

# Dr Sina Baghal

AL & ML | Research Engineer

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## WORK EXPERIENCE

- TD (Data Scientist III)** Jul 23 - Present
  - Current position*
  - Develop models to analyze customer behavior across the full banking portfolio to detect fraudulent activity. Support stakeholders with ad-hoc requests by applying problem-solving and programming expertise.
  - Tags:** Python PySpark SQL SAS Problem Solving Modeling Data Science
- CIBC (Quantitative Analyst)** Aug 22 - Jul 23
  - Developed Python packages and designed methodologies to meet risk management mandates. Implemented OOP with parallel processing to handle large datasets and leveraged bash scripting to ensure maintainability.
  - Tags:** Mathematical Finance FRTB Python Performance Optimization Parallel Processing OOP
- Huawei Noah's Ark Lab (Machine Learning Researcher)** Feb 22 - Aug 22
  - Accelerated neural networks' SoftMax layer in PyTorch for both training and inference. Achieved baseline accuracy using only the optimal number of bits for classification, i.e.,  $\lceil \log_2 c \rceil$  where  $c$  is the number of classes.
  - Tags:** Deep Learning Transformers Quantization Research Weight Distributions Pytorch
- University of Waterloo (Postdoc (CS), Grad (C&O))** May 16 - Feb 22
  - Conducted research in stochastic optimization and graph neural networks. Served as a teaching assistant for graduate and undergraduate courses.
  - Tags:** Numerical Analysis Integer Programming Optimization Statistics Machine Learning Python CPU/GPU C++ MATLAB Parallel Processing Dask Spark Code Performance Optimization OOP
- Young Scholars Club (Seasonal Mathematical Olympiad Coach (Iran))** Sep 06 - May 16
  - Taught courses in Advanced Mathematics. Led challenging problem-solving sessions (e.g., Putnam) to develop students' mathematical skills and contributed to the problem-design committee.
  - Tags:** Problem Solving Mathematical Olympiad Problem Design

## SELECTED DEVELOPMENT PROJECTS

- Solving Pasur Using GPU-Accelerated Counterfactual Regret Minimization** ([arXiv Preprint](#))
  - Developed a CUDA-accelerated computational framework with optimized memory management to simulate a fishing card game, enabling the creation of an AI agent to play the game using Reinforcement Learning.
  - Tags:** Reinforcement Learning Generative AI Artificial Intelligence Counterfactual Regret Minimization Efficient Computing PyTorch CUDA Game Theory GPU Optimization Memory Management Nash Equilibrium
- Generative Modeling of Heston Volatility Surfaces Via Variational Autoencoders** ([Project Page](#), [Code](#))
  - Trained a Variational Autoencoder (VAE) on Heston stochastic volatility models to generate volatility surfaces for option pricing. Unlike traditional methods that impose structural assumptions on volatility dynamics, this Model Agentic VAE approach directly learns features from data, delivering greater flexibility and adaptability.
  - Tags:** Deep Learning Generative AI Variational Autoencoder PyTorch Heston Model Volatility Surfaces Vectorization Monte Carlo Simulation Numerical Analysis Optimization Option Pricing
- Implementing Deep Smoothing for Implied Volatility Surfaces** ([Project Page](#), [Code](#))
  - Implemented Deep Smoothing of the Implied Volatility Surface in Python, developing custom training and convergence methods that greatly reduce runtime and increase flexibility over traditional approaches.
  - Tags:** Deep Learning Generative AI Feed Forward Networks PyTorch Volatility Surfaces Vectorization SSVI Convex Optimization CVX Fine-tuning Option Pricing

## EDUCATION

- University of Waterloo** May 16 - Apr 21
  - PhD in Mathematical Optimization at the department of Combinatorics & Optimization*
- Sharif University of Technology** Sep 06 - Jul 12
  - Bachelor's and Master's degree in Fundamental Mathematics*

## ACADEMIC PROJECTS

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- **Solution Manual to Stochastic Calculus for Finance II** ([Manuscript](#))

Authored a complete solution manual for Stochastic Calculus for Finance II, covering all exercises.

**Tags:** Mathematics Stochastic Calculus Option Pricing Finance Probability Theory

- **A Matrix Concentration Inequality for Products** ([arXiv Preprint](#))

Provided a non-asymptotic bound on the product of random positive semidefinite matrices, which can be used to analyze the convergence behavior of stochastic gradient descent in machine learning.

**Tags:** Mathematics High Dimensional Statistics Probability Theory

- **A Termination Criterion for Stochastic Gradient Descent for Binary Classification**<sup>1</sup> ([arXiv Preprint](#))

Developed a computationally efficient early stopping criterion for machine learning, supported by theoretical guarantees, showing strong predictability on unseen data. Presented at the [NeurIPS](#) and the [Fields Institute](#).

**Tags:** Stochastic Gradient Descent Mixture of Gaussians Machine Learning Early Stopping Markov Chains Stochastic Stability

## SELECTED HONORS AND AWARDS

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International Scientific Olympiad in Mathematics (Silver Medal, 2010). Iranian Math. Olympiad (Silver Medal, 2005)<sup>2</sup>

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<sup>1</sup>PhD Dissertation

<sup>2</sup>Olympiad medals are awarded annually to 40 out of 320,000 competing students