

% In-Lecture Assignment #3 on April 20, 2020

```
% Consider performing an iterative maximization of
%  $J(x) = 8 - x^2 + 6 \cos(6x)$ 
% via the steepest descent algorithm (JSK equation (6.5) on page 116)
% with the sign on the update reversed from negative to positive so that
% the algorithm will maximize rather than minimize; i.e.
%  $x[k + 1] = x[k] + \mu \left. \frac{dJ(x)}{dx} \right|_{x=x[k]}$ 
```

% a. Visualize and analyze the shape of the objective function $J(x)$.

% 1) Plot $J(x)$ for $-5 < x < 5$. Give the Matlab code for your answer.

```
x = [-5 : 0.01 : 5];
J = 8 - x.^2 + 6 * cos(6*x);
plot(x, J); %% At end of document
```

% 2) Describe the plot.

% It's a sum of a concave down parabola and a cosine, which creates
% multiple local maxima.

% 3) How many local maxima do you see?

% 11

% 4) Of these local maxima, how many are global maxima?

% Only one, located at $x = 0$.

% b. Derive the steepest descent update equation

% $dJ(x)/dx = -2x - 36\sin(6x)$

% and modify the code below to include the derivative of $dJ(x)/dx$

```
% Code below modified from a solution by a Spring 2019 student
% polyconverge.m find the maximum of  $J(x)=x$  via steepest descent
N=50; % number of iterations
mu=0.001; % algorithm stepsize
x=zeros(1,N); % initialize sequence of x values to zero
x(1)=0.7; % starting point x(1)
for k=1:N-1
    x(k+1)= x(k) + (-36*sin(6*x(k)) - 2*x(k))*mu; % update equation
end
figure();
stem(x); % to visualize approximation
x(N)
```

% c. Implement the steepest descent algorithm in Matlab with $x[0] = 0.7$.

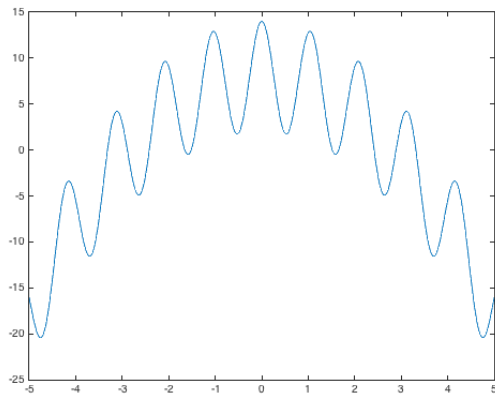
% 1) To what value does the steepest descent algorithm converge?

% $x = 1.0376$

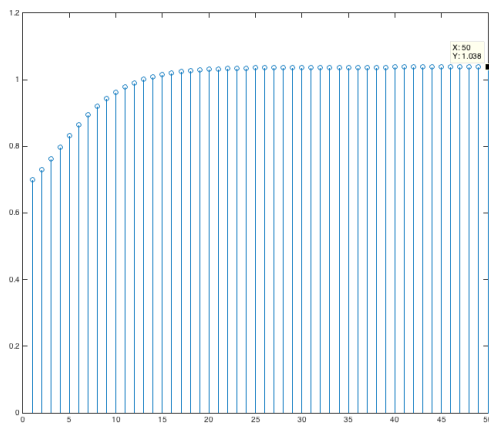
% 2) Is the convergent value of x in the global maximum of $J(x)$? Why or why not?

% No. The only global maximum of $J(x)$ occurs at $x = 0$.

% The objective function $J(x)$ is plotted below vs. x



% The plot below shows the trajectory of $x[k]$ values vs. k



% Below, the objective function $J(x)$ is highlighted with the global maximum at $x = 0$,
% the starting point of the steepest descent (hill climbing) algorithm at $x = 0.7$, and
% the point where the steepest descent (hill climbing) algorithm converges at $x = 1.0376$.

