

CSCI 4560/6560 Evolutionary Computation

Assignment Number 3: Due 10/07/2025 by eLC

The use of Generative AI tools is not allowed

1. **[20 Points][MID]** Consider a genetic algorithm using a vector of integer representation with vectors of length 5. The fitness is to be maximized. Assume that the initial population was as follows:

Individual	Genotype	Fitness
1	5,2,5,3,1	10
2	4,2,3,3,3	20
3	3,4,1,2,5	10
4	1,4,3,2,5	30

- (a) What is each individual's probability of being selected as parent if proportional (roulette wheel) selection is used?
- (b) What is each individual's probability of being selected as parent if deterministic binary tournament selection is used (in which two distinct individuals compete in any tournament and ties are broken randomly)?
- (c) If we select individuals 3 and 4 as parents for N point crossover for some value of N, can the genotype of a resulting child be 3,4,3,2,5? how about 1,4,1,2,3? Briefly justify your answer.
2. **[20 Points][MID]** Consider a genetic algorithm doing unconstrained maximization using a vector of float representation with vectors of length 5. Assume that the range for each gene is from 0 to 10 inclusive. Assume that the population at some stage was as follows:

Individual	Genotype					Fitness
1	3.1	4.4	1.3	2.2	5.2	20
2	1.3	4.4	3.1	2.2	2.5	30
3	5.4	2.2	5.3	3.3	1.3	40
4	4.5	2.2	3.5	3.3	3.1	10

- (a) If we select individuals 1 and 2 as parents for whole arithmetic recombination crossover, give the genotype of one possible child that may result. Very briefly explain how you got it.
- (b) If we select individuals 3 and 4 as parents for one-point crossover, give the genotype of one possible child that may result. Very briefly explain how you got it.
- (c) If we select individual 1 for uniform mutation and assuming that the first gene is to be mutated, give the genotype of one possible child that may result. Very briefly explain how you got it.
- (d) **[For 6560 Students, Extra credit for 4560]** What is each individual's probability of

being selected as parent if deterministic ternary tournament selection is used (in which three distinct individuals compete in every tournament)?

3. **[20 points][MID]** Consider a genetic algorithm using permutation representation with length 10. Consider the following two parents:

Parent1: A B C D E F G H I J

Parent2: E H I J F A C D G B

- (a) Give two examples of individuals that could result from doing the swap mutation to Parent1.
- (b) Give an example of an individual that could result from doing order crossover of Parent1 and Parent2. Briefly explain how you got this individual.
- (c) Give an example of an individual that could result from doing the cycle crossover of Parent1 and Parent2. Briefly explain how you got this individual.

4. **[20 points][MID]:** Short answers please!

- (a) What is the difference between a $(\mu + \lambda)$ evolution strategy and a (μ, λ) evolution strategy? Give one advantage for using each of these two methods over the other.
- (b) Which of the following strategies has the highest selection pressure for survival to the next generation:
 - i. a (10,10) evolution strategy
 - ii. a (5+10) evolution strategy
 - iii. a (5,10) evolution strategy

Briefly justify your answer.

- (c) **[For 6560 Students, Extra credit for 4560]** What is wrong with a (μ, μ) evolution strategy? Very briefly propose a way to fix it.

5. **[20 points][MID]:** Short answers please!

- (a) Why is a (μ, λ) evolution strategy usually better than a $(\mu + \lambda)$ evolution strategy for optimization in a dynamically changing fitness landscape?
- (b) Mention one way to reduce selection pressure in modern Evolutionary Programming when used for continuous functional optimization.
- (c) Identify two points of difference between Genetic Algorithms and classical Evolutionary Programming using finite state machines.