Chapter 27
Intelligent Techniques Inspired by Nature and Used in Biomedical Engineering

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ABSTRACT

Managing medical information and knowledge is becoming an increasing problem for healthcare professionals. Medical science that contains ever-increasing amounts of knowledge, such as the medical history of a patient, medical data about diseases, diagnosis and treatment methods, should be necessarily a science of information. The real problem faced by patients and healthcare providers is finding and using relevant knowledge at the right time. In this context, in the middle of 1950s, intelligent computer systems, called clinical decision support systems (CDSS), were introduced as a new concept. CDSS is defined as an active intelligent system that can help medical experts to make decisions by taking specific recommendations. Also, it provides decisions based on resolving patient-specific information and related medical truths. The objective of this chapter is to focus on these systems and explain relations with the field of artificial intelligence methods, approaches, or techniques in this manner.

INTRODUCTION

Biomedical Engineering which is an important engineering area is interdisciplinary. Biomedical engineering is the application of the principles and problem-solving techniques of engineering to the fields of biology and health care. Biomedical engineers work with physician, clinicians, therapists, and other health care workers to develop systems, equipment, devices, and software in order to solve health care problems. In other words, the challenges created by the diversity and complexity of living systems require creative, knowledgeable, and imaginative people for working in same teams such as physicians, scientists, engineers, and even business professionals. Thus, they can produce an instrument to monitor, restore, and enhance normal body function. The biomedical engineer is ideally trained to work at the intersection of science, medicine, and mathematics to solve biological and medical problems. (IEEE EMB, 2015).

DOI: 10.4018/978-1-5225-8903-7.ch027

Biomedical engineers try to develop and evaluate systems and products such as artificial organs, prostheses (artificial devices that replace missing body parts), instrumentation, medical information systems, health management. Also, they interest to create new equipment or environments for such purposes as maximizing human performance, or providing non-invasive diagnostic tools using their knowledge of engineering (Biomedical Engineering, 2016). For this reason, biomedical engineers often use artificial intelligence to solve health care problems.

Generally, biomedical engineering is one direction of the growing field of medical or health care sciences, which develops the application of engineering, computer, and information sciences for the problems of health and life sciences. At each stage of medical practice, decision quality can have a significant impact. Human decision-making performance may be at the lowest level, and the problem may deteriorate as complexity increases. For these reasons, the importance of improving the medical decision support system is increasing, and the mostly use of these intelligent systems in all areas of medicine is becoming increasingly widespread. Decision-making and the use of artificial intelligence (AI) for medical decision-making is based on knowledge-intensive expert consultation systems which was introduced at the beginning of the 1970s. Meanwhile, sophisticated software environments are increasingly combining AI ideas and methods. Because at the same time they try to facilitate the task of building, validating and testing medical knowledge bases (Deperlioglu et al., 2015).

Jack Copeland describes artificial intelligence as "Artificial Intelligence (AI) is often defined as a science that does things that require intelligence when done by computers. AI has achieved some success in limited or simplified areas. However, AI last five years since its establishment, has been very slow progress and provide early optimism about reaching the level of human intelligence. It has led to the evaluation of deep difficulty of the problem." (Copeland, 2000). On the other hand, Clancey and Shortliffe provided this definition for medical AI in 1984:

Medical artificial intelligence is primarily concerned with the creation of AI programs that make diagnosis and treatment recommendations. Unlike medical applications based on other programming methods, such as statistical and probabilistic methods, medical AI programs are based on the symbolic patterns of disease entities and their relationship to patient factors and clinical findings (Clancey & Shortliffe, 1984).

In the medical field, there is too much available data, so it is difficult for physicians to work on very different situations for each encountered case. As general, there is often need for expert support during evaluation of large mass of information in order to perform the related operations. Therefore, physicians work in quite difficult conditions and they need help in their daily work. In order to facilitate physicians' work, examine large data sets, and perform any other tasks like finding similarities and differences among situations, software systems are also developed for decision support. After Lipkin and Hardy introduced the decision support system concept in 1958, Ledley and Lusted developed an approach to make inference automatically (Ledley & Lusted, 1959; Lipkin & Hardy, 1958). Such systems often use artificial intelligence components to do their tasks on evaluating big databases which is prepared by the experts. So, they are called as expert systems or knowledge-based systems. From 1950 till today, many expert systems or knowledge-based systems have been developed in different medical fields. As seen in Figure 1, there are many different types of medical tasks, which can be applied by expert systems. It is possible to list some of them as follows (Coiera, 2003).