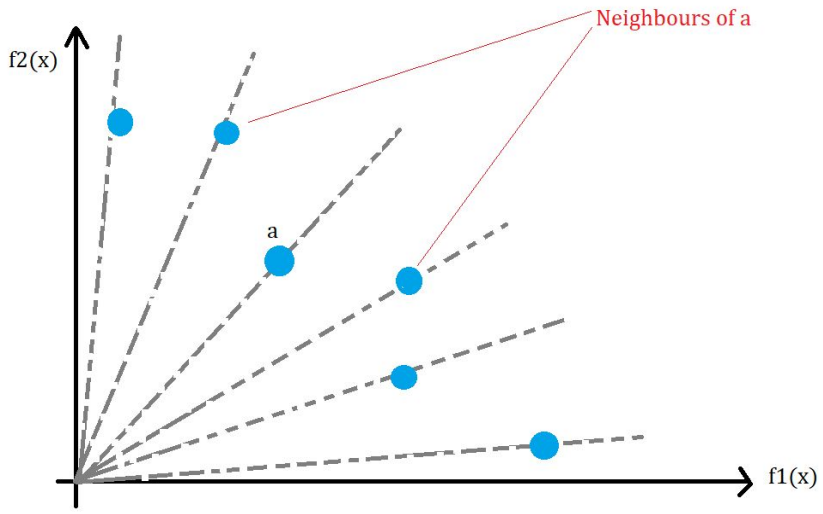
Submitted by: Ranji Raj

Assignment 25 (MOEA / D)

Take a look at the Multi-objective Evolutionary Algorithm based on Decomposition (MOEA/D) from the lecture and answer the following questions.

- Please explain the basic concept of MOEA/D and how it tries to solve a multi-objective problem.

- Decomposes the multi-objective problem into a number of single-objective problems by using **scalarization functions**.
- Use of a **neighbourhood structure** between these problems.
- Aims to find different parts by assigning different **weights** on the PF by solving the SOPs.
- Merge all the objectives into one single value with a **weighted sum** of objective functions.



- What are possible advantages and disadvantages of this approach?

+ Does **NOT** rely on Pareto dominance.
+ In comparison to NSGA-2, it provides a **good distribution** of solutions along with the PF.
+ By the good distribution of reference directions, it provides better **diversity.**

- Choice of appropriate **scalarization function** is crucial which is problem-dependent.
- For disconnected PFs, the **reference directions** might be unsuitable.

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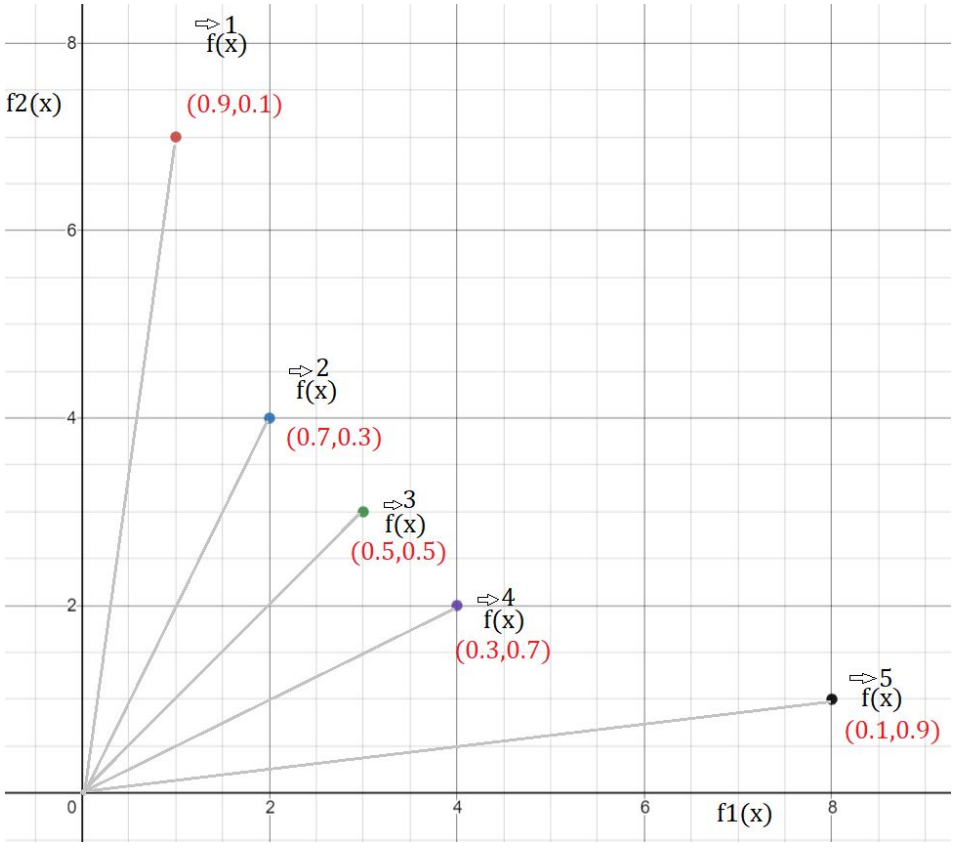
In the following, MOEA/D is used for a **minimization** problem with 2 objectives, a population size of $N = 5$, a neighborhood size of $T = 3$ and an archive size of 5. The neighborhood $B(i)$ of each problem i consists of its closest weight vectors in terms of Euclidean distance. The following table shows the weight vectors and the current population of MOEA/D. The archive consists of the same 5 solutions.

i	$\vec{\lambda}^i$	$\vec{f}(x^i)$
1	$(0.9, 0.1)$	$(1.0, 7.0)$
2	$(0.7, 0.3)$	$(2.0, 4.0)$
3	$(0.5, 0.5)$	$(3.0, 3.0)$
4	$(0.3, 0.7)$	$(4.0, 2.0)$
5	$(0.1, 0.9)$	$(8.0, 1.0)$

- Identify the neighborhoods $B(i)$ for $i = \{1, .., 5\}$.



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By Euclidean distance,

Population	$\vec{f}(x^1)$	$\vec{f}(x^2)$	$\vec{f}(x^3)$	$\vec{f}(x^4)$	$\vec{f}(x^5)$
$\vec{f}(x^1)$	0	3.16	4.47	5.83	9.21
$\vec{f}(x^2)$	3.16	0	1.41	2.82	6.70
$\vec{f}(x^3)$	4.47	1.41	0	1.41	5.38
$\vec{f}(x^4)$	5.83	2.82	1.41	0	4.12
$\vec{f}(x^5)$	9.21	6.70	5.38	4.12	0

Solutions in lighter font indicate farthest

The weighted sum on $\vec{f}(x^i)$ & $\vec{f}(y)$,

$F(x^1)$	1.6	$F(y^1)$	1.5
$F(x^2)$	2.6	$F(y^2)$	2.5
$F(x^3)$	3	$F(y^3)$	3.5
$F(x^4)$	2.6	$F(y^4)$	4.5
$F(x^5)$	1.7	$F(y^5)$	5.5

Solutions in green font indicate archive updated

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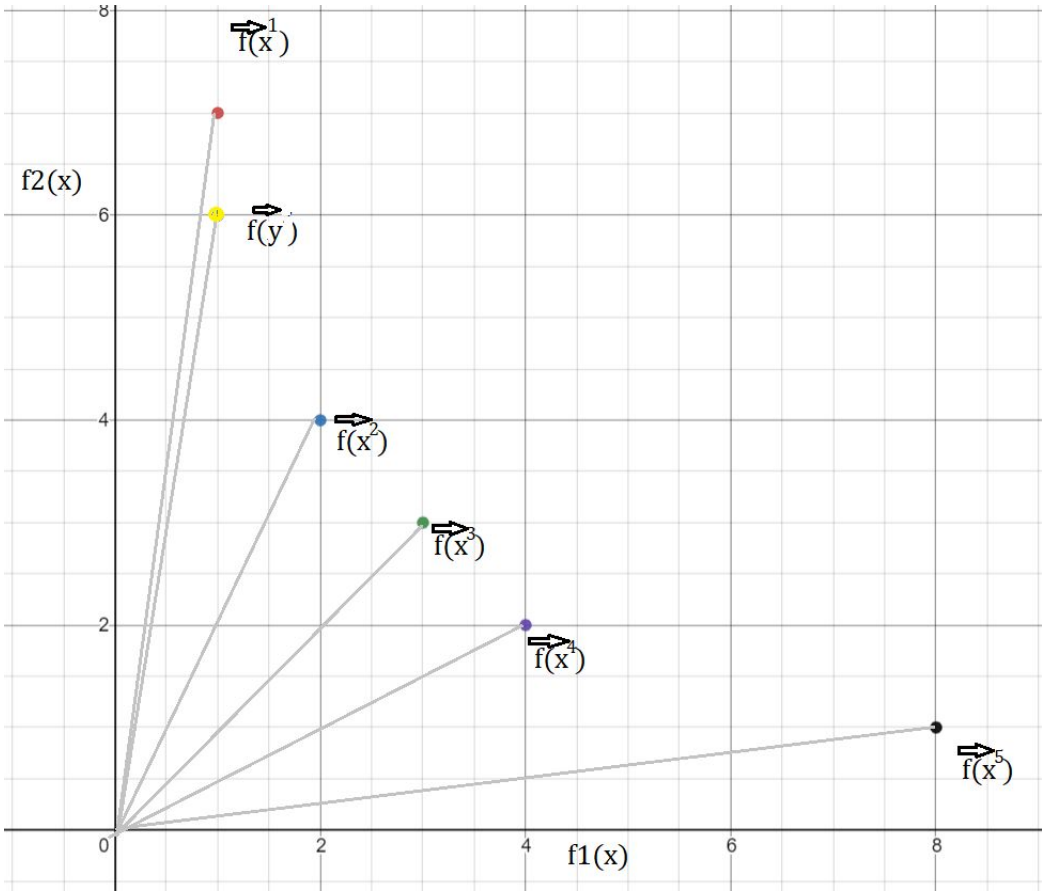
Neighbourhood updated with new solutions,



Population	$\vec{f}(x^1)$	$\vec{f}(x^2)$	$\vec{f}(x^3)$	$\vec{f}(x^4)$	$\vec{f}(x^5)$	$\vec{f}(y)$
$\vec{f}(x^1)$	0	3.16	4.47	5.83	9.21	1
$\vec{f}(x^2)$	3.16	0	1.41	2.82	6.70	2.23
$\vec{f}(x^3)$	4.47	1.41	0	1.41	5.38	3.60
$\vec{f}(x^4)$	5.83	2.82	1.41	0	4.12	5
$\vec{f}(x^5)$	9.21	6.70	5.38	4.12	0	5
$\vec{f}(y)$	1	2.23	3.60	5	5	0

Solutions in lighter font indicate farthest