전기전자공학수학
Computer Simulation HW2

2018142023 조성민

8.25 Write a simple MATLAB program for implementing the steepest descent algorithm using the secant method for the line search (e.g., the MATLAB function of Exercise 7.11). For the stopping criterion, use the condition $\|\boldsymbol{g}^{(k)}\| \leq \varepsilon$, where $\varepsilon = 10^{-6}$. Test your program by comparing the output with the numbers in Example 8.1. Also test your program using an initial condition of $[-4, 5, 1]^{\top}$, and determine the number of iterations required to satisfy the stopping criterion. Evaluate the objective function at the final point to see how close it is to 0.

<Theory>

Steepest descent algorithm

- $x^{(k+1)} = x^{(k)} - \alpha_k \nabla f(x^{(k)})$
- $\phi_k(\alpha) = f(x^{(k)} - \alpha \nabla f(x^{(k)}))$
- $\alpha_k = \arg min \phi_k(\alpha) = \arg min f(x^{(k)} - \alpha \nabla f(x^{(k)}))$

<Implementation>

- $g(x_1, x_2, x_3) = (x_1 - 4)^4 + (x_2 - 3)^2 + 4(x_3 + 5)^4$
- $\nabla g = 4(x_1 - 4)^3 + 2(x_2 - 3) + 16(x_3 + 5)^3$
- $\| g^{(k)} \| \leq \varepsilon$ where $\varepsilon = 10^{-6}$
- Initial condition = $[-4, 5, 1]^T$

<MATLAB code>

1.steep_desc

```
function [x,N]=steep_desc(grad,xnew)

epsilon_x = 10^(-6);
epsilon_g = 10^(-6);
max_iter=1000*length(xnew);

for k = 1:max_iter
    xcurr=xnew;
    g_curr=feval(grad,xcurr);
    if norm(g_curr) <= epsilon_g
        disp('Terminating: Norm of gradient less than');
        disp(epsilon_g);
        k = k-1;
            break;
    end %if

    alpha=linesearch_secant(grad,xcurr,-g_curr);

    xnew = xcurr-alpha*g_curr;

    if norm(xnew-xcurr) <= epsilon_x*norm(xcurr)
        disp('Terminating: Norm of difference between iterates less than');
        disp(epsilon_x);
        break;
    end %if

    if k == max_iter
        disp('Terminating with maximum number of iterations');
    end %if
end %for

disp('Final point = ');
disp(xnew');
disp('Number of iterations = ');
disp(k);
```

2. grad(g)

```
function y=g(x)
    y=[4*(x(1)-4).^3; 2*(x(2)-3); 16*(x(3)+5).^3];
end
```

$-\nabla g = 4(x_1-4)^3 + 2(x_2-3) + 16(x_3+5)^3$

<Result & Analysis>

```
>> steep_desc(@g,[-4;5;1])
Terminating: Norm of gradient less than
   1.0000e-06
Final point =
   4.0022e+00   3.0000e+00  -4.9962e+00
Number of iterations =
    25
```

-steep_desc 함수에 gradient g, initial condition $[-4,5,1]^T$을 입력했을 때 출력이 위와 같음을 알 수 있다.