Quiz1
COSC 6367 *Evolutionary Programming*
Th. Feb. 21, 2008

Your Name:
Your SSN:

Problem 1 --- Selection and Survival of the Fittest [14]:
Problem 2 --- ES [10]
Problem 3 --- Crossover and Mutation [10]
Problem 4 --- Genetic Programming [9]
Problem 5 --- Genetics [8]
Problem 6 --- Questions [9]:

Σ [60]:

Grade:

The quiz is "open books and notes" and you have 75 minutes to complete the quiz; it will count 11% or 12% towards the overall course grade.

1) Selection / Survival of the fittest [14]

a) What role do selection operators, such as roulette wheel and k-tournament selection, play in evolutionary computing systems? [2]

They select parents to breed the next generation based on the principles of the survival of the fittest.

b) Assume you use k-tournament selection with a population size of 100. What is the probability that the best individual is selected—assume there is a single best individual—and give the general formula for the probability. What is the impact of decreasing k (let us say from 5 to 4) in tournament selections? [4]

$$1-\left(1-\frac{1}{100}\right)^{k}$$

It decreases the selective pressure

c) Assume you develop an evolutionary computing system that employs a mutation, crossover, and copy operators and 5-tournament selection and you observe premature convergence and too much selective pressure. What of the following measures would you take to alleviate the problem? No justification is required! [3]

a. Increase the population size
b. Decrease the mutation probability
c. Replace the current fitness function f by a function $g(x)=(f(x))^{0.1}$
d. Remove the copy operator

a, d

d) Assume you have to implement roulette wheel section. Give a sketch how you would do that! [5]

See notes

2) ES [10]

a) Rechenberg's 1/5 rule reduces the variance σ in the case that the system was not very successful in finding better solutions. Why? [3]

Since we are not finding better solutions, we have reached the top of the hill.

b) Some ES approaches associate the variance σ with individuals in the population—every object is mutated based on the mutation rate it is associated with it, which also changed by crossover and mutation operators. What advantage do you see in using such and approach? [4]

Each solution maintains its "optimal" way to be changed. Each dimension is treated differently.

c) What is the idea behind making co-variance matrices be part of mutation operators, such as in the operators that are described in sections 4.4.2 and 4.4.3 of the textbook? [3]

We are able to have different step sizes for different dimensions. This helps us to treat different dimensions separately.

3) Crossover and Mutation [10]

a) Many implementations of evolutionary computing systems use a high mutation rate in early stages of the search, but use a low mutation rate in late stages of the search. Why? [4]

This is done in order to first conduct exploration and then exploitation (get up a hill). Also, we tend to avoid premature convergence.

b) Compare Wright's heuristic crossover with arithmetical crossover (also called whole arithmetical recombination on page 51 of the textbook)? What are the similarities? What are the differences between the two operators? [4]

Similarities: Solutions are on a straight line joining the two points.
Differences: We don't get boundary solutions with arithmetic operators. Arithmetic crossover always gives a legal solutions whereas in case constraints are violated, heuristic operators will give invalid solutions.

c) Compare uniform crossover with 1-point crossover for binary string chromosomal representations! What is the main difference between the two operators? [2]

Uniform crossover exhibits no positional bias as opposed to 1-pt crossover.
Uniform crossover takes either mother or father genes whereas 1-pt crossover takes one part of the result from the mother and the other from the father.

4) Genetic Programming [9]

a) Explain how the crossover operator in genetic programming works. What can be said about the size of the obtained offspring—can it be larger than the size of the larger parents? [4]

Swaptrees can be large.

b) Many genetic programming systems only use a copy and crossover operators, but no mutation operator. Any explanation for that? [3]

Crossover is also considered as a mutation.

c) How is symbolic regression different from traditional regression? [2]

Symbolic regression explores parameters as well as the form of the function.

5) Genetics [8]

a) What is meiosis? What is its role in human reproduction? [4]

b) Gametes (sperm and egg cells) are haploid and not diploid in human beings. Why do you believe is this the case? [4]

6) Questions [9]

a) EC systems search probabilistically for good solutions. What advantages you see in using probabilistic algorithms over determinic algorithms for solving complex search problems? [5]

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a) Probabilistic algorithms are less likely to get stuck.
b) We are also likely to find multiple good solutions.
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b) What is the main difference between state space search and solving optimization problems? [2]

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State space search needs to store the path from the initial stage to
the goal state, whereas while solving optimisation problems, we are
only concerned with the goal state.
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c) What is the main difference between hill climbing and simulated annealing? [2]

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Hill climbing only climbs up to find a solutions whereas simulated
annealing, being a probabilistic algorithm, allows non-upward moves as
well.
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