An ontology-based interpretable fuzzy decision support system for diabetes diagnosis

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Authors: Shaker El-Sappagh, Jose M. Alonso, Farman Ali, Amjad Ali, Jun-Hyeog Jang, Kyung-Sup Kwak

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Abstract: Diabetes is a serious chronic disease. The importance of clinical decision support systems (CDSSs) to diagnose diabetes has led to extensive research efforts to improve the accuracy, applicability, interpretability, and interoperability of these systems. However, this problem continues to require optimization. Fuzzy rule-based systems (FRBSs) are suitable for the medical domain, where interpretability is a main concern. The medical domain is data-intensive, and using electronic health record (EHR) data to build the FRBS knowledge base and fuzzy sets is critical. Multiple variables are frequently required to determine a correct and personalized diagnosis, which usually makes it difficult to arrive at accurate and timely decisions. In this paper, we propose and implement a new semantically interpretable FRBS framework for diabetes diagnosis. The framework uses multiple aspects of knowledge-fuzzy inference, ontology reasoning, and a fuzzy analytical hierarchy process (FAHP) to provide a more intuitive and accurate design. First, we build a two-layered hierarchical and interpretable FRBS; then, we improve this by integrating an ontology reasoning process based on SNOMED CT standard ontology. We incorporate FAHP to determine the relative medical importance of each sub-FRBS. The proposed system offers numerous unique and critical improvements regarding the implementation of an accurate, dynamic, semantically intelligent, and interpretable CDSS. The designed system considers the ontology semantic similarity of diabetes complications and symptoms concepts in the fuzzy rules' evaluation process. The framework was tested using a real dataset, and the results indicate how the proposed system helps physicians and patients to accurately diagnose diabetes mellitus.

Keywords: Clinical decision support system, diabetes diagnosis, fuzzy inference system, ontology reasoning, fuzzy interpretability

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