CHARLIE COWEN-BREEN

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EDUCATION

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

Trinity College, University of Cambridge, M.A.St. Applied Math. & Theoretical Physics *2022 - 2023*
- Holding *Trinity Studentship in Mathematics*, graduated with *Merit*.
- *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 Investigator Sofia Villar, conducted a theoretical comparison of optimal adaptive trial designs to the optimal strategy when randomised controlled trials (RCTs) are used to determine treatment allocations.
- Under these frequentist assumptions, derived the optimal number of patients to include in RCTs to be $O(\log N)$, where N is the patient horizon, in contrast to previous work in a Bayesian setting.

Researcher, **Princeton University** *(Senior Thesis)* *February, 2021 - present*
- With Ching-Yao Lai and Yongji Wang, 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.

- Trained 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 (**Princeton Classics**)
- Model discovered more than 100 errors to date, including typos in online libraries, and errors made by ancient scribes. Independently conceptualized and implemented recommendation-based graphical interface, which recommends potential errors to Classics experts with a hit-rate of approximately 100 times the proportion of existing errors in given texts

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

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, 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.*

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

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

SKILLS AND INTERESTS

Programming	Python: TensorFlow, PyTorch, C++, Java, knowledge of Linux	
Data Visualization	The Daily Princetonian (Princeton Student Newspaper)	*2020 - 2021*
Music	King's Voices, Princeton Chapel Choir	*2018 - Present*
Sailing	Princeton Sailing Team, skipper	*2018 - Present*
Humanities	One of 80 students nationwide selected for Princeton Symposium	*2017*