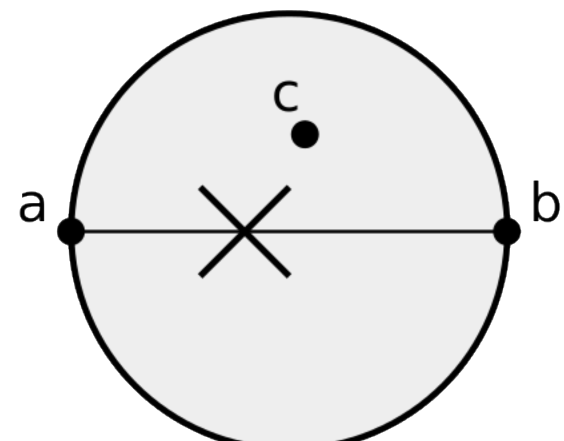
Output file: link.txt

```
12
0    0    1
1    1    2
2    1    3
...
8
0    0    1
2    1    3
4    3    4
```

# Programming Project #1: Generate a Planar Subgraph

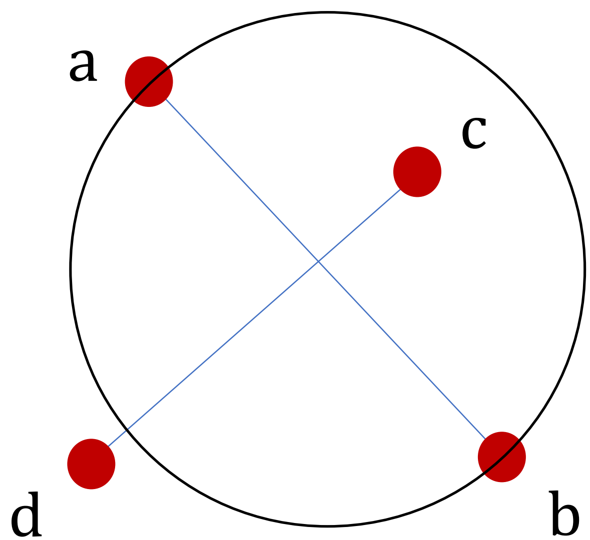
- Implement a designated algorithm to remove the links
- Cut a link between two neighboring nodes a and b, if there is other node c is within their the closed disc, where line segment $\overline{ab}$ is a diameter

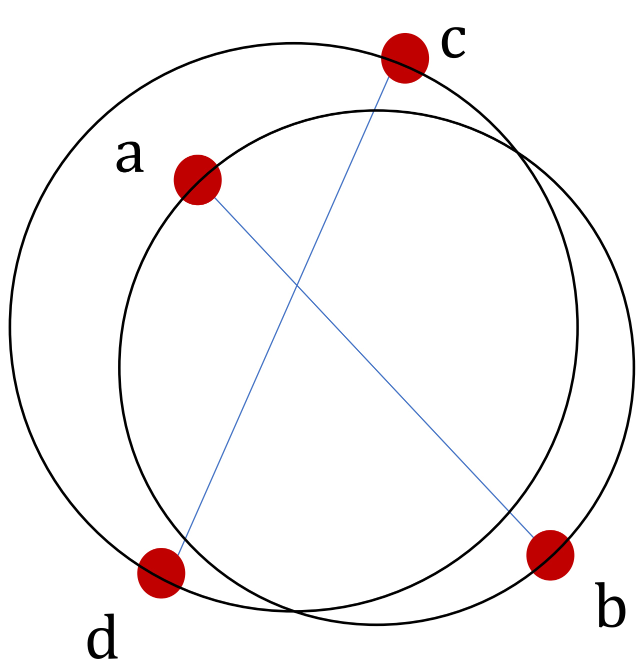


# Why does the algorithm work?

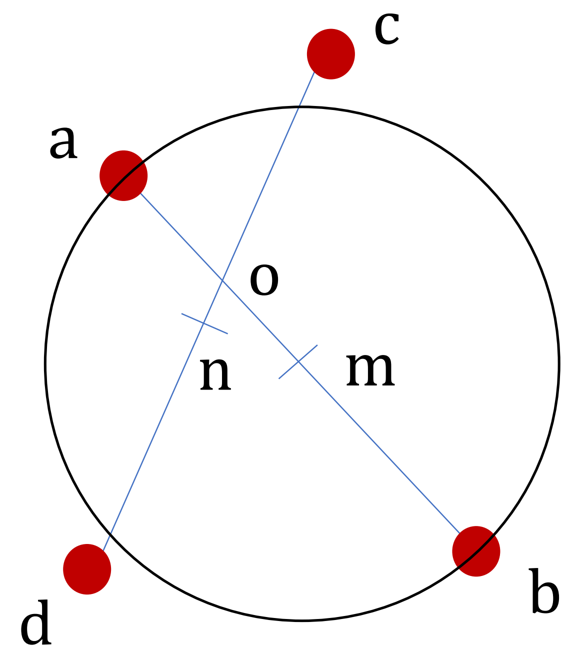
- Prove by contradiction
- Assume that there is an intersection node on the segments $\overline{ab}$ and $\overline{cd}$



# Why does the algorithm work?

- Let $m$ and $n$ denote the middle points of $\overline{ab}$ and $\overline{cd}$, respectively
- Without loss of generality, we assume that $\overline{am}$ and $\overline{cn}$ intersect at node $o$
- Since node $a$ is not in the circle of which $\overline{cd}$ is the diameter, $\overline{cn} < \overline{an}$…(1)
- Similarly, since node $c$ is not in the circle of which $\overline{ab}$ is the diameter, $\overline{am} < \overline{cm}$…(2)

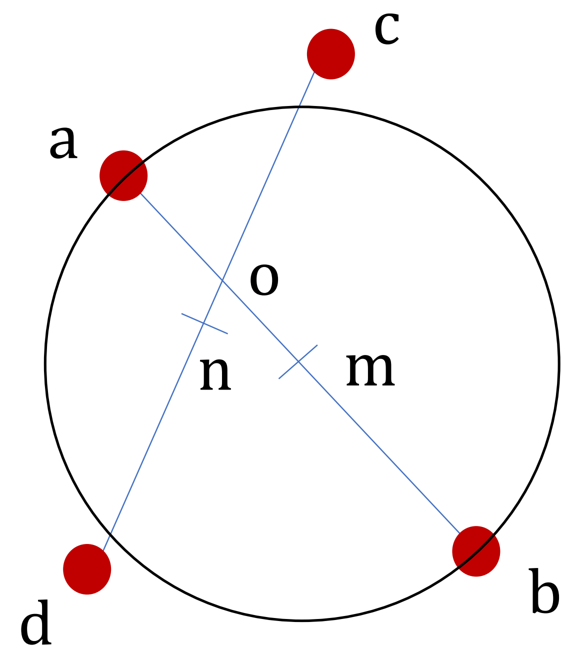


# Why does the algorithm work?

- $\overline{cn} < \overline{an}$…(1)
- $\overline{am} < \overline{cm}$…(2)
- (1)+(2) $= \overline{cn} + \overline{am} < \overline{an} + \overline{cm}$…(3)

- Due to triangular inequality, $\overline{ao} + \overline{on} \geq \overline{an}$…(4)
- Similarly, $\overline{co} + \overline{om} \geq \overline{cm}$…(5)
- (4)+(5) $= \overline{ao} + \overline{om} + \overline{co} + \overline{on} = \overline{am} + \overline{cn} \geq \overline{an} + \overline{cm}$…(6)

- (3) $\rightarrow\leftarrow$ (6)



# Input Sample: node.txt

11

| | | |
|---|---|---|
| 0 | 1.4142 | 1.1534 |
| 1 | 1.97 | 1.85 |
| 2 | 0.8823 | 1.3926 |
| 3 | 1.9996 | 1.9484 |
| 4 | 0.6301 | 1.9145 |
| 5 | 0.3329 | 1.1756 |
| 6 | 1.952 | 0.5866 |
| 7 | 1.8181 | 0.4043 |
| 8 | 0.4949 | 1.946 |
| 9 | 0.2079 | 1.4758 |
| 10 | 0.1364 | 1.4084 |

# Output Sample: link.txt

22

| | | |
|---|---|---|
| 0 | 0 | 1 |
| 1 | 0 | 2 |
| 2 | 0 | 3 |
| 3 | 0 | 6 |
| 4 | 0 | 7 |
| 5 | 1 | 3 |
| 6 | 2 | 4 |
| 7 | 2 | 5 |
| 8 | 2 | 8 |
| 9 | 2 | 9 |
| 10 | 2 | 10 |
| 11 | 4 | 5 |
| 12 | 4 | 8 |
| 13 | 4 | 9 |
| 14 | 4 | 10 |
| 15 | 5 | 8 |
| 16 | 5 | 9 |
| 17 | 5 | 10 |
| 18 | 6 | 7 |
| 19 | 8 | 9 |
| 20 | 8 | 10 |
| 21 | 9 | 10 |

11

| | | |
|---|---|---|
| 0 | 0 | 1 |
| 1 | 0 | 2 |
| 3 | 0 | 6 |
| 5 | 1 | 3 |
| 6 | 2 | 4 |
| 7 | 2 | 5 |
| 12 | 4 | 8 |
| 17 | 5 | 10 |
| 18 | 6 | 7 |
| 19 | 8 | 9 |
| 21 | 9 | 10 |

# Note

- Deadline: 10/11 Thu
- E-course
- **C Source code**
- **Readme including**: *brief description* and *time complexity* analysis of you implementation