BURAK VARICI

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Current Position

Carnegie Mellon University, Machine Learning Department, Pittsburgh, PA — 07/2024 - present
Postdoctoral Researcher, Advisor: Prof. Pradeep Ravikumar

Education

Rensselaer Polytechnic Institute, Troy, NY — 05/2020 - 05/2024
Ph.D. in Electrical Engineering, Advisor: Prof. 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 exploring its potential applications.

Research Experience

RPI Information Sciences Group — Troy, NY
RPI-AIRC Scholar, Advisor: Prof. Ali Tajer — 01/2020 - 05/2024

Causal Representation Learning from Interventions

- Designed a novel framework for analyzing causal representation learning via score functions under interventions. Established identifiability results along with probably correct algorithms.
- Published our results for general transformations at AISTATS [C4]. The manuscript for the results on linear transformations is submitted to JMLR [P2], and an earlier version is available in arXiv [P1]. The manuscript for the unknown multi-node interventions is under review [P4]

Intervention Design via Causal Bandits

- Designed causal bandit algorithms with relaxed assumptions compared to the prior work. Established lower and upper bound regret guarantees for both static and time-varying systems. Published papers at JMLR [J1], JSAIT [J3], and ISIT [C5].

Scalable Interventional Structure Learning

- Developed consistent algorithms for efficient learning of intervention targets and improving the structure learning of causal graphs.
- Published papers for both causally sufficient (NeurIPS [C2]) and causally insufficient systems (UAI [C3]).

Structure Learning of Undirected Graphical Models

- Developed algorithms for structure learning of shared subgraphs for multiple undirected graphical models, and analyzed sample complexities. Published one paper at AISTATS [C1].

RPI Intelligent Systems Laboratory — Troy, NY
Graduate Research Assistant, Advisor: Prof. Qiang Ji — 08/2018 - 12/2019

- Researched on low-cost eye-gaze tracking systems, and leveraged probabilistic methods to personalize deep models with limited annotation.

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.

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

Proposed a framework for causal discovery from a mixture of DAGs, and established identifiability conditions for causal relationships in the mixture. Published one paper at TMLR [J2]. Established the necessary and sufficient conditions for interventional causal discovery in mixture models and proposed efficient algorithms [P3].

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

C4 **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)*

P4 **B. Varıcı**, E. Acartürk, K. Shanmugam, and A. Tajer, "Linear Causal Representation Learning from Unknown Multi-node Interventions", arxiv:2406.05937, 2024.

P3 **B. Varıcı**, D. Katz-Rogozhnikov, D. Wei, P. Sattigeri, and A. Tajer, "Interventional Causal Discovery in a Mixture of DAGs", arXiv:2406.08666, 2024.

P2 **B. Varıcı**, E. Acartürk, K. Shanmugam, A. Kumar, and A. Tajer, "Score-based Causal Representation Learning: Linear and General Transformations", arxiv:2402.00849, 2024 *(submitted to JMLR).*

P1 **B. Varıcı**, E. Acartürk, K. Shanmugam, A. Kumar, and A. Tajer, "Score-based Causal Representation Learning with Interventions", arXiv:2301.08230, 2023.

C5 Z. Yan, A. Mukherjee, **B. Varıcı**, and A. Tajer, "Improved Bound for Robust Causal Bandits with Linear Models", *International Symposium on Information Theory, 2024.*

J3 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.*

J2 **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.*

J1 **B. Varıcı**, K. Shanmugam, P. Sattigeri, and A. Tajer, "Causal Bandits for Linear Structural Equation Models", *Journal of Machine Learning Research (JMLR), 2023.*

C3 **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.

C2 **B. Varıcı**, K. Shanmugam, P. Sattigeri, and A. Tajer, "Scalable Intervention Target Estimation in Linear Models", *Neural Information Processing Systems* (NeurIPS), 2021.

C1 **B. Varıcı**, S. Sihag, and A. Tajer, "Learning Shared Subgraphs in Ising Model Pairs", *International Conference on Artificial Intelligence and Statistics* (AISTATS), 2021.

Talks

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

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

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

Skills and Coursework

Technical: Python, TensorFlow/PyTorch, MATLAB

Relevant Graduate Courses: Machine Learning, Deep Learning, Probabilistic Graphical Methods, Distributed Machine Learning, Trustworthy Machine Learning, Bandit Algorithms, Computational Optimization, Stochastic Optimization and Reinforcement Learning, Information Theory, Computer Vision, Speech Processing.

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 AIRC Fellowship 2020

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

Teaching Experience

Teaching Assistance, Rensselaer Polytechnic Institute Troy, NY
ECSE 2410: Signals and Systems Spring 2020

Teaching Assistance, Rensselaer Polytechnic Institute Troy, NY
ECSE 2610: Computer Components and Operations Spring 2019

Teaching Assistance, Rensselaer Polytechnic Institute Troy, NY
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), IEEE Transactions on Signal Processing