Predicting selection of artificial network by cluster coefficient

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Abstract

In this paper, an artificial network such as A-life is targeted. A predicting method for the selection limit in a heterogeneous system by using a cluster coefficient as an index, which shows small world structure, is proposed.

As evaluation, evolutions of IT infrastructures in an enterprise have been employed for the study as the most typical example. Although IT infrastructures change rapidly and evolution has been continued, the number of a server has been increased. In practical, increase of the total cost of ownership (TCO), including management cost, caused by the increase of servers is the current problem. The relation between the simulation for the evolution and selections in IT infrastructures, and cluster coefficient were observed. The result shows that cluster coefficient and selection predictions are related. In fact, the maturity for a system can be obtained by observing a cluster coefficient for IT infrastructures simply. The number of heterogeneous elements shows the selection limit. The selection limit rate at which the global behavior is not destructed can be obtained from these two measurement values, without performing simulations.

1 Introduction

In information processing based on A-life, information processing which can be realized by employing a group that varies dynamically, maintaining redundancy and diversity, has been argued. In an artificial network, global behaviors always change being accompanied with local interaction fluidly as well. The artificial network for this paper is defined as the one in which the global behavior is determined artificially.

A grid computing [1] which requires common global behavior even in the case where it is distributing locally, Web service [2] which forms a processing system on a common network, and the IT infrastructure [3] of the company which connote a large number of the heterogeneous element are the examples of an artificial network.

In an artificial network, after global behavior, such as evolution and selection, are decided artificially, a local interaction occurs. The quantity of elements mainly becomes a problem in such cases. In most of those problems, the quantity of the capacity that systems possess and elements in the systems are almost equal. In such a case, the system cannot be maintained unless the collective quantity is reduced. For example, too many employees are not necessary because it is not effective. Therefore, the employees are reduced in such a case. Besides, some efficiency improvements can be obtained for production line by reducing employees. This is the top-down emergence [4]. The self-organization criticality [5] resembles it well. In a problem in real issues, the number of the element tends to be reduced after it is expanded.

However, in case that the number has been reduced in the simplicity, individual properties of the element are abandoned and the property of the whole system has consequentially been destroyed. Then, it is required that the number of the element is reduced without changing the property of the system. In the case of the artificial network, the relation of the node for which the persistence node is selected as an evolution is acquired. It can be expressed with the order formation of minimizing the system components as an emergence [6]. The important issue here is, how much of the elements can be reduced without destroying the property of the network. In other words, a prediction method by the simulation is being required. In the case of factory, it is a prediction to determine how many of employees can be reduced without changing their process. However, the selection cannot be predicted simply by the simulation since the simulation becomes even more complicated and difficult as it closes to the realistic.

Therefore, the relationship between cluster coefficient and general behavior of the network in the selection of the system has been investigated. Since selections are predicted only by network behaviors, the time and effort for prediction trial calculation can be reduced. It can be applied to the prediction for the composition result of server consolidation of the IT infrastructure in an enterprise. It is a representative example of the artificial network.

2 Artificial network

The artificial network described in this paper shows the relationship between an element as a center and other elements. It is formed by the top which shows edge and an element which shows the interaction in the simplicity. They are shown in Figure 1.

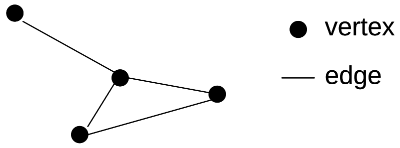

Figure 1. Artificial network

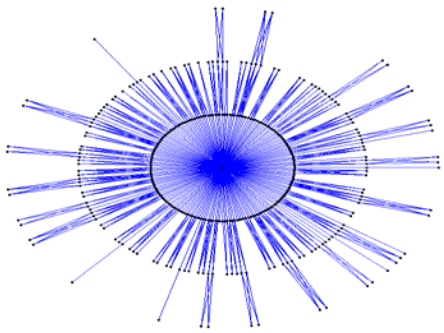

Figure 2. IT infrastructure in the enterprises described by artificial network

Figure 2 shows an enterprise IT infrastructures. The top as a center is client PC, and the relationship between the servers for the treatment is shown in the circumference. Set of vertex and edges indicate the property of the system. The form shown Figure 2 indicates the relationship between the systems. Therefore, the property of the system is destroyed in case that the top is reduced simply. It is necessary to acquire the relation of the node in which the persistence node is selected in order to maintain the property of the system. In other words, the edge re-connects with the peak which substitutes for the neighborhood and is maintained even in case that the number of the peak reduces. It is shown in Fig. 3.

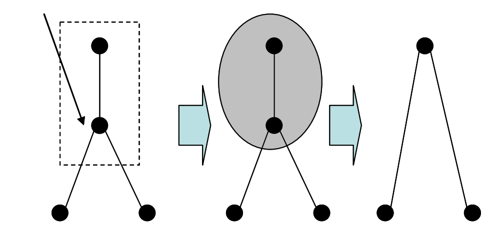

Figure 3. Behavior in the selection

In case where the artificial order in which the element of the system is minimized is given, decrease of the top and reconnection of the edge are repeated as shown in Figure 3 while the element maintains the property of the system. However, this behavior can be obtained only in case where element and substitution element selected are homogeneous relation. It is not possible to obtain this behavior in case that the relation is heterogeneous.

3 Cluster coefficient

The cluster coefficient [7] which shows small world structure as an index is introduced here. Since a cluster coefficient is an index with which the element itself carries out the self reference of the relation with other elements, it is believed to be effective for investigating the relation of an artificial network. In other words, in case where a cluster coefficient is compared to an acquaintance relation, their acquaintances become acquainted and come out and a certain probability is expressed.

The cluster coefficient is obtained from the equation below under the condition that Γ_v is a neighborhood of v , E is a set of Γ_v edges and k_v is the node number of the neighborhood.

$$r_v = \frac{|E(\Gamma_v)|}{\binom{k_v}{2}}$$

Next, an actual artificial network is measured based on the cluster coefficient.

4 The simulation of the selection in the IT infrastructure

The network shown in Figure 4 which imitates the IT infrastructure as a representative example is created, and the simulation of the selection is executed. This resembles the structure of actual IT infrastructure shown in Figure 2, and almost the same form can be expressed.

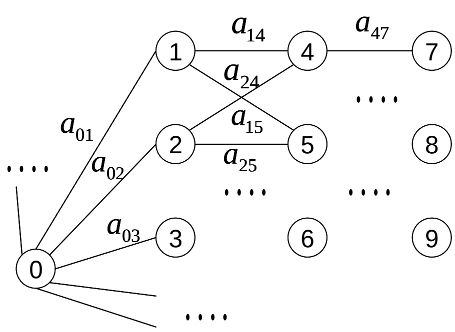

Figure 4. Simulation of artificial network

A random network is generated for each top. The edge is expressed by a_{ij} . The edges and the tops are determined randomly. It is expressed by the equations below.

$$a_{0i} = \hat{a}_{0i}, \quad a_{ij} = a_{0i} \cdot \hat{a}_{ij}, \quad a_{jk} = a_{0i} \cdot a_{ij} \cdot \hat{a}_{jk}$$

$\hat{a}$ is determined as 1 or 0 randomly.

In the equal type (homogeneous), each top possesses the parameter of type and cost and the selection shall be repeated as long as the parameter of the cost permits it. In the other type (heterogeneous), the selection is not generated. This transition is shown in Figure 5.

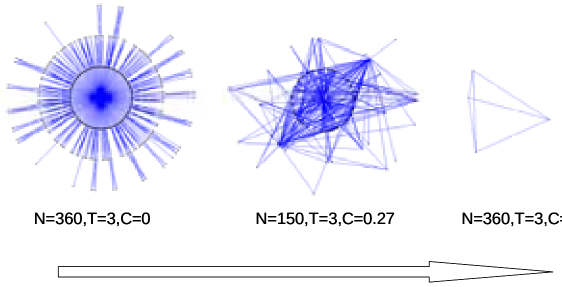

Figure 5. Change of network

N is the number of the vertexes and C is a cluster coefficient. C, at this time, changing from 0 to 1 finally is noticed. Focusing on the selection simulation, the 100, 200, 500, and 1000 peaks and the type parameter were fixed to the cluster coefficient of 0.3, and the simulation was performed 50 times per each. The result is shown in Figure 6.

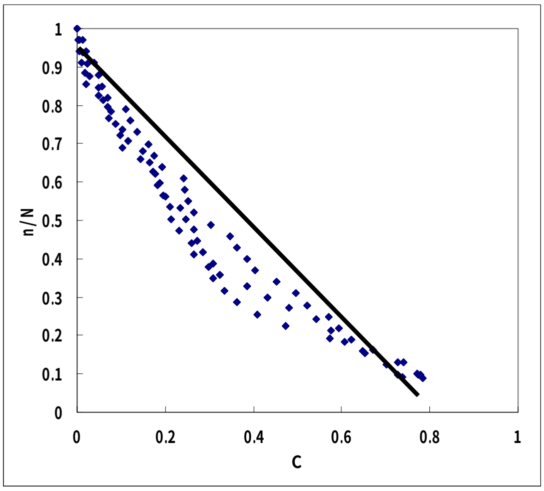

Figure 6. Selection ratio and cluster coefficient

A vertical axis is a selection ratio and a horizontal axis is a cluster coefficient. A cluster coefficient and a selection ratio have the relation of an inverse proportion. Therefore, in the artificial network of IT infrastructure, in case where a cluster coefficient is investigated, a grade of the selectivity can be obtained. For example, a selection ratio is 0.7 supposing Figure 6 to a cluster coefficient is 0.2. Selection will already have been performed about 0.3 from the original element. That is, in IT infrastructure, in case where a cluster coefficient is investigated simply, the degree of a system's maturity is obtained. Then, the parameter of consequences and types shows the selection limit, as the hetero genius element can not be selected. For example, it is clear that 60%of a system can be selected even at the maximum, in the case that 40% of it is the hetero genius. It will be able to estimate the culling rate of the degree in which the system does not collapse by these two measured value without performing the simulation.

5 Conclusion

In this paper, the relationship between the transitions for the selection of the cluster coefficient in an artificial network has been clarified. The relationship between them is almost an inverse proportion. The selection ratio can be estimated regardless the number of the element in case where the cluster coefficient can be measured using the property. The local behavior with the order in which the number of the element in a system had to be minimized has been clarified by the change of the cluster coefficient.

However, the parameter of precision criterion and costs and types are not mentioned this time. These will be one of our targets in the future.

6 Reference

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