Assignment 16 Crossover Methods

An important part of an EA is the recombination. In the lecture, you have seen a number of different crossover operators for this purpose. Please answer the following questions.

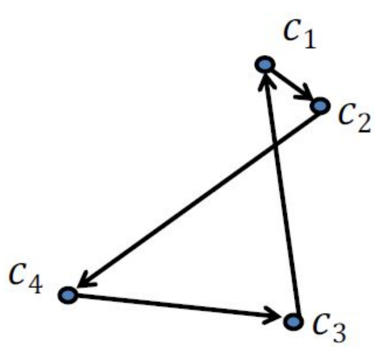
- What is the purpose of a crossover operator in an EA?

Crossover operator is used in combining partial solutions of parents to form new, promising solutions (offsprings).

- What is the difference between a crossover operator in a single-objective and in a multi-objective problem? Which modifications to the crossover might be necessary in multiple objectives?

No difference. As in Multi-Objective problem we just change the selection criteria on the basis of the number of objectives and everything else remains unchanged.

- You are working in a company that specializes in the logictics area and your current task is to design an EA to solve a Traveling Salesman Problem (TSP). It was already decided that the permutation representation is used for this problem as shown in the lecture. Now you need to decide for a suitable crossover method. Your boss asks you to use a one point crossover. What is your reaction? Please explain why this choice might be good or bad.



If we have a representation as c_2-c_4-c_1-c_5-c_3 and another one as c_2-c_4-c_5-c_1-c_3
And we perform one-point crossover then we obtain c_2-c_4-c_5-c_1-c_3
And c_2-c_4-c_1-c_5-c_3 we observe we obtain the same children as the parents but no diversity. Also their average distances will be the same as they are identical. So even if our objective was to minimize the distance

(single-objective) or minimize cost (bi-objective) crossover has no impact on these objectives. The main aspect of crossover is to have new unique solutions from the parents. If we use permutation representation then it alone can contribute to new solutions crossover has no role to play. So using one-point crossover is not a good idea.

- You are optimizing a problem where a solution is represented through a 2-dimensional real-valued vector. For the two individuals $\vec{x} = (1.2, 5.0)$ and $\vec{y} = (0.4, 2.2)$, please perform
  - an offspring solution through arithmetic crossover with $\vec{\lambda} = (0.5, 0.8)$ and $\epsilon = 0.0$.
  - two offsprings using a one point crossover.

  Graphically show the locations of the produced solutions in the 2-dimensional decision space.

Using Arithmetic crossover,

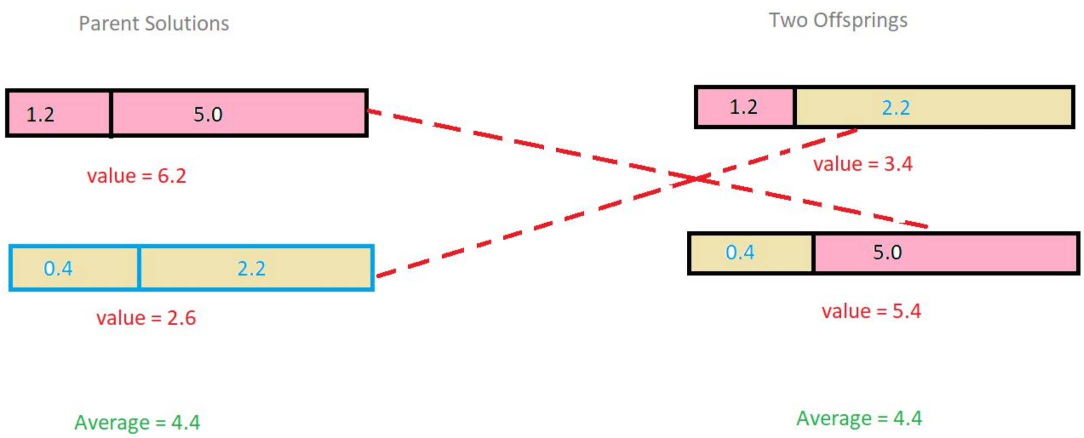
$$z_i = \lambda_i x_i + (1 - \lambda_i) y_i \ , \lambda_i \in [0 - \varepsilon, 1 + \varepsilon]$$

$\overline{x1} = 1.2$, $\overline{y1} = 0.4$, $\overline{\lambda 1} = 0.5 \in [0, 1]$
$z_1 = 0.5 * 1.2 + (1 - 0.5) * 0.4 \Rightarrow z_1 = 0.8$

$\overline{x2} = 5.0$, $\overline{y2} = 2.2$, $\overline{\lambda 2} = 0.8 \in [0, 1]$
$z_1 = 0.8 * 5 + (1 - 0.8) * 2.2 \Rightarrow z_2 = 4.4$

$\overline{z} = (0.8, 4.4)$

Using One-point crossover,



Plot