Advances in Economics, Business and Management Research, volume 50

3rd International Conference on Management Science and Engineering (MSE 2017)

Characteristics and Managementof Knowledge Emergence

Fu JIN[1]
School of Management
Shenyang Normal University,
Liaoning, Shenyang, China
jinfu8655@163.com

Li-Jun ZOU[2]
School of Management
Shenyang Normal University,
Liaoning, Shenyang, China
Jennifer192@163.com

Jie JIN[3]
School of Management
Shenyang Normal University,
Liaoning, Shenyang, China
jinjie1111@163.com

Xia WANG[4]
School of Management
Shenyang Normal University,
Liaoning, Shenyang, China
15702497570@163.com

***Abstract*--This paper gives the definition of emergence of knowledge, and explains its connotation and characteristics. On this basis, this article identifies the state of knowledge emergence, classification and characteristics of intelligence resource system, and then it gives the management strategy of knowledge emergence in intelligence resource system. The conclusion has an important significance to the study of knowledge creation and swarm intelligence in the future.**

Keywords-Knowledge emergence; Swarm intelligence; intelligent agent; intelligent complex adaptive systems (ICAS)

I. INTRODUCTION

Emergence is the fundamental characteristic of complex system. It usually refers to the emergence of new structures and new attributes in the process of self-organization complex systems. “Complexity science is essentially a discipline about emergence, and studies how to identify the basic laws of emergent phenomena.”[1]This paper argues that the group intellectual resources system with knowledge as the main body follows the law.

II. DEFINITION AND CONNOTATION OF EMERGENCE

Emergence is also called outbreak or presentation. The word derives from systematic science. Emergent property refers to the attribute, characteristics, behaviors and functions of those that exist in high levels, but when it restores to the lower level, it will cease to exist. Most of the studies on emergence are descriptive work that were based on numerical simulations or experimental observations, lacking of operational technical means or methods[2], which makes it difficult to define accurately its emergence from a phenomenon.

The emergence of ideas can be traced back to Aristotle's interpretation of the Zeno paradox, and the statement of the whole sentence is different from the sum of its parts. Now emergence is defined as “The system global behavior is generated by the interaction between local components” [3] or “The macro effect originates from microcosmic” [4],these macro global behaviors or characteristics are not provided by micro organizations, its can only be manifested by the whole [5].

Based on this statement, there are two ways of thinking about emergence: Firstly, time dimension of system evolution is selected based on the predictable thinking. From the predictable perspective of whole characteristics of system, we give a cognitive explanation of emergence. Secondly, based on hierarchical thinking, the definition of emergence is defined from the relation between low-level and high-level features.

III. DENIFINITON, CAHRACTERISTICS AND CLASSIFICATION OF KNOWLEDGE EMERGENCE

Research on the emergence of knowledge, from the perspective of intellectual resource management, the scholar named Jin Fu has proposed that the knowledge emergence has intellectual subjects with the characteristics of "ICAS" in a systematic way. These intellectual subjects appear the new structure, mode and characteristics in the process of “Knowledge Self-organization”. The phenomenon which is special knowledge creation appears on the macro level of the system.

Researches show that the emergence of knowledge has five characteristics: newness, synergy, integrity, dynamics and identification. In the management of groups or agents, knowledge emergence brings knowledge creation and a

solution orfeasibility decision plan for unstructured complex problems.

There is a link between hierarchical concept and interpretation that knowledge emergence from the perspective of intellectual resource management. Generally, it reveals the law of knowledge emergence by means of the relation between agents from low level to high level. According to the standards that different levels have different feedback types and causality relationship presented by Fromm, this paper divides the evolution process of knowledge emergence into four categories, and uses them to explain the predictability of knowledge emergence: Type I simple knowledge emergence, Type II weak knowledge emergence, Type III multiple knowledge emergence, Type IV strong knowledge emergence.

In the process of interaction of agents, there are multiple interactions and knowledge sharing, which produce several results of knowledge emergence at the same level, and these results are recognized as new agents with a more advanced intelligent adaptive nature and complexity of behaviors. These results affect each other, which forms a higher level of knowledge emergence, resulting in a volume change to qualitative change.

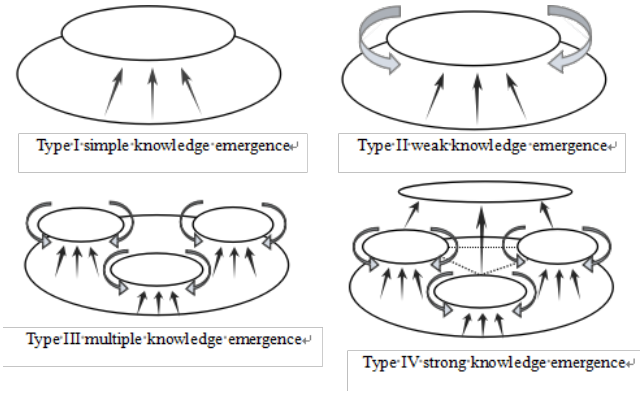

Figure 1: Four types of knowledge emergence based on Fromm model

For the explanation of knowledge emergence based on levels, combining with the Ryan's [7] study, a researcher of sciences of complexity, we believe that knowledge emergence as a method of knowledge creation can be recognized and grasped and become a methodology of revealing knowledge creation. The core of knowledge emergence is the establishment of intellectual resource system based on sciences of complexity, which is used to interpret and reveal the generation process of knowledge emergence, its identification methods and quantitative judgments, etc.

With regard to the measures of the characteristics of emergence, we understand it from identifying the concepts of "scope", "resolution", and "state". Their specific explanations are as follows.

Concept 1 "Scope": we use S(x) to represent the spatial scope of the agent in the intellectual resource system; use S (t) to represent the time range of the agent in the intellectual resource system, especially to specify the time period for the survival of the intellectual resource system.

Concept 2 "resolution": The resolution of time and space is represented by R (t) and R(x), respectively, which reflect the agent's ability of dynamic learning or cognition.

Concept 3 "State": the state of the intellectual resource system at a certain time is co-determined by its scope and resolution. The macro state is represented by M (Macro Environment, using the first letter), and the micro state is represented by μ (Micro Environment, using the Greek letter "μ"). The micro –macro state satisfies the following equations:

$$R_M \le R_\mu (1)$$

$$S_M \ge S_\mu \ (2)$$

$$(R_M, S_M) \ne R_\mu S_\mu (3)$$

Based on the definition of three concepts above, we identity the characteristics of knowledge emergence system, and then deduce property 1 and property 2.

Definition of the characteristics of knowledge emergence: if the attribute of an intellectual resource system doesn't exist in micro state, but exists in macro state, then the attribute is the acquisition characteristic of the knowledge emergence system.

For the macro state M, we use the set $P_\mu^M(t) = \{P_1, P_2, P_3, ..., P_n\}$ to represent it at the time t existing in macro state, while u doesn't exist. Based on the definition, obviously there are natures as follows.

Property 1: the attribute of knowledge emergence is the result of the nonlinear interaction between agents in the intellectual resource system.

Definition of the attribute of weak emergence: if Sm=Sμ, then R_M<Rμ. At this time H (M) <H (μ), Shannon entropy (knowledge stock in the basis of information) in macro state is smaller than in micro state. Therefore, the knowledge emergence at this time is known as weak emergence.

Weak emergence reflects the upper limit of the knowledge stock of agents in the system, not the inherent attributes of the system.

If R_M=Rμ, then S_M>Sμ. At this time, H (M)>H (μ), for the M's attribute of knowledge emergence in macro state, "p", we define it as minimum macro state.

Definition of minimum macro state: supposing that ψ is the macroscopic state of emergent characteristic, "p", if p is present in ψ, but doesn't exist in any state with the same ψ resolution, therefore ψ is the minimum macroscopic state.

Property 2: if the emergent characteristic p exists in the macroscopic state M, but does not exists in any state that is the same as the M resolution but is small, therefore the emergent characteristic is called the novel knowledge emergence characteristic.

In conclusion, agents with the ability of adapting and learning in intellectual resource system, through the process of aggregation, loss, and reorganization and so on, produce one or more new knowledge of the emergence of the process

and result, and constitute the system of knowledge emergence.

IV. Analysis Of Characcheristics And Management Emergence

The emergence of knowledge belongs to the macro characteristics of intelligence resources system, and has the characteristics of intelligent complex adaptive system (ICAS).

Knowledge emergence and its hierarchy: Spatial scale, hierarchical scale and spatial dimension. The micro activities in the bottom of the system will produce macro properties, structures, patterns and so on. This micro - to - macro effect is a two-way influence. The emergence of knowledge has the characteristics of spatial structure. From individual to group level, there is certain knowledge overlap among members of team, that is, knowledge base, which is the key to achieve knowledge sharing, and simultaneously, team knowledge will emerge into organizational knowledge. [8]

See Fig. 2, two members at the time T have stock of knowledge for A and B, respectively. Although there is certain knowledge overlap, they are not internalized by each other; at the time points of T1, due to the interaction among members, the amount of knowledge overlap increases and produce internalization. The quantity of knowledge sharing also increases, and so forth. As the interaction progresses, there will be $A^nB^n>A^1B^1$, which is the emergence of knowledge from individuals to groups. A new knowledge of organizational level emerges when a certain scale is reached, that is, AB.

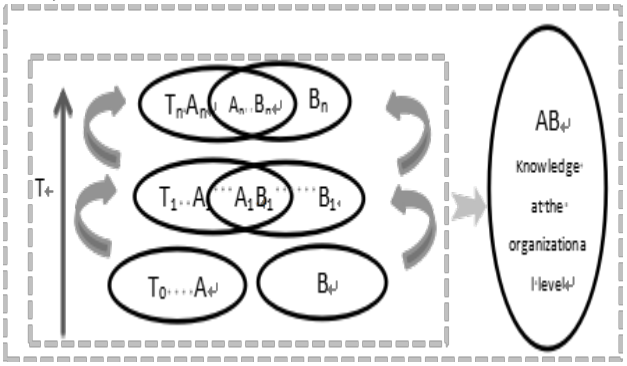

Figure 2: Hierarchical phenomena of knowledge emergence

Knowledge Emergence and Predictability: Time Scale, Process and Dynamic. With the passage of time, agents interact with one another at the basis of overlap of knowledge, so that the results of knowledge cannot be accurately measured, but the direction and level of knowledge in a certain range can be predicted, which is expressed in a certain vector character.

Knowledge Emergence and Environment: The continued development of knowledge must be carried out in an open system so that information, energy, material and knowledge can be exchanged. According to the principle of entropy to increase, the outside world continues to give these, and to form a dynamic "knowledge or intellectual flow", and the system continues to produce interaction to reduce the degree of confusion. Environment acts as a boundary variable (external policy), and in order to produce the phenomenon of knowledge, the environment should give a favorable boundary assignment and appropriate macro - control policies.

Knowledge emergence and observers: the human-based intellectual resource, and the new idea (new idea) is the activity of human intelligence products [9]. Agents generate new ideas, create new knowledge and produce scale effects [10], which are designed to help intellectual groups solve problems or develop new products. Knowledge-based organizations also need to demonstrate intelligent behavior that responds to the environment and effectively intervene in the environment.

The management of knowledge emergence [9, 10]: according to Jin Fu's and other scholars' researches, the management of knowledge emergence can do: (1) implementation of new ideas of intellectual management with human-oriented;(2) reinforcement of cultivating knowledge resources, and the exertion of the role of core experts; (3) strengthening the construction of intellectual sharing environment; (4) establishment of a mechanism conducive to knowledge creation.

Reference

[1] (U.S) John H. Holland: Zhou Xiao-mu, Han Hui. Implicit order: adaptation leads to complexity [M]. Shanghai: Shanghai science and Technology Education Press, .2000.

[2] Luo Ji-gui. The formation mechanism about emergence in a complex system [D]. Shanghai University, 2008

[3] Liu, H, Abraham, A, Clerc, M., Chaotic, dynamic, characteristics, in, swarm, intelligence [J]. Applied, Soft, Computing, Journal, 2007, (7): 1019-1026.

[4] Jin Shi-yao, Huang Hong-bing, Gao Fan. Emergence-oriented research on Multi-Agent Systems and its State of Arts [J]. Chinese Journal of computer, 2008, 31 (6): 881-895.

[5] Fromm, J.Types, and, Forms, of, Emergence [J].Physics, 2005.

[6] Ryan A J.Emergence is coupled to scope, not level: Research Articles [J]. Complexity, 2010, 13(2):67-77

[7] Wang Feng-bin, Chen Jian-xun. Knowledge Emergence on Cross-level Organization Learning [J]. Chinese Journal of management, 2010 (1): 17-23.

[8] Jin Fu. Knowledge organization intellectual resources management [M]. Science Press, 2011.146-147.

[9] Jin Fu, section. The knowledge organization intellectual resources management theory in the future [J]. Journal of Shenyang Normal University (SOCIAL SCIENCE EDITION), 2012, 36 (4): 58-61.