Nicolas Boullé

Research Fellow at the University of Cambridge

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Research interests

Numerical analysis, machine learning, computational physics

Employment

Since 2022 **Simons Postdoctoral Research Fellow**, University of Cambridge, UK
Joint appointment between the Isaac Newton Institute and DAMTP.

Education

2018-2022 **DPhil in Numerical Analysis**, University of Oxford, UK
Supervised by Prof. Patrick Farrell and Prof. Alex Townsend.

2017-2018 **Visiting Research Student**, Cornell University, USA
Supervised by Prof. Alex Townsend.

2015-2017 **BSc and 1st year of MSc in Mathematics**, ENS Rennes, France

2013-2015 **University foundation course in mathematics**, Lycée Saint-Louis, France

Prizes and scholarships

2022 **STEM for Britain**, *finalist*
Presenting work on learning Green's functions at the UK Parliament.

2021 **IMA Leslie Fox Prize for Numerical Analysis**, *2nd prize*
For work on PDE learning theory with Green's functions.

2021 **G-Research PhD Prize**, *2nd place (£5000)*
For the development of rational neural networks.

Travel awards

SIAM Student Travel Award in 2020, 2021, and 2022.

Research supervision

2021-2022 **1 undergraduate student from Yale**
Research project on learning fractional PDEs.

Summer 21 **3 undergraduate students from Cornell, Johns-Hopkins, Yale**, *(with A. Townsend)*
Cornell REU project on learning features of PDEs from Green's functions.

Summer 20 **1 MSc student**, *(with Y. Nakatsukasa and D. Samaddar)*
Oxford InFoMM mini-project on time series forecasting with deep learning.

Teaching

Fall 21 **Tutor for Approximation of functions**, Mathematical Institute, University of Oxford

Fall 20 **Tutor for Approximation of functions**, Mathematical Institute, University of Oxford

Fall 19 **TA for Practical Numerical Analysis**, Mathematical Institute, University of Oxford

Fall 19 **TA for Approximation of functions**, Mathematical Institute, University of Oxford

Submitted papers

15. **N. Boullé**, I. Newell, P. E. Farrell, and P. G. Kevrekidis, *Two-Component 3D Atomic Bose-Einstein Condensates Support Complex Stable Patterns*, submitted.

14. **N. Boullé**, P. E. Farrell, and M. E. Rognes, *Optimal control of Hopf bifurcations*, submitted.

13. **N. Boullé**, J. Słomka, and A. Townsend, *An optimal complexity spectral method for Navier–Stokes simulations in the ball*, submitted.

Publications

12. **N. Boullé**, S. Kim, T. Shi, and A. Townsend, Learning Green's functions associated with parabolic partial differential equations, J. Mach. Learn. Res. (2022).

11. **N. Boullé**, P. E. Farrell, and A. Paganini, *Control of bifurcation structures using shape optimization*, SIAM J. Sci. Comput. (2022).

10. **N. Boullé** and A. Townsend, *A generalization of the randomized singular value decomposition*, ICLR (2022).

9. **N. Boullé**, C. J. Earls, and A. Townsend, *Data-driven discovery of Green's functions with human-understandable deep learning*, Sci. Rep. (2022).

8. **N. Boullé**, V. Dallas, and P. E. Farrell, *Bifurcation analysis of two-dimensional Rayleigh–Bénard convection using deflation*, Phys. Rev. E (2022).

7. A. Ellingsrud, **N. Boullé**, P. E. Farrell, and M. E. Rognes, *Accurate numerical simulation of electrodiffusion and osmotic water movement in brain tissue*, Math. Med. Biol. (2021).

6. **N. Boullé** and A. Townsend, *Learning elliptic partial differential equations with randomized linear algebra*, Found. Comput. Math. (2022).

5. **N. Boullé**, E. G. Charalampidis, P. E. Farrell, and P. G. Kevrekidis, *Deflation-based identification of nonlinear excitations of the three-dimensional Gross–Pitaevskii equation*, Phys. Rev. A (2020).

4. **N. Boullé**, Y. Nakatsukasa, and A. Townsend, *Rational neural networks*, NeurIPS (2020).

3. E. G. Charalampidis, **N. Boullé**, P. E. Farrell, and P. G. Kevrekidis, *Bifurcation analysis of stationary solutions of two-dimensional coupled Gross–Pitaevskii equations using deflated continuation*, Commun. Nonlinear Sci. Numer. Simulat. (2020).

2. **N. Boullé** and A. Townsend, *Computing with functions in the ball*, SIAM J. Sci. Comput. (2020).

1. **N. Boullé**, V. Dallas, Y. Nakatsukasa, and D. Samaddar, *Classification of chaotic time series with deep learning*, Physica D (2020).

Study group with industry reports

2. D. Barton, N. Boullé, E. Campillo-Funollet, C. Hall, S. Ruangdech, and Y. Zhou, *Compressing aerodynamic hazard data* (with Zenotech), ESGI 162, 2020.

1. E. Campillo-Funollet, N. Boullé, M. Ebeling-Rump, A. Pichler, A. Farid, M. P. Goodridge, H. Lee, B. Lyu, and M. Sejeso, *Uncertainty in seismic inverse problems* (with BP), ESGI 145, 2019.

Academic visits and talks

Oct 22 **EPFL**, *invited by Daniel Kressner*

Sept 22 **Imperial College**, *Numerics & Acoustics Workshop*

Aug 22 **BIFD conference**, *Netherlands*
July 22 **Equadiff 15 conference**, *Czech Republic*
June 22 **University of Cambridge**, *invited by Carola Schönlieb*
June 22 **IMA Conference on Numerical Linear Algebra and Optimization**, *Birmingham*
June 22 **Householder Symposium on Numerical Linear Algebra**, *Italy*
May 22 **University of Oxford**, *Numerical Analysis seminar*
Apr 22 **ICLR 2022 conference**
Apr 22 **SIAM Conference on Uncertainty Quantification**
Mar 22 **Virtual study group**, *V-KEMS*
Mar 22 **STEM for Britain**
Feb 22 **Cornell University**, *invited by Alex Townsend*
Jan 22 **PRISM Residential workshop**
Jan 22 **SIAM UKIE Annual Meeting**
Oct 21 **University of Oxford**, *Junior Applied Mathematics Seminar*
Aug 21 **11th Montreal Industrial Problem Solving Workshop**
July 21 **SIAM Annual Meeting**
July 21 **British Early Career Mathematicians' Colloquium**, *University of Birmingham*
June 21 **20th IMA Leslie Fox Prize Event**
Jan 21 **21st Geilo Winter School**
Dec 20 **NeurIPS 2020 conference**
Nov 20 **University of Oxford**, *Numerical Analysis seminar*
July 20 **European Study Group with Industry 162**, *University of Leeds*
Aug-Sept 19 **Simula Research Laboratory**, *visiting Marie Rognes*
Apr 19 **European Study Group with Industry 145**, *University of Cambridge*
Oct 18 **University of Oxford**, *Numerical Analysis seminar*
Apr 18 **MIT**, *visiting Jonasz Słomka*
Nov 17 **Cornell University**, *SCAN seminar*
Sept 17 **Memorial University of Newfoundland**, *visiting Alex Bihlo*

Professional activities

2023 **Co-organizer of a minisymposium**, 93rd GAMM Annual Meeting
Title: Randomized algorithms in numerical linear algebra.

2022 **Highlighted Reviewer of ICLR 2022**

Since 2021 **Referee for NeurIPS, ICML, ICLR, SIAM J. Sci. Comput., and Physical Review Research**

2021 **Co-organizer of a minisymposium**, SIAM Annual Meeting
Title: Approximation theory of neural networks.