Vrije Universiteit Amsterdam
Exam Evolutionary Computing
15.12.2005

Your name must be written on each sheet in CAPITALS.

NOTES:

1. You can answer the questions in English or in Dutch.

2. Points to be collected: 90, free gift: 10 points, maximum total: 100 points.

3. Grade: total number of points divided by 10, rounded up to the first decimal.

QUESTIONS

1. We have a (simple) scheduling problem. We need to manufacture 100 objects $\{o_1, \ldots, o_{100}\}$ on one machine as quickly as possible. The time needed to make object o_i is $t_i > 0$. This t_i is independent from the order in which the objects are processed and also independent from the time when the object o_i is made. Furthermore, there are switch costs, defined as the time needed to rearrange the machine setup from manufacturing object o_i to manufacturing object o_j. The cost of switching from object o_i to o_j is given by $c_{ij} > 0$. The question is: in which order should we produce these objects to make the total time needed minimal?

   Your task is to specify an EA suitable[1] to provide an answer to this question. In particular, give

   (a) **(5p)** a representation, that is, the syntax of the chromosomes (genotypes) and a mapping between chromosomes and orderings (phenotypes),

   (b) **(5p)** a fitness function,

   (c) **(5p)** an appropriate crossover operator,

   (d) **(3p)** an appropriate mutation operator,

   (e) **(3p)** an appropriate parent selection mechanism,

   (f) **(3p)** an appropriate survivor selection mechanism,

   (g) **(3p)** an initialization method,

   (h) **(3p)** a stop condition.

2. **(10p)** Let us assume that the previous problem is a real-life application that occurs and needs to be solved every day. Assume also that you have only limited time available from the moment you get the problem data and the moment you need to provide a solution. What are then the most important performance criteria for the EA you develop? In other words, how would you compare two EAs for solving this problem? Give an answer in terms of statistical measures, for instance, AES, MBF, SR and the corresponding standard deviations, if appropriate. Provide arguments to motivate your answer. If you wish, you

---

[1]The EA does not have to be "smart" (efficient). But the representation and the operators should be such that a solution can be found.

can give a figure (that is, graph, table, histogram, whatever form you prefer) that you would like to use for comparing two possible EAs for solving this problem.

NB. This figure is optional, and it will be imaginary, in the sense that it is not based on real data, but on data as you could obtain.

3. **(5p)** Consider the following statement:

> EAs as problem solvers are completely different from other heuristic approaches, like local search (LS). EAs and LS are competitors that force the user to choose either approach and apply it in the purest possible form.

Is this statement correct or not? Give arguments.

4. (a) **(5p)** Explain the difference between adaptive and self-adaptive parameter control.

(b) **(5p)** Give an example of self-adaptive parameter control. That is, give the rough description of an EA of your choice, specify a parameter to be self-adapted and define a self-adaptation mechanism for this parameter.

(c) **(5p)** Give an example of adaptive parameter control. That is, give the rough description of an EA of your choice, specify a parameter to be adapted and define an adaptation mechanism for this parameter.

5. Let us assume that we have a population of four individuals $S = \{a, b, c, d\}$ with fitness values given by $f(x)$ as shown in the following table (to be maximized).

x	$f(x)$	$\mathrm{IP}_f(x)$	$g(x)$	$\mathrm{IP}_g(x)$
a	1			
b	1			
c	2			
d	4			

(a) **(10p)** What are the probablities $\mathrm{IP}_f(x)$ for each $x \in S$ to be selected by fitness proportional (roulette wheel) selection, based on this fitness function f?

(b) **(10p)** Let g be another fitness function, obtained as $g = f + 100$. What are the probablities $\mathrm{IP}_g(x)$ for each $x \in S$ to be selected by fitness proportional (roulette wheel) selection, based on this fintness function g?

NB. You may give approximate figures of these probabilities without decimals, e.g., "around 75 %".

6. **(10p)** Incorporating human guidance into an evolutionary process, as in interactive evolutionary applications, implies advantages as well as disadvantages. Give a list of such (dis)advantages.

NB. 2 points for each correct item, with a maximum of 10 points in total.