Submitted by: Ranji Raj

Assignment 31 (Constraint Handling in MOP)

Consider the following bi-objective minimization problem with 2 decision variables and 1 inequality constraint:

$$\begin{aligned} min \quad & F(\vec{x}) = (f_1(\vec{x}), f_2(\vec{x})) = ({x_1}^2 + {x_2}^2, |x_1 - x_2 - 2 \cdot x_1 \cdot x_2 + 2|) \\ subject\ to \quad & g_1(\vec{x}) = |x_1 + x_2| > 2 \end{aligned}$$

And a population consisting of the following eight solutions:

$$\begin{array}{llll} x^{(a)} = (0,0) & x^{(b)} = (1,1) & x^{(c)} = (2,2) & x^{(d)} = (-3,0) \\ x^{(e)} = (1,2) & x^{(f)} = (-1,0) & x^{(g)} = (3,-2) & x^{(h)} = (1,3) \end{array}$$

Take a look at the constraint handling techniques in MOPs and answer the following questions.

- What advantages and disadvantages do you find between using penalty function for each objective and constrain-domination?

Penalized objective function

Advantages:

- Using a **penalty function** convert a constrained problem to an unconstrained one.
- The new fitness value is computed based on value of **fitness function** & **penalty term**.
- The amount of constraint violation is indicated by the **penalty term.**

Disadvantages:

- Penalty term sometimes ***distorts*** the objective function. (static penalty)
- Small R-value ⇒ lesser distortion ⇒ optimum may not be found.
- Large R-value ⇒ distortion creates artificial local minima ⇒ near true optimum.

Constrain-domination

Advantages:

- No conversion involved instead, measure the constraint violation for the solutions.

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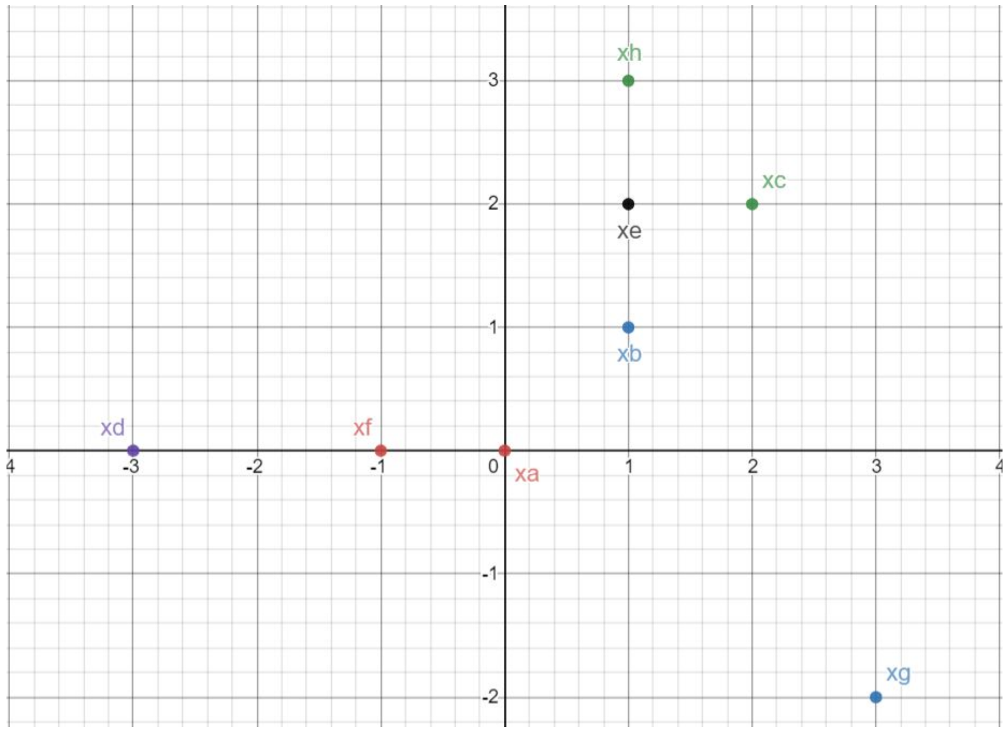
- Which solutions of the population are constrain-dominated by solution $x^{(d)}$?



Solutions, (x^{*})	Fitness, $F(\vec{x})$	Constraint, $g_1(\vec{x})$
$x^{(a)}$	(0, 2)	$0 \ngtr 2$
$x^{(b)}$	(2, 0)	$2 \ngtr 2$
$x^{(c)}$	(8, 6)	$4 > 2$
$x^{(d)}$	(9, 1)	$3 > 2$
$x^{(e)}$	(5, 3)	$3 > 2$
$x^{(f)}$	(1, 1)	$1 \ngtr 2$
$x^{(g)}$	(13, 19)	$1 \ngtr 2$
$x^{(h)}$	(10, 6)	$4 > 2$

$x^{(d)}$ **constraint dominates** $x^{(a)}$, $x^{(b)}$, $x^{(f)}$, $x^{(g)}$, $x^{(h)}$

- Which solutions are constrain-dominated by solution $x^{(b)}$?

$x^{(b)}$ **constraint dominates** none. It has a **larger** constraint violation value than any other solutions.

- Which solutions are non-dominated according to constrain-domination?

$x^{(c)}$, $x^{(d)}$, $x^{(e)}$

- Which solutions are the most reliable?

$x^{(c)}$, $x^{(d)}$, $x^{(e)}$, $x^{(h)}$