Chapter V
Applications of Artificial Immune Systems in Agents

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ABSTRACT

Artificial Immune Systems (AIS) have been widely used in different fields such as robotics, computer science, and multi-agent systems with high efficacy. This is a survey chapter within which single and multi-agent systems inspired by immunology concepts are presented and analyzed. Most of the work is usually based on the adaptive immune response characteristics, such as clonal selection, idiotypic networks, and negative selection. However, the innate immune response has been neglected and there is not much work where innate metaphors are used as inspiration source to develop robotic systems. Therefore, a work that involves some interesting features of the innate and adaptive immune responses in a cognitive model for object transportation is presented at the end of this chapter.
INTRODUCTION

In this chapter, a revision of different applications in agents inspired by the vertebrate immune system is developed. Among different applications, there are cases where artificial immune systems (AISs) have been used for either single or multiple-agents. Some applications like computer vision, agent navigation or agent cognitive models have been designed and developed.

Most of applications are inspired by the adaptive immune response but there has not been much work including metaphors of the innate immune response.

Along this chapter different projects where innate and adaptive immune responses are emulated will be presented.

The main goal of this chapter is to present different works where AISs are applied to robotics and multi-agent systems. At the end, three projects that implement immune inspired multi-agent systems are presented; the first one is a prospective project that uses cognitive models based on immunology for object recognition and classification in a multi-agent system where all the agents have similar features. The second work deals with adaptive strategies in robot-soccer using metaphors from immunology and the last work presents a cognitive model inspired by the innate and adaptive immune responses for object transportation. The prospective project is being developed in the Intelligent Systems Research Laboratory (LISI) at National University of Colombia and the last two ones were also developed in LISI and recently presented on international conferences.

BACKGROUND

AISs have been used in robotics since middle 90’s, where Akio Ishiguro, S. Ichikawa and Yoshiki Uchikawa (Ishiguro et al., 1994) developed a gait acquisition of a 6-legged walking robot using immune networks. Later other works developed by Ishiguro et al involved concepts of biological immune system for robotic mechanisms in single-agent and multi-agent systems (Ishiguro et al., 1997), (Watanabe et al., 1998).

Among the projects that dealt with single-agent systems, AISs have been widely used for navigation in unknown environments. In the work by Whitbrook (Whitbrook, 2005), an idiotypic network for mobile robot control is proposed. D.A. Romero and F. Nino (Romero & Niño, 2006), proposed an immune cognitive model combined with neural networks for autonomous navigation. In both cases, the models were inspired by the adaptive immune response. Another work in the field of single-agent systems was done by Mark Neal (Neal et al., 2006). In this work, an artificial innate immune response was used in order to supervise and control the internal state of an agent.

In the field of multi-agent systems based on immunology, several works have been applied to cooperation among agents, for example, the work by W. Lee and K. B. Sim (Lee & Sim, 1997), which is based on metaphors from swarm systems and immunology in order to solve different tasks in a distributed autonomous robotic system (DARS). In another work developed by Srividhya Sathyanath and Ferat Sahin (Sathyanath & Sahin, 2002), an artificial immune system is applied to a mine detection problem. Among the multi-agent system applications, one of the most popular problems is robot-soccer; however, no much work based on immunology metaphors in this field has been carried out so far. In the work by Guan-Chun Luh, Chun-Yin Wu and Wei-Wen Liu (Luh et al., 2006, p. 76), they implemented an artificial immune system, specifically; they used an idiotypic network proposed by Jerne, in order to build up strategies for multi-agent systems.

In the multi-agent systems mentioned above, metaphors from innate response are not considered, but in the work by Chingtham Tejbanta Singh, and Shivashankar B. Nair (Singh & Shivashankar, 2005, p. 308), both innate and adaptive responses are used in order to make an outer robot help an inner robot to always follow a predefined path.
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