Date: 31 Jan, 2014

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EE 5322 Intelligent Control Systems
Assignment no 1

Stock Market Time Series Analysis and DFT

The closing price for the NASDAQ tracking stock NVDA is given as an Excel file. Note there are 254 trading days in the year. There are about 22 trading days in a month. Therefore, for trading on a monthly time scale, one considers a 20-day time window. This allows one to capture many motions of the stock while not spending too much in broker's fees by churning the stock. On-line trades now run about $15 per transaction.

1. a. Compute the 20 day MA. Plot on the same figure as the stock closing price.

b. Plot the stock minus the 20 day MA.

c. Compute and plot the 20 day moving sample variance.

d. On the same figure, plot the stock closing price, the 20 day MA, and

the MA plus three times the 20 day standard deviation

the MA minus three times the 20 day standard deviation.

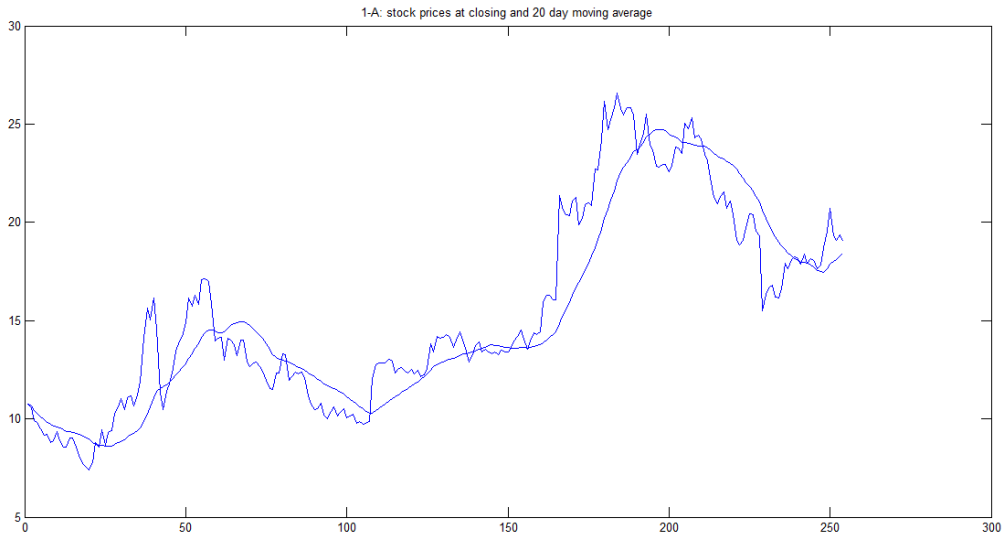
The last two lines are known as the Bollinger Bands, after John Bollinger.

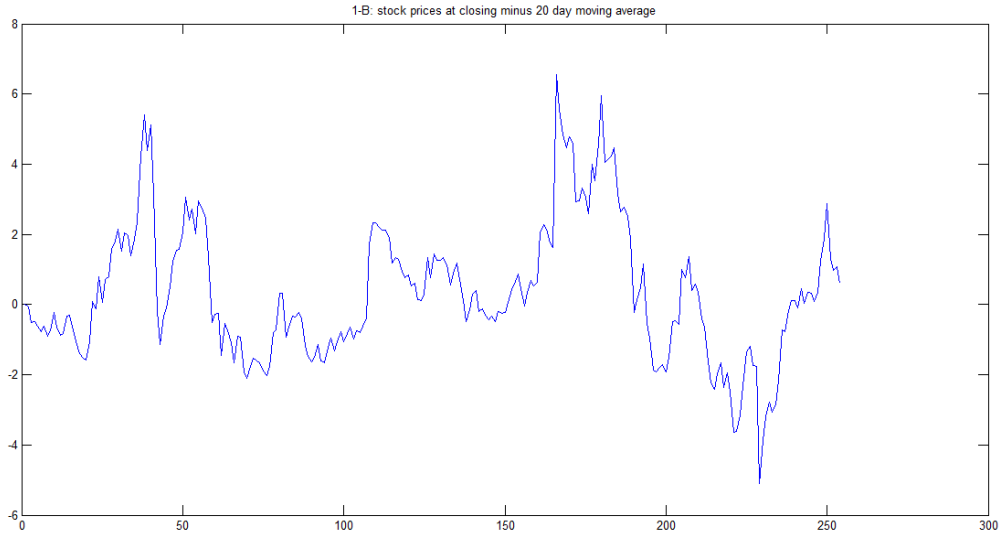
Solution :

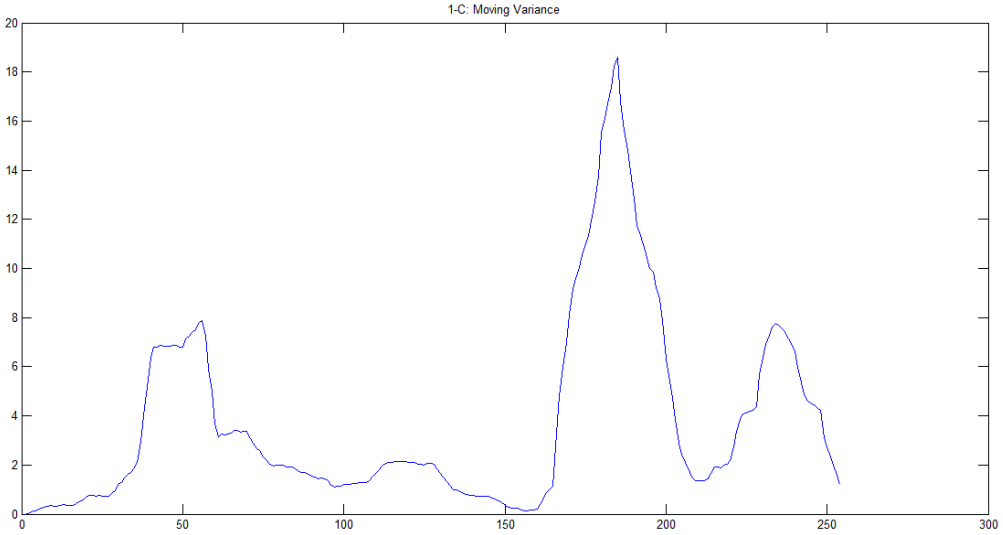
```
%%
        % Import data into matlab.
stock_prices = b;                   % import data from excell and save it in an array.
data = size(b);                     % save the size of the data array.
data = data(1);                     % select data from column 1.
%%
        %compute and plot the moving average
sum = 0;                            % initiate sum = 0.
mov_avg = size(stock_prices);       % set range of moving average.
for i = 1:data                      % setting up loop to calculate the sum.
sum = sum + stock_prices(i);        % calculating the sum with each stock price iteratively.
if i <= win_size                    % check if the value of i is less than the window size.
mov_avg(i) = sum/i;                 % calculate the moving average.
else
sum = sum - stock_prices(i-win_size);% sum is the diff of final sum and stock prices* window
moving backwards.
mov_avg(i) = sum/win_size;          % moving average of particular iteration is sum/window.
end
end
%%
         %plot the stock minus the 20 day moving average
figure(1);
plot(stock_prices);
title('1-A: stock prices at closing and 20 day moving average');
hold on;
plot(mov_avg);                          % plot moving average for each iteration.
         %plot the stock minus the 20 day moving average
figure(2);
plot(stock_prices-mov_avg');            % plot the difference of the moving average abd the
stock prices.
hold on;
title('1-B: stock prices at closing minus 20 day moving average');
%%
         %Calculating the moving variance
mov_var = size(stock_prices);           % Assign the size of the moving variance matrix.
sum = 0;                                % Reset sum to 0.
for i = 1:data                          % Set the number of iterations.
sum = sum+(stock_prices(i)-mov_avg(i))^2;% calculate the sum for the moving variance.
if i <= win_size                        %if the index is less than the window size, don't
subtract old data
mov_var(i) = sum/i;                     % calculate the moving variance
```

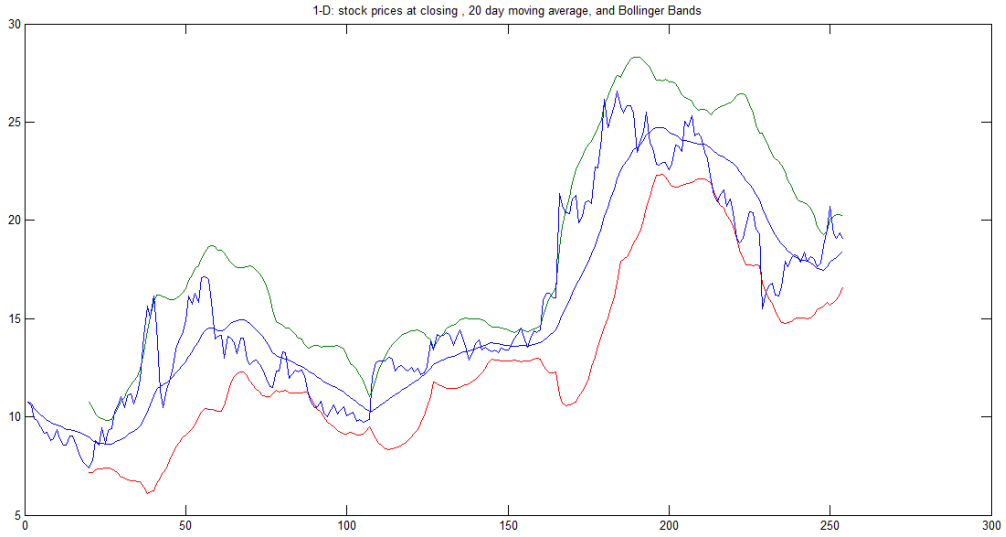
```
else
sum = sum-(stock_prices(i-win_size)-mov_avg(i-win_size))^2;% calculate the sum for moving
variance.
mov_var(i) = sum / win_size;             % calculate the moving variance
end
end
%%
          %plot the moving variance
figure(3);
plot(mov_var);                           % plot the moving variance.
title('1-C: Moving Variance');

%%
          %calculate boolinger bands
%[mid,uppr,lowr] = bollinger(stock_prices, 20 , 0, 3);

[mid,uppr,lowr]= bollinger(stock_prices);
Bollinger3 = [mid, uppr,lowr];

%%
          %compute the 20 day deviation (deviation) from the variance
deviation=sqrt(mov_var);

          %plot the closing price, 20 day mov_avg.

figure(4);
plot(stock_prices);                      % plot stock prices.
hold on;
plot(mov_avg);                           % plot the moving average.
hold on;
title('1-D: stock prices at closing , 20 day moving average, and Bollinger Bands');

figure(5);
plot(Bollinger)
hold on;
title('1-D : Bollinger Bands of stock_prices')
```

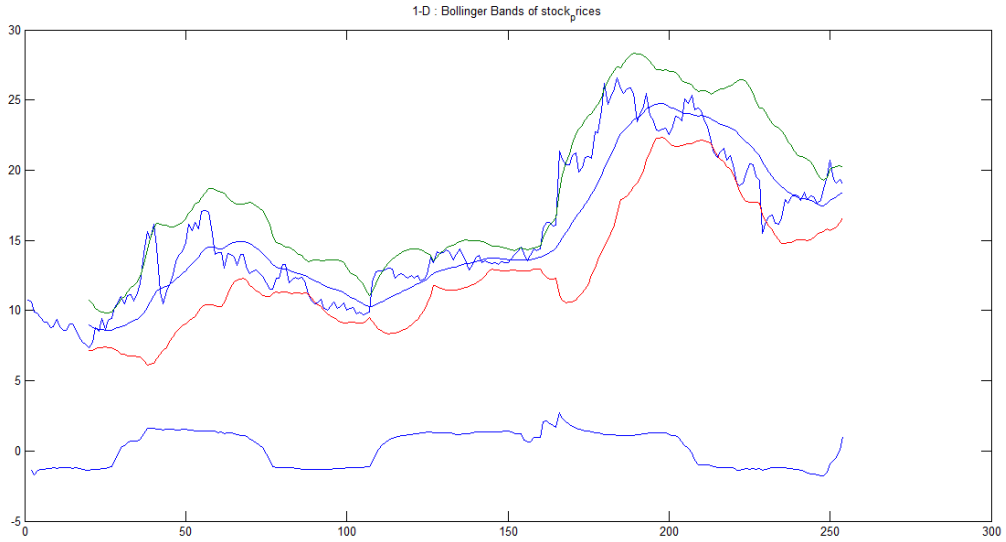
Plots :




1-B: stock prices at closing minus 20 day moving average
8
6
4
2
0
-2
-4
-6
0
50
100
150
200
250
300


1-C: Moving Variance
20
18
16
14
12
10
8
6
4
2
0
0
50
100
150
200
250
300





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2. a. Compute and plot the 20 day moving skew.

b. Compute and plot the 20 day moving kurtosis.

c. Can you use these statistics to find a leading indicator for movements in the stock?

i.e. how can we predict using statistics when the stock is about to break its trend (change its pattern)?

Solution: No it is not possible to predict when the stocks will change their trend.

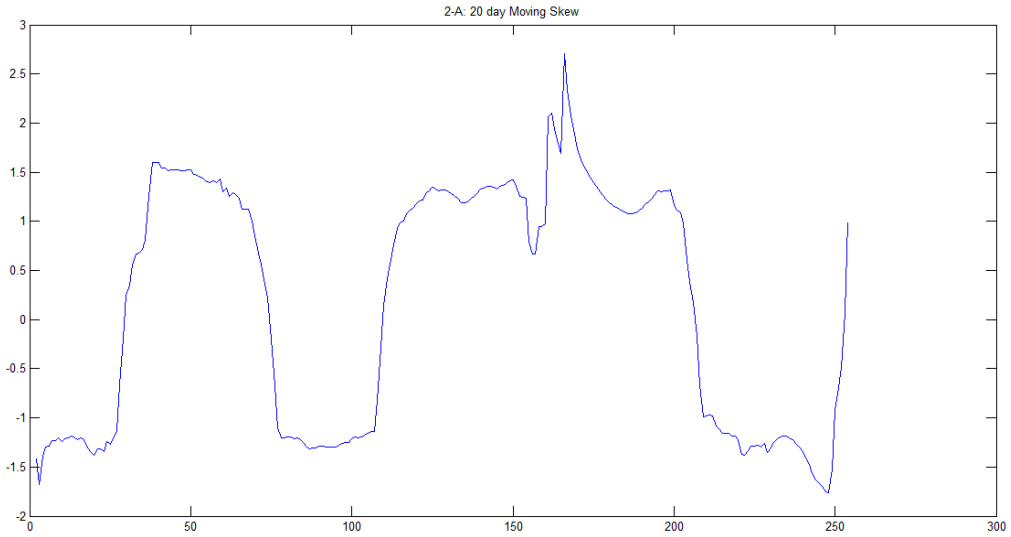
```
%%
          %compute and plot the 20 day moving skew
mov_skew = size(stock_prices);
sum = 0;
for i = 1:data
sum = sum+(stock_prices(i)-mov_avg(i))^3;
if i <= win_size %if the index is less than the window size, don't subtract old data
mov_skew(i) = sum/(i*deviation(i)^3);
```

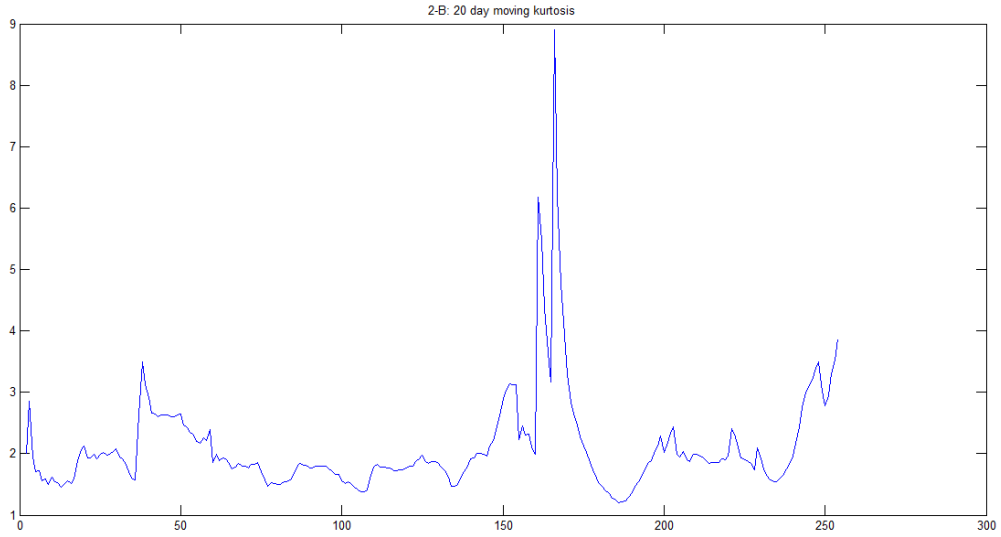
```
else
sum = sum-(stock_prices(i-win_size)-mov_avg(i-win_size))^3;
mov_skew(i) = sum/(win_size*deviation(i)^3);
end
end
%%
figure(6);
plot(mov_skew);
title('2-A: 20 day Moving Skew');

%%
          %compute the 20 day moving kurtosis
mov_kurt = size(stock_prices);
% k = kurtosis(mov_kurt)
sum = 0;
for i = 1:data
sum = sum+(stock_prices(i)-mov_avg(i))^4;
if i <= win_size            % check if the index is less than the window size,
mov_kurt(i) = sum/(i*deviation(i)^4);
else
sum = sum-(stock_prices(i-win_size)-mov_avg(i-win_size))^4;
mov_kurt(i) = sum/(win_size*deviation(i)^4);
end
end

%%
          %plot the 20 day moving kurtosis
figure(7);
plot(mov_kurt);
title('2-B: 20 day moving kurtosis');
```

Plot:





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3. a. Compute and plot the autocorrelation.

b. Compute and plot the autocovariance

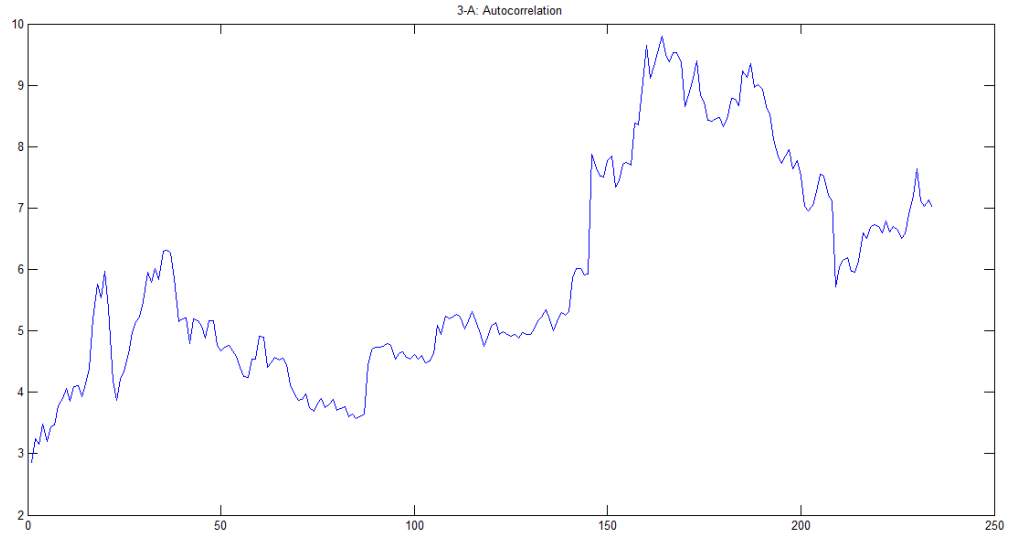
Solution:

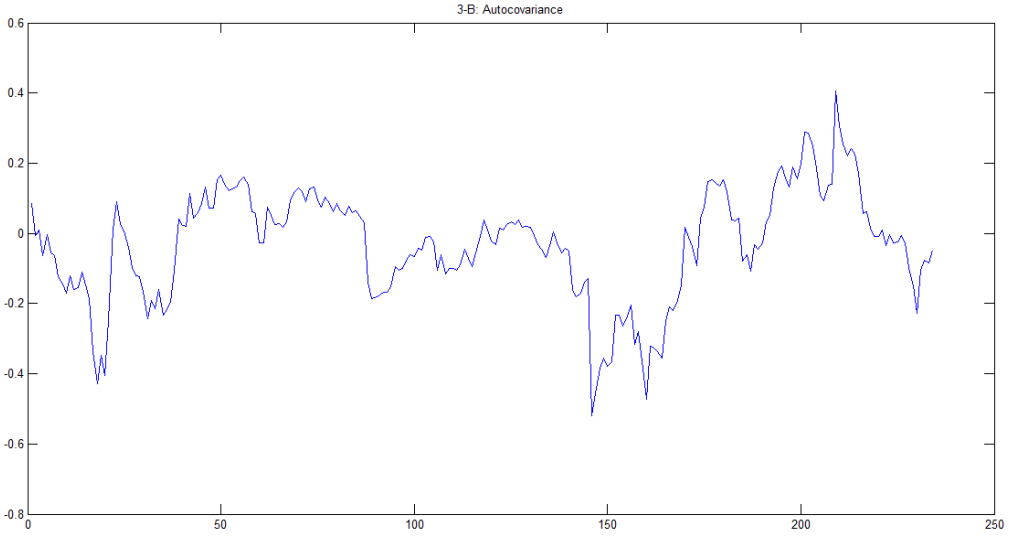
```
%%
          %compute and plot the autocorrelation
auto_cor = size(stock_prices);
for n = 1:data - win_size
sum = 0;
for k = 1:win_size
sum=stock_prices(k)*stock_prices(k+n);
end
auto_cor(n)=sum/win_size;
end
%%

figure(8);
plot(auto_cor);
title('3-A: Autocorrelation');

%%
          %compute and plot the autocovariance
auto_cov=size(stock_prices);
for n=1:data - win_size
sum=0;
for k=1:win_size
sum=(stock_prices(k)-mov_avg(k))*(stock_prices(k+n)-mov_avg(k+n));
end
auto_cov(n)=sum/win_size;
end
%%
figure(9);
plot(auto_cov);
title('3-B: Autocovariance');
```

Plots:





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4. a. Compute and plot the DFT of the entire signal.

b. Compute and plot the DFT of the entire signal minus the 20 day MA.

c. Compute and plot the time-varying DFT using a moving window of 20 days.

d. Compute and plot the time-varying DFT using fixed bins of 20 days in length.

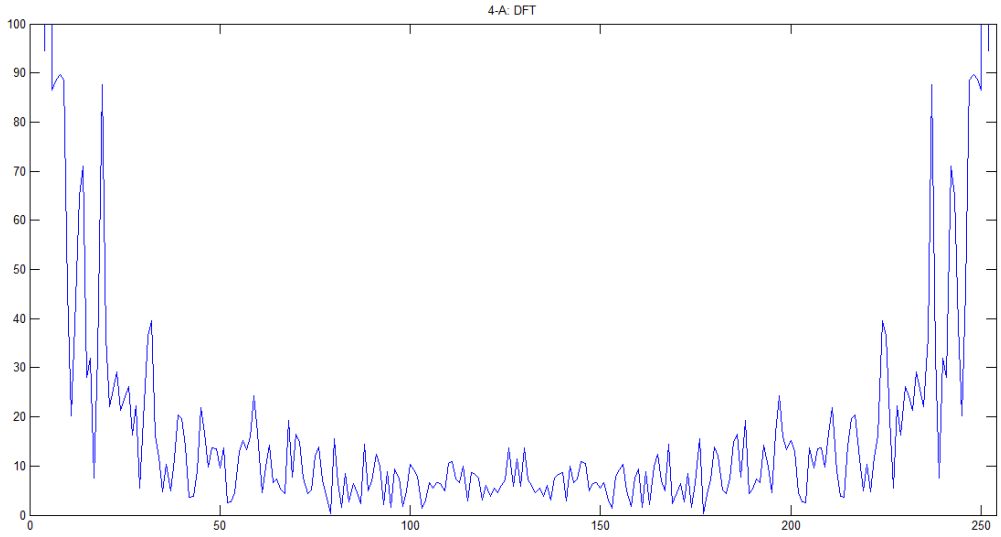
Any news about predicting movements in this stock?

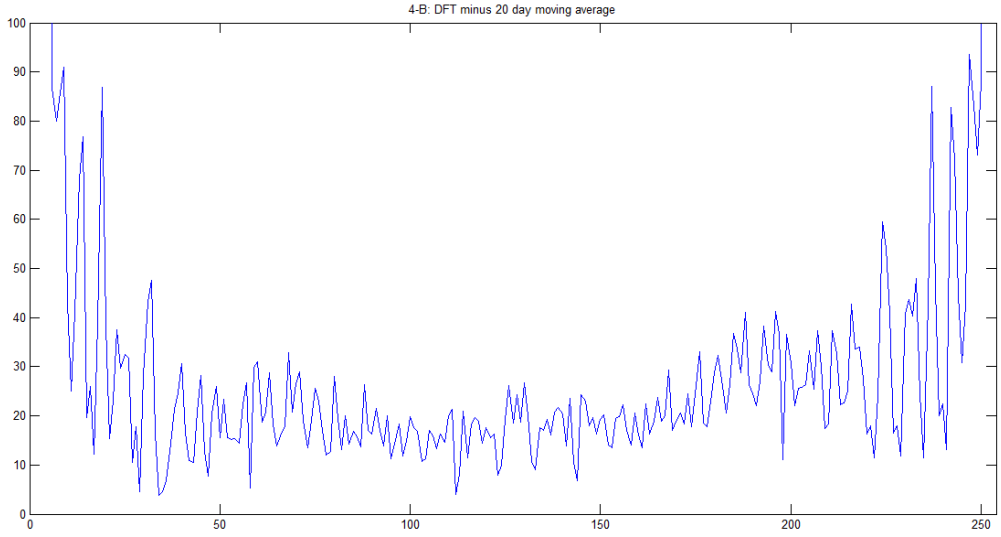
Solution: The stock prices are rising towards the end of the year. It is not a good time to buy.

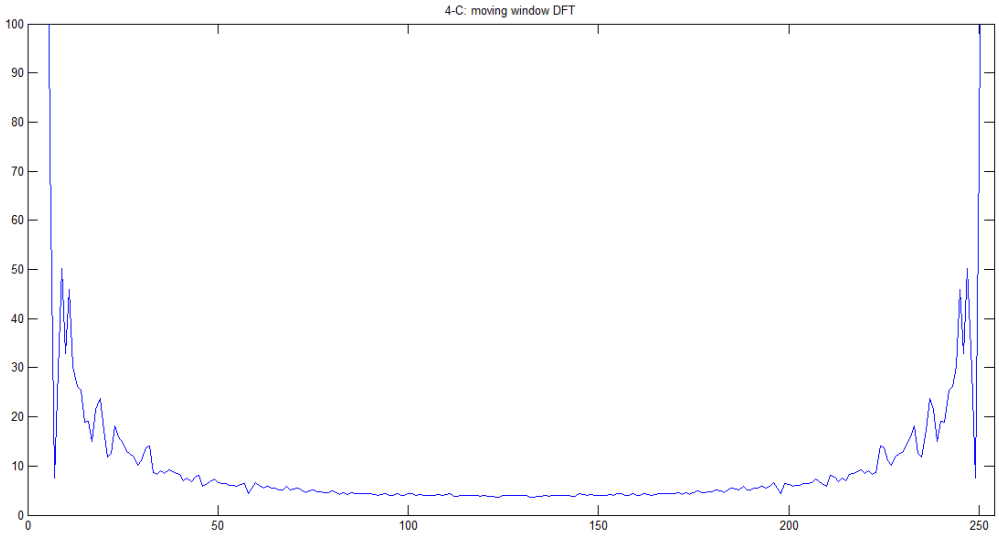
```
%%
          %compute and plot the DFT
DFT = fft(stock_prices',data);

%%
figure(10);
k = 1:data;
```

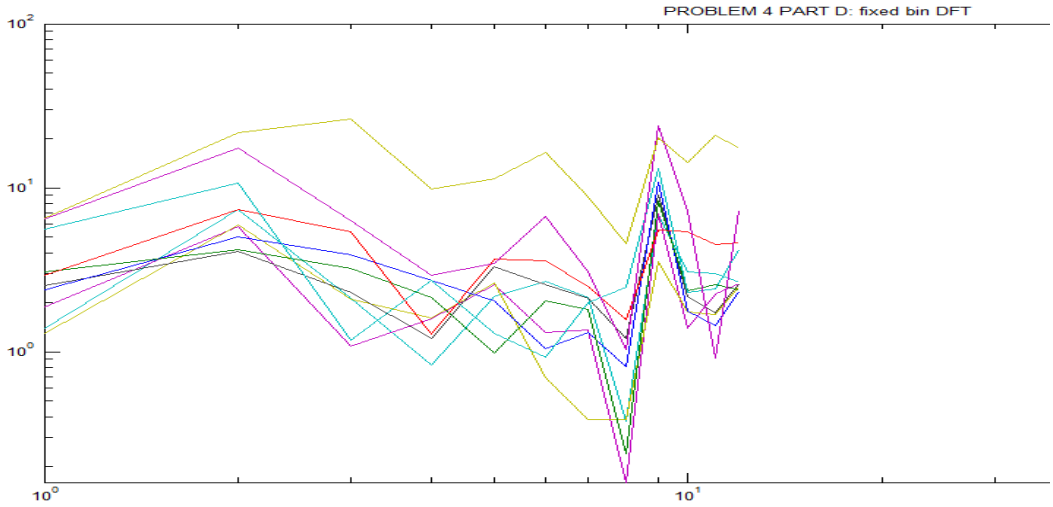
```
plot(k,abs(DFT));
axis([0,data,0,100]);
title('4-A: DFT');

%%
          %compute and plot the DFT - 20 day moving average
DFT2 = fft(stock_prices',data);
DFT2 = DFT2 - mov_avg;

%%
figure(11);
k = 1:data;
plot(k,abs(DFT2));
axis([0,data,0,100]);
title('4-B: DFT minus 20 day moving average');

%%
          %compute and plot the moving window DFT
DFT3 = fft(mov_avg',data);

%%

figure(12);
k = 1:data;
plot(k,abs(DFT3));
axis([0,data,0,100]);
title('4-C: moving window DFT');
%%

L = [1:254];
w = 2*pi*(L-1)/254; % Frequency being scaled to be within 2pi
time = L(:,1);
price = L(:,2);
for k = 1:254
    Sum = 0;

    if k-win_size+1 < 0
    for n = 1:k
        Sum = Sum + price(n)*exp(-1i*2*pi*(k-1)*(n-1)/254);
        cost(k,n) = Sum;
    end
    else
     for n = 1:254
        Sum = Sum + price(n)*exp(-1i*2*pi*(k-1)*(n-1)/254);
        cost(k,n) = Sum;
     end
    end
end

figure(14)
mesh(win_size,time,abs(cost))
hold on;
%%
          %compute and plot the fixed bin DFT

DFT4 = [];
for i = 1:data/win_size
DFT4 = [DFT4, fft(stock_prices((i - 1)*win_size+1:i*win_size))];
end

%%
figure(13);
dim = size(DFT4);
k = 1:dim(2);

plot(k,abs(DFT4));
axis([0,data,0,1])
title('4-D: Fixed bin DFT');
```

Plots:


4-A: DFT
0
10
20
30
40
50
60
70
80
90
100
0
50
100
150
200
250


4-B: DFT minus 20 day moving average
0
10
20
30
40
50
60
70
80
90
100
0
50
100
150
200
250


4-C: moving window DFT
100
90
80
70
60
50
40
30
20
10
0
0
50
100
150
200
250


PROBLEM 4 PART D: fixed bin DFT
10^2
10^1
10^0
10^0
10^1