

# Kayhan Batmanghelich

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<b>Contact Information</b>	5607 Baum Boulevard, Fifth floor Pittsburgh, PA 15206-3701 USA Department of Biomedical Informatics University of Pittsburgh	<i>Office:</i> (412) 648-9037 <i>E-mail:</i> <a href="mailto:kayhan@pitt.edu">kayhan@pitt.edu</a> <i>web:</i> <a href="https://kayhan.dbmi.pitt.edu">https://kayhan.dbmi.pitt.edu</a> <i>Google Scholar:</i> <a href="#">Link</a>
<b>Research Interests</b>	<b>Methodology:</b> Medical Vision, Explainable AI for Health care, Probabilistic Graphical Models, Bayesian Data Analysis, Machine Learning under Data Constraints, Multi-Modal Learning. <b>Applications:</b> Joint modeling of medical images and clinical health records ( <i>e.g.</i> , genetic and free text) for lung diseases ( <i>e.g.</i> , COPD) and Neurodegenerative diseases ( <i>e.g.</i> , Alzheimer’s Disease).	
<b>Academic Appointments</b>	<b>University of Pittsburgh</b> , Pittsburgh, Pennsylvania Assistant Professor, Department of Biomedical Informatics Secondary, Department of Computer Science Secondary, Department of Electrical Engineering Adjunct, Machine Learning Department, Carnegie Mellon University Areas of Research: Machine Learning for Healthcare, Medical Vision, Imaging Genetics, Radiomics	9/2016 – present
	<b>Harvard Medical School</b> , Boston, Massachusetts R25 Research Fellow, Brigham and Women’s Hospital, Department of Radiology Supervisor: Prof. Sandy Wells	9/2015 – 9/2016
<b>Education</b>	<b>Massachusetts Institute of Technology</b> , Cambridge, Massachusetts Postdoctoral Associate, Computer Science and Artificial Intelligence Lab Advisor: Prof. Polina Golland Areas of Research: Multimodal Medical Vision, Machine Learning	6/2012 – 9/2015
	<b>University of Pennsylvania</b> , Philadelphia, Pennsylvania PhD in Electrical and Systems Engineering Advisors: Prof. Christos Davatzikos and Prof. Ben Taskar Thesis: Generative-Discriminative Basis Learning for Medical Imaging Applications	9/2007 – 5/2012
	<b>University of Tehran</b> , Tehran, Iran MSc in Electrical and Computer Engineering Advisor: Prof. Hamid Soltanian-Zadeh Thesis: Atlas-based Segmentation of Brain Structures Using Deformable Models	9/2002 – 9/2005
	<b>Amirkabir University of Technology</b> , Tehran, Iran BSc in Biomedical Engineering Advisor: Prof. Ali Motie Nasrabadi Thesis: Application of Fractal Dimension in Detection of Heart Arrhythmia from Cardiophone	9/1998 – 9/2002
<b>Grants and Awards</b>	<b>NIH R01 HL141813-01 (PI):</b> An Integrative Radiogenomic Approach to Design Genetically-Informed Image Biomarker for Characterizing COPD (\$2.8M) 2018-2023 <b>NSF 1839332 TRIPODS+X (Multi-PI):</b> Collaborative Research: Learning with Expert-In-The-Loop for Multimodal Weakly Labeled Data and an Application to Massive Scale Medical Imaging (\$600K) 2018-2021	

**SAP (PI):** Deep Multi-Domain Learning: A Framework to Incorporate Weak Labels to the Attention Models (\$390K) 2018-2021

**UPMC Enterprises (Co-PI):** Commercialization of Realtime Evaluation for Adverse Events using Intraoperative Neurophysiological - READE IONM (\$300K) 2019-2020

**Competitive Medical Research Fund (PI):** Machine Learning Approach to Characterize COPD using Heritable Image Phenotype (\$40K) 2017-2018

**Pfizer (PI):** Developing Statistical Method to Jointly Model Genotype and High Dimensional Phenotype (\$100K) 2016-2017

**NVIDIA Best Paper,** Machine Learning in Medical Imaging Workshop in MICCAI 2017

**NIH R25 Fellowship,** Computer Assisted Interventions for Cancer Treatment, Brigham Women Hospital 2015

**Second Place,** MICCAI Challenge on Computer-Aided Diagnosis of Dementia based on Structural MRI Data 2014

**M+Vision Grant Fellowship,** The Madrid-MIT M+Vision Consortium 2013

**Travel Award,** 3rd Short Course on Statistical Genetics and Genomics 2013

**Top 10 Cited** article in NeuroImage in 2008 2008

**Top 10 Student Papers,** International Symposium on Biomedical Imaging 2011

**Student Travel Award,** 14th MICCAI conference 2011

**Travel Grant,** Mathematical Problems, Models and Methods in Biomedical Imaging, Institute for Pure and Applied Mathematics (IPAM) 2010

**Ranked 90/~8,000,** Nation-wide university entrance exam rank for MSc 2002

**Ranked 313/~300,000,** Nation-wide university entrance exam rank for BSc 1998

**Invited Talks/  
Presentations**

**April 2020:** “Opportunities for AI in Healthcare: Predicting, Phenotyping, and Explaining,” Imperial College London, UK.

**January 2020:** “Real-World Applications of Explainable Models in Medical Imaging,” DeepMind/Google Healthcare, UK.

**December 2019:** “Unpaired Data Empowers Association Tests,” 12th International Conference of the ERCIM WG, Computational and Methodological Statistics, UK.

**Nov 2019:** “AI-Healthcare Bridge: A Balance Between Prediction and Interpretation,” Radiology, UW St. Louis, US.

**October 2019:** “Multi-Players in GANs: Effects and Applications,” 3rd Machine Learning Research Retreat, SAP, Germany.

**March 2019:** “AI-Healthcare Bridge: A Balance Between Prediction and Interpretation,” Computational Medicine, UCLA, US.

**March 2019:** “AI-Healthcare Bridge: A Balance Between Prediction and Interpretation,” Biomedical Engineering, CMU, US.

**March 2019:** “AI-Healthcare Bridge: A Balance Between Prediction and Interpretation,” Biomedical Engineering, Columbia University, US.

**February 2018:** “Imaging as High dimensional Endophenotype,” Computational Genomics Winter Institute, UCLA, US.

**October 2017:** “Generative Method to Discover Genetically Driven Image Biomarkers,” Computational Biology Department, CMU, US.

**August 2016:** “Diversifying Sparsity Using Variational Determinantal Point Processes,” Joint Statistical Meetings, Chicago, US.

**June 2016:** “Generative Method to Discover Genetically Driven Image Biomarkers,” International Society for Bayesian Analysis, Sardinia, Italy.

**July 2015:** “Understanding Medical Images Through the Lens of Genetics: a Statistical Modeling Approach,” Imperial College of London, London, UK.

**July 2015:** “Generative Method to Discover Genetically Driven Image Biomarkers,” International Conference on Information Processing in Medical Imaging (IPMI) Conference, Isle of Skye, Scotland (oral acceptance rate: 10%).

**June 2015:** “Understanding Medical Images Through the Lens of Genetics: a Statistical Modeling Approach,” Institute for Advanced Application at Geisinger Health System, Danville, US.

**May 2015:** “Understanding Medical Images Through the Lens of Genetics: a Statistical Modeling Approach,” Statistics in Imaging Section of the American Statistical Association meeting, University of Michigan, Ann Arbor, US.

**March 2015:** “Understanding Medical Images Through the Lens of Genetics: a Statistical Modeling Approach,” Tufts University, Boston, US.

**February 2015:** “Imaging Meets the Genetic World: A Joint Modeling Approach,” Applied Statistics Workshop at Harvard University, Cambridge, US.

**November 2014:** “Imaging Meets the Genetic World: A Joint Modeling Approach,” Computer Science Department colloquium talk, University of Massachusetts, Lowell, US.

**June 2013:** “Joint Generative Modeling of Imaging and Genetics,” International Conference on Information Processing in Medical Imaging (IPMI) Conference, Asilomar, US (oral acceptance rate: 13%).

**July 2013:** “Application of Machine Learning in Medical Imaging,” a short course for *M+Vision Fellows*, Madrid, Spain.

**April 2010:** “Disease Classification and Prediction via Semi-supervised Dimensionality Reduction,” IEEE International Symposium on Biomedical Imaging: From Nano to Macro (ISBI) Conference, Chicago, US.

**April 2010:** “Application of Regularized Low-Rank Decomposition for Feature Construction in Computational Anatomy,” Massachusetts Institute of Technology, Cambridge, US.

**July 2009:** “A General and Unifying Framework for Feature Construction, in Image-Based Pattern Classification,” International Conference on Information Processing in Medical Imaging (IPMI) Conference, Williamsburg, US (oral acceptance rate: 17%).

## Teaching

UPitt BIOINF 2023 (Instructor): Biomedical Informatics Journal Club	Fall 2019
CMU 10-708 (Instructor): Probabilistic Graphical Models	Spring 2018
UPenn ESE 605 (Teaching Assistant): Modern Convex Optimization	Spring 2011
UPenn ESE 605 (Teaching Assistant): Modern Convex Optimization	Spring 2009
UPenn ESE 504 (Teaching Assistant): Introduction to Optimization Theory	Fall 2008

## Mentoring Activities

### Post-doctoral Fellows

• Mingming Gong (Lecturer in Statistics Department, University of Melbourne)	2016 – 2019
• Payman Yadollahpour (Research Fellow at Broad Institute)	2018 – 2019
• Junxiang Chen	2018 – present
• Brian Pollack	2018 – present

### PhD Students (as Primary Advisor)

• Sumedha Singla (Computer Science)	2016 – present
• Ke Yu (Intelligence System Program)	2018 – present
• Yanwu Xu (Intelligence System Program)	2019 – present
• Li Sun (Intelligence System Program)	2019 – present

### Master Students

• Jiaming Bai (CMU-LTI)	2018 – present
• Keyi Yu (CMU-LTI)	2018 – present
• Fan Qian (CMU-LTI)	2018 – present
• Lisa Hou (CMU-LTI)	2018 – present

### Undergraduate Students

• Sead Niksic (Hillman Academy)	2017 – 2017
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## Academic Service

### Journal Review

- Nature Research
- Bayesian Analysis
- Journal of Machine Learning
- IEEE Transactions on Medical Imaging
- IEEE Transactions on Pattern Analysis & Machine Intelligence
- IEEE Transactions on Biomedical Engineering
- PLOS Computational Biology
- NeuroImage

### Conference Review

- Area Chair: International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)
- Program Committee: Conference on Neural Information Processing Systems (NIPS)
- Program Committee: Uncertainty in Artificial Intelligence (UAI)
- Program Committee: International Conference on Machine Learning (ICML)
- Program Committee: International Conference on Learning Representations (ICLR)
- Program Committee: Association for the Advancement of Artificial Intelligence (AAAI)
- Organizer: MICCAI Workshop on Imaging Genetics (MicGen)

## Research Training

**Massachusetts Institute of Technology**, Cambridge, Massachusetts, USA

*Postdoctoral Associate*

6/2012 – 9/2016

- **Computer Science and Artificial Intelligence Laboratory (CSAIL)**
  - Constructing a Bayesian model to discover genetic causes of the Alzheimer’s disease using brain imaging features.
  - Developing a probabilistic model to discover genetically-driven imaging biomarkers for Chronic Obstructive Pulmonary Disease (COPD).
  - Leading a group to develop a distributed optimization method for discriminative pattern learning for COPD using pySpark.
  - Collaborating with Brigham and Women’s Hospital (BWH) on the COPDGene project.
  - Mentoring a student with master’s thesis: 3D Texture analysis for characterizing COPD.

**University of Pennsylvania**, Philadelphia, Pennsylvania, USA

*Graduate Student (Research Assistant)*

9/2007 – 5/2012

- **Section of Biomedical Image Analysis**
  - Developed a generative-discriminative method to reduce dimensionality in medical images for computational diagnosis.
  - Proposed an efficient optimizer for large-scale problems intended for medical imaging applications.
  - Demonstrated a generative model to analyze abnormal brain deformation due to aging, using nuclear-norm and image warping.
  - Released a software package to construct a customizable generative-discriminative matrix decomposition for medical imaging applications.
  - Developed manifold-based multiparametric study of brain images in order to characterize tissue abnormality in normal-appearing brain tissue in Multiple Sclerosis.

**University of Tehran**, Tehran, Iran

*Graduate Student (Research Assistant)*

9/2002 – 12/2005

- **Institute for Studies in Theoretical Physics and Mathematics (IPM)**
  - Developed an energy-based method built on Simplex-mesh, for 3D segmentation of the Hippocampus-Amygdala complex in brain MR images.
  - Developed an approach based on information fusion to guide deformable models for automatic detection and accurate segmentation of brain structures.
  - Proposed an intelligent medial representation model for structural brain segmentation.

**Amirkabir University of Technology**, Tehran, Iran

*Undergraduate Researcher*

9/2000 – 9/2002

- Summer internship: Designed an algorithm, for the Philips TM1100 4DSP-core processor to perform real-time high-resolution video image affine transformation.

## Industry Experience

**GE Representation in Iran (TPP)**, Tehran, Iran

*Hardware R&D Intern for CT-Scan Section*

9/2003 – 4/2004

- Developed automatic character recognition software for GE workstation without Digital Imaging and Communications in Medicine (DICOM) capability.

## Publicly Available Software

**sHDP**

Nonparametric Topic Modeling with Word Vectors. This model enables us to naturally exploit the semantic structures of word embeddings while flexibly discovering the number of topics.

Distributed via: <https://github.com/kayhan-batmanghelich/sHDP>

Role: Developer

**GONDOLA**

This software provides a generative method to reduce the dimensionality of medical images in a clinically interpretable yet discriminative way.

Distributed via: <http://www.rad.upenn.edu/sbia/software/gondola/>

Role: Developer

## BASIS

This is a development environment library with accompanying tools for testing and packaging software across platforms and languages.

Distributed via: <http://www.rad.upenn.edu/sbia/software/basis/>

Role: Tester, Developer

## Publications

1. S. Singla, B. Pollack, J. Chen, **K. Batmanghelich**, Explanation by Progressive Exaggeration. *to appear in the Eighth International Conference on Learning Representations (ICLR)*, 2020.
2. J. Chen, **K. Batmanghelich**, Weakly Supervised Disentanglement by Pairwise Similarities. *Thirty-Fourth AAAI Conference on Artificial Intelligence (AAAI)*, 2020.
3. Y. Xu\*, M. Gong\*, J. Chen, T. Liu, K. Zhang, **K. Batmanghelich**, Generative-Discriminative Complementary Learning. *Thirty-Fourth AAAI Conference on Artificial Intelligence (AAAI)*, 2020.
4. Y. Xu†, M. Gong†, C. Li, K. Zhang, **K. Batmanghelich**, Twin Auxiliary Classifiers GAN. *Conference on Neural Information Processing Systems (NeurIPS)*, 2019.
5. H. Fu, M. Gong, C. Wang, **K. Batmanghelich**, K. Zhang, D. Tao, Geometry-Consistent Adversarial Networks for One-Sided Unsupervised Domain Mapping. *Conference on Computer Vision and Pattern Recognition (CVPR)*, pp 2427-2436, 2019.
6. S. M.H. Huisman, A. Mahfouz, **K. Batmanghelich**, B. P.F. Lelieveldt, M. J.T. Reinders, A Structural Equation Model for Imaging Genetics Using Spatial Transcriptomics. *Brain Informatics*, pp 2-13, 2018.
7. Y. Xu, M. Gong, T. Liu, **K. Batmanghelich**, C. Wang, Robust Angular Local Descriptor Learning. *Asian Conference on Computer Vision*, pp 420-435, 2018.
8. S. Singla, M. Gong, S. Ravanbakhsh, F. Sciurba, B. Poczoz, **K. Batmanghelich**, Subject2Vec: Generative-Discriminative approach from a Set of Image Patches to a Vector. *International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)*, pp 502-510, 2018.
9. H. Fu, M. Gong, Ch. Wang, **K. Batmanghelich**, D. Tao, Deep Ordinal Regression Network for Monocular Depth Estimation. *Conference on Computer Vision and Pattern Recognition (CVPR)*, pp 2002 - 2011, 2018.
10. X. Yu, T. Liu, M. Gong, Ch. Wang, **K. Batmanghelich**, D. Tao, An Efficient and Provable Approach for Mixture Proportion Estimation Using Linear Independence Assumption. *Conference on Computer Vision and Pattern Recognition (CVPR)*, pp 4480-4489, 2018.
11. J. Schabdach, S. Wells, M. Cho, **N. Batmanghelich**, A Likelihood-Free Approach for Characterizing Heterogeneous Diseases in Large-Scale Studies. *International Conference on Information Processing in Medical Imaging (IPMI)*, LNCS, pp 170-183, 2017.
12. O. Freifeld, S. Hauberg, J. Fisher III, **N. Batmanghelich**, Transformations Based on Continuous Piecewise-Affine Velocity Fields. *IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI)*, 39 (12), pp 2496-2509, 2017.
13. **N. Batmanghelich**, A. Saeedi, R. J. Estepar, M. Cho, S. Wells, Inferring Disease Status by non-Parametric Probabilistic Embedding. *Workshop on Medical Computer Vision: Algorithms for Big Data (MCV), Held in Conjunction with International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)*, LNCS, pp 49-57, 2016.
14. P. Binder **N. Batmanghelich**, R. J. Estepar, P. Golland, Unsupervised Discovery of Emphysema Subtypes in a Large Clinical Cohort. *7th International Workshop on Machine Learning in Medical Imaging (MLMI), Held in Conjunction with International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)*, LNCS, pp 180-187, 2016.
15. **N. Batmanghelich**†, A. Saeedi†, K. Narasimhan, S. Gershman, Nonparametric Spherical Topic Modeling with Word Embeddings. *Proceedings of the 54th Annual Meeting of the Association for Computational Linguistics (ACL)*, pp 537-542, 2016.

16. **N. Batmanghelich**, A. Dalca, G. Quon, M. Sabuncu, P. Golland, Probabilistic Modeling of Imaging, Genetics and the Diagnosis. *IEEE Transactions on Medical Imaging (TMI)*, pp 1765-1779, 2016.
17. O. Freifeld, S. Hauberg, **N. Batmanghelich**, J. Fisher III, Highly-Expressive Spaces of Well-Behaved Transformations: Keeping It Simple. *Proceedings of the IEEE International Conference on Computer Vision (ICCV)*, pp 2911-2919, 2015.
18. **N. Batmanghelich**<sup>†</sup>, A. Saeedi<sup>†</sup>, M. Cho, R. J. Estepar, P. Golland, Generative Method to Discover Genetically Driven Image Biomarkers. *International Conference on Information Processing in Medical Imaging (IPMI)*, LNCS 9123, pp 30-42, 2015.
19. **N. Batmanghelich**, M. Cho, R. Estepar, P. Golland, Spherical Topic Models for Imaging Phenotype Discovery in Genetic Studies. *Workshop on Bayesian and Graphical Models for Biomedical imaging, International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)*, LNCS 8677, pp 107-117, 2014.
20. C. Wachinger, **N. Batmanghelich**, P. Golland, M. Reuter, BrainPrint in the Computer-Aided Diagnosis of Alzheimer's Disease. *Challenge on Computer-Aided Diagnosis of Dementia. International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)*, 2014.
21. **N. Batmanghelich**, A. Dalca, M. Sabuncu, P. Golland, Joint Modeling of Imaging and Genetics. *International Conference on Information Processing in Medical Imaging (IPMI)*, LNCS 7917, pp 766-777, 2013.
22. Y. Ghanbari, L. Bloy, **N. Batmanghelich**, R. Verma, Dominant Component Analysis of Electrophysiological Connectivity Network. *International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)*, pp 231-238, 2012.
23. **N. Batmanghelich**, B. Taskar, C. Davatzikos, Generative-Discriminative Basis Learning for Medical Imaging. *IEEE Transactions on Medical Imaging (TMI)*, 31(1), pp 51-69, 2012.
24. L. Bloy, M. Ingallhalikar, **N. Batmanghelich**, An integrated Framework for High Angular Resolution Diffusion Imaging-Based Investigation of Structural Connectivity. *Brain Connectivity*, 2(2), pp 69-19, 2012.
25. **N. Batmanghelich**, B. Taskar, C. Davatzikos, Regularized Tensor Factorization for Multi-Modality Medical Image Classification. *International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)*, pp 17-24, 2011.
26. **N. Batmanghelich**, D. Ye, B. Taskar, C. Davatzikos, Disease Classification and Prediction via semi-supervised Dimensionality Reduction. *IEEE International Symposium on Biomedical Imaging: From Nano to Macro (ISBI)*, pp 1086-1090, 2011.
27. **N. Batmanghelich**, A. Gooya, B. Taskar, C. Davatzikos, Application of Trace-Norm and Low-Rank Matrix Decomposition for Computational Anatomy. *IEEE Computer Society Workshop on Mathematical Methods in Biomedical Image Analysis (MMBIA), Computer Vision and Pattern Recognition Workshops (CVPRW)*, pp 146-153, 2010.
28. C. Davatzikos, P. Bhatt, L. Shaw, **N. Batmanghelich**, J. Trojanowski, Prediction of MCI Conversion via MRI, CSF Biomarkers, and Pattern Classification. *Neurobiology of Aging*, 32(12), pp 2322.e19-2322.e27, 2010.
29. **N. Batmanghelich**, B. Taskar, C. Davatzikos, A General and Unifying Framework for Feature Construction, in Image-Based Pattern Classification. *International Conference on Information Processing in Medical Imaging (IPMI)*, LNCS 5636, pp 423-434, 2009.
30. Y. Fan, **N. Batmanghelich**, C. Clark, C. Davatzikos, Spatial Patterns of Brain Atrophy in MCI Patients, Identified via High-dimensional Pattern Classification, Predict Subsequent Cognitive Decline. *NeuroImage*, 39(4), pp 1731-43, 2008.
31. **N. Batmanghelich**, R. Verma, On Non-linear Characterization of Tissue Abnormality by Constructing Disease Manifolds. *IEEE Computer Society Workshop on Mathematical Methods in Biomedical Image Analysis (MMBIA), Computer Vision and Pattern Recognition Workshops (CVPRW)*, pp 1-8, 2008.
32. H. Shariatpanahi, **N. Batmanghelich**, A. Kermani, M. Ahmadabadi, H. Soltanian-Zadeh, Distributed Behavior-based Multi-agent System for Automatic Segmentation of Brain MR Images. *International Joint Conference on Neural Networks (IJCNN)*, pp 4535-4542, 2006.

33. **N. Batmanghelich**, H. Soltanian-Zadeh, B. Aarabi, Knowledge-based Segmentation: Using Simultaneous Shape Prior and Histogram Information to Segment Brain Structures. *IASTED Conference on Signal and Image Processing*, pp 15-17, 2005.
34. M. Karimi, **N. Batmanghelich**, H. Soltanian-Zadeh, C. Lucas, A 3-D Deformable Surface Method for Automatic Hippocampus-Amygdala Complex Segmentation. *IEEE Nuclear Science Symposium Conference Record*, 6, pp 3725-3729, 2004.

## Reports/ Preprints

1. M. Gong, P. Liu, S. Frank, P. Stojanov, D. Tao, G. Tseng, K. Zhang, **K. Batmanghelich**, Unpaired Data Empowers Association Tests, *bioRxiv 10.1101/839159*, 2019.
2. J. Chen, **K. Batmanghelich**, Robust Ordinal VAE: Employing Noisy Pairwise Comparisons for Disentanglement. *arXiv:1910.05898*, 2019.
3. H. Salman, P. Yadollahpour, T. Fletcher, **K. Batmanghelich**, Deep Diffeomorphic Normalizing Flows. *arXiv preprint arXiv:1810.03256*, 2018.
4. M. Gong, K. Zhang, B. Huang, C. Glymour, D. Tao, **K. Batmanghelich**, Causal Generative Domain Adaptation Networks. *arXiv preprint arXiv:1804.04333*, 2018.
5. K. Zhang, M. Gong, J. Ramsey, **K. Batmanghelich**, P. Spirtes, C. Glymour, Causal Discovery in the Presence of Measurement Error: Identifiability Conditions. *arXiv preprint arXiv:1706.03768*, 2017.
6. **N. Batmanghelich**, G. Quon, A. Kulesza, M. Kellis, P. Golland, L. Bornn, Diversifying Sparsity Using Variational Determinantal Point Processes. *arXiv preprint arXiv:1411.6307*, 2014.