Report: Laboratory work 2

Comparison of exponential and running mean for random walk model

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In this work we compare the errors of exponential and running mean. The goal is to determine the most effective quasi-optimal estimation method in conditions of uncertainty.

Part 1. Determination of optimal smoothing constant in exponential mean

Here we conduct a simulation by generating 2 trajectories and simulating measurements of them. Both trajectory has normally distributed random steps with zero mathematical expectation, variance 10 and starts at 10. First one is 3000 steps long and second one is 300 steps long. Measurements have normally distributed random noise with zero mathematical expectation and variance 15.

We identify σ_w^2 and σ_η^2 to compare estimation results with their true values. Here are estimations on few iterations:

varianceMeasurementError1	14.3771
varianceMeasurementError2	12.9024
varianceSystematicError1	10.3499
varianceSystematicError2	9.6481

varianceMeasurementError1	15.0191
varianceMeasurementError2	19.0076
varianceSystematicError1	9.8487
varianceSystematicError2	8.5151

varianceMeasurementError1	15.5326
varianceMeasurementError2	21.1539
varianceSystematicError1	8.5292
varianceSystematicError2	4.4112

In first experiment estimations are closer to the true values of σ_w^2 and σ_η^2. In the second experiment dispersion is higher because of smaller number of steps in the random walking model. But still, if we take mean values of several iterations of the simulations, they are close to real ones. Several examples:

We also determined optimal smoothing coefficient in exponential smoothing. The dispersion for this values are even higher (especially for the second one), as they depend on both variance values. Several examples:

optimalSmoothingCoefficient1	0.5157
optimalSmoothingCoefficient2	0.3641

optimalSmoothingCoefficient1	0.5745
optimalSmoothingCoefficient2	0.5483

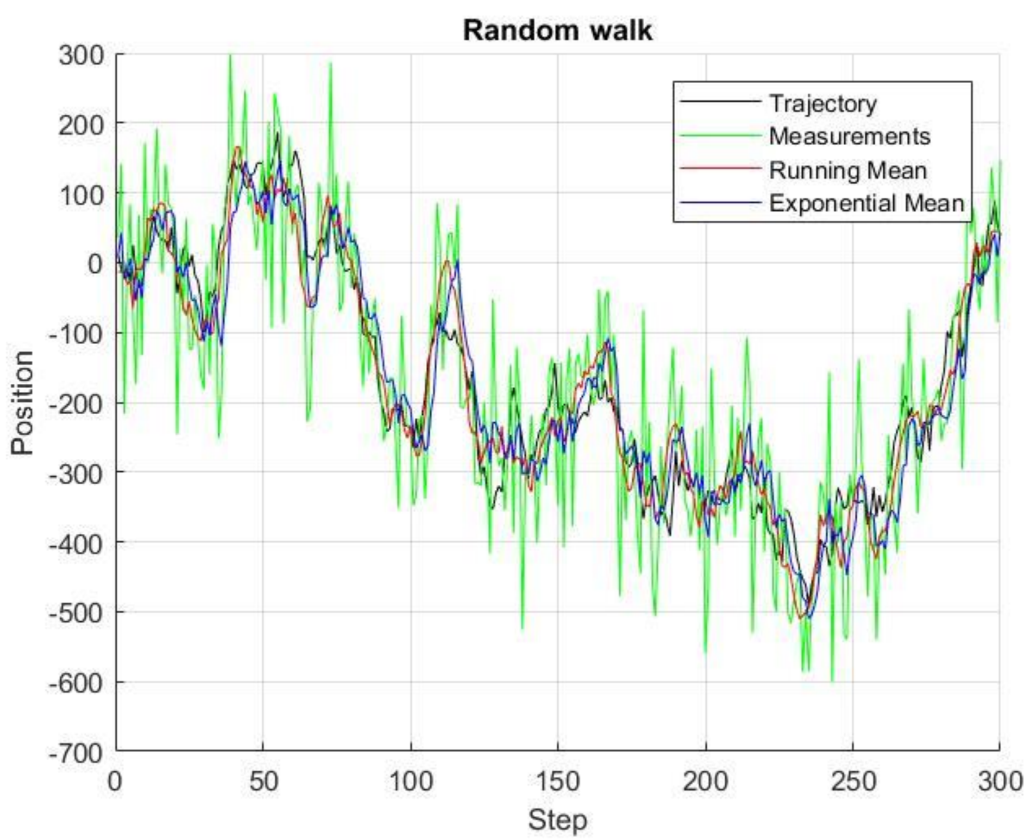
Part 2. Comparison of methodical errors of exponential and running mean.

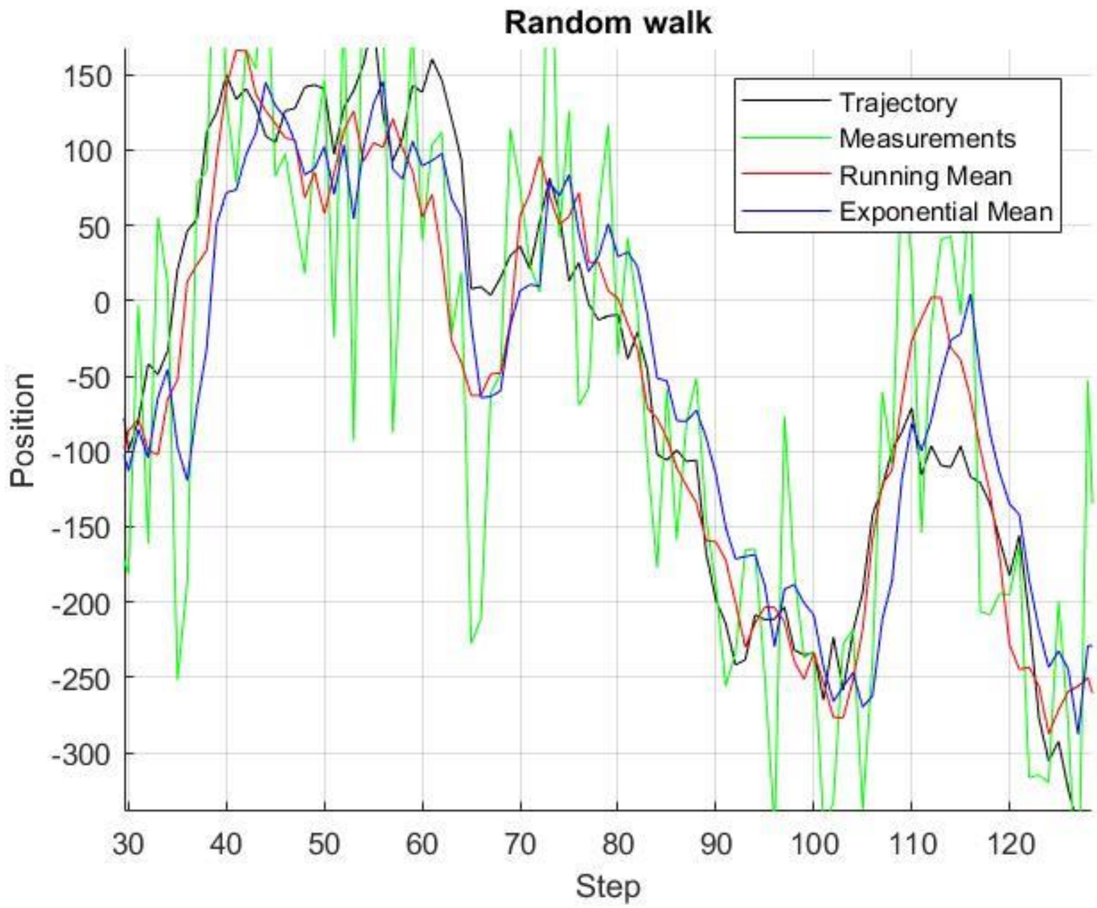
Here we simulated a 300-step trajectory. It had normally distributed random steps with zero mathematical expectation, variance 28^2 and started at 10. Generated measurements had variance of noise 97^2.

Optimal smoothing coefficient $\alpha = 0.25$.

Window size M = 7.

Then we applied running mean using determined window size M and exponential mean.





Conclusions. As can be seen on the zoomed region of the plot, running mean is better for this particular generated trajectory. Exponential mean gives a delay in this case. It is very important to minimize delay in prediction.

Files with the matlab code are attached.