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**Selected Aspects of Stochastic Processes**

**Time series components**

Create on your network disk a new folder and give it the name: *Lab\_03*. This is the folder for the third project of this lab. All the exercises, experiments and scripts made during the laboratory classes are to be saved in the *Lab\_03* project.

Prepare the report from your experiments, in which all tasks are presented, the results are enclosed and discussed. The report contains sections following the structure of this instruction, all properly formatted.

In each section of the experimental part, place the whole R script you developed for the section.

Each graph should be described with appropriate elements, using colours to enhance the graph.

Remark

For the purposes of this instruction, the following notations of time series obtained by students as part of their homework from the previous laboratories were adopted:

* TS\_M time series with monthly seasonality
* TS\_Q time series with quarterly seasonality

1. **Time series simulation based on decomposition**

By experimenting with the parameters, generate different time series based on the additive and multiplicative decomposition model. Consider different cases of small and large variance of the Gaussian white noise. Choose two extreme cases of variance for the additive and multiplicative models. Create the plots of the simulated time series; a common graph for one type of model. Determine the ACF and PACF functions for all the series. Compare the obtained results and discuss them.

1. **Moving average smoothing**

For two selected time series TS\_M and TS\_Q, apply the decomposition method based on the moving average (decide whether simple or centered). Consider two cases: additive and multiplicative decomposition. Show the results in graphs. Analyze both the time series for clear/evident regular components such as trend and seasonality. Discuss the properties of random component, such as absence or presence of regularities and homogeneity of variance.

1. **Smoothing by fitting an analytical trend**

For the two selected time series TS\_M and TS\_Q, apply the decomposition method based on the regression model. Take into account a linear trend. Present the results in graphs. Analyze both time series for trend-to-data fit and seasonality. Discuss the properties of the random component, such as the absence or presence of regularities and the homogeneity of variance.

1. **Comparison of time series smoothing results**

For one of the time series: TS\_M or TS\_Q, compare the previously performed decomposition methods: additive and multiplicative moving average and analytical trend. In which case the best results were obtained? In particular, for which model residuals are "better random" (compare autocorrelation plots)?