A study of spontaneous development of hierarchical systems by constructive approach

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There ubiquitously exist entities with complex hierarchical structure. For example, relationship among individuals or organizations in ecosystem or social systems, the Internet, biochemical networks. The structure of such organizations and networks is self-organized. Fundamental elements in the system make themselves organized into structural and functional units at higher level through interaction with each other. These interactions between units construct ones at further higher level. In this case, such kind of systems makes themselves hierarchical spontaneously. We call the system spontaneous hierarchical system . Development of spontaneous hierarchical system is highly relevant for understanding of emergence and complexity. In this study, we consider the process and conditions of a spontaneous development of hierarchical systems with simulations of interacting chemicals various catalysises and make networks of chemical reactions.

We use a model which consist of tapes and machines invented by Ikegami and Hashimoto [1,2]. Development of population of tapes and machines is based on individual reactions to magnify severalty and diversity of reactions, while it in the original model is described by a chemical system. The system has a special structure and tapes and machines diffuse in the system. We test two types of resource constraint and two types of tape translation method. Furthermore the influence of spatial structure is studied.

In simulation results, we identify four types of relation among tapes and machines: self-reproduction, probabilistic-self-reproduction, parasitism and core-networks. A core-network is a relatively large self-

maintained network of tapes and machines. We observed high diversity of reactions and interaction among various core-networks in the model in which the starting point of translation from a tape to a machine is pre determined. The interaction between core-networks can be considered as the formation of a higher level network. Thus, the development of spontaneous hierarchical system is shown, although they are simple.

That is to say, each network organizes into network of higher level; therefore simple spontaneous hierarchical system is shown.

We can conclude that localization and diversity of reaction are important for development of spontaneous hierarchical system. In general, if elements at a fundamental level interact and variously, they have a possibility to organize structures at higher level s spontaneously.

References

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