FY2022 Grant for International Project Research IMI Joint Use Research Report

2023/03/22

Affiliation: La Trobe University

Position: Head of Department of Mathematical and Physical Sciences

Name: Dr Christopher Lenard

		Reference No.	2022b003	
1.Title of Research Project	Statistics and Mathematical Modelling in Combination			
2.New Proposal	New			
3.Type	Grant for International Project Research			
4.Category	Workshop (I)			
5.Principal Investigator	Name	Dr Christopher Lenard		
	Affiliation	La Trobe University	position	Head of Department of Mathematical and Physical Sciences
6.Project Period	2022/11/16 - 2022/11/18			
7.Key Words	Model identification, Inverse problems, Partial differential equations, Ecological modelling, Infectious disease modelling, Evolutionary modelling, Dynamical systems			
8.Number of	50			

9. Abstract for Research Report

SMMC 2022 in La Trobe University, Melbourne, Australia covered the theme of Statistics and Mathematics in Combination. This is supportive of Kyushu University IMI's change of emphasis towards statistical science and interactions with established IMI mathematicians. Lectures and animated discussions took place on the interface between statistics and mathematical modeling; this was a very positive research education experience for the participants, many of whom work more clearly on one side or the other of the boundary of these disciplines. Several common methodological research challenges emerged from presentations across broad application areas, including model fitting, model selection, and the interpretation of model results when dealing with complex models and/or sparse data. Exciting new methods to combat these challenges were showcased and discussed. The conference was very successful, with 50 participants (online and in person), including graduate students, early and mid-career academics, and senior academics from Japan, Australia, the USA, India, Finland, Malaysia, and New Zealand, and scientists from both government and industry. There were fruitful discussions during lunch breaks and over the conference dinner, extending the

Research report

SMMC 2022 in La Trobe University, Melbourne, Australia covered the theme of Statistics and Mathematics in Combination. This is supportive of Kyushu University IMI's change of emphasis towards statistical science and interactions with established IMI mathematicians. Consequently, IMI is negotiating with La Trobe University to share a new professorial appointment in mathematical statistics, to be based initially at the Australia Branch of IMI. This conference preceded FMFI 2022, which is part of a sequence initiated by IMI, and still strongly supported by IMI through its involvement in Asia Pac. Consortium of Mathematics for Industry.

The conference was very successful, with 50 participants (online and in person), including graduate students, early and mid-career academics, and senior academics from Japan, Australia, the USA, India, Finland, Malaysia and New Zealand, and scientists from both government and industry. Two listed main speakers, Prof. Fioralba Cakoni and Prof Hugh Possingham, were unable to participate. Neither of these speakers had been listed to receive IMI International Program funding.

Lectures and animated discussions took place on the interface between statistics and mathematical modelling; this was a very positive research education experience for the participants, many of whom work more clearly on one side or the other of the boundaries of these disciplines. Several common methodological research challenges emerged from presentations across broad application areas (some of these are discussed in more detail below), including model calibration and quantifying parameter uncertainty, model selection and model results interpretation when dealing with complex models and/or sparse data. Exciting new methods to combat these challenges were showcased and discussed.

Efficiently calibrating complex models. Our first plenary speaker, Professor Jukka Corander (Oslo and Helsinki) presented several robust approaches for parameter inference of computationally-intensive simulator-based models that improve computational feasibility compared to other likelihood-free inference techniques, and which are available in the open-source software platform: Engine for Likelihood-Free Inference (ELFI, elfi.ai). Dr Oliver McLaren (Aukland) continued on with this theme, presenting on some other promising and practical computationally efficient methods for parameter and causal inference, including the use of profile likelihood. Prof Chris Drovandi (QUT) gave a very informative lecture about the use of likelihood-free inference methods in the context of model misspecification. Dr Matthew Adams (QUT) presented a method for analysing deterministic model sloppiness and some possible applications, including uncovering controlling mechanisms underlying the system being modelled, guiding strategic model reduction, and diagnostically comparing the accuracy of different model-data fitting algorithms.

Model fitting with sparse data. Dr Melanie Roberts spoke about the challenges of using modelling to understand soil erosion when dealing with only a handful of data points to calibrate models. PhD student Sarah Vollert presented on a sequential method for efficiently parameterising ensemble ecosystem models with limited data availability.

Using data-informed models to support policy decisions in conservation and public health. Dr Iadine Chadès spoke about the development of algorithms to solve and increase interpretability of Markov decision models and stochastic dynamic programming to help make better decisions in the field of conservation (e.g. adaptive management). Her talk highlighted the importance of being able to make the outputs of complex models (e.g., optimal decisions) sufficiently interpretable so that they are more likely to be trusted. Dr David Price (University of Melbourne) described several statistical and mathematical methodologies that were developed by Australia's situational awareness modelling Program during the COVID-19 pandemic for situational awareness - that is, for understanding the current and potential future status of the epidemic in Australian jurisdictions. He spoke about some challenges with providing near-real-time analytic support to various government decision-making committees, which prompted much lively discussion. Dr Adeshina Adekunle (Department of Defence) continued on with this theme, describing some of the forecasting work of the program in more detail, specifically the particle filter forecasts of the Delta and Omicron strain waves in Australia using an auto stochastic compartmental model.

In addition to the plenary and contributed talks (the standard of which was very high), there were fruitful discussions during lunch breaks and over the conference dinner, extending the collaborative networks of participant researchers. For example, one of the organising committee, Prof Luke Bennetts, met Prof Will Schilders (ICIAM President) through this association. Consequently, Prof Bennetts spoke in March 2023 at a well-attended public panel in Amsterdam. Several early-career statistical scientists from IMI, who have become interested in epidemiology, made significant contact with experts in epidemiology from Australia, USA and India.

Program

[SMMC2022 Main Site]

Nov. 16（Wed.）

9:00-9:15 Participants arrive Day 1

9:15-9:40 Official conference welcome begins –
• Professor Marcel Jackson, Associate Dean Research and Industry Engagement
• Associate Professor Bec Strating, Director – La Trobe Asia
• Dr Rebecca Chisholm, Conference Director

9:40-10:30 Plenary Speaker 1
Jukka Corander(University of Oslo)
Robust and scalable inference for simulator-based models

10:30-10:45 MORNING TEA

10:45-11:45 Plenary Speaker 2
Shizuo Kaji(Kyushu University)
Modelling preference with hyperplane arrangement

11:45-11:55 Contributed talk 1
Yvonne Stokes(The University of Adelaide)
Chemical signalling and tissue response: a moving boundary problem in biology

11:55-12:15 Contributed talk 2
Rahil Valani(The University of Adelaide)
Dynamics of inertial particle focusing in curved ducts

12:15-12:40 Contributed talk 3
Soukaina Hadiri (TBC)
Somes results on the mixed bifractional brownian motion

12:40-14:00 LUNCH

14:00-14:55 Plenary Speaker 3
David Price
Supporting government response to COVID-19 through model-based situational assessment

14:55-15:10 AFTERNOON TEA

15:10-16:00 Plenary Speaker 4
Melanie Roberts(Australian Rivers Institute, Griffith University)
MERGE and the role of gully erosion modelling to protect water quality on the Great Barrier Reef

16:00 Day1 ends

Nov. 17（Thu.）

9:00-9:15 Participants arrive Day 2

9:15-10:05 Plenary Speaker 5
Andrea Bertozzi – zoom
Modeling the Covid-19 Pandemic

10:05-10:30 Contributed talk 4
Malay Banerjee(IIT Kanpur)
Effect of slow-fast time scale on spatio-temporal pattern formation

10:30-10:45 MORNING TEA

10:45-11:35 Plenary Speaker 6
Oliver Maclaren

Dynamics of inertial particle focusing in curved ducts

11:35-11:55 Contributed talk 5
Sarah Vollert(Queensland University of Technology)
A sequential method for efficiently parameterising ensemble ecosystem models

11:55-12:15 Contributed talk 6
Jordan Pitt(The University of Adelaide)
Model predictions of wave overwash extent into the marginal ice zone

12:15-12:40 Contributed talk 7
Adeshina Adekunle(Department of Defence)
A new mathematical modelling framework for capturing and forecasting Australia COVID-19 waves: transitioning from Delta wave into Omicron wave.

12:40-14:00 LUNCH

14:00-14:55 Plenary Speaker 7
Natalie Thamwattana(The University of Newcastle)
Interaction between nanostructures: relation between their atomic distributions and modelling approaches

14:55-15:10 AFTERNOON TEA

15:10-16:00 Plenary Speaker 8
Kei Hirose(Kyushu University)
Penalized likelihood approach in multivariate regression with missing values and its application to materials properties prediction

16:00 Day2 ends

18:00 Conference Dinner for participants who have registered and pre-paid:
Hotel Grand Chancellor Melbourne, 131 Lonsdale Street, Melbourne

Nov. 18（Fri.）

9:00-9:15 Participants arrive Day 3

9:15-10:05 Plenary Speaker 9
Michael Stumpf
The Mathematics and Statistics of CellMaps and Whole Cell Modelling

10:05-10:30 Contributed talk 8
Chris Drovandi(Queensland University of Technology) – zoom
Likelihood-Free Methods and Model Misspecification

10:30-10:45 MORNING TEA

10:45-11:35 Plenary Speaker 10
Iadine Chadès – zoom
Developing AI Decision Tools for Conservation

11:35-11:55 Contributed talk 9
Ton Viet Ta(Kyushu University)
Fish schooling

11:55-12:15 Contributed talk 10
Matthew Adams(Queensland University of Technology)
Analysis of model sloppiness: what can it do, and what's next?

12:15-12:40 Contributed talk 11
Saddam Abbasi(Qatar University)
Identifying state of the process using ML algorithms

12:40-14:00 LUNCH

14:00-14:55 Plenary Speaker 11
Emma McBryde
The application of mathematics to pandemics: some examples of modelling used during COVID-19

14:55-15:15 Contributed talk 12
Komal Singla(Chandigarh University)(TBC) – zoom
Symmetry Analysis and Exact solutions of fractional order (2+1)-dimensional Burgers system

15:15-15:40 Contributed talk 13
Manoj Kumar(Indian Institute of Technology Mandi) (TBC) – zoom
Analysis of Diffusive Size-Structured Population Model and Optimal Birth Control

15:40 Conference ends