COS 710 Assignment 3 Report

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Introduction

The one-dimensional bin packing problem essentially aims to pack a collection of objects into well defined regions called bins, such that they don't overlap. Mathematically this can be defined as:

Given a bin capacity $C > 0$ and a list of objects $\{p_1, p_2, .., p_n\}$, allocate all the items to bins such that the all the items are packed using the smallest number of bins. Each p_i has a size s_j, such that $0 \leq s_j \leq C$. i.e. none of the objects are too big to fit in a bin.

The following sections detail the choice of representation for the chromosomes, i.e., the encoding of possible solutions, the fitness function used to evaluate the strength of a given solution, the genetic operators used, the empirical results of the genetic algorithm implemented to solve the aforementioned problem and finally the evaluation of the ruggedness of the fitness landscape.

Chromosome

A suitable representation for the chromosomes is essential in Evolutionary Computation as it enables the distinction among the possible solutions that may be found. If such a representation were not sufficient, then little to no evolution would take such that future generations would take an arbitrary long time to converge on an optimal solution if any.

For this particular reason, I have chosen to encode a solution, i.e., a chromosome in the population, as a vector of integers v, where each such vector component $v_j \leq C$. The cardinality of v, is equal to the number of bins required to pack all the items and is denoted as $|v|$.

Fitness Function

The fitness function maps a chromosome representation of a potential solution to a scalar quantity, and thus is a means of measuring the quality of a solution.
To evaluate the fitness of an individual in the population, the following fitness function was used:

$$f(v) = \sum_{j=1}^{|v|} \frac{C}{v_j} \text{ , where}$$

▸ v is the vector encoding of a solution (chromosome),
▸ v_j is the number of items contained by the j-th bin, and
▸ C is the capacity of a bin (all bins have the same capacity).

For this particular problem, a good solution, an optimal solution is one in which $f(v)$ is minimal for all possible solution encodings.

Genetic Operators

‣ Selection Operators:

Tournament Selection: The best two individuals from either tournament are selected.

‣ Reproduction Operators:

Crossover: Uniform crossover is used.

Mutation: Gaussian Mutation is used.

Empirical Results

Fitness Landscape Evaluation