HW1 - GA in Numerical Optimization

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I. Objectives

Practice and get familiar with the most widely used evolutionary algorithm — genetic algorithm (GA). In this assignment you need to make use of the taught subject matters about GA's representation, crossover, mutation, and survivor to solve the given problem.

II. Problem Description

Write efficient programs to implement GAs to find the minimal solution of the Schwefel function (SCH):

$$f_{SCH}(\vec{x}) = 418.98291N - \sum_{i=1}^{N} x_i \sin\left(\sqrt{|x_i|}\right)$$

where $-512 \leq x_i \leq 511$ and N = 10. This function is a continuous, multimodal, non-convex, deceptive, and N-dimensional function with a global minimum of 0.

TABLE I
Parameters

	Binary GA	Real-valued GA
Representation	$c_i \in 2^{10}$	$c_i \in \mathbb{R}$
Population	Generation (size 100)	
Parent Selection	Tournament Selection($n = 2$)	
Crossover ($p_c = 0.9$)	Uniform	
	2-point	Whole-Arithmetic
Mutation ($p_m = 1/l$)	Bit-flip	Uniform
Survivor Selection	$\mu+\lambda$	
Termination	500 generations	

III. Result

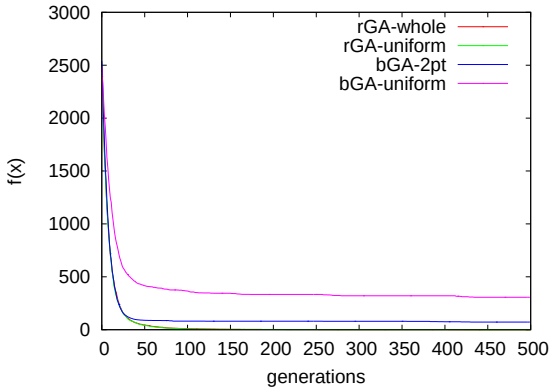

Fig. 1. anytime behavior (averaged over 30 trials) of the above GAs

IV. Comparison

Compare convergence speed and solution quality between different representations and operators; give reasons why some combination performs better (or worse).

A. Convergence Speed

Real-valued GAs and Binary GA with 2-point crossover have same speed at the begin, and Binary GA with 2-point crossover converge first, then the 2 Real-valued GAs converge, then the Binary GA with uniform crossover.

B. Solution Quality

Real-valued GAs have better performance over the 4 GAs, and they could reach the optimum f(x) value (0). However, Binary GAs can't reach the optimum f(x) value, and Binary GA has the worst performance

C. Reason

The representation of the above GAs lead to these outcomes. For Binary GAs, changing of bits would have different degrees of influence due to it's location. Take 0000000000 as example, this gene has it's fitness -512, if the first bit changes to 1 (1000000000), then value would be 0, in the meanwhile, the change of last (0000000001) bit would only lead to the change of 1. And for Real-valued GAs the method of crossover would lead the children be the mid-fitness of their parents, thus would tend to evolute into the mid-point of the search space, which is 0 the optimum point. Thus Real-valued GAs would have better convergence speed and solution quality in this problem.

V. Other Setting

A. Binary GA(Uniform Crossover)

In this section, I had tried different parameters setting for p_c, p_m, n

- 需大量資料才可建立足夠信賴之model

VI. Expected Result

建立一model能將加工參數與及時震動資料進行預測出預期加工品質。

References

[1] Jin, Yaochu, et al. "Data-driven evolutionary optimization: An overview and case studies," IEEE Transactions on Evolutionary Computation, 2018.
[2] Wang, Handing, et al. "Offline data-driven evolutionary optimization using selective surrogate ensembles." IEEE Transactions on Evolutionary Computation, 2018.
[3] Y. Jin, Ed., Knowledge Incorporation in Evolutionary Computation. Springer, 2005.

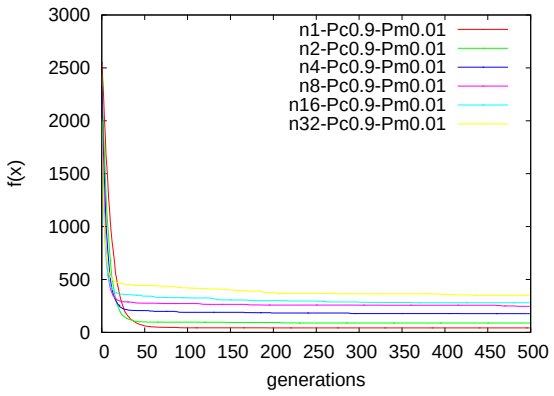

Fig. 2. Binary GA(Uniform Crossover)