The MASCOS Workshop on Probability and its Applications

AMSI seminar room, 8.30-3.30, Friday May 14

PROGRAM

8.30-9.00: Khanhav Au, Australian National University.
Title: Discriminating Between Heavy-Tailed Distributions
Abstract:

These days it is commonly accepted in the financial world that the tails of an asset return distribution are much heavier than those of the Gaussian distribution. Furthermore the choice of distribution is crucial for suchpurposes as value-at-risk and option pricing. Unfortunately, opinion on the tail weight question is divided. One school of thought believes that they are most appropriately modelled by exponential distributions and another believes that power tailed distributions are needed. In the latter group, some believe that variances are finite and others believe that stable distributions should be used.

The question that I will address is, given a competing family of distributions, whose tails are heavier than normal, how large a sample size n does one need to distinguish the tails of the distribution at a specified quantile p? Specifically, how large a sample do we need to distinguish the Laplace from the t distribution, and the t distribution from the stable distribution etc?"

9.00-9.30: Ben Cairns, University of Queensland.
Title: Extinction in metapopulations with environmental stochasticity driven by catastrophes a birth-death process
Abstract:

In contrast to the well-established concepts of resistance and susceptibility of individuals in epidemiological models, many metapopulation models assume that habitat patches are static in number, and that all patches are

suitable for occupancy by a population of the species of interest. In some cases, however, the suitability of a habitat patch may change over time. I will present a continuous-time Markov chain model for a metapopulation in which both the number of local populations and the number of suitable habitat patches vary, the latter according to catastrophic events causing mass unsuitability, followed by the gradual recovery of affected patches. I will discuss mathematical aspects of the model that are relevant to ecological concerns, including hitting times and and quasi-stationary distributions. Of particular interest to metapopulation modelling are those models with a fixed maximum number of patches. I will address the problem of approximating hitting times as the as the maximum number of patches becomes large. With appropriate scaling, the model has a 'semi-stochastic' limit, consisting of deterministic trajectories that are interrupted by linear, downward jumps at Poisson catastrophe times. The expected hitting times of a closed subset of the state space can then be found as the solution to a system of functional differential equations.

9.30-10.00: Zaeem Burq, University of Melbourne.
Title: Some boundary crossing problems for Brownian motion
Abstract:

"Boundary-crossing problems" is a collective term for a large class of problems which includes the Gambler's Ruin Problem, finding the distribution of first-hitting-times (or crossing-times) to a given boundary, finding the distribution of the point of exit from a region, etc. Depending on the exact form of the problem, and the underlying stochastic process, the methods of solution can vary drastically. I'd like to give a brief introduction to the problem that I am working on; questions I have answered, and ones I haven't (yet).

10.00-10.30: Ben Gladwin, University of Queensland.
Title: Long time-frame path computation using least action
Abstract:

Despite the huge increase in computational power in recent times, modelling large bio-molecules is still primarily limited to the simulation of short time frames, which in many cases are not biologically significant. The goal is to provide new insight into experimentally less accessible properties such as structure dynamics and definition of thermodynamic stability criteria.

In this work we use optimisation of Hamiltonian paths to enable calculation of the behaviour of molecular systems over large time frames. We look to calculate molecular trajectories using a boundary value approach derived from experimentally determine starting and ending conformations. This method will provide information throughout the whole time span of the path.

10.30-11.00 Morning tea.

11.00-11.30: Ana Novak, University of Melbourne.
Title: Analysis of packet pair probing methods in the Internet
Abstract:

The appeal of the active probing is its intrinsically end-to-end nature which allows the non-privileged users to probe Internet traffic. In this talk I will describe a packet-pair based method used to estimate packet size and arrival rate on a singular link.

11.30-12.00: Maya Ramakrishnan, University of Melbourne.
Title: A distributed approach to bandwidth allocation in logical networks
Abstract:

We consider a dynamic bandwidth re-allocation scheme in a logically connected network. We pose the problem of bandwidth allocation as an optimisation problem and note that any algorithm that solves such a problem must be scalable. Scalability in this setting is reliant on the algorithm being decentralised in nature. Under assumptions regarding the connectedness of the logical network, the optimisation problem can be solved arbitrarily closely in a distributed manner via a continuous bandwidth (capacity) re-allocation scheme. We use Lyapunov arguments to determine stability of the system. The theoretical framework motivates a discretised system, that is more appropriate from an implementation perspective. Comparisons between the two schemes are presented.

12.00-12.30: Hwan-Jin Yoon, University of Melbourne.
Title: Discrete Regression
Abstract:

In this talk, I will propose a discrete regression model in which both the response and independent variables are random and the marginal distributions are Poisson distribution(or any other discrete infinitely divisible distribution). A range of correlations can be modelled. Estimation of the analogue of correlation and regression is developed.

12.30-1.00: David Sirl, University of Queensland.
Title: Quasi-stationary distributions for continuous-time Markov chains
Abstract:

Quasi stationarity is a notion used to describe the behaviour of processes that eventually die out, but display stationary-like behaviour over any reasonable time scale. For example, a threatened species may survive for extended periods before becoming extinct; a telecommunications network may fluctuate between congested and uncongested states without any apparent change in demand, and stay in each state for long periods; and a chemical system where one species can become depleted (and thus stop the reaction) may settle down to a stable equilibrium.

We provide a summary of known results in the area and look at their application in the context of a particular class of autocatalytic chemical reactions.

1.00-2.00 Lunch.

2.00-2.30: Allan Motyer, University of Melbourne.
Title: Quasi-Birth-and-Death Processes with an Infinite Phase Space
Abstract:

A Quasi-Birth-and-Death (QBD) process is a two-dimensional continuous-time Markov chain for which the generator has a block-tridiagonal structure.

The first component of the QBD process is called the *level*, the second component the *phase*. It is known that the level process of a positive-recurrent QBD process with finitely many possible values of the phase variable possesses a stationary distribution which decays geometrically as the level is increased. The decay parameter is equal to the spectral radius of Neuts' R matrix, which is strictly less than one. For QBD processes with an *infinite* phase space the situation becomes more complicated. The results of Kroese, Scheinhardt, and Taylor (2003), who considered an example of a QBD process with an infinite phase space - the two-node tandem Jackson network - will be presented.

2.30-3.00: Olena Kravchuk, University of Queensland.
Title: Brownian Bridge, the Cramer-von Mises test and the trigonometric score rank test of location
Abstract:

This talk concerns testing the equivalence of two continuous distributions of the same location-scale family. The current presentation brings together the basic convergence theorem of rank statistics ([1], p.225), the trigonometric decomposition of the Brownian Bridge ([1], p.221) and the components of the Cramer-von Mises statistic [2, 4, 3]. It is shown that the square root of the first component of the Cramer-von Mises statistic is an optimal test statistic for testing against either the location alternative of the hyperbolic secant distribution or the scale alternative of the Cauchy distribution [5].

References

[1] J. Hajek, Z. Sidak and P.K. Sen. *Theory of Rank Tests*. Academic Press, San Diego, California, 1999.

[2] J. Durbin and M. Knott. Components of Cramer-von Mises statistics. Part I. *Journal of the Royal Statistical Society. Series B*, 34(2): 290–307, 1972.

[3] J. Durbin, M. Knott and C.C. Taylor. Components of Cramer-von Mises statistics. Part II. *Journal of the Royal Statistical Society. Series B*, 37(2): 216–237, 1975.

[4] M.A. Stephens. Components of goodness-of-fit statistics. *Annals de l'Institut Henri Poincare*, 10:37–54, 1974.

[5] O.Y. Kravchuk. Rank test of location optimal for the hyperbolic secant distribution. Submitted to *Communications in Statistics*, February 2004.

3.00-3.30: Joshua Ross, University of Queensland.
Title: Diffusion approximation for a metapopulation model with habitat dynamics
Abstract:

A stochastic metapopulation model accounting for habitat dynamics is presented. This is the stochastic logistic model with the novel aspect that it incorporates varying carrying capacity. A suitably scaled version of the model is shown to converge, uniformly in probability over finite time intervals, to a deterministic model studied previously by Johnson [1]. We establish a bivariate normal approximation to the quasi-stationary distribution of the process. We also consider the effects of habitat dynamics on metapopulation modelling through a comparison with the stochastic logistic model.

References

[1] Johnson, M.P. (2000) The influence of patch demographics on metapopulations, with particular reference to successional landscapes. *Oikos* 88, 67–74.