

Redes Complexas - Trabalho Prático 2

Paulo Viana Bicalho¹

¹Departamento de Ciência da Computação – Universidade Federal de Minas Gerais (UFMG)

{p.bicalho}@dcc.ufmg.br

1. Introduction

In signed social networks, each edge can be labeled as positive and negative where, positive labels represents friendship and negative labels represent antagonism.

In such network the concept of *structural balance* can be applied to understand the tension between positive and negatives relationships.

The principles underlying *structural balance* are based on psychology theories. The basic idea is that when we choose sets of three connected people (triangles) the labels of three edges can be in 4 different configurations and some configurations are socially and psychologically more common than others. The Figure 5 shows all possible configurations

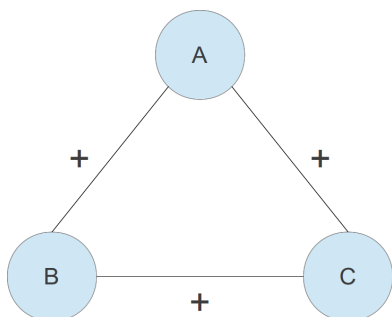


Figure 1. Type 1 - Balanced

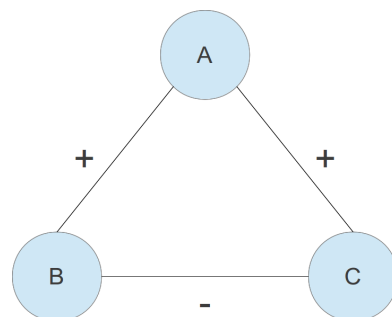


Figure 2. Type 2 - Unbalanced

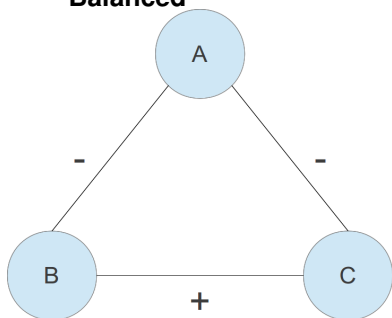


Figure 3. Type 3 - Balanced

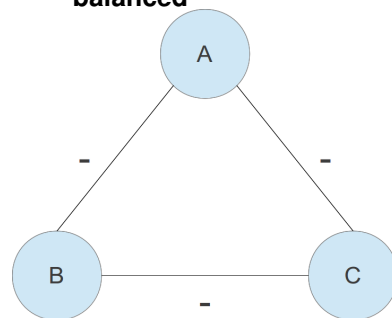


Figure 4. Type 4 - Unbalanced

Figure 5. Types of Triangles

Configurations types 1 (figure 1) and 3 (figure 3) are very common because they agree with their relationships, all three are friends or two are friends and share a common

enemy. The other two types of configurations are unusual and introduces instability into the relationships.

A triangle with three positive edges and one negative (figure 2) corresponds to a person A who is friends of B and C, but B and C are enemies. In this type of configuration, social theories believe that will appear some kind of motivation to B and C become friends or to A become enemy of B or C reaching the configuration type 1 or 3 respectively.

Similarly, there is instability in a configuration 4 (figure 4). In this case, there would be forces motivation two of the three people to "team up" against the third, reaching configuration type 3.

Thus we assume that the triangles with configurations 1 e 3 are balanced while those with configurations 2 and 4 are unbalanced.

In this work, we analyze the structural balance of two signed networks.

2. Networks

2.1. Epinions

Epinions is a general consumer review site that was established in 1999. Members can make review about products and they can decide whether to trust (positive relationship) or not trust (negative relationship) the reviews of other users.

This network was modeled as a signed graph and the table 1 shows the general characteristics.

Network	Nodes	Edges	Triangles
Epinions	131828	841372	4910076

Table 1. Epinions statistics

2.2. Slashdot

Slashdot is a popular technology-related news website focused on the geek community. On this website, users can tag other users as friend or foe building positive or negative relationships, respectively.

Slashdot community was modeled as a signed graph and the table 2 shows the general characteristics of three snapshots of this network. Each snapshot corresponds to a specific date: November 6, 2008; February, 16, 2009 and February, 21, 2009.

Network	Nodes	Edges	Triangles
Slashdot 08-11-06	77350	516575	548054
Slashdot 09-02-16	81867	545671	570569
Slashdot 09-02-21	82140	549202	579565

Table 2. Slashdot statistics

3. Implementation

The algorithm below describes the process of counting and characterizing the triangles from a social network.

```
1 def isBalanced(G,a,b,c):
2     positives = 0
3     negatives = 0
4
5     if G[a][b]['weight'] > 0:
6         positives+=1
7     else:
8         negatives+=1
9
10    if G[a][c]['weight'] > 0:
11        positives+=1
12    else:
13        negatives+=1
14
15    if G[b][c]['weight'] > 0:
16        positives+=1
17    else:
18        negatives+=1
19
20    return ((positives == 3 or positives == 1),positives)
21
22 def main():
23     G = getG(input_file)
24
25     total = 0
26     balanced = 0
27     types = {0: 0, 1: 0, 2: 0, 3: 0}
28     for a in G.nodes():
29         nA = getNeighbors(G,a)
30
31         size = len(nA)
32         for i in range(size-1):
33             b = nA[i]
34             for j in range(i+1,size):
35                 c = nA[j]
36
37                 if( G.has_edge(b,c) ):
38                     total += 1
39
40                     isB,t = isBalanced(G,a,b,c)
41                     types[t] += 1
42                     if( isB ):
43                         balanced += 1
```

To run the application developed, just type:

```
python getTriangles.py <input_file: file>
```

4. Results

The two network used in this work are directed networks. The concept of balanced or unbalanced triangles are not well defined for this type of network therefore were not

considered directions to perform the analysis. In some cases there may be conflicts, A like B but B does not like A, in this cases were assigned negative signs for these relationships.

To understand the structural balance of the two analyzed networks we count the number of occurrences of each type of triangles (see figure 5). The table 3 shows the results found for a Epinions snapshot and all three snapshots of Slashdot. The table 4 summarizes the results showing the number of balanced triangles in each snapshot.

Network	# of type 1	# of type 2	# of type 3	# of type 4
Epinions	3939584 (0.80)	476187 (0.10)	428622 (0.09)	65683 (0.01)
Slashdot 08-11-06	393716 (0.718)	65496 (0.120)	76762 (0.140)	12080 (0.022)
Slashdot 09-02-16	413018 (0.724)	67067 (0.117)	78147 (0.137)	12337 (0.022)
Slashdot 09-02-21	417000 (0.719)	67713 (0.117)	82113 (0.142)	12739 (0.022)

Table 3. Triangles Types

Network	Total	Balanced
Epinions	4910076	4368206 (0.89)
Slashdot 08-11-06	548054	470478 (0.858)
Slashdot 09-02-16	570569	491165 (0.861)
Slashdot 09-02-21	579565	499113 (0.861)

Table 4. Balanced Triangles

As we can see the majority parts of the triangles are balanced in all snapshots. Moreover, the most common triangle configuration type is the type 1 (all three edges are positive). This may indicate that positive relationships are more frequent.

For slashdot we have three different snapshots and we can evaluate the evolution of this network. The first snapshot corresponds to November 6, 2008, the second to February 16, 2009 (three months after the first) and the third to February, 21, 2009 (5 days after the second). We can observe that the percent of balanced triangles grew slightly among this period. The percent of the triangle of type 4 keeps constant and this may indicate that this type of relationship is more stable to what was believed. The other types suffered slight variations.