Chapter 1
Advances in Computational Intelligence in Healthcare

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Abstract. This chapter presents an introduction to the computational intelligence in medicine as well as a sample of recent advances in the field. A very brief introduction of chapters included in the book is included.

1 Introduction

The tremendous advances in computational intelligence in recent years can be attributed to a variety of reasons such as the cheap and easy availability of computing power and so on. First were developed decision-support systems such as INTERNIST in 1970 and MYCIN in 1976. INTERNIST is classified as a rule-based expert system focused on the diagnosis of complex diseases. It has been commercialized later on as Quick Medical Reference (QMR) to support internists’ diagnosis. MYCIN was also a rule-based expert system, but applied to the diagnosis and treatment of blood infections. Created by Ted Shortliffe, this knowledge-based system mapped symptoms to diseases, led to clinical evaluation of its effectiveness, and to the development of an expert system shell EMYCIN. The evolution of artificial intelligence engendered new generations of artificial intelligence systems in medicine, expanding the range of AI methodologies in biomedical informatics, such as implementation of clinical practice guidelines in expert systems, data mining to establish trends and associations between symptoms, genetic information, and diagnoses, and medical image interpretation, to name a few. Researchers stressed the value of early systems for testing artificial intelligence methodologies.

These early systems attempted to model how clinicians reasoned. One major step was to include intelligent systems in clinical practice. Computational intelligence systems in use today are numerous. One of the first one was NéoGanesh, developed to regulate the automatic ventilation system in the Intensive Care Unit (ICU), in use since 1995. Another example is Dxplain, a general expert system for the medical field, associating 4,500 clinical findings, including laboratory test results, with more than 2,000 diseases. Some of these systems are available for routine purchase in medical supplies catalogues. Clinical outcomes have been demonstrated, through
several studies showing the effectiveness of these systems in clinical practice in terms of improving the quality of care, the safety, and the efficiency. One such example is a 1998 computer-based clinical reminder system showing evidence that a particular clinical act – discussing advance directives with a patient – was significantly better performed with the clinical reminders under evaluation than without them. More generally prescription decision-support systems (PDSS) and clinical reminder systems, often based on clinical guidelines implementation, have consistently shown clinical outcomes in several studies. However clinical outcomes are rarely measured, while process variables and user satisfaction are often measured. Obviously computer system intrinsic measures are always reported.

The successful development and deployment of expert systems also called knowledge-based systems in medicine gave tremendous incentive to the researchers to explore this field further. The brittleness of expert systems and the enormous effort involved in the development and maintenance of knowledge bases prompted researchers to look for other approaches. Computational intelligence approaches based on neural networks, fuzzy, logic, case based reasoning, evolutionary computation and the like, filled this perceived need by adding a new dimension to our quest for the application of these techniques in healthcare.

The success of computational intelligence in the healthcare is explained by the shift of focus from centering the system success on the computational performance versus the application domain performance. Indeed successful systems provide a practical solution to a specific healthcare or health research problem. The systems presenting the largest impact, such as the clinical reminders, do not have to represent a challenging conceptual or technical difficulty, but they have to fit perfectly well the clinical domain in which they are embedded – they are application domain driven – versus artificial intelligence driven.

The main purpose of this book is to bring together, under one cover, some of the important developments in the use of computational intelligence to address the challenging problems in the field of healthcare.

2 Chapters Included in the Book

This book is divided into four parts. The first part includes one chapter. This chapter introduces the book and sets a scene related to the advances in computational intelligence in healthcare.

The second part of the book includes five chapters on Artificial Agents in healthcare. Chapter 2 in the book is on Clinical Semantics. It presents the discussion on a flexible and evolving clinical practice supported by open clinical agents for both clinical professionals and patients capable of learning at a human abstraction level. Chapter 3 presents the practical applications of agents in healthcare. The challenges and the future research directions are discussed. Chapter 4 presents three cases regarding the applications of agents in healthcare. The first one is related to the gathering of patient record. The second application involves the retrieval of partial information from an emergency scene. The final application is related to the analysis of the Mobile Agent Electronic Triage Tag System. Chapter 5 is on a joint Bayesian framework for MR Brain scan tissue and structure segmentation based on distributed Markovian