TIME SERIES MODELING APPROACHES

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TALK 1: ABNORMAL SITUATION MANAGEMENT IN CONTINUOUS INDUSTRIAL SYSTEMS: A SIGNAL PROCESSING APPROACH

SPEAKER: GUSTAVO MATHEUS DE ALMEIDA, FEDERAL UNIVERSITY OF MINAS GERAIS, BRAZIL

Abnormal Situation Management (ASM) in continuous industrial systems as steel, petrochemical, and pulp and paper mills, is a major challenge. In brief, abnormal situations encompass any event outside the normal plant operating modes. Since the magnitude of faulty signals are small at the beginning, its recognition by control room operators is virtually impossible. The earlier the detection, the greater the chance of keeping safe, clean, and efficient operations. This work constructs a monitoring system for improving operating performance with focus on abnormal situation management. This system is based on the statistical method of sequential pattern recognition called hidden Markov model (HMM). Since this is a data-driven approach, the required input information is basically data which is continuously collected and stored in medium- and big-sized industries nowadays. The paradigm posed by the current data rich-world is exactly how to transform data into useful information for rational decision making. The real case study uses process historical data regarding the operations of an evaporator belonging to a pulp mill in Brazil. A matter still open relative to these evaporators is the loss of thermal efficiency along time. Based on the nature of the process variables, the given objective of the case study, and practical aspects of the evaporator operation, a continuous HMM having ergodic topology was adopted. Firstly, a benchmark was derived from the collected data set for evaluation purposes. The three most common operating conditions in practice were investigated. From the evaporator dynamics and sample time, the size of the observation sequence, used as input in HMMs, corresponds to thirty minutes of operation of the equipment. Initial results, summarized in confusion matrices, show a satisfactory performance of the monitoring system. It successfully provides real-time current and trend information about the evaporator operating condition. The scores of correct classifications, considering the three operating conditions separately, were equal to 100%, 100%, and 94.4%. The system was also able to handle transitions among the three operating conditions, with scores of correct classifications equal to 84.6%, 100%, and 88.2%. Finally, a measure using the characteristic log-likelihood values (HMM output) of the three operating conditions as reference quantifies the deviation of the current evaporator operating condition in relation to them. A plot similar to control charts, which are intuitive and familiar for control room operators and engineers, are employed for a visual monitoring of the operations. Industrial systems are commonly

multivariable, non linear, noisy, time correlated, and of partial knowledge. This complexity is a major challenge to the development of automatic and reliable monitoring systems, and signal processing approaches as HMM constitute an alternative solution to the usual residues metrics approach. This is joint work with Song Won Park (University of São Paulo).

Talk 2: SIMULATED MAXIMUM LIKELIHOOD IN A MARKOV SWITCHING STOCHASTIC VOLATILITY MODEL

SPEAKER: BOVAS ABRAHAM, UNIVERSITY OF WATERLOO, CANADA

Standard stochastic volatility (SV) models are designed to model the conditional variance. In certain contexts volatility of a return may be affected by structural shifts and hence models for the conditional variance should incorporate such shifts. One approach is to utilize a Markov switching scheme with several regimes for the conditional variance. In this presentation we will use simulated maximum likelihood to estimate such models. We demonstrate with some return series that the estimation procedure is reasonable.

TALK 3: FUZZY SETS APPROACH IN MATHEMATICAL FINANCE AND APPLICATIONS

SPEAKER: AERAMBAMOORTHY THAVANESWARAN, UNIVERSITY OF MANITOBA, CANADA

In the time series literature, usually point estimates of the parameters are used to obtain the minimum mean square error forecasts. For example, the forecast of the $(n+1)$th observation based on $y_1, \ldots, y_n$ from $y_{n+1} - \hat{\mu} = \hat{\phi}(y_n - \hat{\mu})$ does not take into account the parameter variability. Fuzzy forecasts are shown to be better than the MMSE forecasts. Accurate estimates of volatility parameters are needed in option pricing. Generalized Autoregressive Conditional Heteroscedastic (GARCH) models and Random Coefficient Autoregressive (RCA) models have been used for volatility modeling. Option pricing using fuzzy estimates is discussed. An improved option pricing formula for Black-Scholes model with fuzzy volatility is also discussed in some detail.