**CSE848: Evolutionary Computation**
**Michigan State University**

**Assignment HA1: Home Assignment 1**

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1. We are interested in finding the minimum solution of the following five-variable ($n = 5$) Rastrigin function starting from 100 random initial points in $x_i \in [-5.12, 5.12]$:

$$f(\mathbf{x}) = 10n + \sum_{i=1}^{n} \left( x_i^2 - 10\cos(\alpha \pi x_i) \right).$$

Use $\alpha = 0.25, 1.0$, and 2.0. Apply `fminsearch()` to solve each instance with maximum function evaluations of 5,000 and maximum iterations of 2,000 for each run. For each $\alpha$, report the best solution of 100 runs. Can you explain the results obtained? View 'Module 1, Lecture 2, Part 2 – Existing Point-based Optimization Methods: Multi-variable, Unconstrained' video for details on unconstrained optimization algorithms and 'Module 1, Lecture 2, Part 4 – Existing Search and Optimization Methods: Matlab Opt. Codes 1' on how to use `fminsearch()` in Matlab.

2. For the following constrained minimization problem, find the minimum solution using `fmincon()` routine.

$$\begin{array}{rl} \text{Minimize} & f(x_1, x_2) = (x_1 + 1)^2 + (x_2 + 1)^2, \\ \text{Subject to} & g_1(x_1, x_2) = (x_1 - 1)^2 + 4x_2^2 \le 5, \\ & g_2(x_1, x_2) = x_1 - x_2 \ge 1, \\ & g_3(x_1, x_2) = x_1 + 2x_2 \le 2. \end{array}$$

Start with an initial solution $(1, 1)$. Plot the history of intermediate solutions and also plot the reduction of objective values with iteration. View 'Module 1, Lecture 2, Part 2 – Existing Point-based Optimization Methods: Multi-variable, Unconstrained' video for details on unconstrained optimization algorithms and 'Module 1, Lecture 2, Part 4 – Existing Search and Optimization Methods: Matlab Opt. Codes 1' on how to use `fminsearch()` in Matlab. See 'Module 1, Lecture 2, Part 5 – Existing Search and Optimization Methods: Matlab Opt. Codes 2 (pdf)' file for a template on using `fmincon()` to run and plot the history and objective function values.

3. First, solve the following problem using `linprog()` routine of Matlab.

$$\begin{array}{rl} \text{Maximize} & x_1 + 4x_2, \\ \text{subject to} & x_1 + 5x_2 \le 10, \\ & 3x_1 + x_2 \le 15, \\ & x_1 + 2x_2 \ge 1, \\ & x_1, x_2 \ge 0. \end{array}$$

Then, solve it using MATLAB's `intlinprog()` routine for which the second variable is real-valued, but the first variable can only take an integer value.

Show the optimal solutions on a $x_1$-$x_2$ plot of feasible region and explain the validity of the obtained optimal solutions.

See 'Module 1, Lecture 2, Part 5 – Existing Search and Optimization Methods: Matlab Opt. Codes 2 (pdf)' on the use of `linprog()` and `intlinprog()` routines.