

# Elias Bareinboim

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## Main Research Interests

- Artificial Intelligence, Machine Learning, Statistics, Data Science.
- Causality and applications in Bioinformatics, Medicine, Public Health, Economics.
- Robotics, Cognitive Science, Philosophy of Science.

## Education

- Ph.D. in Computer Science – University of California, Los Angeles (UCLA), 2014.  
Title: *Generalizability in Causal Inference: Theory and Algorithms*; Advisor: *Judea Pearl*
- M.Sc. in Computer Science – Federal University of Rio de Janeiro (UFRJ), 2007.
- B.Sc. in Computer Science – Federal University of Rio de Janeiro (UFRJ), 2004.

## Academic Positions

- Assistant Professor, Computer Science, Purdue University, Fall/2015-now.
- Assistant Professor (courtesy appointment), Statistics, Purdue University, Fall/2015-now.
- Faculty Affiliate, Regenstrief Center for Healthcare Engineering, Purdue University, Jun/2017-now.
- Postdoctoral Scholar, Cognitive Systems Lab/UCLA, Judea Pearl, Fall/2014-Summer/2015.
- Research Assistant, Cognitive Systems Lab/UCLA, Judea Pearl, Fall/2009-Summer/2014.

## Teaching

### At Purdue (instructor):

- CS 47100 (undergraduate), Introduction to Artificial Intelligence, Spring/2017.
- CS 57800 (graduate) Machine Learning, Fall/2015.
- CS 59000-AI (graduate), Artificial Intelligence, Fall/2016.
- CS 59000-AML (graduate), Advanced Machine Learning / Causal Inference, Spring/2016, Fall/2017.

### Before Purdue:

- CS 262Z (graduate), Causal Inference, instructor with J. Pearl and J. Tian, UCLA, Spring/2013.
- CS 262Z (graduate), Causal Inference, teaching assistant, UCLA, Spring/2010, Spring/2011.
- MAB 525 (undergrad), Special Topics in Artificial Intelligence, instructor with J. C. P. Silva, Federal University of Rio de Janeiro (UFRJ), Spring/2007.

## Awards and Honors

- AI's 10 to Watch, IEEE Intelligent Systems, 2016.
- NIPS-16 Outstanding Reviewer Award, 2016.
- Notable Paper, 19th Annual Best of Computing, ACM Computing Reviews, 2015.
- Edward K. Rice Outstanding Doctoral Student Award (given to a single PhD student in all engineering and applied sciences majors), School of Engineering and Applied Sciences, UCLA, 2014.
- AAAI-14 Outstanding Paper Award (1 out of 1406 papers), 2014.
- Outstanding Graduating PhD Student (commencement award), Computer Science, UCLA, 2014.
- Google Outstanding Graduate Research Award, Computer Science, UCLA, 2014.
- Dan David Prize Scholarship, area Artificial Intelligence (\$15,000), Tel Aviv University, 2014.
- UCLA Dissertation Year Fellowship (DYF) (~\$35,000), 2013-2014.

- Yahoo! Key Scientific Challenges Award, area Machine Learning & Statistics (\$5,000), 2012.
- ACM A.M. Turing Centenary Celebration Student Scholarship - SIGACT, 2012.
- Ph.D.'s Fellowship, UCLA (~\$45,000), 2008-2009.
- Top 10 award – National contest of M.Sc. thesis (2007), Brazilian Computer Society, 2008.
- Ph.D.'s Fellowship, Fulbright – U.S. Dep. of State / CAPES-MEC, declined, 2008-2012.
- Ph.D.'s Fellowship, Brazilian Research Council CNPq, declined, 2008-2012.
- Master's Fellowship, Special Program, Ministry of Education – COPPE / UFRJ, 2005-2007.
- Undergraduate's Fellowship, Brazilian Research Council CNPq, 2003-2005.

## Selected Publications

27. Bryant Chen, Daniel Kumor, Elias Bareinboim (2017)  
Identification and Model Testing in Linear Structural Equation Models using Auxiliary Variables  
*Proceedings of the 34th International Conference on Machine Learning (ICML)*, 2017.
26. Andrew Forney, Judea Pearl, Elias Bareinboim (2017)  
Counterfactual Data-Fusion for Online Reinforcement Learners  
*Proceedings of the 34th International Conference on Machine Learning (ICML)*, 2017.
25. Junzhe Zhang and Elias Bareinboim (2017)  
Transfer Learning in Multi-Armed Bandits: A Causal Approach  
*Proceedings of the 26th International Joint Conference on Artificial Intelligence (IJCAI)*, 2017.
24. Juan Correa and Elias Bareinboim (2017)  
Causal Effect Identification by Adjustment under Confounding and Selection Biases  
*Proceedings of the 31th AAAI Conference on Artificial Intelligence*, AAAI Pr, 2017.
23. Junzhe Zhang and Elias Bareinboim (2016)  
Markov Decision Processes with Unobserved Confounders: A Causal Approach  
*Purdue AI Laboratory, Technical Report (R-23), Dec/2016*.
22. Bryant Chen, Judea Pearl, Elias Bareinboim (2016)  
Identification by Auxiliary Instrumental Sets in Linear Structural Equation Models  
*Proceedings of the 25th International Joint Conference on Artificial Intelligence (IJCAI)*, AAAI Press, pp. 3577-3583, 2016.
21. Elias Bareinboim (2016)  
Comment on “Causal Inference using invariance prediction: identification and confidence intervals by Peters, Buhlmann and Meinshausen”  
*Journal of the Royal Statistical Society, Series B*, forthcoming.
20. Elias Bareinboim and Judea Pearl (2016)  
Causal Inference and the Data-Fusion Problem  
*Proceedings of the National Academy of Sciences (PNAS)*, v. 113(27), 2016.
19. Elias Bareinboim, Andrew Forney, Judea Pearl (2015)  
Bandits with Unobserved Confounders: A Causal Approach  
*Proceedings of the 28th Annual Conference on Neural Information Processing Systems (NIPS)*, pp. 1342-1350, 2015.

18. [Elias Bareinboim](#) and Jin Tian (2015)  
Recovering Causal Effects From Selection Bias  
*Proceedings of the 29th AAAI Conference on Artificial Intelligence*, AAAI Pr, pp. 3475-3481, 2015.
17. Judea Pearl and [Elias Bareinboim](#) (2014)  
External Validity: From do-calculus to Transportability across Populations  
*Statistical Science*, v. 29(4), pp. 579-595, 2014.
16. [Elias Bareinboim](#) and Judea Pearl (2014)  
Transportability from Multiple Environments with Limited Experiments: Completeness Results  
*Proceedings of the 27th Annual Conference on Neural Information Processing Systems (NIPS)*, pp. 280-288, 2014.
15. [Elias Bareinboim](#), Jin Tian, Judea Pearl (2014)  
Recovering from Selection Bias in Causal and Statistical Inference  
*Proceedings of the 28th AAAI Conference on Artificial Intelligence*, AAAI Pr, pp. 2410-2416, 2014.  
**Outstanding Paper Award (1 out of 398 accepted papers).**
14. [Elias Bareinboim](#) and Judea Pearl (2013)  
A General Algorithm for Deciding Transportability of Experimental Results  
*Journal of Causal Inference*, v. 1(1), pp. 107-134, 2013.
13. [Elias Bareinboim](#), Sanghack Lee, Vasant Honavar, Judea Pearl (2013)  
Transportability from Multiple Environments with Limited Experiments  
*Proceedings of the 26th Annual Conference on Neural Information Processing Systems (NIPS)*, pp. 136-144, 2013.
12. [Elias Bareinboim](#) and Judea Pearl (2013)  
Causal Transportability with Limited Experiments  
*Proceedings of the 27th AAAI Conference on Artificial Intelligence*, AAAI Press, pp. 95-101, 2013.
11. [Elias Bareinboim](#) and Judea Pearl (2013)  
Meta-transportability of Causal Effects: A Formal Approach  
*Proceedings of the 16th International Conference on Artificial Intelligence and Statistics (AISTATS)*, JMLR, pp. 135-143, 2013.
10. [Elias Bareinboim](#) and Judea Pearl (2012)  
Causal Inference by Surrogate Experiments (or,  $z$ -Identifiability)  
*Proceedings of the 28th Conference on Uncertainty in Artificial Intelligence (UAI)*, AUAI Press, pp. 113-120, 2012.
9. [Elias Bareinboim](#) and Judea Pearl (2012)  
Transportability of Causal Effects: Completeness Results  
*Proceedings of the 26th AAAI Conference on Artificial Intelligence*, AAAI Press, pp. 698-704, 2012.
8. [Elias Bareinboim](#), Carlos Brito, Judea Pearl (2012)  
Local characterizations of Causal Bayesian Networks  
*Lecture Notes in Artificial Intelligence*, v. 7205, Springer-Verlag, pp. 1-17, 2012.
7. [Elias Bareinboim](#) and Judea Pearl (2012)  
Controlling selection bias in Causal Inference  
*Proceedings of the 15th International Conference on Artificial Intelligence and Statistics (AISTATS)*, JMLR, pp. 100-108, 2012.

6. Judea Pearl and Elias Bareinboim (2011)  
Transportability across studies: A formal approach  
*Proceedings of the 25th AAAI Conference on Artificial Intelligence*, AAAI Press, pp. 247-254, 2011.
5. Judea Pearl and Elias Bareinboim (2011)  
External Validity and Transportability: A formal approach  
*Proceedings of the Joint Statistical Meetings*, American Statistical Association, pp. 157-171, 2011.
4. Paulo Carvalho, J. Fischer, J. Perales, J. Yates, V. C. Barbosa, Elias Bareinboim (2011)  
A statistical approach for analyzing marginal cases in shotgun proteomics  
*Bioinformatics*, v. 27(2), 2011.
3. Elias Bareinboim, Carlos Brito, Judea Pearl (2011)  
Local characterizations of Causal Bayesian Networks  
*Proceedings of Graph Structures for Knowledge Representation and Reasoning – IJCAI, 2011*.
2. Elias Bareinboim and Valmir C. Barbosa (2008)  
Descents and nodal load in scale-free networks  
*Physical Review E*, v. 77(4), American Physical Society, 2008.
1. Elias Bareinboim, Ana T. R. Vasconcelos, Joao C. P. Silva (2007)  
Grammatical inference applied to linguistic modeling of biological networks  
*E. Journal of Communication, Information & Innovation in Health*, v.1, pp. 329-333, 2007.

## Tutorials / Short Courses

- “Causal Inference and the Data-Fusion Problem”  
International Conference on Autonomous Agents and Multi-agent Systems (AAMAS), Sao Paulo, Brazil, May/2017.
- “Introduction to Causal Inference”  
West Coast Experiments Conference (Graphical Models in Economics), Los Angeles, CA, Apr/2017.
- “Causal Inference and the Data-Fusion Problem”  
Association for Advancement of Artificial Intelligence (AAAI), San Francisco, CA, Feb/2017.
- “Causal Inference and the Data-Fusion Problem”  
Department of Computing Science, University of Alberta, Edmonton, Canada, August/2016.
- “Causes and Counterfactuals: Concepts, principles, and tools” (with J. Pearl)  
Neural Information Processing (NIPS), Lake Tahoe, Nevada, December/2013.
- “Causality and Big Data”  
EMC<sup>2</sup> Summer School on Big Data, Rio de Janeiro, Brazil, February/2013.
- “An Introduction to Causal Inference”  
The Second IEEE Conference on Healthcare Informatics and Systems Biology (Analyzing Big Data For Healthcare and Biomedical Sciences), UCSD, La Jolla, California, September/2012.

## Invited Talks / Presentations

- 2017 CVPR-17 Workshop “Functionality, Physics, Intentionality, and Causality”, Honolulu, HI.
- 2017 Statistical Society of Canada Annual Meeting, Winnipeg, Canada.
- 2017 School of Engineering, University of São Paulo (USP), São Paulo, Brazil.
- 2017 Institute of Computing, University of Campinas (UNICAMP), Campinas, Brazil.

- 2017 Workshop on Causal Analysis in the Social Sciences (Sloan), UCLA, CA.
- 2017 NSF Workshop: Advancing the Science of Transportation Demand Modeling, UC Berkeley, CA.
- 2017 Computer Science, University of Wisconsin, Madison, WI.
- 2017 Computer Science, ISI / University of Southern California (USC), CA.
- 2016 NIPS-16 Workshop “Inference and Learning of Hypothetical and Counterfactual Interventions in Complex Systems”, Barcelona, Spain.
- 2016 AAI-16 Fall Symposium on Accelerating Science: A Grand Challenge for AI, Arlington, VA.
- 2016 Department of Public Health Sciences, University of Chicago, Chicago.
- 2016 54th Allerton Conference on Communication, Control, and Computing, UIUC, IL.
- 2016 Department of Computing Science, University of Alberta, Edmonton, Canada.
- 2016 International Conference on Thinking (ICT), Providence, RI.
- 2016 Joint Statistical Meetings (JSM), Chicago, IL.
- 2016 Workshop on Statistical Causal Inference and its Applications to Genetics, Centre de Recherches Mathématiques (CRM), Montreal, Canada.
- 2016 Frontiers of Engineering Symposium (US-JP), National Academy of Engineering (NAE), CA.
- 2016 Max Planck Institute (Empirical Inference), Tübingen, Germany.
- 2016 Department of Computer Science and Mathematics, University of Passau, Germany.
- 2016 Munich Workshop on Causal Inference and Information Theory (MCI), Munich, Germany.
- 2016 Statistics Colloquium, Purdue University, West Lafayette, IN.
- 2015 Computer Science, Purdue University, West Lafayette, Indiana.
- 2015 Biostatistics and Computer Science, Johns Hopkins University, Baltimore, Maryland.
- 2015 Computer Science Division, University of California, Berkeley, California.
- 2015 Department of Computer Science, University of Southern California (USC), CA.
- 2015 School of Information and Computer Science, University of California, Irvine, CA.
- 2015 Department of Computer Science, Cornell University, New York.
- 2015 Department of Statistics, Stanford University, California.
- 2015 World Congress of Statistics, International Statistics Institute, Brazil.
- 2014 Department of Economics, University of Chicago, Chicago.
- 2014 Kyoto International Conference on Modern Statistics, Kyoto.
- 2014 International Workshop on Causal Inference and its related topics, Tokyo.
- 2014 ACM-SIGKDD-14 Workshop on Discovery Informatics, New York.
- 2014 UAI-14 Workshop on Causality: Learning and Prediction, Quebec City, Canada.
- 2014 NICTA, Sydney, Australia.
- 2014 Institute of Mathematical Statistics (IMS) Annual Meeting, Sydney, Australia.
- 2014 MURI, Office of Naval Research (ONR), UCLA, Los Angeles, California.
- 2014 Atlantic Causal Inference Conference, Brown University, Providence, RI.
- 2014 Joint Mathematics Meetings, American Mathematical Society, Baltimore, Maryland.
- 2013 NIPS-13 Workshop on Causality (Large-scale Experimental Design), Lake Tahoe, NV.
- 2013 MURI, Office of Naval Research (ONR), UCLA, Los Angeles, California.
- 2012 Graduate School of Engineering, Federal University of Rio de Janeiro (UFRJ), Brazil.
- 2012 Computer Science Colloquium, Federal University of Rio de Janeiro (UFRJ), Brazil.
- 2012 MURI, Office of Naval Research (ONR), UCLA, Los Angeles, California.

- 2011 International Workshop on Mining Multiple Information Sources, International Conference on Data Mining (ICDM), Vancouver, Canada.
- 2011 58th World Congress of Statistics, International Statistics Institute (ISI), Dublin.
- 2011 DERI/National University of Ireland (NUI), Galway, Ireland.

## Funding

- NSF, Robust Intelligent, Collaborative Research, Medium, PI  
Title: Causal Inference: Identification, Learning, and Decision-Making  
Amount: approx. \$536,515 (=50% of total), 10/01/17 - 09/31/20.
- DARPA FunLol (Fundamental Limits of Learning), co-PI  
Title: Fundamental Limits of Learning Concepts and Models for Complex Systems  
Amount: approx. \$125,000 (=16.6% of total), 10/01/16 - 12/01/17.

## Professional Service

- Editorial board, Journal of Causal Inference, 2017-now.
- Chair (with K. Zhang, C. Uhler, J. Zhang, D. Janzing), 7th UAI Causality Workshop, 2017.
- Co-organizer (with K. Zhang, J. Li, L. Liu), KDD Workshop on Causal Discovery, 2016.
- Co-organizer (with F. Eberhardt, R. Silva, J. Mooij, M. Maathuis), UAI Causality Workshop, 2016.
- Guest Editor (with J. Pearl, B. Schölkopf, K. Zhang, J. Li), Special Issue on Causality, ACM Transactions on Intelligent Systems and Technology (TIST), 2015.
- Co-organizer (with B. Schölkopf, K. Zhang, J. Zhang), ICML 2014 Workshop on Causal Modeling and Machine Learning, 2014.
- Reviewer, National Science Foundation (NSF), area: Methodology, Measurement, and Statistics, 2014.
- Program Committee-Conferences:
  - 2017: UAI, AAI, AISTATS, NIPS (rev).
  - 2016: UAI, AAI, IJCAI, ECAI, NIPS (rev).
  - 2015: UAI, AAI, AISTATS, NIPS (rev), UAI-Causality.
  - 2014: UAI, ICML, AISTATS, KDD-DI.
  - 2013: UAI, AAI, ICML, IJCAI, NIPS-Causality, IEEE-BigData, UAI-Causality.
  - 2012: UAI, ICML.
  - 2011: UAI, IJCAI, NIPS (rev), ICDM-MMIS.
  - 2010: KR (rev).
- Reviewer-Journals:
  - 2017: J. of Machine Learning Research (JMLR), J. of Causal Inference.
  - 2016: Biometrika, Bayesian Analysis, J. Causal Inference, Epidemiology, Behaviormetrika.
  - 2015: Artificial Intelligence Journal, Biometrics, J. of Causal Inference, Epidemiology.
  - 2014: Statistical Science, The British Journal for the Philosophy of Science, Annals of Applied Statistics.
  - 2013: Scandinavian Journal of Statistics, Annals of Applied Statistics, J. of Machine Learning Research (JMLR), J. of Causal Inference, Statistics in Medicine, Statistics.
  - 2012: J. of Machine Learning Research (JMLR), IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI), Statistics in Medicine, Bioinformatics, J. of Proteome Research.
  - 2011: J. of Causal Inference.
  - 2009: J. of Proteomics, Bioinformatics, Physica A.

- Computer Science Department/Purdue:
  - Member, Admissions Committee, cycle: Fall/2016, Fall/2017.
- Computer Science Department/UCLA:
  - Reviewer for PhD Admissions Committee, 2013-2014;
  - Invited discussant in panel about graduate school for new PhD students, 2013;
  - Mentor for 3 PhD students, 2010-2013.

## Professional Associations

- Association for the Advancement of Artificial Intelligence (AAAI), since 2011.
- Association for Computing Machinery (ACM), since 2011.
- Brazilian Computer Society (SBC), since 2004.

## Industrial Experience

- Intern (Systems/Data Mining), **Google Inc**, Mountain View/CA, USA, Summer 2009.
- Consultant-Software Engineer, **Programare Software Factory**, Brazil, Feb/2008 – Aug/2008.
- Co-Founder and Director, **Linux Solutions Ltda**, Brazil, 1999 – 2004.