

# Newsletter

## Mathematics & Statistics

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### NZIMA MEETING



This year, the New Zealand Institute of Mathematics and its Applications (NZIMA) is sponsoring a thematic programme on algorithmics. The programme centres on the design and analysis of algorithms and their applications to contemporary problems in such areas as discrete mathematics, computational biology, social sciences and communication networks.

Directed by Mike Atkinson (University of Otago) and Charles Semple (University of Canterbury), the programme began with a 5-day meeting at The Crown Hotel in Napier, from 18-22 February 2008.

The expository lectures and contributed talks highlighted the diversity of the programme. Topics ranged from computational algebra to computational biology, and from theoretical underpinnings to practical solutions, and supercomputers. Organised by the directors and Mark Wilson (University of Auckland and a former UC student), the Department was well-represented by postgraduate students Josh Collins, Beata Faller, Miriam Hodge, Peter Humphries, Michael Snook, and Gloria Teng, together with its frequent German visitors Tanja Gernhard and Simone Linz.

In addition to the Napier meeting, a number of other activities are planned including a more focused and tutorial-like meeting to be held in Kaikoura in July, and a series of public lectures later in the year by Professor David Harel, a prominent, popular science author.

For further details of the programme, see <http://www.cs.otago.ac.nz/algorithmics/home/> or contact Charles Semple ([c.semple@math.canterbury.ac.nz](mailto:c.semple@math.canterbury.ac.nz))

## CONGRATULATIONS

Presented to HOD **David Wall** to commemorate the successful completion of his 5<sup>th</sup> Speights Coast to Coast race since 1984. The 18 -year gap between his last 2 races proves that you can't keep a good man down!



### COE Poster Competition

Congratulations to **Michael Langton**, who was awarded a merit prize in the College of Engineering's research poster competition. The competition required entrants to provide a 750-word summary of their research including research questions and methods, written for an academic audience. They then had to produce an A1-sized poster aimed at a high school audience that explained their research and its potential consequences.

Other entrants included Rachael Tappenden (co-supervisors Ian Coope, Bob Broughton and Peter Renaud) and, from Mechanical Engineering, Zohreh Barani Lonbani (co-supervisor David Wall).

**Surface Reconstruction**  
Creating a smooth surface from laser-scanned points

**1. Real world object**

**2. Scanned points**

The points are **scattered**, not organised at all. The number of them can be huge - **14 million points** in this model. That's far too many to deal with all at once if we want to do it fast.

My new method covers the points with **thousands of spheres**.

**3. Covering spheres**

**4. 3D functions**

Each sphere contains a **3D implicit function** matching its own little piece of the object. The function goes through all the points in the sphere, smoothly flowing between them.

Key words: Radial Basis Functions (RBFs)

**5. Virtual surface**

The small functions in the spheres are carefully **blended** where they overlap. This creates a single gigantic function representing the entire surface.

Key words: Partition of Unity

**What it means**

With this new technique we can work with orders of magnitude larger point sets, faster and more accurately. This enables more detailed computations with scans of physically bigger and more complex objects.

Michael Langton - Mathematics & Statistics, JCU

Introduction  
Laser scanners measure the locations of many individual points on an object's surface. Converting these back into a continuous shape is a challenging problem.

movie visual effects  
computer graphics  
modelling  
rapid prototyping & much more

**Technical Stuff**

To generate the covering spheres, we first choose the number of points,  $n$ , that each sphere will contain. Next, we repeatedly pick the next uncovered point and expand a sphere around it until it covers  $n$  points.

Inside each sphere, we generate an **implicit function** that fits the surface locally. This is a function  $f(x, y, z)$  that gives a real number for each 3D point  $(x, y, z)$ . This value is positive inside the surface and negative outside it; on the surface it is defined as the points where  $f(x, y, z) = 0$ . The function is made with Radial Basis Functions (RBFs).

To **blend** the small surfaces, we give each sphere a positive 'weight' function  $w_i$  that goes down to 0 at its edge. At any point the blended value is found by adding the small functions according to their proportion of the total weight. This is known as the partition of unity method.

$$f(x, y, z) = \frac{\sum_{i=1}^n w_i f_i(x, y, z)}{\sum_{i=1}^n w_i}$$

Congratulations also to **Thomas Steinke**, who won the prize for best Summer Project oral presentation.

### THE GOOD OLD DAYS?

From the depths of the HOD's office has emerged a dusty, yellowing position description for the Chair of Pure Mathematics, dated 1 January 1964 – a position that carried the princely salary of £3-4,000!

Back in 1964, the University's internal student numbers totalled 3,931, and the Mathematics Department boasted its own mathematical typewriter on which all mathematical material could be prepared by the Department Secretary – the good old days?

Names that appear in the job description include the recently deceased Professor Lawden, Mary Harding, John de la Bere, Frank Gair, Robert Long and David Robinson. The latter three, of course, are familiar faces in the Department to this day.

## WELCOME TO OUR DEPARTMENTAL VISITORS (E = Erskine Fellow)

<u>Visitor</u>	<u>Organization</u>	<u>Host</u>	<u>From</u>	<u>To</u>	<u>Room</u>	<u>Extn</u>
Dr Tim Robinson	University of Wyoming, USA	J Brown	13/12/07	11/7/08	605	8028
Dr Robin Havea	University of the Sth Pacific, Fiji	D Bridges	1/2/08	11/7/08	605	8028
Prof Angus MacIntyre (E)	Queen Mary, University of London	D Bridges	2/2/08	16/4/08	607	8875
Dr Beatrice Pelloni	Reading University, UK	D Bridges	2/2/08	16/4/08	607	8875
Dr M Bartholomew-Biggs (E)	University of Hertfordshire, UK	I Coope	22/2/08	11/4/08	605	8028
Prof Ron Christensen (E)	University of New Mexico, USA	C Scarrott	5/5/08	31/7/08	607	8875
Prof Christopher Bose	University of Victoria, Canada	R Murray	1/7/08	31/12/08	605	8028
Prof Horst Malchow (E)	University of Osnabrück, Germany	A James	1/9/08	2/11/08	607	8875
Prof Brian Sleeman (E)	University of Leeds, UK	M Plank	6/9/08	19/10/08	607	8875

Professor Helmut Schwichtenberg, who visited Douglas Bridges in March, was recently interviewed by the German newspaper Die Zeit, in "Zeit online". The interview was entitled "Schöne Beweise!" ("Beautiful Proofs") and can be found at <http://www.zeit.de/2008/12/OdE21-Logik-Interview>

### PAPERS ACCEPTED

**Jennifer A Brown, Mohammad Salehi, Mohammad Moradi, Gavin Bell & David R Smith:** *An Adaptive Two-Stage Sequential Design for Sampling Rare and Clustered Populations* (Population Ecology)

**Adam Smith, Jennifer Brown & Timothy Robinson:** *The response of rare herbaceous plants to the removal of weeds in an unproductive environment* (Community Ecology)

**Iris Loeb:** *Factoring out Intuitionistic Theorems: Continuity Principles and the Uniform Continuity Theorem* (Logic and Theory of Algorithms: Lecture Notes in Computer Science, Eds: A Beckmann, C Dimitracopoulos and B Löwe)

**Frank Lad & Patrizio Frederic:** *Two moments of the logitnormal distribution, Communications in Statistics* (Computation and Simulation, vol. 37 #7, 2009)

**Frank Lad, Gianna Agro & Giuseppe Sanfilippo:** *Sequentially forecasting economic indices using mixture linear combinations of EP distributions* (Journal of Data Science, vol. 8 # 1, 2009)

### PAPERS PUBLISHED

**Moorhead K T, Lee D S, Chase J G, Moot A R, Ledingham K, Scotter J, Allardyce R, Sentilimohan S T & Endre Z:** *Classifying Algorithms for SIFT-MS Technology and Medical Diagnosis* (Computer Methods and Programs in Biomedicine, Vol 89 (3), pp 226-238, ISSN: 0169-2607, 2007)

**Lin J, Lee D S, Chase J G, Shaw G M, LeCompte A, Lotz T, Wong X W, Lonergan T & Hann C E:** *Stochastic Modelling of Insulin Sensitivity and Adaptive Glycemic Control for Critical Care* (Computer Methods and Programs in Biomedicine, Vol 89 (2), pp 141-152, ISSN: 0169-2607 (Invited)

**D S Bridges & H Diener:** *The pseudocompactness of  $[0, 1]$  is equivalent to the uniform continuity theorem (with Hannes Diener)* (J. Symbolic Logic 72 (4), 1379-1383, 2008-03-26)

**M A Baroni & D S Bridges:** *Continuity properties of preference relations* (Elec. Notes in Theor. Comp. Sci. 202, 19-25, 2008.

**D S Bridges & L S Vita:** *Proximal connectedness*, (Fundamenta Informaticae 83 (1-2), 25-34, 2008.