

# Onto-oriented expert system for supporting diagnostic and therapeutic decisions in the field of Chinese image medicine

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**Abstract**— The article is devoted to the development of onto-oriented decision-making support expert system for Chinese image medicine (CIM). The detailed structure of the diagnostic CIM ontology and its sub-ontology is presented: nosological ontology, topological diagnostic ontology and ontology of methods for obtaining sensory-image diagnostic information. The use of diagnostic ontology as the basis for modeling the semantic space of the CIM, the accumulation and use of this knowledge in the expert system for diagnostic and therapeutic decision-making support in CIM is substantiated; the scheme is developed and the algorithm of such an expert system is described.

**Keywords**— *ontology, expert systems, Integrative Medicine, Chinese Image Medicine*

## I. INTRODUCTION

According to the World Health Organization strategy in the field of traditional medicine [1], as well as Chinese image medicine scientific research program as an important component of integrated scientific medicine [2], one of the topical scientific and applied issue is the creation of an integrated onto-oriented information-analytical environment for scientific research, professional healing and e-learning for Chinese image medicine (CIM). The development purpose of this information-analytical environment is to ensure the effective organization and work coordination of the CIM-therapists, the CIM researchers, persons who the CIM study, as well as the formation of modern intelligent information resources and resources in the field of traditional, complementary and integrated medicine at the national and international levels.

General architecture of integrated onto-based information analytical environment of scientific research, professional healing and e-learning of Chinese image medicine developed in the paper [3] and presented in fig.1.



Fig. 1. General architecture of integrated onto-based information analytical environment of scientific research, professional healing and e-learning of Chinese image medicine

Important components of this integrated environment are the expert system and ontology of the CIM, which is the core of the knowledge base underlying the information-analytical environment. Onto-orientation of the Knowledge Base will allow to eliminate subjective factors, fuzziness and semantic heterogeneity of diagnostic and therapeutic concepts and images, make it possible to reuse the ontologically structured CIM terms and ensure their integrity and clarity for the CIM-therapists community.

## II. RELATED WORKS

Not many expert integrated systems are known in the integrative medicine field. So the Virtual Medical Doctor (VMD) system is intended to replace the first stage of the patient's examination by a physician [4]. For the implementation of ontology and data input are used: OWL, Protégé, SWRL. VMD takes into account not only the

physical condition of the patient but also his emotional state, in this regard, in its work uses two ontologies: Mental and Physical Ontology. To detect medical scenarios Bayesian network was used that detects random variables set and their conditional dependencies with the help of an oriented acyclic graph. The HEARTFAID project aims at creating tools for building medical expert systems for monitoring and treatment of patients with heart failure [5]. Heart Failure Ontology was developed, including about 200 classes, 100 properties, and more than 2000 examples. Where possible, concepts are provided by the CUI (Concept Unique Identifier) identifier with UMLS (Unified Medical Language System). UMLS Knowledge Source Server, used as the main guide to medical terms, integrates around 100 different thesauruses. For realizing the ontology and output data it was used: OWL, Protégé, rules (SWRL). Personal Health Assistance Service Expert System (PHASES) provides tips on how to eat well and lead a healthy lifestyle (which are recommended for physical activity) [6]. PUFF is also known, that is an expert system for diagnosing lung diseases. The doctor directs the patient to the laboratory, where the patient inhales / exhales through a tube connected to the computer that measures the consumption and volume of air. PUFF accepts pulmonary examination data from a patient with supporting data (age, sex, smoking history) and prints a diagnosis. [7]. Ontology-Oriented Diagnostic System for Traditional Chinese Medicine Based on Relational Refinement is an onto-oriented system for traditional Chinese medicine based on relational refinement that uses a range of knowledge-based technologies. [8]. In all of these works emphasize the need to use ontology to solve the uncertainty problem, which is very common in medical diagnostics, as well as to improve diagnostics with considerations and possibilities of conclusions. This proves the topicality of the development of diagnostic and therapeutic CIM ontology, as well as onto-oriented expert system CIM.

### III. MAIN PART

The central component of the CIM expert system is a diagnostic  $\mathbf{O}_D$  and therapeutic  $\mathbf{O}_D$  ontologies CIM. Let's consider more detail the diagnostic ontology CIM structure. It is established that diagnostic ontology, which as its sub-ontologies should include nosological ontology  $\mathbf{O}_N$ , topological diagnostic ontology  $\mathbf{O}_T$  and ontology  $\mathbf{O}_M$  of methods for obtaining sensory-image diagnostic information (ontology of diagnostic methods) in CIM. From a formal point of view, the diagnostic ontology of CIM can be submitted as such three of its sub-ontologies:

$$\mathbf{O}_D = \{\mathbf{O}_N, \mathbf{O}_T, \mathbf{O}_M\} \quad (1)$$

Nosological ontology  $\mathbf{O}_N$  CIM shows knowledge about types (classes) of diseases that are accepted in the diagnostic theory of CIM. Topological diagnostic ontology  $\mathbf{O}_T$  CIM presents data about the topological localization of diseases related to the physical body (Jing system), the energy

system (Chi system), and the psycho-mental-spiritual system (the Shen system) of a person, in particular, contains data about parts of the body, organs, the physical body tissues, data on bioactive points and energy channels of the human energy system, data about the information, psycho-emotional, mental and spiritual topological aspects of human. It should be noted that the topological ontology can be represented as a sequence of inserted topological ontologies  $\mathbf{O}_{T_1} \subset \mathbf{O}_{T_1} \subset \dots \subset \mathbf{O}_{T_K}$

with varying degrees of topological detalization, that present the hierarchically organized set of inserted splits of the human body image into parts (human body parts, organ systems, individual organs, and organ areas). Also, the topological ontology contains data not only about the human body areas, but also data about the relations between them, which, at the formal mathematical level, is the set of relations  $\mathbf{R}$  between the elements of the topological ontology.

Ontology  $\mathbf{O}_M$  of diagnostic methods in CIM reflects knowledge about methods of obtaining sensory-image diagnostic information in the CIM. With each nosological class of the CIM, it is necessary to relate the set of those diagnostic methods, on the basis of which information can be obtained, sufficient for referring the patient to this nosological class. Therefore, it seems appropriate, besides the choice of the CIM-expert of the nosological class from ontology  $\mathbf{O}_N$ , to indicate which method or combination of diagnostic methods he used for establishing a chosen diagnosis. And also to indicate which senses, images, emotions from defined in advance (created) taxonomy of the psycho-mental-spiritual states of the CIM-specialist were present in his mind and were interpreted by him as corresponding nosological signs.

Let's consider in more detail the general structural features of the above ontologies, and in order to simplify the presentation and understanding of the material, we will assume that these ontologies are ordinary taxonomies. In this case, we will have diseases taxonomy (nosological taxonomy) in the CIM, which will be given as:

$$\mathbf{O}_N = \langle \mathbf{\Omega}_N, \subset \rangle \quad (2)$$

where  $\mathbf{\Omega}_N$  is a set of diseases types in the CIM, which is an appropriate diseases glossary in the theory of CIM, and the relation “ $\subset$ ” is the relation of the strict inclusion that takes place between the glossary elements (concepts)  $\mathbf{\Omega}_N$ . Topological taxonomies will respectively be presented as:

$$\mathbf{O}_{Tf} = \langle \mathbf{\Omega}_{Tf}, \subset \rangle, \quad \mathbf{O}_{Te} = \langle \mathbf{\Omega}_{Te}, \subset \rangle, \quad \mathbf{O}_{Ti} = \langle \mathbf{\Omega}_{Ti}, \subset \rangle,$$

where  $\mathbf{\Omega}_{Tf}$  is a set types of anatomical areas (parts of the body, organs, tissues) of the physical body of a human; set  $\mathbf{\Omega}_{Te}$  is a set of components (bioactive points, collaterals, energy channels, energy centers) of the human energy system;



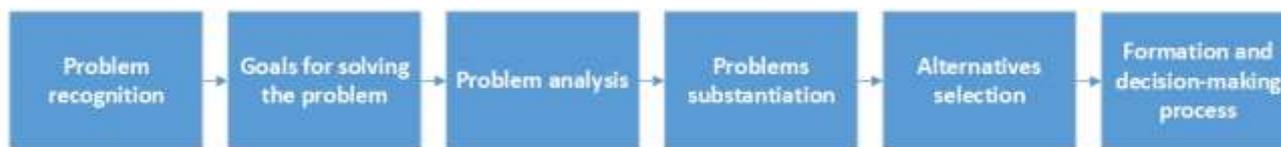


Fig. 5. The main decision-making process stages

Rules  $\Psi \rightarrow \Omega$  are interpreted using the form:

$$IF \Psi, THEN \Omega, \quad (5)$$

Consequently, the inference mechanism follows a sequence: a rule is executed, the left part of which  $\Psi$  is compared with the existing parameters in the set  $S_1$  and acquires the truth. As a result, the set  $S_1$  is replenished due to the facts stated in the right part of the product  $\Omega$ . This generates an inference chain of intermediate and final decisions.

The most accepted approach to medical decision-making is to comply with the procedure for the implementation of compulsory actions: problem recognition; setting goals for solving the problem; studying the problem by collecting and processing information, analysis results, examination of a patient, medical card; substantiation of alternative actions; comparison and selection of alternatives; formulating and decision-making process.

The expert system decision tree creating of the is due to the image of the sequence of questions asked by the doctor in solving the problem of treatment selection. The program moves from question to question until a solution is found or the possible transitions are exhausted.

#### IV. CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

The paper substantiates the necessity of developing a machine-interpreted model of the CIM ancient knowledge, which would solve the problems of heterogeneity, polysemantics, which are present during the diagnostic and therapeutic decision-making by the CIM-therapists. Separation of the nosological, topological ontology and ontology of diagnostic methods allowed to create a diagnostic CIM ontology, which, in combination with the original classes set and mathematical models, is the basis for developing ontology-oriented expert system decision-making support for Chinese image medicine. Further research is intended: to specify the relationship between syndromes, which will increase the accuracy of diagnostic decisions; to develop algorithms of logical conclusions for diagnostic and therapeutic decision-making in the field of CIM.

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