

# Robert Joseph George

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## EDUCATION

### California Institute of Technology (Caltech)

Ph.D. Mathematics and Computer Science

Pasadena, CA

Incoming - Sep 2023

- **Fellowship:** Institute fellowship.
- **Supervisor:** Anima Anandkumar

### University of Alberta

BS.c Honors Applied Mathematics and Computer Science, First Class

Edmonton, AB

Sep 2019 - Jun 2023

- **Honors Thesis 1:** Numerical Analysis for Real-time Nonlinear Model Predictive Control of Ethanol Steam Reformers.
- **Honors Thesis 2:** Hybrid Dealiased Convolutions.
- **Academic Profile:** GPA: overall (3.8/4.0); Mathematics + CS only (3.9/4.0). Dean's Silver Medal and Dean's Honor Roll.

## WORK EXPERIENCE

### Caltech

Research Intern, Theoretical Machine Learning Group

Pasadena, CA

Jul 2022 - Present

- **Deep Learning:** Foundations of Deep Learning; understanding Rank and Spectral Bias in Neural Networks plus applications to solving PDEs using Fourier Neural Operators. Work still in progress to understand the various theoretical properties of these models and generalize to Physics-informed Neural Operator.
- **Academic advisor:** Anima Anandkumar

### University of Alberta

Research Intern, Department of Mathematics and Statistics

Edmonton, AB

May 2022 - Present

- **Hybrid Dealiased Convolutions:** Optimization of the Fast Fourier Transform Algorithm using Hybrid Dealiasing.
- **Impact:** Hybrid Dealiasing improvements and produced the first ever algorithm for 1D/2D/3D convolution using this approach. Developing them for existing state-of-the-art fast Fourier transform libraries such as FFTW++. Work still in progress before publishing in SIAM Journal on Scientific Computing.
- **Academic advisor:** John Bowman

### Alberta Machine Intelligence Institute (Amii)

Research Intern, Reinforcement Learning and Artificial Intelligence Lab

Edmonton, AB

Jan 2022 - Jan 2023

- **Reinforcement Learning:** Optimization of RL environments - Decreased training time by around 50% on all environments and proposed a new hyperparameter approach. Released the code as open source on Github. RL researchers use the codebase to test their RL and AI agents. Optimized it further by including Just in Time compilation.
- **Theoretical Machine Learning:** Comparing the theoretical properties of Implicit vs Explicit Kernel Features using functional analysis. Analyzing Gaussian Processes vs Bayesian Linear Regression using Kernel Features; In charge of writing up the paper and conducting experiments.
- **Academic advisor:** Martha White and Adam White

Work Integrated Learning Opportunity

Mar 2022 - Mar 2022

- **Duties:** Created discussion activities centred around introductory Python concepts to various startups and colleges.
- **Impact:** Helped startups and colleges to educate their workspace/students and enabled them to take advanced courses.

### University of Alberta

Research Assistant, Artificial Intelligence Computational Group

Edmonton, AB

Jan 2022 - Jul 2022

- **Climate Forecast:** Led the climate forecast team using Machine learning Techniques to predict the climate over the next year, especially for the Prairies and Global Forecast Team. Analyzed seasonal patterns like ENSO, NAO, SAO etc.
- **Impact:** Part of the \$3 Million project aims to mix artificial intelligence with agriculture to help cattle ranchers.
- **Academic advisor:** David Wishart

### Pacific Institute for the Mathematical Sciences (PIMS)

Research Assistant, Department of Mathematics and Statistics

Toronto, ON

Jan 2022 - Dec 2022

- **Research Projects:** Numerical Analysis for NMPC of Ethanol Steam Reformers and Finding the solution space of a homogeneous linear ODE. The work is was part of my Honors Thesis and Honors ODE course - Github
- **Impact:** Performed simulations, numerical and a rigorous theoretical analysis of first-order quasi-PDEs.
- **Academic advisor:** Xinwei Yu

### Canadian VIGOUR center (CVC)

Research Assistant, Department of Medicine and Dentistry

Edmonton, AB

Jan 2022 - Jun 2022

- **Research Project:** Prediction of the next clinical event of a patient with a certain disease using Process Mining Tools.
- **Impact:** Worked on the codebase, summarized papers relating to Petri Nets and compared it to using DL Models.
- **Academic advisor:** Russ Greiner

### Microsoft

Data Science Intern, Azure Compute

Redmond, WA

Jun 2021 - Aug 2021

- **Azure Dedicated Hosts:** Improved the efficiency of Azure, 0.05% increase in accuracy.
- **Machine Learning and AI:** Worked in Azure alongside Microsoft Research to create Interpretable and Explainable Classifiers (Explainable Boosting, LIME and SHAP Kernel Explainer) and did feature importance using Mutual Information and other statistics. Used AI tools in Power BI to verify the results and create reports.
- **Impact:** Helped lay the foundation for more research and increase in efficiency led to a \$200 Million save for Microsoft.

### University of Alberta

Research Assistant, Faculty of Engineering and Arts and Business

Edmonton, AB

Nov 2020 - May 2021

- **Research Project:** Enhancing Occupational Health and Safety Performance of companies through data analysis.
- **Impact:** Data collection and analysis on social media discussions about workplace fatalities. Usage of social media APIs.
- **Academic advisors:** Lianne Lefsrud, Joel Gehman, Heather Eckert

## TEACHING EXPERIENCE

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### Department of Mathematics and Statistics

Edmonton, AB

*Honors Calculus I (Real Analysis)/ Honors Linear Algebra*

*Apr 2021 - May 2023*

- **Duties:** Graded Assignments and helped students understand foundational concepts. (MATH 117/Decima Robinson Center)
- **Impact:** Helping students understand foundational concepts in Real Analysis, Linear Algebra, Statistics and Calculus.
- **Academic Instructor:** Jochen Kuttler

*Honors Calculus II (Multivariable Real Analysis)*

- **Duties:** Graded Assignments and helped students understand foundational concepts. (MATH 118/MATH 217/MATH 227)
- **Impact:** Helping students understand foundational concepts in Real Analysis and Multivariable Real Analysis.
- **Academic Instructor:** Jochen Kuttler

### Department of Computer Science

Edmonton, AB

*Formal Languages, Automata, and Computability Theory*

*Sep 2021 - May 2023*

- **Duties:** Duties include holding office hours per week, grading & creating assignments and exams. (CMPUT 474)
- **Impact:** Helping students understand concepts in Automata, Computability and Complexity Theory.
- **Academic Instructor:** Dale Schuurmans

*Algorithms II*

- **Duties:** Duties include holding office hours per week, grading & creating assignments and exams. (CMPUT 304)
- **Impact:** Helping students understand concepts in Algorithms, Approximation Algorithms and Complexity Theory.
- **Academic Instructor:** Ryan Hayward

*Algorithms I*

- **Duties:** Duties included holding office hours per week and grading assignments and exams. (CMPUT 204)
- **Impact:** Helped students understand concepts in Algorithms and Data Structures. Average TA rating of (4.93/5.0).
- **Academic Instructor:** Ehab Elmallah

*Basics of Machine Learning*

- **Duties:** Duties included holding office hours per week and grading assignments and exams. (CMPUT 267)
- **Impact:** Helped students understand concepts in Theoretical Machine Learning. Average TA rating of (4.91/5.0).
- **Academic Instructor:** Martha White

## HONORS AND AWARDS

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- Dean's Silver Medal in Science 2023
- Google Computer Science Research Program Scholar 2022
- The Harry E. Balfour Scholarship in Mathematics 2022
- University of Alberta Undergraduate Leadership Award (International) 2022
- Dr. Clement W Bowman Scholarship in Honors Applied Mathematics (Twice) 2022
- Mathematical and Statistical Sciences Undergraduate Student Research Award (USRA, Twice) 2022
- The Mathematical Contest in Modeling (Successful Participant Award) 2022
- International Undergraduate Summer Enrichment Program - Excellence grade (Top 5 students) 2021
- Morgan Stanley (Code For Good Hackathon Winner) 2021
- Mathematical and Statistical Department Excellence Scholarship 2021
- Merit List Holder (7 Years) - Bronze Medal 2019
- Prime Ministers Foundation Fellowship 2018
- Gulf Mathematics Olympiad - Bronze Medal 2018
- Prime Ministers Foundation Award for Academic Excellence and Leadership 2018

## CONFERENCE PROCEEDINGS AND WORKSHOPS

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Jiawei Zhao, **George, Robert Joseph**, Yifei Zhang, Zongyi Li and Anima Anandkumar "Incremental Fourier Neural Operator" *NeurIPS 2022 Workshop AI4Science*, 2022.

**George, Robert Joseph**. "EDCDE - Extended Discovery of Closed-Form Differential Equations", *International Conference of Learning Representations Tiny Paper*, 2023

## UNDERGRADUATE HONORS THESIS

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**George, Robert Joseph**, and Xinwei Yu. "Numerical Analysis for real-time Nonlinear Model Predictive Control of Ethanol Steam Reformers." *Canadian Undergraduate Mathematics Conference*, 2022.

**George, Robert Joseph**, Noel Murasko and John Bowman. "Hybrid Dealiasing Convolutions." *Joint Mathematics Meetings*, 2023.

## PRESENTATIONS AND POSTER SYMPOSIUMS

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**George, Robert Joseph**, Martha White, Adam White and Samuel Neumann. "Making Reinforcement Learning Experiments More Reproducible and Computationally Efficient." *Undergraduate Research Symposium* (Also at Alberta Machine Intelligence Institute Reverse Expo) , 2022, pp. 15-16.

## SUMMER SCHOOLS

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*Summer School in Logic and Formal Epistemology*, Carnegie Mellon University, 2022.

*International Undergraduate Summer Enrichment Program*, University of Alberta, 2021.

Alberta Number Theory Days XIII, *Banff International Research Station for Mathematical Innovation and Discovery*, 2021.

Western Summer School in Algebra, *University of Alberta*, 2020.

## LEADERSHIP EXPERIENCE

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### Cohere For AI

*Machine Learning Theory Learning Group Lead*

Toronto, ON  
Oct 2022 - Present

- **Activities:** In charge of co-organizing the ML Theory Learning Group and holding discussions with researchers on advances in the field. Topics include Optimization, Generalization theory, Computational Learning Theory, Domain Generalization etc.
- **Impact:** Helping researchers learn various topics in theoretical ML and RL.

### Mathematical Sciences Society (MSS)

*Treasurer and Member*

Edmonton, AB  
Aug 2019 - Aug 2023

- **Activities:** Promoted the MSS during club fairs and our love for math through various events and wrote the Math Integration Bee contest problems. The club was perfect for me to debate, interact, have fun, and engage in activities.
- **Impact:** Responsible for keeping track of the funds, restocking, buying new merch managing the entire community.

### Google

*Developer Student Founder and Leader*

Edmonton, AB  
Jul 2020 - Apr 2022

- **Google Developer Technologies:** Developer Student Lead/Founder for The University of Alberta DSC Chapter
- **Impact:** Helped organized events and promoted the usage of Google developer technologies. Collaborated with startups, Google Developer Experts etc. Grew the club to around 1,000 members. Got promoted to lead the whole of Alberta province and have been advising various GDSC clubs in North America for 2 years.
- **Manager:** Madusha Cooray

### Undergraduate Research Initiative (URI)

*Peer Undergraduate Research Liaison (PURL) and Reviewer*

Edmonton, AB  
Aug 2021 - Apr 2022

- **PURL:** Helped support the URI through involvement in promotion and outreach activities, event logistics and peer-advising.
- **Impact:** Promoted related research opportunities. Assisted with the coordination of the Mentor Award, Research Crawls, and High school programs. Helped guide undergrads especially underrepresented students find research-related jobs.
- **Team Lead:** Crystal Synder

### Association for Computing Machinery (ACM)

*Founder and Chair*

Edmonton, AB  
Aug 2020 - Apr 2022

- **Activities:** Founder the University of Alberta ACM Chapter. Hosted hackathons, workshops and other events.
- **Impact:** Organized various club meetings and collaborated with different clubs facilitating effective knowledge of CS. Improved student access to important resources in CS such as Machine Learning, Artificial Intelligence etc.
- **Team Lead:** Nelson Amaral

### University of Alberta

*Science Mentor and Service Learning Volunteer*

Edmonton, AB  
Nov 2019 - Apr 2022

- **Activities:** Mentor for the Faculty of Science and Identified social issues in the Edmonton community.
- **Impact:** Mentoring 20 Mentees and helped them gain awareness of the campus and resources available to them as well as shared relevant experiences. I also connected with the different organizations such as Hope mission, operation friendship, Edmonton food bank to support the homeless and give back to the community.

## PROJECTS

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- **MinAtar - Faster:** MinAtar Faster is an optimized testbed for AI agents which implements miniaturized versions of several Atari 2600 games. We also provide benchmarks for standard RL agents on the various environments. **Github**
- **Computer Vision - Using Object Detection Models to Identify and Count Arctic Wildlife:** Research oriented, Artificial Intelligence Thesis - Localization and classification of caribou in the Canadian Arctic - **Github**
- **Theoretical Algorithms Implementation:** Implementation of Algorithms from CLRS book - **Github**
- **Fillactive Community App:** The app uses incentives and gamification to promote exercise for self worth and build a community among students, teachers and Fillactive - Acquired by **Morgan Stanley**
- **The Mathematical Contest in Modeling:** Water and Hydroelectric Power Sharing among the river basin (Problem B in the MCM) using Flow Algorithms - Published (Drought and Rain Magazine)
- **Machine Learning Algorithms Implementation:** Implementation of Algorithms from several Machine Learning/Deep Learning courses at the University of Alberta - Github

## PROFESSIONAL AFFILIATIONS

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- Institute of Mathematical Statistics (IMS)
- Association for Computing Machinery (ACM)
- Pacific Institute for the Mathematical Sciences (PIMS)

## JOURNAL REVIEWER

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- Journal of Machine Learning Research (2022 - Present)
- Canadian Journal of Undergraduate Research (2021 - 2022)
- Eureka Journal - Undergraduate Science Journal (2020 - 2022)

## SKILLS SUMMARY

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- **Languages:** Python, C++, Asymptote, Mathematica, LaTeX, SQL, MySQL, Git
- **Frameworks:** Scikit, OpenGym, TensorFlow, Pytorch, Panadas, Numpy, GCP, Azure, Compute Canada
- **Technical:** Machine Learning, Deep Learning, Algorithms, Mathematics, Data Engineering/Visualization/Analysis
- **Soft Skills:** Leadership, Public Speaking, Time Management, Teamwork, Communication, Problem Solving, Research
- **Courses:** Graph Theory, Advanced Algorithms, Computer Vision, Theoretical Machine Learning, Real Analysis, Numerical Methods, Linear Algebra, Complex Analysis, Searching and Planning in AI, Complexity and Automata Theory