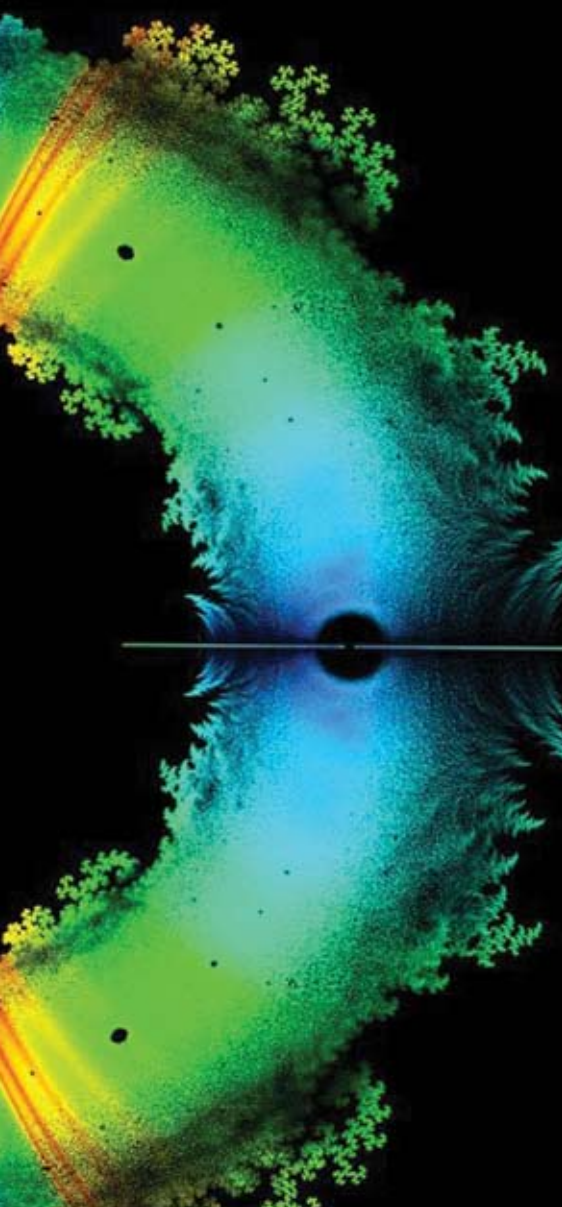


COMPUTER ASSISTED RESEARCH MATHEMATICS AND ITS APPLICATIONS (CARMA)



FACULTY OF SCIENCE AND INFORMATION TECHNOLOGY



OVERVIEW

CARMA forms the base for a vibrant cross-university and intra-university Priority Research Centre. There is no corresponding group in Australia and there are very few internationally.

CARMA subsumes the former Functional analysis and Discrete mathematics Research Groups. Formation of the new group reflects changes in the mathematical research being undertaken at Newcastle

Mathematics as “the language of high technology” underpins all facets of modern life and current Information and Communication Technology (ICT) is ubiquitous. Yet no research centre exists focussing on the implications of developments in ICT, present and future, for the practice of research mathematics. CARMA proposes to partly fill this gap through the exploitation and development of techniques and tools for computer-assisted discovery and disciplined data-mining including mathematical visualization.

Advanced mathematical computation is equally essential to solution of real-world problems; sophisticated mathematics is core to software used by decision-makers, engineers, scientists, managers, and who design, plan and control the products and systems key to present day life.

OBJECTIVES

- To perform research and development relating to the informed use of computers as an adjunct to mathematical discovery (including current advances in cognitive science, in information technology, operations research and theoretical computer science).
- To perform research and development of mathematics underlying computer-based decision support systems, particularly in automation and optimization of scheduling, planning and design activities, and to undertake mathematical modelling of such activities.
- To promote and advise on the use of appropriate tools (hardware, software, databases, learning object repositories, mathematical knowledge management, collaborative technology) in academia, education and industry.
- To make the University of Newcastle a world-leading institution for Computer Assisted Research Mathematics and its Applications.

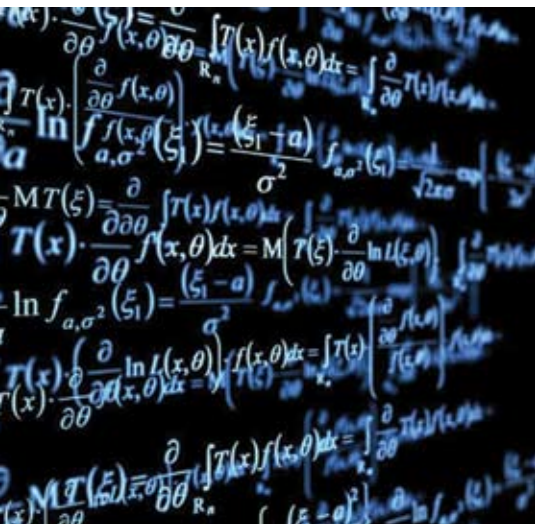
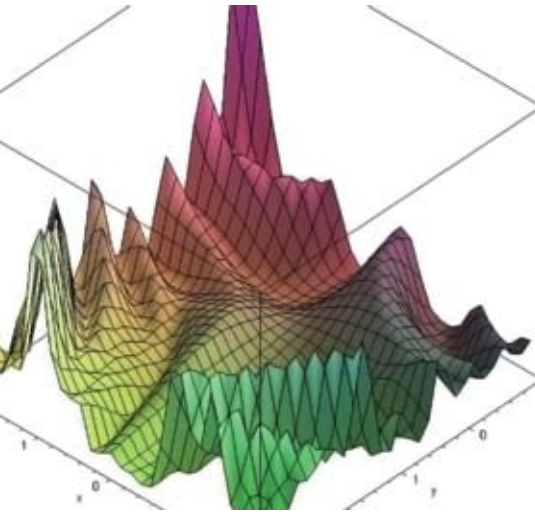
RESEARCH SUPPORT

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EXTERNAL COLLABORATORS

BHP Billiton; Constraint Technologies International Pty Ltd; Canadian National Centre of Excellence for Mathematics of Information Technology and Complex Systems (MITACS); CSIRO Energy Technology; Mater Hospital, Radiation Oncology Department; Hunter New England Area Health, Service, Innovation and Reform Unit; Hunter Valley Coal Chain Logistics Team; MapleSoft Inc; Mathematical Association of America; International Mathematical Union; MathResources Inc; National Institute of Standards and Technology; Sun Micro Systems.



EXAMPLES OF CURRENT PROJECTS

Analysis Classical, harmonic, non-linear, convex analysis. Fixed point theory and variational analysis in nonreflexive space.

Continuous Optimization Maximum entropy optimization, wavelet analysis and image reconstruction methods.

Discrete Optimization Accurate scheduling for open-pit mining, modelling effects of uncertainty in geological estimates on the extraction schedule.

Simple Topological Groups Understanding simple totally disconnected locally compact groups.

RESEARCH OUTCOMES

- Current best results on irrationality of Zeta-function values obtained.
- Leading edge results on structure of maximal monotone operators.
- Lower cost airline schedules that are more robust to operational disruptions.
- Design of pill fabrication for major international drug company.
- Optimized delivery of radiotherapy (IMRT) treatment for cancer.
- Largest accurate geological models for mineral extraction.
- Consultation with gaming industry, real-world network design and scheduling.

RESEARCH TOPICS

Computational Analysis and Number

Theory: computer-assisted study of links between analysis, number theory, knot theory and mathematical physics. Development of mathematical data-mining tools.

Discrete Mathematics: all aspects of graph theory with emphasis on algebraic graph theory and ties to design theory.

Linear and Nonlinear Analysis including: convexity; variational methods; fixed point theory; Banach space geometry; frames and wavelet analysis. Applications to dynamical systems, control, optimization, and image or signal reconstruction.

Optimization and Simulation: models and algorithms for optimization and solution of large-scale problems, including constraint programming and meta-heuristics.

Study of Non-porous Media with coupled systems of partial differential equations applied to geotectonics and pattern formation.

Topological Groups: structure and automorphisms of totally disconnected groups; links to harmonic analysis, geometry, number theory and discrete maths.

Harmonic Analysis: Fourier analysis, wavelets, time-frequency analysis, sampling and signal processing applications; singular integrals and frames; Clifford analysis and applications to hypercomplex signal processing.

Number Theory: "Arithmetic, algebraic and combinatorial properties of solutions of differential and difference equations; (in)dependence of numbers that come as values of special functions; Diophantine analysis."

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