

Deterministic and Heur approach on finding the minimum of a function

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Abstract

The importance of a genetic algorithm is beyond comprehension. Not only that we have impossible problems to solve by human intelligence, but we have discovered a way on how to have a chance against the most complicated questions in the universe, *genetic-algorithms*. Indeed, this is not enough, for we, humans, are forever in the search of excellence and that is why there exist communities of scientists that try to create better and better algorithms that can solve problems.

1 Objective

Find the difference between a deterministic algorithm and a non-deterministic algorithm that has 94% chance on discovering the root of 4 functions:

- a. Booth
- b. Eusom
- c. Shubert
- d. Rastrigin

1.1 Definitions

Booth Function

$$f(X) = (x_1 + 2x_2 - 7)^2 + (2x_1 + x_2 - 5)^2 \quad (1)$$

Eusom Function

$$f(x, y) = -\cos(x_1)\cos(x_2)\exp(-(x - \pi)^2 - (y - \pi)^2) \quad (2)$$

Shubert Function

$$f(\mathbf{x}) = f(x_1, \dots, x_n) = \prod_{i=1}^n \left(\sum_{j=1}^5 \cos((j+1)x_i + j) \right) \quad (3)$$

Rastrigin Function

$$f(x, y) = 10n + \sum_{i=1}^n (x_i^2 - 10\cos(2\pi x_i)) \quad (4)$$

2 Setup

The language that the algorithm is written in is *C++* to improve the speed. Simple data structures were used: simple variables, matrices.

The experiments are done within 2, 5 and 20 dimensions vectors. For each dimension, each function will be run with a deterministic or non-deterministic approach to find the minimum. The non-deterministic approach will be composed of 5000 runs of a random input and taken the minimum from all of these 5000 runs. Each non-deterministic experiment will be ran 3000 times to create a statistic that can showcase the probability/the chances of that approach.

3 Sample Calculation

Functions	Booth	Easom	Shubert	Rastrigin
Determ	10	-0.000030	0.989725	5
Min Heur	1e-05	-0.998634	-84.80898	0
Mean Heur	0.00370408	-0.8463373	-84.75004	0.0530826
StdDev Heur	0.003893287	0.1331897	0.06020627	0.06103807

4 Conclusion

The fact that we can get this good only with a random search algorithm demonstrates the power of randomness. The true power within these algorithms resides in their capability to transform themselves in better versions. This is so called "genetic-algorithm" that can determine the desired solution to a problem that no deterministic algorithm can provide in polynomial time.

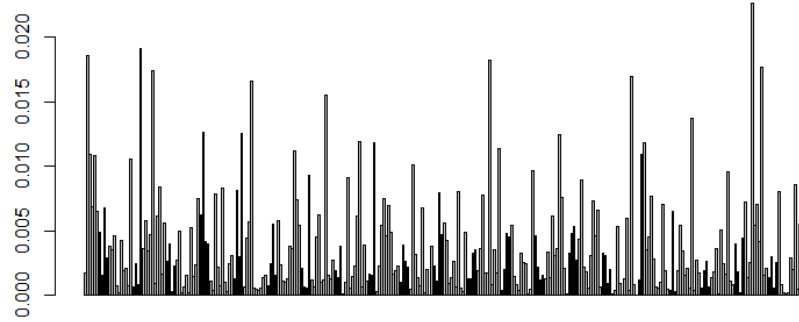


Figure 1: Booth in 2 dimensions

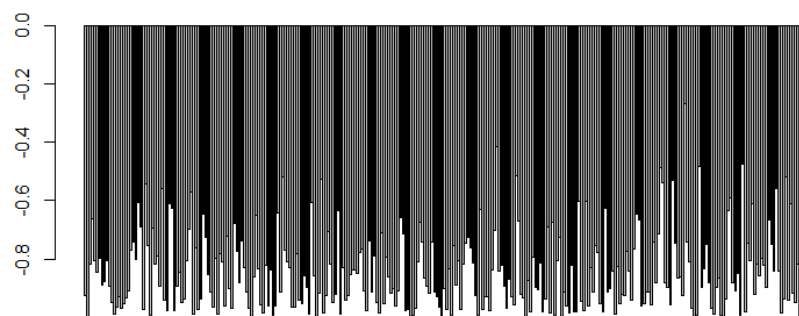


Figure 2: Easom in 2 dimensions

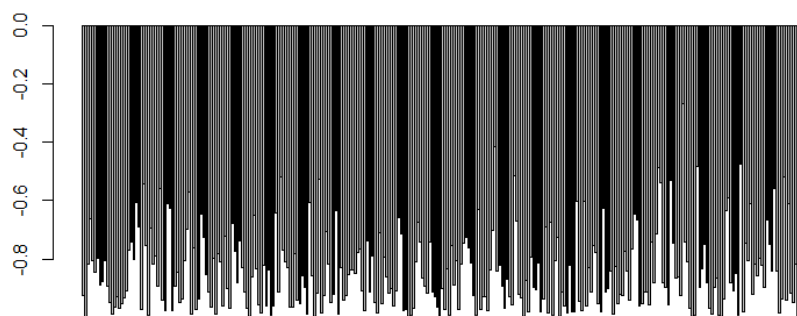


Figure 3: Easom in 5 dimensions

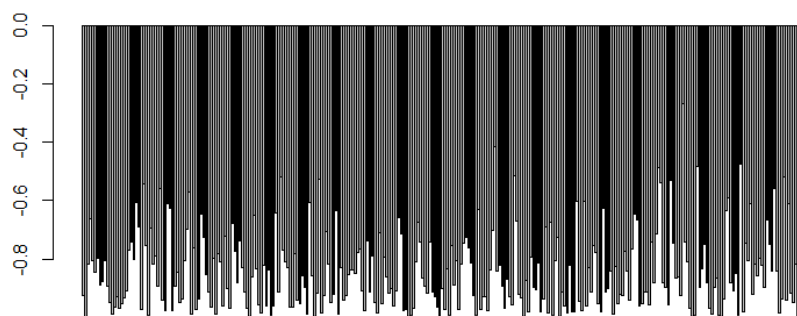


Figure 4: Easom in 20 dimensions

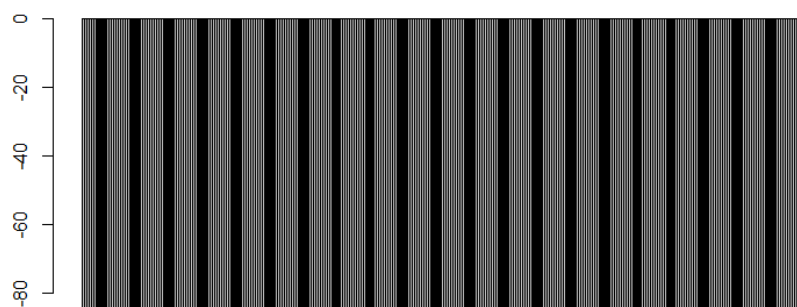


Figure 5: Shubert in 2 dimensions

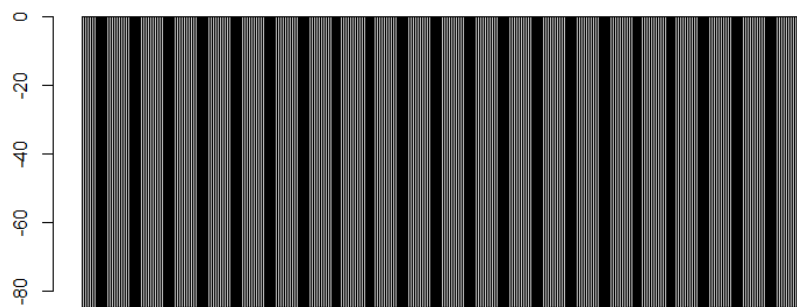


Figure 6: Shubert in 5 dimensions

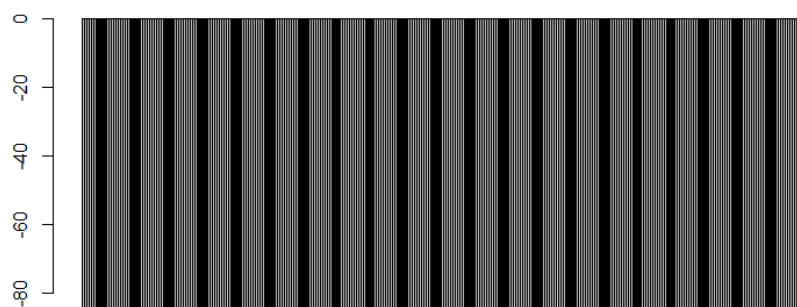


Figure 7: Shubert in 20 dimensions

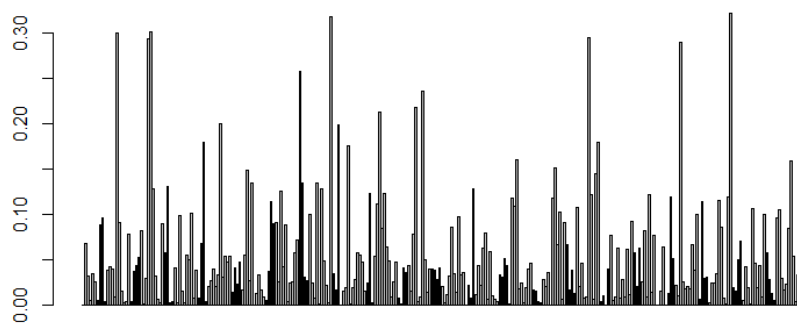


Figure 8: Rastrigin in 2 dimensions

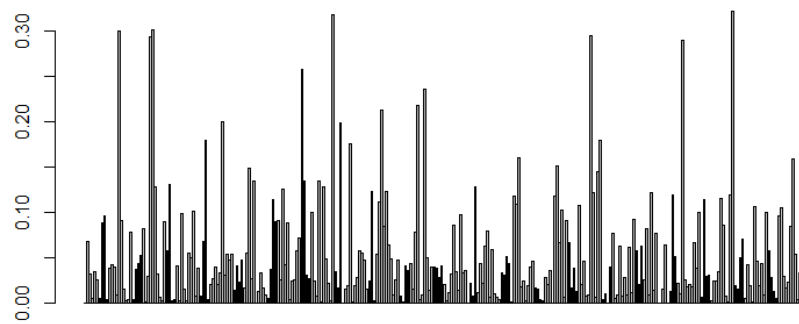


Figure 9: Rastrigin in 5 dimensions

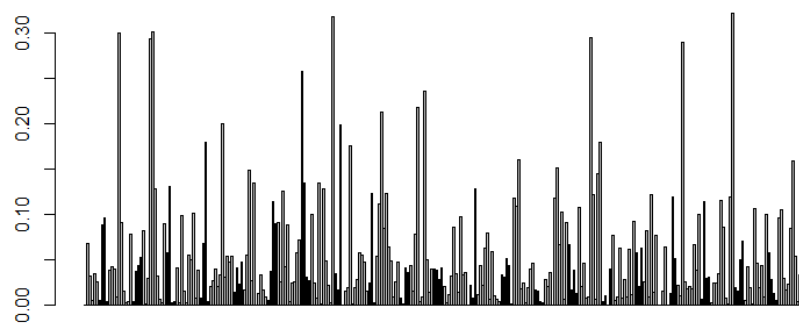


Figure 10: Rastrigin in 20 dimensions