*COSC 6367 Evolutionary Programming Spring 2012*

*Dr. Eick*

*Solution Sketches Quiz2*

Tu., April 10, 2012

Your Name:

Your Student id:

Problem 1 --- Selection Operators [4]

Problem 2 --- Binary String Genetic Algorithms [6]

Problem 3 ----Parameter Control [5]

Problem 4 --- Using EC for Numerical Optimization [13]

Problem 5 --- Swarm Intelligence [24]

:

**Grade:**



The exam is “open books and notes” and you have 75 minutes to complete the exam; it will count approx. 11-12% towards the overall course grade.**1) Selection [4]**

Assume you use 2-tournament selection with population size 100; what is the probability that the third-worst solution[[1]](#footnote-1) is chosen (giving just the formula is fine!) [4]

**There are 5 positive cases: (98, 98), (98, 99), (98, 100), (99, 98) and (100,88). Therefore, the probability is: 5/10000=0.5%**

**2) Binary String Genetic Algorithms [6]**

a) Compare 1-point crossover with uniform crossover! What are the main differences between the two crossover operators? [3]

**1-point crossover uses one crossover point whereas uniform crossover uses of up to n-1 crossover points (n is the length of the string)[1.5]. In 1 point-crossover the allele values of neighboring stings are preserved from the parents (except those cut at the crossover point), and therefore for 1-point crossover has a propositional bias[1]. Uniform crossover on the other hand has the tendency to get 50% of the allele values from each parent (distributional bias) whereas when 1-point crossover is used large portions of the allele values might originate from a single parent, if the crossover point is far away from the middle[0.5].**

b) Assume you evolve binary stings of length 100 and you use the binary string mutation operator with pm=0.02. Explain how binary string mutation works! How many bit-flips do you expect at on average, if you use this operator to evolve binary strings of length 100? [3]

**The mutation operator goes through all positions of a bitstring, and the value at a position is flipped with a probability of 2%. [2]**

**100\*0.02=2 [1]**

**3) Parameter Control [5]**

**Give an example** of adaptive parameter control in an evolutionary computing system! [4]

**No answer given!**

4) Using EC for Numerical Optimization [13]

Assume the following function f

f(a,b,c) = cos(c)\*sin(b)+((a+b)/(1+ c\*\*sin(a-b)))

has to be **minimized** subject to the following two constraints:

(C1) (b\*\*2 + c\*\*2) <1

(C2) a+b=1

1. Assume you use the penalty function approach to solve this optimization problem. Give the fitness function you would use in this case and explain how it will be used! [6]

The penalty functions approach could use the following modified fitness function g(a,b,c) which is defined as follows:

g(a,b,c)= f(a,b,c) + w\*((min(0,1-b\*\*2+c\*\*2) + |a+b-1|))

where w is a parameter which determines the amount of penalty associated with constraint violations. [In most approaches, w is increased during the run of the evolutionary computing system]

1. What is the idea of the adaptive penalty function approach? What advantages do you see in this approach? [4]

The penalty associated with constraint violations is adjusted based on (desirable) properties of the population. [1.5]

Advantage: Approach is not sensitive to bad initial choices for initial values of penalty weights, as those are adapted quickly better choices [1.5]

Any Other advantages??

1. What is the idea of the *repair function approach* to cope with constraints in optimization problems? Limit your answer to 2-3 sentences! [3]

Every time an illegal solution x is obtained as result of crossover or mutation, a repair operator *rep* is applied to x which creates a legal solution y from x (y=*rep*(x)) which is used in place of x. Therefore, the evolutionary computing system only searches the space of legal solutions, when the repair function approach is used.

**4) Swarm Intelligence and Agent-based Systems [24]**

1. Robots are used a lot these days in manufacturing and for exploration tasks. What advantages you see in using a swarm of smaller robots over a single bigger robot? What disadvantages do you see?[6]

Advantages Swarm Robots:

More fault tolerant [1.5]

Different types of robots can be used which specialize in different tasks[1]

Robots are more agile due to lower weights [1]

Robots can distribute in space based on the work which has to be done [1]

No central control is required [0.5]

Less expensive?!? [0.5]

Swarm is more adaptable [0.5]

Robots can work in parallel [0.5]

Disadvantages:

Single big robot Easier to design and control as there is no need for coordination, local communication, and task allocation. [1.5]

Can probably do task which involve larger quantities better as swarm robots have to use teams of robots for the same task [0.5]

1. Corne, Reynolds, Bonabeau Book Chaper [11]
	1. Swarm Intelligence centers on how swarms of individual agents can solve problems cooperatively; what other assumptions are typically made by swarm intelligence approaches about agents and the way they interact? [3]
	* *Agents are autonomous and operate in parallel*
	* *Little or no centralized control*
	* *Stigmergy (indirect communication)*
	* Other answers might receive credit
	1. Swarm intelligence systems frequently rely on indirect communication between agents (stigmergy), rather than direct communication. Do you have **any explanations why this is the case**? [3+up to 3 extra points]

Explanations which received credit include:

Directly Communicating with millions of agents is complex and time consuming

Much simpler and cost effective!

Local Communication is okay for many applications in which local rather than global tasks have to be solved.

Cheaper Agents could be produced.

Comment: 50% of students discussed what stigmergy is but never tried to give an explanation…

* 1. African Macro Termites which grow fungus build very complex nest structures consisting of outer walls, floor structure, royal champers, brood chambers, garden areas, tunnels and galleries. Provide an explanation why the termites can solve such a difficult task, although a single termite has quite limited intelligence. Limit your answer to at most 6 sentences! [5]

Other explanations exist!

 Here is one possible explanation!

* + *Termites use sets of simple rules*
	+ *Which set of rules is used is determined by patterns observed by termites and other sensual input which act as stigmergic trigger.*
	+ *As the construction evolves, it changes its appearance leading the termites to follow other rules associated with the next stage of the construction and this process continues until the nest is completed. Pheromones are used to recruit idle termites into ongoing tasks.*
1. Particle Swarm Optimization[7]
	1. How are positions of objects updated in the PSO approach? Limit your answer to at most 4 sentences! [3]

No solution given; for solution see page 23 of the article! I subtracted one point if you did not mention the probabilistic aspect of the position update.

* 1. What are the main differences between PSO approach and traditional EC approaches? [4]

Main Differences PSO from EC:

* No discarding of solutions or creation of new solutions through genetic operations. [1]
* In PSO, solutions are **agents** with their **own memory** which **probabilistically move over the search space guided by their own and social experience—based on motion rules which are specific for particular PSO approaches.** [2]
* Survival of the fittest is replaced through probabilistic motions towards promising regions of the search space based on past experience.[1]
* **Other differences?**
1. Only two solutions are worth than that solution. [↑](#footnote-ref-1)