Mazdak Abulnaga

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Education

Massachusetts Institute of Technology, Cambridge, MA 2023
Ph.D. in Electrical Engineering and Computer Science
Advisors: Polina Golland and Justin Solomon
Thesis: Volumetric Mapping for Medical Imaging and Geometry Processing
Research interests: geometry processing, computer graphics, computer vision, machine learning, medical image analysis

Massachusetts Institute of Technology, Cambridge, MA 2018
S.M. in Electrical Engineering and Computer Science GPA: 4.9/5.0
Thesis: Volumetric Parameterization to a Canonical Template (Morris Joseph Levin Award)
Advisors: Polina Golland and Justin Solomon

University of British Columbia, Vancouver, BC 2016
B.A.Sc. in Electrical Engineering (with co-op), Minor in Commerce GPA: 4.33/4.33
Graduated with Distinction, ranked 1st in Electrical and Computer Engineering
Thesis: Detecting wheezing in children using a Synchrosqueezing transform (Advisor: Guy Dumont)

Research Experience

MIT Computer Science and Artificial Intelligence Lab & Harvard Medical School 09/2023 –
Postdoctoral Fellow – advisors: Adrian Dalca, John Guttag, and Bruce Fischl (Cambridge, MA)

- Research in geometry processing and machine learning with applications in health care and biology

GeomeriX Group – INRIA & École Polytechnique 01/2024 – 02/2024
Visiting Research – advisor: Maks Ovsjanikov (Paris, France)

- Research in deep learning for nonrigid 3D shape correspondence

MIT Computer Science and Artificial Intelligence Lab 09/2016 – 04/2023
Graduate Research Assistant – advisors: Polina Golland and Justin Solomon (Cambridge, MA)

- Developed geometry processing and machine learning methods to study volumetric shapes and develop placental health indicators using fetal Magnetic Resonance Images (MRI) in close collaboration with researchers and physicians at Harvard Medical School
- Developed a symmetric volume mapping algorithm for finding dense correspondences between tetrahedral meshes by analyzing symmetric distortion energies and through a constrained optimization
- Developed deep learning models for segmentation of placental shapes in MRI time series
- Developed a volumetric parameterization algorithm for standardized analysis and visualization of the placental shape, demonstrating sub-voxel accuracy and followup studies examining twin pregnancies

Philips Research North America 06/2018 – 08/2018
Research Scientist Intern with Jonathan Rubin (Cambridge, MA)

- Developed deep learning models in PyTorch to automatically segment ischemic stroke lesions in multi-modal Computed Tomography Perfusion (CTP) scans of the brain

UBC Pediatric Anesthesia Research Team 01/2016 - 04/2016
Undergraduate Research Assistant (part-time) – advisor: Mark Ansermino (Vancouver, BC)

- Developed signal processing algorithms to identify wheezing in respiratory sounds to improve the diagnosis and treatment of pneumonia in low-resource settings

Johns Hopkins University Image Analysis and Communications Lab 05/2015 – 07/2015
Undergraduate Research Assistant – advisor: Jerry Prince (Baltimore, MD)

- Designed and developed a graphical user interface toolbox to explore shape change patterns of the cerebellum associated with disease and function loss

TRIUMF: Canada's National Nuclear and Particle Physics Lab 01/2015 – 05/2015
Research Intern with Ruediger Picker (Vancouver, BC)

- Created and analyzed simulations of ultracold neutron experiments using Monte Carlo-based analysis

UBC Electrical and Computer Engineering in Medicine Group 05/2013 – 08/2013
Undergraduate Research Assistant – advisor: Guy Dumont (Vancouver, BC)

- Developed study protocols and data processing algorithms for two studies examining the effect of a mobile exercise game, Mobilekids, on reducing sedentary lifestyle in youth

Technical Skills

Languages: Python, Matlab, C, C++, CUDA, Java, Julia, LaTeX
Software and Tools: PyTorch, TensorFlow, Git, GCP, 3D Slicer, Adobe Illustrator, Unix/Linux

Thesis

Abulnaga S.M., **Volumetric Mapping for Medical Imaging and Geometry Processing**, Ph.D. Thesis. Cambridge, MA: Massachusetts Institute of Technology, March 2023.

Abulnaga S.M., **Volumetric Mesh Parameterization to a Canonical Template**, S.M. Thesis. Cambridge, MA: Massachusetts Institute of Technology, June 2018. **Morris Joseph Levin Award**.

Journal Publications

Abulnaga, S.M., Dey, N., Young, S.I., Pan, E., Hobgood, K.I., Wang, C.J., Grant, P.E., Abaci Turk, E., Golland, P., **Shape-aware Segmentation of the Placenta in BOLD Fetal MRI Time Series**, *Machine Learning for Biomedical Imaging (MELBA)*, 2, 2023.

Abulnaga, S.M., Stein, O., Golland, P., Solomon, J., **Symmetric Volume Maps: Order-Invariant Volumetric Mesh Correspondence with Free Boundary**, *ACM Transactions on Graphics*, 42.3 (25), 2023. *Presented at SIGGRAPH 2023.*

Abulnaga, S.M., Abaci Turk, E., Bessmeltsev, M., Grant, P.E., Solomon, J., Golland, P., **Volumetric Parameterization of the Placenta to a Flattened Template**, *IEEE Transactions on Medical Imaging*, 41.4, 2022.

Abaci Turk, E., Abulnaga, S.M., Luo, J., Stout, J.N., Feldman, H.A., Turk, A., Gagoski, B., Wald, L.L., Adalsteinsson, E., Roberts, D.J., Bibbo, C., Robinson, J.N., Golland, P., Grant, P.E., Barth, W.H. Jr., **Placental MRI: Effect of Maternal Position and Uterine Contractions on Placental BOLD MRI Measurements**, *Placenta*, 2020.

Garde, A., Umedaly, A., Abulnaga, S.M., Junker, A., Chanoine, JP., Ansermino, J.M., Dumont, G.A., **Evaluation of a Novel Mobile Exergame in a School-based Environment**, *Cyberpsychology, Behavior, and Social Networking*, 2016.

Garde, A., Umedaly, A., Abulnaga, S.M., Robertson, L., Junker, A., Chanoine, JP., Ansermino, J.M., Dumont, G.A., **Assessment of a Mobile Game (MobileKids Monster Manor) to Promote Physical Activity Among Children**, *Games for Health Journal*, 2015.

Conference Publications

Dey, N., Abulnaga, S.M., Billot, B., Abaci Turk, E., Grant, P.E., Dalca, A.V., Golland, P., **AnyStar: Domain Randomized Universal Star-convex 3D Instance Segmentation**, *IEEE/CVF Winter Conference on Applications of Computer Vision (WACV)*, 2024.

Li, L., Zhang, P., Smirnov, D., Abulnaga, S.M., Solomon, J., **Interactive All-hex Meshing via Cuboid Decomposition**, *ACM Transactions on Graphics (TOG): SIGGRAPH ASIA*, 40.6, 2021, Tokyo, JN.

Abulnaga, S.M., Abaci Turk, E., Bessmeltsev, M., Grant, P.E., Solomon, J., Golland, P., **Placental Flattening via Volumetric Parameterization**, *MICCAI: International Conference on Medical Image Computing and Computer Assisted Interventions*, 2019, Shenzhen, CN.

Rubin, J., Abulnaga, S.M., **CT-To-MR Conditional Generative Adversarial Networks for Ischemic Stroke Lesion Segmentation**, *IEEE ICHI: International Conference on Healthcare Informatics*, 2019, Xi'an, CN.

Abulnaga, S.M., Yang, Z., Carass, A., Kansal, K., Jedynak, B.M., Onyike, C.U., Ying, S.H., Prince,

J.L., **A Toolbox to Visually Explore Cerebellar Shape Changes in Cerebellar Disease and Dysfunction**, *SPIE: International Society for Optics and Photonics Medical Imaging*, 2016, San Diego, CA.

Yang, Z., Abulnaga, S.M., Carass, A., Kansal, K., Jedynak, B.M., Onyike, C.U., Ying, S.H., Prince, J.L., **Landmark Based Shape Analysis for Cerebellar Ataxia Classification and Cerebellar Atrophy Pattern Visualization**, *SPIE: International Society for Optics and Photonics Medical Imaging*, 2016, San Diego, CA.

Peer-Reviewed Workshops and Abstracts

Chi, Z., Cong, Z., Wang, C.J., Liu, Y., Abaci Turk, E., Grant, P.E., Abulnaga, S.M., Golland, P., Dey, N., **Dynamic Neural Fields for Learning Atlases of 4D Fetal MRI Time-series**, *Med-NeurIPS: Medical Imaging Meets NeurIPS*, 2023, New Orleans, USA.

Liu, Y., Karani, N., Abulnaga, S.M., Xu, J., Grant, P.E., Abaci Turk, E., Golland, P., **Consistency Regularization Improves Placenta Segmentation in Fetal EPI MRI Time Series**, *MICCAI PIPPI 2023: MICCAI Workshop on Perinatal, Preterm, and Pediatric Image Analysis*, 2023, Vancouver, CA.

Abulnaga, S.M., Young, S.I., Hobgood, K., Pan, E., Wang, C.J., Grant, P.E., Abaci Turk, E., Golland, P., **Automatic Segmentation of the Placenta in BOLD MRI Time Series**, *MICCAI PIPPI 2022: MICCAI Workshop on Perinatal, Preterm, and Pediatric Image Analysis*, 2022, Singapore.

Schnitzer, T., Abulnaga, S.M., Bibbo, C., Grant, P.E., Golland, P., Solomon, J., Abaci Turk, E., **Automatic Segmentation of Twin Regions in Mo-Di Placentae Based on Geometric Analysis of Spatiotemporal BOLD MRI Signals**, *ISMRM: Annual Meeting of the International Society for Magnetic Resonance in Medicine*, 2022, London, UK.

Cai, E.*, Abulnaga, S.M.*, Abaci Turk, E., Grant, P.E., Golland, P., **Automatic Segmentation of the Placenta in BOLD MRI**, *MICCAI PIPPI 2020: MICCAI Workshop on Perinatal, Preterm, and Pediatric Image Analysis*, 2020, virtual.

Abulnaga, S.M., Abaci Turk, E., Adalsteinsson, E., Barth, W.H. Jr., Roberts, D.J., Grant, P.E., Solomon, J., Golland, P., **Volumetric Mapping of the Placenta to a Flattened Template for Visualization of Regional Anatomy and Function**, *In-Utero MRI*, 2020, Oxford, UK.

Abaci Turk, E., Gagoski, B., Stout, J., Abulnaga, S.M., Copeland, N., Roberts, D.J., Golland, P., Wald, L., Adalsteinsson, E., Grant, P.E., Rathi, Y., **Assessment of Placental Microcirculation by Joint Analysis of Flow Compensated and Non-flow Compensated Intravoxel Incoherent Motion Data**, *ISMRM* 2019, Montreal, CA.

Abulnaga, S.M., Rubin, J., **Ischemic Stroke Lesion Segmentation in CT Perfusion Scans Using Pyramid Pooling and Focal Loss**, *MICCAI BrainLes 2018: MICCAI BrainLesion Workshop*, 2019, Granada, ES.

Abulnaga, S.M., Abaci Turk, E., Luo, J., Solomon, J., Wald, L.L., Adalsteinsson, E., Bibbo, C., Robinson, J.N., Barth Jr., W.H., Roberts, D.J., Grant, P.E., Golland, P., **Volumetric Mesh-based Mapping of the Placenta to a Canonical Template for Visualization of Regional Anatomy and Function**, *ISMRM*, 2018, Paris, FR.

Abulnaga, S.M., Abaci Turk, E., Luo, J., Solomon, J., Wald, L.L., Adalsteinsson, E., Bibbo, C., Robinson, J.N., Barth Jr., W.H., Roberts, D.J., Grant, P.E., Golland, P., **Mapping of the Placenta to a Canonical Template for Visualization of Regional Function**, *ISMRM Workshop on MRI of the Placenta*, 2018, Atlanta, USA.

Invited Presentations

Volumetric Mapping for a Standardized Representation of the Placenta in MRI 2023
Baker Lab, Institute for Protein Design, University of Washington, Seattle, WA.

Volumetric Mapping for Medical Imaging and Geometry Processing 2022 & 2023

Laboratoire d'Informatique, École Polytechnique, virtual.
Sabuncu Lab, Cornell Tech University, New York, NY.
EZ Lab, Princeton University, virtual.

Algorithms to Study Placental Health and Function in MRI 2022
West African Conference on AI in Health Care, virtual.

Towards a Standardized Representation for the Analysis and Visualization of Placental Function in MRI 2022
Center for Developmental Health: Monthly Science Talk, Oregon Health and Sciences University, virtual.

Volumetric Parameterization of the Placenta to a Flattened Template 2022
International Shape Stats Seminar, virtual.

Computational Tools for Using MRI data to Study Placental Function and Development 2021
ISMRM Placenta & Fetus Study Group: Scaling Up Fetal and Placenta MRI, and Some Tools of the Trade, virtual.

Flattening the Placenta in MRI to Visualize Local Anatomy and Function 2021
Placenta Interface Seminar Series, virtual.

Placental Flattening via Volumetric Parameterization 2019 & 2020
Boston Medical Imaging Workshop, Cambridge, USA.
University College London: Vision and Imaging Science Group, London, UK.
University of British Columbia, Robotics and Control Lab, Vancouver, CA.
IPMI 50$^{\text{th}}$ Anniversary Summer Course and National Doctoral Forum on Medical Imaging, Chengdu, CN.

Machine Learning for Monitoring Fetal Health in MRI 2019
MIT College of Computing Launch: Computing Exposition, Cambridge, MA.

Awards

MathWorks Fellowship (twice awarded)	2021–2023
MICCAI Outstanding Reviewer Award, Honorable Mention	2021
NSF Graduate Research Fellowship (GRFP)	2018–2022
NSERC Postgraduate Scholarship (PGS-D)	2018–2021
Morris Joseph Levin Thesis Presentation Award	2018
Siebel Fellowship	2017
Association of Professional Engineers and Geoscientists Gold Medal Award	2016
Elizabeth and Leslie Gould Scholarship in Engineering	2016
Matti Niit Memorial Prize in Electrical Engineering	2016
UBC Academic Scholarship	2016
UBC Dean's Honour List	2012–2016
Jim and Helen Hill Memorial Service Award in Electrical Engineering	2015
Fluor Canada Ltd. Award in Electrical Engineering	2015
Charles and Jane Banks Scholarship	2014–2015
Sherwood Lett Memorial Scholarship (UBC Premier Undergraduate Scholarship)	2014–2015
UBC Wesbrook Scholar	2014
Western Canada Group of Chartered Engineers Prize	2014
UBC Trek Excellence Scholarship	2013 & 2015
Edward and Aldine Madsen Scholarship	2013

Academic Service

Reviewer, Medical Imaging meets NeurIPS Workshop	2023
Reviewer, Machine Learning for Health Conference	2023
Reviewer, International Conference on Medical Image Computing and Computer Assisted Interventions	2019–2023
Reviewer, IEEE Transactions on Medical Imaging	2019–2023
Reviewer, International Journal of Computer Assisted Radiology and Surgery	2021
Reviewer, Pacific Conference on Computer Graphics and Applications	2019–2020
Reviewer NeurIPS Machine Learning for Healthcare	2019–2020

Teaching and Mentorship

Undergraduate Research Mentor 2019–2022

- Katherine L. Hobgood (2021-2022)
- Eileen Pan (2021-2022)
- Phineas Scovel (2022)
- Vivan Vu (2021)
- Simon Kuang (2020)
- Emily Cai (2019-2020)

Teaching Assistant: Probabilistic Systems Analysis and Applied Probability 2020

- Taught the foundations of probability theory through interactive tutorial sessions and office hours

Leadership

MIT EECS Communications Lab 03/2019 – 02/2023
Communication Advisor

- Coached graduate students and post-doctoral fellows on technical communication including, writing, oral and poster presentations, and grant applications
- Developed workshops and wrote articles on technical communication to serve as online CommLab resources

MIT EECS Mentorship Improvement Group 09/2020–06/2021
Co-founder

- Interviewed several successful mentors and organizations at MIT to compile a list of best-practices for graduate student mentorship, featured on the MIT EECS website
- Launched a mentorship discussion group with current EECS graduate students

MIT EECS Graduate Application Assistance Program (GAAP) 09/2020–12/2020
Organizer and mentor

- Developed training sessions on effective communication coaching and mentored one student through graduate school applications

MIT EECS Graduate Student Association (GSA) 10/2017–01/2020
President

- Proposed and developed a $\$60,000$ budget for academic, social, orientation and recruiting events for the EECS graduate student body containing over 700 graduate students
- Acted as a liaison between the department leadership and graduate students, helping plan academic and organizational changes

Industry Experience

Backflip AI 2023 - Present
Technical Consultant

- Formulating technical strategy for machine learning on 3D geometry

AI Optics 2020 - 2022
Machine Learning Consultant

- Formulated technical strategy for an early stage startup and engineered machine learning infrastructure, enabling scalable model development on large-scale datasets
- Developed deep network models for disease classification in retinal images

Chevron Canada 2014
Electrical Engineering Co-op Intern (Burnaby, BC)

- Managed two electrical system upgrade projects at an oil refinery by designing specifications, planning, and directing the installation of system equipment

Press	**MIT News**: A better way to match 3D volumes	2023
	World Economic Forum: Algorithms can now map placentas and ensure healthy pregnancies	2019
	Fierce Biotech: To bring MRIs into pregnancy monitoring, MIT uses algorithms to chart the placenta	2019
	Engadget: MIT's algorithm could improve imaging techniques during pregnancy	2019
	TechXplore: New technique stretches out MRI scans of placentas so they can be more accurately analyzed	2019
	Health Imaging: New algorithm improves MRI for pregnancy monitoring	2019
	AuntMinnie: New technique unravels 3D MRI scans of the placenta	2019
	SiecleDigital: MIT: un nouvel algorithme pour ameliorer les techniques d'imagerie	2019
	MIT News: Using algorithms to build a map of the placenta	2019
	MIT CSAIL News: Better fetal health – by building a map of the placenta	2019