

Nematollah (Kayhan) Batmanghelich

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Objective	Building efficient inference and computational tools to elucidate the statistical connections between imaging, genomics, and medical health records, to improve our understanding of human diseases.	
Research Interests	Medical Imaging: Imaging genetics, Computer-aided diagnosis using medical images, Joint modeling of medical images and clinical health records, Computational anatomy. Machine Learning: Deep Learning, Graphical models, Bayesian data analysis, Probabilistic programming, Scalable inference. Optimization: Scalable first-order optimization, Distributed optimization.	
Positions Held	University of Pittsburgh , Pittsburgh, Pennsylvania Assistant Professor, Department of Biomedical Informatics Areas of Research: Imaging Genetics, Machine Learning for Healthcare 9/2016 – present	
	Harvard Medical School , Boston, Massachusetts R25 Research Fellow, Brigham and Women’s Hospital, Department of Radiology Supervisor: Prof. Sandy Wells 9/2015 – 9/2016	
Education	Massachusetts Institute of Technology , Cambridge, Massachusetts Postdoctoral Associate, Computer Science and Artificial Intelligence Lab Advisor: Prof. Polina Golland Areas of Research: Imaging Genetics, Machine Learning 6/2012 – 9/2015	
	University of Pennsylvania , Philadelphia, Pennsylvania PhD in Electrical and System Engineering Advisors: Prof. Christos Davatzikos and Prof. Ben Taskar Thesis: Generative-Discriminative Basis Learning for Medical Imaging Applications 9/2007 – 5/2012	
	University of Tehran , 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	
	Amirkabir University of Technology , 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	
Honors	NVIDIA Best Paper , Machine Learning in Medical Imaging Workshop in MICCAI NIH R25 Fellowship , Computer Assisted Interventions for Cancer Treatment, Brigham Women Hospital Second Place , MICCAI Challenge on Computer-Aided Diagnosis of Dementia based on Struc-	2016 2015

tural 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

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 Experience

- Teaching Assistant for Modern Convex Optimization: 1/2011 – 4/2011
Delivered lectures in several class sessions, provided office hour support and graded weekly assignments for Modern Convex Optimization (ESE605), University of Pennsylvania.
- Teaching Assistant for Modern Convex Optimization: 1/2009 – 4/2009
Provided office hour support and graded weekly assignments for Modern Convex Optimization (ESE605), University of Pennsylvania.
- Teaching Assistant for Introduction to Optimization Theory: 9/2008 – 12/2008
Provided office hour support and graded weekly assignments for Introduction to Optimization Theory (ESE504), University of Pennsylvania.
- Lecturer for “Software Toolbox for Undergraduate Students in EE”: 4/2003 – 5/2003
Delivered lectures for six-week course about MATLAB, SPICE and some other useful softwares for undergraduate students in Electrical Engineering, Azad University, Shahre-Rey.

- Teaching Assistant for undergraduate course in Microprocessor Lab: 12/2001 – 05/2002
Provided in-lab support to third year undergraduate students, Amirkabir University of Technology.

Research Experience

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 Alzheimers 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 masters 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.

Professional 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.

Professional Activities

Program Committee

- MICCAI Workshop on Imaging Genetics (MicGen)
- MICCAI Workshop on Medical Computer Vision
- 3rd International Workshop on Pattern Recognition in NeuroImaging (PRNI)
- MICCAI Workshop on Medical Computer Vision

Journal Reviews

- Bayesian Analysis

- IEEE Transactions on Medical Imaging
- IEEE Transactions on Pattern Analysis & Machine Intelligence
- IEEE Transactions on Biomedical Engineering
- PLOS Computational Biology
- NeuroImage

Conference Reviews

- International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)
- Conference on Neural Information Processing Systems
- IEEE International Symposium on Biomedical Imaging
- Workshop on Mathematical Methods in Biomedical Image Analysis (MMBIA)

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. 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)*, to be appear in LNCS, 2017.
2. 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*, 2017.
3. **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)*, to be appear in LNCS, 2016.
4. 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.
5. **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.
6. **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.
7. 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.
8. **N. Batmanghelich**[†], A. Saeedi[†], 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.
9. **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.

10. 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.
11. **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.
12. 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.
13. **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.
14. L. Bloy, M. Ingalhalikar, **N. Batmanghelich**, An integrated Framework for High Angular Resolution Diffusion Imaging-Based Investigation of Structural Connectivity. *Brain Connectivity*, 2(2), pp 69-19, 2012.
15. **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.
16. **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.
17. **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.
18. 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.e192322.e27, 2010.
19. **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.
20. 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.
21. **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.
22. 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.
23. **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.
24. 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.
1. **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.