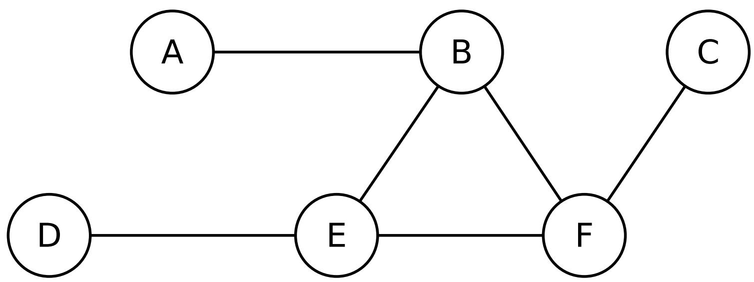
CSC303: Practice Questions

We'll be covering solutions in-tutorial on April 8th

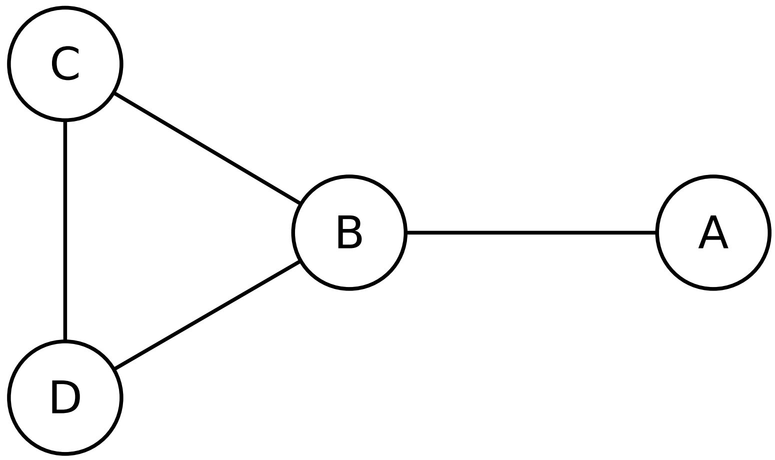
Question 1:

(a) Run the Sintos & Tsaparas algorithm on the following graph G to find the solution to the MINSTC problem. Recall, in MINSTC our goal is to producing a labeling of strong & weak edges such that STC is preserved and the number of weak edges in minimized.



Make sure to draw the complementary graph G_T. Find the optimal vertex covering of G_T manually.

Question 2: Cluster the following graph using the Girvan-Newman algorithm



Question 3: A classmate of yours is studying homophily with respect to yodeling in a network. In this network, there exists data on 1-way friendships. In the network, the directed edge $\langle A, B\rangle$ signifies that A views B as a friend, but the feeling is not mutual. Your classmate finds that given that B is a yodeler, there is no change in the probability that A yodels based on direction of friendship (i.e. the probability that A yodels is the same when either $\langle A, B\rangle$ or $\langle B, A\rangle$ is in the network). Is this evidence for or against social influence causing homophily with respect to yodeling? Briefly justify.

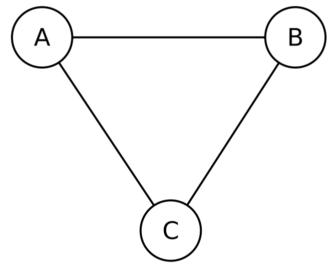
Question 4: Are all labellings of all undirected trees completable to a strongly balanced network? Either provide a proof or a counterexample.

Question 5: Recall the product diffusion process described in class. Recall that each node using product A has a reward of a per neighbour also using A, and that each node using product B has a reward of b per neighbour also using B.

Assume that we change our model so that mismatching neighbours each get a reward of $c < a, b$. For a node u using B, what proportion of u's neighbours must be using A for it to be non-detrimental for u to switch?

Question 6: In class we saw how to represent SIS using SIR, and in tutorial you saw the SEIR model. How can you represent SEIR as a SIR model with $t_E = 1$? Assume the SEIR contact network is directed.

Question 7: Prove that no solution to the following bargaining network is stable



Question 8: The bargaining networks we have seen assign \$1 to each edge. Under this constraint we've seen that a solution (M, v) is stable iff $\forall (A, B) \in E \setminus M : v(A) + v(B) \geq 1$, where $G = (V, E)$ is the underlying network.

If we allow for edges to have different weights (e.g., A and B can split \$1.5, and B and C can split \$0.75, and so on), then does our previous theorem still capture stable solutions (i.e., solutions in which no two nodes out of the matching can make a strictly better deail among themselves)?

Justify your answer.

Question 9: Consider the following matching problem

$m_1 \succ_{w_1} m_2 \succ_{w_1} m_3$
$m_2 \succ_{w_2} m_1 \succ_{w_2} m_3$
$m_1 \succ_{w_3} m_2 \succ_{w_3} m_3$
$w_2 \succ_{m_1} w_1 \succ_{m_1} w_3$
$w_1 \succ_{m_2} w_2 \succ_{m_2} w_3$
$w_1 \succ_{m_3} w_2 \succ_{m_3} w_3$

(a) Run MPDA and FPDA on the given preferences

(b) Which solution is female-pessimal, and which is male-pessimal?

Question 10: If we add a new line in a subway system, then can Braess' paradox emerge? Ignore the time it requires to load/unload travelers. Is it important whether we're considering the travel time of people or subway cars? Is it important whether we consider subway cars to have finite or infinite capacity?

Question 11: Consider the problem of decentralized search. Assume that instead of only providing a node with it's neighbours and their grid-distance to the target, we also provide a node with their neighbours' weak links. How could you improve the decentralized search heuristic with this information?

Question 12: Assume you run a fast food restaurant. The sales of your products roughly follow a power law distribution. To take advantage of bulk purchases, you would like to maximize the inequality in the sales distribution. How could you do this?

Question 13: Compute the structural virality of a graph consisting of a node u_0 with n children, $u_1, \dots u_n$.

Question 14: Describe a graph which is not a social network (i.e., the nodes cannot be people or similarly intelligent entities such as companies or Star Trek's Data), but where Triadic closure could be argued to be applicable.

Question 15: Using the methods from A1, try to prove some of the properties of the signed Laplacian matrix that we saw when introducing the Ozdoizgoti algorithm in week 4.

HINT: For the exam, you may want to briefly review the key ideas behind statistical tests (i.e., null & alternate hypothesis) before the test.