# Kevin S. Bello Medina (Kevin Bello)

kbello@cs.cmu.edu • https://kevinsbello.github.io/

## Research Interests

I am broadly interested in Artificial Intelligence and Machine Learning. My research focuses on developing algorithms that are computationally and statistically efficient for various machine learning problems. *Specific Topics of Interest*: Combinatorial problems in machine learning, causal discovery, structured prediction, convex relaxations, high-dimensional statistics, fundamental limits, latent variable modeling.

## Academic Positions

**Joint Postdoctoral Fellow** Sept. 2021 - present
University of Chicago (Booth School of Business) and
Carnegie Mellon University (Machine Learning Department)
*Mentors: Bryon Aragam (UChicago) and Pradeep Ravikumar (CMU)*

## Education

**Ph.D. in Computer Science** Aug. 2016 - Aug. 2021
Purdue University, Indiana, USA
*Thesis: "Structured Prediction: Statistical and Computational Guarantees in Learning and Inference"*
*Advisor: Jean Honorio*

**B.Sc. in Mechatronics Engineering (Robotics)** Aug. 2009 - Dec. 2014
Universidad Nacional de Ingenieria, Lima, Peru
*Summa Cum Laude*

## Honors and Awards

- **NSF Computing Innovation Fellowship**
  Prestigious award given by the Computing Research Association and
  Computing Community Consortium to support two-year postdoctoral positions 2021
- **Bilsland Dissertation Fellowship**
  Competitive award given to the most outstanding students at Purdue University 2021
- Travel award to attend NeurIPS 2018, 2019
- Grant to participate in the Machine Learning Summer School, Kyoto University 2015
- Highest accumulated GPA of my class, Universidad Nacional de Ingenieria 2014
- Peruvian Council of Science and Technology (Concytec) research grant 2013
- **Presidente Manuel Pardo y Lavalle Prize**
  Highest honor given to undergraduates at Universidad Nacional de Ingenieria 2012
- Grant to participate in the *1st Latin American Theoretical Informatics School*, University of Chile 2012

## Publications

### Preprints / Under Review

[1] "Improved Gradient-Based DAG Learning".
C. Deng, **K. Bello**, B. Aragam and P. Ravikumar.
Under review, 2022.

[2] "Direct Learning with Guarantees of the Difference DAG Between Structural Equation Models".
A. Ghoshal, **K. Bello** and J. Honorio.
Under review, 2022.

### Peer-reviewed Conferences

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

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

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

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

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

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

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

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

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

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

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

[14] "Panorama of the Market Demand for Mechanical Engineers in South American Countries".
R. Cardenas, **K. Bello**, A. Valle, E. Villota and A. Coronado.
*ASME-IMECE*, USA, 2015.

### Conference Presentations and Invited Talks

[1] "Exact Inference in Structured Prediction"
Research Experience for Peruvian Undergraduates CS Seminar. Virtual, July 2021.

[2] "Bayesian Network Learning with Path Queries"
IEEE EMBS, Universidad Nacional de Ingenieria. Virtual, June 2021.

[3] "Exact Inference in Graphs and its Structural Properties"
Carnegie Mellon University (Pradeep Ravikumar's Lab). Virtual, April 2021.

[4] "Exact Inference in Graphs and its Structural Properties"
Massachusetts Institute of Technology CSAIL (David Sontag's Lab). Virtual, April 2021.

[5] "Exact Inference in Graphs and its Structural Properties"
Massachusetts Institute of Technology CBMM (Tomaso Poggio's Lab). Virtual, April 2021..

[6] "Exact Inference in Graphs"
Peru's 3rd Symposium of Deep Learning. Virtual, January 2021.

[7] "Fairness Constraints can Help Exact Inference in Structured Prediction"
Neural Information Processing Systems (NeurIPS). Virtual, December 2020.

[8] "Ph.D. Research Experience"
TECHSUYO Accelerating digital transformation in Peru. Virtual, October 2020.

[9] "Minimax Bounds for Structured Prediction Based on Factor Graphs"
Artificial Intelligence and Statistics (AISTATS). Virtual, August 2020.

[10] "Exact Inference in Structured Prediction"
Neural Information Processing Systems (NeurIPS). Vancouver, December 2019.

[11] "Learning Latent Variable Structured Prediction Models with Gaussian Perturbations"
Neural Information Processing Systems (NeurIPS). Montreal, December 2018.

[12] "Computationally and Statistically Efficient Learning of Bayes Nets Using Path Queries"
Neural Information Processing Systems (NeurIPS). Montreal, December 2018.

[13] "Labor Market Demand Analysis for Engineering Majors in Peru Using Topic Modeling"
Machine Learning Summer School (MLSS). Kyoto, August 2015.

## Professional Service

- Chair of the LXAI Workshop at ICML 2020.
- **Reviewer**:
  *Conferences*: ICLR 2023, NeurIPS 2022, ICML 2022, ICLR 2022, AAAI 2022, NeurIPS 2021, ICML 2021, AISTATS 2021, ICLR 2021, NeurIPS 2020, IJCAI 2020, NeurIPS 2019.
  *Journals*: Journal of Machine Learning Research (JMLR), IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI), Transactions on Machine Learning Research (TMLR), Journal of Computational and Graphical Statistics (JCGS).

## Research Experience

**Research Assistant** June 2017 - Aug. 2021
*Department of Computer Science, Purdue University* Advisor: *Jean Honorio*

- Analyzed the degree-4 sum-of-squares hierarchy for exact inference in graphs.
- Studied the effect of fairness constraints in exact inference for structured prediction.
- Analyzed information-theoretic bounds for adversarial learning.
- Derived lower bounds to characterize learnability of structured prediction models, specifically, factor graph models with unary and pairwise factors.
- Studied the sufficient conditions to perform exact inference in polynomial time for structured prediction trough the use of semidefinite programming relaxations.
- Developed a computationally efficient method for the learning of latent-variable structured prediction models under Gaussian perturbations, and studied its generalization properties by using PAC-Bayes and Rademacher complexity.
- Studied the learning of causal Bayesian networks by using path queries. A poly-time algorithm with polynomial sample complexity was proposed.

**PhD Intern** May 2020 - Aug. 2020
*Facebook AI* Supervisor: *Maxim Grechkin and Hao Ma*

- Studied backward compatible representations of Facebook content, i.e., explored how to reconstruct an *old* pre-trained embedding given a *new* pre-trained embedding from a more complex model.

**PhD Intern** May 2019 - Aug. 2019
*Facebook AI* Supervisor: *Yunlong He*
- Proposed domain-based metrics for a feature selection algorithm as part of the Ads Ranking team.

## Teaching Experience

**Teaching Assistant** *Department of Computer Science, Purdue University*
- Data Mining and Machine Learning (CS 373) Spring 2021
- Statistical Machine Learning (CS 578) Fall 2020
- Data Structures and Algorithms (CS 251) Fall 2016, Spring 2017

## Academic References

*Pradeep Ravikumar*, Postdoctoral Advisor
Carnegie Mellon University
Professor, Machine Learning Department, School of Computer Science
email: pradeepr@cs.cmu.edu

*Bryon Aragam*, Postdoctoral Advisor
The University of Chicago
Assistant Professor, Booth School of Business
email: nikhyl.aragam@chicagobooth.edu

*Jean Honorio*, Doctoral Advisor
Purdue University
Assistant Professor, Computer Science Department
email: jhonorio@purdue.edu