ENGG7302
Advanced Computational Techniques in Engineering
Tutorial OP1

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In these questions we will use the following test functions (to be minimized):

- F1: $f(x_1, x_2) = x_1^2 + x_2^2$
- F2: $f(x_1, x_2) = 100x_1^2 + x_2^2$
- F3: $f(x_1, x_2) = -2x_1x_2 - 2x_2 + x_1^2 + 2x_2^2$
- F4: $f(x_1, x_2) = 100(x_2 - x_1^2)^2 + (1 - x_1)^2$
- F5: $f(x_1, x_2) = x_1^2 - 10\cos(2\pi x_1) + x_2^2 - 10\cos(2\pi x_2) + 20$

Question 1

Write a matlab function or script to produce a surface/mesh/contour plot of these functions in a user-specified range (e.g. $-3 \leq x_i \leq 3$). For later questions, you can get a good idea of the dynamic behaviour of an algorithm by plotting the search trajectory over the top of the function to be optimized. The matlab function "meshgrid" is useful for producing these plots.

Question 2

(i) Implement a steepest descent algorithm in matlab as described in lectures. To start with, do not use a line search to determine the step size α_k at each iteration; just define $0 < \alpha < 1$ as a constant parameter over all iterations. You should have a line in your code (or a seperate function) that allows you to enter the objective function and its derivates.

(ii) Test your algorithm on functions F1 - F5 above, experimenting with the step size parameter value. You should be able to plot the search trajectory produced by your algorithm as a path through the search space.

Question 3

Modify your steepest descent algorithm to use a line search to determine the value of the parameter α_k. You may use the existing matlab function "fminbnd", which is a combination of golden section search and successive parabolic interpolation (as mentioned in the lecture notes; see the matlab help page on this function for details). Alternatively you can implement the golden section search for yourself and use that.

Rerun the algorithm on the test functions above, recording the values of α_k during the search. Produce a plot of the value of α_k over time. What does this say about the dynamics of the search?