CSE848/ECE848: Evolutionary Computation
A Sample Solution of a Home Assignment Problem

Question:

4. Re-solve the above problem using penalty function method by solving the resulting penalized function $P(x_1, x_2, R)$:

$$P(x_1, x_2, R) = f(x_1, x_2) + R\sum_{j=1}^{J} \langle g_j(x_1, x_2)\rangle,$$

where $\langle\alpha\rangle = \alpha$ if $\alpha > 0$; zero, otherwise. Each variable bound needs to be used as a suitable normalized constraint of type $g(x_1, x_2) \leq 0$. For example, $-2 \leq x_1 \leq 6$ can be replaced by two constraints: $(-x_1 - 2)/2 \leq 0$ and $(x_1 - 6)/6 \leq 0$. Also normalize g_1 and g_2 by dividing the left side by the constant on the right side.

In subsequent sequences, use following R values: 0, 0.1, 1.0, 5.0, 10.0 and 50.0. Solve the unconstrained penalized function in each sequence using `fminsearch` routine of MATLAB. The first sequence is started with solution $(0, 0)^T$. Show the proceedings of each sequence on a x_1-x_2 plot.

Make a single pdf file of all your solutions and submit by going to
Assessments
        Assignments
                Assignment 1
Before the deadline

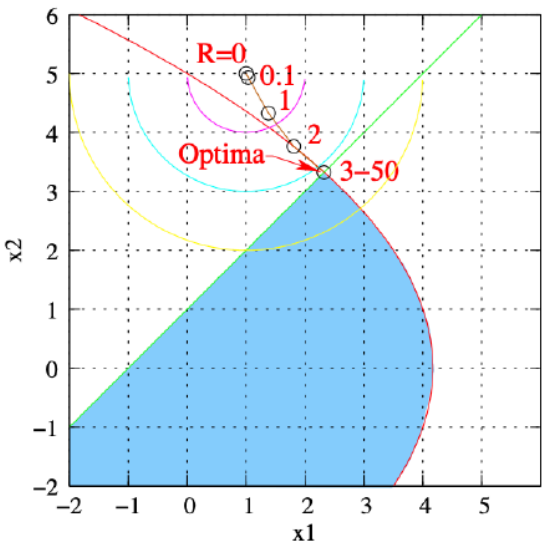
Sample Solution:

Q4. Penalty function method solved using fminsearch() of Matlab. The main code is presented below:

```
% HA2Q4 Solution
global R
penalty = [0, 0.1, 1, 2, 3, 4, 5, 10, 50];
n = size(penalty,2);
x0 = [1, 0];
for i=1:n
    R = penalty(i);
    [x,fv] = fminsearch(@objectiveHA2Q4,x0);
    fprintf("%5.2f  %6.3f %6.3f %6.3f\n",R,x(1),x(2),fv);
    x0 = x;
end
```

objectiveHA2Q4.m file is here:

```
function [f] = objectiveHA2Q3(x)
global R
f = (x(1)-1)^2+(x(2)-5)^2;
g(1) = (6*x(1)+x(2)^2-25)/25;
g(2) = -x(1)+x(2)-1.0;
g(3) = (-x(1)-2)/2;
g(4) = (x(1)-6)/6;
g(5) = (-x(2)-2)/2;
g(6) = (x(2)-6)/6;
cv = 0.0;
for i = 1:6
    if g(i) > 0
        cv = cv + g(i);
    end
end
f = f + R * cv;
```



Results from the Matlab code is here:

R	x1	x2	f
0.00	1.000	5.000	0.000
0.10	1.038	4.930	0.318
1.00	1.380	4.327	2.624
2.00	1.809	3.761	4.094
3.00	2.324	3.325	4.562
4.00	2.325	3.325	4.562
5.00	2.325	3.325	4.562
10.00	2.325	3.325	4.562
50.00	2.325	3.324	4.562

A plot showing how solutions approach constrained optimum from unconstrained optimum is shown above. This solution is same as that in Q3 (obtained by fmincon()).