Understanding the Semantics of the Genetic Algorithm in Dynamic Environments

A Case Study Using the Shaky Ladder Hyperplane-Defined Functions

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Abstract. Researchers examining genetic algorithms (GAs) in applied settings rarely have access to anything other than fitness values of the best individuals to observe the behavior of the GA. In particular, researchers do not know what schemata are present in the population. Even when researchers look beyond best fitness values, they concentrate on either performance related measures like average fitness and robustness, or low-level descriptions like bit-level diversity measures. To understand the behavior of the GA on dynamic problems, it would be useful to track what is occurring on the "semantic" level of schemata. Thus in this paper we examine the evolving "content" in terms of schemata, as the GA solves dynamic problems. This allows us to better understand the behavior of the GA in dynamic environments. We finish by summarizing this knowledge and speculate about future work to address some of the new problems that we discovered during these experiments.

1 Introduction

It has been speculated that the genetic algorithm (GA) makes use of higher levels of content like building blocks and their formalized descriptions in the form of schemata [1]. However, this hypothesis has been hard to substantiate because researchers only observe performance-related measures, like fitness of the best individuals, and low-level descriptions of the GA population, like bit-wise diversity measures. In order to understand the GA in more depth researchers have created the hyperplane-defined functions (hdfs) [2] and the shaky ladder hyperplane-defined functions (sl-hdfs), for dynamic environments [3]. The hdfs (and the sl-hdfs) are designed to represent the way the GA searches by combining building blocks, hence they are appropriate for examining the behavior of the GA at a higher level than just that of bitwise operations and performance. Moreover, the sl-hdfs reflect a large class of problems where there is a global unchanging optimum which has regularly occurring subproblems, but the rewards for those subproblems change in time [4]. Thus the sl-hdfs are a good