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Complexity, Thinking System, and Future Intelligent Machine

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In the present paper, we hold that, if we want to interpret and settle problems about human's cognition or cognition itself, and develop intelligence, we need to know the mechanism of human's brain clearly. If we want to know the riddle of thinking, we must make clear the mechanism of the universal evolution or development of the world. The realization of computer's improvement or intelligence, the creativity of thinking, and the rising of creative things in the world all belong to a same problem: the mechanism about the occurrence, existence, and development of complexity and system. Hence, our paper begins with the discussion about the universal complexity of the world and its creativity, and illustrates the complexity and creativity of thinking system promptly. Then, based on the results discussed above, we probe into the possibility and limitation of the realization of intelligent machine in future.

1 THE MEANING OF COMPLEXITY

In their classic works, L.V.Bertalanffy, C.Shannor, N.Wiener, W.R.Ashby, I.Prigogive, J.V.Neumann, R.Thom and H.Haken almost stated commonly that they were exploring the complexity of our world. The new sciences that they set up are now together called "Complexity Science"(Laszlo and Prigogive I986). But the concept of complexity we often use is still unclear whether in science or in philosophy up to now. We first intend to understand what it is with respect to the objective world, and what it expresses with respect to our thought.

(1) The Source of the Concept of Complexity: The Starting Point of a New World Outlook

Laplace (Pierre Simon) maintained that if we knew the positions and nomentums of all parts of a system, we would be able to know the system about both of its limitless past and limitless future by accurate calculation. In other words, everything can be described as a simple system, that is to say, we can always treat

objects with the viewpoint of simplicity, and there are no complexity and layers in the world if only we have enough ability to recognize and means of treating data. It is the principle or viewpoint of simplicity that has been influencing deeply the thinking of scientists for several centuries.

Kant (Immanuel) thought that something might be wrong with Laplace. He held the view like that of the later philosophy of dialectics and system: the world was a hierarchical system, which had many parts or layers. He said: "In front of us, on one side, nothing but single thing exists; on other side, all things are made up of compositions, so there are not single things." He argued that there was no way between single things and compositions, and that the world was full of the complex relationships of interaction. Kant is the first man who points out that we cannot know exactly the world because there are many layers by which a hierarchical system comes into existence.

Engels (Frederick) gave strong attention to Kant's thought, and adopted the concept of the chance of the dialectics of materialism to understand the existence and development of the hierarchical system of the world. He criticized thoroughly the mechanical determinism according to which only simple, direct necessity prevailed in nature. "Cannot it be produced by an irrevocable concatenation of cause and effect that a particular pea-pod contains five peas and not four or six, that a particular dog's tail is five inches long and not a whit longer or shorter?" "That's wrong," Engels stated. Men, according to him, couldn't consider it be reasonable that all things were simple or only in same big single layer.

In fact, Engels argued, the world of ours composed of many layers. "Hence, whatever view one may hold of the constitution of matter, this much is certain, that it is divided up into a series of big, well-defined groups of a relatively different mass character in such a way what the members of each separate group stand to one another in definite mass ratios, in contrast to which those of the next group stand to them in the ratio of the infinitely large or infinitely small in the mathematical sense ---- It does not alter the case that intermediate links can be found between the separate groups ---- These intermediate links prove only that there are no leaps in nature, precisely because nature is composed entirely of leaps." This is the main idea and first statement of the famous theory of layer, which has great effect, from then onward, in philosophy and in science.

From the beginning of the twentieth century, the direction and scope of man's attention to recognize and research the world have had a great change, being more deep and extensive. There appear more and more things that men can't understand by accurate calculation with classical principles, such as, the origin of the universe, the evolution of the living organisms, the brain, the future of societies, etc., and then new sciences arise: the theory of system, the theory of information, cybernetics, the thermodynamics of structure, synergetics and the theory of chaos. The concept of complexity is more and more used in new sciences. "The objects we are researching are not simple, not in a single layer," almost all men in new sciences expressed their work in such way unanimously. Indeed, the new sciences that we call together "Complexity Science" now research the properties of layers, which all happen on the places having complex relationship with respect to classical sciences.

It is not until middle of the twentieth century that the concept of complexity was formed by introspected mechanical determinism and simple principle, by developed the ideas of Kant and Engels, and by induced the results of new sciences. Around the concept of complexity, a new general outlook is established gradually, meaning that, the world formed with many non-successive qualities or layers, being full of complexity, is a system which is limitlessly existing and developing by itself, in which there are innumerable interrelations that can't be reduced by a single determinism (mechanic determinism or statistical determinism) because those interrelations are produced by chance beyond one layer and changed by time, and, nature is not only changing at all times but also, it is more important, growing and opening up constantly. Men can't know the concrete

forms of the world before they exist, especially those formed by the changes from different layers.

All above are for existence of complexity!

(2) The Definition of the Concept of Complexity: The Interrelation of Striding across Layers

What is complexity?

So far we have no certain answer for this question, even though the word "complexity" has been used in various fields for many years, for which the reason, like Ashby and Prigogine having pointed out, is that the principle of simplicity stays in scientists' mind too strongly, and that the concept of complexity is lack. For a long time, the harmony and orders of the world is understood merely to be simplicity, therefore, in many years the persistent efforts of a lot of scientists are to seek the theorems and laws which stand for the simple relationship of the world, and thus, simplicity becomes one of the perfect symbols of scientific theories. Oddly to say, in opposition to simplicity being a foundation of the world, complexity belongs to a null class concept which does not indicate any concrete object, so to say, "complexity = non-simple = we don't know". Except denying the ability of the recognition of researcher, the concept of complexity has not any meaning.

However things have been changed, now, particularly the situation both in nature science and in social science waiting for new ideas. As Ashby said years ago:

"Science stands today on something of divide. For two centuries it has been exploring systems that are either intrinsically simple or that are capable of being analyzed into simple components. The fact that such a dogma as 'vary the factors one at a time' could be accepted for a century shows that scientists were largely concerned in investigating such systems as allowed this method; for this method is often fundamentally impossible in complex systems."

It is high time to clear the concept of complexity both its connotation and denotation. The definitions of following three levels of complexity given here are based on the new sciences called "complexity sciences", and considered with its history of examination from philosophy.

Complexity is:

(a) A property of objects;

(b) A leap of layers in objects;

(c) An interrelation of striding across layers in objects which is not reduced directly.

Definition (c) is the most important, which brings the light to the substance of complexity, and by holding which we will be able to know where and how to find complexity and use the concept of complexity correctly. It is easy to find that all appearances that we call "non-simple" or that we can not deal with by the principle of simplicity happen in the interfaces of different layers, not in the interior of a single layer. From the point of the theory of layer, objects show themselves a series of different qualities being supplemented each other, thus, the same quality forms one layer, and in the world there are many many layers which all interact, sometimes with this form, sometimes with that form, sometimes taking place, another times disappearing, hence, the world has countless complex interrelations of striding across layers. On this view, the concept of complexity get its base theoretically and find an expression for its own, in other words, it is because the interrelations of striding across layers exist and are irreducible, we have the concept of complexity. The main difference between complexity and simplicity is whether the existence of the interrelations of different layers is acknowledged. Simplicity defines the world (and all things in the world) only as single layer, but complexity does not. With this characteristic or principle we can judge a system belonging to that of complexity or simplicity easily as well.
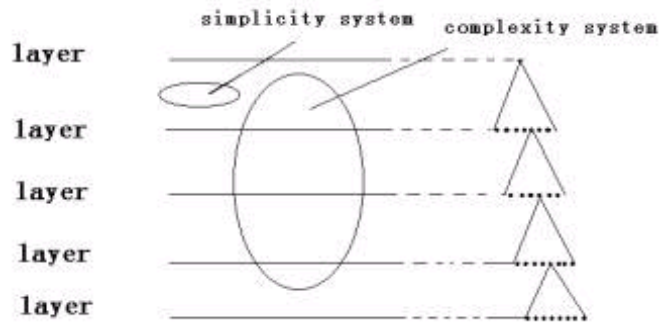
Figure: 1 Layers and Systems:

(1) layer is the matrix of system
(2) simplicity system is within same layer
(3) complexity system is striding-across-layers

The opinions above about the definition of the complexity in three levels are just preliminary. But they are very close to the essence of the new sciences saying before, in which there has not been a consistently and universally acknowledged concept of complexity, and meet basically that the problems of complexity are discussed in academic circles in recent years. The facts following support this point strongly:

Kauffman (Stuart A) advances a very useful idea, which is to descriptively analyze the complexity of systems, that a system can be viewed from a number of different perspectives, and that these perspectives may severally yield different non-isomorphic decompositions of the system into parts. Here is an application of his point: systems for which these different perspectives yield decomposition of the system into parts whose boundaries are not spatially coincident are properly regarded as more descriptively complex than systems whose decompositions under a set of perspectives are spatially coincident.

Another important method to analyses the complexity of systems was developed by Simon (Herbert) and others, which is called the judgment of the interaction complexity of systems. Their main point is that many systems can be decomposed into subsystems for which the intra-systemic causal interactions are all much stronger than the extra-systemic one, and that under the concept of "near- complete decomposability" to make sure whether the subsystem decomposed by S-decomposition and denoted by $\{S\ i \in_c\}$ cross boundaries between the different K- decomposition of a system, a system is interactively simple if none of the subsystems in $\{S\ i \in_c\}$ cross boundaries between the different K-decomposition of a system, and interactively complex in proportion to the extent to which they do.

Obviously, above two and other ways and means of the judgment of complexity which we do not give here are all used on the basis of the interrelations of the boundaries of the subsystems of the different perspectives in a system, even though they have different viewpoints, showing that the scientists in the fields of complexity know where complexity is and how to find it. However, this is merely an exploration for complexity standing on the view of pure science. If examined from the position of the methodology and world outlook of philosophy, we can find most ways and means of the judgment of complexity in the natural science now actually holding a supposition not stated explicitly, i.e., the standpoints I stated above that complexity are the leap of different layers (or levels), the expression of the interrelation of striding cross layers, and the existing form of the objects which have more than two layers. Beyond controversy, everything in our world can be considered composed of many layers, and complexity is regarded naturally as an essential property of the world.

In addition, it is necessary to emphasize that all objects of the new sciences be no other than of striding cross layers: how does the information transmit in different layers? Why can the functions of the subsystems in

different levels co-operate consistently? How does the multi-level-thing jump? And the questions about the boom-and-bust of a system by interrelations between different layers, evolution and the form of hierarchy, etc. It has good reasons to say that the new sciences have a common understanding of complexity. What we do here is to make clear the concept of complexity logically or philosophically on the basis of the work of those new sciences.

(3) Brief Conclusion

The concept or category of complexity has changed men's field of vision from one level to many levels, standing for a new world outlook. It makes science produce   a great revolution after Newton (Isaac), even Einstein (Albert), and go to a new stage ---the Complexity Science. In fact, the world can be observed and studied from the view of simplicity or complexity, both based on the objective reality. Complexity and simplicity are a couple of the categories being the unity of opposites with which we are thinking the world. Can't we understand the natural evolution, the brain and the society without complexity? How can we develop the synthetic theory of the new sciences before investigating the foundation of complexity? It seems that the task to make clear the concept of complexity and of simplicity   has brooked no delay.

2 THE COMPLEXITY OF THINKING SYSTEM

Setting forth one's views according to ideas mentioned above, one kind of the newest understanding about the theory of knowledge and methodology has just gained when thought, the thing that is thought to be the most complicated on the world, is analyzed with the viewpoint and method of the complexity of system: the creative source of human thought is the different relations between the layers in its layer structure. It is a kind of ability that the complexity of thinking system makes for human.

(1)   The Difficulty to Understand and Imitate the Mechanism of Thought

There are at least ten reasons that have been fully thought once to urge us to consider thought as complexity system

1st, the law of whole thought has not been all explained by any theory before.

2nd, the mechanism of the whole of thought can not be imitated in the practice up to now.

3rd, the artificial intelligence research has almost entered to the terminal point.

4th, the unanimous principle between matter structure and its function has met with serious setbacks in the brain science.

5th, it seems the creative ability of psychopath almost differs very little from that of the scientist of genius.

6th, it is more and more difficult to have a dialogue between science and religion.

7th, the research of psychology is more and more far from demonstrative science.

8th, the road of reducing philosophy to science seems to meet its end.

9th, the position of physiology in the research of thinking becomes more and more high.

10th, there are more and more evidences indicating that the location of time and space of thought is a false question.

(2) The Administrative Level Structure of Thinking System

Let us have a range of human's thinking-form, which all persons except the abnormal probably grasp and can express for exchanges: the direct perception / indirect perception / rational faculty / world outlook /

consciousness / sub-consciousness /top-consciousness. These different thinking-forms are obviously not on a plane. The relations of them are neither of part and part nor of factor and factor on same layer, but relations of three-dimensional possessing many different qualities which contain and are contained each other. Different layers are interdependent and interactive. The thinking system appears complexity and possesses particular function because of the relations of its administrative level structure. So the hinge of understanding the particularity of mankind thought system has been found.
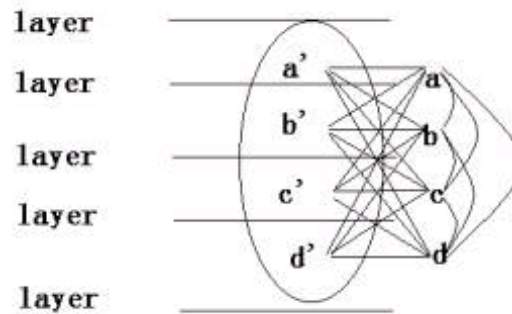
Figure 2: complex causal connection

(1) a,b,c,d are factor of different layers out of system, interacting on each other and crisscross with a',b', c', d'
(2) the relationship of the layers in the complexity system is bound to <u>must</u> reconstruct, so that keep itself as a system and cause evolution.

（**3**）**The Relations of Layers in Thinking System**

Let's consider the relations of layers in thinking system.

Various thinking modes or layers construct a series of hierarchical relations that contain and are contained, restrict and are restricted one another in essence. Things in any layer are in the striding-across-layers mutual relation. The relative independence among layers is obvious, because different layers of thinking interact mutually with their relevant material objects and material subjects. The variation in a layer can change not only the situation of its layer, but also the situation of other layers, and even the unified relation of the whole layer structure. Experience and ideas imported from various ways in different layers will build up the unified relation striding across layers. Hence, the structure of our thinking selects a certain mode, which is the result produced in our thinking by experience in daily life, communication and education.

Our thinking would not stop for a moment and it is always brisk. So it would not be in a single primary mode. For this reason, the relation of changing information in every layer can be coordinated. The things in every layer in our thinking system may often be replaced, even be in chaos. These cases happen probably because our organs has changed, has illusion or has been more accurate, or because we accept a certain new logic of philosophy, or because we are in a certain psychological situation. We will rectify the things in every layer at any time to make them be in order and to reflect the objective world rationally. Except the mechanism processed by the mutual relation that strides across layers, no procedure arranged beforehand can enable our thinking to have creativity and foresight.

The processing of information coming from different layers must be independent. Although people had known that their thinking was independent, the mechanism of interdependence had not been illustrated up to now. The example about splitting apart one's brain shows that there are more than a conscious subject working independently at lease after the brain is cut apart. And this point enlightens that we can understand the

independence of thinking and the working principle of the creativity and the foresight from the angle of value. Every layer and every part in the thinking system may be the conscious subject and the conscious object of other layers at the same time. Among conscious subjects of different layers a relation of value may be built up. The distinction of every part doesn't depend on previous logic or procedures, but on value. And the concept "value" can be understood as the rationality satisfying the situation of every layer, as the satisfaction of the object layers to the subject layers. That value is the crux of the independence of thinking, which is decided by the nature of material of brain and the layer-structure of thinking system itself. The layers of brain and the informational layers of thinking system both keep in touch with their outside directly of indirectly. And the contact enables the rationality of layers to have standards. The leaps or the discontinuous relations of layers make their rationality have no other standard except the standards that multi-subjects are satisfied. Only the value standard satisfying its rationality can connect or communicate the thinking situation and the physical situation. Based on this, we can boldly draw a conclusion that the brain can construct its spiritual ego with such relation of value, and the independence of thinking is realized. The difference of creativity and adaptation is produced and scrabbled by the coordination and the conflict of value among subjects of layers. This is a rapid procedure of acquiring, selecting and eliminating information. From this, we may conclude that if the excitement of one's thinking concentrates and stays in a certain layer and cannot transfer, that is to say, there is no standard of value and the new ideas lose its rationality, he will becomes a psychopath. Surely, it is difficult to judge whether the creator is a psychopath or a genius inventor only with a single new idea or a group of odd ideas. However, the problem can be settled easily if these ideas are considered with the theory of relation of layers. The thinking of a psychopath is on a plane and he regards the rationality of a certain layer as its standard. While the thinking of a scientist is three-dimensional with many layers, ideas or thoughts of a scientist can acquire their rational standard from the value relation of different layers. Though many thoughts of scientists are put forward as assumption or hypotheses, and though many of them are proved to be wrong later, it is different from the fantasy of psychopath in essence. That is to say, a psychopath can only think with a simple mode, while a scientist is with complex one.

It is hard for a normal person to imagine the pain of a psychopath suffering from that they cannot find the rationality for their fantastic ideas in a layer. By the observation and the analysis to psychopaths, we know that their ability of thinking in any layer has not been destroyed and has not cease. Their disease results from no adjustment of certain layers in their thinking structure in time. And the direct cause of this is that the importing port of changing information is blocked up, and the mechanism of information reflection can't work properly. The changing information stays in a certain layer and can't stride across layers and can't get value standards. The lost of value standards lead to the suffering and then the crazy of a psychopath. The spirit of a psychopath has many egos because of the blocking of layers. This case is obvious in religious psychopaths. The medicine given to them can't relieve their pain. The unique way is to open the importing port of information relating with layers, try to transfer the thinking excitement in different layers, evoke the intact ego, enable the thinking to acquire the value relation that creativity need again, and change suffering into happiness.

A normal person always avoids suffering and searches for happiness, so he always find the rationality among changing information in layers, and creates new ideas to get most satisfaction on value. Based on it, if a person can realize the complexity of thinking layers consciously, when he is considering a problem he may connect the results in different layers positively, and put the freedom of a layer into more layers positively. And, what he experiences is not the suffering of a psychopath but limitless happiness.

Human is not endowed with layer structure of thinking. It is formed through the development and the social activity. It may be a conclusion with great rationality: when we are born, we may only have two thinking layers ——"top-consciousness" and "direct perception". They contact directly or indirectly with layers inside or

outside our bodies. Hence, judgments of facts and value mainly depend on feeling. With the continuity of the passing of time and the metabolism, only two layers of thinking structure can't satisfy the examination to the changing information imported continuously and reflect information effectively. A series of middle layers appear between the two basic layers. Layers of thinking increase constantly and the structure improves more and more. We acquire rational faculty gradually and have world outlook and certain personality. On the ground of it, the rationality among layers changes from the field of feeling to the field of ideas. Hence, we have the sprite of independence.

The thought able to be realized and controlled consciously is only a small part of the structure of our thinking system—— a layer or several layers. During the process of thinking, lots of layers work together independently and then build up the complex mutual relation inside and outside our thinking. We can't locate the complexity of thinking system and can't formulate it. Its development depends on itself. What we can discuss are the relations of limited layers. That is the reason why a group of psychopaths can't be treated with a prescription, the reason why many priests fail to preach, and the reason why it is hard for intelligent machines to imitate the whole function of human's thinking system.

(4) Expounding to the Argument about Knowledge

Under the administrative level structure and the complexity of thinking system, we have logically and reasonably explained the argument about mankind's knowledge that is perpetually ceaseless and has no result perpetually: both the empiricism and rationalism all attempt to defeat the other side on a same thinking layer during many centuries. Kaut,I. attempted to harmonize both, but failed to jump out the limitation of the theory of knowledge of plane. Later phenomenology master Husserl,E., dialectics master Hegel,W.F. as well as experts of analyzer school all attempted to explain the whole thought with a layer of thinking. These things people impose from the outside, such as dynamic role, selectivity, construct and creativeness etc., make the theory of knowledge look poor, empty and forced. The thought of those philosophers and thinkers is imprisoned admittedly in the world of the simple aggregate that is formed by the single layer from beginning to end, but ignored the complexity of thinking system, although they all can not free from the complexity of thought. Perhaps the controversy between rationalism and empiricism would have been varied one kind of method if Descartes,R. and Bacon,F. had realized that sense experience and reason are two thought methods of different layers. Perhaps Hume,D. would have not put forward the so-called conclusion problem by which posterity was perplexed if he had understood the thinking formed by many administrative levels. Kant,I. did not realize that the conformity of empiricism and the rationalism, which is called the revolution of Copernicus' type, like the sun center of Copernicus is one-sided: it only work between two administrative levels of thought. Hegel, W. and his successors exaggerated dialectics in the world outlook, but treated with indifference the thinking form of other administrative levels. Wittgenstin,L. realized that there were the thoughts that could not be spoken and be unable to explain clearly, but he did not point out that where the thought form was in. While Heidegger,M. spoke persistently that those could not be spoken and those were unable to explain clearly originally.

3 HOW IS THE COMING COMPUTER

Setting out from the administrative level structure and its function of thinking system, it will be a completely new question for study to explore the possibility and limit of realization of artificial intelligence machine.

(1)　An Experiment of Changing Brains

Now let us see an interesting sublimate experiment about changing brain, which can show the most essential difference between human's thinking system and present computer. It is a standard to judge the object whether or not thinking system, which is similar with that given by Turing for judging machine and human being. Supposed there are two men (A and B) wanted to be the other (A→B and A→B) by changing their brains with each other. The process begins with changing hardware of brains from outside to inside, first organs, then cortex of brains，by separating and transplanting every part to the corresponding position. It can be finished with the modern technology of surgery operations. And the problem arises: what degree should the changing reach if A is B and B is A? But the difficulty is that whether consciousness is composed by parts, and whether the consciousness is decided by the statistical law of the physical and chemical characters of brain material. If the answer to these two questions is negative, the question about degree has no answer. And then we consider the change of software and ask two men forget all the perception knowledge and accept that of the other. The following process is that the change of rational knowledge, their world view including religion, and the sub-consciousness. The same problem comes up: what degree should the changing reach if A is B and B is A? It is obvious that the question is false according to modern science of nerve and bran. From the research of cybernetic and information science, during the course of the change of information, every import and export leads to the change of the whole and the content inside. Though the experiment of changing brain has not happened, the analysis make us reach a conclusion that thinking is a complex system with layer structure, which is established on the basis of the material system and is composed of consciousness. If each incised or separated part (including hardware and software) is replaced and re-organized into a new integer step by step, only inter-changing the space between tow object, such equipment ("brain": that of human or of biology or of machine) is not thinking system. If the reorganizing integer is not only changed in space, but also in its function, mechanism and the content of consciousness, the equipment is a thinking system can be concluded. Understanding this principle, we explain two characters of intelligent computer in future.

(2) Computer's "COMFORT"

Set up a group of information storage possessing same capacity, such as a, b, c, d etc. All storage is a relative independent system that possesses multi-level structure. All storage can be taken into any state of information value being random but definite (matching value standards in administrative level structure of thinking system at cerebrum), and can be imported the signals of many matter lays at the same time, and can be achieved one kind of state so-called "COMFORT". The spatial position of every storage can be adjusted. By this way, a group of information storage is made in half-open-state being mutual independence and mutual influence physically and chemically. All storage has to connect with the information change wave, which can experience and control the information of each matter layer of external world. Thus, in fact we have accomplished one kind of device imitating the complicated system of thought.

(3)Computer's "SATISFACTION"

Here is the mechanism of future intelligence computer (intelligent machine) to be similar with the complexity of thinking system: it needs memory without procedure; the storage and processing of information are unified. Like developing brains, the realization of coming computer intellectual is not by way of the procedure in advance, but by way of constantly importing and exporting, then, among the parts and layers, a kind of reasonable relation called "SATISFACTION" is built temporarily. This is a course of code-editing by oneself: the things of surface layer are constantly composed with new ways, and put into a deeper layer. Thus,

an administrative level structure to be similar with that kind in the thinking system from concrete arriving to abstract and more abstract inside is formed gradually. The new information occupies the surface layer of the storage forever, and interacts with the information leaving over of variously deep layer at the same time, and by which the value of information and of output of various layers are changed. The creativity of computer occurs at various layer relations of storage course that is not only harmonious but also random. It is the most critical question now: can mankind make out such kind of information component that possess the administrative levels structures and the unified course of storage and processing?

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