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Fatemeh Mansourypoor, Shahrokh Asadi



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# Development of a Reinforcement Learning-based Evolutionary Fuzzy Rule-Based System for Diabetes Diagnosis

Fatemeh Mansourypoor<sup>a</sup>, Shahrokh Asadi<sup>a,1</sup>

<sup>a</sup>*Faculty of Engineering, Farabi Campus, University of Tehran, Iran*

## Abstract

The early diagnosis of disease is critical to preventing the occurrence of severe complications. Diabetes is a serious health problem. A variety of methods have been developed for diagnosing diabetes. The majority of these methods have been developed in a black-box manner, which cannot be used to explain the inference and diagnosis procedure. Therefore, it is essential to develop methods with high accuracy and interpretability. In this study, a Reinforcement Learning-based Evolutionary Fuzzy Rule-Based System (RLEFRBS) is developed for diabetes diagnosis. The proposed model involves the building of a Rule Base (RB) and rule optimization. The initial RB is constructed using numerical data without initial rules; after learning the rules, redundant rules are eliminated based on the confidence measure. Next, redundant conditions in the antecedent parts are pruned to yield simpler rules with higher interpretability. Finally, an appropriate subset of the rules is selected using a Genetic Algorithm (GA), and the RB is constructed. Evolutionary tuning of the membership functions and weight adjusting using Reinforcement Learning (RL) are used to improve the performance of RLEFRBS. Moreover, to deal with uncovered instances, it makes use of an efficient rule stretching method. The performance of RLEFRBS was examined using two common datasets: Pima Indian Diabetes (PID) and BioSat Diabetes Dataset (BDD). The experimental results show that the proposed model provides a more compact, interpretable and accurate RB that can be considered to be a promising alternative for diagnosis of diabetes.

**Keywords:** Reinforcement Learning; Evolutionary; Diabetes Diagnosis; Fuzzy Rule-Based; Genetic Algorithm.

## 1. Introduction

Diabetes mellitus is one of the most common diseases in the world. According to the International Diabetes Federation, over 415 million individuals suffered from this disease globally in 2015 [1]. This amount is estimated to reach 642 million in 2040. Diabetes is a metabolic disorder where the body is unable to properly produce or respond to insulin which is required for regulating glucose (sugar). There are two types of diabetes: type 1, which is primarily caused by autoimmune pancreatic  $\beta$ -cell destruction and characterized by absolute insulin deficiency, and type 2, which is characterized by insulin resistance and relative insulin deficiency.

Besides contributing to heart disease, diabetes also increases the risk of developing kidney disease, blindness, nerve damage and blood vessel damage. The exact cause of the disease

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<sup>1</sup> Corresponding author

Email: [fatemehmansourypoor@gmail.com](mailto:fatemehmansourypoor@gmail.com) (F.Mansourypoor), [shahrokh.asadi@ut.ac.ir](mailto:shahrokh.asadi@ut.ac.ir) (S.Asadi)

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