# Kevin Bello

*Curriculum Vitae*

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## Research Interests

- Causal machine learning: Causal discovery and causal representation learning
- Statistical machine learning: structured prediction, learning theory
- Convex and non-convex optimization
- Robustness, interpretability, and fairness
- Applications in neuroscience, genomics, finance, vision, language

## Positions

Sept. 2021– **NSF Computing Innovation Fellow (Postdoctoral Researcher)**.
Machine Learning Department, Carnegie Mellon University *Mentor: Pradeep Ravikumar*
Booth School of Business, University of Chicago *Mentor: Bryon Aragam*

Summer 2020 **Research Intern**, *Facebook AI*, Integrity Team, Seattle, WA.

Summer 2019 **Research Intern**, *Facebook AI*, Ads Ranking Team, Palo Alto, CA.

## Education

2016 – 2021 **Ph.D. in Computer Science**, *Purdue University*, USA.
Bilsland Dissertation Fellowship
*Thesis: "Structured Prediction: Statistical and Computational Guarantees in Learning and Inference"*
*Advisor: Jean Honorio*

2009 – 2014 **B.Sc. in Mechatronics Engineering (Robotics)**, *Universidad Nacional de Ingenieria*, Peru.
*Summa Cum Laude*
*Presidente Manuel Pardo y Lavalle Prize*

## Honors and Awards

1. **DAAD AI-net Fellowship** 2023
   *DAAD's support of an individual two-week networking visit to German institutions, and membership in the DAAD AI-net Fellows and Alumni Network.*
2. NeurIPS Scholar Award 2018, 2019, 2022
3. **NSF Computing Innovation Fellowship** 2021
   *Prestigious award given by the Computing Research Association and Computing Community Consortium to support two-year postdoctoral positions*
4. **Bilsland Dissertation Fellowship** 2021
   *Competitive award given to the most outstanding students at Purdue University*
5. Grant to participate in the Machine Learning Summer School, Kyoto University 2015

6. Highest accumulated GPA of my class, Universidad Nacional de Ingenieria 2014
7. Dean's list, Universidad Nacional de Ingenieria 2010 – 2014
8. Peruvian Council of Science and Technology (Concytec) research grant 2013
9. **Presidente Manuel Pardo y Lavalle Prize** 2012
   *Highest honor given to undergraduates at Universidad Nacional de Ingenieria*
10. University of Chile's grant to attend the *1st Latin American Theoretical Informatics School* 2012
11. 2nd Place in the national programming competition IEEExtreme - INTERCON, Peru 2012

## Publications

Note: * *denotes equal contribution*

### Preprints and working papers

[1] V. Malik, **K. Bello**, A. Ghoshal and J. Honorio. "Identifying Causal Changes Between Linear Structural Equation Models". Under Review at ICML 2024.

[2] T. Chen, **K. Bello**, F. Locatello, B. Aragam, and P. Ravikumar. "Identifying General Mechanism Shifts in Linear Causal Representations". Under Review at ICML 2024.

[3] A. Bagheri, M. Pasande, **K. Bello**, A. Akhondi-Asl and B. N. Araabi. "Bayesian Dynamic DAG Learning: Application in Discovering Dynamic Effective Connectome of Brain". ArXiv:2309.07080.

[4] A. Ghoshal, **K. Bello** and J. Honorio. "Direct Learning with Guarantees of the Difference DAG Between Structural Equation Models". ArXiv: 1906.12024.

### Peer-reviewed conferences

[5] T. Chen, **K. Bello**, B. Aragam and P. Ravikumar. "iSCAN: Identifying Causal Mechanism Shifts among Nonlinear Additive Noise Models". *Neural Information Processing Systems* ***(NeurIPS)***, 2023.

[6] C. Deng, **K. Bello**, B. Aragam and P. Ravikumar. "Global Optimality in Bivariate Gradient-based DAG Learning". *Neural Information Processing Systems* ***(NeurIPS)***, 2023.

[7] C. Deng, **K. Bello**, B. Aragam and P. Ravikumar. "Optimizing NOTEARS Objectives via Topological Swaps". *International Conference on Machine Learning* **(ICML)**, 2023.

[8] **K. Bello**, B. Aragam and P. Ravikumar. "DAGMA: Learning DAGs via M-matrices and a Log-Determinant Acyclicity Characterization". *Neural Information Processing Systems* ***(NeurIPS)***, 2022.

[9] H. Lee, **K. Bello**, and J. Honorio. "On the Fundamental Limits of Exact Inference in Structured Prediction". *IEEE International Symposium on Information Theory* ***(ISIT)***, 2022.

[10] **K. Bello**, C. Ke, and J. Honorio. "A Thorough View of Exact Inference in Graphs from the Degree-4 Sum-of-Squares Hierarchy". *International Conference on Artificial Intelligence and Statistics* ***(AISTATS)***, 2022.

[11] G. Dexter, **K. Bello**, and J. Honorio. "Inverse Reinforcement Learning in the Continuous Setting with Formal Guarantees". *Neural Information Processing Systems* ***(NeurIPS)***, 2021.

[12] **K. Bello***, Q. Xu*, and J. Honorio. "A Le Cam Type Bound for Adversarial Learning and Applications". *IEEE International Symposium on Information Theory* ***(ISIT)***, 2021.

[13] **K. Bello** and J. Honorio. "Fairness Constraints can Help Exact Inference in Structured Prediction". *Neural Information Processing Systems* ***(NeurIPS)***, 2020.

[14] **K. Bello**, A. Ghoshal and J. Honorio. "Minimax Bounds for Structured Prediction Based on Factor Graphs". *International Conference on Artificial Intelligence and Statistics* ***(AISTATS)***, 2020.

[15] **K. Bello** and J. Honorio. "Exact Inference in Structured Prediction". *Neural Information Processing Systems* ***(NeurIPS)***, 2019.

[16] **K. Bello** and J. Honorio. "Learning Latent Variable Structured Prediction Models with Gaussian Perturbations". *Neural Information Processing Systems* ***(NeurIPS)***, 2018.

[17] **K. Bello** and J. Honorio. "Computationally and Statistically Efficient Learning of Bayes Nets Using Path Queries". *Neural Information Processing Systems* ***(NeurIPS)***, 2018.

[18] R. Cardenas, **K. Bello**, A. Coronado and E. Villota. "Improving Topic Coherence Using Entity Extraction Denoising". *The Prague Bulletin of Mathematical Linguistics*, 2018.

[19] R. Cardenas, **K. Bello**, A. Valle, E. Villota and A. Coronado. "Panorama of the Market Demand for Mechanical Engineers in South American Countries". *ASME International Mechanical Engineering Congress and Exposition* ***(IMECE)***, 2015.

## Conference Presentations and Invited Talks

- "New Problems and Future Directions at the Interface of Nonconvex Optimization and Causal Inference"
  - October 17, 2023, INFORMS Annual Meeting, Algorithm Design for Causal Inference Session.
- "iSCAN: Identifying Causal Mechanism Shifts among Nonlinear Additive Noise Models"
  - December 13, 2023, Neural Information Processing Systems (NeurIPS). *Upcoming*.
  - October 19, 2023, Bay Area Machine Learning Symposium (BayLearn).
  - July 29, 2023, Workshop on Spurious Correlations, Invariance, and Stability at ICML.
  - July 10, 2023, Max Planck Institute for Intelligent Systems, Tübingen. *(Host: Bernhard Schölkopf.)*
- "DAGMA: Learning DAGs via M-matrices and a Log-Determinant Acyclicity Characterization"
  - May 16, 2023, Midwest Machine Learning Symposium (MMLS).
  - December 1, 2022, Neural Information Processing Systems (NeurIPS).
  - October 20, 2022, Bay Area Machine Learning Symposium (BayLearn).
- "A View of Exact Inference in Graphs from the Degree-4 Sum-of-Squares Hierarchy"
  - March 30, 2022, International Conference on Artificial Intelligence and Statistics.
- "Exact Inference in Graphs and its Structural Properties"
  - April 15, 2021, Carnegie Mellon University. (Host: Pradeep Ravikumar.)
  - April 14, 2021, Massachusetts Institute of Technology, CSAIL. *(Host: David Sontag.)*
  - April 5, 2021, Massachusetts Institute of Technology, CBMM. *(Host: Tomaso Poggio.)*
  - January 19, 2021, Peru's 3rd Symposium of Deep Learning.
  - July 11, 2021, Research Experience for Peruvian Undergraduates (REPU) CS Summit.
- "Fairness Constraints can Help Exact Inference in Structured Prediction"
  - December 2020, Neural Information Processing Systems (NeurIPS).
- "Ph.D. Research Experience"
  - September 7, 2022, Pontificia Universidad Catolica del Peru.
  - October 29, 2020, TECHSUYO: Accelerating digital transformation in Peru.
- "Minimax Bounds for Structured Prediction Based on Factor Graphs"
  - August 2020, International Conference on Artificial Intelligence and Statistics (AISTATS).

- "Exact Inference in Structured Prediction"
  - December 2019, Neural Information Processing Systems (NeurIPS).
- "Learning Latent Variable Structured Prediction Models with Gaussian Perturbations"
  - December 2018, Neural Information Processing Systems (NeurIPS).
- "Computationally and Statistically Efficient Learning of Bayes Nets Using Path Queries"
  - June 29, 2021, IEEE EMBS, Universidad Nacional de Ingenieria.
  - December 2018, Neural Information Processing Systems (NeurIPS).
- "Labor Market Demand Analysis for Engineering Majors in Peru Using Topic Modeling"
  - August 2015, Machine Learning Summer School (MLSS), Kyoto University.

## Software

2023 **iSCAN** (GitHub, Documentation, PyPi)
Python 3 package designed for localizing which variables, if any, have undergo a casual mechanism shift given multiple heterogeneous datasets.

2023 **TOPO** (GitHub)
Python 3 library that offers improved continuous constrained optimization for DAG structure learning with optimality guarantees.

2022 **DAGMA** (GitHub, Documentation, PyPi)
Python 3 package that provides faster and more accurate continuous constrained optimization for structure learning based on a novel acyclicity characterization via the log-det function.

## Teaching Experience

### Guest Lecturer

SP'22 **Advanced Machine Learning: Theory and Methods**, *Machine Learning 10-716*, Carnegie Mellon University.

F'21 **Probabilistic Graphical Models**, *Machine Learning 10-708*, Carnegie Mellon University.

### Teaching Assistant

SP'21 **Data Mining and Machine Learning**, *CS 373*, Purdue University.

F'20 **Statistical Machine Learning**, *CS 578*, Purdue University.

F'16, SP'17 **Data Structures and Algorithms**, *CS 251*, Purdue University.

## Mentoring

1. Julia Luo, CS/DS BS at UChicago 2023–
2. Tianyu Chen, Statistics MS at UChicago, now PhD student at UTexas Austin 2022–
3. Chang Deng, Applied Math MS at UChicago, now PhD student at Chicago Booth 2021–
4. Zhaoming Li, Applied Math MS at UChicago, now PhD student at NortheasternU 2022–2023
5. Yu-Wei Chen, Statistics MS at Uchicago 2022–2023

## Professional Service

### Editorial

2024 **Production Editor**, Journal of Machine Learning Research (JMLR)

### Workshop organizing committees

2020 LatinX in AI (LXAI) Workshop at ICML *Website chair*

Fall 2023 Learning Theory Alliance (LeT-All) Mentorship Workshop Session chair

### University service

2023 Data Science Institute Summer Lab (UChicago) *Mentor*

### Journal reviewing

2021–2024 Journal of Machine Learning Research (JMLR)

2022–2024 Transactions on Machine Learning Research (TMLR)

2021–2023 IEEE Transactions on Pattern Analysis and Machine Intelligence (PAMI)

2022–2023 Journal of Computational and Graphical Statistics (JCGS)

### Conference reviewing

2019–2023 PC Member, Neural Information Processing Systems (NeurIPS)

2021–2024 PC Member, International Conference on Machine Learning (ICML)

2021–2024 PC Member, International Conference on Learning Representations (ICLR)

2023 PC Member, Conference on Causal Learning and Reasoning (CLeaR)

2022 PC Member, Association for the Advancement of Artificial Intelligence Conference (AAAI)

2021 PC Member, International Conference on Artificial Intelligence and Statistics (AISTATS)

2020 PC Member, International Joint Conference on Artificial Intelligence (IJCAI)

## Academic References

**Pradeep Ravikumar**, Postdoctoral Advisor
Carnegie Mellon University
Professor, Machine Learning Department, School of Computer Science
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**Bryon Aragam**, Postdoctoral Advisor
The University of Chicago
Assistant Professor, Booth School of Business
email: nikhyl.aragam@chicagobooth.edu

**Jean Honorio**, Doctoral Advisor
The University of Melbourne
Senior Lecturer (Associate Professor), School of Computing and Information Systems
email: jhonorio@unimelb.edu.au