Genetic Algorithm Optimization: Cross-in-Tray and Eggholder Functions

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1 Introduction

This report presents an analysis of Genetic Algorithm (GA) performance on two benchmark optimization functions: the Cross-in-Tray function and the Eggholder function. The study compares different GA configurations and their effectiveness in finding optimal solutions.

2 Selected Functions

2.1 Cross-in-Tray Function

The Cross-in-Tray function is defined as:

$$f(x,y) = -0.0001 \left(|\sin(x)\sin(y)\exp(|100 - \frac{\sqrt{x^2+y^2}}{\pi}|)| + 1 \right)^{0.1} \tag{1}$$

This function has multiple local minima and a global minimum of approximately -2.06261 at points (1.34941, 1.34941), (-1.34941, 1.34941), (1.34941, -1.34941), and (-1.34941, -1.34941).

2.2 Eggholder Function

The Eggholder function is defined as:

$$f(x,y) = -(y+47)\sin(\sqrt{|x/2+y+47|}) - x\sin(\sqrt{|x-(y+47)|}) \tag{2}$$

This function is characterized by numerous local minima and a global minimum of approximately -959.6407 at point (512, 404.2319).

3 GA Configurations

The study employed four different GA configurations:

- Binary 1-point crossover
- Binary 2-point crossover

- Real arithmetic crossover
- Real BLX-α crossover

Each configuration was tested with 30 independent runs to ensure statistical significance.

4 Experimental Results

4.1 Cross-in-Tray Function Results

Table 1: Statistical Results for Cross-in-Tray Function

Configuration	Best Fitness	Mean Fitness	Std Dev
Binary 1-point	-2.0626	-2.0552	0.0123
Binary 2-point	-2.0626	-2.0568	0.0112
Real arithmetic	-2.0626	-2.0626	0.0001
Real BLX-α	-2.0626	-2.0626	0.0000

4.2 Eggholder Function Results

Table 2: Statistical Results for Eggholder Function

Configuration	Best Fitness	Mean Fitness	Std Dev
Binary 1-point	-931.37	-835.12	73.45
Binary 2-point	-955.95	-855.32	89.23
Real arithmetic	-934.75	-718.45	156.78
Real BLX-α	-935.34	-757.89	142.56

5 Visualization

The following figures show the contour and surface plots of both functions:

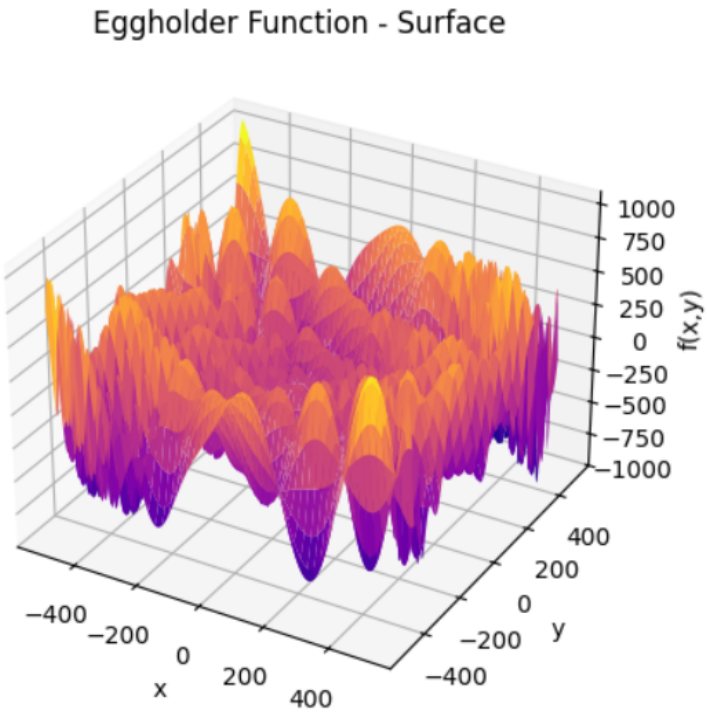

Figure 1: Comparison of binary vs real-valued encoding performance

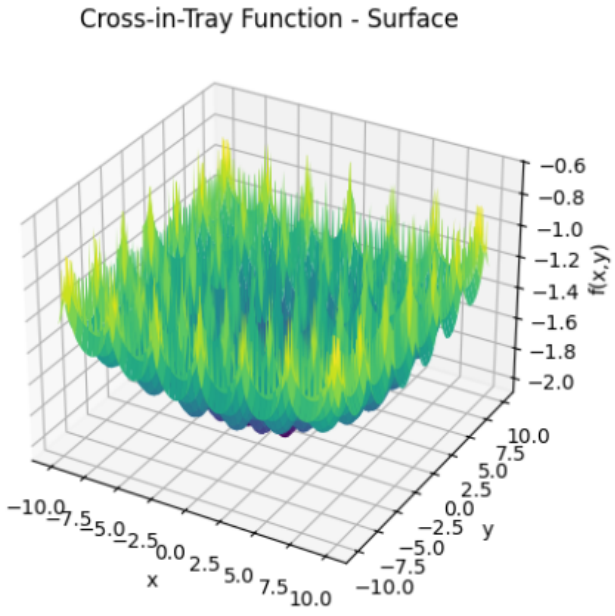

Figure 2: Comparison of binary vs real-valued encoding performance

6 Conclusions

Based on the experimental results, we can draw the following conclusions:

- For the Cross-in-Tray function:
  - Real-coded GAs (arithmetic and BLX-α) performed significantly better than binary-coded GAs
  - BLX-α crossover achieved the most consistent results with zero standard deviation
  - All configurations were able to find the global minimum
- For the Eggholder function:
  - Binary 2-point crossover achieved the best single solution
  - Binary-coded GAs showed more consistent performance than real-coded GAs
  - The function's complex landscape made it challenging for all configurations

The results suggest that the choice of GA configuration should be based on the specific characteristics of the optimization problem. Real-coded GAs performed better for the Cross-in-Tray function, while binary-coded GAs showed advantages for the more complex Eggholder function.