An Approach for Computing Social Capital

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ABSTRACT

In this paper we argue for computing social capital in prevailing social networks. We posit that the number of incoming links to a node does not represent the value of the node's social capital. We have developed a methodology for categorizing the types of connected links according to the nature of social interaction in the incident link. Each incident link will contribute a different value corresponding to its group. By finding the ratio between the total number of connected nodes and their values, we compute the social capital value (SCV). Social capital may yield positive or negative quantity.

Key words : social media, network theory, multiagent systems.

1. INTRODUCTION

Social capital is the wealth that an individual or a group possesses in the, form of positive social connectivity and beneficial communications, which can be attributed to determinants including need, trust, admiration and opposition. In present formulation, financial incentives are excluded from social capital. These determinants are mere phrases to reflect the link between social capital's main sources (i.e., ego-centric social capital owner) and the members of that social capital. For need category, members included in this category have a common interest with the source toward which they unconditionally supportive and connected. Oppositional members will unconditionally block and will try to diminish social capital. In trust category, members provisionally support their target but will verify to reinforce their trust.In admiration category, members remain neutral (i.e., idle) but they are still affirmatively counted toward social capital.When we contrast traditional social capital with the modern social capital in virtual networks, we gain insight for a richer understanding and greater ability to predict the migration over the virtual social network nodes. Prior to the internet, social capital was established through family kinships. Historically, we find that larger, influential families mostly controlled their society by leading the community and controlling the markets. We can say that the stronger the tribe the more dominant it was among others.

Therefore, people would be divided and took sides according to which clan they belonged. The traditional social capital was mostly emanated from the geographical status. In faith communities, the greatest social capital established was under the spiritual doctrines where individuals united under a common dogma and abandoned their family, tribe, city, region and homeland. This unity was possible in the past, because the individuals in societies were dominated by the individual or the group that had the greatest authority or connectivity among them. In the early 1990's, the internet was introduced to the public, which was the first seed in eliminating the geographical limits and abolishing the barrier to information access. Today, geographical limits are no longer considered or we can say that they no longer exist because two individuals who are distant can communicate instantaneously. Information access has multiple pathways and is no longer dominated by the highest authorized individuals or groups. Nowadays, the criteria of establishing a greater social capital has exceeded the traditional ways and has forced governments, organizations, businesses or any social capital seeker to seek greater understanding of individual beliefs, desires and intentions to be able to gain benefits from prevailing social capital. In other word, Individuals gained more access on information and they are no longer limited to their geographical status as they used to be. Therefore, social capital seekers lost their privilege of dominating the information sources. Hence, they have to do more effort toward maintaining individuals' norms. In business, the capital is the net worth of the business. Therefore, social capital has the net worth that yields its real value or in other word, its real influence on the network. In this paper, we will investigate some social media network in order to propose a theoretical model to determine the social capital value (SCV) for any node on the network. In section 2 we will elaborate on origins of social capital. Section 3 will outline salient attributes for our model of social capital. Section 4 provides a succinct mathematical model of social capital. Section 5 describes our initial attempts toward validation using simulation. Section 6 culminates our present developments with concluding remarks.

2. ON PROVENANCE OF SOCIAL CAPITAL IN THE SOCIATY

As mentioned in the introduction the development of ideas and theories about Social Capital and how they affect

complex social networks has been increasing since the 1990's. Today, we see that social capital ideas exert a major influence in such areas of social science research as political science, economics, and the study of human well-being in areas like sociology and even health care. Moreover, we are learning more about the important role of social capital and its influence in society in relationship to such modern technologies for communicating like Facebook, Twitter and other social networks. Around the world we have recently seen how more and more governments are trying to limit people's access to information technologies such as Twitter and Facebook. In the area of Social Capital research access to technologies is becoming more investigated and studied by academia. Some of the reasons for this are, that in countries like Iran, Tunisia and Egypt people have been denied access to these networks and in some cases the government has tried to shut them off completely. In the recent Arab Spring movements several countries closed down computer networks sites and arrested activists who were using these information technologies. In other countries like China the government monitors social networks and restricts access to a lot of these types of social networks. This is because the governments are aware of the power and the amount of Social Capital these networks represent. Even in the United States there are many forces in the government and other institutions who are concerned about these social media sites and networks who would like to limit or restrict their access and availability to people. Recently, in the news we have learned that some groups in the government are monitoring and spying on Facebook and Twitter users and want to limit access to these technologies. As a result, there are many news reports about free speech issues, continuing open access to the internet, and what is the proper role of the government in policing and monitoring the internet. The following literature review will look at what several scholars say about the role of Social Capital in our society and emerging challenges and problems for users of social media to have access to information technologies. Furthermore, the literature review reports what some scholars say about the influence of Social Capital in our society and its importance in academia. In a recent book called The Handbook of Social Capital the editors Dario Castiglione et Al [1] say in the forward that many scholars working in the area of Social Capital investigations do not agree about such fundamental things as definitions and the origins of Social Capital ideas. However, they write that Social Capital has, "been increasingly used in many disciplines of social sciences; it has been made the object of numerous studies and has been discussed in thousands of academic papers (Capital, intro.)." This is made clear in their edited work by dozens of articles on such issues as how Social Capital ideas are being used to investigate social capital in democratic ideas, economic development, global cooperation, multi-cultural and ethnic societies, businesses and financing, and social welfare and public policy formation to name just a few. For example, one article entitled "Social Capital and Collective Action" by authors T.K. Ahn and Elinor Ostrom [1] discusses how Social Capital theory has been used by social scientists to explain and understand the role of social capital in affecting collective action by various groups in relationship to improving such things as social and economic development in society. For example, the authors report that Social Capital studies show that investment in physical capital or improving society's roads, bridges and other infra-structure needs is more likely to take place in a society where the people have a strong social capital and have a high level of trust in their existing political and economic institutions. This kind of study using Social Capital theory shows scholars that improving such things as people's access to information technologies in developing countries might play a major role in helping them better their economic and social situation. Moreover, access to information technologies makes it easier for people to develop more Social Capital and improve their lives. Therefore, it should be of concern to all people that there are some forces which want to limit the growth and power of social networks and access to these types of technologies. Another example in this book of how Social Capital ideas help scholars understand complex networks that might help improve people's lives is the article.

3. SOCIAL CAPITAL CONSTITUENTS

Social capital is a major element for supporting an objective at any time, past, present or the future. However, the approaches for accomplishing this goal differ from one generation to another. Today, social media such as Facebook, Twitter and YouTube represent the main network gates for harnessing social capital. Thus, we can say that these three are the founding pillars that foster social capital on the large scale. According to Google trends [2], figure 1shows the worldwide interest in social media network started almost by the end of 2006. By 2007, this interest rapidly increased to be a revolution in social media (Facebook, Twitter and YouTube). One of the reasons that contributed or may have been the main reason for that revolution was location invariance of "web connectivity" through reinventing the smartphones. This combination of mobility of web connectivity and social media environment created instant event reactions. For example, nowadays an individual who own a smartphone and an account on any of the social media platforms can report an event even before the news organizations knows about it. This given freedom and ability of instant interaction led to overcoming the dominating of information access by powerful political organizations. Figure2 shows that there was an equality interest in mobile and social media in December 2012, which indicates that people started to rely on social media as a source of valid information and that by the aggressive increase of their interest in mobile. From these trends, we can confirm the existence and migration of social capital on the social media (Facebook, Twitter and YouTube).
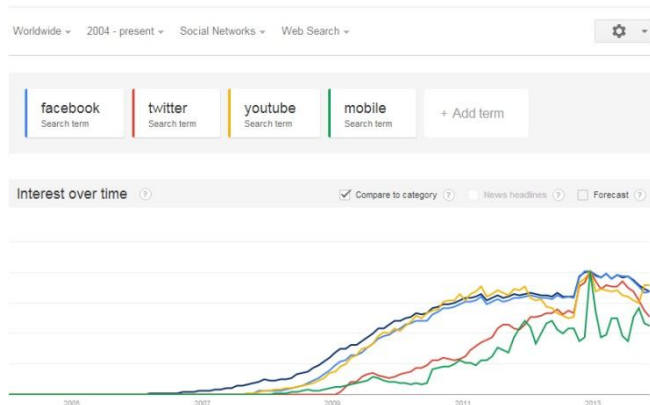
Figure 1: Social media network (Dark Blue), Facebook (Light Blue), Twitter (Red), YouTube (Yellow) and mobile (Green) trends till today.
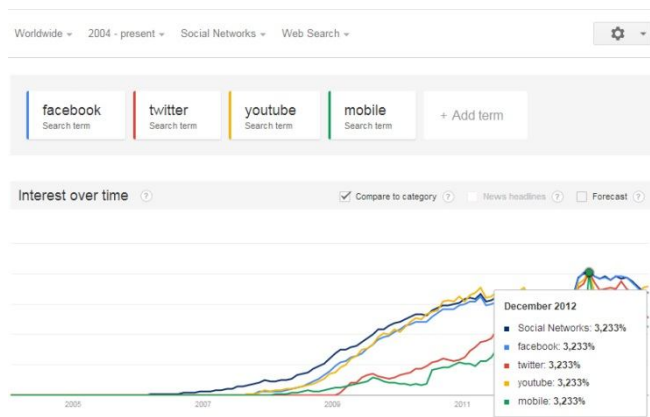

Figure 2: Equality interest in social media network and mobile.

However, because we considered Facebook, Twitter and YouTube as the main network gates for harnessing social capital, therefore these trends do not tell about the migration of social capital among the social media platforms. Table.1 shows the number of active users in the social media platforms of this research. As shown in Table.1, Facebook and YouTube have more than a billion monthly active users [4], [5] and Twitter has two hundred thirty active users every day [6]. Within these numbers, the social capitals are formed. Hence, to identify the amount of social capital for any member of social media platforms, we need to track the members' interactions toward that social capital. Therefore, we have to classify the interactions that are allowed for the social media platform members so, they would be suitable to fulfill the social capital categories.

Table 1: Active users for social media platforms.

Social Platform	Active users
Facebook	One billion+ monthly
Twitter	230 million daily
YouTube	One billion+ Monthly

In a network, an agent is a catalyst between intention and action. There are two major groups of agents among the social network. The first one, systematic agents, is a set of algorithms that is predictable by the system and used by the social platform. The second one, human agents, is represented by the human interaction on the network which is not predictable. Human agents among the network are divided into two sub-groups. The first group is those who use the network in professional matter such as, business advertisement, fighting or defending a cause, news, etc. The other group is those who are using the network for entertainment. The first group is an aware agent and the second is unaware. We can build on these assumptions that everyone using the network is an agent and can be activated at any time. This activation is not systematic and can happen at any time depending on network internal or external motivation toward a cause. This cause can be anything either personal or general and it is not limited to specific interest. In this manner, we can say that social capital on the network is a group of agents who are motivated by a personal cause toward a general cause. In social network, these causes are in the form of information and the social capital will be built according to the interest of the network agents in that information. Therefore, to control the access to these information means controlling the growth of social capital. For example, we can imagine it as a race between attackers and defenders. The attackers who support the cause will try to access more information to support their cause and the defenders will try to ban or miss lead these information to eliminate the cause. As a result, social capital on the network becomes a major factor in steering events. Based on the previous observations, social capital on the social network is generated by providing information. On any network node, the value of information provided to the network's human agents determines the connectivity of those agents to that node. On the other hand, the link's value of the network human agent, while it last, to that node is fluctuated because it depends on human behavior. While the human agents can only interact with the network through systematic agents so, categorizing the systematic agents categorizes the human agents' links to a node on the network. The social capital value of a node on the network will depends on the values of those links toward it. Consequently, the number of the links to a node does not represent its social capital value but it represents only the number of connected links. Based on that, we come up with social capital value (SCV). The SCV depends on the characterization the social network human agent's interactions. Our methodology on finding the SCV for a certain node depends on the value that a link will give when it supports or opposes that node toward its cause. The supporting links connected to a node are fluctuating over time between three categories: unconditional support (need), conditional support (trust) and neutral support (admire). The Oppositional links represent opposition that will disturb the reputation of the node so its social capital would be debilitated.

3.1 Network social capital categories

According to Y. Badr et al. [2] the organization has four types of inter-related social networks: customer, supplier, competitor, and partner. This classification describes the relation between members of social network without considering the centrality of network in order to find the social capital. In other words, the social capital in such classification is distributed over the network members. So as to find the social capital for unique node in the social network, we have to re-identify the relation between all connected nodes and the main node.Each node on the network has its own social capital. The node's social capital value depends on the values of the links from other nodes. The values of the links depend on how much support a node gives toward the main node. Therefore, we categorized the links according to their support toward the node they are connected to. In social network, support can be expressed the most by connected distributive nodes that help the main nodes to spread its influence among the network. The next supported nodes are those who are partially distributive. The last support comes from the nodes that are connected to the main node as receivers but does not make any action among the network. On the other hand, every social capital has opposition which tries to abolish the social capital influence. The following describe the categories of the social capital members in descending order of support:

1. Need members: (unconditional support) are those who distribute the contents without questioning. (Common interest or blinded trust).
2. Trust members: (conditional support) are those who distribute the contents based on their norms.
3. Admiration members: (neutral support) are those who have no interaction within the social capital. Based on "Just to know what is going on".
4. Oppositional members: (opposing links) are those members who try to block the distribution by contempt of the main node's contents.

4. MODULATION OF SOCIAL CAPITAL VALUE

$$\alpha = \frac{N}{V}; \ \beta = \frac{T}{V} \ ; \Omega = \frac{A}{V} \qquad (1)$$

$$OPI = OP + OP\sqrt{\left(\frac{\alpha}{3}\right)^2 + \left(\frac{\beta}{2}\right)^2 + \left(\frac{\Omega}{1}\right)^2} \qquad (2)$$

$$S = V - OPI \qquad (3)$$

$$SCV = \begin{cases} \frac{S^2}{(N\times1)+(T\times2)+(A\times3)} & if \ \frac{OPI}{N+T+A} \\ \frac{-S^2}{(N\times1)+(T\times2)+(A\times3)} & otherwise \end{cases} \qquad (4)$$

SCV: *Social capital value.*
S: *is the amount of pure support.*

V: *Volume (total number of connected links to a node).*
N: *Number of members of need category.*
T: *Number of members of trust category.*
A: *Number of members of admiration category.*
OP: *Number of Oppositional members.*
OPI: *Total amount of opposition.*

4.1 Model description

In contrast our model with Matos's approach, [3] in analyzing social capital, our model will calculate the amount of support that a node has in the form of the number of nodes which are part of the total connected nodes. The maximum amount of support that a node can have is when all connected nodes are from the category of need (N) which at this case SCV will equal V. In Equation (2), OPI represent the total amount of opposition where the influence of the opposition on the other categories is considered by using the other categories ratios to the volume of the social capital as in equations (1). The pure support of the social capital members can be found by finding the value of S in equation (3). In Equations (4), the value of SCV is conditioned by the ratio of the OPI to the total amount of the other categories. When the ratio of OPI to the other categories is less than one then the SCV is positive and when it is greater than one; it will be negative.

4.2 Model coding in Matlab

In the next code the volume of 1000 members has been chosen as an example. The code runs for 100K times. Each time generate random values for N, T, A and OP. When the summation of the generated values equal to the volume, it calculates SCV, otherwise, it regenerate values again. Table.2 shows the meaning of the code expressions used to build up the matlab code.

Table 2: Code terms guide.

Code expression	Meaning
V	Volume of the social capital
N(i)	Need value at i cycle
T(i)	Trust value at i cycle
A(i)	Admire value at i cycle
OP(i)	Opposition value at i cycle
OPI(i)	Oppositional influence value at i cycle
Alpha(i)	Need to volume ratio
Beta	Trust to volume ratio
omega	Admire to volume ratio
SCV	Social capital value

4.3 Matlab Code

```
1. clear;
2. clc;
3. V=1000;
4.   fori=1:100000
5.      N(i)=randi([0 V]);
```

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6.   T(i)=randi([0 V]);
7.   A(i)=randi([0 V]);
8.   OP(i)=randi([0 V]);
9.   sum(i)=N(i)+T(i)+A(i)+OP(i);
10.   if sum(i) == V
11.   need(i)=N(i);
12.   trust(i)=T(i);
13.   admire(i)=A(i);
14.   Opposition (i)=OP(i);
15.   alpha(i) = N(i)/V;
16.   beta(i) = T(i)/V;
17.   omega(i) = A(i)/V;
18.   OPI(i)= OP(i)+OP(i)*sqrt((((alpha(i)/3)^2)+
19.   ((beta(i)/2)^2)+((omega(i)/1)^2)));
20.   S=(V-OPI(i));
21.   if OPI(i)<N(i)+T(i)+A(i)
22.   SCV(i) = S^2/((N(i)*1)+(T(i)*2)+(A(i)*3));
23.   else
24.   SCV(i) =-S^2/((N(i)*1)+(T(i)*2)+(A(i)*3));
25.   end
26.   end
27.   end.

4.4 Simulation

In the simulation, figure 3 shows the different possible values for SCV. In each value of SCV the values of N, T, A and O are different. From the simulation, we can tell that the value of SCV is a maximum positive when most of the members are from the category of need (N) and minimum negative when most of the members are Oppositional members. The negative SCV indicates that the influence of oppositional members on the social capital exceed the support gained by other categories of the social capital. For example figure 3 shows A and B which illustrated the estimated influence by the opposition against the social capital support.
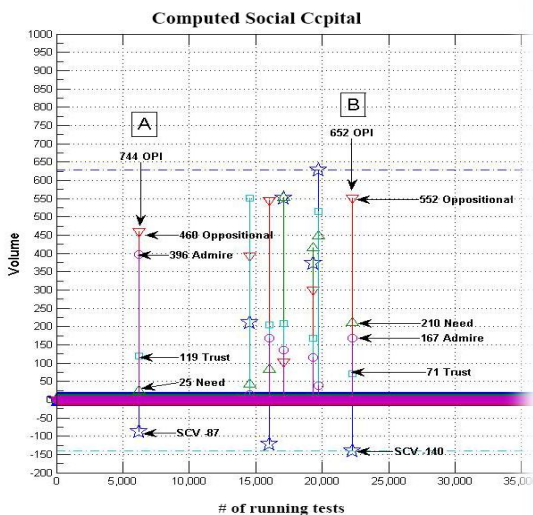

Figure 2: Simulation of positive and negative social capital of 1000 members for 100k times, of random values for each group of the social capital..

The oppositional influence of A is higher than B even though B has more opposition members. The reason for that is, that A has a higher number of admire category and less number of need category. In B, the number of need category is the highest among the other supportive categories. From this example, we can say that the opposition in A has gained 284 members out of the supportive members to be 744 while it was 460. However, the opposition in B, 552, could influence only 100 members out of the supportive categories and to become 652 members.

5. APPLICATIONS

The most applicable environment for tracking the social capital on the network is the social media platforms where the human interactions toward any node on the network can be recorded. Most of the social media platforms have three major systematic algorithm agents where most of the interactions go through. These agents are called share, comment and like. Using the combinations of these three agents, we can identify our categories. Based on the how much support that these agents offer and how much support is given by each category of the social capital, we identified the categories. Table.3 shows social capital categories and their most concomitant social interaction in the network:

Table 3: Social capital categories interactions.

Category	Interaction
Need	Unconditional Share only
Trust	Conditional Share + comment or Like
Admire	Most action is like only
Oppositional	Comment only

We assumed that the social capital growth is the most priority that the social capital's owner is seeking. Based on that, the distributive nodes on the network are the most supportive. Therefore, members of the social capital who are sharing unconditionally are considered as distributive members and the social capital gain its most strength from them. On the other hand, the non-distributive members weaken the social capital. Admire and opposition categories are not distributive members. However, the Oppositional members do not only ban distribution but also; they have to comment to dislike and contempt the owner of the social capital. The trust members will always follow their norms to give their trust. Therefore, they will distribute if their norms are met but they also have to confirm that their norms are met and they will do that by either comment or like.

5.1 Methodology of SCV

The advantage of SCV on other methodologies is that SCV calculates the amount of social capital that is willing to support any cause raised by the owner of that social capital,

while the other methodologies calculate the influence based on the activities of the social capital owner and propose a ratio to describe the score of the social capital or consider the connected nodes as the amount of social capital. For example, let say there are two nodes on the network, A and B. If we assume that both are active nodes and they have different numbers of connected nodes. A has 2000 connected nodes and B has 1000 connected nodes. In the current methodologies the social capital of A and B will be considered having 2000 of social capital for A and 1000 social capital for B. Similarly, other methodologies considered the activities as a measured of social capital and propose a ratio and in this case A and B may have the same ratio that represent the social capital while they in reality have different number of social capital. In our methodology, every node of the social capital will have a value depending on its activities among the social capital network. The final result of our model will represent the number that can be considered as social capital and it will always be equal or less than the total number of connected nodes. As a result, it is possible for B node to have social capital more than A, while it has only 1000 nodes and A has 2000 nodes. The number of nodes of each category in the social capital will determine which node, A or B, has more social capital. For example node A social capital, has 1000 members of need category, 150 of trust category, 350 of admire category and has opposition of 500 members. Node B has 950 of need category and 50 of trust category and has no admire and Oppositional members. Then SCV for A and B will as follow:

For A:α= 0.5, β=0.075, Ω= 0.175
OPI=500+500(0.2445588432) =622.279416
N+T+A=1500 Then SCV is positive
SCV= 807.7080885 ≈ 808 members out of 2000

For B:α= 0.95, β=0.05, Ω= 0.0
OPI=0+0(0.3176519759) =0
N+T+A=1000 Then SCV is positive
SCV= 952.38 ≈ 952 members out of 1000

From the result we can see that B has more social capital than A while A has more connection than B.

6. CONCLUSION

We conclude that the social capital in the social network can be represented by the amount of support not the number of connections. While the capital is the net worth of any business, then the social capital is the net support of the total connections. We found that the social connections in the social network are divided into support, partially support, neutral and non-support. Which means it is not true to consider all of them as a social capital. Moreover, we cannot claim that our methodology is the real measurement for the social influence but it is a way to standardize the measurement so it would be possible to track the migration of social capital in the social network.Finally, social capital depends on human behavior which is unpredictable factor but it is traceable. Therefore, the value of the social capital will change over time depending on the rising events and disturbance that elevate the network interactions.

REFERENCES

1. Castiglione, D., Deth, J. W., & Wolleb, G. (2008). *Social Capital's Fortune: An Introduction.**The handbook of social capital* (p. 1). Oxford: Oxford University Press.
2. Matos, L. (2011). *Multi-level Social Networking to Enable and Foster Collaborative Organizations.**Adaptation and value creating collaborative networks* 12th IFIP WG 5.5 Working Conference on Virtual Enterprises, PRO-VE 2011, São Paulo, Brazil, October 17-19, 2011, proceedings (p. 5). Berlin: Springer.
3. Abreu, A., & Matos, L. (2011). *Social Capital and Collaborative Networks.**Adaptation and value creating collaborative networks* 12th IFIP WG 5.5 Working Conference on Virtual Enterprises, PRO-VE 2011, São Paulo, Brazil, October 17-19, 2011, proceedings (pp. 31-35). Berlin: Springer.
4. **Google Trends**. (n.d.). Google Trends. Retrieved November 16, 2013, from http://www.google.com/trends/explore#cat=0-299-529&q=Facebook,+Twitter,+Youtbue,+mobile&cmpt=q
5. **Who's on Twitter?**. (n.d.). Twitter for Business. Retrieved November 16, 2013, from https://business.twitter.com/whos-twitter
6. **Statistics.** (n.d.). YouTube. Retrieved November 16, 2013, from http://www.youtube.com/yt/press/statistics.html