Chapter I

Overview of Artificial Neural Networks and their Applications in Healthcare

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Abstract

Artificial neural network (ANN) is one of the main constituents of the artificial intelligence techniques. Like in many other areas, ANN has made a significant mark in the domain of healthcare applications. In this chapter, we provide an overview of the basics of neural networks, their operation, major architectures that are widely employed for modeling the input-to-output relations, and the commonly used learning algorithms for training the neural network models. Subsequently, we briefly outline some of the major application areas of neural networks for the improvement and well being of human health.
Introduction

Following the landmark work undertaken by Rumelhart and his colleagues during the 1980s (Rumelhart et al., 1986), artificial neural networks (ANNs) have drawn tremendous interest due to their demonstrated successful applications in many pattern recognition and modeling works, including image processing (Duranton, 1996), engineering tasks (Rafiq et al., 2001), financial modeling (Coakley & Brown, 2000; Fadlalla & Lin, 2001), manufacturing (Hans et al., 2000; Wu, 1992), biomedicine (Nazeran & Behbehani, 2000), and so forth. In recent years, there has been a wide acceptance by the research community in the use of ANN as a tool for solving many biomedical and healthcare problems. Within the healthcare area, significant applications of neural networks include biomedical signal processing, diagnosis of diseases, and also aiding medical decision support systems.

Though developed as a model for mimicking human intelligence into machines, neural networks have an excellent capability of learning the relationship between the input-output mapping from a given dataset without any prior knowledge or assumptions about the statistical distribution of the data. This capability of learning from data without any a priori knowledge makes the neural network quite suitable for classification and regression tasks in practical situations. In many biomedical applications, classification and regression tasks constitute a major and integral part. Furthermore, neural networks are inherently nonlinear which makes them more practicable for accurate modeling of complex data patterns, as opposed to many traditional methods based on linear techniques. ANNs have been shown in many real world problems, including biomedical areas, to outperform statistical classifiers and multiple regression techniques for the analysis of data. Because of their ability to generalize unseen data well, they are also suitable for dealing with outliers in the data as well as tackling missing and/or noisy data. Neural networks have also been used in combination with other techniques to tie together the strengths and advantages of both techniques. Since the book aims to demonstrate innovative and successful applications of neural networks in healthcare areas, this introductory chapter presents a broad overview of neural networks, various architectures and learning algorithms, and concludes with some of the common applications in healthcare and biomedical areas.

Artificial Neural Networks

Artificial neural networks are highly structured information processing units operating in parallel and attempting to mimic the huge computational ability of the
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