Department of
Mathematics and Computing

Research Report 2002–03

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University of Southern Queensland
Faculty of Sciences

Editor: Helen Nkansah

Contents

Chapter 1

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Information for Post Graduate Students

Chapter 2 of this report outlines current research projects being undertaken within the Department.

Read this section to find one or more projects that interest you — then contact the researcher.

- University Research Scholarships

  These scholarships are awarded to students undertaking a research degree in an area within the University's niche research strengths.

  Applicants for one of these scholarships should complete an HD1 form, a scholarship application form and referee report forms. Current USQ research degree candidates are not required to complete an HD1 form but should provide a report on their project to date and a timetable detailing plans for completion of their degree.

  Applicants should ensure that they are familiar with the rules and procedures for their intended degree. Applicants must contact the academic department to enquire about the availability of supervision and to discuss their proposed research topic prior to submission of an application. The contact details for possible academic supervisors are available from the University homepages (refer to url p.5 of this report) or from the Office of Research and Higher Degrees.

  Projects involving human or animal experimentation, including social/psychological research, must conform to NH&MRC guidelines and ethical clearance will be required prior to commencement of any such project.

  Scholarships will normally be offered to candidates intending to enrol as full-time students. The academic year commences on the first Monday in March and candidates are expected to undertake their research for at least 48 weeks per year.

  The base stipend payable to Australian Postgraduate Award APA recipients is determined by the Department of Education, Science and Training (2003 rate was $18,009 per annum). A relocation allowance applies. The University of Southern Queensland intends to supplement each APA stipend by $4,000 per annum for the duration of the scholarship.

  The USQ Research Postgraduate Scholarships for 2004 provide a stipend payable at the base rate applying to APA scholarships. Although no citizenship/residency conditions apply, successful applicants who do not qualify for a Research Training Scheme place will be required to pay full tuition fees.

  Scholarship recipients are permitted to undertake only a strictly limited amount of paid employment. Work undertaken must not interfere with an award holder's study program. The Principal Supervisor and the Deputy Vice-Chancellor (Research and Enterprise) must give approval for paid employment in excess of 8 hours per week.

  It is the applicant's responsibility to ensure that the documentation is complete and forwarded by the specified closing dates to:

  The Office of Research and Higher Degrees
  The University of Southern Queensland
  Toowoomba, Queensland 4350

  Enquiries may be directed to:

  The Office of Research and Higher Degrees, telephone (07) 4631 2956, fax (07) 4631 2955 or email Ms Christine Bartlett at `mailto:bartletc@usq.edu.au`

  Electronic or faxed applications will not be accepted. Academic Referee's Report forms will be accepted by fax.

  Refer to the University website `http://www.sci.usq.edu.au/research/Scholarship` for more detail on scholarships.

- Department Research Scholarships

  The Department of Mathematics & Computing also allocates some funds as Departmental Scholarships, encouraging students to undertake a research degree in an area within the Department's research strengths.

Chapter 2

Research and Development Activity

The Department of Mathematics and Computing has an active research and development programme covering many different fields. The main activities are conveniently classified under the following headings.

1. Fluid mechanics
2. Mathematical Modelling and Optimisation
3. Applied Computer Science
4. Applied Statistics
5. Statistical Methods
6. Mathematics Education
7. Computing Science Education
8. Miscellaneous

Descriptions of the research and development being undertaken in the above categories may be found on the following pages.

A Simulation and Statistical Consulting Group supports the research needs of staff and postgraduate students.

2.1 Fluid mechanics

2.1.1 Low-dimensional modelling of thin film fluid flows

(Roberts, Strunin)

The most complete, accurate and reliable mathematical model describing a wide variety of fluid flows is the Navier-Stokes equations. In many cases, it unfortunately accounts for too many minute details making it virtually impossible to simulate the nature of the phenomena using existing computer facilities. Moreover, even if results are obtained through direct numerical simulations, their qualitative interpretation frequently requires construction of a further simplified model to filter the main features of the flow from those which are of little interest in a given application. Thus there is a continuing need for accurate and reliable *low-dimensional models* capable of resolving the main physical characteristics of flows as well as of serving as an accurate tool for quantitative predictions in engineering applications. The derivation of such relatively simple models based on rigorous mathematical techniques such as centre manifold theory is the object of our current research.

Thin layers of fluids are of considerable importance in the world around us. They occur in many engineering situations including painting, coating and lubrication flows. The human body also uses such thin fluid layers to protect parts of the body and to transport or capture material.

When a jet of fluid hits a flat horizontal surface the fluid spread out radially in a thin, rapidly flowing layer. At a certain distance from the jet a sudden thickening of the flow takes place, which is called the circular hydraulic jump. Over the last decades this phenomenon has been intensively studied experimentally and theoretically with basic theoretical approach being averaging across the flow.

We apply the novel centre manifold technique developed for thin fluid films by A. J. Roberts. The approach has an advantage of rigorous derivation of coupled evoluation equations for the flow thickness and cross-stream average velocity from the Navier-Stokes equations. The set of coupled equations admits time-dependent solutions and thus allows us to study not only a steady-state flow but also non-stationary regimes. The steady-state regimes settle under certain conditions after an intermediate non-

stationary stage.

We also obtain settled non-stationary regimes where the hydraulic jump performs oscillations. A detailed structure of the flow, such as velocity profiles and vortex patterns, is analysed for all regimes.

2.1.2 Turbulence generated by stepwise velocity or density distributions

(Strunin, Roberts)

This problem has significant theoretical interest and also has geophysical and engineering applications. The case where turbulence is generated by the density jump is commonly referred to as the Rayleigh-Taylor instability. This phenomenon has been studied by a group of researchers both experimentally and via numerical computations of the Euler equations.

We aim to analyse these processes using a different approach which is based on the Kolmogorov-type k-l model of fully developed turbulence. In agreement with available experimental data we obtain the quadratic law of expansion of a turbulent layer in time for the Rayleigh-Taylor case and linear law for the shear instability case. The k-l model gives vertical profiles of the average velocity (or density) and profiles of the average kinetic energy of turbulence. Self-similarity and stability of the solutions are demonstrated.

2.1.3 Scaling in decaying turbulent bursts

(Strunin)

Localised turbulent bursts are typical in wall turbulence and geophysical stratified flows where they play a determining role in a transport of tracers (contaminants, temperature, etc). An interesting theoretical and practical question is how strong the burst mixes the tracers up.

One can distinguish the following opposite trends in the burst's development. On the one hand, the burst constantly involves surrounding fluid into the turbulent motion. This process acts towards making the fluid more homogeneous. On the other hand, the turbulent energy distributes over larger volumes of space and decays due to a viscous dissipation. These processes act in the opposite direction.

Evolution of the burst and the tracer are described by self-similar laws in the (k - ϵ) model of turbulence. Analytical solutions show that the fluid remains substantially nonuniform inside the burst. Of particular interest is to inspect if these solutions are attractors of other solutions originating from various initial conditions.

2.1.4 Convection

(Roberts,Passmore)

Vertical heat transport in the ocean, atmosphere and mantle is dominated by the heat carried by the encompassing fluid. Simple convectional motion may be analysed mathematically. Variants of centre manifold theory are being used to develop accurate models of the complex, even chaotic, dynamics of convection between poorly conducting boundaries (representative of convection in the earth's mantle).

In particular, we are investigating the issue of how to specify boundary conditions for mathematical models of the complex dynamics. Such boundary conditions will take account of realistic physical effects of the boundaries.

2.1.5 Turbulent flood flow

(Roberts, Suslov)

We are developing a new model for the dynamics of turbulent flood water. Conventional models are based on the 150 year old St Venant equations. Using the techniques of centre manifold theory described in the next section, the new model is based on the (k - ϵ) model of turbulence but rigorously simplified for shallow-water (or long-wave) flow. The new model should be of wide use in simulating and predicting floods, estuarine flows, and rivers.

2.1.6 Impact delivery of prebiotic organics

(Brookshaw)

A significant fraction of the terrestrial planets' volatile inventory may have been acquired as a late-accreting veneer from impacts of carbonaceous asteroids and comets during the period of heavy bombardment 4.5×10^9 to 3.8×10^9 years ago. In addition to simple volatile molecules such as H_2O and short-chain hydrocarbons, carbonace0ous asteroids

and comets are also rich in complex organics. It has long been speculated that the earth accreted prebiotic organic molecules important for the origins of life from the impacts of carbonaceous asteroids and comets during the period of heavy bombardment. A comprehensive treatment of comet-asteroid interaction with the atmosphere, surface impact, and resulting organic pyrolysis is needed to quantify this source of prebiotic organic molecules.

This project (being done in conjunction with C. F. Chyba, Princeton and W. Davis, NASA Ames) is to extend early work that focused on the earth and quantify the sources of prebiotic organic molecules for Mars.

2.1.7 Impact triggered tsunamis

(Brookshaw)

A consderable amount of interest has been generated in the last few years on the problem of near earth object detection and interception. This interest has been fueled by so-called risk analyses of a catastrophic impact of an asteroid or comet on the surface of the earth. There is little doubt that an asteroid 10 kilometres in diameter (the size of the Cretacious-Tertiary impactor 65 million years ago) impacting the earth would cause global devastation, but the period large impactors is approximately 25 million years. A far more likely scenario is the impact of an object tens of metres in diameter. The 20 Megaton explosion over Tunguska, Siberia in 1908 is thought to have been caused by a stony meteorite of this size.

Though smaller impactors are more frequent the devastation is localised when the impact occurs over land (the Tunguska explosion flatted 2,000 square kilometres of forest). The destructive potential of small impactors increases significantly if the projectile hits the ocean and can generate a tsunami. Little is known of small impactors ability to generate tsunamis, this project, using an hydrodynamic particle code to model the impact into water, and an incompressible finite difference code to model the subsequent wave motion, is making a study of the waves generated by a variety of *small* impactors. With these results a more informed risk analysis should be possible.

2.1.8 Hydrodynamics of pulsar driven winds

(Brookshaw)

Eclipsing millisecond pulsars (*eg.* PSR 1957+20 PSR 1744-24A) are known to exist in binary systems. A stellar wind from the pulsar companion is induced by the high energy particles and radiation of the pulsar wind. The wind from the companion then interacts with the low energy radiation from the pulsar and a bow shock is formed. The bow shock geometry can explain many of the features of the observed eclipsing patterns.l

Using a particle hydrodynamic numerical code we (this work is being done with M. Tavani, Columbia University) are modelling the expansion and bow shock geometry under different conditions relevant for vaporising millisecond pulsars.

2.1.9 Hypervelocity impacts

(Brookshaw)

Since 1944 a number of hypervelocity experiments testing scram-jet engines at the SHARp (Super High Altitude Research Project) facility at Lawrence Livermore National Laboratory, (LLNL) have been carried out. The SHARP gas gun is the largest two-stage light gas gun in the world and is used as a hypersonic research facility. Projectiles 1-10 kg in mass are fired horizontally into air, past high-speed diagnostic equipment (roughly 20 m flight path), and into a projectile-retaining area, a concrete bunker filled with sand.

The recent experiments testing scram-jet engines provide an opportunity to conduct hypervelocity impact experiments at no cost with a total energy (20 MJ) more than 3 orders of magnitude larger than previous studies.

The project is to compare numerical models with the experimental results from diagnostic equipment placed in the sand in the target bunker and is being conducted with P. Fiske, LLNL.

2.1.10 Buoyancy and shear competition in convection

(Suslov)

Surely you know what convection is: haven't you ever boiled water to make tea? The hot fluid with lesser density rises being pushed by the buoyancy

force. And shear in the fluid is familiar to you as well: any river flows faster in the middle than near the banks, so that the fluid layers in the middle of the river slide with respect to the ones which are closer to the bottom or to the banks. This causes flow shear (or friction) forces. But what if both buoyancy and shear forces act simultaneously? Which force will have stronger effect on the resulting fluid flow? You will be able to answer this question while working on this project. Not only will you learn about various modern mathematical and computational techniques, but also this is your chance to study something practically useful: such flow situations occur in many industrial applications such as, for example, thermal insulation systems and chemical vapour deposition reactors.

2.1.11 Resonances in a subcritical channel flow

(Suslov)

Many of you have an idea on what the resonance is: it is a strong amplification of oscillations in a mechanical system subject to a periodic external force. Child's swing is one of many examples. But is such a phenomenon possible in fluid flows, for example, in a classical parabolic flow between two parallel plates–the Poiseuille flow? The answer is yes. And in this project you will learn what sort of oscillations can occur in such a flow using the modern concepts of hydrodynamic stability, dynamical systems and bifurcation theories. The accepted point of view in the worldwide research community is that contemporary mathematical approaches cannot give all desired answers to the question of resonances. Take it positively: it means that there still an opportunity for your own small discovery to be reported to the world! And be prepared: you will need to learn a lot about scientific computing as after the concept is clear it is up to a computer to provide its quantitative validation.

2.2 Mathematical Modelling and Optimisation

2.2.1 Biomechanical models for sprinting

(Harman)

This project involves the application of energy/power models to formulate the differential equations of motion for world-class sprinters in athletics. Anaerobic and aerobic energy supply is used and the interesting effects of running on a curve for the 200 and 400 metre events, are included.

2.2.2 Optimising pacing strategies in running the 400 metre sprint

(Harman)

Using an energy/power model for the 400 metre athletics sprint, it is found that times can be optimised by careful pacing strategies in the middle section of the run. It is poor strategy to run as fast as you can for 400 metres since energy sources are soon depleted.

2.2.3 Optimising running curves in baseball and softball base running

(Harman)

How should a batter run to second base after hitting the ball. The optimal curve to take around first base is not obvious and is poorly understood. Initial work has been done to produce efficient curves for a runner to take. This work needs to be generalised to produce optimal curves.

2.2.4 Ball trajectory dynamics

(Harman, De Mestre)

This project examines the mechanics and the perceptions of judging an outfield catch. A model is developed which uses recent wind tunnel measurements to develop varying drag coefficients at a range of typical speeds for a batted ball. The confounding influence of spin effects are also included. The non-linear differential equations of motion are then solved numerically together with the dynamics of the fielder's perception.

2.2.5 Erodibility and source effects on dust plum formation

(Brookshaw, Butler)

Wind erosion induced dust plumes represent a major problem in Central Australia. These dust plumes remove a substantial amount of nutrients

from the parent soil. This project looks at the effect that source erodibility and location has on the structure of these dust plumes at the local and regional scale. The ultimate aim is to be able to predict erosion rates on a particle size basis, along with the location of sources, purely from dust plum observations.

2.2.6 Heat and topographical effects on the wind flow in the channel country

(Brookshaw, Butler)

The research work of Butler has indicated the existence of a number of secondary processes, such as heating, that play an important role in the formation of dust plumes. These processes interact with each other, to alter the wind flow, across the source area. This project is an initial attempt to quantify these effects on the wind flow, using a fluid dynamical based model.

2.2.7 Models of shear dispersion in channels and pipes using centre manifolds

(Roberts, Strunin)

Zonal models of contaminant dispersion in shear flows describe skewness of contaminant distribution along a channel. In the simplest case, a zonal model considers two zones, fast and slow, leading to a coupled pair of evolution equations for averaged concentrations in each zone. However, existing derivations do not lead to an exact form of these equations. We construct a two-zone model whose accuracy is guaranteed by centre manifold theory. The model leads to a new form for the evolution equations and new values of the interaction coefficients. We formulate appropriate initial conditions for the model and study their influence numerically. Using the correct initial conditions we obtain a good agreement with a direct numerical solution of the original advection-diffusion equations.

The dispersion of the material in the fluid flow inside arbitrarily curved pipes has many applications, for example, blood flow in arteries. Sophisticated analysis is required to model all the interacting physical processes. We are deriving the most complete models for dispersion in curving pipes.

2.2.8 Auto-solitons in various physical systems

(Strunin)

Solitons have been a subject of numerous studies over the last three decades. An upsurge of interest in solitons was to a large extent motivated by integrability properties of certain classes of soliton-generating conservative systems. No less interesting is another type of soliton, called auto-solitons, which encounter in dissipative systems with an intrinsic source of energy. Unlike usual solitons, auto-solitons have unique amplitude and unique speed governed by a dynamical system. A typical system of such type is combustion front where reaction plays a role of the energy source and heat conductivity plays a role of the dissipation.

We are focused on constructing new models of auto-solitons in connection with combustion fronts in solid-phase compounds and extended elementary particles. Distant in scale and nature, these systems nonetheless may be described within closely related mathematical models. A shape of spinning combustion front and a shape of the action function corresponding to the elementary particle are modelled by nonlinear PDEs of similar structure. Those models are relatively simple as they present a single equation with a small number of terms involved. Our model of the spinning combustion front is substantially shorter than existing multi-component models which often rely on poorly justified variables and coefficients. A question of particular interest is whether our model is capable of generating chaotic multi-soliton regimes.

2.2.9 Automatic differentiation techniques for the solution of differential equations

(Spunde)

High order Taylor Series approximations have been shown to be a viable alternative to classical approximations for the solution of systems of ordinary differential equations through the application of techniques of automatic differentiation. Multipoint techniques applied to stiff systems are being investigated; and also multi-variable techniques for partial differential equations.

2.2.10 Road traffic flow modelling

(Plank)

The performance of non-signalised traffic intersections is affected by variability in vehicle behaviours due to differences amongst vehicles/drivers and inconsistency in individual driver behaviour. Research so far has partly quantified the effects of these two factors on measure of intersection performance such as capacity and delay for stationery flow conditions and for simple traffic conflicts. Insight has been gained into the importance of including inconsistency and/or inhomogeneity parameters in formulae which traffic engineers use to measure and predict the degree of congestion at uncontrolled urban intersections under realistic flow conditions. Ongoing and planned research include the modelling of more complex traffic conflicts, the impact of severe inconsistency and inhomogeneity on performance measures, and the development of a useful model for non-stationary flow conditions.

2.2.11 Modelling of driers used in sugar factories

(Plank, McFarlane)

Sugar factories receive billeted cane and produce raw sugar by a number of complicated unit operations. The raw sugar has to conform to certain quality and physical characteristics to be able to be transported anywhere in the world in a variety of climatic conditions. It must also be able to be easily refined into white sugar.

To date, modelling of unit operations has, almost exclusively, assumed steady-state conditions. Unfortunately a variety of disturbances routinely occur in the cane supply, steam supply, mixing and chemical additives amongst others, some or all of which may impact on the raw sugar product.

This on-going project aims to examine the influence of variation in in put variable on the raw sugar product using a stochastic process modelling approach. The ultimate intention is to model the entire sugar factory in order to better understand the nature of interactions amongst input variable and to devise control strategies to improve the output quality.

Work to date has concentrated on the final unit operation of the process — the drying stage. An existing steady-state model has been adapted to deal with variability in the input variables and a method developed of efficiently simulating the drying process in the presence of many input variables.

2.2.12 Dust transport modelling

(Butler)

In the last ten years most Australian capitals have been affected by major dust storms. The majority of this dust originated in the rich farming lands of rural Australia and carries a large amount of the nutrients/chemicals that were present in the soil. Current modelling work is aimed at producing a source based model that will accurately predict dust concentration downwind of the source. It is anticipated that this model will give us insight into where these nutrients/chemicals are being transported and their effect on the various ecosystems in Australia.

2.3 Applied Computer Science

2.3.1 Relating speaker recognition rate with the contents and lengths of speech utterances

(Petrus)

Speaker recognition is the process of automatically recognising who is speaking on the basis of information embedded in speech waves. This technique enables the use of speaker's voice to control access to services which include voice dialling, telephone banking, data base access, information services, accessing restricted premises.

Speaker recognition is a two part process: identification and verification. Identification is the process of determining which registered user provides the given utterance. Verification is the process of accepting or rejecting the speaker's claim. In this research the effects of voice utterance contents and length is studied against the rate of recognising the speaker.

2.3.2 Document technology

(Addie)

An expanding industry concerned with preparation, transformation, communication and presentation of documents has developed over the last decade. The University of Southern Queensland and associated industry in Toowoomba is an active and committed contributor to this industry.

This project has the goal of constructing technical ideas (protocols, document structure concepts, algorithms) in this industry.

2.3.3 Agent-based intelligent information systems development

(Zhang)

Intelligent information systems have excelled conventional Information Systems in capability of learning and adaptability to the changing environment. One approach to developing such kind of systems is to integrate artificial intelligence techniques with agent technique. This project aims to:

1. examine intelligent processing techniques such as fuzzy logic, neural networks and genetic algorithms;
2. exploit agent architectures and communication languages;
3. develop techniques for the integration of intelligent agents.

2.3.4 Distorted-oriented display based html documents viewing system

(Zhang)

Distorted-Oriented Displays DOD is a user interface approach which can display the information of interest at a most detailed level and their context but with distortion. This approach has a feature that it is able to display information as much as possible without losing its context on a limited size computer screen (monitor).

In this project, we will develop a special DOD and it will be applied in viewing the relationship (relevance) among HTML documents on a computer using Java technology.

2.3.5 Broadband network analysis, design and management

(Addie)

Recent work in modelling broadband and internet traffic by R. G. Addie and co-workers has important implications for the analysis, design and management of communication networks. It has now been shown theoretically and experimentally, that traffic becomes closer to Gaussian as it is aggregated. Furthermore, when the Gaussian approximation becomes valid, a law of increasing efficiency sets in which implies that network performance can be maintained at excellent levels despite utilisation approaching one hundred percent. These conclusions are explained in the paper of the August issue of the IEEE Communications Magazine. The central limit theorem result is published in the Journal of Statistical Planning and Inference. Recent work with Ilkka Norros extends the previous results to continuous time Gaussian models with realistic autocorvariance functions.

- Performance Models. This project entails research on continuous time Gaussian models with realistic autocovariance and their implications and further refinement of the central limit theorem for network traffic.
- Architectural Principles for Communication Networks. The analysis tools and ideas already developed, and under development, have important implications for network architecture which will be explored. These include:
  - Multiplexing Gain (the fact that networks become more efficient as traffic grows);
  - Layering of networks: principles and practice;
  - Differentiation of service: principles and practice.
- Measurements. Further implications of the Gaussian analysis described above is the importance of short time-scale behaviour of network traffic. This needs to be understood better in order to provide a sound foundation for dimensioning broadband and IP networks. This work will include:
  - A program of measurements;
  - Statistical theory to support the measurements (including methods for estimating fine time-scale behaviour from more crude measurements).
- Simulation. Development of high speed (using important splitting) simulations to support the analysis and measurement work described previously.
- Network Design. Development of principles of network design applicable to broadband and IP networks.

2.3.6 Programming language design

(House)

A major problem in computing is designing computer languages that provide an effective medium for the design and implementation of large or complex systems. Some difficulties relate to specific language features, others to overall language design considerations.

This project addresses both of the above kinds of difficulties. The research focuses on methods of data and process encapsulation, and on other methods of object declaration. A specific language feature success was the creation of a clean language feature for declaring scientific unit information that specifies allowable data combinations: for example, lengths and masses may be multiplied, but not added. An overall design issue tackled successfully was design of improved block-structuring rules for Algol-like languages. A new paradigm for language type systems is also near completion.

Present work focuses on design of an inverse object-oriented paradigm which, in combination with existing object-oriented concepts, would permit unprecedented flexibility and clarity in a programming language.

A long-term goal is the design of a complex programming language that embodies these concepts.

2.3.7 Systems simulation of meat processing

(McFarlane)

Systems simulation is a powerful strategy for modelling and analysing complex systems in which varying degrees of randomness impacts on the performance of tasks, the arrival and flow between processes, the availability of resources, and the interaction of subsystems competing for scarce resources.

The use of systems simulation as a decision support system is relevant to meatworks, enabling decision makers to explore the operational implications of adjustments to meat processing without the expense and associated risks of major alterations. In this way, managers can evaluate new/alternative technologies and examine the feasibility of implementation at minimal cost. Comparison of alternative technologies, plant design/layout can be made in relation to bottle-necks, capacity, efficiency and resource utilisation as a function of plant layout. The ability to evaluate new technology at minimal cost will lead to more confidence in the expected performance of that technology, allow labour utilisation within new systems to be determined and planned as part of the development and will encourage quicker adoption of technology into industry.

These projects are concerned with the development of 'standard' systems simulation models for all meat processing activities, related to slaughter floor and boning room operations. The development of sophisticated user interfaces and animated graphical displays will allow the models to be used interactively by managers.

2.3.8 Systems simulation of food distribution at the Toowoomba General Base Hospital

(McFarlane)

Systems simulation is a powerful strategy for modelling and analysing complex systems in which varying degrees of randomness impacts on the performance of tasks, the arrival and flow between processes, the availability of resources, and the interaction of subsystems competing for scarce resources.

This project involves the use of systems simulation in the comparison of alternate technologies involved in the preparation and distribution of food throughout a large hospital.

2.3.9 Comparison of alternative slaughter floor configurations

(McFarlane)

Systems simulation is a powerful strategy for modelling and analysing complex systems in which varying degrees of randomness impacts on the performance of tasks, the arrival and flow between processes, the availability of resources, and the interaction proposed by a large meat processor.

2.3.10 Databases: data mining and applications

(Jiuyong Li)

> We are drowning in information, but starving for knowledge. *John Naisbett*

The rapidly growing volume and complexity of modern databases makes the need for technologies to describe and summarise the information they contain increasingly important. Data mining is a process of extracting implicit, previously unknown and potentially useful patterns and relationships from data, and is widely used in industry and business applications.

My data mining research mainly involves designing efficient algorithms to find knowledge from a large collection of data, utilising discovered knowledge to make predictions on future coming data.

Some examples of data mining projects I supervised are:

1. Mining web log file;
2. Personalisation in e-commerce;
3. Robust rule based prediction;
4. Use negative and multiple association rules to increase association rule based classification accuracy.

2.3.11 Security issues of distributed network systems

(Lai, Zhang)

The research will investigage the authorisation for Distributed Computer Network Systems DNS. Authorisation for DNS is the key security factor for success of inter-networking and Internet. Lack of delegation of user rights, delay of access right revocation and identity spoofing are the major areas that need to be addressed. This research will explore methodologies such as User Rights Server, Online Revocation Check and Dynamic Password Scheme for improving the security of authorisation on general DNS. The methodologies will be modelled, fine-tuned and tested under simulated environment using OMNeT++ as well as life situations.

2.3.12 Creating believable computer games characters with artificial intelligence

(Baillie-de Byl)

Today's computer games such as Unreal Tournament 2003 and Splinter Cell amaze avid computer games players with their advanced 3D computer imagery yet the artificial intelligence component of the game still uses traditional AI techniques. In the games industry, developers rarely have the opportunity to work with high level AI such as believable agents (called Non Player Characters NPCs) with emotion and complex behaviour as they are required to work on lower level AI tasks such as agent navigation. The serious obstacle in the games industry today is the lack of AI middleware to lift the burden of such low-level programming tasks off the developers and allow them to concentrate on high-level creative AI tasks. This project will investigate extensions to the Unreal games engine and develop tools for integrating emotional behaviours into the existing NPC data structures. This will not only enable developers ease in programming NPCs, but contribute to a general interface standard for intelligent NPC design and development.

The objectives of these projects will be to investigate the use of artificial intelligence techniques for creating believable agents in computer games. Techniques examined may include among others:

- artifical neural networks;
- affective computing;
- fuzzy logic.

2.4 Applied Statistics

2.4.1 Improving the deviance in generalised linear models

(Dunn)

In standard regression and analysis of variance, the normality assumption implies that the usual t, chi-squared and F tests are exact.

In generalised linear models, however, the normality assumption is relaxed, and consequently, hypothesis testing using the t, chi-squared and F tests are only approximate.

This project would examine a method for making these tests almost exact (that is, exact apart from sampling variability). This would build on previous work by Daniel Burrell, who has showed that the method works well for continuous distributions. This project would explicitly explore the case of discrete response distributions, for which the method will need some extra research.

This project would introduce the student to statistical theory, simulation and generalised linear

models. The project would involve writing computer programs and the experience of working with real data. The results may be publishable.

2.4.2 Toowoomba community development project

(Fahey, Hegney)

A limited term project initiated by the Commonwealth Department of Health and Aged Card and led by Professor Hegney from the Department of Nursing. Co-investigators include academic staff from Nursing, Psychology, and Mathematics and Computing. The aim is to document difficulties faced by elderly people (and their carers) upon discharge from acute care hospitals in Toowoomba and identify any improvements in the design of aged care services which could address these difficulties.

2.4.3 Locum service

(McFarlane)

A report detailing data collection, storage, and analytical strategies and methodologies, to monitor and evaluate the Locum Service intended to support Continuing Education activities and relief for rural doctors, was presented to the Cunningham Centre at the Toowoomba General Base Hospital.

2.4.4 Predictive inference

(Khan)

Prediction distribution is the basis of predictive inference. Unlike the common practice of estimating parameters of a model of performing tests of hypotheses regarding the parameters involved, often the ami of a researcher/practitioner is to predict the value of a future response from a given model. The technique of prediction is used in many real world situations as it has a common sense of appeal and simple interpretation. The prediction distribution is the probability distribution of one or more future (unobserved) responses, conditional on a set of observed responses from the same model. The method is useful in both univariate and multivariate problems. Predictive inference is possible for models with independent as well as dependent and correlated responses. Bayesian and other approaches can be adopted for the purpose of predictive inference. Available methods can handle the conventional normal model and non-normal robust models. Application of predictive inference includes problems in areas such as tolerance regions, model selection, process control, optimisation, perturbation and many others.

2.4.5 Improved estimation for multivariate models

(Khan)

The usual estimators, both the least square and maximum likelihood, can be improved by incorporating *uncertain prior information* in the form of a null hypothesis. The unrestricted estimator and the restricted estimators can be improved by using all available information and recently developed statistical techniques. The method of preliminary test estimators (PTE) has been developed by Bancroft by using the 'Fisher's recipe' of testing out the uncertainty in the null hypothesis. The PTE depends on the levels of significance and is an extreme choice between the unrestricted and restricted estimators. Stein-type shrinkage estimator addresses those problems. However, the shrinkage estimator becomes unreliable when the value of the test statistic is close to zero. The positive rule shrinkage estimator provides further improvement in addition to solving the problem of the shrinkage estimator. Study of the above improved estimators are conducted for different multivariate normal and Student-t models. The later model based estimators are robust and include a family of elliptical models.

2.4.6 Variance modelling in GLMs

(Dunn)

Generalised linear models (glm's) contain a very broad class of models that provide a uniform framework for regression modelling for many types of data. Glm's assume (among other things) that variance is proportional to some function of the mean. However, there are cases in which this mean-variance relationship fails or needs to be estimated. This research will examine the mean-variance relationship through the concept of double generalised linear models which assume link-linear predictors for both the mean and the dispersion. It will also examine statistical models whose responses are not members of the exponential family to extend the idea of generalised linear models.

2.4.7 Tweedie exponential dispersion models

(Dunn)

The generalised linear model framework provides probability distributions or mass functions for many data types, including the standard continuous and discrete data types. Distributions are characterised by their variance function, $V(\mu)$. The Tweedie family densities are distributions for which the variance functions are of the form $V(\mu) = \mu^p$ for some real index $\rho \notin (0, 1)$. Special cases include the normal ($\rho = 0$), the Poison ($\rho = 1$), the gamma ($\rho = 2$), and the inverse Gaussian ($\rho = 3$) distributions. For $1 < \rho < 2$, the Tweedie densities are continuous for $Y > 0$, with a discrete mass at $Y = 0$. For values of ρ apart from 0, 1, 2 and 3, the densities have no closed form. This research examines methods of evaluation for the Tweedie densities, and subsequent applications in generalised linear modelling, including modelling the deviance.

2.4.8 Stochastic modelling of rainfall

(Dunn)

Rainfall has been stochastically modelled in two stages: using binomial distributions for the presence or absence of precipitation (occurrence), and then gamma-based distributions for the amount of rainfall when it occurs (amount).

However, it is possible to model both occurrence and amount by using the Tweedie distributions. In addition, this allows distributions similar but more skewed than the gamma distributions to be used also.

Sara Lennox has performed some excellent preliminary work in establishing that the Tweedie distributions are useful for modelling rainfall. Her models are based on Tweedie generalised linear models, based on the fixed effect and ignoring any outocorrelation in the data. This project would extend this work by examining the following aspects:

- Incorporating the auto-correlation of the data into the model;
- Incorporating random effects into the model;
- Investigating spatial effects.

This project would introduce the student to statistical modelling and Tweedie generalised linear models. The project would involve writing computer programs and the experience of working with real data. The results may be publishable.

2.4.9 Improved confidence intervals on SOI-based rainfall probability charts

(Dunn)

The SOI is often used to make inferences about the rainfall. Stone and Auliciems have used SOI-based rainfall probability charts to demonstrate the effect on the SOI phases on rainfall at different locations. In a recent paper, I have added bootstrap confidence intervals to these charts so that researchers can see where the SOI is having a significant effect and where the effect is probably due to randomness. These bootstrap confidence intervals do not have great accuracy near $p = 0$ or $p = 1$, but could be improved (and the algorithm made faster) by using importance sampling in conjunction with the bootstrap.

The project would introduce the student to computational methods in statistics in the area of bootstrapping and importance sampling, in the context of climatology. The project would involve writing computer programs and working with real data sets.

2.4.10 Numerical derivatives for Tweedie estimation

(Dunn)

The Tweedie distributions can be used for modelling in many situations. To do this with some success requires knowledge of *which* of the Tweedie distributions to use. This requires the maximum likelihood estimation of the parameters of the Tweedie distributions. Eventually, maximum likelihood estimation of the dispersion parameter `phi` is necessary. The derivatives with respect to `phi` are an interesting numerical problem.

This project would introduce the student to computational methods in statistics and Tweedie generalised linear models. The project would involve writing computer programs and the experience of working with real data. The results may be publishable.

2.4.11 Censored Tweedie models

(Dunn)

The Tweedie distribution can be used to model continuous data with exact zeros. This type of data is not unusual, but until recently models for this type of data have been rarely used. An extension of the distributions is to consider censored Tweedie distributions, using data set provided by Dr Neville Bartlett. Censored data is data for which the exact values are known up to a maximum (more rarely, down to a minimum). For example, consider studying the amount of food eaten by cattle to determine the maximum they eat in one feeding session. If a particular beast eats all of the available food, we know that the maximum the beast can eat is at least equal to the amount provided, but possibly more.

This project would introduce the student to computational methods in statistics. Tweedie generalised linear models and censored data. The project would involve writing computer programs and the experience of working with real data. The results may be publishable.

2.4.12 Random numbers for rainfall simulation from Tweedie distributions

(Dunn)

Simulation of rainfall patterns is a common task. It can be used to model river flow, in flood mitigation models and cropping simulations. One difficulty with modelling rainfall is that two models are generally used: The first models whether or not rain falls on a particular day, and the second then models the *amount* of rain if rain actually does fall.

Using the Tweedie distributions, both steps can be combined in to one. It would be interesting to compare the properties of the simulated rainfall generated in this fashion with the simulated rainfall generated using two models.

The project would introduce the student to computational methods in statistics, to random number generation and to the properties of random numbers. It would also expose the student to real-life applications of statistics.

2.4.13 Monitoring clinical performance within and between hospitals

(Fahey, McLeod, Grey, Brodie)

While it is relatively easy to measure how much hospitals cost to build and run, it is much harder to monitor the quality of clinical care that these institutions provide. Large amounts of data on diagnoses, treatments, patient characteristics and patient outcomes are routinely generated each year by Australian hospitals. Data from all hospitals are compiled into single large data sets by each state Health Department and nationally by the Australian Institute of Health and Welfare. A large number of possible process and outcome measures are available for study. We have started comparing caesarean section rates between New South Wales hospitals and comparing twelve month mortality following surgery for fractured hips between Queensland hospitals. Analyses can involve hierarchical generalised linear models.

2.4.14 Toowoomba triage tool

(Wollaston, Fahey, Hegney, MacKay, Miller)

Triage is the process of assigning relative priorities to patients who present at hospital Emergency Departments. To date the process has been subjective and lacked standardisation across hospitals. In this study, we are testing the validity and reliability of a new computer-based algorithm for assisting triage nurses to assign appropriate priorities. The first year of testing is completed with three further phases of rollout and evaluation envisaged. Analyses centre on reliability methods.

2.5 Statistical Methods

2.5.1 Improved estimation: The preliminary test, shrinkage and positive-rule shrinkage estimators

(Khan)

Traditionally the unknown population mean is estimated by the sample mean. Improved estimators, in the sense of admissibility, accuracy and efficiency are recent phenomena in statistical inference. Improved estimators such as the preliminary

test, shrinkage and positive-rule shrinkage estimators, perform better than the traditional estimators based on normal models. When a number of alternative estimators are available to estimate an unknown parameter (scalar or vector) a natural question is, which one should be used and why? The choice obviously depends on the objective of the study and some appropriate criteria to judge the relative performance of the estimators. Generally, in the classical theory of statistics several criteria are employed to judge the characteristics of good estimators. Most common/popular of these criteria include unbiasedness, mean squared error (mse), and quadratic risk. Although the level of emphasis on these criteria varies from application to application, it is desirable that a good estimator will meet the most important/appropriate criterion determined by the researcher, and over perform the rest.

2.5.2 Estimation of mean under uncertain prior information

(Khan)

The most commonly used estimator for the mean vector is the sample mean. This estimator is unbiased and depends only on the sample data. At times, the researchers may have additional information regarding the value of the mean vector from the past experience or other sources of knowledge. Such a prior information is often uncertain in nature. Nevertheless, it can be used in the estimation of the mean vector to improve the quality of the estimator. However, the classical maximum likelihood or least square estimators (e.g. sample mean) is incapable of incorporating such additional information into the estimation of the unknown parameter. Unlike the sample mean, the preliminary test and shrinkage estimators can include both the sample data and the uncertain prior information for the estimation of the unknown parameters, like the population mean vector. I have investigated different improved estimators for various models and studied their properties under various conditions.

2.5.3 Estimation of parameters of regression model under uncertain prior information

(Khan)

The estimation of the slope and the intercept parameters of linear regression model under the constraint of suspected equality of the slopes of two simple regression models is handled. The suspected equality slopes is presented by a null hypothesis and is tested by using an appropriate test statistic. Different estimators of the slope and intercept are defined. Some important statistical properties of the unrestricted, restricted and preliminary test estimators are investigated. Conclusions about the performances of different estimators under various conditions are discussed to explore the optimal choice. Another constraint in terms of the coefficient of distrust on the null hypothesis is introduced in the estimation process, especially for the definition of shrinkage restricted and shrinkage preliminary test estimators. Estimators are compared under various conditions for different values of the coefficient of distrust. Applications in the medical, biological and agricultural sciences are considered.

2.5.4 Estimation under alternative test statistics

(Khan)

The preliminary test estimator depends on the choice of the statistic to remove the uncertainty in the prior information as well as the preselected level significance. Three different tests, namely the World (W) Test, Likelihood Ratio (LR) Test and Lagrange Multiplier (LM) Tests, are used in the literature to test many linear hypotheses. The exact distribution of the test statistics are complicated and often researchers use asymptotic equivalent of the test statistics for inferential purposes. The use of the same approximate chi-square test does not have the correct significance level. This causes conflict in the statistical inference. Use of the approximate chi-square test statistic in the definition of the preliminary test estimator causes conflict in the biases and mean squared errors of the estimators. The use of modified test statistic reduces the conflicts to some extent but does not remove it. Edgeworth size corrected test does a lot better job than the modified test to reduce the conflict. This fact has been studied for various models under the framework of improved estimation.

2.5.5 The multivariate student-t distribution

(Khan)

The customary use of the normal model is under

serious question when the population distribution is symmetric but have heavier tails than the normal distribution. Also, the normal model fails to incorporate dependent but uncorrelated responses. In such cases, the multivariate Student-t distribution provides an appropriate model for the population. Such a model can be viewed as a mixture of normal and inverted gamma distributions. Using this result, we obtained the maximum likelihood estimators of the mean and scale parameters of multivariate Student-t distribution. The model has been used to find appropriate test statistic to test the mean vector. The non-null distribution of the test statistic has been derived. The distribution of the sum of squares and product matrix for the multivariate Student-t model as well as the predictive distribution of future models have been proposed. Similar results for the matrix T model are also obtained.

2.5.6 Predictive inference

(Khan)

Prediction distribution is the basis for many predictive inferences. Unlike the common practice of estimating parameters of a model or performing tests of hypotheses regarding the parameters involved, often the aim of a researcher/practitioner is to predict the value of a (or a set of) future response(s) from a given model. The technique of prediction is used in many real world situations as it has a common sense appeal and simple interpretation. The prediction distribution is the probability distribution of one or more future (unobserved) responses, conditional on a set of observed responses from the same model. The method is useful in both univariate and multivariate problems. Predictive inference is possible for models with independent as well as dependent and correlated responses. Bayesian and other approaches are adopted for the purpose of predictive inference. Available methods can handle the conventional normal model and non-normal robust models. Application of predictive inference includes problems in areas such as tolerance regions, model selection, process control, optimisation, perturbation and many others.

2.6 Mathematics Education

2.6.1 The effects of the use of scientific software for the learning of mathematics

(Cretchley)

Relationships are explored between the choices students make when using technology, their levels of achievement, their mathematics and computer confidence, their motivation to use technology, and their learning and technology preferences.

2.6.2 Calculus reform

(Spunde)

The calculus/algebra reform program at USQ has been in effect since 1988. A computationally rich mathematics instruction program in first year mathematics was developed in a CAUT sponsored project providing an alternative approach to a first semester course in mathematics, and integrating work on both calculus and linear algebra. An Open Learning Quality Enhancement program builds on the work of CAUT project to produce an alternative method of delivering the Foundation Mathematics course (MAT1100) to open learning students equipped with a computer.

The USQ program is unique amongst calculus reform projects in that it concentrates attention on the direct numerical computation of functions, their derivative functions and indefinite integrals, and the application of the rules of calculus to the manipulation of numeric function tables rather than symbolic formulae (in the first instance). A workshop for teachers offered at APL95 by W. Spunde and R. Neidinger (Davidson, N. C.) demonstrated how these numerical ideas could be implemented in Mathematica, Maple, Matlab, ApL, J and on the HP48G and the T182 and T185 calculators. Current development focuses on a hybrid language (J+TkTcl) for mathematics instruction.

The program aims to provide students with a strong background of computational experience on which to base an understanding of mathematical symbolism and symbolic manipulations.

2.6.3 What motivates the study of mathematics and computing?

(McDonald, Cretchley)

It is common knowledge that fewer females than males choose to undertake tertiary studies in Mathematics and/or Computing. Various explanations for why this is so have been put forward, with most focussing on why girls do NOT choose to enter these fields. Recently Patricia Cretchley, Anne Fuller and Christine McDonald began an investigation into the factors that influenced 1st year Mathematics Computing students to enter these courses. Students in Algebra and Calculus 1 have completed a questionnaire, and shortly we will be interviewing selected students to obtain more detailed data. This pilot study will be extended to all Queensland universities.

We hypothesise that girls enter Mathematics/ Computing for different reasons from boys. We further hypothesise the existence of regional (rural vs urban etc.) differences.

If we can identify any such motivational differences, we, and other universities, can better target potential students, both male and female.

2.6.4 Measuring attitudes towards mathematics in early childhood and primary teacher education

(Roberts, C., Cretchley, Harman)

Changes in attitude have been measured over a semester of mathematics in the first year of Early Childhood and Primary teacher training. The unit of study is not a curriculum unit, is taught by mathematicians and explores mathematical ideas and experiences. The Fennema–Sherman Attitudes Scale was used to measure changes in *confidence, effectance motivation*, and *usefulness*. Analysis of the results indicates a challenging outcome — the only significant change was a drop in their perception of the usefulness of mathematics.

2.6.5 Analysis of the effect of the use of powerful mathematical computing software on undergraduate attitudes towards mathematics and learning

(Harman, Cretchley, Ellerton, Fogarty)

The influence of introducing MATLAB into first-year mathematics has been analysed. The key factors studied are influences on attitudes and concept development.

2.7 Computing Science Education

2.7.1 Introductory programming census

(De Raadt, Toleman, Watson)

The Census has now been run twice in 2001 and 2003 and is hoped to run again in 2005. The census involves contacting inst5ructors of all introductory programming courses in Australia and New Zealand and gathering information about languages taught, paradigms taught, tools used and other aspects. The Census has a guaranteed audience which ensures publication success. there is room within the Census for gathering information about topical issues. The 2001 Census gathered information about *why* instructors chose a particular language, which revealed the importance of perceived industry relevance. In the 2003 Census, information was gathered about approach to instruction of problem solving strategies, which reveal little consensus in this regards. This project would be excellent for an Honours or Masters student who has an interest in instruction or programming and wishes to gather conclusive evidence about some issue in that area.

2.7.2 Teaching strategic problem solving

(De Raadt, Toleman, Watson)

This project aims to suggest improvement in teaching of problem solving to novice programmers. The approach under consideration involves extracting the tacit knowledge possessed by expert programmers, formalising it and presenting it to novices in an explicit manner. Past research has shown that

experts can recognise goals within a problem statement and apply, adapt and incorporate predetermined plans which have achieved these goals in the past.

2.7.3 Identifying predictors of programming performance

(De Raadt, Toleman, Watson)

This project is a multi-university study which involves attendees of the BRACE (Building Research in Australasian Computing Research) workshop. The current endeavours of this group involve attempting to identify tests which can reliably predict the success or failure of a student in introductory programming study. Tests being considered assess spatial reasoning, articulation of decision making and learning styles. These tests are considered in light of age, gender and past programming experience.

2.7.4 Online management of student assessment

(Baillie-de Byl)

Contemporary online teaching environments provide a plethora of assessment tools. However, while methods such as multiple choice, matching, fill-in-the-blank and formulaic questions lend themselves to online education and automatic marking, the primary disadvantage of these assessment methods is their poor ability to accurately reflect student learning. Although it is possible to integrate a more accurate means of testing a student's knowledge and understanding (for example, essays and projects) into an online teaching environment, the advantages of using contemporary online education environments ends after the electronic submission. The expert judgment of the respective examiner is essential in marking and critiquing work. Many online educators shy away from electronic submission of essays and projects because of the level of technical expertise required to disseminate, open, critique and administer.

The objective of these projects will be to develop a system to assist examiners with the critiquing and administration of electronically submitted assessment at USQ. The system will be:

- accessible via the Internet;
- formatted for hand-held devices and PCs;
- integrated with existing grading and administration systems at USQ; and
- used in marking and criquing student assessment in both small and large (more than one marker) courses.

2.7.5 Detection of plagiarism in computer programming assignments

(Mason, Watson, Brookshaw)

This research relates to the current plagiarism detection software that is available for finding similarities in computer programming assignments and to produce a set of standard tests to rate each one with the possibility of producing our own algorithm.

2.8 Miscellaneous

2.8.1 Quality monitoring in acute hospitals

(Fahey)

The aim is to develop methods for detecting, reporting and responding to unusual variation in clinical performance between hospitals. The data source used is the NSW medical record front sheet which collects about 120 data items on each of the 1.5 million acute hospital admissions in that state each year. The analysis methods are centred on variation indexes which adjust for chance, 'usual' between hospital variation and confounding variation in clinically meaningful terms (such as potential dollars saved or potential adverse outcomes averted). Response strategies are being investigated through workshops and collaboration with health services research groups at the University of Newcastle.

2.8.2 Holistic finite difference approximations

(Roberts)

We use modern dynamical systems methods to develop accurate finite difference approximation to dynamical equations. The analysis is based upon centre manifold theory so we are assured that the finite difference model accurately models the dynamics and may be constructed systematically. The trick to the application of centre manifold theory is

to divide the physical domain into small elements by introducing insulating internal boundaries which are later removed. Burger's equation is used as an example to show how the concepts work in practice. In this example, the resulting finite difference models are shown to be significantly more accurate than conventional discretisations, particularly for highly nonlinear dynamics. This centre manifold approach treats the dynamical equations as a whole, not just as the sum of separate terms - it is holistic. The techniques developed here will be used to accurately model the nonlinear evolution of quite general spatio-temporal dynamical systems. This project will have enormous impact.

2.8.3 Fractal geometry

(Roberts)

The distribution of plants and animals in their environment is frequently patchy. Recent research has shown that this patchiness occurs, at least sometimes, on all scales in the distribution of the species. This appearance of structure on all scales leads naturally to a description of the distribution as a fractal object. Indeed analysis of the settlement and subsequent evolution of fucoids ("seaweed") off the coast of South Australia is showing the distribution to be a multi-fractal.

A current project is to overcome present limitations in estimating fractal dimensions and determining the multi-fractal spectra. Current methods are based on straight line fits on log-log plots. By generating artificial multi-fractals and comparing the underlying structure of neighbour-distance information, we can determine which multi-fractals best match the physical data. With this fit, we then use the analytically known information about the artificial multi-fractal to estimate the fractal nature of the original.

2.8.4 Bioinformatics: gene expression data analysis

(Jiuyong Li, Grant Daggard)

DNA microarray technology provides a broad snapshot of the state of a cell by measuring the expression levels of thousands of genes simultaneously. Understanding of gene expression data enables humans to study gene functionalities, to predict gene related diseases and develop effective medicines.

In the last few years, a large amount of Microarray data has been collected, from mice to humans in a variant of databases, such as Human Genome Centre and the Stanford Microarray database, etc. The analysis of Microarray data is a new frontier of molecular biology, biomedical and computing research. We are interested in the following two tasks in gene expression data analysis. One is to find gene groups with similar expression patterns and another is to identify genes associated with some diseases.

An example of a bioinformatics project that we supervised is "Find similar patterns in gene expression data".

Chapter 3

Grants and Presentations

3.1 Research, consulting and teaching grants

Research, consulting and teaching development projects to be supported by competitive grants include the following.

- P. Baillie-de Byl. First principle investigator. Early Career Researcher Grant. Project Title: *An AI Middleware Paradigm for Programming Emotionally Believable Agents as Non Player Characters in Computer Games*, USQ Australia, July 2003 – June 2004 ($8,000).
- P. Cretchley. Award for Excellence in Teaching, USQ Australia, 2003 ($5,000).
- P. Fahey. Second principle investigator. Queensland Nursing Council Grant. Project Title: *The Toowoomba Adult Trauma Triage Tool*, November 2002 – November 2003 ($49,964).
- J. Li. First principle investigator. Early Career Researcher Grant. Project Title: *Generating robust predictive classification rule sets*, USQ Australia, July 2002 – June 2003 ($9,704).

3.2 Seminars

The department has an active seminar programme. Seminars organised during the year by the department include the following.

- Ron Addie, Department of Mathematics & Computing, USQ, *The Tale of the Misleading Tail*, January 2003.
- Ron Addie, Department of Mathematics & Computing, USQ, *Guaranteed Performance in the Internet: Is It Possible? Is It Necessary? Is It Available Already?*, March 2003.
- Ron Addie, Department of Mathematics & Computing, USQ, *Asymptotic accuracy in queueing theory*, December 2003.
- Bob Anderssen, Chief Scientist, CSIRO Mathematical and Information Sciences Division, Canberra, *Recovering Information from Plant Biology Data*, November 2002.
- Penny Baillie, Department of Mathematics & Computing, USQ, *Digitising the Red Pen*, March 2002.
- Penny Baillie, Ron House, Richard Watson, Department of Mathematics & Computing, USQ, *If you want it done right .... Making the Web work for all of us*, July 2002.
- Baki Billah, Department of Econometrics and Business Statistics, Monash University, *Unmasking the Theta Method*, September 2002.
- Laurence Bull, Monash University, *Digital Signatures*, April 2002.
- Daniel Burrell, Department of Mathematics & Computing, USQ, *Improving the Deviance Measures in Generalised Linear Models using Quantile Residuals*, May 2003.
- Jinli Cao, Department of Mathematics & Computing, USQ, *A Consumer Scalable Anonymity Payment Scheme with Role Based Access Control*, February 2002.
- Colin Carmichael, Department of Mathematics & Computing, USQ, *Item Response Theory and its Application to the*

Analysis of Introductory Statistics Examination Items, June 2002.

- Edel Chadwick, Department of Mathematics & Computing, USQ, *Motivation and creativity strategies for researchers, based on Neurolinguistic Programming techniques*, June 2002.
- Adrian Chappell, School of Environment and Life Sciences, University of Salford, and Marie Ekstrom, Climatic Research Unit, University of Anglia, *Spatial and Temporal Variation of Australian Continental Dust (1960-1999)*, August 2002.
- Patricia Cretchley, Department of Mathematics & Computing, USQ, *USQ Showcase : Excellence in Teaching*.
- Michael de Raadt, Department of Mathematics & Computing, USQ, *What is being taught in Introductory Programming in Australia*, March 2002.
- Michael de Raadt, Department of Mathematics & Computing, USQ, *Training Strategic Problem Solvers*, April 2003.
- Michael de Raadt, Department of Mathematics & Computing, USQ, *Research Directions*, to Department of Information Systems, USQ, August 2003.
- Sue Dowe, Library, USQ, *Web of Knowledge Demonstration*, October 2003.
- Peter Dunn, Department of Mathematics & Computing, USQ, *Generalised Linear Models for Continuous Data with Exact Zeros*, June 2002.
- Peter Dunn, Department of Mathematics & Computing, USQ, *There must be a better way to mix application output and text study materials*, November 2003.
- Paul Fahey, Department of Mathematics & Computing, USQ, *Modelling Variation in Caesarean Section Rates for NSW Hospitals*, June 2002.
- Warwick Graco, HIC Canberra, *Detection Fraud and Inappropriate Practice*, May 2003.
- Chris Harman, Department of Mathematics & Computing, USQ, *A Biomechanical Power Model for World-Class 400 Metre Running*, May 2002.
- Markus Hegland, Mathematical Sciences Institute, Australian National University, *Association Rules - Algorithms and Applications*, August 2002.
- Zahirul Hoque, Department of Mathematics & Computing, USQ, *Risk behaviour of the improved estimators of the mean vector of multivariate normal distribution under linex loss function*, July 2002.
- Jingyu Hou, Department of Mathematics & Computing, USQ, *Constructing Good Quality Web Page Communities*, March 2002.
- Ken Houston, University of Ulster, *Embedding 'key skills' in undergraduate mathematical sciences programmes*, December 2003.
- Xiaodi Huang, Department of Mathematics & Computing, USQ, *Graph Visualization: Towards Practical Applications*, 11 September 2003.
- Shanthi Joseph, Department of Mathematics & Computing, USQ, *Quantum Simulation of WAN Traffic*, August 2002.
- Jason Jones, Department of Mathematics & Computing, USQ, *Multiple and negative target rule mining*, July 2003.
- Laurie Kanizaj, Department of Mathematics & Computing, USQ, *A Study of Generalised Linear Models with an Application to Modelling Soccer Games*, January 2002.
- Shahjahan Khan, Department of Mathematics & Computing, USQ, *Distribution of regression vector and residual sum of squares of future responses from multiple regression model*, May 2002.
- Shahjahan Khan, Department of Mathematics & Computing, USQ, *Predictive Inference for Linear Models*, Statistics Day 2002, Department of Mathematics & Computing, USQ, November 2002.
- John King, Department of Mathematics & Computing, USQ, *Secure Mobile Computing : Some Problems, Some Solutions*, September 2002.
- Sunny Koh, Department of Mathematics & Computing, USQ, *Palm Size Online Games*, July 2003.

- David Lai, Department of Mathematics & Computing, USQ, *Dynamic Password Scheme*, February 2003.
- David Lai, Department of Mathematics & Computing, USQ, *Introducing and Object Oriented Network Simulation Environment in C++ — A test bed for Network Protocols*, December 2003.
- Sarah Lennox, Department of Mathematics & Computing, USQ, *A Statistical Approach to Rainfall Modelling*, June 2002.
- Sarah Lennox, Department of Mathematics & Computing, USQ, *A Statistical Approach to Rainfall Modelling*, March 2003.
- Jiuyong Li, Department of Mathematics & Computing, USQ, *Construct Robust Rule Sets for Classification*, October 2002.
- Jiuyong Li, Department of Mathematics & Computing, USQ, *Efficient Rule Discovery and Robust Rule-Based Predictions*, April 2003.
- Jiuyong Li, Department of Mathematics & Computing, USQ, *Direct Interesting Rule Generation*, November 2003.
- Yan Li, Department of Mathematics & Computing, USQ, *Blind Signal Separation: The Cocktail Party Problem*, February 2003.
- Zhi Li, Department of Mathematics & Computing, USQ, *An Application of Fuzzy Logic to UPC in ATM Networks*, January 2003.
- Zhi Li, Department of Mathematics & Computing, USQ, *Improving the adaptability of AQM algorithms to traffic loads using Fuzzy Logic Abstract*, December 2003.
- Christine McDonald, Department of Mathematics & Computing, USQ, *Statistical Methods for QTL Mapping*, May 2002.
- David Mason, Department of Mathematics & Computing, USQ, *Detection of Plagiarism in Computer Programming Assignments*, October 2003.
- Ruth Mossad, Faculty of Engineering & Surveying, USQ, *Prediction Shear Forces due to Flood Flow over Sloped Planes*, May 2003.
- Craig Nicholas, Department of Mathematics & Computing, USQ, *Bootstrap Confidence Intervals*, January 2002.
- Khaleel Petrus, Department of Mathematics & Computing, USQ, *Highlights of the 2003 Data Mining Winter School at Monash University*, August 2003.
- Tony Roberts, Department of Mathematics & Computing, USQ, *Resolve subgrid scale interactions in numerical models of PDEs*, January 2003.
- Peter Rowling, Department of Mathematics & Computing, USQ, *Intelligent Agents for Network Management*, December 2002.
- Hong Shen, Graduate School of Information Science, Japan Advanced Institute of Science and Technology, *Non-blocking Optical Multistage Interconnection Networks*, August 2002.
- Dmitry Strunin, Department of Mathematics & Computing, USQ, *Stable Pulse as a Model for Elementary Particle (or What Partial Differential Equations Can Do)*, September 2002.
- Sergey Suslov, Department of Mathematics & Computing, USQ, *Highly accurate spectral method for enclosed incompressible flows: benchmark solution for thermally driven cavity*, January 2002.
- Nick Trefethen, Oxford University and University of Queensland, *Transition to Turbulence in Pipes and Channels*, October 2003.
- Hua Wang, Department of Mathematics & Computing, USQ, *Formal Authorisation Approaches for Role-Based Access Control Based on Relational Algebra Operations*, November 2003.
- Oleg Vasilyev, Department of Mechanical Engineering, University of Colorado, Boulder, *Use of Wavelets for Modelling and Simulation of Multi-Scale Phenomena*, June 2003.
- Jacek Wesolowski, Politechnikal Warszawska, Poland, *Independence Properties of Wishart Matrices*, September 2003.

- Billy Yue, Department of Mathematics & Computing, USQ, *Emotional Stereotyping using Conceptual Graphs for Believable Agents*, June 2003.

  Abdulla Zareer, Department of Mathematics & Computing, USQ, *An XML Based Language for Describing Networks*, October 2003.

Seminars presented outside the University of Southern Queensland:

- Michael de Raadt, *Where is programming heading in universities and how does it match what is happening in industry?*, to members and guests of the Australian Computer Society, Queensland Branch State Forum, Brisbane, October 2002.

- Jiuyong Li, *Efficient Rule Discovery and Robust Rule-Based Predictions*, at the Australian National University, April 2003.

- Shahjahan Khan, *Slopes of two parallel regression lines*, at the Department of Community Medicine, Kuwait University, Kuwait, September 2003.

- Shahjahan Khan, *Improved estimation of the slopes of two suspected parallel regression lines*, at the Department of Statistics, University of Dhaka, Bangladesh, September 2003.

- Shahjahan Khan, *An introduction to improved estimation for some normal models*, at the Department of Statistics, Macquarie University, Sydney, July 2002.

- Shahjahan Khan, *Predictive distributions for linear regression models*, at the Institute of Statistical Research and Training, University of Dhaka, February 2002.

- Tony Roberts, *Dynamics in complex systems science*, at the University of Western Australia, August 2003.

- Tony Roberts, *The prisoners are in two minds*, at QANZIAM, Stradbroke Island, Queensland, September 2003.

- Tony Roberts, *Reproductively induced correlations, Brownian bugs, and plankton patchiness*, at the Fields Institute, University of Toronto, November 2003.

- Tony Roberts, *Modelling fluid flows in thin layers*, at the University of California, San Diego and the University of Colorado, November 2003.

- Tony Roberts, *Rational modelling determines boundary conditions*, at the Fields Institute, University of Toronto, and at the Scripps Institute of Oceanography, California, November 2003.

- Tony Roberts, *Complex systems: rational modelling ensures fidelity*, at the University of Adelaide, December 2003.

- Sergey Suslov, *Flow patterns, instabilities and their control in non-Boussinesq convection*, at the University of Missouri-Columbia, USA, March 2002.

- Sergey Suslov, *Spatio-temporal instabilities in mixed convection of air subject to large temperature gradient*, at the International Conference on *Advanced Problems in Thermal Convection*, Perm, Russia, November 2003.

3.3 Conferences, Workshops and Presentations

Conferences attended by members of the department, and their presentations, are listed below.

- P. Baillie-de Byl. *An Agent with a Passion for Decision Making*, in Proceedings of Agent Based Simulation Conference 3 and as Open Speaker, Passau, Germany, April 2002.

- P. Baillie-de Byl. *Multidimensional Affect Appraisals for Artificial Intelligence*, at the Affective Computing Workshop, Vienna, Austria, April 2002.

- P. Baillie-de Byl. *Distributed Web-Based Critiquing of Electronically Submitted Assessment* in Proceedings of the Web-based Learning Conference, Melbourne, August 2003.

- P. Cretchley & P. Galbraith. *Mathematics or computers? Confidence or motivation?*, in Proceedings of the 2nd International Conference on the Teaching of Mathematics (Undergraduate), Crete, June 2002.

- P. Cretchley. *Mathematics and Technology: how integrated is this learning partnership?*, in Proceedings of the Vienna International Symposium on Integrating Technology into Mathematics Education, Vienna, July 2002.
- P. Cretchley, A.J. Roberts & C.J. Harman. *Engineering Mathematics: Time for a Core Curriculum?*, in Proceedings of EMAC Group at the International Congress on Applied Mathematics, Sydney, July 2003.
- P. Cretchley. *What is effective in the classroom?*, Plenary address at Queensland Association of Mathematics Teachers Annual Conference, USQ, Toowoomba, September 2003.
- M. de Raadt. *Language Trends in Introductory Programming Courses*, in Proceedings of IS2002, Cork, Ireland, June 2002.
- M. de Raadt. *Language Tug-Of-War: Industry Demand and Academic Choice*, in Proceedings of ACE2003, Adelaide, February 2003.
- P.K. Dunn & G.K. Smyth. *Tweedie Family Densities: Methods of Evaluation* in Proceedings of the 16th International Workshop on Statistical Modelling, Odense, Denmark, July 2001.
- P.K. Dunn & S.M. Lennox. *A statistical distribution for improved precipitation modelling Weather and Water*, in Proceedings of the Tenth Annual Australian Meteorological and Oceanographic Society Conference, Perth, February 2003.
- P.K. Dunn. *Dicey statistics*, in Proceedings of the Queensland Association of Mathematics Teachers Annual Conference, Toowoomba, September 2003.
- P.K. Dunn. *What happens with all that maths?*, in the Proceedings of the Queensland Association of Mathematics Teachers Annual Conference, Toowoomba, September 2003.
- P.K. Dunn. *Sweave–when R and LaTeX come together*, in Proceedings of the R Workshop, part of the Queensland Statistics Conference, USQ, October 2003.
- P.K. Dunn. *When is it sensible to model the dispersion in generalized linear models?*, in Proceedings of the Queensland Statistics Conference, USQ, October 2003.
- P. Fahey. *SPSS : An in-service on practical statistical methods for USQ Staff and Post Graduate Students*, offered every semester at USQ, six two-hour sessions.
- P. Fahey & C. Maloney (Toowoomba Health Service District). *Research Methods Workshop*, a half day small group introduction to research methods conducted for staff of Toowoomba Health Service District every month.
- C.J. Harman. *A Biomechanical Model for World Class 400 metre running*, in Proceedings of Conference, Maths and Computers in Sport, Bond University, Queensland, July 2002.
- C.J. Harman. *Running on the Curve*, in Proceedings of ICIAM Conference, Sydney, July 2003.
- S. Khan. *Distribution of sample regression vector and residual sum of squares for the multiple regression vector with normal errors*, in Proceedings of the Sixteenth Australian Statistics Conference, Canberra, July 2002.
- S. Khan. *Predictive distribution of regression vector and residual sum of squares for normal regression models*, in Proceedings of BSA International Conference, Dhaka, Bangladesh, January 2003.
- Jiuyong Li. *Construct Robust Classification Rule Sets*, in Proceedings of the Eighth ACMKDD International Conference on Knowledge Discovery and Data Mining, Edmonton, Canada, July 2002.
- Jiuyong Li. *Direct Interesting Rule Generation*, in Proceedings of the Third IEEE International Conference on Data Mining, Florida, USA, November 2003.
- K. Petrus. Attended Data Mining School Workshop, Monash University, Melbourne, July 2003.
- S. Suslov. *Highly accurate spectral method for enclosed incompressible flows: benchmarking solution for thermally driven cavity*, in Proceedings of ANZIAM2002, the Thirty-Eighth Applied Mathematics Conference, Canberra, February 2002.

- S. Suslov. *On the validity of the linearized Ginzburg-Landau model in realistic problems with spatio-temporal instabilities*, in Proceedings of EMAC02 Conference, Brisbane, September-October 2002.
- S. Suslov. *Multi-mode spatio-temporal instability in non-Boussinesq convection*, in Proceedings of CTAC03 Conference, Sydney, July 2003.
- H. Wang, J. Cao & Y. Zhang. *A flexible payment scheme and its permission-role assignment*, in Proceedings of the 26th Australasian Computer Science Conference (ACSC2003), Adelaide, February 2003.
- H. Wang, J. Cao & Y. Zhang. *Formal authorization approaches for permission-role assignment using relational algebra operations*, in the Proceedings of the 14th Australasian Database Conference, Adelaide, February 2003.

3.4 Conference and Workshop Organisation

Dr. E. Chadwick was on the Organising Committee of the Transitions Conference, USQ, April 2003.

Mrs. P. Cretchley was on the International Committee for the Second International Conference on the Teaching of Mathematics (Undergraduate), chairing a session and introducing/chairing the Australian Guest Speaker Plenary, Crete, June 2002.

Mrs. P. Cretchley was Organiser of a Mini-Symposium on Undergraduate Mathematics Curricula at ICIAM.

Mrs. P. Cretchley was on the Committee as Local Organiser and Chair of a Session for the QAMT Annual Conference, USQ, September 2003.

Dr. P. K. Dunn organised the inaugural Queensland Statistics Conference, USQ, October 2003.

Dr. P. K. Dunn organised an R Workshop as part of the Queensland Statistics Conference, USQ, October 2003.

Dr. P. K. Dunn organised and conducted an R Workshop at USQ, November 2003.

Assoc. Prof. S. Khan was a member of the International Organising Committee for the BSA International Conference, Dhaka, Bangladesh, January 2003.

3.5 Affiliation with Journals

Prof. A. J. Roberts is Electronic Editor for the Australian Mathematics Society, and Editor of the ANZIAM Journal (Electronic Supplement).

Chapter 4

Publications

This chapter lists the research papers written by members of the department for recognised journals and conferences since 2002.

The Department of Mathematics and Computing is also actively involved in the Faculty of Sciences Working Paper Series. These are listed in each staff members' publications as well. A full listing of the current working papers can be found at `http://www.sci.usq.edu.au/research/`. They are accessible in postscript format.

4.1 R. G. Addie

- T. D. Neame, M. Zukerman & R. G. Addie. Modeling Broadband Traffic Streams, Proceedings of *IEEE GLOBECOM '99*, Rio de Janiero, Brazil, December 1999.
- R. G. Addie, P. Mannersalo & I. Norros. Most Probably P and Performance Formulae for B with Gaussian, in *Journal of European Transactions on Telecommunications*, Milano, 2002.
- R. G. Addie. Quantum Simulation — Rare Event Simulation by Means of Closing, Thinning and Distortion, in *Journal of European Transactions on Telecommunications*, Milano, 2002.
- R. G. Addie, T. D. Neame & M. Zukerman. Performance Evaluation of a Queue Fed by a Poisson Burst Process, in *Journal of Computer Networks*, Elsevier, 2002.
- T. Neam, M. Zukerman & R. G. Addie. Internet Traffic Modeling and Future Technology Implications, in Proceedings of *IEEE Infocom 2003*, San Francisco, March–April 2003.
- R. G. Addie, T. D. Neame & M. Zukerman. On asymptotic accuracy in queueing theory - the tale of the misleading tail, in Proceedings of *The Australian Telecommunication Networks and Applications Conference 2003*, Melbourne, December 2003.
- Z. Li, Z. Zhang & R. G. Addie. Improving the Adaptability of AQM Algorithms to Traffic Load Using Fuzzy Logic, in Proceedings of *The Australian Telecommunication Networks and Applications Conference 2003*, Melbourne, December 2003.

4.2 P. Baillie-de Byl

- P. Baillie, M. Toleman & D. Lukose. Engineering Emotionally Intelligent Agents, Chapter in *Intelligent Agent Software Engineering*, ISBN 1−59140−046−5, 2002.
- P. Baillie & D. Lukose. An affecting decision making agent architecture using emotions, Proceedings of *PRICAI 2002*, Tokyo, August 2002.
- P. Baillie & D. Lukose. Emotional Decision Making in Artificial Intelligences, Proceedings of *International Conference on Artificial Intelligence 2002*, Las Vegas, June 2002.
- P. Baillie. An Agent with a Passion for Decision Making, Proceedings of *3rd Workshop on Agent-Based Simulation*, Passau, Germany, 2002.
- P. Baillie & D. Lukose. Affect Appraisals for Decision Making in Artificial Intelligences, Proceedings of *16th European Meeting on Cybernetics and System Research*, Vienna, 2002.

- P. Baillie-de Byl. A Six Dimensional Paradigm for Generating Emotions in Virtual Character, in *International Journal of Intelligent Games and Simulation*, 2003.
- P. Baillie-de Byl. Emotional Influence on Perception in Artificial Agents, in *Journal Informatica*, 2003.
- P. Baillie-de Byl. Distributed Web-Based Critiquing of Electronically Submitted Assessment, Proceedings of *2nd International Conference on Web-Based Learning (ICWL 2003)*, Melbourne, August 2003.

4.3 P. Cretchley

- P. Cretchley & P. Galbraith. Mathematics or computers? Confidence or motivation?, Proceedings of *ICTM2*, Online and CD, Crete, 2002.
- P. Cretchley, A. J. Roberts & C. J. Harman. Engineering Mathematics: Time for a Core Curriculum?, Proceedings of *EMAC2003*, Sydney, 2003.
- L. Galligan, P. Cretchley, L. George, K. Martin-McDonald, J. McDonald & J. Rankin. Evolution and emerging trends of University Writing Groups, in the *Queensland Journal of Educational Research*, Vol. 19, 2003.
- L. George, K. Martin-McDonald, P. Cretchley, J. Rankin, L. Galligan & J. McDonald. Issues that confront professional women entering academe through non-traditional academic career paths, Proceedings of *ATN-WEXDEV 2003 Research Conference*, Perth, 2003.
- P. Cretchley & P. Galbraith. Mathematics, Computers and Umbilical Cords, Proceedings of *Remarkable Delta:03*, Queenstown, New Zealand, November 2003.

4.4 M. de Raadt

- N. Dunstan & M. de Raadt. Evolution of Spatial Data Templates for Object Classification, in *Data Mining: A Heuristic Approach*, Editors H. A. Abbass, R. A. Sarker & C. S. Newton, Idea Group Publishing, 2002.
- M. de Raadt, R. Watson & M. Toleman. Language Trends in Introductory Programming Courses, Proceedings of *Informing Science and IT Education Conference*, Cork, Ireland, 2002.
- M. de Raadt, R. Watson & M. Toleman. Language Tug-Of-War: Industry Demand and Academic Choice, Proceedings of *Fifth Australasian Computing Education Conference (ACE2003)*, Adelaide, 2003.
- M. de Raadt, M. Prokopenko & M. Butler. Evolving Tactical Formations on the RoboCup Field, *Workshop on Adaptability in Multi-Agent Systems, The First RoboCup Australian Open 2003*, Sydney, 2003.
- M. de Raadt, R. Watson & M. Toleman. Introductory programming languages at Australian universities at the beginning of the twenty first century, in *Journal of Research and Practice in Information Technology*, 2003.

4.5 P. Dunn

- P. Dunn, C. Harman. Calculus Demonstrations Using MATLAB, in *International Journal of Mathematical Education in Science Technology*, 2002.
- P. Dunn. Understanding Statistics Using Computer Demonstrations, in *Journal of Computers in Mathematics and Science Teaching*, 2003.
- P. Dunn. What Happens when a 1+1+r die is rolled? in *Journal: The American Statistician*, 2003.

4.6 P. Fahey

- D. Hegney, A. McCarthy, M. B. de la Rue, P. Fahey, D. Gorman, K. Martin-McDonald, G. Pretty & D. Sundin-Huard. Discharge Planning for the Acute Sector for People Over the Age of 65, in *Journal: Collegian*, Melbourne, 2002.
- D. Hegney, A. McCarthy, M. B. de la Rue, D. Gorman, K. Martin-McDonald, P. Fahey & G. Pretty. The Interface of Acute and Aged Care: the Role of the Nurse in a Provincial Area, in *Australasian Journal on Ageing*, 2003.

4.7 C. J. Harman

- C. J. Harman. A Biomechanical Power Model for World-Class 400 Metre Running, Proceedings of *Sixth Australian Conference on Mathematics and Computers in Sport*, Sydney, 2002.

- C. J. Harman. Reform Calculus - Yesterday, Today and Tomorrow, in *New Zealand Journal of Mathematics*, Auckland, 2003.

4.8 S. Khan

- S. Khan. Likelihood Inference on the Mean Vectors of Two Multivariate Student-t Populations with Unknown Diagonal Covariance Matrix, in *Journal of Statistical Studies*, Dhaka, 2002.

- S. Khan & A. K. Md. E. Saleh. Stein-type Estimators for Mean Vector in Two-Sample Problem of Multivariate Student-t Populations with Common Covariance Matrix, in *International Journal of Statistical Sciences*, Bangladesh, 2002.

- S. Khan. A Note on an Optimal Tolerance Region for the Class of Multivariate Elliptically Contoured Location-scale Model, in *Calcutta Statistical Association Bulletin*, Calcutta, 2002.

- S. Khan & Z. Hoque. Estimation of the Slope Parameter for Linear Regression Model with Uncertain Prior Information, in *Journal of Statistical Research*, Dhaka, 2002.

- S. Khan. Distribution of sum of squares and products Matrices for the Generalized Multilinear Matrix-T Model, in *Journal of Multivariate Analysis*, 2002.

- S. Khan. Estimation of the Parameters of Two Parallel Regression Lines Under Uncertain Prior Information, in *Biometrical Journal*, WeinHeim, Germany, 2003.

- S. Khan & A.K. Chattapadhyay. Predictive Analysis of Occupational Mobility Based on Number of Job offers, in *Journal of Applied Statistical Science*, USA, 2003.

- S. Khan & Z. Hoque. Preliminary Test Estimators for the Multivariate Normal Means Based on the Modified W, LR and LM Tests, in *Journal of Statistical Research*, Dhaka, 2003.

4.9 Jiuyong Li

- J. Li, R. Topor & H. Shen. Construct Robust Rule Sets for Classification, Proceedings of *8th ACM SIG KDD International Conference on Knowledge Discovery and Data Mining*, Canada, 2002.

- J. Li, H. Shen & R. Topor. Mining the Optimal Class Association Rule Set, in *Knowledge-Based Systems*, Ireland, 2002.

- L. Gu, J. Li, H. He, G. Williams, S. Hawkins & C. Kelman. Association Rule Discovery with Unbalanced Class Distributions, Proceedings of *AI 2003: Advances in Artificial Intelligence*, Perth, December 2003.

- J. Li & Y. Zhang. Direct Interesting Rule Generation, Proceedings of *Third IEEE International Conference on Data Mining*, Melbourne, Florida, November 2003.

4.10 Yan Li

- Y. Li. Adaptive Speech Separation Using Hybrid Approach, chapter in *Advances in Communications and Software Technologies*, Greece, 2002.

- Y. Li & D. M. W. Powers. Speech Separation Based on Higher Order Statistics Using RNa, Proceedings of *Hybrid Information Systems*, Germany, 2002.

- Y. Li, D. Powers & K. Pope. A New Approach to Blind Signal Deconvolution Using Recurrent Neural Networks, in *International Journal of Knowledge-Based Intelligent Engineering Systems*, United Kingdom, 2003.

4.11 A. W. Plank

- D. Hegney, A. Plank & V. Parker. Nursing Workloads: The Results of a Study of

Queensland Nurses, in *Journal of Nursing Management*, London, 2003.

- V. Parker, A. Plank & D. Hegney. Adequacy of Support for New Graduates During Their Transition into the Workplace: a Queensland, Australia Study, in *International Journal of Nursing Practice*, Melbourne, 2003.
- D. Hegney, A. Plank & V. Parker. Workplace Violence in Nursing in Queensland, Australia. A Self-Reported Study, in *International Journal of Nursing Practice*, Victoria, 2003.

4.12 A. J. Roberts

- A. J. Roberts. A Holistic Finite Difference Approach Models Linear Dynamics Consistently, in *Mathematics of Computation*, `http://www.ams.org/mcom/`, 2002.
- R. V. Roy, A. J. Roberts & M. E. Simpson. A Lubrication Model of Coating Flows over a Curved Substrate in Space, in *J. Fluid Mech.*, Cambridge, England, 2002.
- M. J. McGuinness & A. J. Roberts. Efficient Design of Tall Tapered Feeders, Proceedings of *2001 Mathematics-In-Industry Study Group*, Adelaide, January 2001.
- A. J. Roberts. Low-Dimensional Modelling of Dynamical Systems Applied to Some Dissipative Fluid Mechanics, Chapter in *Nonlinear Dynamics*, Singapore, 2003.
- A. J. Roberts. A Set Towards Holistic Discretisation of Stochastic Partial Differential Equations, in *The Anziam Journal*, `http://anziamj.austms.org.au`, 2003.
- R. V. N. Melnik & A. J. Roberts. Modelling Nonlinear Dynamics of Shape-Memory-Alloys with Approximate Models of Coupled Thermoelasticity, in *ZAMM*, `http://www3.interscience.wiley.com/cgi-bin/jissue/102530484`, 2003.
- A. J. Roberts & T. Passmore. Low Prandtl Number Fluid Convection Modelled Using Symbolic Algebra (REDUCE) and Matlab, Proceedings of *ANZIAM Journal (Electronic Supplement)*, University of Queensland, July 2001.

4.13 W. G. Spunde

- W. Spunde. Integration (Multi-Variable Included) from First Principles, Proceedings of *Remarkable Delta:03 Communications*, Queenstown, New Zealand, November 2003.

4.14 D. V. Strunin

- D. V. Strunin & A. J. Roberts. Dynamics of a Turbulent Layer Generated by Velocity Jump, in *ANZIAM Journal (E)*, Queensland, 2003.
- D. V. Strunin. Nonlinear Instability in Generalized Nonlinear Phase Diffusion Equation, in *Progress of Theoretical Physics Supplement*, Kyoto, Japan, 2003.

4.15 S. A. Suslov

- S. A. Suslov & S. Paolucci. A Petrov-Galerkin Method for Flows in Cavities: Enclosure of Aspect Ratio 8, in *International Journal for Numerical Methods and Fluids*, `http://www3.interscience.wiley.com`, 2002.
- S. A. Suslov. On the Validity of the Linearized Ginzburg-Landau Model in Realistic Problems with Spatio-Temporal Instabilities, Proceedings of *EMAC 02*, Brisbane, September 2002.

4.16 H. Wang

- H. Wang, J. Cao & Y. Zhang. Formal Authorization Allocation Approaches for Role-Based Access Control Based on Relational Algebra Operations, Proceedings of *IEEE*, Singapore, December 2002.
- H. Wang, J. Cao & Y. Zhang. A Flexible Payment Scheme and Its Role-Based User-Role Assignment, Proceedings of *2nd International Workshop on Cooperative Internet Computing*, Hong Kong, August 2001.
- H. Wang, J. Cao & Y. Zhang. Ticket-Based Service Access Scheme for Mobile Users, Proceedings of *Computer Science 2002, 25th Australian Computer Science Conference*, Melbourne, January 2002.

- H. Wang, J. Cao & Y. Kambayashi. Building a Consumer Scalable Anonymity Payment Protocol for Internet Purchases System, Proceedings of *12th International Workshop on Research Issues in Data Engineering: Engineering E-Commerce/E-Business Systems*, San Jose, USA, February 2002.
- H. Wang, Y. Zhang & J. Cao. A Flexible Payment Scheme and Its User-Role Assignment, Chapter in *Cooperative Internet Computing*, USA, 2003.
- H. Wang, Y. Zhang, J. Cao & V. Varadharajan. Achieving Secure and Flexible M-Services Through Tickets, in *IEEE Transactions on Systems, Man and Cybernetics, Part A*, USA, 2003.
- H. Wang, Y. Zhang & J. Cao. Formal Authorisation Allocation Approaches for Permission-role Assignments Using Relational Algebra Operations, Proceedings of *24th Australian Database Conference*, Adelaide, February 2003.
- H. Wang, J. Cao & Y. Zhang. A Flexible Payment Scheme and Its Permission-role Assignment, Proceedings of *ACSC 2003*, Adelaide February 2003.

4.17 Z. Zhang

- Z. Li & Z. Zhang. Monitoring the Conformance of Connections to the Traffic Contract of ATM Networks Using Fuzzy Logic, Proceedings of *Knowledge-Based Intelligent Information Engineering Systems and Allied Technolgies*, Crema, Italy, September 2002.
- B. Limthanmaphon, Z. Zhang & Y. Zhang. Adaptive Case-Based Reasoning Systems for E-Commerce, Proceedings of *International Conference on Intelligent Information Technology*, Beijing, September 2002.