NAT-DL Self-study: MOO & Hyperheuristics   Set 6 (week 8)

1. Portfolio selection is a typical application for multi-objective MHO algorithms. For the portfolio a selection of assets has to be made, so that the task consists in finding an optimal distribution of a budget over these assets. In addition to maximal return, also risk minimisation and asset preferences by the clients play a role. Discuss fitness functions for a metaheuristic MOO algorithm, and explain your approach to solving the problem.

2. Consider the following variant of the All-Ones problem over a discrete search space with two objectives:

   $f_1(x) = |2x_1 - x_2|$ if $x \neq$ "11 . . . 11", and otherwise $f_1(11 \ldots 11) = x_1 x_2$

   $f_2(x) = |2x_2 - x_1|$ if $x \neq$ "11 . . . 11", and otherwise $f_2(11 \ldots 11) = x_1 x_2$

   where x is a string of an even number of bits, with x_1 represents the number of bits equal to 1 in the first half of the string, and x_2 the number of bits equal to 1 in the second half of the chain. What is the optimal Pareto front? What approximations of the Pareto front are likely to be found? Show that using a genetic algorithm one can reach quickly the global optimum, whereas the local search is likely to get trapped. (adapted from Exercise 4.21 in Talbi)

3. Tracking objects in a video in conditions can be difficult for changes of lighting or if the object is get frequently occluded or if it rotates. Design a population-based metaheuristic based on particle swarms for such a tracking task. It can use a number of interest points that characterise the object, although not all of these points can be identified all the time.

4. In multi-objective metaheuristic optimisation, various strategies have been proposed to maintain diversity. For instance, the NSGA-II algorithm is based on a crowding distance measure. Propose a modification of the NSGA-II algorithm in which the crowding operator is replaced by a *k*-means clustering algorithm for some given value of *k*. (adapted from Exercise 5.18 in Talbi)

5. In many problems some solution components are discrete and some are continuous. How can a hyperheurstic algorithm be applied to this problem? This problem is occurs in most GP applications. Can you think of any interesting or more specific cases?

6. It is easy to produce toy examples with a non-connected Pareto front. Can you think of an example of a real-world problem where the Pareto front is non-connected?