2007-08 Program on Risk Analysis, Extreme Events and Decision Theory

SPEAKER ABSTRACTS

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"Generalized Copula Structures for Multiattribute Utility Functions"

We define MAU copulas that express a continuous and bounded utility function that is strictly increasing with its arguments in terms of its marginal utility functions. We show the conditions under which MAU copulas yield the additive, multiplicative, and multilinear forms of utility functions, or the functional forms of partial utility independence. We use sensitivity analysis to illustrate how a decision maker can determine *a priori* the order of joint utility assessments needed for a given problem.

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Abstract: TBD

"Principles"

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"Operations Research and Risk Analysis"

Probabilistic risk assessment provides practical techniques for predicting and managing risks (i.e., the frequencies and severities of adverse consequences) in complex systems. In this presentation, we survey methods for probabilistic risk assessment, emphasizing methods for estimating accident frequencies (e.g., fault trees, event trees) and dealing with uncertainties (e.g., Bayesian statistics, Monte Carlo simulation). For systems under threat from intelligent adversaries, we also briefly discuss the application of game-theoretic ideas.

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"Prediction for Max-Stable Processes via an Approximated Conditional Density"

The dependence structure of a max-stable random vector is characterized by its spectral measure. Given only the spectral measure, we present a method for approximating the conditional density of an unobserved component of a max-stable random vector given the other components of the vector. The approximated conditional density can be used for prediction. We also present a new parametric model for the spectral measure of a multivariate max-stable distribution. This model is used to perform prediction for both a time series and spatial process.

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"Heavy Tails and Financial Time Series Models"

Heavy tails is a common feature of most financial time series.

Multivariate regular variation is often used as a building block for modeling heavy-tailed multivariate phenomena. Interestingly, many time series models, such as GARCH and stochastic volatility (SV) models that are commonly used for modeling financial time series, have finite dimensional distributions which are regularly varying. The implication of this property, as applied to the limit theory for the sample mean, autocovariance and autocorrelation functions, and extremes for these models, will be described. While GARCH and SV models share many of the same properties-both are Martingale differences and exhibit heavy tails and volatility clustering, it turns out that the extremal behavior is quite different. Unlike a SV process, extremes cluster for a GARCH process. This provides a potential method for discriminating between SV and GARCH models from the data. (This is joint work with Thomas Mikosch.)

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"Prior Elicitation"

Abstract: TBD

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"The Challenges of Analysing Outbreaks of Infectious Diseases"

Outbreaks of infectious diseases can cause considerable risks to public health and associated alarm throughout communities. Analysing an outbreak of a novel infectious agent or a well known infectious agent in a novel setting provides challenges to statisticians and quantitative epidemiologists because: there is considerable pressure for immediate answers to both biological and public health questions; little data are available early on; and what data are available have biases in that patients with the longest times, for example from infection to showing symptoms, are less likely to appear in the earliest available data. Increasingly sophisticated statistical methods have been developed to provide unbiased estimates of key epidemiological parameters in "real time". As ever, sound science-based public health decisions depend on the quality of the available data, the suitability of the analytical methods, and the understanding by policy makers of the required assumptions as well as the uncertainty associated with the results obtained.

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"Elicitation of Expert Opinion as a Prior Distribution"

Bayesian statistical methods provide a formal mechanism for taking into account expert subjective opinion that has been expressed as a prior (probability) distribution. Obtaining such a distribution is the purpose of an elicitation method: it asks the expert to perform meaningful assessment tasks and forms a probability distribution from the elicited assessments. Different elicitation methods are required for different situations, depending
on, for example, the sampling model, the background experience of the expert, and the structure of the prior model. Tasks that could form part of many elicitation methods are described and biases that commonly affect them noted. Some elicitation methods are described, focusing on those suitable for quantifying opinion about generalised linear models. The role of overfitting and feedback is discussed. Applications where the methods have been used are outlined.

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"Extreme Value Statistics for Atmospheric Data"

Often the extreme values of atmospheric data are of the most interest to researchers and practioners. Recently, much work has been carried out using univariate extreme-value theory for these data sets. Some investigation into potential methods for handling spatially correlated data has been investigated, and some software has been made available. This will be a review of

some of the proposed methods for modeling extremes for such types of datasets, and R software currently available.

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Abstract: TBA

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"Technical Approach to Financial Risk for Extreme Events" (*)

Studies which assert the inadequacy of currently available measures of financial risk in capturing extreme market conditions, also suggest the need for alternative measures of risk that are more appropriate for such events. Volatility, for instance, is justified for stable market scenarios, but it is weak in addressing portfolio risks under aberrant market fluctuations. The Partitioned Multiobjective Risk Method (PMRM), developed in 1984, has been successfully deployed to a variety of engineering applications including dam safety, flood warning and evacuation, navigation systems, software development, and project management, among others. A measure of an extreme portfolio risk, denoted by f_4, is defined as the *conditional expectation* for a lower tail region of the distribution of the possible portfolio returns. The PMRM-based portfolio selection model can provide safeguards against extreme losses without compromising the achievable returns on investments as suggested by currently available portfolio models. While there is one-to-one correspondence between f_4 and the Value-at-Risk (VaR), f_4 can be more descriptive of the thickness of the lower-tail—hence making it potentially more robust than VaR. It is worth mentioning that f_4 is related to the concept of *semivariance*—a measure of the conditional variance for a prespecified region of a given distribution.

(*) This presentation draws on the paper by Santos-Haimes, "Applying the Partitioned Multiobjective Risk Method (PMRM) to Portfolio Selection," *Risk Analysis*, **24**(3), 2004.

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"Challenges to Applied Risk Management"

Major challenges to applying risk analysis and decision analysis to important decisions involving extreme events are outlined. Concepts and procedures to address these challenges are discussed.

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"Atlantic Hurricanes and Climate Change"

Abstract: TBD

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"Risk Analysis and Risk Management in an Uncertain World"

This talk discusses how one can link the tools of risk assessment and our knowledge of risk perception to develop risk management options for dealing with low probability-high consequence events. I apply these concepts to a current Wharton Risk Center project on "Managing Large-Scale Risks in a New Era of Catastrophes" that discusses the role of the public and private sectors in insuring, mitigating and financing recovery from natural disasters in the United States.

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"Critical Weather Forecasts: The Needle in the Haystack"

Weather forecasts can and do save thousands of lives per year in the U.S. by allowing people to take short-term protective action, such as evacuation. However, protective action is often costly. The key is identifying the needle in the haystack – the forecast conditions that should trigger protective action. Weather forecasts are not generally designed to provide specific risk assessments to help users identify these critical forecast conditions. In the case of the hurricane threat, quantifying specific risk is particularly difficult because forecast information evolves dynamically and because the historical record of both storms and forecasts is too sparse to provide easy statistical risk measures.

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"Overview talk"

Abstract: TBD

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“Environmental Risk Assessment”

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"Psychology of Risk"

Abstract: TBD

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"Testing and Modeling Extreme Dependencies in Financial Markets"

Testing and modeling extreme dependencies in financial markets are difficult tasks. The first part of talk introduces a new dependence concept, the quotient correlation which is defined as an alternative to Pearson's correlation that is more intuitive and flexible in cases where the tail behavior of data is important. Using the new dependence concept, a new test statistic (the gamma test statistic) is derived. The gamma test can efficiently detect tail (in)dependencies in all simulated examples.

Classical treatments of multivariate extremes use certain multivariate extreme value distributions to model the dependencies between components. An alternative approach based on multivariate max-stable processes enables the simultaneous modeling of dependence within and between time series. We propose a specific class of max-stable processes, known as multivariate maxima of moving maxima (M4 processes for short), and present procedures to estimate their coefficients. To illustrate the methods, some examples are given for modeling jumps in returns in multivariate financial time series.