Chapter V

Multi–Objective Optimization Using Artificial Immune Systems

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ABSTRACT

The human immune system (HIS) is a highly evolved, parallel and distributed adaptive system. The information processing abilities of HIS provide important aspects in the field of computation. This emerging field is referring to as the Artificial Immune Systems (AIS). In recent years, AIS have received significant amount of interest from researchers and industrial sponsors. Applications of AIS include such areas as machine learning, fault diagnosis, computer security and optimization. In this chapter, after surveying the AIS for multi-objective optimization, we will describe two multi-objective optimization algorithms using AIS, the Immune Dominance Clonal Multi-objective Algorithm (IDCMA), and the Nondominated Neighbor Immune Algorithm (NNIA). IDCMA is unique in that its fitness values of current dominated individuals are assigned as the values of a custom distance measure, termed as Ab-Ab affinity, between the dominated individuals and one of the nondominated individuals found so far. According to the values of Ab-Ab affinity, all dominated individuals (antibodies) are divided into two kinds, subdominant antibodies and cryptic antibodies. And local search only applies to the subdominant antibodies while the cryptic antibodies are redundant and have no function during local search, but they can become
INTRODUCTION

The human immune system (HIS) is a highly evolved, parallel and distributed adaptive system. The information processing abilities of HIS provide important aspects in the field of computation. This emerging field is referring to as the Immunological Computation, Immunocomputing or Artificial Immune Systems (AIS) (Tarakanov & Dasgupta, 2000) which can be defined as computational systems inspired by theoretical immunology and observed immune functions, principles and models, which are applied to problem solving (de Castro & Timmis, 2002a). In recent years, AIS have received a significant amount of interest from researchers and industrial sponsors. Some of the first work in applying HIS metaphors was undertaken in the area of fault diagnosis (Ishida, 1990). Later work applied HIS metaphors to the field of computer security (Forrest, Perelson, Allen, & Cherukuri, 1994), which seemed to act as a catalyst for further investigation of HIS as a metaphor in such areas as Anomaly Detection (Gonzalez, Dasgupta, & Kozma, 2002), Pattern Recognition (Carter, 2000; Timmis, Neal, & Hunt, 2000; White, & Garrett, 2003), Job Shop Scheduling (Hart & Ross, 1999; Coello Coello, Rivera, & Cortes, 2003), Optimization (de Castro & Von Zuben, 2002; Jiao & Wang, 2000) and Engineering Design Optimization (Gong, Jiao, Du, & Wang, 2005; Hajela, Yoo, & Lee, 1997).

In this chapter, after surveying the AIS for optimization, we will describe two multi-objective optimization algorithms using AIS, the Immune Dominance Clonal Multi-objective Algorithm (IDCMA) and the Nondominated Neighbor Immune Algorithm (NNIA). IDCMA is unique in that its fitness values of current dominated individuals are assigned as the values of a custom distance measure, termed as Ab-Ab affinity, between the dominated individuals and one of the nondominated individuals found so far. According to the values of Ab-Ab affinity, all dominated individuals (antibodies) are divided into two kinds, subdominant antibodies and cryptic antibodies. And local search only applies to the subdomi-
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