Department of Mathematics and Statistics

2015 PhD Projects

The Open University

Project title	Bayesian dynamic forecasting of high frequency data
Principal supervisor	Alvaro Faria
Second supervisor	Paul Garthwaite
Discipline	Statistics
Research area/keywords	Non-linear time series forecasting, Bayesian dynamic models, statistical models for high frequency data
Suitable for	Full time students

Project background and description

With recent technological advances, there has been an increasing demand for statistical forecasting models that can detect and quantify patterns, assess uncertainties, produce forecasts and monitor changes in data from high-frequency processes in various areas. Those include short-term electricity load forecasting in energy generation as well as wireless telemetric biosensing in healthcare where monitoring of patients in their natural environment is desirable. Usually, many such processeses are well modelled by non-linear auto-regressive (NLAR) models that are dynamic and can be sequentially applied in near real-time. There are a number of proposed NLAR forecasting models in the literature mostly non-dynamic and/or not appropriate for high-frequency time series data applications.

Forecasting and monitoring data from high-frequency processes can be a multivariate non-linear time series problem. This project takes a Bayesian approach to the problem, building up on recently proposed analytical state-space dynamic smooth transition autoregressive (DSTAR) models that approximate the underlying process non-linearities. DSTAR models have been shown to be promising for forecasting certain non-linear processes (as described in the reference listed below), but issues still remain before such models can be usefully adopted for assimilation of high-frequency data in practice. This project aims to tackle some of the outstanding issues, such as the following.

- How to include information from co-variates on the DSTAR models without compromising demands for fast computations?
- How to retain model interpretability in relation to STAR model parameters?
- How to effectively model multiple cyclic behaviour of different orders?
- How alternative approximations to non-linearities improve on the existing polynomial ones? Would sequential simulation methods such as particle filtering provide appropriate answers?

Hourly electricity load data for a region in Brazil are available for the project. The project will involve theoretical developments in statistical methodology, as well as a large amount of practical work requiring good statistical programing skills: current software for these models is written in R and Mathematica.

Background reading/references

- Santos, A. J. and Faria, A. E. (2013) 'The dynamic Bayesian smooth transition autoregressive models.' Technical Report 13/03, Department of Mathematics and Statistics, The Open University. http://statistics.open.ac.uk/2013_technical_reports
- Santos, A. J. (2014) 'Dynamic Bayesian Smooth Transition Autoregressive (DBSTAR) models for non-stationary nonlinear time series.' PhD Thesis, Department of Mathematics and Statistics, The Open University.