CL603: Optimization
Tutorial 4

Course Instructor: Prof. Mani Bhushan (mbhushan@iitb.ac.in)
Course TAs: Om Prakash (prakash.om@iitb.ac.in),
Varun (varun.p@iitb.ac.in)

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Specific Aim: To implement and compare performances of steepest-descent and Fletcher-Reeves Conjugate-Gradient (FRCG) line search methods, on the Rosenbrock function.

Consider the following function (known as Rosenbrock function):

$$f(\mathbf{x}) = 100(x_2 - x_1^2)^2 + (1 - x_1)^2$$

Use $x_{\text{initguess}} = [1.5 \;\; 1.5]^T$, $N = 15000$ as the maximum number of iterations (steepest descent requires large number of iterations) and $\epsilon = 10^{-8}$ as the tolerance on square of gradient-norm.
Do the following in Python or MATLAB:

1. Implement steepest-descent method. Use analytically computed gradient.
2. Implement FR-CG (Fletcher Reeves Conjugate Gradient) method. Use analytically computed gradient wherever required. A pseudo-code for the FR-CG algorithm is given in the class notes

For both the methods, use a backtracking strategy to choose an acceptable α. The parameters for this backtracking strategy are: $\bar{\alpha} = 5, \rho = 0.8, c = 0.1$. Refer to "Algorithm Backtracking Line Search" in the notes to see the pseudo code. To visualize the results, do the following:

1. Plot $\mathbf{x}$ versus iteration number i.e. x_1 with iteration number. and x_2 with iteration number in same figure.
2. Generate a figure which shows the value of $f(\mathbf{x})$ versus iteration number.
3. Label the axis and give title in each figure you generate.

Note: If you have worked out all the past tutorials, then at the end of this tutorial you should now have implementation of all the line search methods: Steepest-descent, Newton, Quasi-Newton (BFGS, DFP), and FR-CG on the Rosenbrock function. You can compare performances of all these methods yourself and play around with various parameters (such as those used in inexact line search or the initial conditions) to see the performances of the various methods.

Learning is fun. Best of Luck!