Exam Evolutionary Computing
22. 10. 2014

NOTES:

1. YOUR NAME MUST BE WRITTEN ON EACH SHEET IN CAPITALS.
2. Answer the questions in English.
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 a closed book exam (no materials are allowed).

QUESTIONS

1. A factory consists of n machines $m_1, m_2, ..., m_n$, capable of processing raw material into semi-products. The processing speeds of the machines (in tons of raw material processed per hour) are $s_1, s_2, ..., s_n$. The factory has to accomplish k orders, $k > n$, each specified by the amount of raw material (in tons) to be processed: $o_1, o_2, ..., o_k$. Each order is carried out on a single machine without interruptions. The sequence of processing the orders does not influence the speed and switching from one order to another is done without delay. However, machine m_1 can only process orders not larger than 5 tons, while other machines have no such limitation. You are asked to design an evolutionary algorithm (EA) to assign orders to machines so that they are accomplished in the shortest possible time. (Note that the time of finishing the last order counts as the time of accomplishing the orders). 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) **(5 pt)** how your EA handles constraints (if applicable).
2. (a) **(2p)** What is permutation representation?
   (b) **(7p)** Describe how Partially Mapped Crossover works. Illustrate it with an example.
   (c) **(3p)** Describe how Scramble Mutation works. Illustrate it with an example.

3. (a) **(6p)** Explain self-adaptation of parameters in evolutionary algorithms. Hints: discuss *what* is self-adaptation supposed to do, *why* do we expect that it will achieve this, and *how* does the mechanics of self-adaptation work in general.

   (b) **(10p)** Describe in detail how self-adaptation of mutation stepsizes works in evolution strategies. (Discuss the cases of one σ and n σ's separately.)

   (c) **(6p)** Is the order in which the $\vec{x}$ part and the $\vec{\sigma}$ part are mutated important? Why?

4. (a) **(5p)** Given a multiobejctive optimization problem in the k-dimensional decision space $\mathbb{R}^k$ with n objectives $f_1, \ldots, f_n$ to be maximized, what is the definition of dominance between two given candidate solutions?

   (b) **(3p)** What is the Pareto-optimal set belonging to this problem?

   (c) **(3p)** What is the Pareto-optimal front belonging to this problem?

5. (a) **(3p)** What are (dis)advantages of interactive EAs?

   (b) **(3p)** What are typical application areas for interactive EAs?

   (c) **(4p)** Describe two ways of performing subjective selection in interactive EAs?

   (d) **(4p)** Why do interactive EAs usually work on small populations?

6. **(4p)** Consider the following statement:

   > 'An EA with a high average solution quality is always better than an EA with a low average solution quality.'

   Is this statement correct or not? Give arguments.