

Zeshan M. Hussain

Curriculum Vitae

Research Interests

My research develops machine learning methods at the intersection of representation learning, causal inference, and physician-AI interaction, with a primary clinical focus in oncology. Current directions include improving sample efficiency for LLM-based clinical prediction, integrating real-world evidence with experimental data for reliable causal effect estimation, and studying how physicians interact with AI-based recommendations in practice.

Education & Training

- 2025–Present **Residency, Internal Medicine**, *Brigham and Women's Hospital*, Longwood, MA
- 2017–2025 **M.D. with Honors in a Special Field, Health, Sciences, and Technology (HST)**, *Harvard Medical School*, Longwood, MA,
Thesis: *Uncovering Bias Mechanisms in Observational Studies*
(Published in *ICML 2026*; see [3].)
- 2019–2023 **Ph.D., Electrical Engineering and Computer Science**, *MIT*, Cambridge, MA,
Thesis: *Towards Precision Oncology: A Predictive and Causal Lens*
MD-PhD Program at Harvard and MIT
- 2016–2017 **M.S., Computer Science**, *Stanford University*, Stanford, CA
- 2012–2016 **B.S., Computer Science**, *Stanford University*, Stanford, CA

Experience

Research

- 2019–2023 **Ph.D. Student**, *Clinical Machine Learning Group*, MIT
Thesis: *"Towards Precision Oncology – A Predictive and Causal Lens"*
Advisor: Prof. David Sontag.
- Developed methods/algorithms to train state space models, transformer-based models, and LLMs for clinical prediction, causal inference, and physician-AI interaction
 - See my [personal page](#) for an updated summary of my research.
- 2016–2017 **M.S., Research Student**, *QIAI Lab & Hazy Research Lab*, Stanford
Advisors: Dr. Daniel Rubin, Prof. Chris Ré
- Worked on methods to automate domain-specific data augmentation for deep learning models
 - Developed machine learning models to improve decision-making and diagnosis of breast cancer from mammography
- 2016–2017 **B.S., Research Intern**, *DIR Group*, Dayton Interventional Radiology
Advisor: Dr. Mubin Syed
- Developed machine learning model trained on temporal blood clot signals to predict tPA effectiveness at clot dissolution for a particular patient
 - Contributed to development of a novel bariatric embolization technique

Industry

- 2020–2021 **CTO & Co-Founder, Humaine**
Conversational AI coaching for training of medical personnel, including medical students, residents, and other trainees.
- Part of MIT Sandbox and Harvard iLab Venture Program
 - Top 10 Startup at MIT 100K Accelerate Final, “Best Social Hack” at HackHarvard
- 2015 **Software Engineer Intern, Acupera, San Francisco**
Built a custom programming language and IDE to enable providers to “code” care management plans

Publications

* indicates equal contribution.

Preprints

- [1] I. Demirel, L. Shi, Z. Hussain, and D. Sontag, “LLMs can construct powerful representations and streamline sample-efficient supervised learning,” *arXiv preprint arXiv:2603.11679*, 2026.

Peer-Reviewed Publications

- [2] Z. Hussain, B. D. Lam, F. A. Acosta-Perez, I. B. Riaz, M. Jacobs, A. J. Yee, and D. Sontag, “Evaluating physician-AI interaction for cancer management: Paving the path toward precision oncology,” *ACM Transactions on Computing for Healthcare*, 2026 (**in press**)
Invited for Oral Presentation at ACM SIGCHI Interactive Health Conference 2026 (premier human-computer interaction venue; declined due to clinical service).
- [3] I. Demirel*, Z. Hussain*, P. De Bartolomeis, and D. Sontag, “Uncovering bias mechanisms in observational studies via predictive performance,” in *International Conference on Machine Learning*, PMLR, 2026 (**in press**).
- [4] Z. Hussain*, E. De Brouwer*, R. Boiarsky, S. Setty, N. Gupta, G. Liu, C. Li, J. Srimani, J. Zhang, R. Labotka, *et al.*, “Joint AI-driven event prediction and longitudinal modeling in newly diagnosed and relapsed multiple myeloma,” *NPJ Digital Medicine*, vol. 7, no. 1, p. 200, 2024.
- [5] I. Demirel, E. De Brouwer, Z. Hussain, M. Oberst, A. A. Philippakis, and D. Sontag, “Benchmarking observational studies with experimental data under right-censoring,” in *International Conference on Artificial Intelligence and Statistics*, pp. 4285–4293, PMLR, 2024.
- [6] A. M. Alaa, Z. Hussain, and D. Sontag, “Conformalized unconditional quantile regression,” in *International Conference on Artificial Intelligence and Statistics*, pp. 10690–10702, PMLR, 2023.
- [7] Z. Hussain*, M.-C. Shih*, M. Oberst, I. Demirel, and D. Sontag, “Falsification of internal and external validity in observational studies via conditional moment restrictions,” in *International Conference on Artificial Intelligence and Statistics*, pp. 5869–5898, PMLR, 2023.
- [8] Z. Hussain*, M. Oberst*, M.-C. Shih*, and D. Sontag, “Falsification before extrapolation in causal effect estimation,” *Advances in Neural Information Processing Systems*, vol. 35, pp. 6161–6174, 2022.
- [9] Z. Hussain*, R. G. Krishnan*, and D. Sontag, “Neural pharmacodynamic state space modeling,” in *International Conference on Machine Learning*, pp. 4500–4510, PMLR, 2021.
- [10] R. K. Karlsson, M. Willbo, Z. Hussain, R. G. Krishnan, D. Sontag, and F. D. Johansson, “Using time-series privileged information for provably efficient learning of prediction models,”

in *International Conference on Artificial Intelligence and Statistics*, pp. 5459–5484, PMLR, 2022.

- [11] M. K. Sana, Z. Hussain, M. H. Maqsood, and P. A. Shah, “Artificial intelligence in celiac disease,” *Computers in Biology and Medicine*, p. 103996, 2020.
- [12] A. J. Ratner, H. R. Ehrenberg, Z. Hussain, J. Dunnmon, and C. Ré, “Learning to compose domain-specific transformations for data augmentation,” *Advances in Neural Information Processing Systems*, vol. 30, p. 3239, 2017.
- [13] Z. Hussain, F. Gimenez, D. Yi, and D. Rubin, “Differential data augmentation techniques for medical imaging classification tasks,” in *AMIA Annual Symposium Proceedings*, vol. 2017, p. 979, American Medical Informatics Association, 2017.
- [14] Z. Hussain, F. Gimenez, D. Yi, and D. Rubin, “Data augmentation for mammography classification,” in *Advances in Neural Information Processing Systems ML4H Workshop*, 2016 (**Spotlight**).
- [15] M. I. Syed, R. Gallagher, Z. Hussain, A. Shaikh, P. J. Cain, K. Morar, M. Sebastian, R. Tyrrell, A. Guehl, and R. Erdelyi, “Combination of thrombolysis and glycoprotein iib/iiia inhibition in chronic peripheral thrombosis: A case report,” *International Journal of Radiology and Radiation Oncology*, vol. 3, no. 1, pp. 004–006, 2017.
- [16] E. D. SoRelle, O. Liba, Z. Hussain, M. Gambhir, and A. de la Zerda, “Biofunctionalization of large gold nanorods realizes ultrahigh-sensitivity optical imaging agents,” *Langmuir*, vol. 31, no. 45, pp. 12339–12347, 2015.

Invited Talks & Presentations

- 2023 **American Society of Hematology (ASH)**, San Diego, CA
ASH Annual Meeting *Abstract*
Title: Evaluating Physician-AI Interaction for Multiple Myeloma Management: Paving the Path towards Precision Oncology
- 2023 **Stanford University**, Stanford, CA
Stanford MedAI Seminar Series *Talk*
Title: Benchmarking Causal Effects from Observational Studies using Experimental Data
- 2022 **MIT**, Cambridge, MA
MIT-MGB AI Cures Conference *Poster Presentation*
Title: Falsification before Extrapolation in Causal Effect Estimation
- 2022 **MIT**, Cambridge, MA
MIT-MGB AI Cures Conference *Poster Presentation*
Title: Neural Pharmacodynamic State Space Modeling
- 2018 **Dana Farber Cancer Institute**, Boston, MA
Big Data and Precision Medicine Conference *Breakout Session*
Title: Disease Progression Modeling
Big Data and Precision Medicine Conference (Invited as co-author.)
Title: Forays into understanding multiple myeloma with machine learning
- 2018 **Harvard Medical School**, Longwood, MA
Soma Weiss Research Day *Poster Presentation*
Title: Modeling disease progression in multiple myeloma
- 2017 **AMIA Annual Symposium** *Oral Presentation*
Title: Differential data augmentation techniques for medical imaging tasks

2016 **NeurIPS ML4H Workshop**

Oral Presentation

Title: Data augmentation for mammography classification

Teaching & Mentorship

Teaching

2022 Teaching Assistant for 6.871 (Machine Learning for Healthcare) at MIT

Mentorship

2019-Present **Resident Tutor**, Winthrop House, Harvard University

Mentored >100 undergraduate pre-medical students on medical school applications, including mock interviews, personal statement review, and individualized advising. Organized community events, both social and academic, for Winthrop students.

2021 Mentor, MIT Summer Research Program – Fernando Acosta Perez
Current PhD Student at University of Wisconsin-Madison

Service

Conferences

2025 Reviewer, Uncertainty in Artificial Intelligence (UAI)

Top Reviewer Award

2022 Reviewer, Neural Information Processing Systems (NeurIPS)

2022 Reviewer, International Conference on Machine Learning (ICML)

Top Reviewer Award (Top 10%)

2021 Reviewer, International Conference on Machine Learning (ICML)

2021 Reviewer, Uncertainty in Artificial Intelligence (UAI)

Journals

2021 Reviewer, Journal of Machine Learning Research (JMLR)

Workshops

2023 Reviewer, Time Series Representation Learning for Health (ICLR Workshop)

Awards and Honors

2025 MD with Honors in a Special Field, *cum laude*

2025 Top Reviewer Award (~Top 10%), UAI 2025

2022 NIH Ruth L. Kirschstein National Research Service F30 Award Recipient

2022 Top Reviewer Award (Top 10%), ICML 2022

2019 NDSEG Fellowship Alternate Awardee

2016 Award of Excellence

Presented to top 10% of graduating seniors who exemplify leadership in the Stanford community

2013 AFRL Repperger Fellow

Competitive grant given to undergraduates to pursue research at the Air Force Research Lab (AFRL).