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Feature estimation and testing for linear regression with time series regressors

Abstract: In many real world applications, the response variable of interest is observed with a time series which is believed to influence the response in some way. For example, in econometric applications, the variables of interest are often observed at different time frequencies, such as financial and macroeconomic variables. The former being observable at high frequencies (e.g. daily, hourly or minute-by-minute) and the latter at far lower frequencies (often monthly or quarterly). Similarly in geostatistical applications it is important to understand how climatological data impacts climate change indicators, such as ice-shelf extent. Again, the climatological data (such as temperature) can be observed at a very high frequency, whereas the climate change indicators are often observed yearly. In many of these applications, the physical dynamics which relate the regressors to the response variable is complex and often unknown. In which case, even a basic understanding of the linear relationship between the response and the regressors could be useful. Due to the large number of regressors, consistent parameter estimation in the linear model is only achieved with regularisation, which is often done through dimension reduction or an additive penalty. But a disadvantage of most regularisation methods, is that the type of regularisation is tied to how the model is specified (smooth, sparse, periodic etc). Misspecification of the model can lead to spurious conclusions. However, if we treat the regressors as random variable, then the expectation of the normal equations will lead to a system of equations which are well posed (without the need to regularize). Therefore, in liue of any knowledge of the structure of the coefficients, the structure of the time series can be exploited to estimate the normal equations and thus consistently estimate the regression coefficients. In this talk, we propose a method for estimating the coefficients in a high dimension linear regression model, where the regressors come from a second order stationary time series. The proposed approach can be described as a deconvolution method for linear regression models. This estimates, both the regression coefficients and its Fourier transform, and allow us to test for different types of features in the regression coefficients. We show that the estimators are unbiased, consistent and asymptotically normal. Further, we propose a method for estimating the asymptotic variance of coefficient estimators. We show how the resulting estimator can be used (i) to test for smoothness of the parameters (ii) test for differences between two regression models and (iii) test for linear dependence.

We apply our method to assessing the impact that daily temperatures have on the size of the Arctic ice shelf over the past 40 years.

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