Exam Evolutionary Computing
9.1.2014

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 have to solve a packing problem for a shipping company using an evolutionary algorithm. You are given a rectangular container of dimensions $W \times L \times H$ and a set of N rectangular boxes of dimensions $x_i \times y_i \times z_i, i = 1 \ldots N$. You need to find an arrangement of all boxes (position and rotation) so that they all fit within the container. Boxes cannot overlap or cross the container walls but it is ok if they float, i.e. a box can be set at a position without something being directly under it. Please specify:
   (a) **(5 pt)** a representation, that is, the syntax of the chromosomes (genotypes) and a mapping between chromosomes and phenotypes,
   (b) **(5 pt)** an appropriate fitness function,
   (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. **(18 pt)** Give three reasons for using an island model EA and motivate your answer.
3. **(12 pt)** Consider a standard GA with binary representation of length $l = 10$, population of size $\mu = 100$, bit-flip mutation with $p_m = 0.1$, one point crossover with $p_c = 1$, fitness proportional parent selection and generational replacement. You are given schema $H =$ ###0#110## with fitness $f(H) = 0.8$. The number of examples of H in the current population is $n_t = 12$. Following Holland's model and assuming that the average fitness of the population is 0.4, **derive** the expected number of examples of H in the next generation.
4. (a) **(4 pt)** What kind of problem is the packing problem of Question 1 (FOP, COP or CSP)?

(b) **(4 pt)** If you were tuning your EA for the problem of Question 1 which performance measure would you use to evaluate a parameter vector for the EA? Why?

5. **(8 pt)** Give two examples to demonstrate that the choice of representation is important for the performance of an EA.

6. Given two permutation individuals $P_1 = 47128356$ and $P_2 = 72643518$:

   (a) **(3 pt)** What are their offspring using partially mapped crossover

   (b) **(3 pt)** What are their offspring using cycle crossover?

7. **(8 pt)** Consider the following statement:

   > "Automatic tuners can take over the whole design process making a human almost unnecessary for the design of an EA application."

   Is this statement correct or not? Give arguments.