CSE 6240 - Spring 2015
Web Search & Text Mining
Homework 7

Due: 04/12/2015 11:55pm

1. Strong and weak ties in the network (50%)
   a) What is 'Strong Triadic Closure Property'? Using a graph example, show in detail how it is used to prove the theorem on local bridges and weak ties mentioned on page 17 of slides 'lecture 10.3'. (10%)
   b) In the following 3 networks (figure 1, 2, 3) with each edge labeled as either a strong or weak tie, which nodes violate the 'Strong Triadic Closure Property'? Explain your answer. (15%) (strength d-c in figure 1 is missing. Please work on both cases)

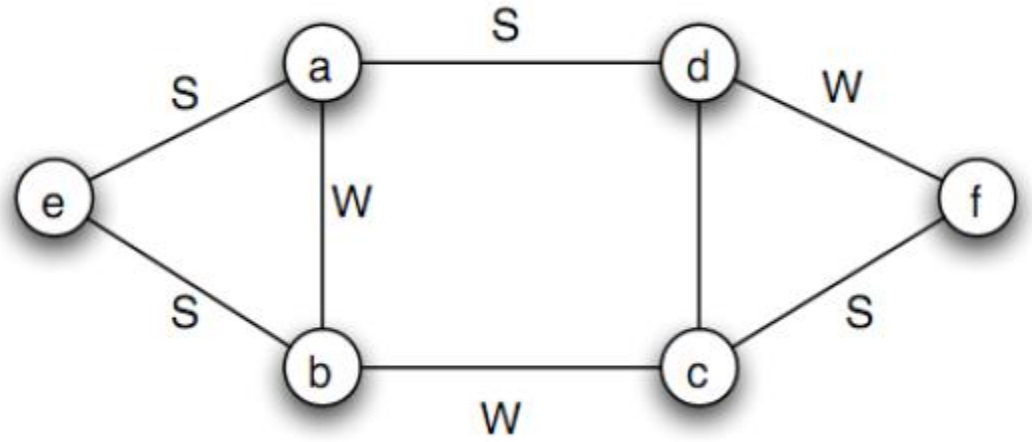

Figure 1

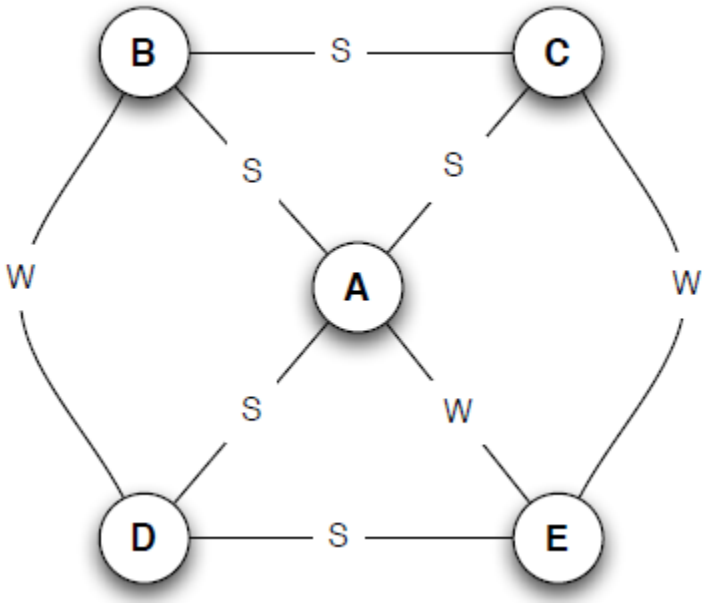

Figure 2

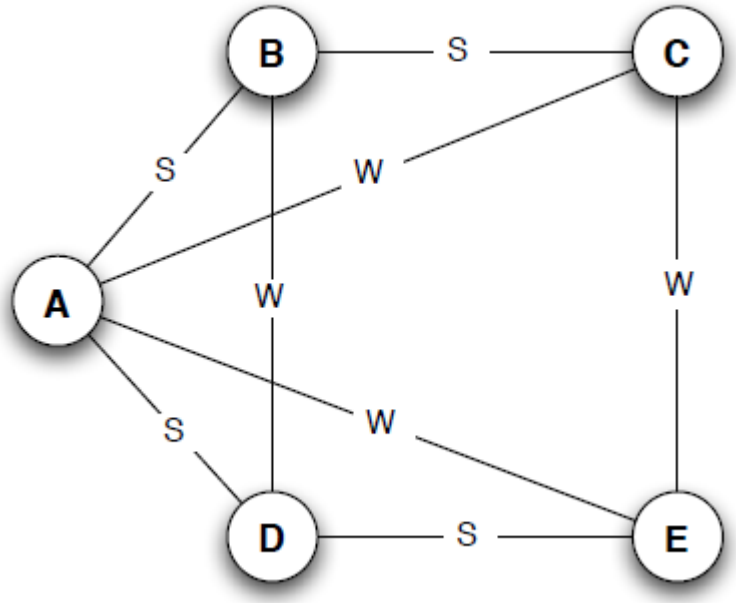

Figure 3

c) Show the process of partition the following graph (figure 4) using Girvan-Newman method. (Please refer to NCM chapter 3.6 for G-N method) (25%)

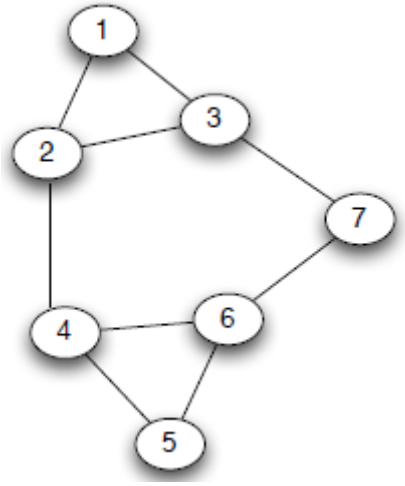

Figure 4

2. Structural Balance in Social Networks (50%)
   a) Consider the 3-node social networks in Figure 5, 6, 7, in which all pairs of nodes know each other, and each pair is either friendly or hostile as indicated by the '+' or '-' label on each edge. A fourth node D wants to join this network, and establish either positive or negative relations with each existing node A, B, and C. For each case, can node D do this in such a way that it doesn't become involved in any unbalanced triangles? If there is a way for D to do this, say how many different such ways there are, and give an explanation. Otherwise, give an explanation why not. (30%)

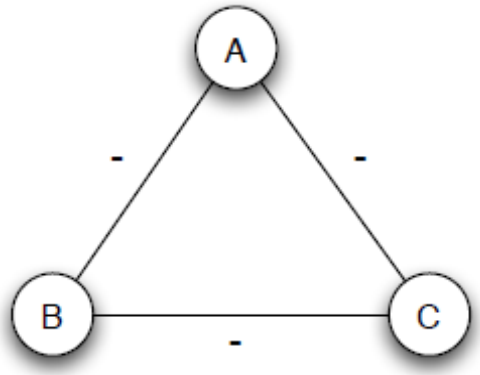

Figure 5

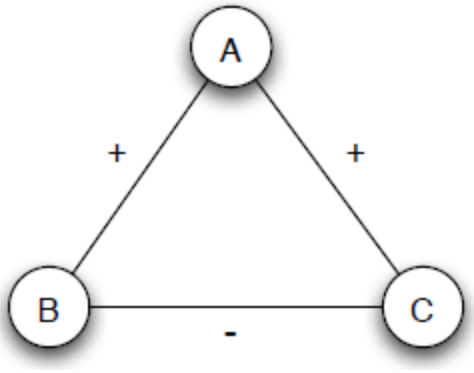

Figure 6

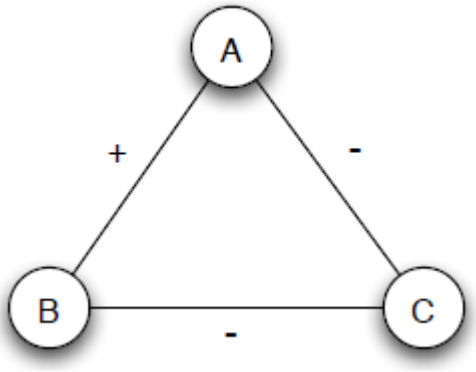

Figure 7

b) Using what you've worked out in Questions a, consider the following question. Take any labeled complete graph on any number of nodes that is not balanced; i.e. it contains at least one unbalanced triangle. (Recall that a labeled complete graph is a graph in which there is an edge between each pair of nodes, and each edge is labeled with either + or -.) A new node X wants to join this network, by attaching to each node using a positive or negative edge. When, if ever, is it possible for X to do this in such a way that it does not become involved in any unbalanced triangles? Give an explanation for your answer and prove it. (Hint: Think about any unbalanced triangle in the network, and how X must attach to the nodes in it.) (20%)

3. (Bonus) Write a program checking if a graph is balanced or not. (50%)
Given an UNDIRECTED graph, your program should read a number of signed edges and output 'YES' if it is balanced and 'NO' if not. Please refer to the slides for the algorithm and follow the INSTRUCTIONS below.

Input format:

Your program should read from STANDARD INPUT stream.

The first line contains two integers, n and m, denoting number of nodes and edges. Nodes range from 0 ~ n-1 and n will be maximally 1,000,000.

The following m lines describe m edges. Each line contains two integers x, y, and a sign '+' or '-', denoting a signed undirected edge between x and y. There is NO self-loop and NO duplicate edges.

Output format:

Your program should write to STANDARD OUTPUT stream.
If the graph is balanced, output 'YES'. Otherwise, output 'NO'.

Sample Input:

```
5 4
1 2 +
3 4 +
4 5 -
5 3 +
```

Sample Output:

```
NO
```

Below are some instructions:

a. Your program should contain only ONE file, naming checkBalance_LASTNAME_FIRSTNAME.xxx where xxx is the possible extension (java, c, cpp, py). Please upload it along with your report directly (don't use zip and no need to write readme or report).
b. Your program should NOT assume any command line parameters like input/output files. It should directly read from standard input and write to standard output.
c. You may write in any language you like, but please be prepared to demo in TA hour if it is none of C++, Java and Python or it uses any third-party libraries.