CSE848: Evolutionary Computation
Michigan State University

Assignment HA4: Home Assignment 4

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1. Write a binary-coded genetic algorithm (BGA) with binary tournament selection operator, one-point crossover operator and bit-wise mutation operators. No elite preservation is to be used. Apply the BGA code to solve two, 30-variable maximization problems constructed from 10, three-bit substrings (s_i, $i = 1, 2, \ldots, 10$). The structure of the overall function is given below:

$$F(s) = 10 \sum_{i=1}^{10} f(s_i),$$

where 30-bit string s is constructed from 10, three-bit substrings as $s = (s_1 \cup s_2 \cup \cdots \cup s_{10})$. Two subfunctions as a function of three bits are defined below:

Problem 1: The subfunction f is a function of *unitation* u, defined as the #1s in the three-bit substring: $f(u) = u/3$. For example, f(011) = f(101) = f(110) = 2/3 = 0.67, as for these three substrings $u = 2$.

Problem 2: $f(u) = 0.9 - u/3$ for $u < 3$, and $f(3) = 1$.

Notice that for both problems, the optimal string is the all-1 string s^* =(111 ... 1) having $F(s^*) = 100$.

Two construction procedures are used:

Construction 1: The first three bits of s are used to construct the first subproblem, the next three bits of s are used to construct the second subproblem, and so on. Thus, the final three bits (28-th, 29-th and 30-th bits) are used to construct 10-th subfunction.

Construction 2: 1st, 11-th and 21-st bits of s are used to construct the first subproblem, then 2nd, 12-th and 22-nd bits of s are used to construct the second subproblem, and so on. The 10-th subfunction uses 10-th, 20-th and 30-th bits of s.

Use the following parameters: Population size = 60, crossover probability = 0.9, mutation probability = 1/30, and maximum generation = 200. Solve each problem with each construction method (a total of four cases) using your BGA code. Run each of the four cases 30 times and report the best, median, mean, and worst function value. For the median run, plot population-best and population-average function value versus generation counter.

Compute the schema growth in terms of proportion of population containing 10 three-bit building blocks (111) and their competitors (000) for each construction procedure on one plot for each problem. For example, for Construction 1, the first building block and its competitor are (111 $\star\ldots\star$) and (000 $\star\ldots\star$), respectively. Remember a * matches a 1 or a 0 in a string. The second building block and its competitor are ($\star\star\star$ 111 $\star\ldots\star$) and ($\star\star\star$ 000 $\star\ldots\star$), and so on. Derive the building block and its competitor for Construction 2 accordingly.

Explain your results from your understanding of schema theorem, properties of the two problems defined above, and properties of BGA operators.