

Mario Diaz

Research Associate C

Instituto de Investigaciones en Matemáticas Aplicadas y en Sistemas (IIMAS)
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Education

Degree: **Ph.D. Mathematics and Statistics (2013 - 2017)**
 Institution: Queen's University, Kingston, Canada
 Advisors: James Mingo and Serban Belinschi
 Thesis: *Global Fluctuations of Random Matrices and the Second-Order Cauchy Transform*

Degree: **M.Sc. Probability and Statistics (2011 - 2013)**
 Institution: Centro de Investigación en Matemáticas (CIMAT), Guanajuato, Mexico
 Advisor: Víctor Pérez-Abreu
 Thesis: *Analysis of the Asymptotic Spectra of Multiantenna Channels via Free Probability*

Degree: **B.Eng. Electronics and Communications (2006 - 2011)**
 Institution: Universidad de Guadalajara, Guadalajara, Mexico
 Advisor: Víctor Pérez-Abreu
 Thesis: *Analysis of the Asymptotic Ergodic Spectral Efficiency of MIMO Systems*

Academic Experience

Postdoctoral Researcher

Centro de Investigación en Matemáticas, Mexico 2018 - 2019
 Worked on theoretical machine learning, data privacy and random matrices

Joint Postdoctoral Scholar

Arizona State University (ECEE) & Harvard University (SEAS), U.S. 2017 - 2018
 Worked on the mathematical and statistical theory of data privacy

National System of Researchers (SNI) Research Assistant

Centro de Investigación en Matemáticas, Mexico 2009 - 2011
 Worked on the analysis of the asymptotic ergodic capacity of multiantenna wireless systems

Research Assistant

Institute of Robotics and Intelligent Systems, Universidad de Guadalajara, Mexico 2008 - 2009
 Worked on non-asymptotic improvements to motion planning algorithms

Research Interests

My research interests lie on the intersection of information theory, probability, and statistics. My work mainly focuses on data privacy, theoretical machine learning, and random matrices.

Publications

Journal Papers

1. M. Diaz and J. Mingo. "On the analytic structure of second-order non-commutative probability spaces and functions of bounded Fréchet variation." *Random Matrices: Theory and Applications*, vol. 12, no. 1, Art. No. 2250044, 2023. [DOI:10.1142/S2010326322500447](https://doi.org/10.1142/S2010326322500447)
2. M. Diaz, A. Jaramillo and J.C. Pardo. "Fluctuations for matrix-valued Gaussian processes." *Annales de l'Institut Henri Poincaré (B) Probabilités et Statistiques*, vol. 58, no. 4, pp. 2216 – 2249, 2022. [DOI:10.1214/21-AIHP1238](https://doi.org/10.1214/21-AIHP1238)

3. T. Sypherd, M. Diaz, J. Cava, G. Dasarathy, P. Kairouz and L. Sankar. "A tunable loss function for robust classification: calibration, landscape, and generalization." *IEEE Transactions on Information Theory*, vol. 68, no. 9, pp. 6021 – 6051, 2022. [DOI:10.1109/TIT.2022.3169440](https://doi.org/10.1109/TIT.2022.3169440)
4. H. Wang, H. Hsu, M. Diaz and F. Calmon. "To split or not to split: The impact of disparate treatment in classification." *IEEE Transactions on Information Theory*, vol. 67, no. 10, pp. 6733 – 6757, 2021. [DOI:10.1109/TIT.2021.3075415](https://doi.org/10.1109/TIT.2021.3075415)
5. M. Diaz, H. Wang, F. P. Calmon and L. Sankar. "On the robustness of information-theoretic privacy measures and mechanisms." *IEEE Transactions on Information Theory*, vol. 66, no. 4, pp. 1949 – 1978, 2020. [DOI:10.1109/TIT.2019.2939472](https://doi.org/10.1109/TIT.2019.2939472)
6. M. Diaz, J. Mingo and S. Belinschi. "On the global fluctuations of block Gaussian matrices." *Probability Theory and Related Fields*, vol. 176, no. 1 – 2, pp. 599 – 648, 2020. [DOI:10.1007/s00440-019-00925-1](https://doi.org/10.1007/s00440-019-00925-1)
7. S. Asoodeh, M. Diaz, F. Alajaji and T. Linder. "Estimation efficiency under privacy constraints." *IEEE Transactions on Information Theory*, vol. 65, no. 3, pp. 1512 – 1534, 2019. [DOI:10.1109/TIT.2018.2865558](https://doi.org/10.1109/TIT.2018.2865558)
8. M. Diaz and V. Pérez-Abreu. "On the capacity of block multi-antenna channels." *IEEE Transactions on Information Theory*, vol. 63, no. 8, pp. 5286 – 5298, 2017. [DOI:10.1109/TIT.2017.2712711](https://doi.org/10.1109/TIT.2017.2712711)
9. S. Asoodeh, M. Diaz, F. Alajaji and T. Linder. "Information extraction under privacy constraints." *Information*, vol. 7, no. 1, Art. no. 15, 2016. [DOI:10.3390/info7010015](https://doi.org/10.3390/info7010015)

Conference Papers

1. L. Monteiro, R. Cruz, F. Calmon and M. Diaz. "On the inevitability of the Rashomon effect." *Proceedings of the IEEE International Symposium on Information Theory*, pp. 549 – 554, 2023.
2. M. Diaz, P. Kairouz, J. Liao and L. Sankar. "Neural network-based estimation of the MMSE." *Proceedings of the IEEE International Symposium on Information Theory*, pp. 1023 – 1028, 2021. [DOI:10.1109/ISIT45174.2021.9518063](https://doi.org/10.1109/ISIT45174.2021.9518063)
3. H. Wang, H. Hsu, M. Diaz and F. P. Calmon. "The impact of split classifiers on group fairness." *Proceedings of the IEEE International Symposium on Information Theory*, pp. 3179 – 3184, 2021. [DOI:10.1109/ISIT45174.2021.9517723](https://doi.org/10.1109/ISIT45174.2021.9517723)
4. S. Asoodeh, M. Diaz and F. Calmon. "Privacy amplification of iterative algorithms via contraction coefficients." *Proceedings of the IEEE International Symposium on Information Theory*, pp. 896 – 901, 2020. [DOI:10.1109/ISIT44484.2020.9174133](https://doi.org/10.1109/ISIT44484.2020.9174133)
5. T. Sypherd, M. Diaz, L. Sankar and G. Dasarathy. "On the α -loss landscape in the logistic model." *Proceedings of the IEEE International Symposium on Information Theory*, pp. 2718 – 2723, 2020. [DOI:10.1109/ISIT44484.2020.9174356](https://doi.org/10.1109/ISIT44484.2020.9174356)
6. T. Sypherd, M. Diaz, L. Sankar and P. Kairouz. "A tunable loss function for binary classification." *Proceedings of the IEEE International Symposium on Information Theory*, pp. 2479 – 2483, 2019. [DOI:10.1109/ISIT.2019.8849796](https://doi.org/10.1109/ISIT.2019.8849796)
7. H. Wang, M. Diaz, JCS Santos Filho and F. P. Calmon. "An information-theoretic view of generalization via Wasserstein distance." *Proceedings of the IEEE International Symposium on Information Theory*, pp. 577 – 581, 2019. [DOI:10.1109/ISIT.2019.8849359](https://doi.org/10.1109/ISIT.2019.8849359)
8. H. Wang, M. Diaz, F. P. Calmon and L. Sankar. "The utility cost of robust privacy guarantees." *Proceedings of the IEEE International Symposium on Information Theory*, pp. 706 – 710, 2018. [DOI:10.1109/ISIT.2018.8437735](https://doi.org/10.1109/ISIT.2018.8437735)
9. S. Asoodeh, M. Diaz, F. Alajaji and T. Linder. "Privacy-aware guessing efficiency." *Proceedings of the IEEE International Symposium on Information Theory*, pp. 754 – 758, 2017. [DOI:10.1109/ISIT.2017.8006629](https://doi.org/10.1109/ISIT.2017.8006629)
10. M. Diaz. "On the symmetries and the capacity achieving input covariance matrices of multi-antenna channels." *Proceedings of the IEEE International Symposium on Information Theory*, pp. 1073 – 1077, 2016. [DOI:10.1109/ISIT.2016.7541464](https://doi.org/10.1109/ISIT.2016.7541464)

Preprints

1. J. Perusquía, M. Diaz and R. Mena. "On a divergence-based prior analysis of stick-breaking processes." [arXiv:2308.11868](https://arxiv.org/abs/2308.11868)

2. S. Asoodeh and M. Diaz. "Privacy loss of noisy stochastic gradient descent might converge even for non-convex losses." [arXiv:2305.09903](https://arxiv.org/abs/2305.09903)
3. M. Diaz, P. Kairouz and L. Sankar. "Lower bounds for the minimum mean-square error via neural network-based estimation." [arXiv:2108.12851](https://arxiv.org/abs/2108.12851)

Citations. Currently my Google Scholar profile has [454 citations](#) and an [h-index of 10](#).

Awards

1. Principal Investigator of PAPIIT Project IN103224, Mexico 2024 – 2025 (\$102,000 MXN up to date) Desigualdades de procesamiento de la información no lineales y sus aplicaciones en privacidad
2. Level I Member of the National System of Researchers (SNI), Mexico 2022
3. Principal Investigator of PAPIIT Project IA101021, Mexico 2021 – 2022 (\$147,767 MXN) Estimación de medidas de divergencia: límites fundamentales e implicaciones en privacidad
4. Candidate Member of the National System of Researchers (SNI), Mexico 2019
5. Nominated by Queen's University for the 2018 *Canadian Mathematical Society (CMS) Doctoral Prize* Each Canadian university nominates at most one doctoral student for this outstanding performance award
6. *Ontario Trillium Scholarship*, Canada 2013 - 2017
Only 75 of these scholarships are awarded every year in the whole province of Ontario
7. *Science and Technology National Council (CONACYT) Graduate Scholarship*, Mexico 2011 - 2013
8. *National System of Researchers (SNI) Undergraduate Research Assistantship*, Mexico 2009 - 2011

Teaching Experience

Lecturer

- Aprendizaje de Máquina Teórico. Universidad Nacional Autónoma de México, 2020/21/22/24
- Inferencia Estadística. Universidad Nacional Autónoma de México, 2023
- Fundamentos Estadísticos de Privacidad. Universidad Nacional Autónoma de México, 2022/23
- Teoría de la Información y Estadística. Universidad Nacional Autónoma de México, 2021
- Teoría Matemática para Aprendizaje Máquina. Universidad de Guanajuato, 2019
- Matrices Aleatorias: Teoría y Aplicaciones Contemporáneas¹. CIMAT, 2018

Past Students

1. Flores López, Ricardo (M.Sc. Math., UNAM, January 2024)
2. Cruz Flores, Christian Rodrigo (M.Sc. Math., UNAM, November 2022)
3. Barrera Hernández, Diego Adrián (B.Sc. Math., UNAM, September 2022)
4. Caudillo Amador, Diego de Jesús (M.Sc. Prob. & Stats., CIMAT, November 2019)
5. Tavarez Rodríguez, Judith (M.Sc. Prob. & Stats., CIMAT, August 2019)
6. Madrid Padilla, Carlos Misael² (B.Sc. Math., Universidad de Guanajuato, June 2019)

Most Relevant Conferences and Workshops Attended

1. *XIV Symposium of Probability and Stochastic Processes*. Guanajuato, Mexico 2023
Invited Talk: Analysis of private machine learning models via couplings and contraction
2. *Seminario Interinstitucional de Matrices Aleatorias (SIMA)*. Mazatlán, Mexico 2023
Invited Talk: Método de Stein en probabilidad libre
3. *XVI Latin American Congress of Probability and Mathematical Statistics (CLAPEM)*. São Paulo, Brazil 2023
Contributed Talk: A brief introduction to differential privacy
4. *Information-Theoretic Methods for Trustworthy Machine Learning*. Berkeley, U.S. 2023
Contributed Talk: Contraction of Markov kernels and differential privacy I

¹ Jointly with V. Pérez Abreu and C. Vargas

² Jointly with V. Pérez Abreu

5. *Information Theory and Applications Workshop (ITA)*. San Diego, U.S. 2023
Contributed Talk: Differential privacy as contraction of f-divergences
6. *55 Congreso Nacional de la SMM*. Online Event 2022
Invited Talk: Mecanismos privatizantes como mapas contractivos
7. *Congreso Nacional de Matemática Aplicada e Computacional (CNMAC)*. Online Event 2022
Invited Talk: A geometric perspective to local differential privacy and its applications
8. *Seminario Interinstitucional de Matrices Aleatorias (SIMA)*. Guanajuato, Mexico 2022
Invited Talk: On the analytic structure of second-order non-commutative probability spaces
9. *International Symposium on Information Theory (ISIT)*. Aalto, Finland 2022
Tutorial: Information-theoretic tools for responsible machine learning
10. *XX Escuela de Probabilidad y Estadística*. Online Event 2022
Mini course: Una introducción a la privacidad
11. *Workshop on Information-Theoretic Methods for Rigorous, Responsible, and Reliable ML*. Online Event 2021
Contributed Talk: Neural network-based estimation of the MMSE
12. *International Symposium on Information Theory (ISIT)*. Online Event 2021
Contributed Talk: Neural network-based estimation of the MMSE
13. *Bernoulli-IMS One World Symposium 2020*. Online Event 2020
Contributed Talk: Data-Driven MMSE estimation: theoretical guarantees for model auditing
14. *Taller de Matemáticas para Aprendizaje de Máquinas*. Guanajuato, Mexico 2020
Mini course: Elements of statistical learning
15. *XV Latin American Congress of Probability and Mathematical Statistics (CLAPEM)*. Merida, Mexico 2019
Invited Talk: Analysis of artificial neural networks: old and new random matrix theory perspectives
16. *I Taller Inter-institucional de Ciencia de Datos e Inteligencia Artificial*. Puebla, Mexico 2019
Invited Talk: Garantías teóricas de algunas metodologías de aprendizaje máquina
17. *52 Congreso Nacional de la SMM*. Monterrey, Mexico 2019
Invited Talk: Garantías teóricas de algunos métodos de aprendizaje máquina en privacidad
18. *Taller Conjunto de Deep Learning y Ciencia de Datos CIMAT - INAOE*. Guanajuato, Mexico 2019
Invited Talk: A tunable loss function for classification
19. *Applications to Random Matrices and Free Probability of Free NC Functions*. Toronto, Canada 2019
Invited Talk: Deep linear neural networks: a free probabilistic approach
20. *Free Probability: the Applied Perspective*. Montreal, Canada 2019
Invited Talk: Utility cost of additive privacy mechanisms and eigenvalue gaps of sample covariance matrices
21. *Inter-institutional Seminar on Random Matrices (SIMA)*. Guanajuato, Mexico 2018
Mini course: Some occurrences of random matrix theory in information theory
22. *International Symposium on Information Theory (ISIT)*. Vail, U.S. 2018
Contributed Talk: The utility cost of robust privacy guarantees
23. *Information Theory and Applications Workshop (ITA)*. San Diego, U.S. 2018
Invited Talk: Robust privacy guarantees for privacy-utility trade-offs
24. *XIII Symposium of Probability and Stochastic Processes*. Mexico City, Mexico 2017
Invited Talk: A new approach to the CLT for the linear statistics of random matrices
25. *Inter-institutional Seminar on Random Matrices (SIMA)*. Guanajuato, Mexico 2017
Invited Talk: Matricial second-order conditional expectations
26. *Mathematical Congress of the Americas (MCA)*. Montreal, Canada 2017
Invited Talk: A new application of free probability theory: data privacy
27. *Canadian Ann. Symp. on Operator Algebras and Their Apps. (COSy)*. Thunder Bay, Canada 2017
Invited Talk: On the fluctuations of block Gaussian matrices
28. *21st International ITG Workshop on Smart Antennas*. Berlin, Germany 2017
Invited Talk: Random operator-valued models: combining stochastic and algebraic models
29. *Analytic versus Combinatorial in Free Probability*. Banff International Research Station, Canada 2016
Invited Talk: On the fluctuations of polynomials in Gaussian matrices

30. *Complex Analysis and Noncommutative Functions*. Toulouse, France 2016
31. *International Symposium on Information Theory (ISIT)*. Barcelona, Spain 2016
Contributed Talk: On the symmetries and the CAICM of multiantenna channels
32. *Canadian Ann. Symp. on Operator Algebras and Their Apps. (COSy)*. Montreal, Canada 2016
33. *Great Plains Operator Theory Symposium (GPOTS)*. Urbana-Champaign, U.S. 2016
34. *Canadian Ann. Symp. on Operator Algebras and Their Apps. (COSy)*. Waterloo, Canada 2015
35. *Inter-institutional Seminar on Random Matrices (SIMA)*. Guanajuato, Mexico 2015
Invited Talk: Free probability based optimizations: capacity of multiantenna communication systems
36. *Conference on Stochastic Processes and their Applications (SPA)*. Buenos Aires, Argentina 2014
Contributed Talk: On an operator-valued free probability based model for systems with block dynamics
37. *Free Probability Concentration Week*. College Station, U.S. 2014
38. *Workshop on Risk Analysis in Economics and Finance*. Guanajuato, Mexico 2013
39. *Random Matrices School (EMA)*. Guanajuato, Mexico 2012
Invited Talk: Marchenko-Pastur law and multiantenna communications
40. *Workshop on Solutions to Industrial Problems*. Guanajuato, Mexico 2012
41. *Inter-institutional Seminar on Random Matrices (SIMA)*. Guanajuato, Mexico 2011
Invited Talk: Some numerical aspects of the Stieltjes transform: correlated MIMO systems
42. *National Conference and International Conference in Computer Science ANIEI*. Jalisco, Mexico 2010
43. *Summer Research Program*. Guanajuato, Mexico, 2010
44. *Inter-institutional Seminar on Random Matrices (SIMA)*. Guanajuato, Mexico 2010
Invited Talk: Correlated MIMO systems
45. *Inter-institutional Seminar on Random Matrices (SIMA)*. Guanajuato, Mexico 2009
Invited Talk: Random Matrices: An Application to Wireless Communication (Multiuser Detection)
46. *Summer Program in Probability and Statistics*. Guanajuato, Mexico 2009
47. *Summer Research Program*. Guanajuato, Mexico, 2009
48. *Stochastic Methods and Dynamical Systems*. Guanajuato, Mexico 2009
49. *Workshop on Solutions to Probability Problems: Second Phase*. Yucatan, Mexico 2008
50. *Workshop on Solutions to Probability Problems: First Phase*. Guanajuato, Mexico 2008
51. *National Conference and International Conference in Computer Science ANIEI*. Chihuahua, Mexico 2007
52. *Workshop on Solutions to Calculus Problems*. Guanajuato, Mexico 2007

Seminar and Colloquium Talks

Seminar and colloquium talks given at

- Arizona State University (U.S.)
- Centro de Investigación en Matemáticas (Mexico)
- Huawei's Mathematical and Algorithmic Sciences Lab (France)
- Institut de Mathématiques de Toulouse (France)
- Instituto Politécnico Nacional (Mexico)
- Texas A&M University (U.S.)
- Universidad Autónoma de Nuevo León (Mexico)
- Universidad Autónoma de San Luis Potosí (Mexico)
- Universidad Autónoma de Sinaloa (Mexico)
- Universidad Autónoma Metropolitana (UAM)
- Universidad de Guadalajara (Mexico)
- Universität des Saarlandes (Germany)
- Queen's University (Canada)

Miscellaneous Academic Activities

Reviewer³ for

- ALEA Latin American Journal of Probability and Mathematical Statistics
- AMS Mathematical Reviews
- Conference on Geometric Science of Information
- Conference on Neural Information Processing Systems
- EURASIP Journal on Wireless Communications and Networking
- Foro Nacional de Estadística
- IEEE Communications Letters
- IEEE Information Theory Workshop
- IEEE International Symposium on Information Theory
- IEEE Journal on Selected Areas in Information Theory
- IEEE Transactions on Information Forensics and Security
- IEEE Transactions on Information Theory
- Information and Inference: A Journal of the IMA
- International Symposium on Information Theory and Its Applications
- Temas de Ciencia y Tecnología

Organizer of the Information Theory, Machine Learning and Statistics Seminar
Universidad Nacional Autónoma de México, Mexico 2020 - 2024

Co-organizer of the Mini-encuentro de Análisis Matemático y Temas Relacionados
Universidad Nacional Autónoma de México, Mexico 2023

Co-organizer of the Non-Commutative Analysis Seminar
Universidad Nacional Autónoma de México, Mexico 2020 - 2022

Co-organizer of the Inter-institutional Seminar on Random Matrices (SIMA)
Centro de Investigación en Matemáticas, Mexico 2019

Organizer of the MAPLe Seminar (Matrices Aleatorias y Probabilidad Libre)
Centro de Investigación en Matemáticas, Mexico 2019

Co-organizer of the XVII School of Probability and Statistics
Centro de Investigación en Matemáticas, Mexico 2019

Coordinator of the Math & Stats Graduate Seminar⁴
Queen's University, Canada 2015 - 2016

Organizer of a series of mini courses on probability, statistics and related topics given by graduate students
Centro de Investigación en Matemáticas, Mexico 2013

Lecturer of a mini course on Coding Theory
CUCEI Universidad de Guadalajara, Mexico 2011

Coach of the CUCEI Universidad de Guadalajara's programming contest teams
Universidad de Guadalajara, Mexico 2008 - 2011

TopCoder rating⁵: 1351, 2009. Profile: <https://www.topcoder.com/members/Cumbias/>

Coach of the Jalisco team for the Mexican Mathematical Olympiad (high school)
Jalisco, Mexico 2006 - 2008

Most Relevant Results in Academic Contests

1. *Mexico and Central America ACM ICPC Programming Contest*, Mexico 2010. **Sixth Place**
Among approximately 80 teams from Mexico and Central America

³ [AMS Mathematical Reviews](#); [Web of Science Peer Reviews](#).

⁴ Additional events organized: Research at MAST, Christmas Talks 2015, and Christmas Talks 2016.

⁵ TopCoder is a company which organizes online computer programming competitions.

2. *ANIEI Programming Contest*, Mexico 2010. **First Place**
Among approximately 30 teams from Mexico
3. *National Math Contest "Pierre Fermat"*, Mexico 2008. **Finalist**
On-site final in a nationwide competition
4. *World Finals ACM ICPC Programming Contest*, Canada 2008. **Honorable Mention**
Among approximately 100 teams from all around the world
5. *Mexico and Central America ACM ICPC Programming Contest*, Mexico 2007. **First Place**
Among approximately 80 teams from Mexico and Central America
6. *ANIEI Programming Contest*, Mexico 2007. **First Place**
Among approximately 10 teams from Mexico
7. *Universidad de Guadalajara Calculus Tournament*, Mexico 2007. **First Place**
Campuswide competition
8. *Historical Essay Contest "Vida y Obra de Benito Juárez"*, Mexico 2006. **First Place**
Among all the high schools in the city
9. *XIX Mexican Mathematical Olympiad*, Mexico 2005. **Second Place**
Among approximately 200 contestants from Mexico
10. *XV National Contest in Physical Devices and Experiments*, Mexico 2005. **Participant**
Among approximately 40 teams from Mexico

Computer Skills

Languages: C/C++, MatLab, R, Python.

Applications: LaTeX, MS Office, Simulink.

Languages

Spanish: native speaker.

English: good command.

Last Update: March 2024