**Final project. Extraction of a useful signal from noisy data**

The objectives of this assignment are to encourage you to think creatively and critically to extract a useful signal from noisy experimental data, find best estimation method of a dynamical process and make forecast of its future development.

This assignment is to be done in groups of 4 students, and only one document is submitted for the group. You may also freely talk with students in other groups, but the final documents that you submit must be done only by your group.

The assignment consists of two parts.

**Part 1. Best approximation method**

Chose best approximation method of given experimental data to reconstruct the dynamics of process in question. You may apply quasi-optimal estimation methods such as running mean, forward-backward exponential smoothing, and complex minimization of deviation and variability indicator.

1. Provide grounds why the chosen method is the best method of approximation.

*Criteria might be the following:* visual analysis, quantitative criteria, simplicity of implementation, and any other arguments.

1. Which regularities are found from obtained approximation after reduction of noise?
2. Discuss what are the risks of obtained estimations and conclusions about the process.

**Data for group 1. Mean-arterial pressure**

*Matlab file:* MAP.mat  
*Format of data:* 1 column – mean arterial pressure of a man of 24 years old.

**Data for group 2.** **Sunspot numbers.**

*Matlab file:* Sunspot.mat  
*Format of data:* 1 column – year, 2 column – month, 3 column – date in matlab format

To convert to date in a understandable format use matlab command datestr(data(:,3))

4 column – monthly sunspot number

**Data for group 3. Solar radio flux at F10.7 cm.**

*Matlab file:* Radio\_Flux.mat  
*Format of data:* 1 column – year, 2 column – month, 3 column – solar radio flux at F10.7 cm**.**

**Part 2. Tracking and forecasting in conditions of measurement gaps**

The trajectory of a moving object is disturbed by normally distributed unbiased random acceleration with variance . In general measurements of coordinate are performed every second with variance of measurement noise . Observation interval is 200 seconds. However, there are measurement gaps. Probability of measurement gaps is (group 1), (group 2),   
(group 3).

*Task* *1:* Develop Kalman filter to track moving object under this conditions.

*Task* *2:* Determine filtered and extrapolated errors of estimation (1 step and 7 steps ahead) over 500 runs of filter. Compare them with true estimation errors.

*Task 3.* Analyze the decrease of estimation accuracy in conditions of measurement gaps. Compare results when measurements are obtained without gaps.

**Consult charts Final\_project\_discussion.pdf**

**Thursday, May 26**

Present your results with charts in 20 minutes.

**Friday, May 27**

Submit the final version of your project to canvas.