CHARLIE COWEN-BREEN

(617) 909 0198 ⋄ 20 Pemberton St., Cambridge, MA., USA ⋄ ccbreen@mit.edu ⋄ https://github.com/charliecb

EDUCATION

Massachusetts Institute of Technology, Ph.D. candidate, Mathematics *September, 2023 - present*

- 5.0/5.0 GPA, supported by NDSEG fellowship.
- *Previously:* Department of EECS, advised by Stephen Bates. Transferred to math in 2024.
- *Relevant coursework:* Generative AI in biology; quantitative methods in natural language processing

Trinity College, University of Cambridge, M.A.St. Applied Math. & Theoretical Physics *2022 - 2023*

- Awarded (one of four) *Trinity Studentship in Mathematics.*
- *Graduate coursework*: general relativity, stochastic calculus, Bayesian modelling and computation, advanced probability, information theory

Princeton University, A.B. Mathematics *2018 - 2022*

- *Magna cum laude*, 4.0 departmental (3.96 overall) GPA, Certificate in Statistics and Machine Learning.
- *Relevant graduate coursework*: deep learning theory, high-dimensional probability, probability theory, advanced algorithm design, computational complexity, statistical theory and methods, Riemann surfaces

Boston University Academy *2014 - 2018*

- *Summa cum laude*, completed 14 Boston University courses, 4.0 technical GPA

RESEARCH EXPERIENCE

Research collaborator, **UK Medical Research Council**: *January, 2023 - present*

- Under the supervision of MRC Programme Leader Sofia Villar, derived theoretically optimal sample size for certain randomized controlled trials (Grade: 100/100). *In preparation.*

Researcher, **Princeton University** *(Senior Thesis)* *February, 2021 - present*

- With Ching-Yao Lai and Tristan Buckmaster, deployed physics-informed neural networks (PINN) to construct model of ice-hardness across Antarctica, revealing contradictions in widely-accepted previous assumptions. Discovered undesirable overfitting behavior in PINNs, now named "cheating".
- Independently proposed and developed theoretical framework for alternative algorithm (SPINNs), which is robust against cheating, and is necessary for accuracy of the model deployed to Antarctica.

Co-creator, **ΛΟΓΙΟΝ**: *May, 2022 - present*

ML-powered tool for detecting transliteration errors in ancient texts.

- Conceived and deployed masked language model to detect errors in and reconstruct the writings of Byzantine authors (PyTorch), under guidance of Barbara Graziosi and Johannes Haubold.
- Model discovered more than 100 peer-reviewed errors to date, including typos in online libraries, and errors made by ancient scribes.

ENGINEERING EXPERIENCE

Software Engineering Intern, **Meta Reality Labs** *June - August, 2021*

- Incorporated probabilistic and statistical methods in order to apply domain adaptation technique (to remedy disparity in performance between demographic groups) to Oculus hand-detection network
- Transitioned from software engineering to research, presenting results and discussing with research scientists weekly (invited to return as researcher). Known on team for combinatorial/probabilistic analysis
- Formerly employed at **Facebook AI Research**, *AI Habitat* team *January - February, 2021*

Software Engineering Intern, **Ava Robotics**, spinoff of **iRobot** *June - August, 2019*

- Developed and deployed image classification software on a 3D depth camera to differentiate office objects
- Collaborated on robot localization and mapping with a small team of robotics software engineers. Go-to team member for mathematical explanation of algorithms.

AWARDS AND FELLOWSHIPS

NDSEG Fellowship, **U.S. Department of Defense** *September 2024 -*
Trinity Studentship in Mathematics, **Cambridge University** *2022 - 2023*
Sigma Xi Book Award for Outstanding Research, **Princeton Mathematics** *2022*
Inducted into Sigma Xi **Princeton Mathematics** *2022*
Inducted into Phi Beta Kappa **Princeton University** *2022*
Peter A. Greenberg Memorial Prize **Princeton Mathematics** *2021*
- Awarded for outstanding accomplishments in mathematics by juniors

Shapiro Prize for Academic Excellence **Princeton University** *2020*
- Recognizes highest acheiving 3% of first and second years

Allen G. Shenstone **Princeton Physics** *2019*
- Awarded by the Department of Physics for excellence in coursework and promise in independent research

Breakout Fellow **Program in Mathematics for Young Scientists** *2018*

PUBLICATIONS/PREPRINTS

Charlie Cowen-Breen, Yongji Wang, Stephen Bates, Ching-Yao Lai. Euler operators for mis-specified physics-informed neural networks. *ICML AI for Science, 2024.*

Yongji Wang, Ching-Yao Lai, and Charlie Cowen-Breen. Discovering ice-shelf rheology via physics-informed neural networks. *In review by Science.*

Charlie Cowen-Breen, Creston Brooks, Barbara Graziosi, Johannes Haubold. Logion: Machine-Learning Based Detection and Correction of Textual Errors in Greek Philology. *Ancient Language Processing, 2023.*

Barbara Graziosi, Johannes Haubold, Charlie Cowen-Breen, Creston Brooks. Machine Learning and the Future of Philology: A Case Study. *Transactions of the American Philological Association, 2023.*

Charlie Cowen-Breen, Ching-Yao Lai, and Yongji Wang. Navigating physics-informed loss landscapes with stochastic gradient descent. *In preparation.*

Charlie Cowen-Breen, Sofia Villar. Guidelines for Sample Sizes: Randomised Controlled Trials are nearly Optimal for Overall Patient Health, if the Right Number of Patients is Chosen. *In preparation.*

Charlie Cowen-Breen, Elene Karangozishvili, Narmada Varadarajan, Thomas Wang. Pattern Problems related to the Arithmetic Kakeya Conjecture. *In preparation, preprint:* https://arxiv.org/abs/2011.07056.

SERVICE/TEACHING EXPERIENCE (OVER 400 HOURS)

Teaching Assistant, **Princeton University** *2019 - 2022*
- Selected by instructor to TA for Accelerated Honors Analysis I & II, the most rigorous first-year courses
  - Invited to return for three consecutive years
  - Hold review sessions twice per week, write supplementary notes and distribute to students
- As *Social Chair*: responsible for ensuring well-being of students & developing community during pandemic
- Additionally selected to TA for MAT300, multivariate analysis

Teaching Assistant, **MIT** *2024*
- Selected by instructor to TA for 6.S951, modern mathematical statistics

SKILLS AND INTERESTS

Programming	Python: TensorFlow, PyTorch, C++, Java, knowledge of Linux	
Singing	King's Voices (Cambridge University), Princeton Chapel Choir	*2018 - 2023*
Jazz guitar	MIT musical theatre, jazz band	*2023 - 2024*
Sailing	Princeton Sailing Team, skipper; MIT	*2018 - 2024*
Humanities	One of 80 students nationwide selected for Princeton Symposium	*2017*
Astronomy	One of 36 students selected for Summer Science Program in Astrophysics	*2017*