Exam Evolutionary Computing
23.10.2013

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. An airline company asks you for a model that predicts weekly ticket demand for a specific route based on N variables $V = v_1, v_2, ..., v_N$ which represent factors such as the time of year, current economic descriptors, etc. For this purpose, they provide you with historical data of several years back in the form of logs. These logs contain one row per week with values for the N factors and the total number of tickets sold during that week. You are asked to design an evolutionary algorithm that can produce such a predictive model. 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
2. **(15 pt)** What are the two main difficulties with evolving art and music? Discuss ways to deal with these problems.
3. (a) **(3 pt)** Is the evolution of a Genetic Algorithm a Markov chain? Explain.
   (b) **(4 pt)** Explain what is the takeover time and what is the mixing time. How should they relate?
4. (a) Classify the following problems as FOP, COP or CSP:
      i. **(2 pt)** Specify true/false assignments for n logical variables such that a given propositional formula (e.g. $(X_1 AND X_2) OR (X_3 AND X_4)$) evaluates to true.

ii. **(2 pt)** Decide an investment portfolio with a maximal expected profit. You can choose from N companies, each with p_i expected profit per euro invested. The total investment cannot exceed the available funds.

iii. **(2 pt)** Schedule a production process by ordering certain operations on a single machine so that production takes minimal time. You have to perform N distinct operations (once each), some operations must precede others $prec(O_x, O_y) = true/false$ while switching the machine between two operations takes a certain time $st(O_x, O_y)$.

iv. **(2 pt)** Place eight queens on a chessboard so that no two queens check each other.

(b) **(5 pt)** Which constraints of the above problems can be handled by repairing infeasible candidates? Explain how.

(c) **(5 pt)** Which constraints of the above problems can be handled by preserving feasibility using appropriate representation/initialization/operators? Explain how.

(d) **(2 pt)** Which constraints of the above problems can only be handled using penalties? Why?

5. **(5 pt)** You want to evolve a chess playing agent but you have no available opponent (human or software) or datasets to use for fitness calculation. How will you evaluate the candidate solutions and how will you most efficiently handle selection?

6. (a) **(5 pt)** Describe two methods for maintaining diversity.

   (b) **(6 pt)** Consider two parents $A = 11111$ and $B = 00000$ and two offspring $C = 10011$ and $D = 11011$. How would they be paired if we used deterministic crowding? I.e. which is p_1, p_2, o_1, and o_2? Use the Hamming distance for the binary representation: the distance between two strings is the number of bits they differ in.

   (c) **(2 pt)** What crossover operator was used in (b) above?

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

   'According to the No Free Lunch Theorem, the concept of *"on-line tuning"* is impossible.'

   Is this statement correct or not? Give arguments.