Homework #2

Due date & time: May 02, 2019, 10:00AM

Do the following problems and exercises.

1. Discuss why steady-state GAs and ES form two extremes regarding the population size and the number of offspring created.

2. Given a population of μ individuals, which are bit-strings of length L. Let the frequency of allele 1 be 0.3 at position i, that is, 30% of all individuals contains a 1, and 70% a 0 at the ith position on the chromosome. How does this allele frequency change after performing k crossover operations with one-point crossover? How does it change if uniform crossover is performed?

3. In order to minimize the n-dimensional sphere model

$$f(x) = \sum_{i=1}^{n} x_i^2, \quad x_i \in \mathbb{R}\,, i = 1, \ldots, n,$$

where $n = 10$, implement the following evolution strategies:

   (a) $(1, 1)$-ES with fixed step-sizes for Gaussian mutation;
   - $\sigma = 0.01, 0.1,$ and 1.0

   (b) $(1 + 1)$-ES with fixed step-sizes for Gaussian mutation.
   - $\sigma = 0.01, 0.1,$ and 1.0

The starting point for all experiments is (1, 1, . . . , 1). The termination criteria are either (1) the objective value of the individual is equal to or less than 0.005, or (2) the number of generation/iteration is equal to or greater than 10 million (10,000,000). Do ten independent runs of each experiment and record the time (in terms of the number of generation/iteration) when the search stops. Organize two tables for $(1, 1)$-ES and $(1 + 1)$-ES, respectively. The table should look like

$(1 \overset{+}{,} 1)$-ES	$\sigma = 0.01$	$\sigma = 0.1$	$\sigma = 1.0$
Run #1	$\cdots$	$\cdots$	$\cdots$
$\cdots$	$\cdots$	$\cdots$	$\cdots$
Run #10	$\cdots$	$\cdots$	$\cdots$

4. Observe the running processes of problem 3. Compare and contrast the results you obtained in problem 3 and discuss what you think about the difference between $(1,1)$-ES and $(1+1)$-ES.

5. Repeat problem 3 with uncorrelated Gaussian mutation with n step-sizes. Use the step-sizes specified for each condition in problem 3 as the starting step-sizes. Decide your own τ, τ', and ε_0 for mutating the individual.

6. Compare and contrast the results you obtained in problems 3 and 5. Discuss what you think about the self-adaptation.

7. Repeat problem 3 with the 1/5-rule. Use the step-sizes specified for each condition in problem 3 as the starting step-sizes and adjust them with the 1/5-rule. Decide your own G and a for using the 1/5-rule.

8. Compare and contrast the results you obtained in problems 3, 5, and 7. Discuss what you think about the 1/5-rule for the self-adaptation of strategic parameters.