Assignment 3 Determining and removing drawbacks of exponential and running mean

Group 6:

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Part I

```
clc
clear
close all
```

T1: Generate true trajectory and measurements.

Generating true trajectory using the random walk model

```
n =300;
X=zeros(n,1);
X(1)=10;

v_w = 28^2; % variance
sigma_w = sqrt(v_w); % standard deviation

for i=2:n
    w = sigma_w*randn; % normally distributed random noise
    X(i) = w + X(i-1);
end
```

Generating measurements:

```
v_eta = 97^2; % variance
sigma_eta = sqrt(v_eta); % standard deviation
eta = sigma_eta*randn(n,1); % normally distributed random noise
z = eta+X; %measurements
```

T2: Forward-Backward exponential Smoothing

```
chi = v_w/v_eta;
alpha = (-chi+sqrt(chi^2+4*chi))/2;

X_es = z;
for i = 2:n
```

```
    X_es(i) = X_es(i-1)+alpha*(z(i)-X_es(i-1));
end

X_esb = X_es;
for i = n-1:-1:1
    X_esb(i) = X_esb(i+1)+alpha*(X_es(i)-X_esb(i+1));
end
```

T3: Make visual comparison of results

```
M = floor((2-alpha)/alpha);
v_rm = v_eta/M;
v_es = v_eta*alpha/(2-alpha);

X_rm = z;
for i= (M+1)/2:n-(M+1)/2
    X_rm(i) = 0;
    for k = i-(M-1)/2:i+(M-1)/2
        X_rm(i) = X_rm(i) + z(k);
    end
    X_rm(i) = X_rm(i)/M;
end


%Indicators
d_rm=0;
d_es=0;

for i=1:n
    d_rm = d_rm + (z(i,1)-X_rm(i,1))^2;
    d_es = d_es + (z(i,1)-X_es(i,1))^2;
end

out1 = ['Deviation indicator for Running mean is ',num2str(d_rm)];
disp(out1)
```

```
Deviation indicator for Running mean is 2285979.3804
```

```
out2 = ['Deviation indicator for Exponential mean at alpha= ',num2str(alpha),' is ',num2str(d_e
disp(out2)
```

```
Deviation indicator for Exponential mean at alpha= 0.24999 is 1853856.8746
```

```
v_rm=0;
v_es=0;

for i=1:n-2
    v_rm = v_rm + (X_rm(i+2,1)-2*X_rm(i+1,1)+X_rm(i,1))^2;
    v_es = v_es + (X_es(i+2,1)-2*X_es(i+1,1)+X_es(i,1))^2;
end

out3 = ['Variability indicator for Running mean is ',num2str(v_rm)];
```

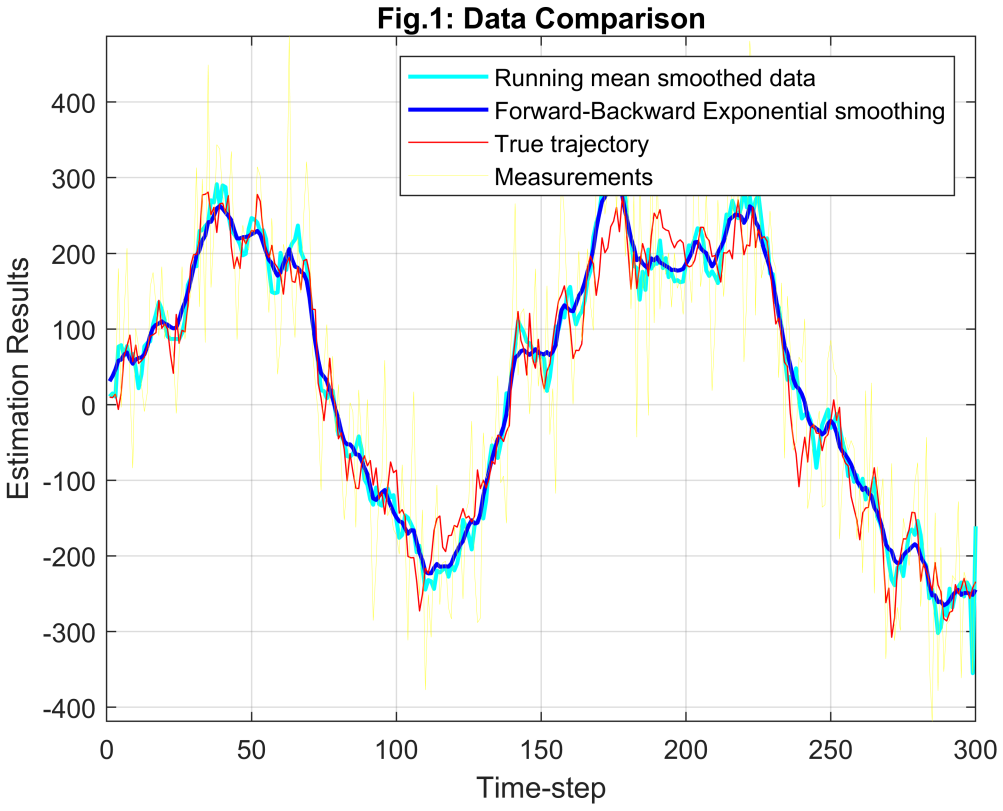
```
disp(out3)
```

```
Variability indicator for Running mean is 341228.8713
```

```
out4 = ['Variability indicator for Exponential mean at alpha= ',num2str(alpha),' is ',num2str(v
disp(out4)
```

```
Variability indicator for Exponential mean at alpha= 0.24999 is 404159.6284
```

```
figure
plot(X_rm,'c',"LineWidth",1.5)
hold on
plot(X_esb,'b',"LineWidth",1.5)
plot(X,'r')
plot(z,'y',"LineWidth",0.1)
title('Fig.1: Data Comparison')
legend('Running mean smoothed data','Forward-Backward Exponential smoothing','True trajectory',
xlabel('Time-step')
ylabel("Estimation Results")
grid on
axis([0 300 -inf inf])
```



Conclusions:

- The trajectory in the foraward exponential smoothing with compared with the true trajectory showed delayed response but then thus is compensated by the use of backward exponential smoothing and providing a better smoothen curve.

- The application of forward-backward smoothing to the trajectory gives more precise results with very less disturabances. The path followed by this gets more smoothen as we move backward from the final value to initial values.
- While deviation indicator is almost the same between Running mean and Exponential smoothing method, variability indicator for Running mean method is much less than the one of Exponential smoothing. This means that Running mean provides better accuracy in this case.