Artificial Intelligence
Genetic Algorithms Coursework

March 6, 2021

1 Abstract

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2 Continous Optimisation

Note 1 *All the results for this section was produced with the following parameters*

- *N=4*
- *Lower bound = -5*
- *Upper bound = 5*

No further mentions will be provided for those hyperparameters

2.1 Subtask 1.C: Performance

For the evaluation of the algorithm, we will use two standarized functions,

2.1.1 Sphrere

the Sphere(Commondly known as F_1 in the literature[3]) contains a single minima and its considered a easily solveable function.

$$f(x) = \sum_{i=1}^{n} x_i^2$$

2.1.2 Rastrigin's function

Rastrigin's function(Commondly known as F_4 in the literature[3]), is considered a very difficult task due to its large number of local minima and its enormous search space.

$$f(x) = 10 \cdot n + \sum_{i=1}^{n} [x_i^2 - 10\cos(2\pi x_i)]$$

2.1.3 Optimal hyperparameters

We will evaluate against, Mutation and Crossover rates as well as population. The following results are the averages after 10 runs for each function, on 4 dimensions, using balanced selection and standard normal mutation distribution(see below).

2.1.4 Performance Results

Note 2 *The following results was produced with the following hyperparameters and operators*

- *Population 1000*
- *Crossover Rate 0.8*
- *Mutation Rate 0.2*
- *Elitistic Search(see next subsection)*
- *Uniform mutation step(see next subsection)*

2.2 Subtask 1.D, algorithm tuning

- Balanced and Elitistic Wheel selection
- Mutation distribution

2.2.1 Balanced and Elitistic selection

The initial implementation of the selection operator, involved a balanced wheel selection based on the relative fitness of the individual on the current generation, as well as an individual probability of each individual to mate. Using both metrics we determined if an individual was allowed to mate or not. This implementation allowed less ideal candidates to mate with some probability, as this approach allowed the algorithm to avoid local minima traps easily. After some refinement this approach was ambandoned for a simpler elitistic wheel selection. In this selection strategy, the relative fitness is the only factor that affects an individuals probability to mate. The data below shows the improvement using the simpler method.

2.2.2 Gaussian and Uniform mutation step

The initial implementation of the mutation operator used a step taken from a Gaussian distribution with $\mu = 0, \sigma = 1$. The desired effect was to select a tiny step as a mutation operation the majority of the times, while leaving a small probability for a larger step, statistically this was used to avoid again, local minima. After some experimentation we improved our mutation operator by choosing a uniform distribution within the range [-1,1]. As the probability for a bigger step increases, we gain a significant performance boost when we have a relatively small mutation probability.

Note 3 *The following results was produced with the following hyperparameters*

- *Population 1000*
- *Crossover Rate 0.8*
- *Mutation Rate 0.2*

	Balanced	Elitistic
F1	124	98
F4	107	87

(a) Balanced vs Elitistic(Gaussian Mutation)

	Balanced	Elitistic
F1	133	90
F4	94	67

(b) Balanced vs Elitistic(Uniform Mutation)

Figure 1: A

References

[1] *Bäck, Thomas, Evolutionary Algorithms in Theory and Practice (1996), p. 120, Oxford Univ. Press*

[2] *Holland J.H. (1984) Genetic Algorithms and Adaptation. In: Selfridge O.G., Rissland E.L., Arbib M.A. (eds) Adaptive Control of Ill-Defined Systems. NATO Conference Series (II Systems Science), vol 16. Springer, Boston, MA. https://doi.org/10.1007/978-1-4684-8941-5_21*

[3] *Carvalho, D. B. et al. "The Simple Genetic Algorithm Performance: A Comparative Study on the Operators Combination." (2011).*