Dr. Pedro Juan Soto

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Senior Postdoctoral Researcher in Applied Mathematics and Computer Science at Virginia Tech. Passionate about science and mathematics, with strong technical and interpersonal skills for working in a team.

Education

- **City University of New York** — **New York, NY**
  Ph.D student in Computer Science — *2020–2022*
- **Florida International University** — **Miami, FL**
  Graduate student in Computer Science — *2017–2020*
- **Florida International University** — **Miami, FL**
  Majored in Mathematics, Minored in Physics — *2012–2016*

Publications

Peer-Reviewed

- **Pedro Soto**, Jun Li, and Xiaodi Fan. Dual Entangled Polynomial Code: Three-Dimensional Coding for Distributed Matrix Multiplication. In *Proceedings of the 36th International Conference on Machine Learning (ICML)*, volume 97 of *Proceedings of Machine Learning Research*, pages 5937–5945. PMLR, 09–15 Jun 2019
- **Pedro Soto** and Jun Li. Straggler-free Coding for Concurrent Matrix Multiplications. In *2020 IEEE International Symposium on Information Theory (ISIT)*, pages 233–238. IEEE, 2020
- Xiaodi Fan, **Pedro Soto**, Xiaomei Zhong, Dan Xi, Yan Wang, and Jun Li. Leveraging Stragglers in Coded Computing with Heterogeneous Servers. In *2020 IEEE/ACM 28th International Symposium on Quality of Service (IWQoS)*, pages 1–10. IEEE, 2020
- Xiaodi Fan, Angel Saldivia, **Pedro Soto**, and Jun Li. Coded Matrix Chain Multiplication. In *2021 IEEE/ACM 29th International Symposium on Quality of Service (IWQoS)*, pages 1–6. IEEE, 2021
- **Pedro Soto**, Xiaodi Fan, Angel Saldivia, and Jun Li. Rook coding for batch matrix multiplication. *IEEE Transactions on Communications*, 70(6):3641–3654, 2022
- **Pedro Soto**, Ilia Ilmer, Haibin Guan, and Jun Li. Lightweight projective derivative codes for compressed asynchronous gradient descent. In *Proceedings of the 39th International Conference on Machine Learning*, volume 162 of *Proceedings of Machine Learning Research*, pages 20444–20458. PMLR, 17–23 Jul 2022
- Felisa J. Vázquez-Abad, Oliver Shetler, and **Pedro Soto**. Quantile formulation for optimization under a qualitative risk constraint. In *2022 IEEE 61st Conference on Decision and Control (CDC)*, pages 2979–2984, 2022
- Xiaodi Fan, **Pedro Soto**, Yuchun Zou, Xian Su, and Jun Li. Sequence-Aware Coding for Leveraging Stragglers in Coded Matrix Multiplication. In *IEEE International Conference on Communications (ICC)*. IEEE, 2023
- Soo Go, Victor Pan, and **Pedro Soto**. Root-Squaring for Root-Finding. In *Computer Algebra in Scientific Computing*. Springer International Publishing, 2023

- Keren Censor-Hillel, Yuka Machino, and **Pedro Soto**. Near-optimal fault tolerance for efficient batch matrix multiplication via an additive combinatorics lens. In *31st International Colloquium On Structural Information and Communication Complexity*, 2024

Preprints

- **Pedro Soto**, Haibin Guan, and Jun Li. Locally Random P-adic Alloy Codes with Channel Coding Theorems for Distributed Coded Tensors. In *Arxiv*, abs/2202.03469
- Mariya Bessonov, Ilia Ilmer, Tatiana Konstantinova, Alexey Ovchinnikov, Gleb Pogudin, and **Pedro Soto**. Obtaining Weights for Gröbner Basis computation in Parameter Identifiability Problems. In *Arxiv*, abs/2202.06297
- Ilia Ilmer, Alexey Ovchinnikov, Gleb Pogudin, and **Pedro Soto**. More Efficient Identifiability Verification in ODE Models by Reducing Non-Identifiability. In *Arxiv*, abs/2204.01623
- Oren Bassik, Yosef Berman, Soo Go, Hoon Hong, Ilia Ilmer, Alexey Ovchinnikov, **Pedro Soto**, and Chee Yap. Robust parameter estimation for rational ordinary differential equations. In *Arxiv*, 2303.02159
- Helen Byrne, Heather Harrington, Alexey Ovchinnikov, Gleb Pogudin, Hamid Rahkooy, and **Pedro Soto**. Algebraic identifiability of partial differential equation models, 2024

Presentations

- Dual Entangled Polynomial Code: Three-Dimensional Coding for Distributed Matrix Multiplication, *International Conference on Machine Learning*, Long Beach, CA, June 2019.
- A Distributed Decoding Algorithm for Coded Matrix Multiplication, *International Symposium on Information Theory*, Paris, France, July 2019.
- Dual Entangled Polynomial Code: Three-Dimensional Coding for Distributed Matrix Multiplication, *CRA-WP Grad Cohort for URMD*, Austin, TX, March 2020.
- Straggler-free Coding for Concurrent Matrix Multiplications, *International Symposium on Information Theory*, Los Angeles, California, USA, June 2020
- Coded matrix chain multiplication, *2021 IEEE/ACM29th International Symposium on Quality of Service (IWQOS)*, Virtual Conference, June 2021.
- Lightweight Projective Derivative Codes for Compressed Asynchronous Gradient Descent, *International Conference on Machine Learning*, Baltimore, Maryland, July 2022.
- Quantile Formulation for Optimization under a Qualitative Risk Constraint, *IEEE Conference on Decision and Control (CDC)*, Cancun, Mexico, December 2022
- Robust Parameter Estimation, *Differential Algebra and Related Topics XI (DART)*, Queen Mary University of London, London, UK, June 2023
- Coded Distributed Batch Matrix Multiplication via an Additive Combinatorics Lens, *SIAM Conference on Applied Algebraic Geometry (AG23)* Eindhoven University of Technology, Eindhoven, The Netherlands July, 2023
- Lightweight Projective Derivative Codes for Compressed Asynchronous Gradient Descent*Special Session on Optimization, Machine Learning, and Digital Twins at the AMS 2024 Spring Eastern Sectional Meeting* Washington DC 2024
- Coded Distributed Batch Matrix Multiplication via an Additive Combinatorics Lens *AMS Special Session on Advances in Coding Theory at the Joint Mathematics Meetings (JMM) 2024*

Committees, Reviewing, and Professional Activity

- (Reviewer) (ICML) International Conference on Machine Learning (2022)
- (L-CSS) Control Systems Letters (2022) Reviewer
- (Reviewer) (CDC) Conference on Decision and Control (2022)
- (Reviewer) Advances in Applied Mathematics (2022)
- (Reviewer) Advances in Mathematics of Communications (2022)
- (Program Committee) (ICA3PP) International Conference on Algorithms and Architectures for Parallel

Processing (2023)
- (Organizer) Special Session on Tensor Algebra & Networks at the AMS 2024 Spring Eastern Sectional Meeting (2024)
- (Reviewer) (ISIT) International Symposium on Information Theory (2024)

Previous Research Experience

- **Department of Mathematics, Virginia Tech** — **Blacksburg, Virginia**
  Postoctoral Associate — *2023-2024*
  Currently performing research on applying algebraic coding theory to distributed computing, under the supervision of Dr. Gretchen Matthews.
- **Mathematical Institute, University of Oxford** — **Oxford, United Kingdom**
  Senior Postoctoral Scholar — *2022-2023*
  Performed research on Integrative Algebraic and Systems Biology, under the supervision of Dr. Heather Harrington and Dr. Julian Edwards, on the use of tensor decomposition for multi-omics data analysis.
- **The Taub Faculty of Computer Science, Technion** — **Haifa, Israel**
  Visiting Postdoctoral Researcher — *2022*
  Performed research on Distributed Coded computation under the supervision of Dr. Keren Censor-Hillel. We worked on extending her work on matrix multiplication on the clique model to include faulty nodes.
- **The Graduate Center at CUNY** — **New York, NY**
  Ph.D. researcher in coding theory, distributed computing, and its applications to ML — *2020-2022*
  Performed research, under the supervision of Dr. Jun Li, on generalizing coded distributed matrix multiplication to handle stragglers and other faults encountered in more general (multi)-linear computations such as tensor computations and machine learning algorithms in distributed systems.
- **School of Computing & Information Sciences, FIU** — **Miami, FL**
  Ph.D. researcher in coding theory and distributed computing — *2018-2020*
  Performed research, supervised by Dr. Jun Li, on the use of coded computation for matrix multiplication and machine learning algorithms in distributed systems.
- **School of Computing & Information Sciences, FIU** — **Miami, FL**
  Ph.D researcher in Quantitative Information Flow — *2017*
  Performed research, under the supervision of Dr. Geoffry Smith, into a new axiomatic foundation of cybersecurity centered around the concept of Bayes vulnerability, a generalization of g-leakage, which generalizes many of the traditional information measures (such as Shannon and Renyi entropy).
- **Department of Mathematics, University of Notre Dame** — **South Bend, Indiana**
  Undergraduate Research - Ramsey Theory (Combinatorics) — *2016*
  Performed research, under the guidance of Dr. David Galvin, in a sub-branch of combinatorics called Ramsey Theory, and investigated a conjecture made by Neil Hindman dealing with the algebraic properties of subsets of the natural numbers that are preserved when randomly painted with a finite collection of colors.
- **Department of Physics, Florida International University** — **Miami, FL**
  Undergraduate Research Assistant – Modern Physics Education — *2012-2014*
  Co-authored a manuscript which at the time was called "Modern Physics from an Undergraduate View" together with Farid Salazar and Josuan Calderon, based on a set of lecture notes of Dr. Rajamani Narayanan. Conducted advanced studies in theories of special relativity, wave mechanics, simple solid-state models, and quantum and statistical physics under the supervision of Dr. Rajamani Narayanan. The manuscript has now evolved into a textbook that is under contract to be published by the CRC press.

Teaching Experience

- **The Graduate Center at CUNY** — **New York, NY**
  Teaching Assistant — *2022*

  My task was to teach the students how to engage in research-level projects by teaching them how to read scientific articles, pose scientific hypotheses, and design experiments to test said hypotheses. I also taught the students how to effectively communicate their scientific results and helped the students learn many distributed systems concepts that I have acquired through my research experience.

- **School of Computing & Information Sciences, FIU** — **Miami, FL**
  Teaching Assistant — *2018-2020*

  Teach/Lead a programming lab/class where students learn basic programming in Java. I taught many students the basics of algorithms as well as low-level behavior of the Java virtual machine.

- **Wyzant, Inc** — **Miami, FL**
  Wyzant Tutor — *2016-2018*

  Worked as a private tutor where I tutored a variety of subjects such as Calculus I, II, III, Differential Equations, Discrete mathematics, Linear Algebra, Geometry, Algebra, and High School level Competition Mathematics.

- **Florida International University** — **Miami, FL**
  Teaching/Learning Assistant — *2012-2016*

  Duties included, but were not limited to helping teachers prepare lectures, grade assignments, and research-specific class topics of the following courses: Calculus I, Calculus II, Calculus III, Differential Equations, Linear Algebra, Introduction to Advanced Math, Finite Math, Discrete Math, College Algebra, Physics I, Physics I Lab, Physics II Lab, and Modern Physics.

Mentorships

- **Manuel Fernandez** — **Miami, FL**
  High School Student — *2014-2015*

- **Phillipe Dumeny** — **Miami, FL**
  High School Student — *2016-2019*

- **Angel Saldivia** — **Miami, FL**
  Undergraduate Student — *2020*

  - Co-authored paper: **Pedro Soto**, Xiaodi Fan, Angel Saldivia, and Jun Li. Rook coding for batch matrix multiplication. *IEEE Transactions on Communications*, 70(6):3641–3654, 2022

- **Yuhka Machino** — **Haifa, Israel**
  Undergraduate Student — *2022*

  - Coauthored paper: Keren Censor-Hillel, Yuka Machino, and **Pedro Soto**. Near-optimal fault tolerance for efficient batch matrix multiplication via an additive combinatorics lens. In *31st International Colloquium On Structural Information and Communication Complexity*, 2024
  - **Paper won best student award at SIROCCO 24.**

Technical Skills

- **Programming Languages:** Proficient in: C, C++, Python, Haskell, MPI, Java, and TeX
  Also basic ability with: SQL, Neo4J, Apache Spark, Maple, and Sage

Community Outreach and Other Professional Activity

- Presented my research at the *CRA-WP Grad Cohort for URMD* which is now called the CRA-WP IDEAL (Inclusion, Diversity, Equity, Accessibility, and Leadership Skills), Austin, TX, March 2020.
- Participated in the *MSRI Modern Math Workshop*, a workshop designed to encourage undergraduates from underrepresented minority groups to pursue careers in the mathematical sciences, and to build research and mentoring networks among undergraduates, graduate students, and recent PhDs
- Participated in the *SACNAS National Diversity in Stem Conference (NDiSTEM)*, which is dedicated to fostering the success of Chicanos/Hispanics and Native Americans, from college students to professionals, in attaining advanced degrees, careers, and positions of leadership in STEM.
- Participated in the *MSRI Summer Graduate School on Algebraic Theory of Differential and Difference Equations, Model Theory and their Applications*
- Participated in *Students Offering Support* at FIU, a non-profit tutoring service whose proceeds went to helping build infrastructure in developing countries.