BURAK VARICI

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Current Position

Carnegie Mellon University, Machine Learning Department, Pittsburgh, PA — 07/2024 - present
Postdoctoral Research Associate, Supervisor: Pradeep Ravikumar

Education

Rensselaer Polytechnic Institute, Troy, NY — 05/2020 - 05/2024
Ph.D. in Electrical Engineering, Advisor: Ali Tajer
Dissertation: Causal Learning via Interventions: Estimation and Design

Rensselaer Polytechnic Institute, Troy, NY — 08/2018 - 05/2020
M.S. in Electrical Engineering

Bogazici University, Istanbul, Turkey — 09/2013 - 06/2018
B.S. in Electrical & Electronics Engineering

Research Interests

My research centers on the intersection of causality and machine learning. The overarching goal is to develop a methodology that models our world through a causality lens, capitalizing on shared causal mechanisms across diverse data environments. To achieve this, I use the language of *causal interventions* in a wide range of problems, including but not limited to unsupervised representation learning, causal structure learning, and the design of sequential interventions. More recently, my emphasis has been on **causal representation learning** from interventions, and more generally, **identifiable representation learning.**

Research Experience

Causal Representation Learning from Interventions

- Designed a novel framework for analyzing causal representation learning via score functions under interventions. Established identifiability results along with provably correct algorithms.
- Published our results for general transformations at [AISTATS-2024]. The manuscript for the results on linear transformations is under revision for JMLR, and an earlier version – one of the first papers on interventional CRL – is available in arXiv. The paper on multi-node interventions is published at [NeurIPS-2024]. The first paper on the sample complexity of interventional CRL is also published at [NeurIPS-2024].

Intervention Design via Causal Bandits

- Designed causal bandit algorithms with relaxed assumptions compared to the prior work. Established upper and lower bound regret guarantees for both static and time-varying systems. Published papers at [JMLR-2023] , [JSAIT-2024], and [ISIT-2024].

Scalable Interventional Structure Learning

- Developed consistent algorithms for efficient learning of intervention targets and improving the structure learning of causal graphs. Published papers for causally sufficient [NeurIPS-2021] and causally insufficient models [UAI-2022].

Structure Learning of Undirected Graphical Models

- Developed algorithms for structure learning of shared subgraphs for multiple undirected graphical models, and analyzed sample complexities. Published results at [AISTATS-2021].

Professional Experience

Visiting Research Scholar at MIT-IBM Watson AI Lab — Cambridge, MA
Mentors: Dr. Dmitriy Katz-Rogozhnikov, Dr. Prasanna Sattigeri, Dr. Dennis Wei — 09/2022 - 12/2022

Designed a framework for the causal discovery of a mixture of DAGs and established identifiability conditions, published the results at [TMLR-2024]. Established the necessary and sufficient conditions for interventional causal discovery in mixture models and designed efficient algorithms, published at [NeurIPS-2024].

The Rensselaer-IBM AIRC Collaboration
AI Horizons Extern, Mentors: Dr. Prasanna Sattigeri, Dr. Karthikeyan Shanmugam 05/2020 - 08/2020

Researched on combining the causal discovery process with generative modeling and inducing a latent space representative of the underlying structure.

Speech Enabled Smart Technologies Istanbul, Turkey
Research Intern 06/2017 - 08/2017

Built neural networks for a speaker identity verification system.

Publications

1. R. Zhai, K. Yang, CP. Tsai, **B. Varıcı**, and P. Ravikumar, "Contextures: Representations from Contexts", *International Conference on Machine Learning* (ICML), 2025.
2. M. Majid, R. Pukdee, V. Agrawal, **B. Varıcı**, and P. Ravikumar, "On the Consistent Recovery of Joint Distributions from Conditionals", *International Conference on Artificial Intelligence and Statistics* (AISTATS), 2025.
3. **B. Varıcı**, E. Acartürk, K. Shanmugam, and A. Tajer, "Linear Causal Representation Learning from Unknown Multi-node Interventions", *Neural Information Processing Sytems* (NeurIPS), 2024.
4. **B. Varıcı**, D. Katz-Rogozhnikov, D. Wei, P. Sattigeri, and A. Tajer, "Interventional Causal Discovery in a Mixture of DAGs", *Neural Information Processing Sytems* (NeurIPS), 2024.
5. E. Acartürk, **B. Varıcı**, K. Shanmugam, and A. Tajer, "Sample Complexity of Interventional Causal Representation Learning", *Neural Information Processing Sytems* (NeurIPS), 2024.
6. **B. Varıcı**, E. Acartürk, K. Shanmugam, and A. Tajer, "General Identifiability and Achievability for Causal Representation Learning", *International Conference on Artificial Intelligence and Statistics* (AISTATS), 2024. (selected for **oral** presentation)
7. **B. Varıcı**, E. Acartürk, K. Shanmugam, A. Kumar, and A. Tajer, "Score-based Causal Representation Learning: Linear and General Transformations", arxiv:2402.00849, 2024 *(under revision for JMLR).*
8. Z. Yan, A. Mukherjee, **B. Varıcı**, and A. Tajer, "Improved Bound for Robust Causal Bandits with Linear Models", *International Symposium on Information Theory* (ISIT), 2024.
9. Z. Yan, A. Mukherjee, **B. Varıcı**, and A. Tajer, "Robust Causal Bandits for Linear Models", *IEEE Journal on Selected Areas in Information Theory* (JSAIT), 2024.
10. **B. Varıcı**, D. Katz-Rogozhnikov, D. Wei, P. Sattigeri, and A. Tajer, "Separability Analysis for Causal Discovery in Mixture of DAGs", *Transactions on Machine Learning Research* (TMLR), 2024.
11. **B. Varıcı**, E. Acartürk, K. Shanmugam, A. Kumar, and A. Tajer, "Score-based Causal Representation Learning with Interventions", arXiv:2301.08230, 2023.
12. **B. Varıcı**, K. Shanmugam, P. Sattigeri, and A. Tajer, "Causal Bandits for Linear Structural Equation Models", *Journal of Machine Learning Research (JMLR), 2023.*
13. **B. Varıcı**, K. Shanmugam, P. Sattigeri, and A. Tajer, "Intervention Target Estimation in the Presence of Latent Variables", *The Conference on Uncertainty in Artificial Intelligence* (UAI), 2022.
14. **B. Varıcı**, K. Shanmugam, P. Sattigeri, and A. Tajer, "Scalable Intervention Target Estimation in Linear Models", *Neural Information Processing Systems* (NeurIPS), 2021.
15. **B. Varıcı**, S. Sihag, and A. Tajer, "Learning Shared Subgraphs in Ising Model Pairs", *International Conference on Artificial Intelligence and Statistics* (AISTATS), 2021.

Undergrad Research

Boğaziçi University Signal and Image Processing Laboratory — Istanbul, Turkey
Senior Design Project, Advisor: Prof. Murat Saraclar — 10/2017 - 05/2018

- Investigated deep learning techniques for Query-by-example speech search on low-resource languages.
- Completed Bachelor thesis titled "Query-by-Example Speech Search with Neural Networks".

University of Wisconsin-Madison — Madison, WI
Undergraduate Research Assistant, Advisor: Dr. Xinyu Zhang — 05/2016 - 07/2016

- Researched on tracking the orientation of batteryless objects via RFID tags.
- Analyzed characteristics of frequency channels to integrate localization to Gyro in the Air project.

Organizing

Causal Representation Tutorial at AAAI Conference on Artificial Intelligence — 02/2025

Talks

Artificial Intelligence with Causal Techniques Workshop at AAAI — 03/2025
Causal Representation Learning

Booth School of Business at University of Chicago – Aragam' Group — 02/2025
Causal Representation Learning

Carnegie Mellon University - Statistical & Symbolic Learning Group — 03/2024
Score-based Causal Representation Learning from Interventions

Causal Representation Learning Workshop at NeurIPS — 12/2023
Score-based Causal Representation Learning from Interventions

IBM Causal Reinforcement Learning Group — 02/2023
Causal Bandits for Linear Structural Equation Models

Awards & Honors

Allen B. Dumont Prize — 2024
NeurIPS Top Reviewer — 2023
UAI Top Reviewer — 2023
Jerry Dziuba ECSE Graduate Student Service Award — 2022
Belsky Award for Computational Sciences and Engineering — 2022
The Rensselaer-IBM AI Fellowship — 2020-2024
Undergraduate Science Fellowship of Government of Turkey — 2013 - 2018
University Entrance Exam - Ranked 276^{th} out of 1.8 million candidates — 2013
Turkish National Mathematical Olympiad - Silver Medal — 2012
International Balkan Mathematical Olympiad - Silver Medal — 2012
International Junior Balkan Mathematical Olympiad - Gold Medal — 2010

Teaching Experience

Guest Lecturer, Carnegie Mellon University — Pittsburgh, PA
CMU 10716: Advanced Machine Learning - Clustering — March 2025
CMU 10716: Advanced Machine Learning - Causality — January 2025
CMU 10741: Representation Learning - Causal Representation Learning — November 2024

Teaching Assistant, Rensselaer Polytechnic Institute — Troy, NY
ECSE 2410: Signals and Systems — Spring 2020
ECSE 2610: Computer Components and Operations — Spring 2019
ECSE 1010: Introduction to Electrical, Component and Systems Engineering — Fall 2018

Service

Reviewer: NeurIPS (2021, 2022, 2023, 2024), UAI (2023, 2024), AAAI (2023), AISTATS (2024, 2025), IEEE Transactions on Signal Processing, Transactions on Machine Learning Research (TMLR).