Invitation to System Sciences

-Poetry, Philosophy and Science in the Computer Age-

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2.0 Prologue

"Where can poetry find a place in the computer age?" This is a question coming to the mind of people going back home after a hard day, worn out in body and mind. Many people feel computers have deprived peace of mind in compensation for activating the society. The essay I present here tells the opposite – it is a tale on poetry and philosophy born mediated by computers, and also a tale on the dream of crystallizing them into science. Computers handling all kind of problems as abstract entities named information are dreaming the tale – the dream is evanescent and transitory but is with strength alike love of the youth. It will create the next era.

2.1 Phenomena and substances

The word "system" is popular and is generally understood to mean a set with some sort of order. It may seem there is no particular problem related to it. Is it really so? The meeting of two properties, one a "set" as a mere assembly and the other "order", reminds us of the following sentences:

> .....The earth was without form and void, and darkness was upon the face of the deep The Spirit of God moved upon the face of the waters.
>
> God said "Let there be light" and there was light.....

The sentences above are at the beginning of Genesis, and similar sentences appear in numerous legends of the world. They tell us symbolically how the world was created through the meeting of a set called chaos and order representing God. The generic nature of systems has been the basic problem thought about by human beings historically. A part of it has been abstracted and theorized by mathematicians as set theory and established as a branch of science. Order – the formidable being, however, has been made less the target of scientific study compared to nature as the world of matter created by a couple of a set and order itself as the parents. From ancient times order has been considered another name of God, its mystery being studied by divinity as a major theme.

Gradually, the empirical study of nature as the matter system has clearly revealed the relationships of order and the states of systems. The entropy of a system that is proportional to the logarithm of the number of the states of the system has been used as the measure of the order of the system. Entropy originally used as the thermodynamic and statistical mechanical measure of order is now adopted to represent the order of an information system as the measure of the property of an information system. It means that one of the substances of order is represented as entropy. The discussion from now on is not on entropy *per se*. What is important to know is that characterization of order is made not by the study of order itself but by the study, statistical study in particular, of the substance of the system with order.

A mainframe computer for shared academic use is sitting in a building of the Computer Centre on the Yayoi Campus of the University of Tokyo where prehistoric earthenware of the Yayoi Period was discovered. To the Computer Centre, computational problems in all academic disciplines including natural and social sciences and engineering are brought in. There the computer system is continue to process all the systems such as natural systems of atomic nuclei, electrons, molecules, crystals and biological bodies, and human systems of organizations and societies, economic systems of production, sales and profits as information systems – a type of logical systems. The phenomenon taking place there is: All concrete systems of the world we live are abstracted and generalized as information, and reconstructed on computers as information systems. It suggests the possibility of creating a novel and fundamental research discipline regarding the essentials of systems in general. The possibility is grounded on the fact that objects unbelievably versatile in kind and in nature are brought into the computer there after conversion to a single type of system called a digital information system that is a type of discrete time systems. It might be an evanescent dream. Still it is a dream of the computer there just being used without anyone listening to its whisper. I wish to see there someone listening quietly. The dream might be handing out a precious crystal extracted from an endless job of classifying numerous phenomena of systems to yield types, of studying the types to reveal their substances, and of extracting the essentials of the systems as the common entities of the substances.

2.2 Micro and macro

Here is one thing we have to point out explicitly. It is a fact that clarification of statistical aspects of systems never reveals the essentials of the systems. The reason is simple. What statistical analysis and modeling give are the distribution functions of properties and the properties derived from the distribution functions. Consequently, the microscopic properties of the elements of the systems and the macroscopic properties of the systems are related mainly by the distribution functions leaving big gaps between the microscopic properties and the macroscopic properties. In

other words, the effectiveness of statistical methods is limited to the cases where there are big gaps between the microscopic properties and the macroscopic properties. Hence, given a system, when we need to clarify the relationships between each state of the elements of the system and the macroscopic states of the system to a certain extent, statistical thinking and methods have to retreat.

It is the antithesis of the universal dominance of statistics of the modern society beyond the limit of the applicability, and we never intend to reject the idea of considering statistics to be widely useful in general. There is a promising direction to find a better statistical modeling of systems by reflecting the detailed structures of the elements of the systems and their interactions on the distribution functions. The thesis we are going to present is quite apart. It is stated as follows:

> The first step is the identification of each element of a given concrete system, its properties as microscopic properties and the logical relationships of the properties as microscopic relationships. Likewise, the properties of the system and their logical relationships are identified as macroscopic properties and macroscopic relationships. Then, as the next step, we can start to build up a method to define any system by its macroscopic properties and their macroscopic relationships grounded on the microscopic properties of the elements and the microscopic relationships. The method consists of 3 sub steps of analyzing individual concrete systems as phenomena, abstracting the commonality as types, identifying the substances of the systems from types, and finally abstracting the essentials from the substances. Let us name it a system scientific method.

By converting any concrete system to an abstract system based on the statements above, hence an abstract system is directly convertible to an information system, we can process any complex system directly on computers. It make it possible to clarify complex systems, that have been handled only statistically so far, in a scientific manner starting from microscopic structures and functions and ending with macroscopic structures and functions of the systems. It further make it possible to make diversified and discipline dependent research methods in mathematical systems, natural systems, and social systems interoperable, and to realize an advanced generic discipline, say general system theory, by integrating all individual disciplines systematically. We thus are filling the gaps of micro and macro within individual disciplines and interdisciplinary areas of study.

2.3 System sciences

Let us organize what stated in **2.** to make it clearer. Let system science be defined as constructed by sequential steps as follows:

1) The abstraction step: The step to abstract microscopic properties and their relationships, and macroscopic properties and their relationships from individual concrete systems.
2) The structure definition step: The step to represent the macroscopic properties and their

relationships of the abstract system by the microscopic properties and their relationships.

3) The semantic step: The step to identify the possibility and the method to transformation one abstract system to another abstract system.

4) The computational step: The step to transform an abstract system to an information system, and then collect input output pairs by running the information system.

5) The validation step: The input output pairs derived at the computational step are compared with the observed input output pairs of the individual concrete systems to validate the steps 1) ~ 4).

6) The natural history step: The step to apply steps 1) ~ 5) to many and varieties of concrete systems as have been practiced historically in natural sciences to establish science as a general discipline, in biology in particular.

7) The classification step: The step to classify the results of the step 6) and clarify the characteristics of individual types.

8) The generalization step: The step to clarify the commonality among the types to abstract substances and essentials.

We make some comments on the steps. The step 3) on semantics borrows the term "semantic" from linguistics simply to mean how a given term is explained or replaced by other terms, or transformed to some other terms. The step 4) on computing can be divided into two sub steps:
4-1) The programming step: The step to transform an abstract system to an information system.
4-2) The information processing step: The step to derive and collect the outputs of the information system for given input data sets.

The definition of system science here is merely the generalization and the procedure definition of the methods in science. System science is more interested in the relationships of the whole and the elements and in abstract properties and their relationships rather than in concrete properties and their relationships. The first aim of the definition is for synthesizing academic disciplines and art, currently torn into many isolated branches and blocked in communications; it includes the provision of the common ground and methods for it. The second aim is reorganizing culture into systems controllable in totality to get out of cultural isolations of valued areas through the provided common ground and methods. There is no guarantee that such system science can realize the second Renaissance following the Renaissance symbolized by Leonardo [Lionardo] da Vinci (1452-1519) who synthesized academic studies, art and technology. Considering the fact that only direction of the progressive evolution of life is the evolution of societies and organizations of human beings rather than the evolution of individual human beings sitting on the top of the evolution tree of life, isn't it wrong to say that what system science aim to synthesize and generalize individualized cultures is the main stream of the evolution of the future culture? The statement is grounded on the fact that

turning anything concrete into general systems, say systemization, is another way of representing the integration of socializing, synthesizing, organizing, and generalizing.

2.4 Epilogue

Wonders come from meetings of people. Sprung are what beyond individuals. Human beings are the highest order systems nature has created. Splendid are stories woven through human contacts. It stands symbolically the beauty of the characteristics of systems beyond their elements.

The information age, often called computopia in a utopian view, depicts the age of highly organized societies mediated by computer processed information. Important is the system oriented viewpoint for deriving the inter-related totality of systems through system analysis and planning beyond organizing media. It is plausible that the system age is considered to be desirable more than the information age, and system science is above computer science having more potential. Ripples are coming to the foot of our lonely computer at the Computer Centre, sounding it. System science needs abundance of flexible and unconstrained intelligence and systematic thinking in constructing a unified brain and intelligence that are self organizing and self advancing, breaking the barriers of specialists in divided fields of studies of art, science and technology. This essay is dedicated to the souls looking toward such a direction.

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