Project Phase - 3 (Final Project Evaluation)

- **Use Project Phase -2 code** for solving the constraints optimization problems
- The code should have comments that will be describing the steps/procedure of an optimization algorithm
    - Solve three test problems using **bracket-operator penalty method**
    - **The range on α should be found from the bounds on x vector. Therefore, no need to consider bounds on x –vector in bracket-operator penalty method.**
- Final Presentation
    - Choose proper title of the project
    - Description of method and flow chart
    - Results and Discussion: Include your results, discuss them and also write observations
    - Conclusions: Conclude your study
- Deadline of uploading the code and presentation in a zip file is **30 Oct. 2023, 10 PM.**

Important points for results and discussion section:

- Parameter setting for the algorithm, parameters setting for the test problems
- Run your algorithm from **10 different starting points** and tabulate the function values as (1) best, (2) worst, (3) mean, (4) median, and (5) standard deviation
- Include convergence plots of function value vs no. of iterations, Plot for no. of function evaluations vs no. of iterations, contour plots, etc.
- Note that in case you are not getting the correct results, those results should also be reported and write the possible reason for the same.

Appendix: Constraint Optimization Problems

Problem 1:

$$\min \boldsymbol{f}(\boldsymbol{x}) = (\boldsymbol{x_1} - \mathbf{10})^3 + (\boldsymbol{x_2} - \mathbf{20})^3,$$

$$\textit{subject to } \boldsymbol{g_1}(\boldsymbol{x}) = (\boldsymbol{x_1} - \mathbf{5})^2 + (\boldsymbol{x_2} - \mathbf{5})^2 - 100 \geq 0,$$

$$\boldsymbol{g_2}(\boldsymbol{x}) = (\boldsymbol{x_1} - \mathbf{6})^2 + (\boldsymbol{x_2} - \mathbf{5})^2 - 82.81 \leq 0,$$

$$\mathbf{13} \leq \boldsymbol{x_1} \leq \mathbf{20}, \qquad \mathbf{0} \leq \boldsymbol{x_2} \leq \mathbf{4}.$$

- Number of variables: 2 variables.
- The global minima: x* = (14.09500000000000064, 0.8429607892154795668), f(x*) = -0.6961:81387558015

Problem 2:

$$max\ \boldsymbol{f}(\boldsymbol{x}) = \frac{\boldsymbol{sin^3(2\pi x_1)\, sin(2\pi x_2)}}{\boldsymbol{x_1^3(x_1 + x_2)}},$$

$$\textit{subject to } \boldsymbol{g_1}(\boldsymbol{x}) = \boldsymbol{x_1^2} - \boldsymbol{x_2} + \mathbf{1} \leq \mathbf{0},$$

$$\boldsymbol{g_2}(\boldsymbol{x}) = \mathbf{1} - \boldsymbol{x_1} + (\boldsymbol{x_2} - \mathbf{4})^{\mathbf{2}} \leq \mathbf{0},$$

$$\mathbf{0} \leq \boldsymbol{x_1} \leq \mathbf{10}, \qquad \mathbf{0} \leq \boldsymbol{x_2} \leq \mathbf{10}$$

- Number of variables: 2 variables.
- The global minima: x∗ = (1.227, 4.245) , f (x∗) = 0.0958.

Problem 3:

$$\boldsymbol{min\ f(x) = x_1 + x_2 + x_3}$$

$$\textit{subject to } \boldsymbol{g_1(x) = -1 + 0.0025(x_4 + x_6) \leq 0},$$

$$\boldsymbol{g_2(x) = -1 + 0.0025(-x_4 + x_5 + x_7) \leq 0},$$

$$\boldsymbol{g_3(x) = -1 + 0.01(-x_6 + x_8) \leq 0},$$

$$\boldsymbol{g_4(x) = 100x_1 - x_1x_6 + 833.33252x_4 - 83333.333 \leq 0},$$

$$\boldsymbol{g_5(x) = x_2x_4 - x_2x_7 - 1250x_4 + 1250x_5 \leq 0},$$

$$\boldsymbol{g_6(x) = x_3x_5 - x_3x_8 - 2500x_5 + 1250000 \leq 0},$$

$$\boldsymbol{100 \leq x_1 \leq 10000}$$

$$\boldsymbol{1000 \leq x_i \leq 10000, i = 2, 3}$$

$$\boldsymbol{10 \leq x_i \leq 1000, i = 4, 5, \dots, 8}$$

- Number of variables: 8 variables.
- The global minima: x∗ = (579.3167, 1359.943, 5110.071, 182.0174, 295.5985, 217.9799, 286.4162,395.5979), f (x∗) = 7049.3307.