Bilal **Chughtai**

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Education

Trinity Hall, University of Cambridge — *Cambridge, UK*

BA & MMath in Mathematics — *2017 - 2021*

- Part IA - Class 1 (72%, unranked)
- Part IB - Class 1 (83%, ranking 17 of 240)
- Part II - Class 1 (unranked due to COVID-19 pandemic)
- Part III - Distinction (88%, ranking 22 of 272)
  Examinable courses: Quantum Field Theory, General Relativity, Cosmology, Field Theory in Cosmology.
  Essay: "The Search for CMB B-Mode Polarization from Inflationary Gravitational Waves" (90%)

Center for AI Safety — *Remote*

ML Safety Scholars Program — *June - August 2022*

- Intense fully-funded 10 week summer program. Took online courses in the fundamentals of deep learning and ML Safety. Ranked in the top quartile in assignments.
- Implemented various DL architectures from scratch in PyTorch, including MLPs, CNNs, RNNs and Transformers.

Saint Olave's Grammar School — *London, UK*

Secondary and Sixth Form Education — *2010 - 2017*

A levels:	Mathematics A* • Further Mathematics A* • Physics A* • Chemistry A* • Biology AS A • EPQ A
University Entrance Exams:	STEP1 S (117/120) • STEP2 S (116/120) • STEP3 1 (92/120) • MAT 74/100
GCSEs:	7 A*s • 3 As • FSMQ A

Experience

Stanford Existential Risks Initiative — *London, UK*

ML Alignment Theory Scholar — *October 2022 - Present*

- Primary research contributor on a mechnistic interpretability (MI) paper entitled "A Toy Model of Universality: Reverse Engineering How Networks Learn Group Operations", available on arxiv. Accepted as a spotlight at ICLR Workshop Physics4ML 2023 (top 9% of accepted papers), and under review at ICML 2023.
- We build on my mentor's (Neel Nanda) prior work on understanding grokking of modular addition. We reverse engineer how networks implement composition in arbitrary groups, find a consistent representation theory (!) based algorithm, and then use this understanding to investigate the universality hypothesis of mechanistic interpretability.

Met Office — *Exeter, UK*

Foundation (Junior) Scientific Software Engineer (SSE) — *January 2022 - June 2022*

- Member of the ExCALIBUR (Exascale Computing ALgorithms and Infrastrucures benefiting UK Research) pool of deployable SSEs.
- Worked in the LFRic project on infrastructure supporting next generation weather modelling systems, optimised for new supercomputer hardware. Development in Python and Fortran.

Cambridge Assessment — *Cambridge, UK*

Assistant Examiner — *July 2021, July 2022*

- Worked in several small teams marking in excess of 800 candidate scripts annually for the STEP Mathematics II and III exams.

Soft Matter Group, DAMTP, University of Cambridge — *Cambridge, UK*

Summer Research Student — *July - October 2020*

- Work as part of the RAMP Epidemic Modelling Taskforce on the PyRoss project; a library for structured epidemiological compartment models.
- Implemented and optimised new computational models involving sophisticated control scenarios such as lockdowns, vaccinations and testing.
- Work involved reading papers, pen and paper calculations, model making, computational work, data analysis and written work. Defended my ideas weekly in group seminars.

Metaswitch Networks — *London, UK*

Software Engineering Intern — *June 2019 - August 2019*

- Worked in the Support Tools team within Information Systems on enhancements to a Google Cloud based Business Intelligence platform.
- Picked up several new technologies quickly. Work required research, planning, writing, testing, and deployment stages. Participated in daily and weekly team meetings following the agile methodology.
- Migrated old C# Extract-Transfer-Load (ETL) processes uploading data to Google BigQuery to a newer, more robust infrastructure. Cleaned and used new data source to produce dynamic reports for internal end users.
- Wrote python scripts to enhance permission deployment to our Google Project, to both improve speed and to reflect organisational changes better through use of active directory groups over raw emails. Deployed as jobs on a long GitLab CI/CD pipeline and also to run hourly via a dockerised crontab job.

Private Tutor
London, UK

Self Employed
May 2020 - Present

- Over 200 hours of tutoring experience, mostly in GCSE and A level Maths.
- Written preparatory resources and tutored students in university entrance exams including the MAT, ENGAA and STEP.
- Provided mock interviews to university applicants in the physical sciences.
- Developed my ability in effectively communicating complex mathematical and scientific ideas to a range of age groups.

Volunteering

Cambridge University Powerlifting Club
Cambridge, UK

Webmaster
May 2021 - Present

- Designed and deployed a new club website (cuplc.co.uk), reducing club costs and increasing maintainability for future committees. A web development project built using Ruby, Jekyll, HTML and CSS.
- Automated previously manually curated club student and alumni records through open source OpenPowerlifting data. Updates daily.
- Organised logistics for the 2022 Varsity Powerlifting competition against Oxford, and helped run the event on the day.
- Assist in general running of the club, including running a freshers fair stall and introductory sessions, team training, in house competitions and socials.

Trinity Hall JCR
Trinity Hall, Cambridge, UK

Webmaster
November 2017 - March 2020

- Responsible for maintaining and updating the JCR website, as well as aiding the committee with technical tasks.
- Ran technical aspects of the yearly college room ballot, the process by which students choose their room for the following academic year. Worked closely with several different groups of people, balancing requirements. System consisted of a database storing the state of the ballot linked via a python script to a custom web app that displays this state in a more user friendly form, by overlaying live properties of the rooms onto a floor plan. Properties include a room's availability or occupant, its weekly rent, whether it is ensuite, etc.
- Sat on the college IT Advisory Group, representing the undergraduate body regarding IT matters.
- Helped organise and run freshers week events for new undergraduates at Trinity Hall.

Project Work

Part III Essay
University of Cambridge

Part III, Mathematical Tripos
2021

- The Part III essay is an extended piece of scientific writing. It involves reviewing recent literature on a certain modern topic in mathematics or theoretical physics, and collating the information elegantly and clearly.
- My essay "The Search for CMB B-Mode Polarization from Inflationary Gravitational Waves" described in full detail the scientific basis and current cutting edge in a very exciting current area of research in trying to understand fundamental physics via precision cosmology. Awarded 90%.

CATAM
University of Cambridge

Parts IB and II, Mathematical Tripos
2018-2020

- Contributing to my second and third years grades, CATAM - "Computer Aided Teaching of All Mathematics" - were a set of computational mathematics projects, requiring programming to complete. Code in MATLAB and Python.
- Selected Projects:
  - Factorisation of large integers, implementing and testing the effectiveness of continued fraction methods from the Number Theory course.
  - Simulation of geodesic orbits around particular black hole metrics, a direct application of content taught in the General Relativity course.

Skills

Programming	*Proficient:*	Python • MATLAB • LaTeX
	Familiar:	HTML • CSS • JavaScript • SQL • Fortran • PyTorch
Technologies	*Proficient:*	Windows • Linux • Git • SVN • Jekyll
	Familiar:	Google Cloud Suite
Hobbies		Powerlifting • Bouldering

Honors & Awards

2021	**Offer to study for a PhD**, with Blake Sherwin (Part III Essay supervisor) in theoretical cosmology at DAMTP	*Cambridge, UK*
2021	**Parks Prize for Mathematics**, for "obtaining a particularly strong result in Tripos Examinations"	*Cambridge, UK*
2020	**Wylie Prize for Mathematics**, for "obtaining a particularly strong result in Tripos Examinations"	*Cambridge, UK*
2020, 2021	**Trinity Hall Bateman Scholarship**, for "obtaining a first class result in Tripos Examinations"	*Cambridge, UK*
2018, 2019	**Trinity Hall Scholarship**, for "obtaining a first class result in Tripos Examinations"	*Cambridge, UK*
2017	**HG Abel Prize**, for "outstanding A level results", awarded by Saint Olave's Grammar School	*London, UK*
2017	**Highest Performer at A-level**, Saint Olave's Grammar School	*London, UK*