Complementary Dual Detectors
for Effective Classification

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Abstract. In this paper we introduce a method of using a pair of complementary negative detectors. When both self and non-self antigens are given, we can build a pair of complementary negative detectors using self and non-self antigens respectively and augment the results given by the detectors. When self or non-self antigens change over time, antibodies of a negative detector that gives a false positive error for the change, are used to fill the holes of the other negative detector giving a false negative error. They try to adapt to the change in complementary ways.

1 Introduction

Natural immune systems have the ability to adaptively learn, to memorize, and to recognize self and non-self to defend the body from possibly harmful foreign pathogens. An artificial immune system (AIS) is a computational system based on the metaphors of the natural immune system [1]. Recently, there has been a lot of researches on AIS and its applications [1, 5, 8, 10, 11].

Negative detectors are pattern matching systems that detect the changes of protected strings by storing strings negatively selected with respect to the strings to be protected [2]. Since the introduction of negative detectors, interest in negative detection has been growing, especially for applications in which noticing anomalous patterns is important, like computer security and computer virus detection [5].

Chao and et al. [3] outlined features of an information immune system (IIS) that could help people deal with the glut of data. As discussed in [3], negative detectors and negative selection could be used to censor unwanted information. Unlike anomaly detection or change detection, in most information systems, we can assume we have both self and non-self examples, for examples, filtering news group articles or emails.

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In this paper we introduce a method of using a pair of complementary negative detectors by using both self and non-self antigens. Antibodies of a negative detector that gives a false positive error, can be used to fill the holes that the antibodies of the other negative detector do not detect, thus giving a false negative error.

2 Related Works

2.1 Immune Systems

Immunity is composed of both non-specific (innate immunity) and specific components (adaptive immunity). They work together in an interactive and cooperative way resulting in a more effective way than either could be alone. The adaptive immunity is of great interest in most AISs [10].

Adaptive immune system has four distinctive properties: specificity, diversity, memory, and self/non-self recognition. Functionally, an immune response consists of two interrelated events: recognition of antigen and response to that antigen, generation of effector cells and molecules. Antigen-presenting cells, B lymphocytes, and T lymphocytes are the primary cells of the immune response. For basic immune system information, read [10].

In the immune system, T cells go through a maturation process in the thymus. In the thymus T cells are censored against the normally occurring peptide patterns of the body(self). T cells that react with self are deleted in the thymus(negative selection). Only those T cells that survive this censoring operation are allowed to mature [4].

Clonal selection theory gives a model to explain the adaptive immunity [10]. On the surface of B cells, there are surface receptors that can bind to an antigen. When exposed to an antigen, a small group of B cells which bind to the antigen recognizes it. Coupled with a costimulatory signals from helper T cells, these B cells are stimulated. This simulation causes the B cells to proliferate and mature into effector cells(plasma cells and memory cells). The plasma cells secret antibodies specific for the antigen and often the secreted antibodies have higher affinity to the antigen(affinity maturation). The memory cells do not secret antibodies, but when they encounter the same antigen again, they proliferate more rapidly and mature into effector cells producing high affinity antibodies. During proliferation, the B cells go through the hyper somatic mutation. The hyper somatic mutation gives chances to develop B cells that can produce higher affinity antibodies to the antigen. However, the mutation may occur to develop B cells that are reactive to self antigens. These B cells go through a negative selection. They are either destroyed, inactivated or they go through receptor editing. B cells then go through a positive selection, only those B cells that have high affinity to the antigen are selected from cell death.

2.2 Negative Detectors

Antibodies that bind to antigens are called the complementary antibodies. Antigens can be represented as the complementary antibodies in a shape space [10].