

JAVIER MORALES, PhD

Machine Learning Researcher

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PROFESSIONAL EXPERIENCE

**Research Associate | University of Maryland
College Park | CSCAMM | 2017 –2020**

Artificial intelligence and deep neural architecture search

- Discovered a new geometric structure for semi-discrete optimization with application to neural evolution, open endedness and NAS.
- Developed a neural architecture search algorithm that without parameter sharing, samples 40 times more architectures per compute than contemporaneous hill-climbing methods.
- With a single GPU in 12 hours, this algorithm designs and trains a network with an error rate of 4.06 on CIFAR-10 for computer vision.

Machine learning and multi-agent systems

- Developed clustering algorithms in abstract graphs and a framework to control autonomous drone flocking using multi agent systems.
- Derived the first result in the literature for global convergence of the Cucker-Smale multi agent system with short-range information in generic dimensions.

Convergence rates and quantification of uncertainty

- Proved first result in the literature for global convergence rates/uncertainty quantification for the Kuramoto model.
- The Kuramoto model is 30 years old and is used to model synaptic firing of brain cells.

**Honorary Guest | ETH | Zurich | Switzerland
2016 – 2017**

Optimal Transport and Collective Dynamics

- Derived first results for the global well-posedness, dynamics, and stability of the spatially homogeneous Vicsek model using optimal transport.
- *The Vicsek model*, introduced in 1995, is used to model collective behavior, such as a flock of birds.

**Academic Guest | Ecole Normale Supérieure
Lyon | France | 2015 – 2016**

Geometry of PDEs

- Found new geometric structure for gradient flow interpretation for kinetic and reaction-diffusion equations with boundary conditions. We recovered the family of PDEs with boundary conditions using the celebrated JKO implicit Euler scheme.

EDUCATION

PhD, Mathematics | University of Texas at Austin | 2017

MS, Mathematics | University of Texas at Austin | 2014

BS, Mathematics | Simón Bolívar University | 2012

AWARDS AND HONORS

Frank Gerth III Dissertation Award (2017)

- University of Texas at Austin

Math Olympiad, Silver and Bronze medals

- Olimpiada Iberoamericana de Matemáticas (2010),
- Competencia Iberoamericana Interuniversitaria de Matemáticas (2009)
- Co-founder of the first mathematics Olympiad team at the Universidad Simón Bolívar, Venezuela

First Place Award, Admission test (2007)

- Simón Bolívar University

SKILLS

Machine Learning and AI: Python, Pytorch, SQL, RNN, LSTM, Transformers, Training deep neural nets to superhuman accuracy level, Advanced data augmentation techniques, Automatic neural architecture search and network pruning, Natural Language Processing (NLP), Computer Vision.

Advance Computing: GPU, Cuda framework with multithreading, remote development, AWS, Redshift, S3, Linux, Windows, Git & GitHub.

LEADERSHIP

Conference Organizer

- Young Researchers Workshop: Kinetic descriptions, in theory and applications, UMD (2018)

Mentoring

- Mentored undergraduate thesis on computer science and artificial intelligence.

Academic Journal Referee

- Discrete and Continuous Dynamical Systems
- *Acta Applicandae Mathematicae*
- *Communications in Mathematical Sciences*
- *Journal de Mathématiques Pures et Appliquées*
- *Annales de l'Institut Henri Poincaré C, Analyse Non Linéaire*

**Full course Instructor | University of Maryland August
2017 – 2020**

- Taught 6 semesters of applications of linear algebra and honors differential equations.

SELECTED PUBLICATIONS

- Traditional and accelerated gradient descent for neural architecture search, with F. Morales and N. Trillos. arXiv:2006.15218, submitted to *Journal of Machine Learning Research, JMLR*, 2020.
- Semi-discrete optimization through semi discrete optimal transport: a framework for neural architecture search, with N.Trillos. arXiv:2006.15221, submitted to *Journal de Mathématiques Pures et Appliquées*, 2020.
- On the trend to global equilibrium for Kuramoto Oscillators, with D. Poyato. arXiv:1908.07657, submitted to *Annales de l'Institut Henri Poincaré C, Analyse Non Linéaire*, 2019.
- Flocking with short-range interactions, with J. Peszek, and E. Tadmor. *Journal of Statistical Physics*, 2019.
- Emergence of phase concentration for the Kuramoto-Sakaguchi equation, with S.-Y. Ha, H. K. Kim, and J. Park. *Physica D*, 2019.
- Emergent dynamics of the Kuramoto ensemble under the effect of inertia, with S.-Y. Ha and Young-Pil Choi. *DCDS*, 2018.
- Global well-posedness of the spatially homogeneous Kolmogorov-Vicsek model as a gradient flow, with A. Figalli and M.-J. Kang. *Arch. Ration. Mech. Anal.* 2018.
- A new family of transportation costs with applications to reaction-diffusion and parabolic equations with boundary conditions. *J. Math. Pures Appl.* 2018.
- J. Morales, Least action principles with applications to gradient flows and kinetic equations, Ph.D. thesis, The University of Texas at Austin, May 2017.

SELECTED CONFERENCE PRESENTATIONS

- SIAM Conference on Analysis of Partial Differential Equations. La Quinta, California, December 2019.
- XVII International Conference on Hyperbolic Problems Theory, Numerics, Applications. University Park, Pennsylvania, June 2018.
- PDE Seminar Gradient Flow Techniques and Applications to Collective Dynamics. Georgia Institute of Technology, January 2017.
- CMC Winter School on Applied Math and Math. Physics. Department of Mathematical Sciences, Seoul National University, December 2016.
- Analysis Seminar. Ecole Normale Supérieure, Lyon, October 2015.
- International Workshop on Elliptic and Kinetic Partial Differential Equations. IMPA, Rio de Janeiro, July 2015.
- Analysis Seminar. ETH Zurich, September 2014.