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Decorrelation strategies for the integration of finite sequences of a stochastic process into Gauss-Markov models

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The modeling of satellite measurements series pose a special challenge because
of the huge amount of data and the strong correlations between the measurements.
In connection with the large number of parameters the rigorous computation of an
appropriate stochastic model is a demanding task.

This contribution discusses the large variety of possible strategies to treat
correlated measurements with constant sampling rate. At first view
the regularly structured covariance matrices suggest fast Toeplitz algorithms. But the equidistant measurement series can be also interpreted as a finite sequence of a time discrete covariance stationary stochastic processes with infinite extension. The stochastic process can be represented and analyzed in different quantities in the time domain as well as in the frequency domain. The signal itself and its autocovariance function in the time domain be accompanied by the periodogram and the spectral distribution/spectral density function in the
frequency domain. These four quantities and their relations in between can be clearly represented in form of a "Magic Square", which gives a good basis to analyze the stochastic process, study truncation effects and model the behavior by parametric and non parametric approaches.

The focus of this study considers the pro and cons of possible strategies to decorrelate finite sequences of measurements and is motivated by GOCE gradiometer measurements. The measurement series are characterized by large correlations over long time spans with a periodic behavior with respect to the orbital period and a fragmentation of the time series into parts, due to satellite maneuvers and calibration phases. The decorrelation process is crucial for the gravity field estimation. Therefore efficient strategies are necessary to get as much signal as possible also from the highly correlated, fragmented measurements series. Special attentions has to take place to avoid data loss during the warmup phase of recursive decorrelation procedures.