

Preface

In the monograph at hand, we explore theoretical and experimental justification of the use of *Artificial Immune Systems* as a *Machine Learning Paradigm*. Our inspiration stems from the fact that vertebrates possess an immune system, consisting of highly complex biological structures and processes, that efficiently protect them against disease. A biological immune system is capable of detecting a wide variety of agents, including viruses, parasites and cancer cells, and distinguishing them from the organism's own healthy tissue. This is achieved in the *adaptive immune* subsystem of the immune system.

More specifically, the adaptive immune (sub)system continuously performs a self/non-self discrimination process. In machine learning terms, the adaptive immune system addresses a *pattern classification problem with extreme class imbalance*. Over the recent years, classification problems with class imbalance have attracted the interest of researchers worldwide. However, little attention has been paid so far to the use of artificial immune systems in addressing classification problems with a high or extreme degree of class imbalance.

We address the fundamental problems of pattern recognition, i.e. (*clustering, classification* and *one-class classification*), by developing artificial immune system-based machine learning algorithms. We measure the efficiency of these algorithms against state of the art pattern recognition paradigms such as *support vector machines*. Particular emphasis is placed on pattern classification in the context of the class imbalance problem. In machine learning terms, we address degenerated binary classification problems where the class of interest to be recognized is known through only a limited number of positive training instances. In other words, the target class occupies only a negligible volume of the entire pattern space, while the complementary space of negative patterns remains completely unknown during the training process. A practical application of this approach may be found in the design of recommender systems that require the use of only positive examples of the preferences of their users. We show, through application on real data, that artificial immune systems address such problems efficiently.

The general experimentation framework adopted throughout the current monograph is an open collection of one thousand (1000) pieces from ten (10) classes of

western music. This collection has been extensively used in applications concerning music information retrieval and music genre classification. The experimental results presented in this monograph demonstrate that the general framework of artificial immune system-based classification algorithms constitutes a valid machine learning paradigm for clustering, classification and one-class classification.

In order to make the book as self-contained as possible, we have divided it into two parts. Specifically, the first part of the book presents machine learning fundamentals and paradigms with an emphasis on one-class classification problems, while the second part is devoted to biological and artificial immune systems and their application to one-class classification problems. The reader, depending on his/her previous exposure to machine learning, may choose either to read the book from its beginning or to go directly to its second part. It is our hope that this monograph will help graduate students, researchers and practitioners to understand and expand artificial immune systems and apply them in real-world problems.

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