Building an Ontology and Knowledge Base of the Human Meridian-Collateral System

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Abstract

Meridian-collateral knowledge is a profound and complex part of the whole traditional Chinese medicine (TCM). It is the basis for many TCM-related computer applications. This work aimed to develop a sharable knowledge base of the human meridian-collateral system for those applications. We began the work by building a frame ontology of the meridian-collateral system (called OMCAP); and then developed a large-scale sharable instance base (called IMCAP), which was, with the aid of the tool OKEE. The OMCAP consists of 89 categories and 38 slots, and the IMCAP contains 1549 instance frames.

1. Introduction

The theory of meridians and collaterals is one of the profound theories of traditional Chinese medicine (TCM). It was systematically developed by ancient Chinese medical theorists and practitioners in their prolonged practice over thousands of years. The theory is closely related to acupuncture therapy, and is the foundation of acupuncture, moxibustion, massage, qigong, and clinical practice of other related fields of TCM [1][2][3][4][5][6].

In this paper, we introduce a frame-based domain ontology of the meridian-collateral system, called OMCAP, which is in the spirit of the Generic Frame Protocol [7], with a few significant extensions. With the OMCAP ontology, we have built a large-scale sharable instance base, called IMCAP (Instances of Meridians, Collaterals, Acupoints and acu-mox Prescriptions), which contains instance frames of categories in the OMCAP. The knowledge base is intended to be used in TCM-related applications such as automated diagnosis and therapy, medical instruction and training, and natural language processing.

In the beginning of OMCAP and IMCAP development, we obtained a list of influential knowledge sources recommended by our experts [1][2][3][4][5][6]. We conducted a comprehensive survey to identify the categories, instances, relations,

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The results of the survey outline the four major components of the OMCAP, mainly in the spirit of Gruber's view of ontologies [8]: A set of basic and common categories (e.g. Integer, String and Terms); a set of categories which are not unique in the theory of meridians and collaterals, but are necessary to define the OMCAP; a set of categories (including Acupoints, Meridians, Collaterals, and Acu-Mox Prescriptions) and their relations (including has-all-disjoint-subcategories, has-disjoint-subcategories, and has-all-subcategories); and a set of formal axioms for constraining the interpretation of those categories and their relations.

In addition to being a language for describing the instance frames of categories, the OMCAP plays two other significant roles. Firstly, slots in a category are placeholders for the instance frames of that category, and they are to be filled in during the knowledge acquisition process. Secondly, axioms in the OMCAP can be used both in knowledge inference and knowledge verification during the knowledge acquisition procedure: When acquired knowledge violates such axioms, the knowledge engineer is alarmed to identify and resolve the problems.

The rest of the paper is organized as follows. Section 2 presents the frame-based language for the OMCAP and IMCAP and discusses a few issues in developing the OMCAP and IMCAP. Section 3 introduces a tool for building and managing ontologies and knowledge bases. Section 4 presents the two-year effort of building ontology OMCAP and instance base IMCAP. Section 5 discusses a few issues regarding the OMCAP and IMCAP, and concludes the paper.

2. A Frame-Based Language for the Ontology OMCAP and IMCAP

Before presenting the frame-language for the OMCAP and IMCAP, we need to discuss two general yet important issues in ontology building, namely categories and taxonomic relations.

To develop the OMCAP, we need to start from a few common categories, such as Integer, Float, Boolean, Char, String, Terms, and CTime (i.e. ChineseTime, formatted in YYYYMMDDHHMMSS). Of course, in addition to the common categories above, we need to consider TCM-specific common categories, including the categories Zang-Fu Organs and its subcategories Zang Organs and Fu Organs, and Five Elements, and Illnesses. These common categories are already available and widely used in other ontologies as well [9][10][11][12].

In the meridian-collateral system itself, there are four broad categories, i.e. Acupoints, Meridians, Collaterals, and Acu-Mox Prescriptions, and each of these categories has subcategories.

To build a domain ontology, we define a taxonomical relation between categories and their instance. In our practice with ontological engineering, we have encountered and summarized several common and specific taxonomic relations among categories and instances, including has-all-disjoint-subcategories, has-disjoint-subcategories, has-all-subcategories, has-subcategories, subcategory-of,