

Ruth Baker

Professor of Applied Mathematics

Mathematical Institute, University of Oxford

Research

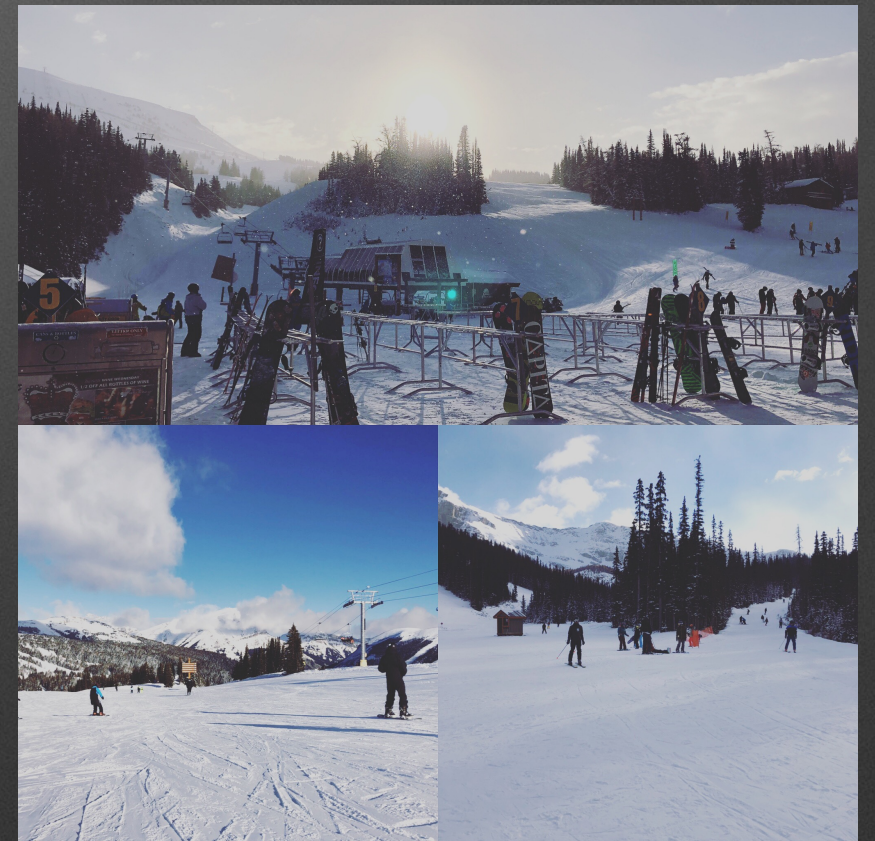
- Cell and developmental biology
- Efficient methods for stochastic simulation
- Inference, model selection, experimental design
- Model coarse graining

Research philosophy

- Simple models can often lend the most insight

Burning question

- Models aren't perfect, and biology is generally noisy and incompletely observed. Can theoretical biology tools ever live up to the hype?



Dr Chris P. Barnes

Associate Professor in Systems and Synthetic Biology

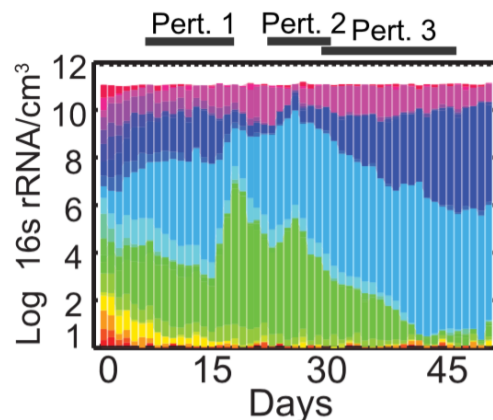
University College London

@cssb_lab

christopher.barnes@ucl.ac.uk

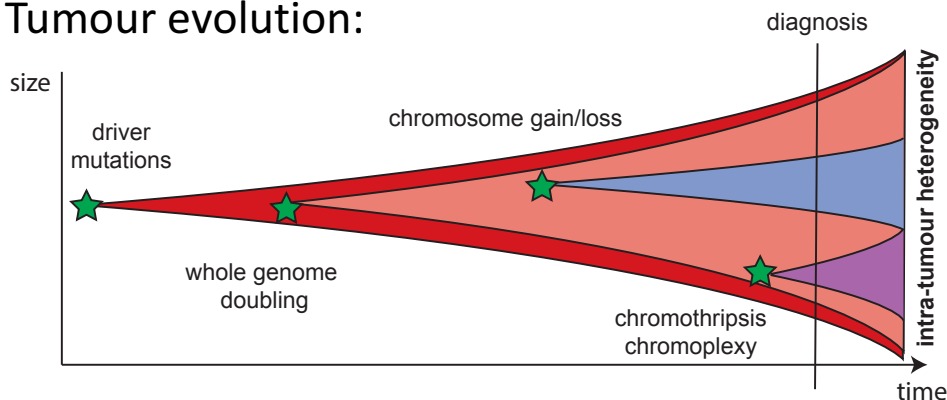
Inference for complex systems

Microbiomes:

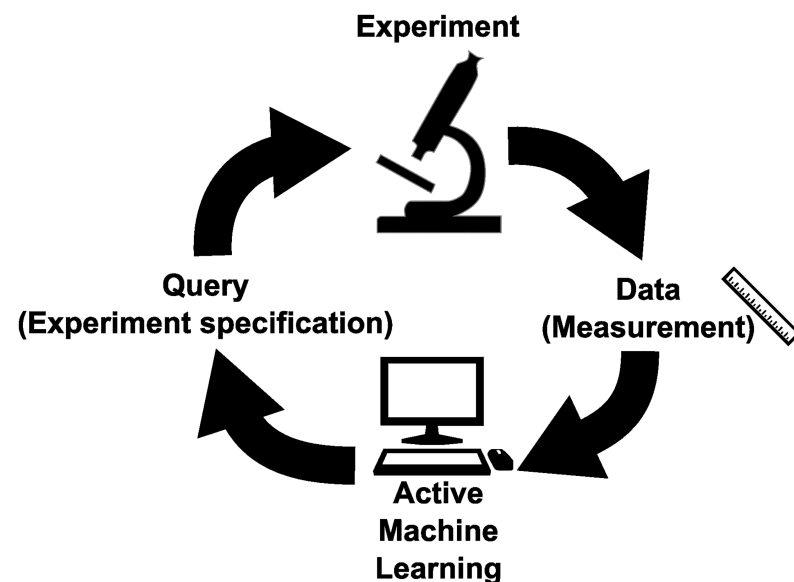


$$\frac{d}{dt}x_i(t) = \mu_i x_i(t) + x_i(t) \sum_{j=1}^L M_{ij} x_j(t)$$

Tumour evolution:



Autonomous data collection





Alexandre Bouchard-Côté

Associate professor
UBC Statistics

Some questions I am interested in



How to perform Bayesian “goodness of fit”
without reference to an alternative model?



How to trade-off computational and statistical efficiency for
minimum Bayes risk estimators?



Scalable methods for high-dim. diffusions (in part. Wright-Fisher)?



How to automate construction of Lyapunov functions? e.g. for PDMPs

Alex Browning

PhD Student at QUT, Brisbane, Australia

I'd like to know...

How can mathematical models be applied clinically to directly inform treatments for individual patients?

Dave Campbell
Associate Professor,
Simon Fraser University

- A recent paper had 29 groups examine the race effect of referee bias. Using the same data, groups disagreed on size and occasionally sign of the effect.
- Which classes of assumptions can be assessed?
- Can assumption impact be measured/quantified?

Oksana Chkrebtii

About me: I am an Assistant Professor in the Department of Statistics at The Ohio State University in Columbus, Ohio (home of the MBI).

Interests: Bayesian inference for dynamical systems models when likelihoods are intractable e.g. numerical approximations/solutions, unknown transition probabilities.

Discussion question: Mechanistic models incorporate physical constraints such as conservation laws. However, many approximations e.g. data assimilation, LNA, computer model emulation etc. do not necessarily enforce these constraints. When can this be safely ignored and when do we need to sacrifice computational efficiency to enforce such constraints?

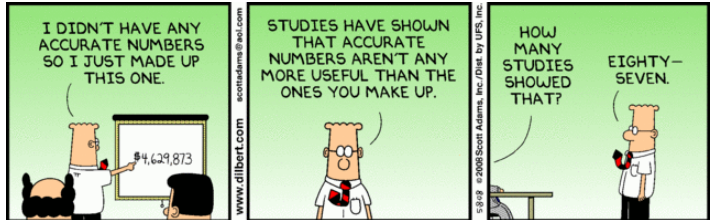


Name: Matthias Chung

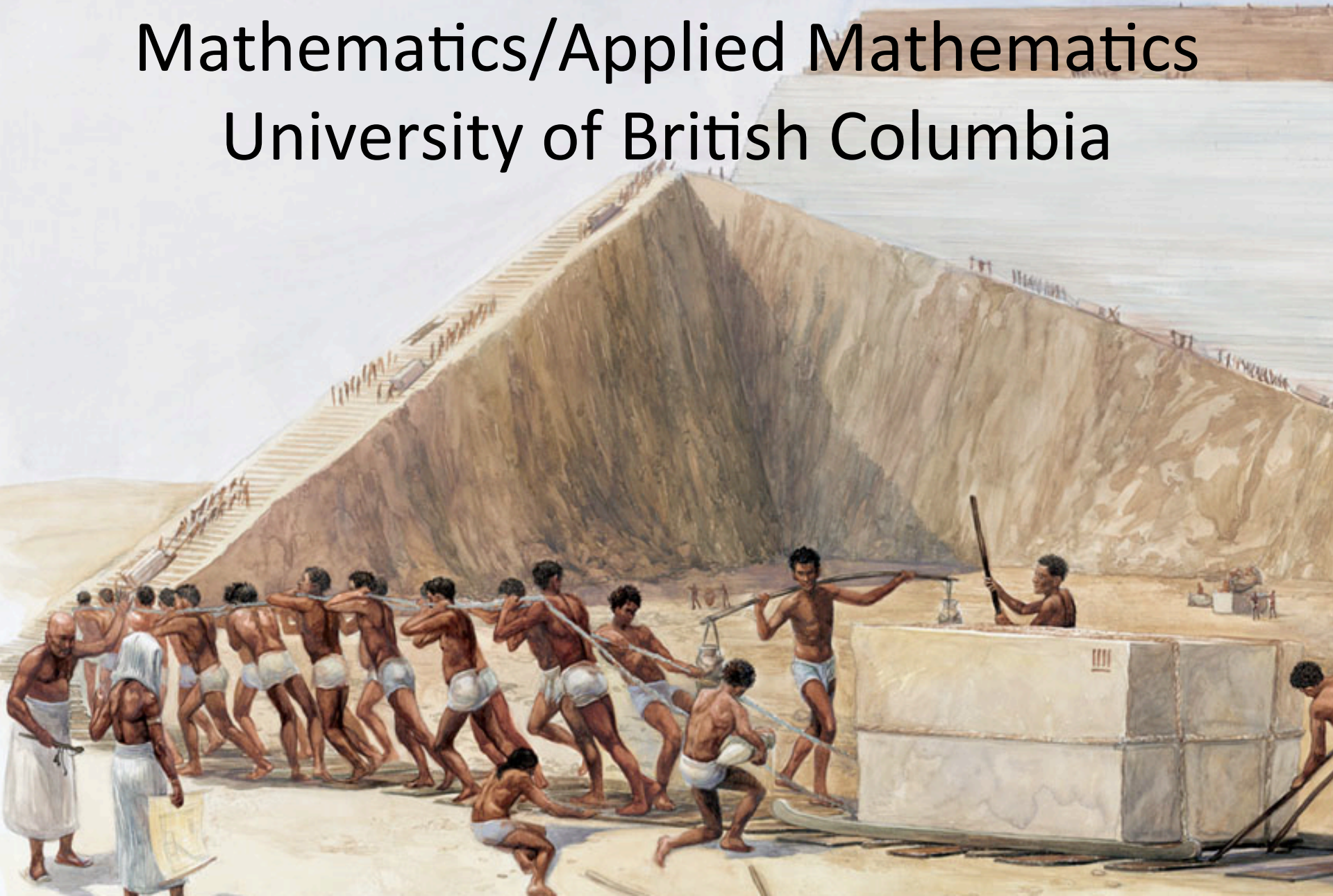
Position/Institution: Associate Professor
Department of Mathematics and
Computational Modeling and Data Analytics
Academy of Integrated Science
Virginia Tech, USA

Burning question: Is there a scientific community
on parameter identification?

Philosophy:



Dan Coombs
Mathematics/Applied Mathematics
University of British Columbia



Adelle Coster, Applied Maths, UNSW Sydney

I like using mathematics to break open the black box of biology and find “possible versions of the truth” of how things work.

I would like to discuss the different ways this might be achieved using stochastic models.

When you can measure what you are speaking about and express it in numbers, you know something about it, but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind.

Lord Kelvin



- Senior Lecturer in Applied Mathematics
- School of Mathematics, University of Manchester, UK
- *“Since our computing resources are distributed and scalable, our philosophical approach and the algorithms that we design need to reflect this.”*
- Challenge: *“Could we be focussing more on what experimentalists actually need to extract from their data?”*



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CALGARY

Dr Rob Deardon

Associate Professor, Biostatistics

Faculty of Veterinary Medicine & Dept. of Mathematics & Statistics

Burning question for workshop/life:
What am I missing...?

Mike Dowd

Professor

Dept of Mathematics & **Statistics**

Dalhousie University, Halifax, Canada



What I am interested in?

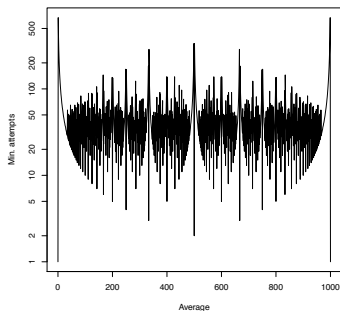
- Statistics for the marine sciences (oceanography, marine ecology)
- Methods for emerging data types (new observing platform/sensors: spatio-temporal, multivariate, fast-sampling)
- The fusion of earth system models and data via statistical inference (data assimilation)

Some 'burning issues' ...

- Scaling up Bayesian approaches to treat large scale problems (big models/ big data)
- Inference for dynamical systems, esp. dynamics centric
- Sampling strategies for spatio-temporal systems (to catch up with the measurement revolution).

- ▶ *Scientific philosophy*: Measure twice, cut once
 - ▶ Simulate your assumptions
 - ▶ Simulate your analysis
 - ▶ Keep a data journal . . .

- ▶ *Burning question*: How do we communicate to policy makers and the public about uncertainty?





Barbel Finkenstadt
University of Warwick, UK
Department of Statistics



Interested in: Statistical Inference for small & large dynamical data sets in Systems Biology

**My philosophy of science question:
How do we combine models with data to represent and explain natural and social phenomena?**

Paul François

McGill University (Physics)

Burning question : how do we convince biologists that mathematical models are needed in biology ? Is there any clear “homerun” ?

Personal philosophy: Simple is beautiful (and useful).

John Fricks
Associate Professor
School of Mathematical and Statistical Sciences
Arizona State University

Burning question for the week:
Does a particular stochastic model fit my data well?
(Any new methods on the model verification front?)

Provocative personal view on science:
Do we have to quantify everything in science?
(i.e. What is the scientific point of your mathematical model?)

Jill Gallaher
Applied Research Scientist
Department of Integrated Mathematical Oncology
at Moffitt Cancer Center

Question:
How do we deal with incomplete or missing data?

**“We do not know what the rules of the game are;
all we are allowed to do is to watch the playing...” -Richard Feynman**

Priscilla Greenwood (Cindy)

Prof. Emerita, Univ. of British Columbia

We have 2 versions of "THE SAME" model:

1. A deterministic parametric model, data, inference

2. A stochastic parametric model, internal noise data, inference

e.g. SIR, predator-prey

Question: criteria for model choice?



Ramon Grima
Associate Professor,
University of Edinburgh

Personal philosophy of science:

Approximations are a beautiful tool if well done

Burning Question for the workshop:

How do we construct fast and accurate inference methods for single-cell data?

Jonathan Harrison

jonathan.harrison@maths.ox.ac.uk

PhD Student

Wolfson Centre for Mathematical Biology
University of Oxford



Mathematical
Institute

Question: when selecting between models that encode different hypotheses, how do we cope with all our models being 'wrong'?

Oxford
Mathematics



@jonty3502

My name is **Barbara Holland**. I am currently based at the **University of Tasmania** in **Hobart**.



not this one



I lecture in Maths and Stats and am a member of the **Theoretical Phylogenetics** research group.

My burning question for the workshop is how to we get beyond measuring relative goodness of fit of our models (e.g. by AIC) to measuring absolute goodness of fit in cases like the phylogenetic scenario when our models are a complicated mix of combinatorial structure and continuous parameters. What should our residual diagnostics look like?

I am not sure about a one sentence philosophy of science, maybe – *“Make predictions, otherwise you can’t even be wrong!”* or maybe *“Add 1 part curiosity, 1 part scepticism and 1 part beer/coffee (depending on preference) and mix well.”*

Aaron A. King

Ecology & Evolutionary Biology, Mathematics,
Complex Systems
University of Michigan

Burning Question:

Likelihood-based inference for realistically complex epidemiological models from genomic data: how?

Philosophy of Science:

The history of scientific progress is the history of instrumentation: if we figure out to look farther or deeper, we will see things we've not yet imagined.

Ideas for Group Discussions:

- software for parameter inference
- phylodynamics



Name: Mark Lewis

University: Alberta

Position: Joint between Math/Stat Sciences and Biological Sciences

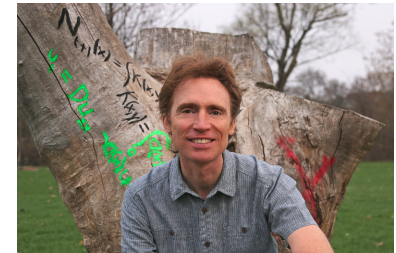
Burning question: how to do good statistical inference with mechanistic ecological models

Philosophy: work with people who know more than me about whatever problem I'm working on

[18w5144] BIRS

Mathematical and Statistical Challenges in Bridging Model Development,
Parameter Identification and Model Selection in the Biological Sciences

Frithjof [Frityof] Lutscher
Professor
University of Ottawa



Burning question: (How) will I ever feel comfortable and confident
enough yo use real data with my models?

Challenge:

Data is where theories go to die.



About me:

Oliver Maclaren

Lecturer in Department of Engineering Science

University of Auckland, New Zealand.



Some Questions:

- Why is a model like the Ricker model hard to estimate? E.g why do standard approaches based on the full data do so poorly? Is the problem really ‘philosophical’ (Wood, 2010)? What are the underlying mathematical reasons? What is the role of approximation in statistics?
- How do we do ‘honest’ statistics/parameter estimation starting from inherently non-identifiable models, without just imposing solutions? What are the conceptual and methodological implications of the non-identifiable setting?
- Does Bayes really solve all our problems? Why/why not? If not, what’s next? What can we learn from other areas like classical inverse problems theory, classical statistics, likelihood theory etc?

Some Philosophy:

- Meaning is use, so try things
- Models and methods are different things
- There is probably not a universal scientific method, and all approaches have flaws
- Simple models aren’t more likely to be true, but are often easier to work with and improve
- Ask simple questions of complex models

Adam L MacLean

Assistant Professor of Quantitative & Computational Biology
Department of Biological Sciences
University of Southern California
macleana@usc.edu



[@adamlmaclea](https://twitter.com/adamlmaclea)

Research

- Dimensionality reduction and single-cell data analysis
- Bayesian inference for agent-based models
- Dynamical systems in biology

PHILOSOPHY OF SCIENCE

I am looking for the model that is wrong everywhere except for a single prediction
(and I am looking for that prediction!)

BURNING (OR AT LEAST WARM) QUESTIONS

1. When – and how much – should we care about identifiability for biological models?
2. How to develop appropriate inference schemes for models that cross multiple scales?

- Wellcome Trust Research Fellow
- Centre for Mathematical Medicine & Biology, Nottingham, UK

How much should I trust my model?

or, perhaps, rephrased as

How do I put sensible confidence on a mechanistic model prediction for a new situation?

or, perhaps, rephrased as

How do I pull together model selection, parameterisation, experimental design, and estimates of model discrepancy to make models of well-quantified predictive power?

Thomas Pak

- First-year PhD student
- Mathematical Institute, University of Oxford
- Supervisors: Prof Ruth Baker and Dr Joe Pitt-Francis

- “Somewhere, something amazing is waiting to be known.” - Carl Sagan

- Burning questions:
 - “What makes a mathematical model testable?”
 - “What would you tell your past self who just started his/her PhD?”

Stephanie Peacock

Postdoctoral researcher

Biological Sciences &
Department of Ecosystem and Public Health
(Faculty of Veterinary Medicine)



Science doesn't know everything; otherwise, it'd stop.

Interested in learning more about

- Fitting individual-based models to data
- Bridging different types of data (quantitative/qualitative)



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Michael Plank

Associate Professor

University of Canterbury

New Zealand

Ahorangi tuarua

Te Whare Wānanga o

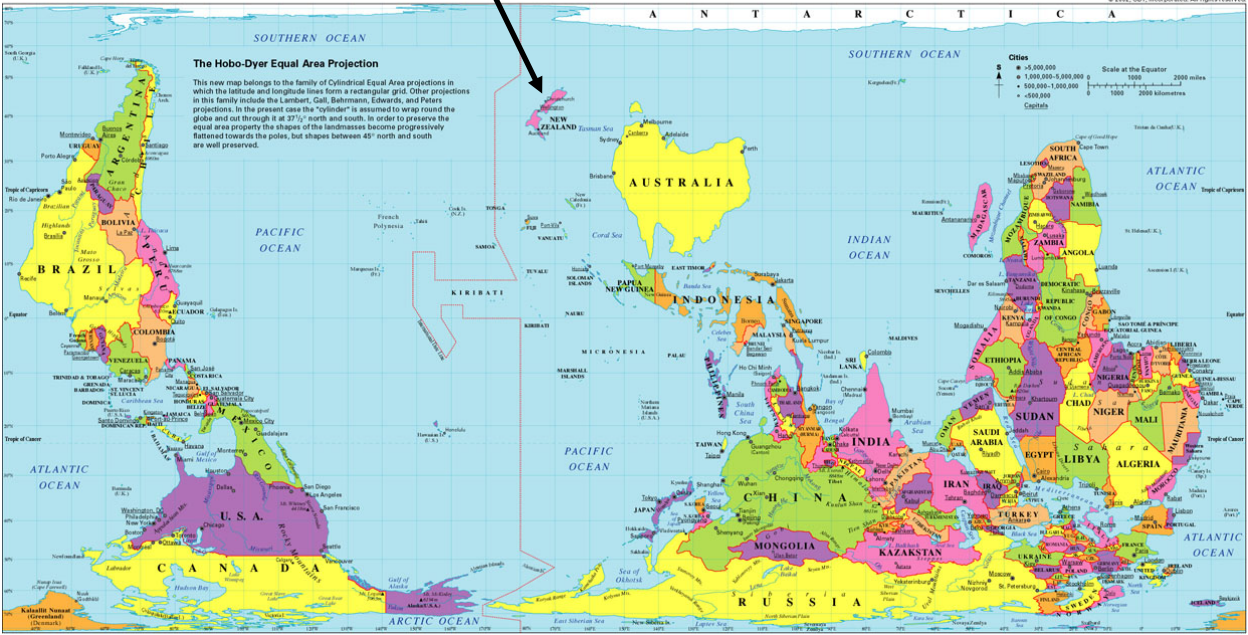
Waitaha

Aotearoa

How can I model the effect of local spatial structure in an invasive population?

Doing science should be fun, relevant, inclusive and kind

Christchurch | Ōtautahi



- Lecturer in Statistics at Newcastle University (UK)
- Burning question:
How can methodological researchers ensure they are working on problems applied researchers care about?
- Personal philosophy of science:
Approximate Bayes!



Tom Prescott

Post-doc

Wolfson Centre for
Mathematical Biology
Mathematical Institute
University of Oxford

One sentence personal philosophy
of science:

What would Borodin do?





Susanna Röblitz
Associate Professor
Computational Biology Unit
Department of Computer Science
University of Bergen



Science motto:

“Essentially, all models are wrong, but some are useful.”

(George Box, 1987)

Question: What is a useful model?



Mat Simpson

mj-simpson.com

Role: Applied Mathematics Queensland University of Technology, Australia

Interests: connecting models of cell biology processes to experimental data

Question: How do we make models useful and quantitative?

David M. Umulis

Associate Head of Biomedical Engineering

Purdue University

West Lafayette, IN

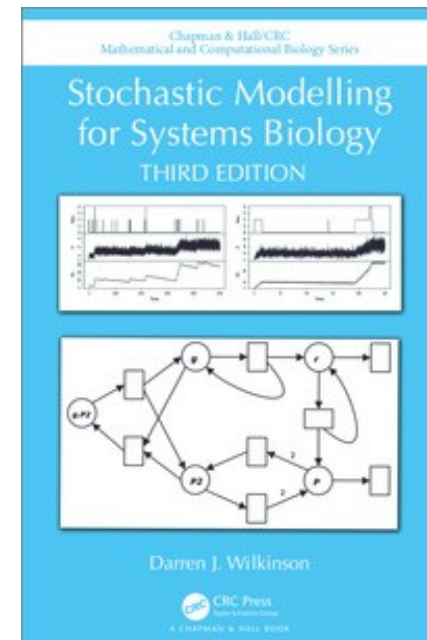
Burning question: What are the best ways to balance objectives in optimization problems with mixed types of data- RNA measurements, fluorescent immunostaining, biochemistry, etc.

Philosophy of science: Mathematical modeling needs to be a tool used with equal merit as the other assays in the experimental toolbox such as imaging and genetics to drive future discovery

See you all on Monday!!!!

Darren Wilkinson

- Professor of Stochastic Modelling @ Newcastle University, U.K.
- Turing Fellow @ The Alan Turing Institute, U.K.
- @darrenjw
- <http://tinyurl.com/darrenjw>
- Controversial opinion: Functional programming helps to solve many of the algorithmic and computational challenges in this field



Richard Wilkinson

- Professor of Statistics, School of Maths and Statistics, University of Sheffield
- Research interests: uncertainty quantification, Bayesian methods, applied science,
- Burning question: how can/should we learn from imperfect models?
- Philosophy of science: objectivity is an unachievable goal

Francis Woodhouse

Hooke Research Fellow

Mathematical Institute, University of Oxford

fwoodhouse.com



active bio-inspired mechanics
networked systems
stochastic collective behaviour

My philosophy:
*Simple, qualitative models are
just as valuable as complex,
quantitative models.*

**“In 25 years applied
mathematical scientists in
biology will learn THIS in their
first year of graduate work”**

“In 35 years all model development and fitting will be done by machine, and therefore applied mathematical scientists in biology will no longer be needed”