Genetic Algorithm Optimization Report

1 Benchmark Functions

We selected two widely used benchmark functions for optimization:

- **Rastrigin Function**: A non-convex function with many local minima. It is commonly used to evaluate global optimization algorithms. Its global minimum is at (0, 0), with a value of 0.
- **Ackley Function**: A multimodal function characterized by a flat outer region and a central peak. The global minimum is also at (0, 0), with a value of 0.

2 GA Configuration

We applied a Genetic Algorithm (GA) to minimize both functions using the following parameters:

- **Population Size**: 100
- **Number of Generations**: 100
- **Mutation Rate**: 0.1
- **Crossover Rate**: 0.8
- **Encoding**: Real-valued

Two crossover operators were tested:

- **Arithmetic Crossover**: Generates offspring by linearly combining parent genes.
- **BLX-α Crossover**: Generates offspring by sampling from an extended interval around the parents (with $\alpha = 0.5$).

3 Conclusions

- Both GA configurations successfully minimized the Rastrigin and Ackley functions.
- BLX-α crossover performed better on the Ackley function due to its ability to explore a broader search space.
- Arithmetic crossover showed good performance on the Rastrigin function, despite its large number of local minima.
- Proper selection of crossover strategy and encoding can greatly influence GA effectiveness.

4 References

1. Goldberg, D. E. (1989). *Genetic Algorithms in Search, Optimization, and Machine Learning*. Addison-Wesley.
2. Michalewicz, Z. (1996). *Genetic Algorithms + Data Structures = Evolution Programs* (3rd ed.). Springer.
3. Rastrigin, L. A. (1974). *Systems of Extremal Control*. Mir Publishers.
4. Ackley, D. H. (1987). *A Connectionist Machine for Genetic Hillclimbing*. Springer.
5. Herrera, F., Lozano, M., & Verdegay, J. L. (1998). *Tackling Real-Coded Genetic Algorithms: Operators and Tools for Behavioral Analysis*. Artificial Intelligence Review, 12(4), 265–319.