Chapter 16
Challenges and Opportunities of Soft Computing Tools in Health Care Delivery

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ABSTRACT

During the last decade, modern hospitals have witnessed a growth in the amount of information acquired, stored, and retrieved more than ever before. While aimed at helping healthcare personnel in providing care to patients, this high stream of data can also have a negative impact if not delivered in a simple and organized way. In this chapter, the authors explore the current opportunities and challenges that soft computing predictive tools face in healthcare delivery, and they then present an example of how some of these tools may contribute to the decision-making of health care providers for an important critical condition in Intensive Care Units (ICU)—septic shock. Despite current challenges, such as the availability of clean clinical data, accuracy, and interpretability, these systems will likely act to enhance the performance of a human expert and permit healthcare resources to be used more efficiently while maintaining or improving outcomes.

INTRODUCTION

Since its early beginnings in the 1960s, bioinformatics started changing the way in which health care was delivered to patients. The growing amount of information describing several aspects of patients’ interaction with hospital facilities, forced new models and research pathways to emerge in order to both improve patients’ outcomes and decrease hospital costs (Shortliffe & Cimino, 2006).

Medicine based on evidence has become a standard for health care delivery in which population-based studies have shown the success of response to drugs and therapies (Sackett & Rosenberg, 1995). Those population studies can only be carried out through the use of databases
containing relevant information to the outcome pursued. Those databases, first collected by hand, are nowadays digitally acquired and stored, containing, but not limited to, medical, demographic and social data.

In the specific case of Intensive Care Units (ICUs), small changes in the management of critically ill patients can significantly affect their outcome. To better support care management, several models have been developed and continuously tuned to inform clinicians about the patient condition and to assist them during the decision-making process (Benner, Hughes, & Sutphen, 2008). Since a huge amount of data is collected in the ICUs, those models can select, combine and make use of data according to the outcome under assessment.

ICU databases usually consist of data acquired from bedside monitors, lab test results, drug administration, nurses’ and clinicians’ progression notes, demographic and admission/discharge information. However, due mainly to the dimensionality of the data and the lack of time to make decisions, reliable tools are needed to process the information and integrate results in a human-understandable way.

Prediction, classification, and scoring systems are needed in ICUs to address different situations. Most of them are currently performed using mathematical models that combine objective and subjective information and return results based on their previous training.

Soft computing approaches have not been absent in this growing field, although they still find resistance to their use in several medical applications. Both neural networks and fuzzy systems have been used since their early development, to classify/predict patient outcomes with variable success. However, strategies used during modeling continue to evolve making contemporary models more reliable, understandable and transparent (Milley, 2000).

In this chapter, we start by making an overview of the steps required to find new patterns in a clinical database. We present the most commonly used soft computing tools, and explore current opportunities and challenges these tools may have in healthcare delivery. Then, we present an example of how some of the introduced soft computing tools may contribute to the decision-making process of health care providers managing septic shock in Intensive Care Units (ICU). Models are developed together with data reduction strategies, and several measurements are performed in order to assess their performance, while using a cross-validation schema.

Improvements obtained in classification and predictive tasks show that soft computing tools have won a place in medical and epidemiological modeling, and future years will see a significant growth in the use of these tools for clinical practice.

BACKGROUND

Large amounts of data are generated within the healthcare industry describing patients, hospitals resources, disease diagnosis, electronic patient records, or medical devices. These data are a very important resource to be processed and analyzed for knowledge extraction that potentially enables support for cost-savings and decision making in the organization. The key for data exploration of this type lies in data mining.

Some of the vast potential for data mining applications in healthcare can be listed as:

- Evaluation of the effectiveness of medical treatments by comparing causes, symptoms, and courses of treatments, data mining can deliver an analysis of which courses of action are more effective (Milley, 2000). For example, the outcomes of patient groups treated with different drug regimens for the same disease or condition can be compared to determine which treatments work best and are most cost-effective (Kincade, 1998). Another example of
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