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

Final Project: MDO via IDF
Due 16th. December, 2013

Extend the your code to solve the same unconstrained multidisciplinary optimization problem using either the direct or adjoint method through an IDF approach.

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\begin{aligned}
\text{minimize} \quad & f(x,y) = -20e^{-[(x_1-1)^2+0.25(x_2-1)^2]} + y_1 + \cos(y_2) \\
\text{with respect to} \quad & x_1, x_2 \in \mathbb{R}^n \\
\text{where} \quad & R_1(x, y_1(x, y_2)) : y_1 = -3e^{-[(x_1+1)^2+0.25(x_2+1)^2]} + \sin(y_2) \\
& R_2(x, y_2(x, y_1)) : y_2 = -3e^{-[5(x_1-3)^2+0.25(x_2-3)^2]} + e^{-y_1}
\end{aligned}
$$

1. Provide the following in a written report:

   (a) Introduce the necessary additional elements into the optimization framework to allow for an MDO approach through the IDF method. You may compute the derivatives through either the adjoint or direct approach. However you do need to compare the derivative against the finite-difference approach. Compare the derivatives uptop 16 decimal places match. If they do not, then explain why? For the finite difference, use both first- and second-order discretizations and show that as you progressively reduce the value of epsilon (perturbation) that the gradient converges at the expected rates.

   (b) Use a Quasi-Newton framework to find the optimum solution. Show your derivation of the equations. Use a fixed step length (No line search is required) and select $(-0.1, -1)$ as your initial point.

   (c) Show a contour plot of the function and over plot the optimization path. Compare the optimization path between the MDF and IDF approaches.

   (d) Provide and compare the convergence plots of the function value and gradient between the MDF and IDF. The y-axis would either be the function value or gradient, while the x-axis is the number of design cycles.

   (e) Discuss your choice of any parameters that were used.

Reports must be handed in a PDF format.

For those who have chosen an individual project, repeat the steps above for your own optimization problem defined in the previous proposals.