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*Imperial College London*
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# Nicolas Boullé

## Research interests

Numerical analysis, machine learning, operator learning

## Employment

2024-date **Assistant Professor in Applied Mathematics**, Imperial College London, UK.
Department of Mathematics.

2022-2024 **Research Fellow**, University of Cambridge, UK.
Isaac Newton Institute and Department of Applied Maths and Theoretical Physics.

## 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

2024 **SIAM Activity Group on Linear Algebra Best Paper Prize**

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,
Imperial PI, personal support: $485k.

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

## Research supervision

PhD students:

- Gustav Conradie (Cambridge, with Matthew Colbrook), 2024-date.
- Kelan Gray (Imperial, with Matthew Colbrook), 2025-date.
- Jack Ross (Imperial, with Martin Rasmussen), 2025-date.
- Christina Runkel (Cambridge, with Carola Schönlieb), 2021-date.
- Oussama Zekri (ENSAE Paris, with Anna Korba), 2025-date.

Undergraduate and MSc students: Markus Dablander (2020), Franklin Deng, Jack Krew, Henry Smith (2021), Emily Zhang, Qile Jiang (2023), Gustav Conradie (2024), Yudi Cai, Penelope Forcioli, Emmet

Haddad, Moritz Hauschulz, Ade Olugboji, Lars Slettengren, Emre Ulusoy, Advaith Velavan, Yaxuan Wang, Oussama Zekri, Zihan Zhou (2025).

## Teaching

2025-date **Lecturer for Mathematical Foundations of Machine Learning**, Imperial College London.

2025 **Lecturer for Finite Element**, AIMS Rwanda.

2019-2021 **TA/Tutor for Approximation of functions**, University of Oxford.

2019 **TA for Practical Numerical Analysis**, University of Oxford.

## Professional activities

2025 **Program Committee**, International Conference on Scale Space and Variational Methods in Computer Vision 2025

2024 **Co-organizer of a minisymposium**, SIAM Conference on Applied Linear Algebra
Title: Operator Learning and Linear Algebra.

2023-2024 **Co-organizer of the Cambridge ACA seminar**

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

2022 **Highlighted Reviewer of ICLR 2022**

2021-date **Referee for several journals and conferences, including NeurIPS, ICML, ICLR, JMLR, and SISC.**

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

## Submitted papers

34. J. Bao, **N. Boullé**, T. J.B. Liu, R. Sarfati, and C. J. Earls, *Text-Trained LLMs Can Zero-Shot Extrapolate PDE Dynamics*, submitted.

33. **N. Boullé**, M. Colbrook, and G. Conradie, *Convergent Methods for Koopman Operators on Reproducing Kernel Hilbert Spaces*, submitted.

32. J. Rowbottom, S. Fresca, P. Lio, C.-B. Schönlieb, and **N. Boullé**, *Multi-Level Monte Carlo Training of Neural Operators*, submitted.

31. O. Zekri and **N. Boullé**, *Fine-Tuning Discrete Diffusion Models with Policy Gradient Methods*, submitted.

30. C. Runkel, S. Xiao, **N. Boullé**, and Y. Chen, *Operator learning regularization for macroscopic permeability prediction in dual-scale flow problem*, submitted.

29. O. Zekri, A. Odonnat, A. Benechehab, L. Bleistein, **N. Boullé**, and I. Redko, *Large Language Models as Markov Chains*, submitted.

28. N. Bouziani and **N. Boullé**, *Structure-Preserving Operator Learning*, submitted.

## Publications

27. R. Sarfati, T. J.B. Liu, **N. Boullé**, and C. J. Earls, *What's in a prompt? Language models encode literary style in prompt embeddings*, EMNLP (2025).

26. T. J.B. Liu, **N. Boullé**, R. Sarfati, and C. J. Earls, *Visualizing in-context probability trajectories of LLMs*, ICLR (2025).

25. R. Sarfati, T. J.B. Liu, **N. Boullé**, and C. J. Earls, *Lines of Thought in Large Language Models*, ICLR (2025).

24. **N. Boullé** and M. Colbrook, *Multiplicative Dynamic Mode Decomposition*, SIAM J. Appl. Dyn. Syst. (2025).

23. D. Persson, **N. Boullé**, and D. Kressner, *Randomized Nyström approximation of non-negative self-adjoint operators*, SIAM J. Math. Data Sci. (2025).

22. T. J.B. Liu, **N. Boullé**, R. Sarfati, and C. J. Earls, *LLMs learn governing principles of dynamical systems, revealing an in-context neural scaling law*, EMNLP - *Oral* (2024).

21. **N. Boullé**, D. Halikias, S. E. Otto, and A. Townsend, *Operator learning without the adjoint*, J. Mach. Learn. Res. (2024).

20. **N. Boullé** and M. Colbrook, *On the Convergence of Hermitian Dynamic Mode Decomposition*, Physica D (2024).

19. **N. Boullé** and A. Townsend, *A Mathematical Guide to Operator Learning*, Handbook of Numerical Analysis (2024).

18. **N. Boullé**, A. Herremans, and D. Huybrechs, *Multivariate rational approximation of functions with curves of singularities*, SIAM J. Sci. Comput. (2024).

17. **N. Boullé**, D. Halikias, and A. Townsend, *Elliptic PDE learning is provably data-efficient*, PNAS (2023).

16. F. Laakmann and **N. Boullé**, *Bifurcation analysis of a two-dimensional magnetic Rayleigh-Bénard problem*, Physica D (2024).

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

14. **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).

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).

## Technical reports

3. **N. Boullé**, J. Słomka, and A. Townsend, *An optimal complexity spectral method for Navier–Stokes simulations in the ball*, arXiv:2103.16638, 2021.

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 (since 2023)

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| **Workshop on Infinite-dimensional ML**, invited speaker, Zurich, Switzerland. | September 2025 |
| **University of Vienna**, invited by Otmar Scherzer, Vienna, Austria. | July 2025 |
| **Householder Symposium XXII**, plenary speaker, Ithaca, USA. | June 2025 |
| **University of Manchester**, Manchester, UK. | May 2025 |
| **AIMS Rwanda**, Kigali, Rwanda. | April 2025 |
| **ETH Zurich**, invited by Rima Alaifari, Zurich, Switzerland. | March 2025 |
| **Ensta Paris**, Paris, France. | March 2025 |
| **University of Oxford**, Oxford, UK. | January 2025 |
| **Maxwell Institute**, Edinburgh, UK. | November 2024 |
| **California Institute of Technology**, Los Angeles, USA. | November 2024 |
| **University of British Columbia**, Vancouver, Canada. | November 2024 |
| **Simon Fraser University**, Vancouver, Canada. | November 2024 |
| **Oberwolfach workshop on Inverse Problems**, Germany. | October 2024 |
| **Imperial-UCL Numerics Seminar**, London, UK. | October 2024 |
| **CNRS Besançon**, Besançon, France. | October 2024 |
| **I-X Imperial College London Seminar**, London, UK. | October 2024 |
| **Firedrake 2024 Conference**, Oxford, UK. | September 2024 |
| **Huawei Workshop**, invited speaker, Bordeaux, France. | September 2024 |
| **Workshop on ML in infinite dimensions**, invited speaker, Bath, UK. | August 2024 |
| **4th Symposium on ML and Dynamical Systems**, invited speaker, Canada. | July 2024 |
| **Cornell University**, USA. | June 2024 |
| **Grenoble AI for Sciences Workshop**, keynote speaker, France. | May 2024 |
| **SIAM Conference on Applied Linear Algebra**, prize lecture, France. | May 2024 |
| **Alan Turing Institute**, online seminar. | May 2024 |
| **University of Bath**, Numerical Analysis seminar, UK. | April 2024 |
| **One World Mathematics of Machine Learning**, online seminar. | April 2024 |
| **Dynamics, Data and Deep learning workshop**, invited speaker, UK. | March 2024 |
| **SCML2024 Conference**, invited speaker, Japan. | March 2024 |
| **Inria Strasbourg**, invited by Victor Michel-Dansac, France. | February 2024 |

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| **University of Cambridge**, M4DL Workshop. | January 2024 |
| **University of Birmingham**, Applied Mathematics Seminar. | January 2024 |
| **Lawrence Livermore National Laboratory**, DDPS Webinar. | December 2023 |
| **UCLouvain**, invited by Estelle Massart, Belgium. | October 2023 |
| **Johns Hopkins University**, online Postdoc Seminar. | September 2023 |
| **Maths4DL Conference**, invited speaker, UK. | July 2023 |
| **29th Biennial Numerical Analysis Conference**, UK. | June 2023 |
| **Brown University**, invited by Brendan Keith, USA. | June 2023 |
| **British Applied Mathematics Colloquium**, UK. | April 2023 |
| **UCL**, Math4DL workshop. | March 2023 |
| **SIAM Conference on Computational Science and Engineering**, Netherlands. | February 2023 |
| **KU Leuven**, invited by Daan Huybrechs, Belgium. | February 2023 |
| **The Alan Turing Institute**, Oden-Turing workshop. | January 2023 |