

# 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)

## 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

- 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. Sejso, *Uncertainty in seismic inverse problems* (with BP), ESGI 145, 2019.

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## 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**

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## 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.