Chapter 9
Using Probabilistic Neural Network to Select a Medical Specialist Agent

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ABSTRACT
The authors aim to design the Multi-agent system, in which the software agents interact with each other to diagnose a disease and decide the treatment plan(s). In this chapter, the authors present a novel approach of applying Probabilistic Neural Network (PNN) to classify the childhood disease and their respective medical specialist. Normally this classification is performed by the pediatricians. The system that has been presented here, imitates the behavior of a pediatrician while selecting super specialist doctor. This decision making mechanism will be embedded in an agent called Intelligent Pediatric Agent. To design the PNN, a database consisting of 104 records has been gathered. It includes 17 different sign symptoms and based on their values, one of the five super specialists is selected. A Back propagation Neural Network (BPNN) has also been designed to compare the results produced by the PNN and it is found that PNN is more promising.

INTRODUCTION
In medical domain, there are conditions which demand participation of different super specialists to handle the situation. A specialist has to decide whom to consult for advice. For instance, if a child is suffering from heart stroke as well as dyspnoea (see Appendix A) then, the pediatrician may decide to consult the cardiac surgeon. Medical specialists
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face such circumstances quite frequently and they tend to learn this decision making through their experiences and keep updating their medical knowledge.

There are number of researchers around the world, from various streams viz. operation research, computer science, mathematics and statistics, trying to design a system that can emulate the behavior of any specialist for such decision making. In the next section, we shall discuss some of the decision making systems. These systems are primarily based on Neural Networks.

This chapter is a part of the Multi-agent system described by Devi (2005). Let us briefly describe the terms used for healthcare professionals in India. A General Doctor (GD) is one who holds basic medical degree like MBBS and is usually positioned at the rural areas to provide general medical treatments. A specialist doctor/physician holds higher postgraduate degree (like M.S., M.D.) after his/her graduation. These specialists are posted at the district level and serve as referral centers. Super Specialist physician holds further specialization degrees (like DM, MCh) in medical or surgical fields and are usually placed at the research institutes and the laboratories.

For each level of healthcare center, we develop the agents to assist the doctors. The basic definition and attributes of an agent are described by Bradshaw (1997). The agent that supports GD is termed as User Agent (UA), and the agent that behaves as a pediatrician is named as Intelligent Pediatric Agent (IPA). During normal diagnosing procedure, UA and IPA communicate with each other (Mago & Devi, 2007). But in some cases the IPA seeks help from the Super Specialist Agent (SSA) to diagnose the disease and then to decide the treatment plan. The situation involves the decision making on the part of the IPA to select an appropriate SSA. This decision making is very crucial for the effectiveness of healthcare delivery system. Hence, the aim of this chapter is restricted to decide which SSA is to be contacted as per the given sign symptoms provided by the UA. To solve this complex problem, Probabilistic Neural Network (PNN) and Back Propagation Neural Network (BPNN) based decision making system is developed.

In order to understand the whole system, an abstract view of the system is described in the subsequent sub section.

Abstract View

The Multi Agent System (MAS) is a system in which the agents are connected in an intelligent fashion so as to achieve their pre-defined objectives (Wooldridge, 2002). These agents interact with each other, according to their capabilities, and try to produce the desired result. Moreover, there may or may not be any human interference as the intelligence is supposed to be embedded in them (as a software code).

There are numerous papers describing usage of MAS in healthcare. All these papers are domain specific; for instance, they provide assistance to patients for the appointments or support the doctors in diagnosing some specific diseases. They are also used to give advice to health care personnel dealing with the traumatized patients, and to improve vaccination rates, etc. All these systems are aimed at improving the medical delivery system. Similarly, we also aspire to create an agent based environment to provide medical assistance for childhood diseases.

Figure 1 depicts an abstract view of the system wherein, the UA, IPA and the SSA are shown. The UA supplies the sign-symptoms; the IPA using its knowledge tries to provide the assistance by providing treatment plan(s). In certain cases, the IPA finds it difficult to diagnose a disease, it utilizes the PNN and the BPNN based decision making system to decide the SSA. Mago (2007), describes a system based on Bayesian Network (BN) to handle the same problem, but it lacks future enhancement. The BN based systems are inflexible in nature, i.e. one needs to re-work on the prior probabilities altogether if there is any
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