INTELLIGENT DECISION SUPPORT SYSTEMS – EXERCISES XI – EVOLUTIONARY MULTIPLE OBJECTIVE OPTIMIZATION

I. Indicate the truth (T) or falsity (F) for the below statements.

a) Recombination can introduce new information to the optimization

b) The impact of the mutation on the evolutionary search is exploitative rather than explorative

c) Evolutionary optimization methods require multiple runs with different parameter values to approximate the Pareto frontier

d) Tournament selection belongs to the class of ordinal selection methods

e) The max point attains not better values than the nadir point on all objectives

f) VEGA applies a generation model of managing the population

g) The crowding distance for the non-dominated solutions in NSGA-II is equal to infinity

h) SPEA2 includes the archive members in the selection process

i) SMS-EMOA is an indicator based evolutionary algorithm for multiple objective optimization

II. Given the following chromosome in the binary encoding [1 0 1 1 0 0], representing an example solution for the knapsack problem, present a chromosome obtained after a flip bit mutation:

III. Given the two below presented chromosomes in the binary encoding:

1	**0**	**1**	**1**	**0**	**0**

0	**1**	**1**	**0**	**0**	**1**

present a pair of chromosomes obtained after applying 2-point crossover with crossover points after the second and fifth genes:

IV. Given the following table of fitness values for seven solutions ***a*** - ***g*** (fitness F_i to be maximized):

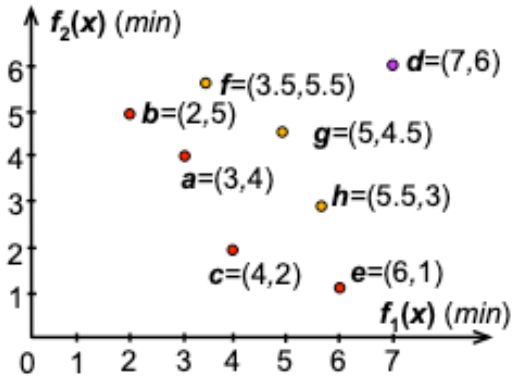
sol	*a*	*b*	*c*	*d*	*e*	*f*	*g*
F_i	3	1	3	2	0.5	1.5	1

Indicate the parents selected for the recombination operator with the tournament selection of size 4, when the following subsets of solutions participate in each tournament:

i) {*a, d, f, g*} - *Winner*:

ii) {*b, c, e, f*} - *Winner*:

V. Consider a set of solutions ***a***-***h*** in the objective space with two minimized objectives (see figure below).



a) Use the Kung's method to identify the first non-dominated front.

b) Show the Pareto fronts used by NSGA-II as the primary sorting criterion.

c) For all solutions, compute their raw fitness values (sum of strengths of dominating solutions) according to the rules of SPEA2.

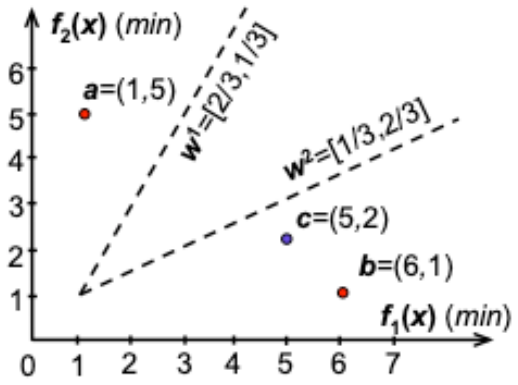
d) Which solution: ***a*** or ***c*** would be found more favorable by:

NSGA-II (draw cuboids related to the respective crowding distances),

SPEA2 (draw distances to the k=1 nearest neighbor), or

SMS EMOA (draw individual contributions to hypervolume; assume $\boldsymbol{d}=z^{ref}$).

VI. Consider a population composed of just two solutions ***a*** and ***b***, which is evolved by MOEA/D with the two uniformly distributed weight vectors provided in the figure. The latter ones are used as the parameters in the weighted Chebyshev distance from the reference point. Solutions ***a*** and ***b*** are the only ones contained in the current external archive.



a) Compute the current reference point according to MOEA/D.

b) Associate solutions ***a*** and ***b*** with the targets (which solution is the best for which target?).

c) Assume that by recombining ***a*** and ***b*** (the neighborhood's size T=2) and further mutating the newly obtained solution, we obtain solution ***c***. Will it become the new best solution for some target(s)? Show the new archive.