Social Network Analysis - Fall 2021 - Final Exam

Total points 59.5/80

Total Marks: 80 Time: 2 hours

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2021JCS2260

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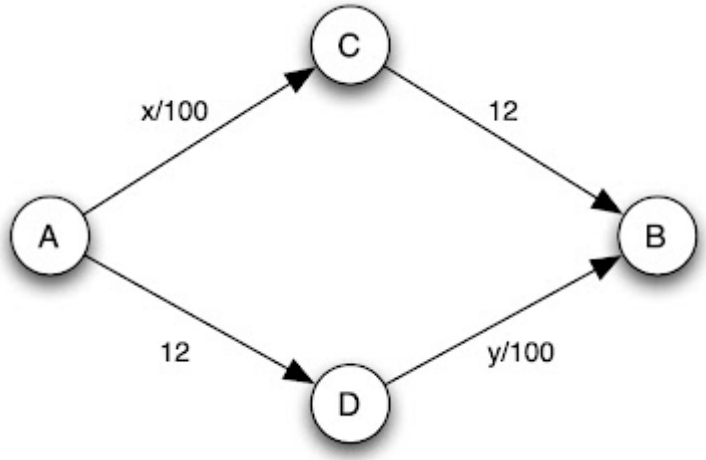
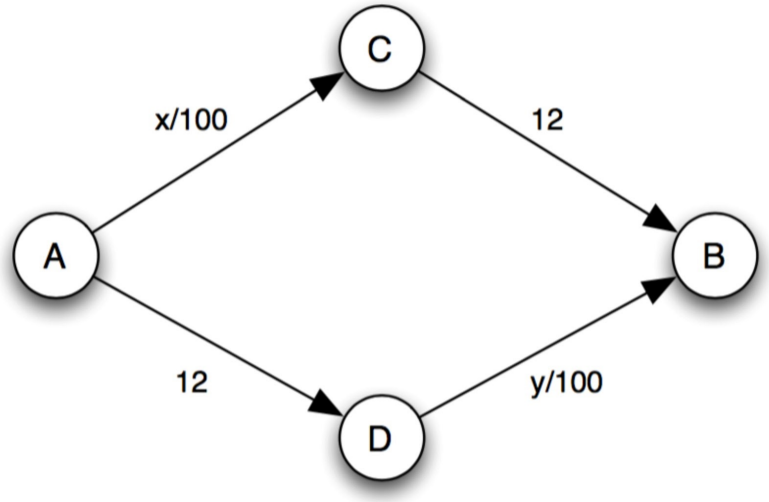
✓ Q1(a). There are 2000 cars which must travel from town A to town B. There are two possible routes that each car can take: the upper route through town C or the lower route through town D. Let x be the number of cars traveling on the edge AC and let y be the number of cars traveling on the edge DB. The directed graph in the figure below indicates that travel time per car on edge AC is x/100 if x cars use edge AC, and similarly the travel time per car on edge DB is y/100 if y cars use edge DB. The travel time per car on each of edges CB and AD is 12 regardless of the number of cars on these edges. Each driver wants to select a route to minimize his travel time. The drivers make simultaneous choices. Find Nash equilibrium values of x and y. 3/3



let say x drivers are uses the upper route and 2000-x users uses second route then x=2000-x x=1000 so 1000/100 + 12 =10+12=22 total travel time from a to b. x=1000 and y=1000

Q1(b). Now the government builds a new (one-way) road from town C to town D. The new road adds the path ACDB to the network. This new road from C to D has a travel time of 0 per car regardless of the number of cars that use it.



✓ i) Find a Nash equilibrium for the game played on the new network. 1/1

There will be an equilibrium when x=2000 and y=2000 but it will lead for a worse time for everyone. At the equilibrium, every driver will uses the route through c and d

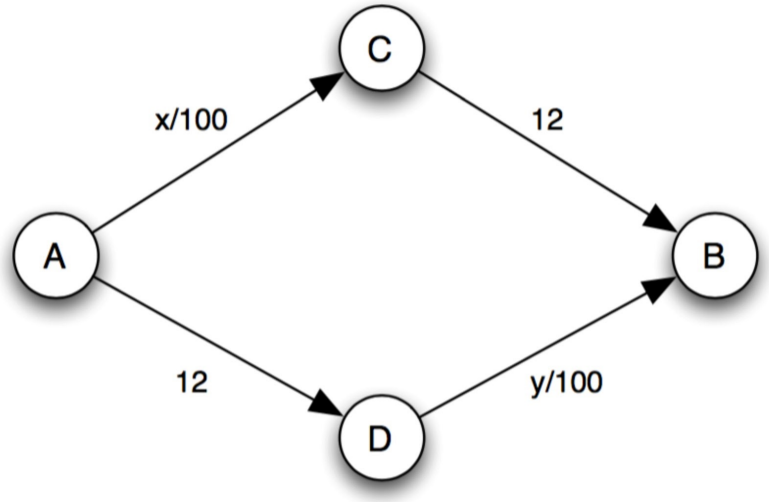
✓ ii) What are the equilibrium values of x and y? 1/1

Equilibrium values X=2000 and y=2000

✗ iii) What happens to total cost-of-travel (the sum of total travel times for the 2000 cars) as a result of the availability of the new road? 0/1

At the equilibrium, every driver will uses the route through c and d. Travel time now= 2000/100+0 +2000/100=40. Here no driver is benefitted from changing their route. So total cost will increase

Q1(c). Suppose now that conditions on edges CB and AD are improved so that the travel times on each edge are reduced to 5. The road from C to D that was constructed in the previous question is still available.



✗ i) Find a Nash equilibrium for the game played on the network with the smaller travel times for CB and AD. 0/1

The nash equilbrium requires the three routes to have some travel time A-C-B, A-C-D-B,A-D-B.
so x/100+5=x/100+y/100=5+y/100.
If any route is slower, then that driver will switch from slower to faster one.

✓ ii) What are the equilibrium values of x and y? 1/1

Both X=1000 and Y=1000

✗ iii) What is the total cost-of-travel? 0/1

Total cost=15

✗ iv) What would happen to the total cost-of-travel if the government closed the road from C to D? 0/1

Q2. Consider the two-player game with players, strategies and payoffs described in the game matrix shown below.

Jit \ Kit	U	D
T	$x, -x$	$-y, y$
F	$-z, z$	$x, -x$

✓ a) Find the mixed Nash Equilibrium probabilities p and q for playing T and U. 4/4

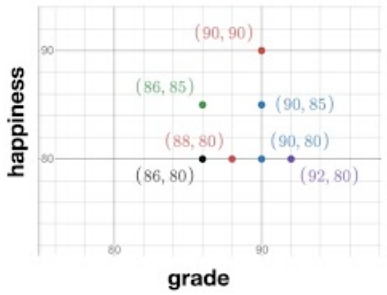
p=(x+z)/(2x+y+z) ,q= (x+y)/(2x+y+z)

✗ b) What is the relationship between p and q? 0/1

p=((x+z)/(x+y))*q

Q3. Consider the game in the figure below with 2 payoffs for each player, grade and happiness, which cannot be compared with each other. The values of the payoffs are given as (grade; happiness) for each player (column player's payoffs in blue colour). In the figure, when row player and the column player plays "preso", row player gets a payoff (grade=90; happiness=90) and the column player gets a payoff (grade=90; happiness=80).

		column player: preso	column player: exam
row player	preso	(90; 90) | (90; 80)	(86; 85) | (92; 80)
	exam	(92; 80) | (86; 80)	(88; 80) | (88; 80)



✓ (a) What strategy is each player likely to play? Why? 4/4

Column player -> exam because he will get better payoff grade and happiness remains unchanged.
Row player will decide based on the happiness or grades of the column player,
if happiness then preso.
if grade then exam.

✓ (b) Does any player have a strictly dominant strategy? If yes, which one? 2/2

Column player has strictly dominant strategy to play the play the exam.

✗ (c) Draw the best response graph for this game. 0/3

There will exist two best response graph based on the the priority of row player.
1) grade major priority and happiness lower priority of row player.
a)row.exam-->col.exam-->row.preso--> col.exam
b)col.preso-->row.exam
2) happiness- major priority and grade-lower priority.
a)row.preso-->col.exam-->row.preso
b)row.exam-->col.exam
c)col.preso-->row.preso

✗ (d) Extend the Nash equilibrium definition for this setting. 0/2

✗ (e) Based on your definition, identify the Nash equilibrium(ia) of this game? 0/1

✗ (f) Find the social and pareto-optimal solutions for this game. 0/4

Q4. Consider the two-player game described by the payoff matrix below.

		Player B	
		L	R
Player A	U	$1, 1$	$0, 0$
	D	$0, 0$	$5, 5$

✓ (a) Find all pure-strategy Nash equilibria for this game. 2/2

Nash equilibria will be formed between player A's U and Player B's L and second will be formed when Player A's D and Player B's R.

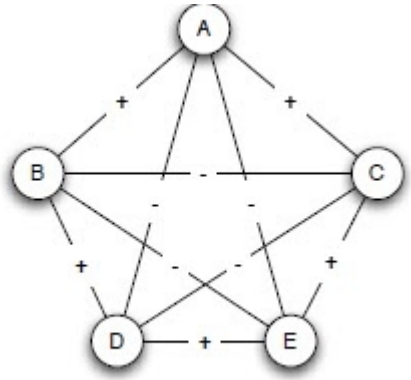
✓ (b) This game also has a mixed-strategy Nash equilibrium; find the probabilities the players use in this equilibrium, together with an explanation for your answer. 5/5

p=probability of choosing U by player A and q is the probability of choosing L by player B. By solving we get p=5/6 and q=5/6.

✓ (c) Keeping in mind Schelling's focal point idea, what equilibrium do you think is the best prediction of how the game will be played? Explain. 2/2

According to Schelling's focal idea, Player A's D and Player B's R will be at focal point because of the higher payoff.

Qs 5. Consider the graph below:



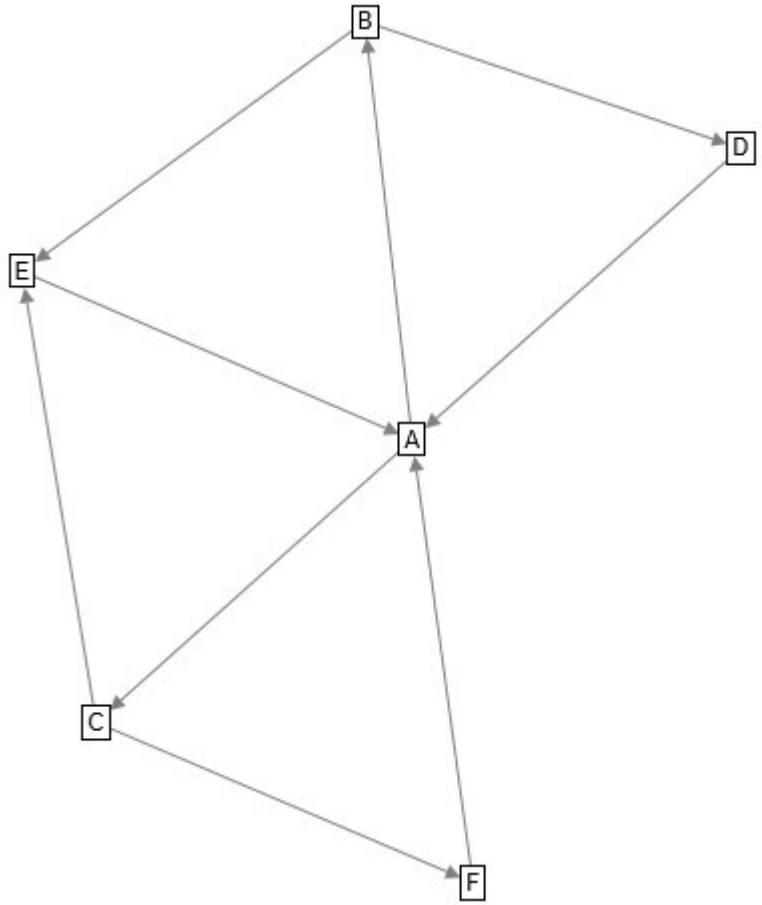
✓ a) Is the graph balanced? Why or Why not? 2/2

The graph is not balanced because ACE contains two +,s and one- s. Hence it violates Graph balanced property.

✓ b) Is the graph weakly balanced? Why or Why not? 2/2

The graph is not weakly balanced because in case of ACE there is two+ and one- . Hence it violates the weakly balanced property.

Qs 6. Consider the graph below:



✓ a) Calculate the basic Page Rank values of the 6 nodes after the 1st iteration of the basic Page Rank algorithm. 3/3

A= 1/2, B=1/12,C=1/12,D=1/12,E=1/6,F=1/12

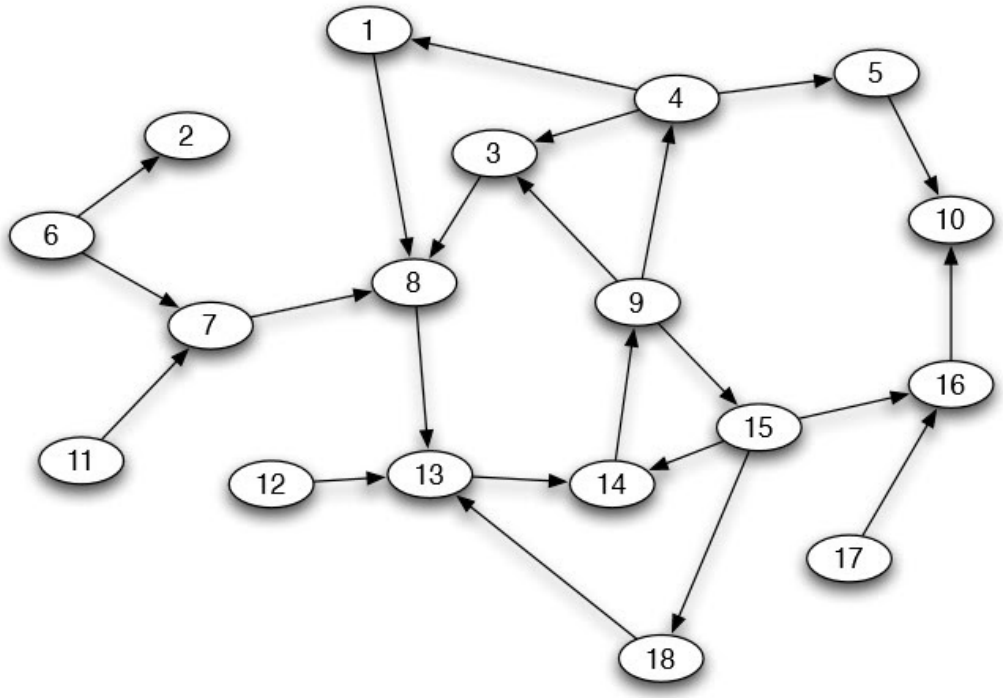
✓ b) Calculate the basic Page Rank values of the 6 nodes after the 2nd iteration of the basic Page Rank algorithm. 3/3

A=1/3,B=1/4,C=1/4,D=1/24,E=1/12,F=1/24

✓ c) Change the above graph in any way to showcase the problem of basic PageRank algorithm. 2/2

If we invert the edges between A and B and also between A and C the Page rank will accumulate. hence the problem of basic PageRank is resolved.

Qs 7, Assume that the graph above shows the Bow-Tie structure



✓ a) How many nodes are there in the Giant SCC component? 2/2

9 nodes ✗

✓ b) Which nodes belong to Tendrils from IN nodes? 2/2

2 ✗

✗ c) Give an example of an edge that can be deleted to increase the size of OUT. 0.5/2

15--18 ✗

✓ d) How can we form a Tube in this graph? 2/2

If we join from 6 to 5 We can form a tube in this graph. ✗

Qs 8.

Assume a scenario where you have to decide if a news you receive from a source is true or fake. Because of the reliability of the source the probability of the news being true is 3/4. To be sure you ask your friends for their opinion also. Suppose that the probability that your friend will give you the correct opinion is 3/5. Based on Information Cascade determine the probability of:

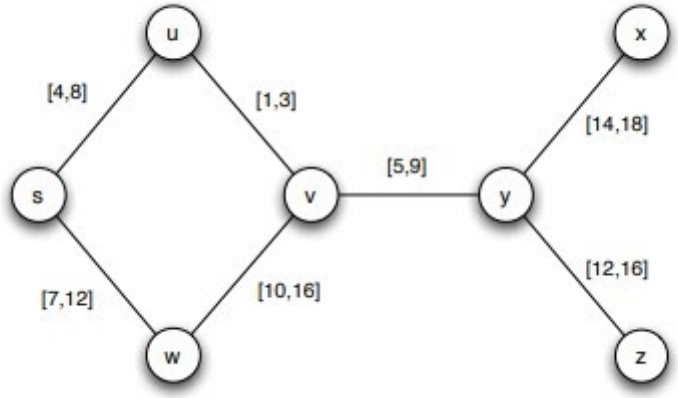
✓ a) The news is fake if one of your friend thinks it is fake. 2/2

numerator = 1/4*3/5
denominator= (1/4*3/5)+(3/4*2/5)
final answer= 3/9=1/3

✗ b) The news is true if 1 friend thinks it is true and 3 friends think it is fake. 1/4

numerator= 1/4*3/4*3/4*3/4 *3/5
denominator= 1/4*3/4*3/4*3/4*3/5+3/4*1/4*1/4*1/4*2/5
final answer= 81/87

Qs 9 a) Suppose you are studying the spread of a rare disease among the set of people pictured below. The contacts among these people are as depicted in the network in the figure, with a time interval on each edge showing when the period of contact occurred. We assume that the period of observation runs from time 0 to time 20. Which nodes could potentially have acquired the disease by the end of the observation period, at time 20



✓ i) if u is the initially affected person? 1/1

s,v,w,y,x,z ✗

✓ ii) if z is the initially affected person? 1/1

y,x ✗

✓ b) Assume that individuals are connected to 4 other people in a tree structure. What is the maximum contagion probability that a disease can have so that it does not turn into an epidemic? Why? 2/2

The disease will not turn into epidemic when Reproductive number is less than 1 here d=4
So, R=q*d = q*4<1 so q<0.25 Hence maximum contagion probability is 0.25

✓ c) Give two reasons why you think that the SIRS model is not appropriate to represent the COVID epidemic. 2/2

In case of covid, there is also need of Protected stage if any person is vaccinated. It is highly unlikely that he may get covid again. Also quarantined staged is missing in case of SIRs model.

Qs 10.

Answer True or False.

✓ a) K4 is a non-Planar graph. 1/1

- [ ] True
- [x] False ✓

✓ b) In Spring Graph Layout Algorithm it is possible that there are both a force of attraction and a force of repulsion between 2 nodes. 1/1

- [x] True ✓
- [ ] False

✓ c) In Fish-eye view Degree of Interest of a point is dependent only on its distance from the focus point. 1/1

- [ ] True
- [x] False ✓

✓ d) In Hyperbolic Geometry the circumference of a circle of 1 cm diameter is less than pi cm 1/1

- [ ] True
- [x] False ✓

✓ e) Term frequency is inversely proportional to Document frequency 1/1

- [ ] True
- [x] False ✓

✓ f) Information Cascades are easy to start and stop. 1/1

- [x] True ✓
- [ ] False

✗ g) Contagion probability of a disease can be decreased by Social distancing 0/1

- [x] True ✗
- [ ] False

✓ h) As the number of long range links increase, oscillations of SIRS epidemics increase. 1/1

- [x] True ✓
- [ ] False