Alexey Izmailov

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Education

Brown University

Providence, RI

ScM Applied Mathematics, Bachelor of Science in Mathematics and Computer Science — *Expected May 2024*

- **Relevant Coursework**:
  Graduate - Recent Applications of Probability and Statistics (Monte Carlo methods and information theory), Modern Algebra I, Numerical Solutions to Partial Differential Equations I (finite difference methods) & II (classical finite element methods) & III (finite element exterior calculus & applications), CFD for Compressible Flows, Partial Differential Equations I
  Undergraduate - Independent Study (reduced order methods via neural networks; advised by Professor Mark Ainsworth), Seminar on Wavelets and Applications, Distributed Systems, Machine Learning, Design and Analysis of Algorithms, Data Science, Blockchains and Cryptocurrencies, Data Structures and Algorithms, Applied Dynamical Systems, Statistical Inference, Topics in Abstract Algebra (Galois Theory)

Experience

Rodriguez Flow Group Research Assistant

Providence, RI

Brown University, Department of Engineering — *December 2021 - Present*

- Designing and implementing a novel Python package for demonstrating a forward-inverse workflow for acoustically-forced bubble cavitation problems and associated material characterization via PINNs
- Implementing a second-generation forward PDE solver for inertial micro-cavitation rheometry in Newtonian and non-Newtonian fluids
- Developing numerical simulations for bubble cavitation for supercomputer processing of three dimensions for viscoelastic-air and water-air simulations with biomedical applications to mitigate adverse health effects from ultrasounds as part of the Eulerian Multiphase Solver

Undergraduate Summer Research Assistant

New York City, NY

Flatiron Institute, Center for Computational Mathematics — *June 2022 - August 2022*

- Developed *scikit-stan*, a novel open-source Python interface to Stan with a *scikit-learn* API for probabilistic programming
- Implemented, tested, and distributed a hybrid Stan-Python codebase that is publicly available: https://pypi.org/project/scikit-stan/
- Implemented generalized regression models with high degree of customizability and modularity for priors, family-link combinations, and adherence to several visualization libraries
- Active maintainer and contributor to the repository; working on extending and optimizing the library of available models

CRUNCH Group Research Assistant

Providence, RI

Brown University, Department of Applied Mathematics — *February 2022 - May 2022*

- Implemented and parallelized numerical algorithms in C and Nektar++ for simulation of the fractional quasi-geostrophic PDE to study turbulent flows with novel fractional spectral vanishing viscosity methods and packaged for internal research use
- Designed and implemented a distributable visualization GUI for Bayesian techniques in SciML

Curriculum Developer and Instructor

Virtual

Everaise Academy — *May 2020 - August 2020*

- Developed curriculum in advanced topics in number theory and combinatorics at the high AIME and olympiad level
- Held office hours and provided detailed feedback on problem sets for 100+ students
- Published a proprietary 256 page text about mathematical problem solving and preparation for mathematics competitions

Personal Projects

Numerical Methods for Partial Differential Equations

Scientific Computing

Python, MATLAB, C++, MPI, Julia — *Code Repository*

- In-progress project regarding the implementation of various schemes for solving partial differential equations using FDM and FEM algorithms
- Implemented Crank-Nicolson, Forward and Backward Euler, Lax-Friedrichs, Lax-Wendroff and Method of Lines for Transport and Heat equations
- Parallelized serial C codes in MPI for execution in supercomputing setting
- Progressing into schemes for lubrication-type equations and expanding to spline interpolation schemes

DisasseML: Machine Learning Disassembler

Systems & Machine Learning

TensorFlow, scikit-learn, and Numpy — *Code Repository*

- x86 disassembler to AT&T and Intel syntaxes using an encoder-decoder architecture on LSTM cells with gridsearch hyperparameter optimization
- Attains a 22.0% error rate on locally-generated training, testing, and validation sets

BrunoCoin: A Fully Functional Cryptocurrency

Systems & Blockchains

GoLang, gRPC — *Code Repository*

- Multi-threaded proof-of-concept cryptocurrency and blockchain from scratch featuring proof of work mining, full transaction capabilities, etc...
- Closely follows design described in Bitcoin's whitepaper with resolution of some theoretical threats such as DoS attacks
- Used a gRPC server with Google's Protobuf as a local simulation of network communication with 1000+ nodes and 200+ miners

Skills

Languages Python, Stan, C++, Go, Julia, SQL, MATLAB, Java
Frameworks MPI, CUDA, Slurm, TensorFlow (+ Probability), Docker, Apache Spark, gRPC, GTest, GMesh

Publications and Graduate Directed Reading Programs

Brown University Directed Reading Program Spring '21 Write-up, 27 p.
- Wrote a 27 page report about my graduate functional analysis directed reading program covering reproducing kernel Hilbert spaces, representations and applications such as the Karhunen-Loeve transform; view here

Brown University Directed Reading Program Fall '21 – Dirichlet's Theorem & L-series
- Primarily focuses on number theory over function fields with the goal of gaining a deeper appreciation of how many standard number theory facts (over the integers) have direct analogs in function fields and how Dirichlet's primes in arithmetic progressions is proved in the function field setting. Text: GTM 210, Rosen, *Number Theory in Function Fields*

Awards

Winner of Brown Math Contest for Modelling 2022

Winning submission in weekend-long math modelling competition where with 2 other teammates, we solved an optimization problem for optimal concert hall geometry design using CFD; awarded a modest cash prize and fees paid for ICM/MCM in 2023

UTRA Spring 2023 Grant Recipient

Amount: $ 1,200, awarded to select undergraduate researchers at Brown University for furthering research under Professor Kavita Ramanan

UTRA Summer 2022 Grant Recipient

Amount: $ 2,500, awarded to select undergraduate researchers at Brown University for furthering research in the Rodriguez Flow Research Group

USA Math Talent Search Silver Medalist (2018), Bronze Medalist (2017, 2019)

Top 70 competitor in premier USA math competition

USA National Chemistry Olympiad Semi-finalist (2017, 2018)

Top 1000 competitor in main USA chemistry competition

USA National Computing Olympiad Silver Medalist (2019)

Top 5000 competitor in main USA computing competition

American Invitational Mathematics Examination Qualifier (2019)

Top 5000 competitor in main USA mathematics competition

National Catholic Math League Absolute Winner (2018, 2019)

Absolute winner in national math competition for US Catholic high schools

AZSEF Mu Alpha Theta Award Recipient (2018)

Sole mathematical award for the most creative application of mathematics at Arizona's state science fair based on paper title "An Analytical Approach to Bounding Divisors in Binary and Ternary Cubic Diophantine Equations Via Ellipsoidal Rotations"

Leadership

Teaching Assistant (PHP2561) *Providence, RI*

Brown University *January 2022 - May 2022*
- Elected as TA for graduate bioinformatics & data science course focusing on implementation of algorithms for biomedical research
- Demonstrated and graded assignments written in Julia as well as helping to debug faulty Julia code
- Advised technical aspects of a final research project, at the masters level, within a health/biomedical context

Lead Teaching Assistant (MATH1530) *Providence, RI*

Brown University *June 2021 - August 2021*
- Elected as lead TA for undergraduate abstract algebra sequence covering group, ring, and field theory
- Effectively provided weekly feedback (4.67/5.0 post hoc rating by students) on problem sets and held weekly office hours for 30+ students
- Coordinated with other TAs to ensure expedient grading and foster a welcoming environment