The Connection Law and Networks

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Abstract: Cooperation is one of the most important factors in organizations. Unsolved issues of cooperation are still left although many researches have been published. One is the mechanism of cooperation. In Barnard's book, He analyzed the principle of cooperation, but he did not explain the mechanism of cooperation because he considered the ability of each individual to be equal. We believe Barnard's idea to be incorrect; therefore, we will discuss this issue and try to understand network organization using mathematical model to prove our point. Furthermore, we attempt to simulate a percolation model of network organization, and to discover the connection law under the condition that the abilities of all individuals are not equal. Discovering the connection law of cooperation is vital because it will take on more significance in the age of Information Technology than ever before.

Keywords: *connection law, network organization, mechanism of cooperation, percolation, simulation*.

I. INTRODUCTION

Many different groups are formed by individuals and subgroups. These groups face their different situations when they deal with various social activities. One type of the different groups is an organization such as an enterprise and/or a firm. Cooperation is one of the most important factors in organizations. Some unsolved issues of cooperation are still left. One of them is the mechanism of cooperation.

In this paper we review the relevant literature of network analysis and discuss the issue of cooperative mechanism. The main contributions of this paper is that we discover the connection law under the condition of the abilities of all individual's are not equal in network organization using computer simulation with percolation model.

The rest of this paper is organized as follows. In the next section, we review some background and previous literature of the cooperation theories. In section 3, we focus on computer simulation with an invasion percolation model, and we explain the connection law in network organization. The final section contains concluding remarks.

II. BACKGROUND

An organization, especially a corporate organization like an enterprise, would not only vary with the structure of the organization, but also with the cooperative relationship with other firms and the fluctuation of the economic situation. Needless to say, cooperation is one of the most important factors determining the success or failure of a corporate organization. Cooperation is meaningful not only for the participants of the organization, but also for the management of the organization itself to discover the mechanism of cooperation.

The market is controlled by the relationships between business entities under the principle of competition. The relation between demand and supply is adjusted and the effective allocation of managerial resources can be realized through the mechanism of market price. On the other hand, the internal process of vertical integration in under the control of authority in traditional organizations. Organizations generate a participant consciousness and a belonging sense of memberships, and create a trust value.

Network organizations realize both the merit of the market and the organization and maintain the relationship among autonomous business entities under the utilization of common managerial resources. A network organization is a form which differs from the form of an organization and market, and it is considered as a form located at the middle between market and organization, so it is called a moderate organization.

Network organization could be considered as one of the cooperative systems. Network organizations provide a higher degree of responsiveness to change that cannot be obtained within hierarchical organizational structures [1]. Cooperation plays an important role in network organization. For instance, personal contacts play key roles in obtaining information about job opportunity [2, 3]. The relationships among the firms in network organization are analyzed. The relationship between corporate performance and the structure of network such as centrality and network size are also measured [4-6].

Most of the recent researchers focused on the relationship among firms and the structure of network organizations. But they do not take mechanism of cooperation, one of the most important issues into consideration in their research.

III. CONNECTION LAW

Invasion percolation model is one kind of complex theories [7]. Invasion percolation model will be executed in this paper to uncover the mechanism of connection in business activities.

1. Connection by individuals

In order to uncover the mechanism of connection, percolation model and hypothesis are executed as below.

Suppose that the percolation model will be executed in a two-dimensional square lattice system. And the following steps will be executed in our percolation model.

Step1. Each individual and/or business entity could be considered as a node in percolation model. Each one has its own ability of *p*. The starting node exists and its optional ability is p. The range of p is from 0 to 1.

Step2. Neighbor node of the starting node means von Neumann neighborhood with random number of p hereby.

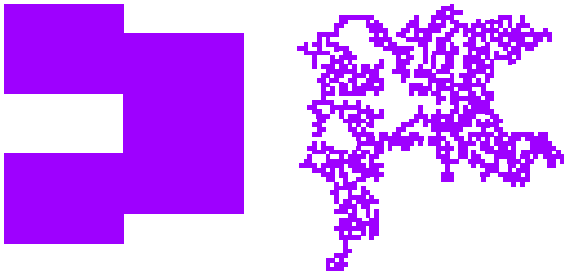
Step3. Sort the ability of each neighbor node of the starting node and compare the ability of the starting node with the abilities of each neighbor node.

Step4. Put the node whose value of p is the smallest one in the neighbor nodes into the cluster of starting node if there is any node whose value of p is smaller than the starting node. And then new neighbor nodes will be formed.

Step5. Execute the sequence from step 3 to step 4 repeatedly until *n* if there exists the node whose p is less than starting node in the cluster of new neighbor node until the p of all neighbor nodes is larger than the starting node.

From these steps mentioned above, we can image that business entities, as the starting node, do their business activities repeatedly and expand their scale gradually depending upon the ability of the starting node. The business entity could be explained as the autonomous individual or autonomous company.

The relationship between ability (influence) of the starting node and the average of cluster caused from the repeated activities of the starting node with computer simulation can be illustrated as Fig. 1 and Fig. 2.



[n=1000, p=0.2] [n=1000, p=0.8]

Fig.1. Simulation results of percolation model

Cluster curve of the starting node could be divided into three parts in Figure 2.

The first is the group of node whose abilities are all smaller than 0.40. And the increasing ranges of the average of cluster, as the speed of incorporate is very small. And the second is the group of node whose abilities are from 0.40 to 0.68, and its increasing range is obviously large one. And the third is the group of node whose abilities are over 0.68, and it shows the same trend as the first one.

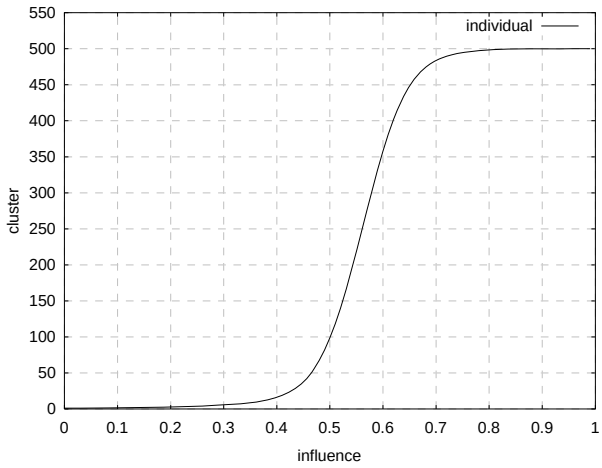


Fig.2. Relationship between Individual influence and cluster

Some conclusions will be drawn as follows.

1. If the ability of each node is smaller than 0.4, the gap among each node is very small even if there are big difference between them.

2. If the ability of each node is lager than 0.40, the gap of each node is very remarkable even if there are very small differences.

3. If the ability of each node is larger than 0.68, the gap of each node is very small again even if there are some difference between them.

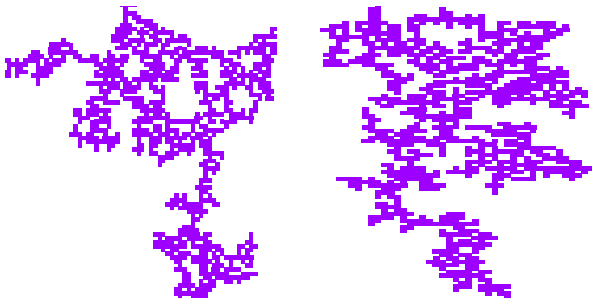
The ability hereby can be considered the influence such as transaction power and the R&D of new products in the case of enterprise. Other influences, for instance, capital power, sales power and the power of market share also will be included. Therefore, the result of competition will be reversed at any time if the market share is less than 40 percent. In the case that the market shares are larger than 40 percent, the power will be remarkable even if the difference between them is only 1 percent. It means the competition is under an uncertain situation. At last, if the market share is larger than 68 percent, the power becomes a very small one again. It could be explained that this is an uncertain situation, but in fact it is impossible that the market share of two companies are both over 50 percent.

2. Connection by new clusters

The computer simulation mentioned above is executed under the condition of each node whose ability does not grow with the increase of the number of node in new cluster. In other words, the ability of new cluster is equivalent to the ability of the starting node. It is a constant variable. Such phenomenon is only seen in small enterprises. The ability of new cluster will grow with the increase of the number of node in new cluster in many business cases.

One typical example of competitions is the competition between Sony and the JVC. It is a competition of the network organization, but not as an individual organization. The ability of the network organization will be improved with the expansion of new cluster. Therefore, the ability of p will grow when the number of nodes increases in new cluster. In other words, it is better to consider the ability of new cluster instead of the starting node.

It is necessary to revise program mentioned in previous section in this paper from this viewpoint. The result of new computer simulation is shown in Figure 3 and Fig. 4.



[n=1000, p=0.2] [n=1000, p=0.8]

Fig.3. Simulation results of the revised percolation model

Figure 4 shows the tendency which the ability of new cluster grows depending upon the ability of new cluster formed with other nodes. The tendency stops at the ability of 0.76 of new cluster. It means that business entities with small ability have a greater advantage to organize a network organization. In network organization a small enterprise will obtain a larger merit.

A gap between individual and the new cluster formed with other nodes is illustrated in Figure 5.

Gap between individual and the new cluster formed with other nodes grows remarkably with the ability increasing of other nodes, and stops at 0.43 of the ability. The gap will continue to grow slowly when the ability of an individual is larger than 0.43, and stop at 0.78 with the ability increasing of an individual. Therefore, in comparing with an individual, the new cluster formed with other nodes under 0.43 will get a bigger effect of connection. It is necessary to connect with other individuals for these entities when their abilities are

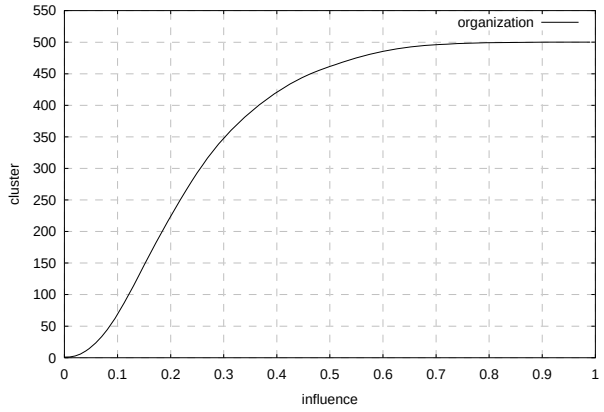


Fig.4. Relationships between the ability of new cluster and the effect of connection

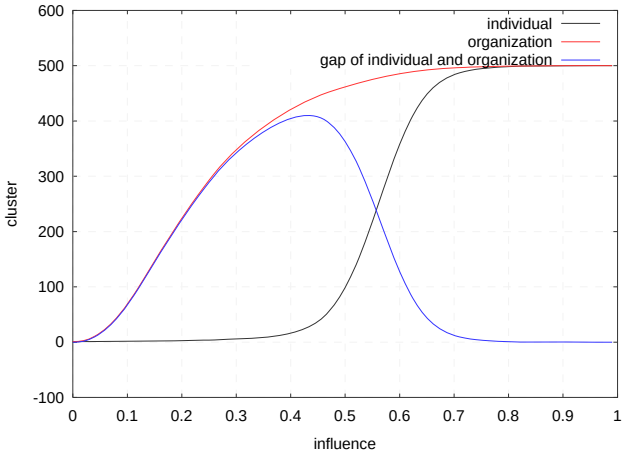


Fig.5. Gaps between the Ability of Individual and the New Cluster

under 0.43 and it is not necessary to connect with other individuals when their abilities are over 0.78 because the connect effect will be small.

The author called it the connection law in this paper. The connection law means entities such as individuals and/or companies need to connect with each other when their abilities are small than 43 percent in order to get much more advantages and benefits from cooperation. The advantages and benefits will be very small if their abilities are larger than 78 percent. This result shows us the principle of the connection and helps us to understand how to cooperate with each.

IV. CONCLUSION

As the mechanism of cooperation to determine the economy of connection, the connection law in an organization has been uncovered in this paper under the consumption that the ability of each individual is not equal.

The next research is to measure the ability (such as influence or power) of the individual and the ability of the individual organized by network, and uncovers the relationship between ability of business entity and corporate performance based on this conclusion.

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