A Synthesis of Optimal Stopping Time in Compact Genetic Algorithm Based on Real Options Approach

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ABSTRACT

This paper introduces the real options approach, which is an evaluation tool for investment under uncertainty, to analyze optimal stopping time in genetic algorithms. This paper focuses on the simple model of EDAs named the compact genetic algorithm. This algorithm employs the probability vector as a model that scales well with the problem size. We analyze optimal stopping time of trap problems and propose an optimal stopping criterion as a decision contour. The proposed criterion also provides a stopping boundary, where termination is optimal on one side and continuation is on the other. This region suggests when it is worth continuing the algorithm and helps save computational effort by stopping early. Moreover, when the reset method is applied, the algorithm can reach a higher solution quality. The proposed technique can also be applied to analyze other problems.

Categories and Subject Descriptors

I.2.8 [**Artificial Intelligence**]: Problem Solving, Control Methods, and Search – *Control theory*

General Terms

Algorithms, Management, Economics, Experimentation

Keywords

Genetic Algorithms, Real Options, Optimal Stopping Time

1. INTRODUCTION

Stopping criterion is a common setting condition in many learning algorithms. However, identifying a suitable criterion is critical to a solution quality. Generally, an algorithm terminates when it reaches an upper limit on the number of generations or evaluations. This paper presents a different approach to analyze an optimal stopping time by using the real options approach. The optimal stopping problem is an important class of a stochastic control problem that arises in economics and finance, such as finding optimal exercise rules for financial options. Fortunately, there are similarities between the problem of finding an optimal stopping time in genetic algorithms and finding optimal exercise rules for financial options. The concept behind this technique is that finding an optimal stopping time of the algorithm can be viewed as deciding when to exercise a call option. To explore this approach, Rimcharoen et al. [1] propose finding optimal stopping time in the compact genetic algorithm. Using this special class of genetic algorithms, the compact genetic algorithm [2], the underlying uncertainty can be viewed as a probability distribution. This distribution automatically captures the underlying uncertainty of the problem, which can be simulated to obtain an evolutionary process of the algorithm. This forms a basis in using the real options valuation in order to determine when it is worth stopping the algorithm.

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2. OPTION-BASED METHODOLOGY

Using the real options analysis, we derive some contours, or so called exercise region, that suggest boundaries of preference fitness values in each generation. If the solution's models do not satisfy these bounds, the algorithm should decide to stop. Only appropriate candidate should continue. We also substantiate the proposed criterion with an analysis on scalability of a trap problem. We formulate a generic stopping function with the exercise regions that scale well, and show that the new stopping policy can help save computational effort when stopping early and that the evolutionary process reaches a higher solution quality when the reset method is incorporated.

In case of early stopping, we employ the stopping region as a policy to stop running the algorithm. It suggests that it is unlikely to achieve a good solution with the fitness value that falls within this stopping region. Thus, the algorithm should stop and save a computational effort when the fitness value is unlikely to lead to the optimal solution.

To improve the solution quality, we suggest reversing the probability vector when the fitness falls into the stopping region (instead of stopping early). Each dimension of the probability vector is reversed by 1 minus probability in that dimension. Using this approach, the algorithm can explore the solution in the counterpart and provides an opportunity to search more candidate solutions when the model seems to go bad. The proposed methodology would be more beneficial to a harder problem. Experiments using the boundary function estimated from 3 and 4 trap shows that we can reach an optimal solution of some copies of 5-trap.

3. REFERENCES

[1] Rimcharoen, S., Sutivong, D. and Chongstitvatana, P. Real options approach to finding optimal stopping time in compact genetic algorithm, In *Proceedings of IEEE International Conference on Systems, Man, and Cybernetics*, 2006.

[2] Harik, G. R., Lobo, F. G. and Goldberg, D. E. The compact genetic algorithm, *IEEE Trans. on Evolutionary Computation*, 1999, 3(4): 287-297.