The Defined Cliffs Variant in Dynamic Environments

A Case Study Using the Shaky Ladder Hyperplane-Defined Functions

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ABSTRACT

The shaky ladder hyperplane-defined functions (sl-hdfs) are a test suite utilized for exploring the behavior of the genetic algorithm (GA) in dynamic environments. This test suite can generate arbitrary problems with similar levels of difficulty and it provides a platform for systematic controlled observations of the GA in dynamic environments. Previous work has found two factors that contribute to the GA's success on sl-hdfs: (1) short initial building blocks and (2) significantly changing the reward structure during fitness landscape changes. Therefore a test function that combines these two features should facilitate even better GA performance. This has led to the construction of a new sl-hdf variant, "Defined Cliffs," in which we combine short elementary building blocks with sharp transitions in the environment. We examine this variant with two different levels of dynamics, static and regularly changing, using four different metrics. The results show superior GA performance on the Defined Cliffs over all previous variants (Cliffs, Weight, and Smooth). Our observations and conclusions in this variant further the understanding of the GA in dynamic environments.

TRACK: Genetic Algorithms

Categories and Subject Descriptors

F.2. [**Analysis of Algorithms**]: Misc. I.2.8 [**Artificial Intelligence**]: Search

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1. INTRODUCTION

To facilitate controlled observations on the GA in dynamic environments, a test suite of problems is necessary. A test suite allows us to control the inputs to the system and define metrics for the outputs. Moreover, the more parameters of the system (e.g. time and severity of shakes, difficulty of the problem) that are controllable, the easier it is to test explanations for the observed behavior. The test functions that we use to explore the GA in dynamic environments, the shaky ladder hyperplane-defined functions (sl-hdfs) [3], are a subset of the hdfs [2]. Holland created these functions in part to meet criteria developed by Whitley [9]. Other test suites for EAs in dynamic environments exist, such as the dynamic knapsack problem, the moving peaks problem and more [1], but these other suites are primarily concerned with comparing absolute performance of different EA variants. The hdfs, on the other hand, are designed to represent the way the GA searches by combining building blocks, and thus are well suited for understanding the operation of the GA [4] [5] [6] [8]. Previously, work on sl-hdfs [4] [5] [6], has presented three ways of constructing the sl-hdfs (called "variants") by manipulating the way building blocks are constructed, combined, and changed. These different variants were called the Cliffs, Weight, and Smooth variants. Here we introduce a new variant which we call Defined Cliffs. This variant has defined short building blocks but combines them in complex and unrestricted ways. We begin by reviewing the sl-hdfs and the previous three variants. We then describe the new variant, and compare it to the previous variants using a variety of measurements. We examine the behavior of the GA on this new variant, discuss the results and draw some conclusions.

2. SHAKY LADDER HYPERPLANE-DEFINED FUNCTIONS AND VARIANTS

In this section we describe the sl-hdfs and the variants we will be exploring. For an in-depth explanation of the construction of the sl-hdfs see [6]. As mentioned, the sl-hdfs are a subset of Holland's hdfs [2], however, to make the hdfs usable as a test platform in dynamic environments we place three restrictions on the hdfs: (1) The Unique Position Condition (UPC), which requires that all elementary schemata contain no conflicting bits; (2) The Unified Solution Condition (USC), which guarantees that all of the specified bits in the positive-valued elementary level schemata must be present in the highest level schema, and that all intermediate schema are a composition of lower level schema; and (3) The Limited Pothole Cost Condition (LPCC), which states