Exam Evolutionary Computing
22.10.2012

NOTES:

1. YOUR NAME MUST BE WRITTEN ON EACH SHEET IN CAPITALS.
2. You can answer the questions in English or in Dutch.
3. Points to be collected: 90, free gift: 10 points, maximum total: 100 points.
4. Grade: total number of points divided by 10.
5. This is an open book exam (no other materials than the book are allowed)

QUESTIONS

1. You are asked to design an evolutionary algorithm that will plan the floor layout of a production plant. The company has purchased a new building and needs to convert it to a functional production plant by installing machinery and facilities. You must place n facilities $f_1, f_2, ..., f_n$ in the plant. The building has n available locations $l_1, l_2, ..., l_n$ that can station these facilities (each location can accommodate only one facility). For each pair of locations a distance $D(l_i, l_j)$ is specified and for each pair of facilities a flow of material $F(f_i, f_j)$ is specified. The transportation of one unit of material for one unit of distance costs one euro. You need to make an efficient assignment of facilities to locations, i.e. a one-to-one mapping of facilities to locations so that the total transportation cost is minimized. Please specify:
   (a) **(5 pt)** an appropriate fitness function,
   (b) **(5 pt)** a representation, that is, the syntax of the chromosomes (genotypes) and a mapping between chromosomes and phenotypes,
   (c) **(2 pt)** an appropriate crossover operator,
   (d) **(2 pt)** an appropriate mutation operator,
   (e) **(2 pt)** an appropriate parent selection mechanism,
   (f) **(2 pt)** an appropriate survivor selection mechanism,
   (g) **(2 pt)** an initialization method,
   (h) **(2 pt)** a stop condition,
   (i) **(8 pt)** how your EA handles constraints (if applicable).
2. (a) **(2 pt)** Describe the *replace worst* survivor selection operator.
   (b) **(2 pt)** Describe the *tournament* survivor selection operator.
   (c) **(5 pt)** How is their effect on the population diversity different?
   (d) **(5 pt)** Which one would you choose for a unimodal and which one for a multimodal problem? Why?

3. (a) **(6 pt)** What are all the possible problem types considering the existence of constraints and an objective function? Give an example for each type.

   (b) **(4 pt)** For which type of problem are you forced to use indirect constraint handling? For which type of problem is direct constraint handling possible?

4. **(16 pt)** A type of parameter control is the so-called *Operator Selection*, i.e. choosing a suitable variation operator among several options before producing offspring. How would you do that with an adaptive approach and how with a self-adaptive?

5. (a) **(3 pt)** What can be the advantages of non-random initialization?

   (b) **(9 pt)** Describe three ways of "intelligent" (non-random) initialization of an EA.

6. **(8 pt)** Genetic Programming can be positioned as "the automatic evolution of computer programs". Do you think that GP can be seen as the general problem solving computer, i.e. an algorithm producing new algorithms to solve problems without the need for human designers and programmers? Give arguments either way.