2004 ACT & NSW Joint Minimeeting

26 – 27 November 2004

Vincentia Golf Club

Jervis Bay

New South Wales

Australia

Supported by ANZIAM: Australian and New Zealand Industrial and Applied Mathematics

Programme for the 2004 ACT and NSW joint ANZIAM minimeeting

The meeting dinner will be held at 7pm in the Glasshouse. There will not be a set menu but guests can order directly off the Club's Chinese, Thai and Australian menu. For example, the Thai banquet is $20 a person. Also, some bottled wine will be supplied.

Friday 26th November

From 12 noon	Registration

Session Chair: Tim Marchant

1.25pm	Opening	
1.30pm	Bill Gibson (University of Sydney)	Beyond Neural Networks
2.00pm	Bob Anderssen (CSIRO and ANU)	Modelling the Relaxation Modulus of Linear Viscoelasticity as a Kohlrausch Function
2.30pm	Ross Moore (Macquarie University)	A Number Theoretic Take on the "Social Golfer" Problem
3.00pm	Afternoon Tea	

Session Chair: Harvi Sidhu

3.30pm	Markus Hegland (ANU)	Concentration of Measure and the Approximation of Functions of Many Variables
4.00pm	William Bertram (University of Sydney)	A threshold model for Australian Stock Exchange equities
4.30pm	Shev MacNamara (ANU)	Modelling Gene Regulatory Networks
7.00pm	Dinner	Glasshouse

Saturday 27th November

Session Chair: Rodney Weber

9.00am-9.25am	Coffee	
9.30am	Paul–JamesWhite (University of Wollongong)	
10.00am		
10.30am	Morning Tea	
11.00am	Tim Marchant (University of Wollongong)	Earthquake damage in underground roadways
11.30am	Close and student prize award	

Abstracts of Presentations

Bill Gibson
University of Sydney

Beyond Neural Networks

In the past, attention has mainly been focussed on neurons and the role they play , both individually and as parts of networks, in the functioning of the brain and nervous system However, glial cells outnumber neurons in the brain, and it is now becoming apparent that far from just performing supportive and housekeeping tasks, they are also actively engaged in information processing and possibly even learning.

In this talk, I will concentrate on a subset of glial cells called astrocytes that currently are the subject of intensive experimental investigation, and outline the approach we are taking to modelling these cells and the communication pathways between them.

Bob Anderssen
CSIRO

Modelling the Relaxation Modulus of Linear Viscoelasticity as a Kohlrausch Function

In order for the Boltzmann model of linear viscoelasticity to have sensible physics, its kernel, the relaxation modulus must have fading memory. The fading memory is normally modelled as a completely monotone function. A special and quite interesting case is the Kohlrausch function. The talk will discuss some consequences associated with such a choice.

Ross Moore
Macquarie University

A Number Theoretic take on the "Social Golfer" problem

16 golfers can play in foursomes once per day for 5 days, meeting every other player exactly once. The same is not possible for 20 golfers playing for 6 days. Why is this not so? What is the best possible (i.e., the most "sociable") schedule?

These particular questions are instances of the "Social Golfer" problem, which is often tackled using "constraint programming" to search for acceptable tournament schedules. But better answers can often be obtained from schedules and designs constructed using elementary concepts from number theory. Such techniques are reasonably well-known to combinatorialists and have been used in other settings. I'll describe some of these methods and present some optimal designs that do not appear to have been previously associated to the "Social Golfer" problem.

Markus Hegland
ANU

Concentration of Measure and the Approximation of Functions of Many Variables

An important but little studied factor affecting high-dimensional approximation is the geometry, in particular the concentration property, of high-dimensional spaces. This property has been quantified by Milman in the past using the concentration function.

Here the concentration function and a variant is used to obtain error bounds for several approximations. Known error bounds for piecewise constant approximations are recovered, and new bounds for additive approximations are obtained first for a class of functions defined by radial basis functions and then for a more general function class.

This is joint work with Paola Pozzi, Freiburg, and Vladimir Pestov, Ottawa.

William Bertram
University of Sydney

A threshold model for Australian Stock Exchange equities

The examination of high frequency equity data from the Australian Stock Exchange has unearthed many interesting phenomena. Of all the behaviour detected, two effects stand out as being the most prominent. The first is the existence of strong periodic behaviour in the various measures of volatility. The second is an effect called 'Zero Return Enhancement', whereby a disproportionate amount of trading takes place at a constant price. In this talk we present a threshold model to describe the phenomenon of zero return enhancement that is present in Australian Stock Exchange data. We fit the model to Australian data for small and large time scales and find that the model provides an excellent representation of the distribution of stock returns.

Shev MacNamara
ANU

Modelling Gene Regulatory Networks

Continuous and discrete time Markov models for regulated gene expression are formulated and analysed. Computational results suggest that lumpability of Markov chains may be a useful method for understanding the relationships between observed mesoscopic properties of a cell and the underlying genetic networks that control them.

Paul-James White
University of Wollongong

Fluids of varying viscosity/viscoelasticity exhibit both solid and fluid characteristics. Some examples of viscoelastic fluids include toothpaste, soft-serve ice cream, ketchup, gelatin, melted chocolate and tar. The goal of the project was to implement an algorithm that successfully animates viscoelastic fluids in three dimensions. In order to achieve this goal, we began by performing various runs with varying parameters of a pre-existing 2D and 3D Navier-Stokes simulation engine in order to enhance our understanding of the existing model. We studied numerical schemes to handle the additional elastic/plastic terms to model viscoelastic behavior, and formulated a two dimensional viscoelastic simulation incorporating these additional terms. After obtaining a working algorithm, we were able to generate different animation effects such as merging and bouncing. We also generated simulations displaying how the elastic coefficient changes the behavior of the liquid. We then implemented the algorithm in three dimensions. Our modification of the existing three dimensional simulation engine generated realistic results. A visual palette illustrating the behavior of a viscoelastic liquid undergoing dropping and pouring with various elastic and/or plastic parameters was created. Reference video footage of actual physical examples of viscoelastic liquids, e.g. ketchup, gelatin, toothpaste, and "goop", was taken. From the reference toothpaste footage and the visual palette of pouring behavior, we were able to determine the elastic and plastic parameters necessary to animate realistic looking toothpaste. We explored different effects such as bouncing, varying viscosity with strain rate to approximate ketchup, and squirting behavior with the three dimensional viscoelastic code.

Tim Marchant
University of Wollongong

Earthquake damage in underground roadways

Earthquake damage in underground roadways and mine workings is considered, with particular application to coal mines on the West Coast of New Zealand's South Island. This is a Mathematics in Industry Study Group (MISG) problem from the 2005 Auckland meeting. The scenario

considered is the effect on the mine workings of an earthquake, of moment magnitude eight, being generated by a rupture of the Alpine fault. An empirical relation from the seismology literature is used to relate earthquake magnitude, distance from the epicentre and the peak ground acceleration resulting from the seismic waves. This relation is used to estimate the likely damage at the mine site. Also, the decay scale for Rayleigh (surface) waves is calculated and the implications for the mine workings considered. The two-dimensional scattering of shear (SH) seismic waves from the mine workings is considered. Analytical solutions relevant to various mine tunnel geometries are presented with the stress and displacement amplification, due to scattering from the mine workings, calculated and discussed.