$$\alpha U + \beta\,\xi \cdot \nabla U + (U \cdot \nabla)U = -\nabla P$$

AI-Driven Mathematical Discovery:
Singularities, Algorithms, and Beyond

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$$\text{score}(f) \xrightarrow{\text{evolve}} \text{prompt LLM} \xrightarrow{\text{mutate}} \text{score}(f')$$

Joint Distinguished Interdisciplinary and Applied Mathematics and Mathematics Colloquium
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Machine learning is transforming mathematical discovery, enabling advances on longstanding open problems. This talk explores two complementary approaches illustrating different paradigms for AI and mathematics.
On the one hand, I will present a systematic discovery of unstable singularities in multi-dimensional partial differential equations. While most numerical methods historically found only stable singularities, we discover families of unstable singularities requiring infinitely precise initial conditions. Combining curated machine learning architectures with high-precision optimization and mathematical analysis, we achieve in some cases near machine precision, meeting requirements for rigorous computer-assisted proofs.
On the other, I will discuss AlphaEvolve, a general-purpose evolutionary coding agent that uses large language models to autonomously discover old and new mathematical constructions and potentially go beyond them. AlphaEvolve tackles a wide variety of problems across analysis, geometry, combinatorics, and number theory. This illustrates how general-purpose AI systems can systematically successfully explore broad mathematical landscapes at an unprecedented speed, leading us to do mathematics at scale.
Together, these examples reveal complementary roles for machine learning and mathematics in the future: deep, precision-focused small models for specific problems versus broad, systematic exploration across domains via large models.

Javier Gomez-Serrano, Professor of Mathematics at Brown University. He completed his PhD in Mathematics at the Universidad Autónoma de Madrid in 2013, where his dissertation won the best of the year award. Before joining the faculty at Brown in 2022, he held academic positions at Princeton University and the University of Barcelona.
His research operates at the intersection of partial differential equations, fluid mechanics, spectral geometry, rigorous computer-assisted proofs, and machine learning. He is recognized for effectively integrating artificial intelligence into mathematical research. Notably, he has utilized Physics-Informed Neural Networks (PINNs) alongside other computational methods to help locate self-similar blow-up profiles in fluid equations. Furthermore, he has collaborated extensively with Google DeepMind to develop AlphaEvolve, an advanced AI system capable of successfully tackling open problems across a wide range of mathematical fields.
His work has been featured by several prominent science and news outlets, including Quanta Magazine, El País, Communications of the ACM, Scientific American, and Spektrum.
Professor Gomez-Serrano's innovative work has been recognized with an extensive list of international accolades. In 2025 alone, he received the R. E. Moore Prize for Applications of Interval Analysis, the MCA Prize from the Mathematical Congress of the Americas, and was selected as a Simons Fellow in Mathematics. His distinctions also include: The Antonio Ambrosetti Medal (2023), The Antonio Valle Prize (2018), and The Vicent Caselles Mathematical Research Award from the Spanish Royal Mathematical Society and the BBVA Foundation (2017). His research has been supported by competitive funding, including an ERC Starting Grant and an NSF CAREER award. Currently, his work is backed by an NSF AIMing Grant, which funds the development of machine learning methodologies to solve complex mathematical problems.