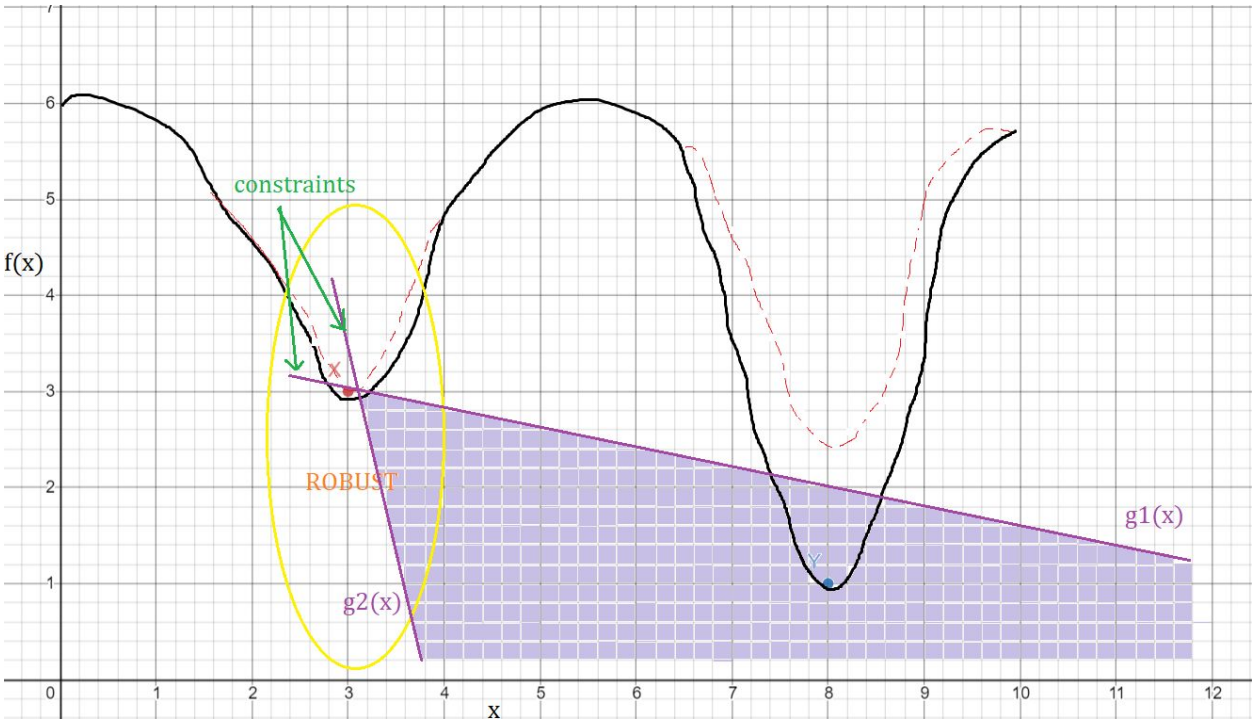
Submitted by: Ranji Raj

Assignment 28 (Robustness II)

Please answer the following questions related to Robustness.

- Explain the difference between robustness and reliability. Show a graphic example with at least one solution that is robust but not reliable, and another solution that is reliable but not robust.

1. **Robust designs** are designs where the variation in performance of the function wrt variation in relevant variables is **minimal**.
2. **Reliable designs** are designs at which the chance of system failure is **low.**



- What is the difference between robustness in single- and in multi-objective problems? Explain what changes are needed in type I and type II robustness for multi-objective problems.

1. In MOP, we should consider the robustness for all m-objectives (as preferred by DM).
2. The combined effect of variations in all m-objectives has to be used as a measure of sensitivity to variable perturbation.

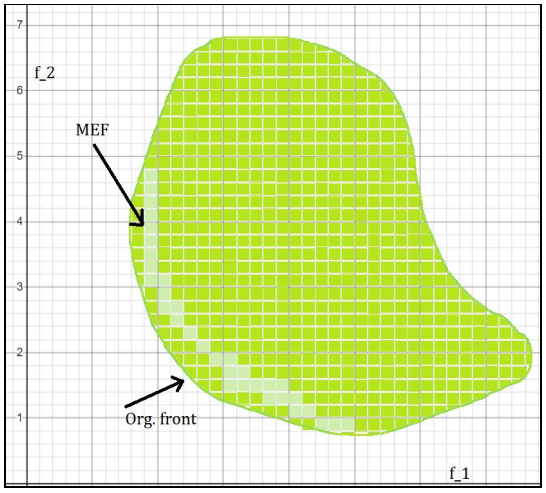
For any solution to be **Type I - MO Robust solution** if it is the global Pareto-optimal solution of form:

Min $F^{eff}(x) = (f_1^{eff}(x), f_2^{eff}(x),..., f_m^{eff}(x))$ subj to $x \in S$

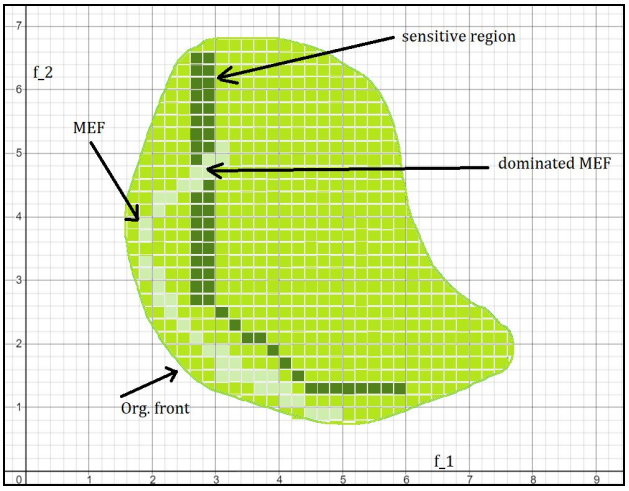
(where, $f_j^{eff}(x) = \frac{1}{|B_\delta(x)|} \int_{y \in B_\delta(x)} f_j(y)\, dy$; $|B_\delta(x)| \Rightarrow$ vol. of the δ-neighbourhood).

The obtained PF for this problem is called **M**ean **E**ffective **F**ront ⇒ cat. in 4 cases.

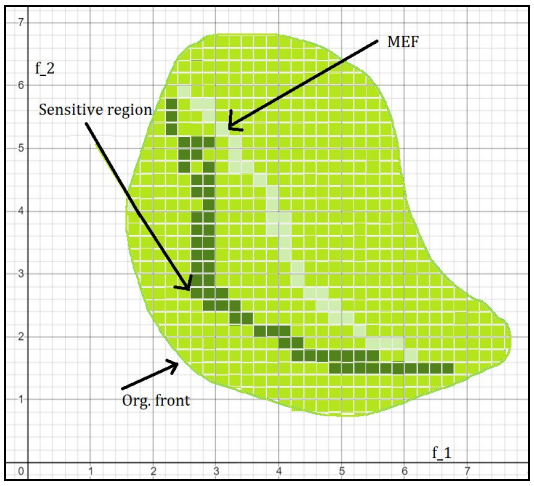
C1: Entire PF + MEF robust.



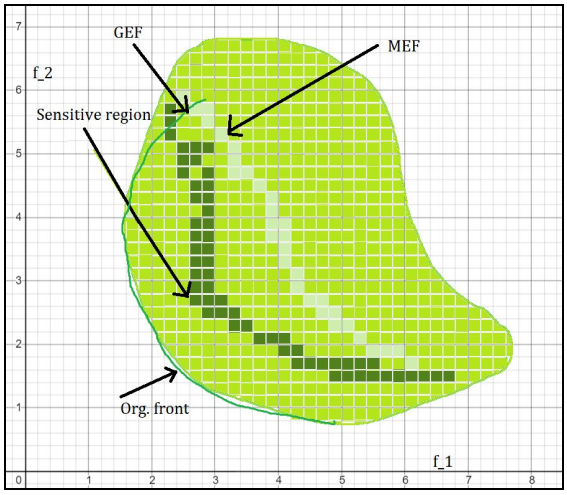
C2: Part of MEF robust



C3: MEF non-robust.



C4: Part of GEF non-robust.



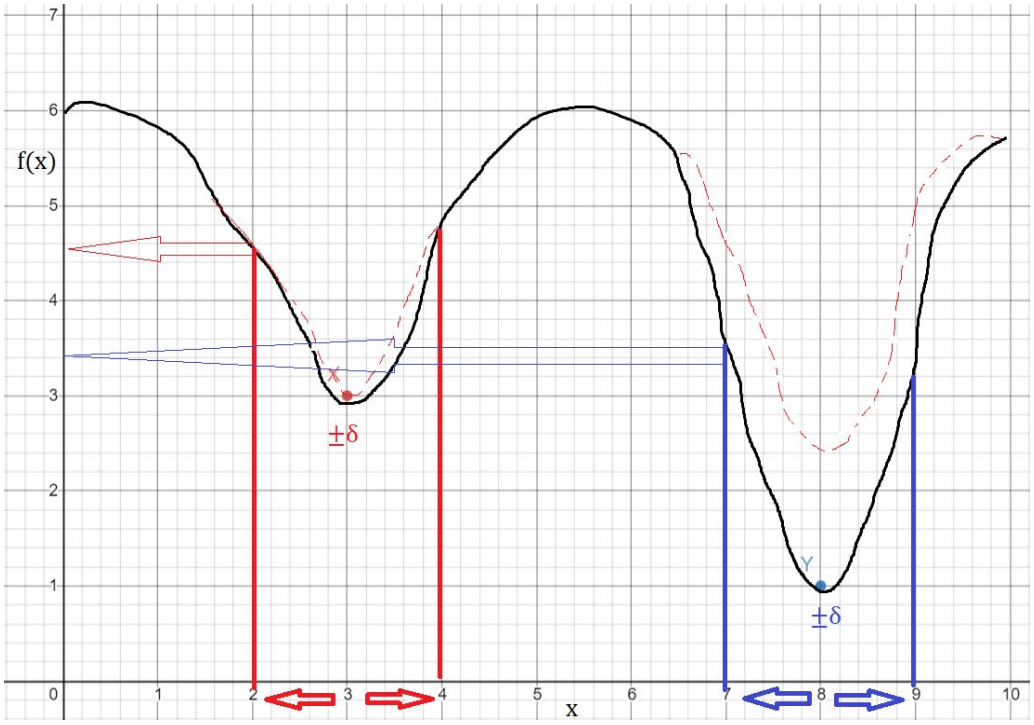
For any solution to be **Type II - MO Robust solution** if it is the (global) feasible Pareto-optimal solution of form:

Min F(x) = $(f_1(x),...,f_m(x))$

subj to $\dfrac{\|F^P(x) - F(x)\|}{\|F(x)\|} \leq \eta \;\&\; x \in S$

- In type I robustness, what is the influence of the parameter δ?

1. In the context of type I robustness, the **hyperparameter** δ represents the **neighbour** of a particular solution by going $\pm\delta$ around a solution i.e. x+δ or x-δ. ($\delta = 0 \Rightarrow$ no sampling).
2. The volume or size of the neighbourhood (set of neighbours) is defined by $\mathbf{B_\delta(x)}$.
3. The choice of δ is very critical as allows to provide **acceptable** solutions in an optimization problem.



- Discuss how the parameter η influences type II robustness.

1. η is a user-defined threshold used in the context of type II robustness $\frac{\|f^{eff}(x) - f(x)\|}{\|f(x)\|} \leq \eta$ & $f^{eff}(x) = f^{P}(x)$
2. If the η value is increased ⇒ accept every solution.
3. If the η value is decreased ⇒ $f^{eff}(x) - f(x)$ is indifferent.