Bogdan Toader

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Research Interests

My research is focused on methods for recovering signals at high resolution from blurred and noisy measurements. So far I have developed theory for the stability of the super-resolution problem with non-negative measures. Current and future work include developing algorithms for deconvolution with space-varying and unkonwn point spread function and applying them to large scale microscopy data.

More generally, I am interested in the broader fields of compressed sensing, mathematical signal processing, optimisation, machine learning and their application to problems arising in other scientific fields.

Employment

July 2019–present **Post Doctoral Research Associate**, *University of Cambridge*, Cambridge, UK.
Based at the Cambridge Advanced Imaging Centre (CAIC).
Working on **deconvolution algorithms for light-sheet microscopy**, in collaboration with the Cambridge Image Analysis Group in the Department of Applied Mathematics and Theoretical Physics and MRC Laboratory of Molecular Biology.

Education

Oct 2018–Mar 2019 **Enrichment Student**, *Alan Turing Institute*, London, UK.
Six months placement at UK's national institute for data science and artificial intelligence.

2015–2019 **PhD in Mathematics**, *University of Oxford*, Oxford, UK.
Industrially Focused Mathematical Modelling (EPSRC Centre for Doctoral Training) in collaboration with the National Physical Laboratory (NPL).
Main research project on **theory and algorithms for super-resolution.**
Expected end date: December 2019.

Advisors	Prof Jared Tanner, Dr Andrew Thompson
Industrial supervisors	Dr Stephane Chretien, Dr Peter Harris (NPL)

2009–2013 **BSc (Hons) Computer Science and Mathematics with Industrial Experience**, *University of Manchester*, Manchester, UK.
First class degree with final grade above 80%.

2005–2009 **Romanian Baccalaureate**, *"Gheorghe Munteanu Murgoci" National College*, Braila, Romania.
Final grade of 9.91 (out of a maximum of 10).

Publications

1. **The dual approach to non-negative super-resolution: perturbation analysis**
   S. Chretien, A. Thompson, B. Toader
   2020, submitted
   Preprint on arXiv: https://arxiv.org/abs/2007.02708

2. **Sparse non-negative super-resolution – simplified and stabilised**
   A. Eftekhari, J. Tanner, A. Thompson, B. Toader and H. Tyagi
   Applied and Computational Harmonic Analysis, 2019, accepted
   Preprint on arXiv: https://arxiv.org/abs/1804.01490

3. **The dual approach to non-negative super-resolution: impact on primal reconstruction accuracy**
S. Chretien, A. Thompson, B. Toader
2019 13th International conference on Sampling Theory and Applications (SampTA) – Proceedings pages 1-4, 2019

4. **Global air transport complex network: multi-scale analysis**
W. Guo, B. Toader, R. Feier, G. Mosquera, F. Ying, S. Oh, M. Williams, A. Krupp
Springer Nature Applied Sciences (SNAS), vol.1(7), 2019

5. **Non-negative super-resolution is stable**
A. Eftekhari, J. Tanner, A. Thompson, B. Toader and H. Tyagi
2018 IEEE Data Science Workshop, DSW 2018 - Proceedings pages 100-104, 2018

6. **Spatially varying deconvolution for light-sheet microscopy**
B. Toader, J. Boulanger, Y. Korolev, M. Lenz, C.B. Schonlieb, L. Muresan
In preparation

Other Research Experience

Jul–Sep 2016 **Deflating Magnetic Oscillations**, *Culham Centre for Fusion Energy*, Abingdon, UK.
Used deflation to find multiple periodic solutions to a system of ODEs that describes the behaviour of plasma. In collaboration with Culham Centre for Fusion Energy.
Supervisors Prof Patrick Farrell (Oxford), Dr Wayne Arter (CCFE)

May–Jul 2016 **Improved Source Reconstruction from Hydrophone Data**, *National Physical Laboratory*, London, UK.
Analysed how compressed sensing can be applied to a problem on ship localisation from measurements of the sound in the shipping lane, proposed by the National Physical Laboratory. An extension of this work to grid-free compressed sensing applied to the same problem has been the focus of my PhD project for the following three years.
Supervisors Prof Jared Tanner (Oxford), Dr. Andrew Thompson (Oxford), Dr Peter Harris (NPL), Dr Stephane Chretien (NPL)

2012–2013 **Formal Verification of Dynamical System**, *University of Manchester*, UK.
Final year undergraduate thesis on using the automatic theorem prover MetiTarski to analyse equilibrium and stability properties of dynamical systems.
Supervisor Dr Eva Navarro-López

Presentations

Jul 2020 *SIAM Conference on Imaging Science (IS20)*, online – poster presentation

Jan 2020 *Quantitative BioImaging*, Oxford, UK – poster presentation

Aug 2019 *International Conference on Continuous Optimization*, Berlin, Germany – oral presentation

Jul 2019 *13th International Conference on Sampling Theory and Applications*, Bordeaux, France – oral presentation

Mar 2019 *InFoMM Annual Meeting*, Oxford, UK – oral presentation

Feb 2019 *InFoMM Group Meeting*, Oxford, UK – oral presentation

Jul 2018 *Curves and Surfaces Conference*, Arcachon, France – oral presentation

Jun 2018 *6th IMA Conference on Numerical Linear Algebra and Optimization*, Birmingham, UK – oral presentation

Jun 2018 *2018 IEEE Data Science Workshop*, Lausanne, Switzerland – poster presentation

Mar 2018 *InFoMM Annual Meeting 2018*, Oxford, UK – oral presentation

Mar 2018 *Numerical Analysis Seminar*, Oxford, UK – oral presentation

Feb 2018 *Research Workshop on Optimization and Big Data*, KAUST, Saudi Arabia – poster presentation

Jan 2018 *SIAM UKIE Annual Meeting*, Southampton, UK – poster presentation

May 2017 *InFoMM Group Meeting*, Oxford, UK – oral presentation

Mar 2017 *InFoMM Annual Meeting 2017*, Oxford, UK – poster presentation

Other Academic Events

Dec 2019 *Data Study Group*, Alan Turing Institute, London, UK
Implemented deep learning based solution for image segmentation applied to brighfield microscopy data.

Jun 2019 *Mathematics in Industry New Zealand Workshop*, Auckland, New Zealand
Implemented optimal transport based solution for decomposing spectrum of cheese samples into different components (fat, protein etc.).

Jan 2019 *Mathematics of Imaging CIRM Winter School*, Marseille, France

Jun 2018 *142nd European Study Group with Industry*, Palanga, Lithuania
Worked on predicting the sustainable income of loan applicants according to rules from the central bank.

Jun 2017 *Summer School on Structured Regularization for High-Dimensional Data Analysis*, Henri Poincare Institute, Paris, France

Dec 2016 *Data Study Group*, Alan Turing Institute, London, UK
Implemented network model to solve an air traffic prediction problem proposed by Airbus.

May 2016 *116th European Study Group With Industry*, Durham, UK
Implemented mixed integer programming solution to problem on scheduling field trials proposed by Syngenta.

Mar 2016 *InFoMM Graduate Modelling Camp*, Oxford, UK
Worked on calculating trajectory of footballs. Won IMA Best Team Performance prize.

Awards

2018 *Travel Award*, SIAM UKIE Annual Meeting, Southampton, UK

2016 *IMA Best Team Performance Prize*, InFoMM Graduate Modelling Camp, Oxford, UK

2015 *EPSRC InFoMM CDT Studentship*, Oxford, UK

2010 *Golden Anniversary Prize*, University of Manchester, UK
For excellence in first year studies, awarded to the students with the first five highest grades in the first year.

2006–2009 *Bronze Medal at the National Mathematical Olympiad*, Romania in 2007, 2008 and 2009
Won various prizes at other national and regional mathematics contests, including the national contest organised by the editors of the Romanian mathematical journal "Gazeta Matematica" for students who regularly send solutions to the problems published in the journal.

Teaching Experience

2016–2018 **Continuous Optimisation**, *University of Oxford*, Oxford, UK.
Teaching assistant for 4th year undergraduate course. Responsible with marking weekly assignments and solving problems on the board during classes, to groups of up to 15 students. Ran revision classes independently to groups of 30 students.

Lecturer Prof Coralia Cartis

2016–2018 **Integer Programming**, *University of Oxford*, Oxford, UK.
Teaching assistant for 3rd year undergraduate course. Responsible with marking weekly assignments and solving problems on the board during classes, to groups of up to 15 students. Ran revision classes independently to groups of 30 students.
Lecturer Prof Raphael Hauser

2016–2017 **Computational Mathematics**, *University of Oxford*, Oxford, UK.
Lab demonstrator for 1st year undergraduate Matlab classes. Presented new material in the form of live computer demo to groups of up to 20 students.
Lecturer Dr Andrew Thompson

2010–2011 **Peer Assisted Study Sessions Leader**, *University of Manchester*, Manchester, UK.
Weekly sessions with 1st year undergraduate students, in groups of around 6, assisting them with basic mathematics and programming.

Industry Experience

2013–2015 **Technology Associate**, *Morgan Stanley*, London, UK.
Worked in the Pricing Technology team for the Interest Rate Derivatives business, where I used Scala and Perl to build and improve the pricing tools used by quantitative analysts and traders.

Jun–Jul 2012 **Summer Intership, Technology**, *Credit Suisse*, London, UK.
Part of the team that maintains the Unix servers in the EMEA region. On top of handling daily requests from users, I improved my shell scripting skills.

2011-2012 **Industrial Placement, Technology**, *Morgan Stanley*, London, UK.
Worked as part of the Institutional Securities Group Technology division in one of the teams developing and supporting the equities trading systems. Acquired experience of working with large sets of data.

Outreach

2017–2018 **Lord Williams's School**, *Thame, Oxfordshire, UK.*
Ran two outreach sessions (in 2017 and in 2018 respectively) aimed at pre-final year students about doing research in applied mathematics. Presented material on the mathematics of machine learning.

Computer Skills

Advanced Matlab, Python, Java, Scala, Linux, LaTeX

Intermediate C, C++, Perl

Other

Languages Romanian (native), English (fluent)

Hobbies Gliding, running, hiking, climbing, skiing, guitar