

1. (18 pts total) Give one real-life example of each of the following types of networks; then, briefly describe one empirical technique that could be used to measure the structure of each of the following networks (i.e., to fully determine the positions of all the edges), and one phenomenon regarding the network that you are interested in which network analysis methods may help to understand:

(a) (3 pts) An acyclic (or approximately acyclic) directed network

遇轉折處就轉彎的迷宮；計算轉折處和路徑

(b) (3 pts) A cyclic directed network

神經網絡；數中間經過的傳遞點和傳遞路徑；網絡常有回饋機制

(c) (3 pts) A tree (or approximate tree)

族譜；家人和親緣關係；家人之間的親密程度

(d) (3 pts) A planar (or approximately planar) network

Electric circuit；節點和電線；電流如何流動

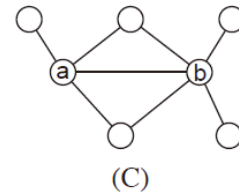
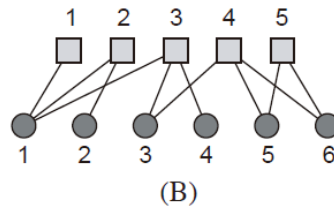
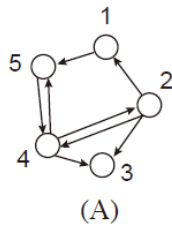
(e) (3 pts) A bipartite network

Actors & movies/scenes；演過的電影和演過的劇情橋段；特定演員在特定劇本種類中的表現

(f) (3 pts) A temporal network (or sequence of edges)

匯率變化；轉折點、上升、下降；如何預測匯率的漲跌？

2. (14 pts total) Consider the following three networks:



(a) (3 pts) Give the adjacency matrix for network (A).

A	1	2	3	4	5
1	0	1	0	0	1
2	1	0	1	1	0
3	0	1	0	1	0
4	0	1	1	0	1
5	1	0	0	1	0

(b) (3 pts) Give adjacency list for network (A).

A	
1	{2,5}
2	{1,3,4}
3	{2,4}
4	{2,3,5}
5	{1,4}

(c) (5 pts) Give adjacency matrices for both one-mode projections of network (B).

B(square)	1	2	3	4	5
1	0	1	1	0	0
2	1	0	0	0	0
3	1	1	0	1	0
4	0	0	1	0	1
5	0	0	0	1	0

B(circle)	1	2	3	4	5	6
1	0	1	1	1	0	0
2	1	0	0	0	0	0
3	1	0	0	1	1	1
4	1	0	1	0	0	0
5	0	0	1	0	0	1
6	0	0	1	0	1	0

(d) (3 pts) What is the cosine similarity of vertices a and b in network (C)?

$$similarity = \cos\theta = \frac{A \cdot B}{\|A\| \|B\|} = \frac{3}{\sqrt{4}\sqrt{5}} \approx 0.67$$

Collaboration：方婕瑀