An Adaptive Simplex Genetic Algorithm

Linyu Yang
Department of Computer Science
Texas A&M University
College Station, TX 77843-3112

John Yen
Department of Computer Science
Texas A&M University
College Station, TX 77843-3112

Abstract

In this paper, based on our previous research on simplex genetic algorithm, we put forward an adaptive approach for the self-adaptation of the percentage of simplex. According to the average fitness of those individuals generated by simplex operator in a certain generation, a set of rules is designed to adaptively adjust the simplex percentage within a certain range. This helps the algorithm always run at a relative optimized simplex percentage. We test our approach on both testbed problems and a real metabolic modeling problem. The results are satisfactory.

1 SIMPLEX-GA

Simplex method is a local search technique that uses the current data set to determine the promising direction of search. We developed a simplex GA hybrid approach by introducing the simplex method as an additional operator in the genetic algorithm. (Yen et al. 1998). During the reproduction step of each iteration, the hybrid approach applies the simplex method to a top percentage of the population to produce new candidate solutions in the next generation. The rest of the new population are generated using the GA's reproduction scheme (i.e., selection, crossover, and mutation). Before the run, we should specify the simplex percentage, which corresponds to the percentage of population to which the simplex is applied. For example, a 50% simplex-GA applies the simplex to the top half population.

2 SELF-ADAPTATION OF SIMPLEX PERCENTAGE

Running a genetic algorithm entails setting a number of parameter values. Recent years many researchers have developed effective ways to adaptively adjust the running parameter values (crossover probability, mutation rate, etc.) according to GA's performance during the course of a run. In our simplex GA hybrid, since simplex operator is a critical operator, therefore we focus on how to adaptively adjust the simplex percentage in our research.

Our adjusting is based on the observed performance as the run takes place. At the very beginning an initial simplex percentage is set. The hybrid GA will use this percentage to generate the next generation from the initial population. By measuring the effect of simplex operator with that initial percentage after the new population is generated, that percentage will be increased / decreased within a certain range accordingly. The changed simplex percentage will be used to generate the next generation. This process iterates until the end of the program. The measure of the effectiveness of simplex operator is done by comparing the average fitness of those individuals generated by simplex operator in a certain generation with the average fitness of the whole population of that generation.

Since simplex operator is often in effective, to avoid the simplex percentage increases too fast, we add one rule to stochastically increase the simplex percentage with the probability $P_+ = \exp(\Delta f)$
where $\Delta f=(fitness_{simplex}-fitness_{whole}) / fitness_{whole}$

3 RESULTS

We have applied our proposed approach on sin maximization problem and a real metabolic modeling problem. We compared the results between adaptive simplex GA and fixed-percentage simplex GA. For the first problem, adaptive approach outperforms its alternative on the convergence rate with the same quality of final solution. For the second problem, adaptive approach outperforms its alternative on both the convergence rate and the final fitness. The following table shows the average fitness comparison between two approaches of six runs on metabolic modeling problem:

Table 1 Average fitness comparison for six runs

Approach \ Trials	Initial	5000	12000 (final)
Adaptive simplex GA	45.26	0.0599	0.035
45% simplex GA	45.26	9.8206	9.685

References

Yen, J., Liao, J.C., Lee, B., and Randolph, D. (1998) "A Hybrid approach to modeling metabolic systems using a genetic algorithm and simplex method," *IEEE Trans. on Systems, Man, and Cybernetics-Part B: Cybernetics*, 28:173-191.