MECH 579: Multidisciplinary Design Optimization
Department of Mechanical Engineering, McGill University

Project #1: Unconstrained Optimization
Due 26th. September, 2013

Write a numerical code to minimize the Rosenbrock function defined below using a slew of gradient based optimization algorithms. The function is a non-convex function and has a global minimum at $(1, 1)$. The minimum is at the bottom of a narrow parabolic valley that is curved on the x-y plane. The function is often used to test the performance of optimization algorithms.

$$f(x, y) = (1 - x)^2 + 100(y - x^2)^2$$

1. Write four codes using the steepest descent, nonlinear conjugate gradient, quasi-Newton, and Newton method to solve for the minimum of the function. Use a simple backtracking line search method to compute the step length. You may choose one particular algorithm for the conjugate gradient (either the Hestenes-Stiefel, Polak-Ribiere, or Fletcher-Reeves) and quasi-Newton (DFP or BFGS) method.

2. Provide the following in a written report:

   (a) Convergence of the gradient (y-axis: log of the gradient, x-axis: iteration) and a comparison of the convergence.

   (b) Contour plot of the path of the optimization algorithm.

   (c) Compare the line search algorithm (backtracking) with a fixed step length.

Reports must be handed in a PDF format. All plots must have both x- and y-axis labels, a legend clearly describing the various lines, and a title with a Figure number. Plots generated with MS Excel are not acceptable and assignments will not be graded.

Bonus (Extra Credit): You may include one of the following:

1. Select one additional algorithm each for the conjugate gradient and the quasi-Newton methods and compare them.

2. Apply the general line search algorithm to all the methods and compare the results.