Dissertation

Time Deformation Models: Theory and Practice

This dissertation develops theory and techniques of time deformation modeling in context of time series. Equipped with Bayesian methodology, we systematically study inference schemes of continuous autoregressive models for both univariate and multivariate stochastic processes. After analysis of linear time series, we proceed to non-linear time series modeling. Our approach is to start with ``standard'', e.g. stationary, models, then deform time to get more realistic models. We formally define time deformation, and discuss under what conditions a time series can be deformed from stationary ones. We study relations of time deformation models and stochastic volatility models, and find the latter are special cases of the former. We develop inference schemes for time deformed continuous autoregressive models by using Markov Chain Monte Carlo algorithms. With such preparation, we address practical problems of pricing financial instruments which are used for investment and risk management. We are concerned with commonly accepted diffusion processes with varying volatilities. Interpreting the source of conditional heterogeneity by connecting it to uneven time evolution, we use time deformation modeling approaches to make inference and forecasts. We also discuss structures of multivariate and matrix-variate dynamic linear models (DLM). With stochastic variance-covariance the model is more flexible but harder to analyze. We decompose variance-covariances, then use inverted Wishart-Beta model to get conjugacy. We employ stochastic convolution to interpret discount factors that are widely used in practice, and generalize discounting methods. Finally we obtain multivariate versions of filtering formulas in context of DLM.

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