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Robust adjustment of the parameters of a multivariate linear regression model with autoregressive noise: an application to EPN coordinate time series

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A description of the noise of GPS coordinate time series from different stations is of main importance to interpret properly the tectonic velocity. Unfortunately, correlations within and particularly between time series remain mainly disregarded, leading thus to an overestimation of the corresponding precision.
By means e.g. of least-squares variance component estimation, the residuals of the multivariate least-squares adjustment can be used to estimate iteratively the noise structure of the corresponding coordinates time series. To that aim, a combination of white and coloured noise is often preferred, which power law can be estimated or fixed in advance to a flicker noise.
For the correct estimation of the functional model parameters such as linear trend, amplitudes and frequencies of the seasonal components, outliers should be properly identified and downweighted. However, they are often eliminated thanks to a simple testing procedure, which involves thus a preprocessing step. Correspondingly, missing observations are interpolated before carrying out the least-squares estimation.
We present an alternative procedure that allows a self-tuning robust adjustment of the parameters of the multivariate linear regression model, considering the coloured noise as a vector-autoregressive (VAR) process with t-distributed white noise components. We make use of a generalized expectation maximization algorithm to estimate the functional parameters jointly with the VAR coef[U+FB01]cients, the scale factors and the degree of freedoms of the Student-distribution. This way, the restrictive assumption of normality of the noise, which is the basis of most maximum likelihood approaches to estimate power laws, can be elegantly circumvented. Missing observations are simply modelled as outliers and iteratively downweighted within the estimation.
We apply the proposed strategy to the analysis of three long years daily coordinates time series of four stations of the EUREF Permanent Network (EPN) located in the Czech Republic. An information criterion is used to determine the order of the VAR process in advance. We show that the noise structure changes with the quality of the observations. Moreover, the cross-correlations (VAR coefficient) have different patterns, which depend on the distance between stations. Our algorithm can be easily extended to allow for a deeper analysis of the cross-correlation structure of the EPN coordinates time series. Moreover, the corresponding information can be used to account for correlations in the velocity computation.