HW 01 - Financial Econometrics

Details

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HW - 01

If you have opened the simulink project (.prj) file with Matlab,

your MATLABPATH should be set so that the relative references to data and functions "just work".

Load data

```
crsp = xlsread('data/sizeDecileReturns.xls');

% Looks like dates are never actually used, remove them for code readability
date = crsp(:, 1);
crsp = crsp(:, 2:end);

% You say to use percentage returns in all of the examples. Change decimal to percent here
crsp = crsp * 100;

% Short G format is easy to read and actually prints things right
format shortG;

% Seed
rng(1234);
```

Problem 1

A)

```
mean(crsp)
```

```
ans =
      0.072779      0.055515      0.059556      0.066928      0.073444      0.066704      0.066107      0.059582      0.052707     0.0075381
```

```
max(crsp)
```

```
ans =
        8.1969        3.1555        2.6871        2.8165        3.2541        3.7652        4.8502        5.1655        5.3187        5.5913
```

```
min(crsp)
```

```
ans =
       -5.1477        -4.282       -5.1066       -3.2128       -3.7655       -4.3835       -4.6154       -5.2493       -5.6997       -5.4798
```

B)

```
% Largest Decile 1 percentage return
d1 = nan(length(crsp), 2);
[d1(:, 1), d1(:, 2)] = sort(crsp(:, 1), 'descend');
d1(1, :)
```

```
ans =
        8.1969           641
```

```
% Smallest Decile 10 absolute percentage return
d10 = nan(length(crsp), 2);
[d10(:, 1), d10(:, 2)] = sort(abs(crsp(:, 10)));
d10(1, :)
```

```
ans =
       0.00157         1026
```

C)

```
% This makes sense, corr of those in similar market cap ranges is higher
corr(crsp(:, end), crsp(:, 1:end-1))
```

```
ans =
       0.48889      0.54885      0.62216      0.73042       0.7573      0.79241      0.84265      0.88099      0.90879
```

D)

```
% i) w = 1 means divide by N, which is without bias correction
std(crsp .^ 2, 1)
```

```
ans =
         2.811      0.92969       1.0644      0.83739       1.1605       1.4418       1.8878       1.9875        2.288       2.7111
```

```
% ii) w = 0 means divide by N-1, which is with bias correction
std(crsp .^ 2, 0)
```

```
ans =
        2.8121      0.93006       1.0648      0.83772        1.161       1.4424       1.8886       1.9882       2.2889       2.7122
```

```
% iii) w = 0 means divide by N-1, which is with bias correction, and dim = 2 does rowwise operation
std_bias_rowwise = std(crsp .^ 2, 0, 2);
std_bias_rowwise(1)
```

```
ans =
        2.2444
```

E)

Again, if you have opened the simulink project (.prj) then the functions should be visible on the path already. Otherwise they are in the `functions` folder.

```
normal_log_likelihood(0, 0, 1)
```

```
ans =
      -0.91894
```

F)

Kind of tricky here. Can't just compute this directly using `log(prod(normal_pdf(...)))`. Computationally not enough precision so this just goes to -Inf (because the product went to 0). Instead, bring the log inside the product first to change the multiplication to addition.

$$log(\prod_{i=1}^{N} \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x_i-\mu)^2}{2\sigma^2}})$$

$$\sum_{i=1}^{N} log(\frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x_i-\mu)^2}{2\sigma^2}})$$

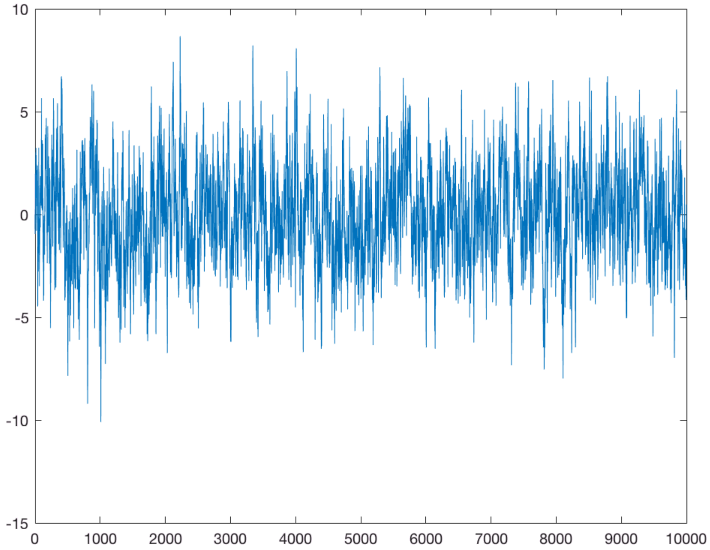
```
x     = crsp(:, 5);
mu_x  = mean(x);
var_x = var(x);

modified_normal_log_likelihood(x, mu_x, var_x)
```

```
ans =
       -1479.3
```

Problem 2

A)

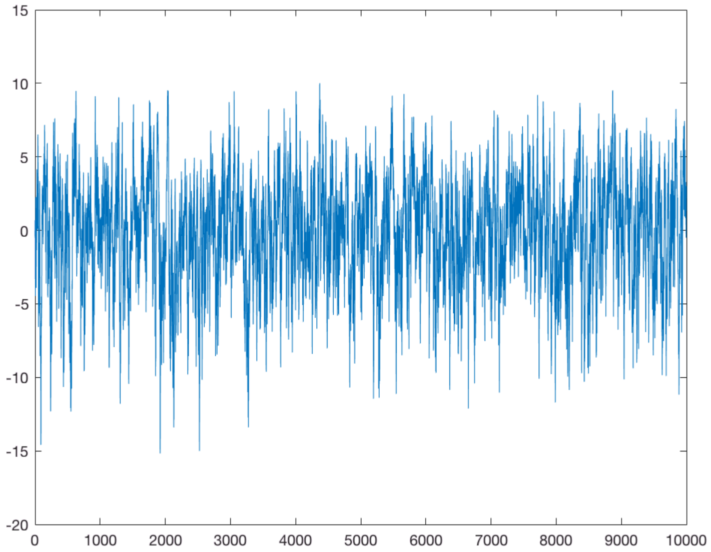
```
% Params
e     = randn(10000, 1);
Y_a   = zeros(10000, 1);
Y_0   = 0;
alpha = 0.1;

for(i = 1:length(e))

    % Take care of starting case
    if(i == 1)
        Y_a(i) = (1 - alpha) * Y_0 + e(i);
        continue
    end

    Y_a(i) = (1 - alpha) * Y_a(i-1) + e(i);
end

plot(0:length(Y_a), [Y_0; Y_a])
```



B)

```
% Params
e     = randn(10000, 1);
Y_b   = zeros(10000, 1);
Y_0   = 0;
e_0   = 0;
alpha = 0.1;

for(i = 1:length(e))

    % Take care of starting case
    if(i == 1)
        % This stays the same as before because at t = 0, the indicator is 0
        Y_b(i) = (1 - alpha) * Y_0 + e(i);
        continue
    end

    % One liner that just uses logicals instead of if statement
    I = double(e(i-1) < 0);

    Y_b(i) = (1 - alpha) * Y_b(i-1) + (1 + I) * e(i);
end
```

```
plot(0:length(Y_b), [Y_0; Y_b])
```



C)

As the length of the time series in a increases, the sample kurtosis should converge to 3, the same as the normal distribution. The reason for this is easy to see if we expand the recusion a bit. For example, consider the first two terms, Y_2 and Y_1.

$$Y(2) = (1-\alpha) * ((1-\alpha) * Y(0) + e(1)) + e(2)$$

The only random pieces here are $e(1)$ and $e(2)$, both of which are normally distributed. The sum of two independent normal random variables is another normal random variable, so $Y(2)$ is normally distributed with a kurtosis of 3. Extending this to the general case means that all of $Y(t)$ is normally distributed with a kurtosis of 3.

```
kurtosis(Y_a)
```

```
ans =
        3.0444
```

```
kurtosis(Y_b)
```

```
ans =
        3.0989
```

Problem 3

A)

```
% Create a var for decile 5 since we use it a lot
crsp_5 = crsp(:, 5);

% # of returns less than 0
sum(crsp_5 < 0)
```

```
ans =
   552
```

```

% # of returns equal to 0
sum(crsp_5 == 0)
```

```
ans =
     0
```

```

% # of returns greater than 0
sum(crsp_5 > 0)
```

```
ans =
   704
```

B)

```
% Number of absolute returns greater than 2x the std
sd_2x = 2 * std(crsp_5, 1);
sum(abs(crsp_5) > sd_2x)
```

```
ans =
    51
```

C)

```
% Which days had negative returns?
neg_rows = find(crsp_5 < 0);
rNeg = crsp_5(neg_rows);

% Average of those negative days
mean(rNeg)
```

```
ans =
     -0.61055
```

```

% Std Dev of those negative days
std(rNeg, 1)
```

```
ans =
       0.5426
```

D)

```
% returns of all deciles in that day >0
sum(all(crsp > 0, 2))
```

```
ans =
   333
```

```

% i) return of at least 1 decile in that day >0
sum(any(crsp > 0, 2))
```

```
ans =
        1030
```

```

% ii) no positive returns in that day
% Just the logical flip of the one before
% sum(all(crsp < 0, 2)) this makes more sense to me
sum(~any(crsp > 0, 2))
```

```
ans =
   226
```