An Internet Application to Manage an OWL Ontology for Medical Computational Problem Solving

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Introduction: There is a plethora of medical algorithms in the web, which refer to Medical Computational Problems (MCPs) and provide all computational facilities required to solve a Medical Problem. MCPs are medical problems, the solution of which deals with mathematical or statistical models, signal or image processing, and estimation of parameters. The main problem in exposing MCPs is that the existing information about them is scattered and poorly organized. This paper presents an OWL Ontology Model that manages MCPs by means of organizing and visualizing their existing knowledge. Furthermore, an internet application that deals with the Ontology Model and provides an infrastructure to describe and associate MCPs, algorithmic solutions, and algorithmic implementations is built. Finally, an innovative algorithm that constructs the problems vectors from the ontology individuals is illustrated.

Methods: In order to create a Medical Computational Problems - Knowledge Base (MCPs-KB) a prototype MCP ontology model was designed and implemented by use of the Ontology Web Language (OWL). The tool Protégé with its OWL plug-in was used to build the MCP ontology. The user space and three computational spaces – medical problem, solutions, and implementation – are proposed in order to provide a detailed accurate description of the MCP Ontology. The problem space consists of medical computational problems; the solution space is composed of algorithm solutions, whereas implementation model objects assist in carrying out the solutions. The user model objects consist of the users and their different capabilities. A high level MCPs-KB can be modelled as a collection of these objects, their intra-relations within each space and their inter-relations across the spaces. Th e Unified Medical Language System (UMLS) Metathesaurus was utilised in order to achieve concept consensus by providing a standardized medical terminology. To describe MCPs references in a structured manner, the BibTex OWL- Ontology was adjusted into MCP Ontology. An Internet Client-Server application was built by utilizing Remote Method Invocation (RMI). The Client is the one that connects with the RMI Server through RMI. Two common examples of the Client's requests from the RMI Server are: to represent a MCP description in OWL and to search for a particular MCP or algorithm. The GUI client is a dynamic user friendly interface; different user categories are equipped with different interfaces depending on the actions. The RMI Server receives the request, manages the MCPs-KB and returns the results to the client. Specifically, the RMI Server creates and searches instances of the MCP ontology in regard to the client request through Jena-Api. Moreover, the RMI Server assesses the services of the UMLS-Knowledge Server and receives the UMLS descriptions of MCPs Keywords and MCPs Categories through UMLS-Api. A novel algorithm that constructs the MCPs vectors from the ontology individuals is built. These vectors are defined by a matrix based on problems, Concept Unique Identifier (CUI) Keywords and CUI Categories. The CUIs are automatically received by the UMLS-KS and stored into ontologies. These vectors are used to estimate the similarity of the problems, by calculating the cosine of their angle, in order to achieve an efficient search in a MCPs-KB.

Results: In order to evaluate the MCP Ontology by the use of the Internet application, twenty-three cardiology algorithms and their MCPs were described. These MCPs refer to measures of cardiovascular reflexes, risk assessment in myocardial infarction diagnosis of ventricular hypertrophy and tachycardia. Most of those MCPs were originated by the Institute of Medical Algorithms. These formulated descriptions provide a prototype MCPs-KB. The

algorithm that estimates the similarity among MCPs is used in the search process in order to help the knowledge problems authors to identify if a problem exists in the KB.

Conclusions: The research in question deals with the construction of OWL ontologies able to describe MCPs. The aim of this work is to provide an internet application, which will assist expert users in creating a MCPs-KB by utilizing the MCP Ontology and searching efficiently MCPs and their solutions by introducing and exploiting cosine based similarity. This approach inherits the benefits of UMLS, which standardizes the medical terminology. The final aim of this project is to build a Medical Computational Problem Solving Knowledge Portal. This portal could be used in clinical research or more broadly in medical research, by providing existing solutions of MCPs.

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