

Preparing for the Third Millennium: the Views of Life Informatics

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Abstract

The chief aspects of this paper are the condition of the birth of life informatics and its tasks, basic concepts, principles, and structure. There are three phases of combining informatics with medicine: product, technological, and theoretic application of which the goals are respectively the informatization of numerical and word processing, data of medical treatment, and the knowledge of medicine. While reached the third phase we have dealt with two types of biological information, physical and nonphysical, i.e., body information (i.e., the information about body's components and structure), and life information (i.e., the information about life codes and life programs). Life informatics is a main branch of bioinformatics. It is a new member of the medical informatics family, and as such is younger than health informatics, nursing informatics, and dental informatics. Its task is to assist biologists and medical doctors to recognize and interfere the human life information procedure just as they are doing well with human body's matter and energy system. Its basic concepts are life information, life information medicine, and life information therapy. Its most important principles are information materialism, general informatics, and information determinism. Its main branches are biomolecule, cellular, organic, individual, and social informatics. In the third millennium, the life informatics will be a leading discipline in biology, medicine and informatics, which will gradually influence modern philosophy and other humanities.

Keywords

Medical Informatics; Bioinformatics; Body Information; Life Information; Life Informatics

Introduction

Even though there has been a big medical informatics family (health informatics, nursing informatics, dental informatics, etc.) which is thriving today and will continue to do so for the foreseeable future [1,2], some critical questions are not well answered yet, e.g., Can medical informatics be regarded as a separate discipline? What is a separate discipline? Does medical informatics have a distinctive methodology? Has medical informatics become a discipline with distinct subareas? etc. [3]. Possibly a main reason is that this subject has no solid theoretical

basis. H. S. Blois gave an explanation for this.

"It has been pointed out that medical computing is largely drawn by its technological applications, and that it suffers from a lack of critical inquiry into its own foundations. Despite this recognized deficiency, it is unfortunately still the case that proposals to inquire into the fundamentals of the field are received poorly, and that the limited support available is absorbed by developing even more elaborate application systems which continue to be built upon an ill-defined conceptual base. As a result, Medical Information Science as a science remains more of a research program or hope, than a coherent set of accomplishments" [4].

Since 1987 we have been paying our attention to the inquiry of the fundamentals of medical informatics. While being visiting scholars from August 1992 to August 1995, we had conducted co-research on the disciplinary foundation of medical informatics with J. A. Mitchell and A. E. Rikli at Medical Informatics Group, University of Missouri-Columbia, USA. In the same period, we explored the philosophical and epistemological basis of bioinformatics, the combination between informatics and biology, with J. J. Bien and J. Kultgen.

We came back from the USA in August 1995 to serve our motherland, China. Since then we have established the Institute of Medical Informatics and have held a series of seminars on the new member of the medical informatics family, Life Informatics, edited "Communication of Life Information Science", and organized the Association of Life Information Science in Hubei Medical University. More than thirty experts from 20 medical institutes in China joined our research and made their contributions. In this paper, we will report some achievements from 1992 until the present day.

Conditions of the Emerging of Life Informatics

Three Phases of the Combination of Informatics with Medicine

The procedure of combining informatics with medicine is one of learning and understanding the experts in both fields. It is obvious that the combination is developing from easy to difficult, from shallow to deep, from narrow to broad. The procedure can be divided into three phases: applying for simple computer product, developing of hardware and software in treating and preventing diseases, penetrating of concepts and principles of informatics into medicine and biology [5].

When reached the third phase we have dealt with two basic types of biological information: physical and nonphysical, i.e., body information and life information. The human body information is the information about the personal physical body, which is the matter and energy system, e.g., bones and muscles, the digestive system, cellular structure [6], etc. Human life information is information about the personal bioinformation system, e.g., nervous system, DNA [7], etc. We can investigate an organism at five levels: molecule, cell, organ, individual, and society. There is body information and life information at each level. Here the concept body implies any physical subject at any level of life activity.

Generally speaking, traditional biology and medicine are based on physics and chemistry of which the central concepts are matter and energy. With the guidance of physical "reductionism", biologists and medical doctors decompose the human body into organs, cells, and molecules, then they recognize the structure and function at each body level. Based on the physical and chemical factors and targets, doctors can diagnose the diseases of patients and treat them with drugs and equipment. Therefore, traditional medicine (Western Medicine) collects human body information to recognize and arrange the patients' matter and energy systems. The main task of the traditional medicine informatics family is to process human body information so as to assist health care providers.

Life Information is much more Important than Body Information

Life information keeps an organism "alive". It has special form and content at different life levels. At macro-biomolecule level, it is DNA, hereditary information; at cellular level, it is communication of the outside and inside of a cell; at organ level, it is neural system; at a personal level, it is his/her mind consciousness, feeling and emotions; at the social level, it is the communication and control of social members. In a general sense, at any level, information controls the matter and energy horizontally and there is some vertical control between different levels. Therefore, life information is much more important than body information.

Biologists and physicians have done some systematic research on the nervous system and psychology, beginning the 1880's. With the development of the science of modern information, the research on genetic information and cellular information has opened a new epoch for biology and medicine [8]. It is time for us to synthesize the life information theory, technique, and its application. The goal of the so-called Life Informatics (or Life Information Science) is to informatize the theory and practice of biology and medicine [9].

What is Life Informatics?

Life Informatics is one branch of biological informatics (or bioinformatics). It is an interdisciplinary science. Nowadays, it locates at the frontier of international academia. It is a new developing direction of modern information science combined with medicine and whole life sciences. By employing concepts, theory and tools of information sciences, life informatics studies the nature of life information and the laws of life information processing in different layer (molecule, cell, organ, body,

colony, ecology, and universe), and different systems (plant, animal, person, and artificial life); It studies the mechanism of mutual relations, influence, adjustment and control between various layers and systems; It further studies the mechanism of unusual inside structure and outside function for living body caused by departure from normal life information procedure, and prevention and cure in various layers and systems.

Main Principles of Life Informatics

Information Materialism

In the view of information materialism, there are not only material objects and their fields, but also there is information in the universe. Information is neither matter nor energy but a special kind of natural being. After human being emerged, the relation between matter and spirit, existence and consciousness, in nature has gone to a new phase of the relation of matter and information. The highest-level human consciousness came from lower-level animal consciousness. Biological reflection came from physical and chemical reaction. Conscious counteraction on existence is our minds, which controls and adjusts the matter and energy system at the individual level. This kind of control function happens at each level of life activity.

General Informatics

According to the views of general informatics, information motion is a basic motion in the universe [10]. The information carrier is material subject or its field, and information depends on matter and energy. However, information does not absolutely rely on a special carrier and is relatively independent. This dual nature of information determines the duality of information motion. On the one hand, in form, information motion relies on its carrier movement, obeying physical laws at carrier level; on the other hand, in content, information motion is non-physical, obeying nonphysical laws, e.g., no conservation, entropy decrease, program control, etc.

Information Determinism

In the physical world, physical law determines the conditions and movements of nonlife subjects. In the life world, physical function is limited in various degrees at different life levels, and physical law is almost useless in social level. The nature of life is self-metabolism, self-reproduction, and self-organization. Self-organization is self-control by self-programming, e.g., DNA program [11] and social laws and regulations, etc. Information laws determine the condition and movement of life activities [12]. While comparing life information motion to the nonlife one, we find that there are a series of parallel phenomena: life information, its procedure, its control by programming, natural life programming (as in genetic engineering), man-computer system, replacement or subsidiary of the original system, interference in the natural life information procedure.

The Knowledge Structure of Life Informatics

The hierarchical structure is general in the physical world, the life world, and the knowledge world. The feature of hierarchical structure comes from distinct degrees of combination among components at different levels. With the gradual progress of evolution from the physical world to the life world, the physical forces decrease but information power increases. That is the

reason why physical laws do not work at the social level.

We can classify the knowledge of life informatics according to different basis. In light of the biological race, the main branches of life informatics are microorganism informatics, plant informatics, animal informatics, and human informatics [13]. On the base of the hierarchy of life activities, life informatics consists of biomolecule informatics (genetic informatics), cellular informatics, organ informatics (neural informatics), individual informatics (psychology), and social informatics (social psychology, management informatics). In a certain sense, social ideology, science and technology, are life information phenomena at the community or social level. Therefore, we believe that the research on life informatics can build a bridge to connect the physical and life world and the natural and social science.

Conclusion

The new member of medical informatics family, life informatics, has boundless prospects not only in its field but also in information science, life science, philosophy, and other humanities.

So called modern information science is, in nature, a non-life informatics, which has less complexity than life informatics and is an elder branch of general information science. The traditional life science is based on physical concepts, matter and energy [14]. It emphasizes only material and energy metabolism, almost does not mention information exchange in surroundings. However, life informatics will bring about a revolution in traditional biology and medicine. Information materialism will end the age of physical materialism (physicalism). The boundary of natural science and humanities, physics and biology will be broken thoroughly. Therefore, life informatics will be a new leading discipline in the third millennium. According to Martin Rodbell, it is essential that government, industry, and academic institutions prepare for what undoubtedly will be revolutionary changes in both scientific research and medical practice [15].

Generally speaking, the research on life informatics consists of two aspects, theory and application. Establishing its theory is the first, more significant task at the present day if we want to have life informatics started from its developed foundations based on well defined concepts and principles.

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