ALEJANDRO PARADA-MAYORGA

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University of Pennsylvania
Department of Electrical and Systems Engineering
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RESEARCH INTERESTS

Signal processing, abstract harmonic analysis, algebraic signal processing, algebraic neural networks, applications of representation theory of algebras, category theory, graph signal processing, graph neural networks, and compressed sensing.

EDUCATION/TRAINING

Postdoctoral Researcher August 2019 - Present
University of Pennsylvania Philadelphia, PA, USA

- *Algebraic signal processing, algebraic neural networks (AlgNNs), convolutional learning on multigraphs, Lie group algebraic signal processing and convolutional architectures, graphon signal processing, stability of aggregation graph neural networks.* Mentor: Alejandro Ribeiro.

Ph.D. in Electrical Engineering July 2019
University of Delaware Newark, DE, USA

- Thesis: Blue Noise and Optimal Sampling on Graphs (advisor: Gonzalo Arce)

Master in Electrical Engineering May 2012
Industrial University of Santander Bucaramanga, Colombia

- Dissertation: Dynamic Tracking of Facial Expressions using DIP (advisor: Arturo Plata)

B.Sc. in Electrical Engineering (5 years diploma) June 2009
Industrial University of Santander Bucaramanga, Colombia

- Dissertation: Analysis of thermal distribution in iron by Eddy currents using FEM (advisor: Ernesto Aguilera)
- Additional courses: *Abstract Algebra, Real Analysis, Special functions and Complex Analysis, Set Theory, Mathematical Physics I (tensor analysis), Mathematical Physics II (PDE and special functions), Differential equations and dynamical systems.*

HONORS AND AWARDS

- Professional Development Award. University of Delaware April 2019
- National Science Foundation NSF #1815992. $ 300,000. "Blue-Noise Graph Sampling", University of Delaware. I contributed substantially in the preparation of this proposal, under the supervision of Gonzalo R. Arce. June 1 2018 - May 31 2021
- Signal Processing and Communications Graduate Faculty Award. ECE department, University of Delaware May 2018
- UDRF Strategic Initiative Award. "Efficient Design of Uniqueness Sets for Bandlimited Signals on Networks University of Delaware. I assisted Gonzalo R. Arce in the preparation of this proposal.Feb 2018
- Dissertation Fellowship Award. University of Delaware June 2018

- Colciencias Scholarship 617
  Scholarship for Ph.D studies sponsored by the government of Colombia 2014
- Scholarship for Master Studies
  Department of Electrical Engineering, Industrial University of Santander, Colombia. 2009
- Outstanding Student. Industrial University of Santander, Colombia 2003

APPOINTMENTS

- **Visitor Scholar**. Department of Electrical and Computer Engineering
  February 2013- June 2013. **University of Delaware**.

INVITED TALKS

- "Algebraic Neural Networks: Stability to Deformations". Invited seminar talk, CIS department seminar at **University of Delaware**, 2023.
- "Algebraic Neural Networks: Stability to Deformations". Invited seminar talk, CMSE department seminar at **Michigan State University**, 2023.
- "Algebraic Neural Networks: Stability to Deformations". Invited seminar talk, ESE department seminar at **Washington University in St. Louis**, 2023.
- "Algebraic Neural Networks: Stability to Deformations". Invited seminar talk, ECE department seminar at **Michigan State University**, 2022.
- "Algebraic Neural Networks: Stability to Deformations". Invited seminar talk, ECE department seminar at **University of Southern California**, 2022.
- "Algebraic Neural Networks: Stability to Deformations" (delivered by A. Ribeiro). Seminar *Physics meets Machine Learning* at **CERN**.

TEACHING EXPERIENCE

Lecturer/Instructor

- Department of Electrical and Computer Engineering, University of Pennsylvania.
  - Graph Neural Networks (ESE5140) ([CourseWebsite]) Fall 2022.
- Department of Electrical Engineering, Industrial University of Santander.
  - Digital Image Processing 2012
  - Signal Processing 2011-2012

Teaching Assistant

- *Teaching Material Development*. Department of Electrical and Computer Engineering, University of Pennsylvania.
  - Graph Neural Networks (ESE5140) Fall 2020.

  I prepared online educational resources for the course ESE5140 ([CourseWebsite]), taking the main lead in the section devoted to *algebraic signal processing* and *algebraic neural networks* .
- Department of Electrical and Computer Engineering, University of Delaware.
  - Computational Imaging Seminar (ELEG 667) Fall 2016
  - Foundations of Statistical Learning (ELEG 815) Fall 2016
  - Electronic Circuit Analysis II (ELEG312080) Fall 2017

  - Digital Imaging and Photography (ELEG404010) Spring 2018

- Department of Electrical Engineering, Industrial University of Santander.
  - Signals and Systems 2007-2008
  - Digital Signal Processing. 2008-2009

RESEARCH EXPERIENCE BEFORE THE PH.D.

- **Industrial University of Santander** (Colombia), Department of Electrical Engineering
  - **Computational Electromagnetism** (June 2009). Mathematical modeling and simulation of heating in ferromagnetic materials induced by eddy currents: I provided the numerical and mathematical analysis of this problem in rectangular and cubic geometries using the Finite Elements Method (FEM) and developed code for simulation purposes. [pdf]
  - **Image Processing and Nonlinear Dimensionality Reduction** (December 2012). Dynamic tracking of facial expressions: I analyzed the problem of automatic tracking of facial expressions using image processing techniques, manifold analysis of data and nonlinear dimensionality reduction. [pdf]
- **University of Delaware** (USA), Department of Electrical Engineering
  - **Computational Imaging and Compressed Sensing** (Spring 2013): I provided the mathematical analysis necessary to state spectral resolution limits in CASSI systems and provided numerical and experimental results proving the hypothesis stated. [pdf]

PUBLICATIONS

Preprints

1. **A. Parada-Mayorga**, Z. Wang, and A. Ribeiro, "Graphon Pooling for Reducing Dimensionality of Signals and Convolutional Operators on Graphs", (submitted to IEEE-TSP, under review). [2022] [pdf]
2. Butler, L., **Parada-Mayorga, A.**, and Ribeiro, A. Learning with Multigraph Convolutional Filters. (**accepted**, ICASSP 2023) [conference paper] (**equal contribution**).[2022] [pdf]
3. Kumar, H., **Parada-Mayorga, A.**, and Ribeiro, A. Algebraic Convolutional Filters on Lie Group Algebras. (**accepted**, ICASSP 2023) [conference paper]. [2022] [pdf]
4. L. Butler, **A. Parada-Mayorga**, and A. Ribeiro, "Convolutional Learning on Multigraphs", (**accepted** to IEEE-TSP, under review, **equal contribution**). [2022] [pdf]
5. **A. Parada-Mayorga**, Z. Wang, F. Gamma and A. Ribeiro, "Stability of Aggregation Graph Neural Networks", (submitted to IEEE-TSPIN, under review). [2022][pdf]
6. **A. Parada-Mayorga**, L. Butler and A. Ribeiro, "Convolutional Filtering and Neural Networks with Non Commutative Algebras", (submitted to IEEE-TSP, under review). [2022] [pdf]
7. **A. Parada-Mayorga**, H. Riess, A. Ribeiro and R. Ghrist, "Quiver Signal Processing (QSP)", (https://arxiv.org/abs/2010.11525). [2021] [pdf]

Journal papers

1. **A. Parada-Mayorga** and A. Ribeiro, "Algebraic Neural Networks: Stability to Deformations," in IEEE Transactions on Signal Processing, vol. 69, pp. 3351-3366, doi: 10.1109/TSP.2021.3084537. [2021] [pdf]

2. D.L. Lau, G. R. Arce, **A. Parada-Mayorga**, D. Dapena, K. Pena-Pena, "Blue-Noise Sampling of Graph and Multigraph Signals", Special Issue of the IEEE Signal Processing Magazine On Graph Signal Processing: Foundations and Emerging Directions. [2020][pdf]

3. **A. Parada-Mayorga**, D. Lau, Jhony H. Giraldo and G.R. Arce, "Blue-Noise Sampling on Graphs". IEEE Transactions on Signal and Information Processing over Networks. [2019][pdf]

4. E. Salazar, **A. Parada-Mayorga** and G.R. Arce, "Spectral Zooming and Resolution Limits of Spatial Spectral Compressive Spectral Imagers". IEEE Transactions on Computational Imaging. [2019][pdf]

5. **A. Parada-Mayorga** and G. R. Arce, "Colored Coded Aperture Design in Compressive Spectral Imaging via Minimum Coherence," in IEEE Transactions on Computational Imaging, vol. 3, no. 2, pp. 202-216. doi: 10.1109/TCI.2017.2692649. [2017][pdf]

6. **A. Parada-Mayorga** and G.R. Arce, "Spectral Super-Resolution in Colored Coded Aperture Spectral Imaging," in IEEE Transactions on Computational Imaging, vol. 2, no. 4, pp. 440-455. doi: 10.1109/TCI.2016.2612943. [2016][pdf]

7. Rueda, H. F, **Parada, A**, & Arguello, H. "Spectral resolution enhancement of hyperspectral imagery by a multiple-aperture compressive optical imaging system". Ingeniería e Investigación. https://dx.doi.org/10.15446/ing.investig.v34n3.41675. [2014] [pdf]

Conference Papers

1. **A. Parada-Mayorga** and A. Ribeiro, "Stability of Algebraic Neural Networks to Small Perturbations", ICASSP. [2021] [pdf]

2. **A. Parada-Mayorga**, L. Ruiz and A. Ribeiro, " Graphon Pooling in Graph Neural Networks", EUSIPCO. [2020][pdf]

3. **A. Parada-Mayorga**, D. Lau, J. Giraldo, G. Arce, "Blue-Noise Sampling of Signals on Graphs", International Conference on Sampling Theory and Applications (SampTA), Bordeaux. [2019] [pdf]

4. **A. Parada-Mayorga**, D. Lau, J. Giraldo, G. Arce, "Sampling of Graph Signals with Blue Noise dithering", IEEE data Science Workshop, Minneapolis, Minnesota. [2019][pdf]

5. D. Guillot, **A. Parada-Mayorga**, S. Cioaba, G. Arce, "Optimal Sampling Sets in Cographs", IEEE data Science Workshop, Minneapolis, Minnesota. [2019][pdf]

6. E. Salazar, **A. Parada-Mayorga** and G.R. Arce, "Spectral zooming in SSCSI Compressive Spectral Imagers". OSA Imaging and Applied Optics Congress. [2018][pdf]

7. E. Salazar, **A. Parada-Mayorga** and G.R. Arce, "Spatial Super-resolution reconstruction via SSCSI Compressive Spectral Imagers". OSA Imaging and Applied Optics Congress. [2018] [pdf]

8. **A. Parada-Mayorga**, A. Cuadros and G.R. Arce, "Coded Aperture Design for Compressive X-ray Tomosynthesis via Coherence Analysis". IEEE International Symposium on Biomedical Imaging. Melbourne, Australia. [2017] [pdf]

9. **A. Parada Mayorga**, G.R. Arce, "Spectral Super-Resolution in Colored Coded Aperture Spectral Imaging," in Imaging and Applied Optics 2015, OSA Technical Digest (online) (Optical Society of America), paper CTh2E.2. [2015] [pdf]

10. H. Rueda, **A. Parada**, H. Arguello, Y. Wu, D. Prather, and G.R. Arce, "Demonstration of a Higher-Order Discretization Model for Compressive Spectral Imaging," in Imaging and Applied Optics, OSA Technical Digest (online) (Optical Society of America), paper CM4C.4. [2013][pdf]

11. H. Arguello, **A. Parada**, G.R. Arce; "Optimization of pseudorandom coded apertures for compressive spectral imaging". Proc. SPIE 8717, Compressive Sensing II, 87170D. [2013] [pdf]

12. **A. Parada-Mayorga** and A. Plata. "Fast Object Detection using Colour Segmentation". ISSN: 2145-812X. *Tercer Congreso Internacional de Ingeniería Mecatrónica. Bucaramanga.* [2011] [pdf]

13. **A. Parada-Mayorga** and A. Plata. "A New Facial Point Detector using Active Appearance Models". ISSN: 2145-812X. *Tercer Congreso Internacional de Ingeniería Mecatrónica. Bucaramanga.* [2011] [pdf]

Master Thesis

- Dynamic Tracking of Facial Expressions using Digital Image Processing. Industrial University of Santander, 2012. [pdf]

Bsc. Thesis

- Analysis of the Thermal Distribution in Iron by Eddy currents, using the Finite Element Method. Industrial University of Santander, 2009. [pdf]

PROFESSIONAL SERVICE

Reviewer for the following Journals

- IEEE transactions on Image Processing — January 2018-Present
- IEEE transactions on Computational Imaging — January 2018-Present
- IEEE Signal Processing Letters — January 2019-present
- IEEE transactions on Signal Processing — January 2019-present
- IEEE transactions of Signal and Information Processing over Networks — January 2020-present

Reviewer for the following conferences

- 13th International conference on sampling theory and applications — Bordeaux, France. 2019
- 26th European Signal Processing Conference EUSIPCO 2018 — Rome, Italy. 2018

MENTORED STUDENTS

- Harshat Kumar. Ph.D student mentored at **University of Pennsylvania**.
- Zhiyang Wang. Ph.D student mentored at **University of Pennsylvania**.
- Landon Butler. Master student mentored at **University of Pennsylvania**.
- Arda Can Genc. Summer student mentored at **University of Pennsylvania**.
- Edgar Salazar. Ph.D student mentored at **University of Delaware**.
- Daniela Dapena. Ph.D student mentored at **University of Delaware**.
- Ruben Cordoba. Summer student mentored at **University of Delaware**.
- Juan Lopez. Summer student mentored at **University of Delaware**.

LANGUAGES

- English: Full professional proficiency.
- Spanish: Native or bilingual proficiency.