Bao HF: The Concepts and Definitions Related to BMKI——The Principles, Concepts and Methodology of BMKI(Ⅱ), the Proceedings of the 7th China-Japan-Korea Symposium on Medical Informatics, pp135-137,Shenzhen 2005, in Chinese Hospitals, Vol.9 supplements, 2005

The concepts and definitions related to BMKI

——The Principles, concepts and methodology of BMKI(Ⅱ)

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Abstract The paper presented a set of definitions of concept, which have been discussed and explored in the Theory of Bio-Medical Knowledge Integration(BMKI) originally presented by the author. And it is quite clear that these concepts are closely related to data or knowledge integration, data mining, knowledge discovery, decision support, semantic inference etc for EMR, semantic web and all other data or knowledge bases.

Key words Medical Informatics Artificial Intelligence The Theory of Bio-Medical Informatics(BMKI)

1. The introduction

Being different from all other researches or developments in Medical Informatics(MI) or Artificial Intelligence(AI), the research of the Theory of BioMedical Knowledge Integration(BMKI) considers things from the viewpoint which takes the whole biomedical knowledge world as an integral body where the contents are closely and mutually related.

So far, BMKI has discussed a range of questions which the author believes are to be the key points for data or knowledge integration, data mining, knowledge discovery, decision support, semantic inference etc for Electronic Medical Records(EMR), semantic web and all other data or knowledge bases. A part of those concepts and definitions that BMKI has been explored will be are listed below. For each definition or concept, the author tries to make it more structured, with more mathematical sense, wishing to increase its operationality for computer or application.

2. The Definition or Concept System

(1)The problem space: The set of relationships which one tries to realize or clarify.

(2)The method or solution space: The set of physical relation or logic proposition or their composition，through which the objective or problematic relations in the corresponding problem space might be completed.

(3）The cognitive goal: The problem space plus the method or solution space that people are looking for and trying to resolve . Namely, the cognitive goal contains the followings to be determined: (1) cognitive subjects(or carrier) or resources as called by RDF; (2) the corresponding variables or properties of those subjects; (3) the corresponding values of those variables or properties.

(4) The cognitive goal for the declarative data of the patient records(PRs): In general, the cognitive goal for the declarative data of the PRs includes (1) Are there abnormalities exist in the patient; (2)If exist, then what are they? (3) If exist but not certainly identified, then how to gain new information? (4) If exist and certainly identified, then how to treat them?

(5) Three kinds of attributes of data of patient record:, That is (1) the acquirement attributes, eg the Generalized data creator(GDC), (2) the expression or morphological attributes, eg triplet of information and (3) the cognition attributes, eg the cognitive inclination of data of PR for the cognitive goal.

(6) Generalized data creator(GDC): It is composed by two components, ie the generalized Observer or measurer and the generalized reader or estimator. There may be differences in their cognitive validity between the data created by the different types of GDC. BMKI divided the data creators into seven types:

Type Ⅰ of GDC refers to the non-human data acquirement tools such as the laboratory devices, equipments, reagents, etc. The data gained by this type of GDC are more objective or, in some cases, more accuracy. For example, "blood urea nitrogen 7.14mmol/L, blood creatinine 88.4 μmol/L, plasma total protein 55g/L, plasma albumin 28g/L, plasma globulin 27g/L, serum cholesterol 12.93 mmol/L"；

Type Ⅱ of GDC：the measurements and estimations based on the sense-organ-levels of doctor, producing the data such as "no yellowing of the skin", "no abnormalities found in sense organs", etc.

Type Ⅲ of GDC: the measurements and estimations based on the psychological levels of doctor.

Type Ⅳ of GDC: the measurements and estimations based on expertise of doctor;

Type Ⅴ of GDC: the measurements and estimations based on the sense-organ-level of patients or their family members;

Type Ⅵ of GDC: the measurements and estimations based on the psychological levels of patients and their family members;

Type Ⅵ+ of GDC: The measurements and estimations not clearly belonging to the types mentioned above or the types of GDC make no differences for the cognitive goals.

(7) The triplet of information: the most basic information unit or frame, constructed by Information Carrier, variable and value of variable, as presented by BMKI separately and with more mathematical sense, or resource, property and value of property, as called by RDF and with more natural sense. Any kind of information or knowledge might be reduced or transformed at last into a triplet-like form.

(8) Forward data for cognition: The data which confirm the existence of abnormality. For

instance, “menstrual disorder”, etc

(9) Backward data for cognition: The data which deny the existence of abnormality. For example, “no abnormalities found in sense organs”, etc

(10) Non-inclination or background data for cognition: The data which describe the background space, making it clearer and therefore reducing the size of question space. Eg. “Gender female, age 55 yr, date of admission Dec 29, 2000” ,etc

(11)The theory of determination by the cognitive goal: The theory on how the certainty, granularity or so called knowledge quantum are dependent of the cognitive goal, eg key-lock effective relation, etc

(12)The absolute granularity of knowledge: the detail or fineness of knowledge from viewpoint of the elementary or smallest particles recognized in Physics at the present age. _

(13)The relative granularity of knowledge: the detail or fineness of knowledge determined by the cognitive goal.

(14) meta-relations or meta-dimensions: So called ***meta-relations or meta-dimensions*** are those atomic ones, ie for a particular cognitive purpose, which can be no more spilt into the more basic ones. In addition, they are usually independent of each other and the atomic elements or units of logical or thinking processes for that cognitive goal.

(15) Euclidean-like-spaces(ELS) : Totally speaking, Euclidean Space(ES) is the traditional or mathematic space, which is the formalized-space or the space in pure mental world, with nothing substantial in it. Whereas the Euclidean-like-spaces(ELS) are substantial ones, ie the spaces in real world. According to the degree of organization, they have the primarily subdivided types and the order as: General or substantial Euclidean-like Space→ Euclidean-like Space of organic substance →Euclidean-like Space of bio-macromolecule→ Euclidean-like Space of organism.

(16) quasi-infinity or –infinitesimal: A quasi-infinity or – infinitesimal is a quantity or its reciprocal of a thing that is so large or small as to be beyond the cognitive ability at that time. The examples of quasi-infinity are the well-known exponent explosion of operation in AI, the relation between the dynamics of the numerous Brownian’s particles in a container and its transform into temperature. Another example for it is the transform from the contraction of the numberless myofilaments to the arm movement of say a boxer, etc.

(17) Heterogeneous spaces: the spaces with different and independent dimensions one another.

(18) Conceptual Ontotogy(CO): The specifications of a conceptualization, which have the conscious nature.

(19) Experimental Ontotogy(EO): The descriptions of a standard mapping, which are resulted from the physical and statistical experiments rather than determined consciously.

Notations about concepts (18),(19):

T. R. Gruber pointed out:: “What is important is what an ontology is for. My colleagues and I have been designing ontologies for the purpose of enabling knowledge sharing and reuse. In that context, an ontology is a specification used for making ontological commitments.” (http://www-ksl.stanford.edu/kst/what-is-an-ontology.html).

Because the important characteristics of an ontology are its sharability and reusability, as understood by Hanfei Bao, an ontology should be, after all, the standard (or typical) and conceptual knowledge on the universality of a statistical group rather than of an individual.

And based on this interpretation, the author extended the idea of ontology to the

statistically standard (or typical) and experimental (rather than conceptual) knowledge on the universality of a group. Thus the current mainstream ontology is called the conceptual ontology（CO） and the new “ontology” is the experimental ontology(EO).)

(20) Beacon-and-Compass Strategy: In the BioMedical knowledge integration or any other BioMedical intelligent activities, it is absolutely difficult without mapping. Thus the strategy to combine empirical mapping and theoretical reasoning is called the “beacon-and-compass strategy” of BioMedical knowledge integration. That is the number one strategy in BMKI.

Notations about concepts (20): The most empirical and experimental knowledge eg “blood pressure is 80/120 mmHg”, “cough at night”, etc belongs to the type of “know it is so”, rather than “know why it is so”. Usually we have to accept them conditionlessly. The relationships in that kind of knowledge are called “mapping” in mathematics, without needing to reason labouredly. BMKI describes visually the mapping in the empirical and experimental knowledge as “dark sailing dependent on beacon(or island)”, meaning that “the captain” does not have to estimate the course of sailing according to the wind-, the water-flow, the directions of compass pointer, etc. Contrarily, BMKI calls knowledge reasoning of theoretical knowledge eg “A is the ancestor of B and B is the ancestor of C, then A is the ancestor of C. as “dark sailing dependent on compass”.

(21) Big-Or Space: The general understanding or association of the scientific knowledge are based on a “big-or” space, formed by the union operation of many different spaces: $S=S_1 \cup S_2 \cup S_3 \cup \cdots$

Notations about concepts (21): When we read a textbook or listen to a physiology lesson, our mind consciously or subconsciously and continuously move from one effective knowledge background space to another, just by the bridge-factor(s) at the intersection of two spaces. Therefore S is, as Hanfei Bao called, the “big-or”space.

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