

Introduction to Computational Intelligence in Healthcare

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Abstract. This chapter presents introductory remarks on computational intelligence in healthcare practice, and it provides a brief outline for each of the succeeding chapters in the remainder of this book.

1.1 Computational Intelligence and Healthcare Practice

Computational intelligence provides considerable promise for advancing many aspects of healthcare practice, including clinical disease management such as prevention, diagnosis, treatment, and follow-up, as well as administrative management of patients such as patient information and healthcare delivery to patients.

Computational intelligence is the study of the design of intelligent agents. An intelligent agent is a system that acts intelligently—it does what it thinks appropriate for its circumstances and its goal, it is flexible to changing environments and changing goals, it learns from experience, and it makes appropriate choices given perceptual limitations and finite computation.

However, computational intelligence is more than just the study of the design of intelligent agents, in particular, in application domains. It also includes the study of problems for which there are no effective algorithms, either because it is not possible to formulate them or because they are NP-hard and thus not effective in real life applications. Human being (or biological organisms) can solve such problems every day with various degrees of competence: extracting meaning from perception, understanding language, and solving ill-defined computer vision problems. Thus, the central scientific goal of computational intelligence is to understand the principles that make intelligent behavior possible, whether in natural or in artificial systems.

The central engineering goal of computational intelligence is to specify methods for the design of useful, intelligent artifacts. Indeed, the core methods of computational intelligence—neural computing, fuzzy systems, and evolutionary computing—have recently emerged as promising tools for

the development, application, and implementation of intelligent systems in healthcare practice. These computational intelligence tools have offered many advantages in automating and creating a physician-like capability in healthcare practice, as demonstrated by the chapters in this book.

1.2 Chapters Included in this Book

The remainder of this book consists of the following seven chapters: Chapter 2 by Hubal et al. reviews several synthetic character technologies pertinent to healthcare applications. Successful development of such technologies requires fusion of various computational intelligence approaches including behavior modeling, natural language interaction, and visualization. This chapter describes pros and cons among different types of synthetic character technologies, surveys the broad range of health-related applications using synthetic characters, and addresses in detail the development and use of synthetic character applications in healthcare practice. Then, the authors focus on four clinically significant applications of a synthetic character in healthcare: assessing skills in obtaining informed consent, assessing skills in dealing with trauma patients, training medical students to interact with pediatric patients, and training law enforcement officers to manage encounters with mentally ill consumers. Assessments of the validity, usability, acceptance, and effectiveness of these applications are also discussed.

Chapter 3 by Gaál et al. presents an automated menu generator of web-based lifestyle counselling systems based on a well-established branch of computational intelligence, genetic algorithms. The menu generator prepares weekly menus that provide users with personalized advice for preventing cardiovascular diseases. The data used in the menu design as derived from personal medical data combined with nutritional guidelines. A genetic algorithm is used for developing a hierarchical organization and a parallel solution for the generation of dietary menus. The authors demonstrate that the menu generator can successfully create dietary menus that satisfy strict numerical constraints on every nutritional level, indicating that such a system can be useful in practice as an online lifestyle counselling system.

Chapter 4 by Zheng et al. presents evaluation methodologies of healthcare IT applications from a user-acceptance perspective. The authors review the theoretical background of intention models that have been widely used for studying factors governing IT acceptance, with particular focus on the technology acceptance model (TAM), which is a prevalent technology adoption theory in the area of information system research. The authors describe the limitations and pitfalls of the TAM, as well as the applicability of the TAM in the professional context of physicians, with a review of available studies that have applied the TAM to technology adoption issues in healthcare practice.

Chapter 5 by Costa et al. presents the current perspectives on picture archiving and communication (PACS) systems pertinent to image-based healthcare practice. PACS-based infrastructures are currently being driven by medical applications that rely on seamless access to medical image databases. The authors review the key factors that have brought PACS technology up to its present status, and they present their web-based PACS as an example of a state-of-the-art system for cardiology services. New, demanding applications such as content based retrieval, computer-aided diagnosis, image-assisted surgery systems, and co-registration among multimodality studies are transforming PACS into a new generation. These future applications of PACS are also discussed in this chapter.

Chapter 6 by Theofilogiannakos et al. presents computational intelligence approaches for inverse electromagnetic problems of the heart. The electrocardiogram (ECG) remains a major tool for the evaluation and management of patients with cardiac disease. Although adequate for management of most patients, there are conditions in which the ECG is suboptimal. For enhancing the diagnostic value of the ECG, the inverse electromagnetic problem needs to be solved; it is defined as the determination of the heart bound from the field that it impresses on the body surface and the geometry of the thorax through which the field spreads. The authors discuss the basic principles of solving the inverse electromagnetic problem of the heart for actual body geometries, as well as the parameters that affect body surface potentials. The authors also present various computational intelligence techniques that are required for obtaining a precise solution of the inverse problem.

Chapter 6.6 by Maggi et al. is regarding a human-machine interface (HMI) for healthcare and rehabilitation. The authors present computational and biomedical approaches for designing an advanced HMI, in particular, direct brain-computer communication. A new miniaturized system is presented for unobtrusive measurement of biological signals using wearable or embedded sensors that are integrated in the advanced HMI. Based on this interface design, a practical brain-computer communication system is designed, which has the promise to provide rehabilitation and healthcare for severely disabled people.

1.3 Conclusion

Advances in computational intelligence have considerable potential to revolutionize healthcare practice. The primary goal of this book is to present some of the most recent research results regarding the applications of computational intelligence to healthcare practice. Readers will gain a wide perspective on this new and rapidly advancing field by reading the present as well as the preceding volume in this book series, *Advanced Computational Intelligence Paradigms in Healthcare 1*.

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