

Social Network

Data Structures Assignment 4 Graph



2021.5.10

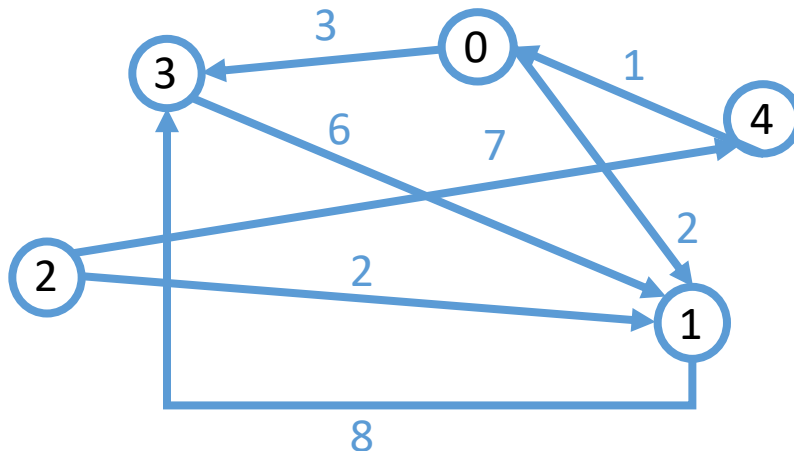
NTHU EECS

Background

- Social network analysis is the process of investigating the structure of a social network.
- In this task, we want to know some properties of a social network, where nodes represent users, and directed edges mean that users can propagate information in that direction.

Representation

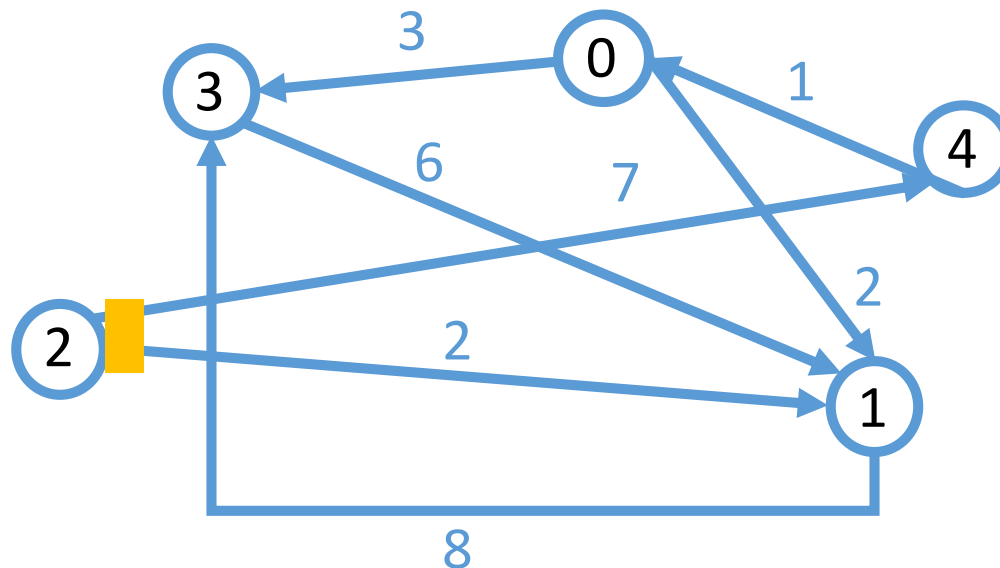
- Use matrices to represent the network.
 - Nonzero digits means weights of the edges.
 - 0 means there are no edges between the two nodes.



	0	1	2	3	4
0	0	2	0	3	0
1	0	0	0	8	0
2	0	2	0	0	7
3	0	6	0	0	0
4	1	0	0	0	0

Information propagation

- Node2 can propagate information to node1.
- Node2 can propagate information to node0.
- Node1 can not propagate information to node2.

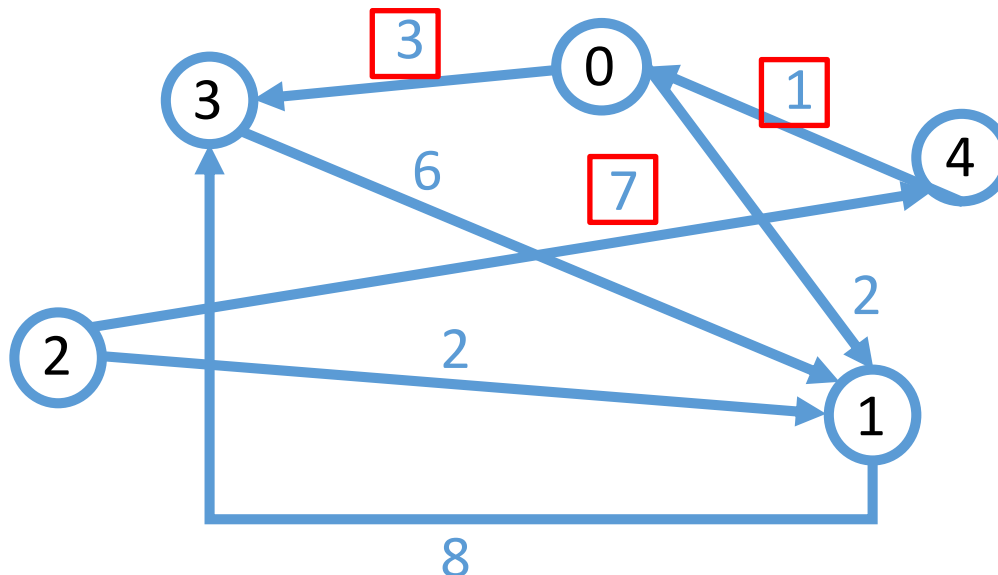


Difficulty Of Information Propagation

- The weights of edges represent the difficulty of information propagation.
 - Smaller difficulty value means that the information is more likely to be propagated.
- The difficulty of a path is determined by summing up the difficulty values of edges in the path.

Difficulty Of Information Propagation

- Node2 can propagate information to node3 with the path : 2->4->0->3
- The difficulty of the path : $7+1+3 = 11$

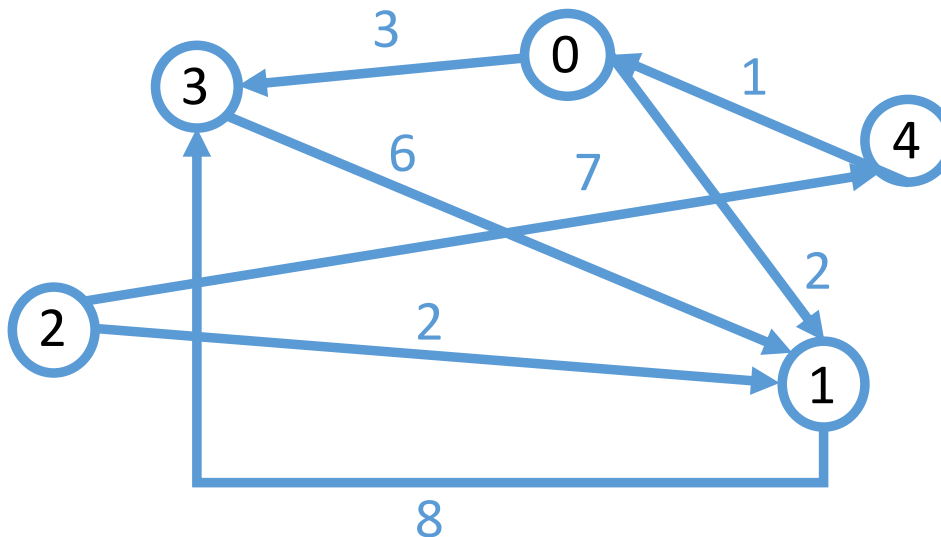


Centrality

- Centrality is a measurement to find out important nodes in a social network.
- Harmonic centrality
 - Definition : $H(x) = \sum_{y \neq x} \frac{1}{d(y,x)}$
 - x means the node we want to measure its centrality.
 - y can be any other nodes (not equal to x).
 - $d(y,x)$ means the difficulty of the least difficult path from y to x .
 - If there are no paths from y to x , $\frac{1}{d(y,x)} = 0$.

Centrality

- The least difficult paths to node0
 - Path(1,0) : no path
 - Path(2,0) : 2->4->0 (difficulty = 8)
 - Path(3,0) : no path
 - Path(4,0) : 4->0 (difficulty = 1)
- Harmonic centrality of node0 = $0 + \frac{1}{8} + 0 + \frac{1}{1} = 1.125$



Goal

- Find out least difficult paths (paths with least difficulty) for each node pair.
 - Print out the nodes that the path traversed.
 - Print the difficulty of the path.
- Show the harmonic centrality of each node.

Input

- Given the number of nodes in the social network.
 - $2 \leq \text{Number of nodes} \leq 100$
- A matrix contains a digit value
 - Non-zero digits represent the weights (difficulty) of the edge between nodes.
 - 0 represents no edge between two nodes

Number of nodes (≥ 2)

The matrix

5					
0	2	0	3	0	
0	0	0	8	0	
0	2	0	0	7	
0	6	0	0	0	
1	0	0	0	0	

Output

- Print out the least difficult path with row major order and the corresponding difficulty for each pair.
- Print out the harmonic centrality of each node.

```
Path(0,1):0->1
Difficulty:2
Path(0,3):0->3
Difficulty:3
Path(1,3):1->3
Difficulty:8
Path(2,0):2->4->0
Difficulty:8
Path(2,1):2->1
Difficulty:2
Path(2,3):2->1->3
Difficulty:10
Path(2,4):2->4
Difficulty:7
Path(3,1):3->1
Difficulty:6
Path(4,0):4->0
Difficulty:1
Path(4,1):4->0->1
Difficulty:3
Path(4,3):4->0->3
Difficulty:4
Centrality(0):1.125
Centrality(1):1.500
Centrality(2):0.000
Centrality(3):0.808
Centrality(4):0.143
```

Constraints

- If the difficulty of the multiple paths are equivalent, select the one which first go through the smaller node. (Compare the nodes)
 - EX: (three paths with the same difficulty)
 - path A: 0->9->1
 - path B: 0->10->1
 - You need to print path A.
- The value of the centrality is **accurate to the third digit after the decimal point.**
 - You can use [lomanip::setprecision\(int\)](#) to achieve this.

HW4 String Comparison Version

- If you develop code based on string comparison constraint, you can submit your code [here](#).
 - EX: (two paths with the same difficulty)
 - path A: 0->10->1
 - path B: 0->9->1
 - You need to print path A.
 - EX: (two paths with the same difficulty)
 - path A: 0->1->2
 - path B: 0->10->2
 - You need to print path A.
- If you decide to use the submission in this newly-opened contest as your score of HW4, please email TA Jeremy (sponge611@gmail.com)

HW4 Timeline

- HW4 registration: 5/10 9:00a.m.~ 5/11 9:00a.m.
- HW4 deadline: 5/25 12:00 (at noon)
- Quiz4: 5/24 18:30~20:30