Multi-Dimensional Parallel Genetic Algorithm using OpenMP

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(Dated: July 1, 2014)

Abstract

We present a detailed description of a multi-dimensional genetic algorithm implemented in C++11 and the OpenMP library. The use of the OpenMP library allows for the algorithm to be implemented using parallel processing and hence operate in an extremely efficient manner. The algorithm also offers a considerable degree of flexibility in allowing the user to experiment with different cross-over operators. Results are presented for several multi-dimensional functions and in comparison to more common genetic algorithms available.

Keywords: Genetic Algorithms, Parallel Algorithms, OpenMP

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INTRODUCTION

GENETIC ALGORITHM COMPONENTS

Chromosome Builder

The Chromosome Builder is responsible for creating a family of chromosomes from the domain space chosen by the user. Each chromosome is represented as a dynamic array of *boolean* values. Although C++ provides a bitset data structure, as part of its Standard Template Library (STL), it does not have the flexibility of determining the length of a bitset at runtime. Therefore, an array was chosen which could be dynamically altered (std::vector) to map to the user supplied domain space. The length of the chromosome is bound by the domain space, for a given dimension of range [a:b] and a precision, P we have

$$2^{N_i-1} < (b-a) \cdot 10^P \leq 2^{N_i} \tag{1}$$

where N_i is the apportioned length of the chromosome for a given dimension. The total length of the chromosomes is then,

$$N_{length} = \sum_{i=1}^{N_{dim}} N_i \tag{2}$$

The OpenMP library allows for each dimension to be computed independently of the others, with a master thread combining all the lengths into a total length. The total number of chromosomes can be set by the user with a default value of 75, the initial values of each chromosome are randomly chosen.