Assignment 2 Comparison of the exponential and running mean for random walk model

PART 2

Group 6:

- Andrei Shumeiko
- Ayush Gupta
- Olga Klyagina
- Simona Nitti


```
clc;
clear;
close all;
```

Task 1: Generate 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
```

Task 2: Generate 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
```

Task 3: Determine optimal smoothing coefficient in exponential smoothing

```
chi = v_w/v_eta
```

```
chi = 0.0833
```

```
alfa = (-chi+sqrt(chi^2+4*chi))/2
```

```
alfa = 0.2500
```

Task 4: Measurement error and window size M

```
M = floor((2-alfa)/alfa)
```

```
M = 7
```

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

Task 5: Running mean and Exponential mean

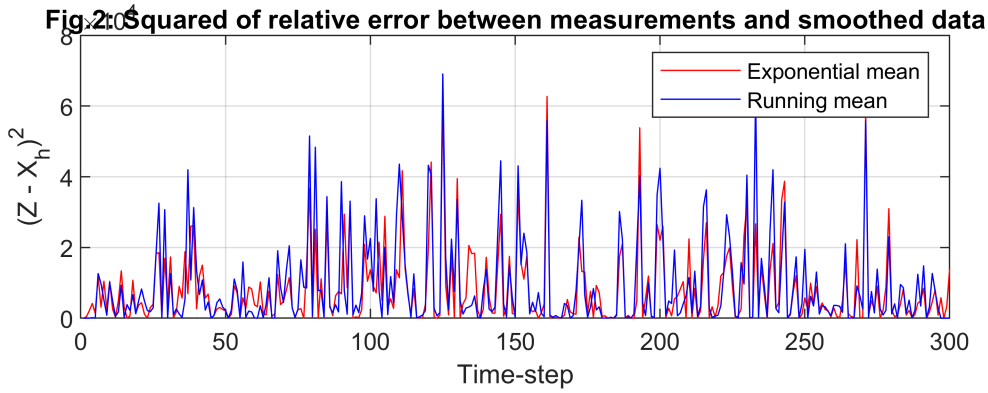
```
X_rm = z;
for i= (M+1)/2:n-(M+1)/2
    X_rm(i) = 0;
    for k = i-(M-1)/2:i+(M-1)/2
        X_rm(i) = X_rm(i) + z(k);
    end
    X_rm(i) = X_rm(i)/M;
end

X_es = z;
for i = 2:n
    X_es(i) = X_es(i-1)+alfa*(z(i)-X_es(i-1));
end
```

Comparitive Plots

```
figure
subplot(2,1,1)
plot(X_rm,'c',"LineWidth",1.5)
hold on
plot(X_es,'g',"LineWidth",1.5)
plot(X,'r',"LineWidth",0.5)
plot(z,'b',"LineWidth",0.5)
title('Fig.1: Data Comparison')
legend('Running mean smoothed data',['Exponentially smoothed data \alpha=', num2str(alfa)],'Tru
xlabel('Time-step')
ylabel('Position')
grid on

subplot(2,1,2)
plot((z-X_es).^2,"r")
hold on
plot((z-X_rm).^2,"b")
grid on
xlabel('Time-step')
ylabel('(Z - X_h)^2')
legend('Exponential mean', 'Running mean')
title('Fig.2: Squared of relative error between measurements and smoothed data')
```



Conclusions

- The true trajectory X was created for 300 steps using the random walk model with initial and variance conditions given.
- Measurements z were generated from the random walk model of X with the given variance.
- The optimal smoothing coefficent alpha comes to be 0.25 showing the best possible smoothing conditions.
- Using the round values the window size M comes to be 7 which is optimal for smoothing conditions.
- For the determined window size M and smoothing coefficent alpha plot between Running mean, Exponential mean, true trajectory and measurements is analysed. This shows as the parameters are for optimal conditions this curve is the best possible smoothen trajectory for the calculated measurements. Even though both methods are in conditions of equal errors conditioned by measurement errors, exponential smoothing with optimal alpha tends to cause more delay than the running mean.
- A plot of the relative error and smoothen data for both the exponential and running mean is studied. The error for running mean has higher peaks but it gradually lowers as the iterations are incraesed compared to the exponential mean.