CSCI 4560/6560 Evolutionary Computation
Final Exam - Fall 2023

NAME:

Problem(1):

Problem(2):

Problem(3):

Problem(4):

Total:

1. **[25 Points]**

   The $3-WayPartition$ problem is stated as follows. Given a set of N positive integers $X = \{x_1, x_2, \ldots, x_n\}$ separate them into three subsets P_1 and P_2 and P_3 such that the sums of the subsets are as similar as possible. For example, if N=7 and the set $X = \{10, 17, 3, 24, 5, 26, 2\}$, the sets $P_1 = \{5, 24\}$, $P_2 = \{17, 10, 2\}$ and $P_3 = \{3, 26\}$ constitute an optimal solution for the $3-WayPartition$ problem in this example as they have equal sums.

   Formulate the $3-WayPartition$ problem as a Genetic or Evolutionary Algorithm optimization. you should specify:

   - A representation.
   - A fitness function. Give 3 examples of individuals and their fitness values if you are solving the above example (i.e. $X = \{10, 17, 3, 24, 5, 26, 2\}$).
   - A set of mutation and/or crossover and/or repair operators. Intelligent operators that are suitable for this particular problem domain will earn more credit.
   - A termination criterion for the evolutionary optimization.

2. **[25 points]: Short answers please**

   (a) Give brief definitions for the following:

      i. Multimodal optimization problems

      ii. The Pareto Front in multi-objective optimization

   (b) Briefly describe two different methods for adaptive parameter control in evolutionary optimization.

   (c) Give the name of one genetic operator that exhibits positional bias and one that exhibits distributional bias.

3. **[25 points]:**

Consider a genetic algorithm using binary representation with strings of length 5. The fitness is to be maximized. Assume that the initial population was as follows:

Individual	Genotype	Fitness
1	10001	A
2	11100	B
3	00011	C
4	01110	D

Assume also that a Goldberg-style canonical generational GA (using proportional selection, 1-point crossover and bit mutation) is used with mutation probability $p_m = 0.01$ and crossover probability $p_c = 1.0$. The population size is kept constant at 4 individuals and all intermediate populations have 4 individuals also.

(a) If A = B = C = D = 10, what is the expected number of instances of the following schemata in the next generation: 1****, 001**.

(b) If A = B = 10 and C = D = 20, what is the expected number of instances of the following schemata in the next generation: 0****, 100**.

(c) Give a set of values for A, B, C, and D which makes the expected number of instances of schema 1**** in the **mating pool** twice the expected number of instances of schema 0**1* in the same pool.

4. **[25 points]: Short answers please**

   (a) Give brief definitions for the following:

      i. The Building Block hypothesis

      ii. Deception in Genetic Algorithms

   (b) Briefly mention one major difference between each of the following pairs:

      i. Fitness sharing and crowding.

      ii. Parameter Tuning and Parameter Control in evolutionary algorithms.

   (c) What is over-selection in genetic programming?