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% Authors ~
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% This function Calculates the minimum of a multi-variable
% mathematical function using Cauchy's Steepest Descent method.

% Inputs ~
    %[z ~ Fuction to minimize]
    %[s ~ Starting Point]

% Outputs ~
    %[ x2 ~ point corresponding to minimum]

% Trial run for function
% syms x y
% z(x,y) = 4*x^2 + 3*y^2 - 5*x*y - 8*x
% [x2] = cauchysSteepestDescent(z,[0,0])

function [x2] = cauchysSteepestDescent(z,s)

syms x y
z(x,y)=z;
x1=s;
iter =0;

dfx = diff(z,x);
dfy = diff(z,y);
df=[dfx dfy];
df_check = [1 1];

%while((df_check(1) ~= 0 || df_check(2) ~=0))
while(iter~=20)
iter = iter + 1;
syms x y lambda
%sprintf("Iter: %d", iter);
x2 = x1 - lambda*df(x1(1),x1(2));

eqn_lambda = z(x2(1),x2(2));
deqn_lambda = diff(eqn_lambda);
lambda = solve (deqn_lambda,lambda);

x2 = x1 - lambda*df(x1(1),x1(2));
%disp(x2);
df_check = df(x2(1),x2(2));
%disp(df_check);


disp('-------------------------------------------')
fprintf('Iteration: %d', iter);
fprintf('\n')
fprintf('Lambda: %f',lambda);
fprintf('\n')
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fprintf('X:');
disp(double(x2));
fprintf('df_check:');
disp(df_check)
fprintf('\n')
fprintf('\n')

x1=x2;
clear lambda x y;

end
z_min = z(x2(1),x2(2));
fsurf(z);
hold on;
plot3(x2(1),x2(2),z_min, 'o');
fprintf('Z minimum : %f' , double(z_min));
end
```

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Iteration: 1
Lambda: 1.000000
X:    -1     1

df_check:[ -1, -1]



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Iteration: 2
Lambda: 0.200000
X:   -0.8000    1.2000

df_check:[ 1/5, -1/5]



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Iteration: 3
Lambda: 1.000000
X:   -1.0000    1.4000

df_check:[ -1/5, -1/5]



-------------------------------------------
Iteration: 4
Lambda: 0.200000
X:   -0.9600    1.4400

df_check:[ 1/25, -1/25]
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Iteration: 5
Lambda: 1.000000
X:   -1.0000    1.4800

df_check:[ -1/25, -1/25]



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Iteration: 6
Lambda: 0.200000
X:   -0.9920    1.4880

df_check:[ 1/125, -1/125]



-------------------------------------------
Iteration: 7
Lambda: 1.000000
X:   -1.0000    1.4960

df_check:[ -1/125, -1/125]



-------------------------------------------
Iteration: 8
Lambda: 0.200000
X:   -0.9984    1.4976

df_check:[ 1/625, -1/625]



-------------------------------------------
Iteration: 9
Lambda: 1.000000
X:   -1.0000    1.4992

df_check:[ -1/625, -1/625]



-------------------------------------------
Iteration: 10
Lambda: 0.200000
X:   -0.9997    1.4995

df_check:[ 1/3125, -1/3125]
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Iteration: 11
Lambda: 1.000000
X:   -1.0000    1.4998

df_check:[ -1/3125, -1/3125]



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Iteration: 12
Lambda: 0.200000
X:   -0.9999    1.4999

df_check:[ 1/15625, -1/15625]



-------------------------------------------
Iteration: 13
Lambda: 1.000000
X:   -1.0000    1.5000

df_check:[ -1/15625, -1/15625]



-------------------------------------------
Iteration: 14
Lambda: 0.200000
X:   -1.0000    1.5000

df_check:[ 1/78125, -1/78125]



-------------------------------------------
Iteration: 15
Lambda: 1.000000
X:   -1.0000    1.5000

df_check:[ -1/78125, -1/78125]



-------------------------------------------
Iteration: 16
Lambda: 0.200000
X:   -1.0000    1.5000

df_check:[ 1/390625, -1/390625]
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Iteration: 17
Lambda: 1.000000
X:   -1.0000    1.5000

df_check:[ -1/390625, -1/390625]



-------------------------------------------
Iteration: 18
Lambda: 0.200000
X:   -1.0000    1.5000

df_check:[ 1/1953125, -1/1953125]



-------------------------------------------
Iteration: 19
Lambda: 1.000000
X:   -1.0000    1.5000

df_check:[ -1/1953125, -1/1953125]



-------------------------------------------
Iteration: 20
Lambda: 0.200000
X:   -1.0000    1.5000

df_check:[ 1/9765625, -1/9765625]



Z minimum : -1.250000
```

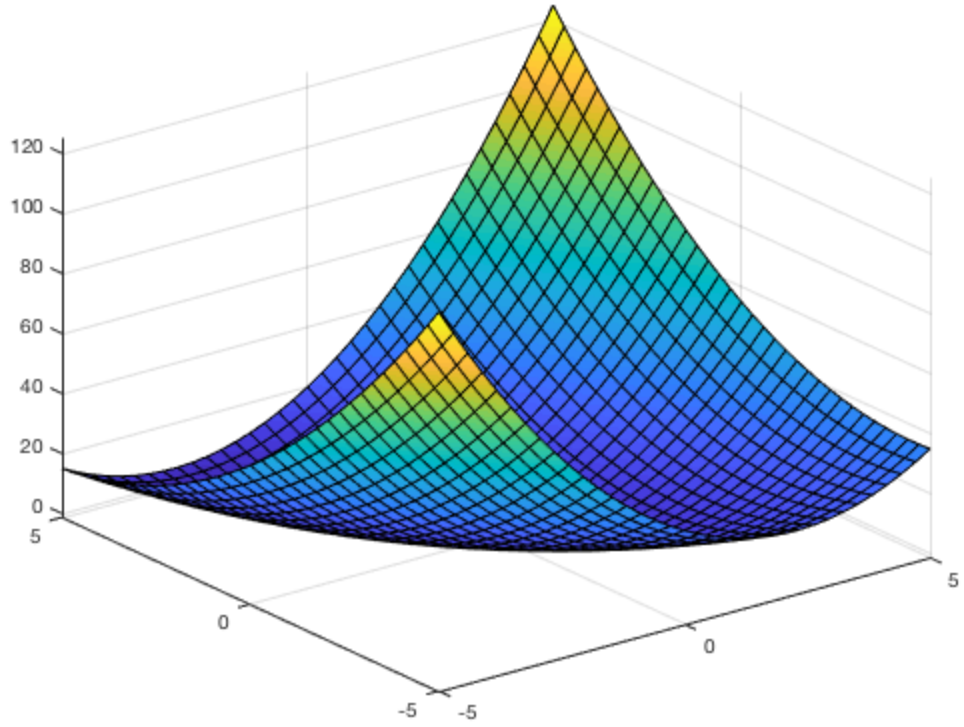

Published with MATLAB® R2017b