Alex Markham

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Research interests

- causal modeling methods and software
- graph theory/combinatorics
- algebraic statistics
- kernel methods
- nonparametric statistics
- methodology/philosophy of science

Current position

2021–2024 **Research Postdoc**, *Division for Mathematics of Data and AI, Department of Mathematics, KTH Royal Institute of Technology*, Stockholm, Sweden

2023 Sep–Dec **Visiting Scholar Research Member**, *Algebraic Statistics and Our Changing World, Institute of Mathematical and Statistical Innovation (IMSI), University of Chicago*, Chicago, IL, USA

Education

2017–2022 **PhD Computer Science (Dr.techn.)**, *Research Group Neuroinformatics, Faculty of Computer Science, University of Vienna*, Austria, (begun in statistics at *Ludwig-Maximilians-Universität*, Munich, Germany, before following advisor to Vienna in 2019)
Grade: 1.0 Sehr Gut

2015–2017 **MS Logic, Computation, and Methodology**, *Department of Philosophy, Carnegie Mellon University*, Pittsburgh, PA, USA
GPA: 3.71/4

2012–2015 **BA Mathematics, BA Philosophy**, *Departments of Mathematics and Philosophy, St. Mary's University*, San Antonio, TX, USA
Honors Program Graduate, Cum Laude, GPA: 3.74/4

Doctoral dissertation

title: *Measurement dependence inducing latent causal models*

advisor: Moritz Grosse-Wentrup, Research Group Neuroinformatics, University of Vienna (Previously at LMU)

committee: David Danks, Halıcıoğlu Data Science Institute, University of California San Diego

committee: Claudia Plant, Research Group Data Mining and Machine Learning, University of Vienna

Master's thesis

title: *A spiking neural network model of reward in visual perceptual learning*

advisor: David Danks, *Carnegie Mellon University*, Departments of Philosophy and Psychology

2nd reader: Joseph Ramsey, *Carnegie Mellon University*, Department of Philosophy

Selected Publications

[1] A. Markham, M. Liu, B. Aragam, and L. Solus, "Neuro-causal factor analysis," 2023. arXiv:2305.19802 [stat.ML]. In review.

[2] D. Deligeorgaki, A. Markham, P. Misra, and L. Solus, "Combinatorial and algebraic perspectives on the marginal independence structure of Bayesian networks," 2023. arXiv:2210.00822 [stat.ME]. In review. *Note: This is a math journal publication, so unlike the rest of the publications (which are for CS/ML venues), author order is alphabetical rather than according to contribution.*

[3] A. Markham, D. Deligeorgaki, P. Misra, and L. Solus, "A transformational characterization of unconditionally equivalent Bayesian networks," in *Proceedings of The 11th International Conference on Probabilistic Graphical Models* (A. Salmerón and R. Rumí, eds.), vol. 186 of *Proceedings of Machine Learning Research*, pp. 109–120, PMLR, 10 2022. arXiv:2203.00521 [stat.ML].

[4] A. Markham, R. Das, and M. Grosse-Wentrup, "A distance covariance-based kernel for nonlinear causal clustering in heterogeneous populations," in *Proceedings of the First Conference on Causal Learning and Reasoning (CLeaR)* (B. Schölkopf, C. Uhler, and K. Zhang, eds.), vol. 177 of *Proceedings of Machine Learning Research*, pp. 542–558, PMLR, 11–13 Apr 2022.

[5] A. Markham and M. Grosse-Wentrup, "Measurement dependence inducing latent causal models," in *Conference on Uncertainty in Artificial Intelligence (UAI)*, pp. 590–599, PMLR, 2020.

Invited Talks

2023.10. **Speaker at Algebraic Statistics for Ecological and Biological Systems workshop**, *Institute for Mathematical and Statistical Innovation (IMSI)*, Chicago, Illinois, USA

2023.09. **Speaker at ML Reading Group**, *Booth School of Business, University of Chicago*, Chicago, Illinois, USA

2023.03. **Speaker at GEMS of Combinatorics Workshop**, *American Institute of Mathematics (AIM)*, San Jose, California, USA

2022.11. **Discussant in Online Causal Inference Seminar (OCIS)**, *Stanford Causal Science Center*, Stanford, California,USA

2022.11. **Interview (in Swedish) for the magazine "Curie"**, `https://tidningencurie.se`, Sweden

2022.04. **Speaker in Scool Machine Learning Seminar**, *Institut national de recherche en sciences et technologies du numérique (INRIA)*, Lille, France

2022.02. **Speaker in Causal Discovery Project Seminar**, *Instituto Nacional de Astrofísica, Óptica y Electrónica (INAOE)*, Puebla, Mexico

2021.12. **Podcast interview in "Abstract: The Future of Science"**, *Ep. 73 – Causality, Graph Theory & the Brain*

Experience

2022–present **Conference and Journal activity**

- General Chair of the Young Scientist Conference at the Digital Futures research center in Stockholm
- Reviewer for Conference on Causal Learning and Reasoning (CLeaR)
- Reviewer for Transactions on Machine Learning Research (TMLR)
- Reviewer for Conference on Neural Information Processing Systems (NeurIPS) workshops
- Reviewer for International Conference on Machine Learning (ICML) workshops
- Reviewer for Journal of Machine Learning Research (JMLR)
- Reviewer for Journal of Computational and Graphical Statistics (JCGS)
- Session Chair at 38th Conference on Uncertainty in Artificial Intelligence (UAI 2022)

2021–present **Seminar Co-organizer**, *Applied Combinatorics, Algebra, Topology, and Statistics (CATS) Seminar*, Department of Mathematics, KTH Royal Institute of Technology, Stockholm, Sweden

2020–present **Libre/Open Source Software Developer**

- Primary author and maintainer of the `MeDIL` Python package for causal modeling `https://medil.causal.dev`
- Contributor to `NetworkX` Python package for network analysis
- Contributor to `Benchpress` Python package for benchmarking structure learning algorithms
- Contributor to `CStrees` Python package for context-specific causal modeling

2019–2021 **Teaching Assistant**, *University of Vienna*, Vienna, Austria
Duties include creating, administering, and grading assignments and exams and occasional substitute lecturing, for between 80 and 130 students.

- 4 semesters: Foundations of Data Analysis

2020 **Tutor**, *Pattern Recognition in Neuroimaging (PRNI) Summer School*
Created and led the tutorial on causal inference and held a tutorial for each of the other topics.

2020 **Workshop Co-organizer**, *Queer in AI*, 37th International Conference on Machine Learning (ICML)

2017–2019 **Teaching Assistant**, *Ludwig-Maximilians-Universität*, Munich, Germany

Duties include creating, administering, and grading assignments and exams and occasional substitute lecturing, all for up to 30 students.

- Seminar on Causal Reasoning and Graphical Models
- Seminar on Brain-Computer Interfaces
- Tutorial on Predictive Modeling
- 2 semesters: Tutorial on Knowledge Discovery and Data Mining
- 2 semesters: Seminar on Current Research in Data Science

2017 **Research Fellow**, *Laboratory for Symbolic and Educational Computing*, Pittsburgh, USA

- received $4,500 USD in funding
- analyzed brain-computer interface data
- causal discovery for effective connectivity
- modeled transitions between neural activity as Markov process

2015–2017 **Teaching Assistant**, *Carnegie Mellon University*, Pittsburgh, PA, USA

- 3 semesters: Introduction to Philosophy
- Nature of Reason

2016 **Instructor**, *Carnegie Mellon University*, Pittsburgh, PA, USA

Taught the course Philosophy of Mind, focusing on computational and causal theories of mind.

2014–2015 **Tutor**, *St. Mary's University*, San Antonio, TX, USA

- Symbolic Logic
- Writing
- Pre-algebra and Algebra (at affiliated secondary school)

Advising

[1] T. Leatherman, "Link prediction using learnable topology augmentation," Master's thesis, KTH Royal Institute of Technology, 2023.

[2] S. Paknejad, "A comparison of clustering methods using the dependence contribution kernel," Master's thesis, University of Vienna, 2021.

[3] A. Chivukula, "Learning the functional relations in MeDIL causal models," Master's thesis, Ludwig-Maximilians-Universität, 2020.

[4] S. Rao, "Causal consistency for transfer learning," Master's thesis, Ludwig-Maximilians-Universität, 2019.

[5] L. Litzka, "Non-negative matrix factorization for high dimensional causal inference," Master's thesis, Ludwig-Maximilians-Universität, 2019.

[6] G. König, "Causal inference on calcium imaging data," Master's thesis, Ludwig-Maximilians-Universität, 2018.

[7] S. Friedl, "Transforming micromodels with complex interventions into macromodels," Master's thesis, Ludwig-Maximilians-Universität, 2018.