

Managing information in Health Informatics

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ABSTRACT

Only once we agree upon our understanding of what words really mean can we debate whether a concept, represented by those words, is or not well represented significantly in specific application. Conceptual clarity and predicative/ impredicative competence are the fundamental components for managing information more effectively in Health Informatics, Healthcare and Medicine applications, while promoting innovation and creativity. Medicine was always the art and science of healing. The science became more and more a mechanistic technology in Healthcare; the art was dropped altogether. But uncertainty-as-problem in the past is slowly morphing into the evaluative concept of uncertainty-as-resource. The key change performance factor is education, distinguishing building on sand from building on rock for Health Informatics! Conceptual clarity, more than instrumental obsession is necessary. In this paper, we present the main concepts of fundamental biomedical enhanced knowledge formalization for Health Informatics and Wellbeing of the future.

Keywords: formalization of medical informatics, fundamental knowledge.

1. INTRODUCTION

Conceptual clarity and predicative/ impredicative competence are the fundamental components for managing information more effectively in Health Informatics, Healthcare and Medicine applications, while promoting innovation and creativity (1). Challenged by conditions beyond the traditional boundary of illness, even medicine and healthcare are discovering that the living is less simple than what the traditional physics paradigm implies and this affects health informatics deeply. As far as the last decades are considered, the most pervasive development of science goes under complexity theory, however defined. Men inevitably see the universe from a human point of view, communicate in terms shaped by the exigencies of human life in a natural uncertain environment, and make rational decisions in an environment of imprecision, uncertainty and incompleteness of information. Both complexity science and chaos theory converge on showing the unavoidability of uncertainty, whether it is embedded into feedback cycles and emergence or in the infinite precision of initial con-

ditions. But, uncertainty-as-problem in the past is slowly morphing into the evolutive concept of uncertainty-as-resource. The key change performance factor is education, distinguishing building on sand from building on rock for Health Informatics! Conceptual clarity, more than instrumental obsession (so typical of this particular time) is necessary. Furthermore, a subtler transformation is ongoing. Both linear and nonlinear techniques are forms of predicative modeling. The difference between predicative and impeditive systems (and models and definitions) is pervasive and often considered of marginal interest in the past century (2).

Conceptual clarity and predicative competence are the fundamental components for managing information more effectively than past approaches for promoting innovation and creativity (3).

As far as the last decades are considered, the most pervasive development of science goes under complexity theory, however defined. Both complexity and chaos converge on showing the unavoidability of uncertainty, whether it is embedded into feedback cycles and

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emergence or in the infinite precision of initial conditions. But, uncertainty-as-problem in the past is slowly morphing into the evolutive concept of uncertainty-as-resource by ontology uncertainty management (OUM) system (4).

However, the 2016 study appeared in the British Medical Journal brings to light some of the consequences of the obsolete, industrial-mechanistic medical practice (5),(6), anticipated by the review article “Death by Medicine”, in 2004 (7) and the related book (8). Challenged by conditions beyond the traditional boundary of illness, even medicine is discovering that the living is less simple than what the traditional physics paradigm implies (5),(6). In this paper, we present the main concepts of fundamental biomedical enhanced knowledge formalization for Health Informatics and Wellbeing of the future.

2. MANAGING INFORMATIONS AND CURRENT HEALTHCARE UNDERSTANDING

According to Swiss clinical psychologist Jean Piaget, human adults normally know how to use properly classical propositional logic. He held that the integration of algebraic composition and relational ordering in formal logic is realized via the mathematical Klein group structure (9). In the last decades, many experiments have shown most adults commit logical fallacies in propositional inferences, and so concluded that Piaget’s claim about adults’ competence in propositional logic was too much rationalist. Doing so, they forgot Piaget’s rigorous and important analysis of the Klein group structure at work in logical and predicative competence. English talking people tend to treat conditionals as equivalences and inclusive disjunctions as being exclusive (10). Nevertheless, the Klein group structure Piaget used can be reused to help us understand better what happens in spontaneous human reasoning and in the production of fallacies. In fact, in mathematics, the Klein four-group or “Viergruppe”, named by German mathematician Felix Klein in 1884, is a group of four transformations with four elements. The Klein four-group is the smallest non-cyclic group, and every non-cyclic group of order 4 is isomorphic to the Klein four-group. The cyclic group of order 4 and the Klein four-group are therefore, up to isomorphism, the only groups of order 4. Piaget applied the Klein four-group to binary connectives, so that a given connective is associated first with itself (in an identical (I) transformation) and then with its algebraic complement (its inverse (N) transformation), also with its order opposite (its reciprocal (R) transformation) and finally, with the combination of its N and R transformations to arrive to what logicians usually call the “dual” (D) transformation (10).

The Klein group structure generates squares of opposition (SOO), and an important component of human rationality resides in the diagram of the SOO, as formal articulations of logical dependence between connectives. SOO are considered as important basic components of logical competence and of human predicative rationality (11). Treating conveniently neutral elements (I), algebraic complements (N) and order reciprocals (R) in an integrated structure, by a valid treatment of duals (D), would guarantee people to make logically valid classical inferences on propositions and to achieve higher conceptual clarity in Health Informatics. But the formal rationality provided by the SOO is not spontaneous

and therefore, should not be easy to learn for adults. This is the main reason why we need reliable and effective training tools to achieve full propositional logic proficiency, and predicative competence in decision making, like the elementary pragmatic model (EPM) (12),(13). In fact, by an abstract point of view, EPM can be even seen as the logic description of the fundamental interaction of two purposive subjects, modeled by the interaction of two Klein groups. In other words, EPM can model all the elementary narrative and rhetoric articulations between two rational, interacting subjects reliably and clearly. Currently, the notion of reasoning or conscious reason may be interpreted in terms of the reasoning process itself being itself explicitly modeled by the reasoning agent in Cognitive Informatics (14). In this way, we can arrive to the core understanding of “the difference that makes the difference” (15).

A subtler transformation is ongoing, however: a transformation working on a deeper level than the move from linear to nonlinear models and patently much less visible than it. Both linear and nonlinear techniques are forms of predicative modeling. The difference between predicative and impredicative systems (and models and definitions) is pervasive in science and often considered of marginal interest in the past century. As a matter of fact, many disciplines, including mathematics, sociology, anthropology, biology, etc., exhibit varieties of self-reference, the primary source of impredicativity (2, p.6). Furthermore, many natural systems do indeed show forms of impredicativity, that is the presence of self-referential cycles in their constitution. Once the supporting or enabling (as well as constraining) capacity of the related environment is provided, the impredicative cycle characterizing the system proceeds in its own way. Apart from the pioneering efforts of American theoretical biologist Robert Rosen (16), and usually without his idea that impredicativity is the next paradigmatic frontier of science, the issue of impredicativity has received little attention in the past (17),(18),(19),(20).

Unsurprisingly, many properties of impredicative systems are still unknown and suitable research programs must be developed. Specifically, from past and current scientific literature we know very little of nested or tangled impredicative systems properties, such as the organism-mind-society encapsulation (21), or the mathematics of impredicativity systems (22). As a matter of fact, according to the author’s humble knowledge, CICT (computational information conservation theory) (23) has been the only approach studying impredicative systems by an operative perspective since 1980s. The living is the domain of “repetition without repetition” (24), i.e., non-monotonic change.

Simpler explanations afford the immediacy of practical methods, sometimes informed more by urgency than by anything else. The reductionist-deterministic paradigm indeed led to significant technological and pharmaceutical progress. But this does not eliminate the need to understand complexity. Leibniz (25) seems among the first to examine science from a complexity perspective. In his view, laws should not be arbitrarily complex. If they are, the concept of the law becomes inoperative. A clear criterion (or criteria) for identifying it is more urgent than ever before, if we want medicine to overcome the limitations inherent in its mechanistic practice. However, complexity, as consubstantial with the living,

is of high-order consequence for medicine. If the living, in particular the human being, is complex, knowing the medical subject, in its complexity, is of practical importance for Health Informatics. As a matter of fact, a science of the living can only be holistic, because the dynamics of the living is the expression of its change as a whole over time. The holistic view entails the fact that the reductionist method will always return a partial understanding of the process (26). The causality specific to interactions in the living includes, in addition to what Newton's laws describe quantitatively, the realization of meaning in connection to the possible future, i.e., anticipation (27).

However, we have to take into account that the notion of anticipation is used currently in medicine with a very precise description attached to it. In medicine, anticipation describes a genetic disorder passed from one generation to another, each time at an earlier onset (the so-called trinucleotide repeat disorders, such as Huntington disease, muscular dystrophy, etc.). For Health Informatics, the operational definition of anticipation, advanced in this paper, underlines and explains, after the fact, the choice made by medical practitioners in trying to understand how the trinucleotide repeat occurs and what is involved in the production of the mutant protein. This expression of anticipation is such that it covers the entire life of the individual: from conception to death. From this perspective, medicine, in its reductionist, industrial procedures, "heals" today and produces invalidity of deeper levels tomorrow. For the Health Informatics and Wellbeing of the future, the anticipatory endowment should translate into the practical consideration informed by the shared awareness of both the patient and physician. The surprising fact is that the idea that medicine's fundamental perspective might be deficient has not led practitioners to question it, and has not resulted in a vigorous attempt to change it.

3. CONCEPTUAL CLARITY

From traditional information modeling point of view, the main focus is on the "direct space" (DS) representation only (Euclidean space). Nevertheless, according to CICTODR (Observation-Description-Representation) approach (23) to grasp the full information content of our reality, DS is just half of the "outer universe" (OU) human representation (shareable representation) and its "co-direct space" (CS) is the other half, the DS natural closure. Coupled to the OU is the "inner universe" (IU) human representation (subjective representation), composed by the "reciprocal space" (RS) and its natural closure, the "reciprocal co-space" (RC), or the DS dual. DS and CS are the coupled, complementary, asymptotic components of the fundamental, irreducible dichotomy of our OU representation (28). This fundamental representation is based on two root components: unfolded information (linear shareable information that can be communicated in a formal way by media) and folded information (complex subjective information that cannot be communicated by traditional media) (3). DS, CS, RS and RC are related to the four fundamental components of the Piaget-Klein group: Identity (I), algebraic complement (additive inverse) (N), order opposite (multiplicative inverse, reciprocal) (R), and dual (D) transformations, respectively. According to CICT, this is the minimum framework required to capture and to conserve full representation

information efficiently (3).

Generalizations built upon statistical averages and probability distributions defy the nature of the entity subject to knowledge acquisition. A doctor will not better address a patient's health condition based on averaging. As a sound example, we can go back to 1975 (29), with benzodiazepines, which trigger aggressiveness instead of acting as tranquilizers. It is a known fact that the same medication can be beneficial to some and (highly) detrimental to others: the "paradoxical effect" of medication. Living processes have multiple outcomes, some antagonistic to the same perturbation. These are very concrete aspects of practicing medicine without looking through the "eyeglasses" of classic physics or chemistry. The patient's unique profile should be the source for describing his condition. Medicine ought to comprehend the non-deterministic nature of both health and disease for each unique subject.

Indeed, changes due to physical forces applied on cells (e.g., a cut or a blow) and genetic processes governing all dynamics are interwoven. As recent, meaningful example, we can recall genetic manipulation. Shinya Yamanaka discovered in 2006 a way to reprogram adult cells into embryo like ones, called induced pluripotent stem (iPS) cells, a find that has revolutionized the stem cell field. It brought Yamanaka the Nobel Prize in physiology or medicine, in 2012. Nevertheless, physical-chemical manipulation has so far proven to be less successful. In 2014, he had to retract his findings and to apologize (30). Conceptual clarity, more than instrumental obsession (so typical of this particular time) is necessary. Those who practice medicine, and even more those who contribute to a science of medicine meant to overcome the limitations inherent in generalizing physics (and the notion of machine) in the living domain will agree on the need for conceptual clarity. The key change performance factor is education, distinguishing from classic, contemporary education and a new one, based on a more reliable control of learning uncertainty ((32-36).

4. CONCLUSION

We live in an age which is widely called the "Age of Information" and Health Informatics must capture as much as possible of it. Education has to be reconceived from the ground up: solid scientific education, in both the physics of the world and in the biology grounded in anticipation, is required. This in itself is a high-order endeavor, since schools continue to indoctrinate new generations in the classic "religion of physics". Medicine was always the art and science of healing. The science became more and more a mechanistic technology; the art was dropped altogether. Knowledge concept is useful for semantic and cognitive studies and research. It is much better to consider semantic information as a material category reflecting the level of internal structural organization of any object and interrelating with domain-dependent basic characteristics (such as the energy and mass of an object). This is the main reason why there are basic issues related to enhanced knowledge which still remain unresolved.

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