

Chapter 18

A Predictive E-Health Information System: Diagnosing Diabetes Mellitus Using Neural Network Based Decision Support System

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ABSTRACT

Diabetes Mellitus is a chronic disease and a major cause of several severe complications and death in both developing and developed countries. The number of diabetes cases world-wide has been climbed up drastically over last decades. Hence, it was of utmost important to manage this illness and to develop tools that help clinicians do their job professionally. Artificial neural networks play a major role herein. In this research, a clinical decision support system that helps in diagnosing diabetes has been developed. The system was implemented using a multilayer perceptron artificial neural network. Due to the fact that there is no systematic way to follow in order to determine the number of hidden layers and neurons in MLP, an algorithm was proposed and followed based on the rules-of-thumb previously defined around this issue. As a result, two different topologies were trained and verified using cross validation technique. The topology that exhibited the best averaged accuracy was that of one hidden layer. The data set was obtained from King Abdullah University Hospital in Jordan.

1. INTRODUCTION

Healthcare is a major concern of communities and individuals. It significantly contributes in countries' economies. Information technology has spread widely in health care industry in the last few decades. Healthcare Information Technology or e-Health is the application of information processing involving both computer hardware and software that deals with the storage, retrieval, sharing, and use of health

DOI: 10.4018/978-1-5225-0159-6.ch018

care information, data, and knowledge for communication and decision making (Brailer & Thompson, 2004). Despite the dramatic growth in the last few decades, the continuous research and the nonstopping achievements in the health care information technology industry prove that this field still in its infancy and many other several research could be conducted. Healthcare Information Technology systems employ several different methods. These systems can be electronic medical records (EMRS), electronic health records (EHRS), personal health record (PHR), payer-based health record, computerized physician order entry (CPOE), clinical decision support, and E-prescribing (Bray, 2010). Nowadays, Clinical Decision Support Systems (CDSSs) are mostly in demand by healthcare practitioners as they usually perform intelligently.

CDSSs are information systems that help healthcare practitioners in making medical decisions about patients using relative patient and clinical data (Dinevski, Bele, Šarenac, Rajkovič, & Šušteršič, 2011). The use of such systems helps in reducing medical errors, minimizing treatment cost, and improving patient's health (Golemati, Mougiakakou, Stoitsis, Valavanis, & Nikita, 2005). In 2005, Garg et al. Stated that CDSSs improved practitioners' performance in 64% of the studies, and patients' outcomes in 13% of them (Garg, et al., 2005). In CDSSs, Artificial intelligence plays a vital role in the applied techniques. These techniques falls under one of two categories; knowledge-based and non-knowledge based systems (Abbasi & Kashiyarndi, 2006). Knowledge-based systems contain knowledge about very specific tasks and facts, and consist of knowledge base, inference engine, and a mechanism to communicate (Abbasi & Kashiyarndi, 2006). Rule-based expert systems and Bayesian Network are examples on the knowledge-based systems. Non-knowledge-based systems employ Machine learning techniques instead, like neural Networks and genetic Algorithms. In health care systems, Machine learning used to learn from description of previously treated patients and help practitioners to diagnose objectively and reliably. In sum, various intelligent techniques could be used to implement CDSS, which one to select depends on the problem domain, the probable Solution, the amount of data available, the cost of the system, the required efficiency, researcher choice and purpose, and many other parameters (Abbasi & Kashiyarndi, 2006). In medicine, CDSS can help in monitoring, alerting, interpreting, assisting, diagnosing, and managing decision support (Pestotnik, 2005).

Neural networks are one of the best solutions in complex, multiple variable systems wherein applying ordinary rule-based programming and following an algorithmic solution is an improbable task. In medicine, Artificial Neural Networks (ANNs) are a hot area of concern in the fields of diagnosis, biomedical analysis, image analysis, and drug development (Tsakona, Paschali, Tsolis, & Skapetis, 2013).

Diagnosis, in medicine, is the recognition of a disease. In traditional methods, clinical practitioners need to deal with huge amount of data of various types which cannot be handled by the human experts. Being the first step in the treatment process, diagnosis is critical and any error in this step can lead to catastrophic consequences, beside the probable delay where conventional methods may last for weeks or even months. What makes things worse is the lack of inexperienced specialists in the diagnosis of a specific disease especially in the developing countries. To summarize, incorrect diagnosis may waste time, resources, quality of health, and even human life (Wasyluk & Raś, 2010). Hence, computer-based methods are becoming inevitable in the diagnosis process due to its efficiency, accuracy, reliability, repeatability, pragmatism, and avoidance of other human being factors such as fatigue, stress, and diminished attention (Panchal & Shah, 2011). A clinical DSS that is developed mainly for diagnosing process is usually called Diagnosing Decision Support Systems (DDSS). Being such a complex real world problem, diagnosing process is best handled using ANNs.

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