

NATANAEL S. ALPAY

QUANTITATIVE RESEARCH | MACHINE LEARNING | APPLIED MATHEMATICS
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RESEARCH PROFILE

Mathematics Ph.D. candidate and author/co-author of 10+ publications and preprints spanning probability, harmonic analysis, complex analysis, optimization, and complex-valued machine learning. Develops theory, algorithms, and numerical experiments for problems involving uncertainty and complex data. Uses large language models as conjecture-generation tools, followed by rigorous proof, computational verification, and reproducible implementation. Presented 20+ research talks at national and international conferences.

EDUCATION

University of California, Irvine - Irvine, CA

Expected May 2027

- Ph.D. Candidate in Mathematics
- M.S. in Applied Mathematics, (December 2025)

Chapman University - Orange, CA

May 2022

- B.S. Mathematics
- B.S. Physics
- B.S. Computer Science
- B.A. French

Honors: Ronald M. Huntington Outstanding Scholarship Award; DataFest First Place/Best Insight; Outstanding Mathematics and Physics Student.

TECHNICAL SKILLS

Mathematics / ML: Probability, stochastic processes, martingales, harmonic analysis, complex analysis, RKHS, optimization, SGD, kernel methods, classification, time series

Programming / Data: Python, SQL, R, C/C++, Java, JavaScript, MATLAB, Mathematica; Numpy, pandas, Matplotlib, Tableau, Excel

Languages: English, French, Russian, Hebrew

RESEARCH AND TECHNICAL EXPERIENCE

Graduate Research Assistant | University of California, Irvine

Sep 2022 - Present

- Extended representer-theorem and kernel-regression methods to complex RKHS; formulated inverse and optimization problems whose solutions include superoscillation sequences and Blaschke products. [This is a seminal work relating physics and machine learning kernel methods via the representer theorem.](#)
- Developed complex-valued stochastic gradient descent; analyzed convergence and directional bias and built numerical experiments that recover theoretical solutions.
- Study sharp inequalities and lower bounds in harmonic analysis using probability, martingales, stochastic processes, and computation.
- Actively using large language models (LLMs) as a research tool, mainly as "conjecture engines" to generate candidate formulas, representations, and proof strategies followed by rigorous verification, proof writing, and reproducible implementation.

Machine Learning Research and Data Analysis | Chapman University

Jun 2020 - Sep 2022

- Analyzed Brain Institute datasets through data cleaning, statistical analysis, and visualization; implemented machine-learning algorithms and built Python/SQL and JavaScript interfaces for scientific data exploration.

Undergraduate Research Mentor | DATA@UCI

Jan 2025 - Jun 2025

- Guided an undergraduate team in high-dimensional data reduction, research design, analysis, and presentation.

Teaching Assistant | University of California, Irvine

Sep 2022 - Present

- Taught calculus, real and complex analysis, and machine-learning-related mathematics; [translated advanced concepts for students with varied technical backgrounds.](#)

SELECTED APPLIED MACHINE LEARNING PROJECT

Early Prioritization of VAERS Vaccine-Symptom Signals

2025 - 2026

- Built a quarter-ahead ranking pipeline using logistic regression and calibrated gradient boosting to prioritize rare vaccine-symptom signals for expert review.
- Benchmarked against PRR, ROR, IC, and EBGM-style methods; evaluated AUPRC, calibration, and precision@k; [presented at CHOC hospital Pediatric and Lifespan Data Science Conference April 29, 2026 and the Biostatistics Symposium of Southern California.](#)

SELECTED PUBLICATIONS

- Alpay & Battaglia, "Complex Stochastic Gradient Descent and Directional Bias in Reproducing Kernel Hilbert Spaces," arXiv, 2026.
- Alpay, De Martino & Diki, "Representer Theorem in Complex Reproducing Kernel Hilbert Spaces," arXiv, 2026.
- Alpay, Cerejeiras & Kahler, "Generalized Fock-Space and Fractional Derivatives," Results in Applied Mathematics, 2026.
- Alpay & Diki, "On the Mittag-Leffler Bargmann Transform," Journal of Mathematical Analysis and Applications, 2023.

COLLABORATION & WORKING STYLE

- Thoughtful, fair, and dependable; years of teaching and grading taught me to make clear, consistent decisions, explain them respectfully, and remain open to new evidence and perspectives.
- Warm, collaborative, and easygoing; [enjoy getting to know the people I work with, building long-term relationships, and contributing to a supportive, positive team environment.](#) Outside work: weight-lifting, Lego, Food, karaoke, and time with friends.

