

Chapter 7.23

An Immune Systems Approach for Classifying Mobile Phone Usage

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ABSTRACT

With the recent introduction of third generation (3G) technology in the field of mobile communications, mobile phone service providers will have to find an effective strategy to market this new technology. One approach is to analyze the current profile of existing 3G subscribers to discover common patterns in their usage of mobile phones. With these usage patterns, the service provider can effectively target certain classes of customers who are more likely to purchase their subscription plans. To discover these patterns, we use a novel algorithm called Artificial Immune Recognition System (AIRS) that is based on the specificity of the human immune system. In our experiment, the

algorithm performs well, achieving an accuracy rate in the range of 80% to 90%, depending on the set of parameter values used.

INTRODUCTION

A sample dataset of 24,000 mobile phone subscribers is used for this study, in which 20,000 records are known to be second generation (2G) network customers and the remaining are 3G network customers. The target field is the customer type (2G/3G). About 75% of the dataset have the target field available and are used for training purposes; while the remaining quarter of the dataset has a missing target field and are meant for prediction.

The objective of the classification is to correctly predict as many 3G customers as possible from the prediction set and obtain insights on the characteristics of the existing 3G customers to be used as reference for their marketing strategy.

To perform this task, we use a novel algorithm called the Artificial Immune Recognition System (AIRS) proposed by Watkins, Timmis, and Boggess (2004), which is based on the processes in biological immune systems.

OVERVIEW OF AIRS

The Human Immune System

The function of the human immune system is to identify and destroy foreign invaders (antigens) which are possibly harmful to the body. It does this through an innate and nonspecific response (mediated by macrophages) and also with an adaptive and specific response (mediated by lymphocytes). An innate response is not directed towards any specific antigens, but against any invaders that enter the body. The adaptive response is mediated mainly by two types of lymphocytes, B-cells and T-cells. The AIRS approach is modeled based on the behavior of B-cells, hence only the behavior of B-cells will be described here. On the surface of each B-cell are receptors that are capable of recognizing proteins of a specific antigen. Through costimulation and suppression of each other, similar B-cells form networks that can recognize similar antigens.

When antibodies on a B-cell bind with an antigen, the B-cell becomes activated and begins to proliferate. Thus, it means that only B-cells which are able to recognize the invading antigen will proliferate and produce clones (a process known as clonal selection). New B-cell clones are produced which are exact copies of the selected B-cells, but then undergo somatic hyper-mutation to generate a wider range of antibodies, so as to be able to remove the antigens from the body. A

small quantity of B-cells remains in the system after the invading antigens have been removed. These B-cells act as an immunological memory to allow the immune system to produce a faster response to similar antigens that might re-infect the body in the future.

The AIRS Algorithm

Processes in biological immune systems have inspired the design of AIRS. An artificial recognition ball (ARB) is used to represent a set of *identical* B-cells. The ARBs in the system will compete for B-cells in order to survive (in the evolutionary sense); therefore an ARB with no B-cell will be removed from the system. A fixed number of B-cells are allowed in the system, so the least stimulated ARB will not be able to get any B-cells, and will therefore be removed from the system. We will at times refer to a B-cell as an ARB, only because an ARB is simply a representation of many B-cells of the same specification. When a new training data record (antigen) is presented to the system, each B-cell is cloned in proportion to how well it has matched the antigen according to the principle of clonal selection. The mutation rate used in the cloning process is *inversely* proportional to how well it matches the antigen. During the mutation process, new clones undergo a process of somatic hyper-mutation, where each attribute of the clones is varied slightly to provide a wider range of response to the training data record. Eventually, the clone with the best fit to the presented antigen will be retained as a memory cell. The memory cells are retained in the system to provide faster response should the system become re-infected with similar antigens.

AIRS relies heavily on finding the similarity (or difference) between a pair of customer records, therefore a proper distance measure needs to be defined. Hamaker and Boggess (2004) conducted a survey of distance measures that can be used in conjunction with AIRS. Based on this survey, we use the *heterogeneous value difference metric*

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