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.

Research prizes

2023 **IMA Lighthill-Thwaites Prize**, 2nd place.

2022 **STEM for Britain**, finalist.

2021 **IMA Leslie Fox Prize for Numerical Analysis**, 2nd prize.

2021 **G-Research PhD Prize**, 2nd place (£5000).

Research grants and fellowships

2023-2028 **Scientific Artificial Intelligence (SciAI) Center**, Office of Naval Research, $11.3m,
Cambridge PI, personal support: $485k.

2022-2023 **INI-Simons Postdoctoral Research Fellowship**, Simons Foundation.

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

18. **N. Boullé**, D. Halikias, and A. Townsend, *Elliptic PDE learning is provably data-efficient*, submitted.

17. F. Laakmann and **N. Boullé**, *Bifurcation analysis of a two-dimensional magnetic Rayleigh-Bénard problem*, submitted.

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

Publications

15. **N. Boullé**, I. Newell, P. E. Farrell, and P. G. Kevrekidis, *Two-Component 3D Atomic Bose-Einstein Condensates Supporting Complex Stable Patterns*, Phys. Rev. A (2023).

14. H. Praveen, **N. Boullé**, and C. Earls, *Principled interpolation of Green's functions learned from data*, Comput. Methods Appl. Mech. Eng. (2023).

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

12. **N. Boullé**, P. E. Farrell, and M. E. Rognes, *Optimal control of Hopf bifurcations*, SIAM J. Sci. Comput. (2023).

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

Apr 23	**British Applied Mathematics Colloquium**, *UK*
Mar 23	**UCL**, *Math4DL workshop*
Feb 23	**SIAM Conference on Computational Science and Engineering**, *Netherlands*
Feb 23	**KU Leuven**, *invited by Daan Huybrechs*
Jan 23	**The Alan Turing Institute**, *Oden-Turing workshop*
Nov 22	**University of Cambridge**, *CIA seminar*
Nov 22	**The Alan Turing Institute**
Nov 22	**University of Leicester**, *CMS Mathematics seminar*
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**, *online*
Apr 22	**SIAM Conference on Uncertainty Quantification**, *online*
Mar 22	**Virtual study group**, *V-KEMS*
Mar 22	**STEM for Britain**, *UK House of Commons*
Feb 22	**Cornell University**, *invited by Alex Townsend*
Jan 22	**PRISM Residential workshop**
Jan 22	**SIAM UKIE Annual Meeting**, *online*
Oct 21	**University of Oxford**, *Junior Applied Mathematics Seminar*
Aug 21	**11th Montreal Industrial Problem Solving Workshop**, *online*
July 21	**SIAM Annual Meeting**, *online*
July 21	**British Early Career Mathematicians' Colloquium**, *online*
June 21	**20th IMA Leslie Fox Prize Event**, *online*
Jan 21	**21st Geilo Winter School**, *online*
Dec 20	**NeurIPS 2020 conference**, *online*
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, JMLR, SISC, ACHA, and Physical Review Research**

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