Comparison of Optimum Mutation Rate for Continuous and Binary Genetic Algorithms

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Abstracts

The genetic algorithm (GA) has been applied to many applications of electromagnetic optimization. Based on the complexity of a cost function and the number of a cost function calls, the convergence speed of a GA can be different. The number of cost function calls can be reduced by using an optimum population size and a mutation rate. The optimum mutation rate and population size of GAs have been studied for the binary and continuous parameter GAs. Recent studies show that a small population size with a high mutation rate converges faster than a large population size with a low mutation rate. The reference written by Back suggested a proper mutation rate (1/L) for a GA using binary parameters, where L is the number of bits in a binary chromosome. It is not an optimum mutation rate for all the binary GAs, but it gives rough range of optimum mutation rate generally.

While a continuous GA uses the continuous N parameters in a chromosome directly, a binary GA uses the encoded binary $N \times K$ bits in a chromosome where K is the number of bit per parameter. In a population size (P), possibly $N \times P$ parameters can be mutated in the continuous GA, and there are $N \times K \times P$ bits can be mutated with a give mutation rate (M%). While numbers of mutated parameter of the continuous GA will be ($N \times P \times M\%/100$), the number of mutated bits of binary GA will be ($N \times K \times P \times M\%/100$) bits. There are different numbers of mutated parameters in the GAs due to the different representations with a given mutation rate. Therefore, the mutation rate of a continuous GA should be different from a binary GA with the mutation process explained above.

It is nice to use continuous GA since there is no encoding and decoding processes and it allows a GA to save time to converge without the encoding and decoding process. Based on the statistical analysis among the GAs using binary and continuous representations and simulation of GAs with many EM applications using different cost functions, the relationship between optimum mutation rates for GAs using continuous and binary representation are compared.