Mahasweta Bhattacharya

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Education

University at Buffalo, State University of New York — Buffalo, NY
Doctor of Philosophy in Biomedical Engineering — *Aug. 2017 – Jan 2023*

University at Buffalo, State University of New York — Buffalo, NY
Master of Science in Electrical Engineering — *Aug. 2015 – May 2017*

West Bengal University of Technology — Kolkata, India
Bachelor of Technology in Electronics and Communication Engineering — *Aug. 2010 – May 2014*

Skills

- **Machine Learning:** Supervised/unsupervised learning, representation learning, causal inference, graph neural networks, multimodal learning, VAEs, uncertainty quantification.
- **LLMs & Agentic AI:** LLM fine-tuning (LoRA/PEFT), RAG pipelines, multi-agent orchestration (Claude/GPT), structured generation, scientific summarization, grounding and consistency checking.
- **Applied ML:** End-to-end ML pipelines, feature engineering, embedding similarity search, statistical modeling, Bayesian inference, high-dimensional data analysis.
- **AI Systems:** Python (PyTorch, TensorFlow, JAX), CUDA/GPU computing, Docker, HPC (Slurm).
- **Data Engineering:** ETL pipelines, data harmonization/QC, SQL/Snowflake, graph databases (Neo4j), S3 data lakes.
- **Cloud & Databases:** AWS (EC2, S3, Batch), SQL, Snowflake, MySQL, S3-based data lakes, scalable storage architectures.

Experience

Senior Scientist — Sept. 2023 – Present
Sanofi — *Cambridge, MA*

- Led the design of an **agentic-AI pipeline orchestrating Claude-based agents** to autonomously aggregate and summarize multimodal biological evidence for target credentialing; delivered scalable plain-language evidence reports, reduced manual review overhead by >**50%**, and operationalized **LLM-driven reasoning in a regulated scientific workflow.**
- Designed a multi-modal foundation model integrating genetics, transcriptomics, and clinical embeddings; achieved **4**× **improvement in causal target recall** over genetics-only baselines and established a transferable representation space for cross-disease generalization.
- Led transcriptomic pharmacodynamics modeling to compare oral vs injectable therapies for Hidradenitis Suppurativa; identified **superior immune-pathway perturbation** for the oral candidate, enabling preclinical advancement and establishing a robust MoA modeling workflow.
- Developed a harmonized meta-analysis pipeline for public HS transcriptomes, producing a **mechanistic target-ranking framework** presented at FOCIS 2025 and forming the computational backbone for patient stratification and network modeling.
- Founded a graph-based bispecific discovery platform integrating synergy metrics, biological embeddings, and **LLM-guided evidence retrieval**; generated **5 novel bispecific target-pair candidates**.
- Built a scalable disease-mapping and indication-discovery engine scoring **232 immune indications in 3 weeks** and scaling to **17,000+ phenotypes**, enabling computational repurposing and whitespace identification.
- Developed an explainable AI-driven target-discovery engine generating **90+ hypotheses** and advancing **7 novel targets** into preclinical evaluation; incorporated causal scoring, embedding similarity, and LLM-augmented evidence synthesis.
- Co-led an automated multimodal target-credentialing platform supporting **30+ therapeutic programs** and enabling **3 preclinical nominations**; introduced modules for causal inference, uncertainty quantification, and prospective validation.

Postdoctoral Fellow, Radiation Oncology — Jan 2023 - Sept 2023
Johns Hopkins University School of Medicine — *Baltimore, MD*

- Developed a GPU-accelerated double-Gaussian proton dose engine as a Python package; achieved **0.28s** mean patient-plan computation vs **4.68s** Monte Carlo with **96% 3D-gamma agreement (2%/2mm)**, demonstrating physics-informed acceleration at ML-scale throughput.
- Architected an end-to-end beam-modeling and validation pipeline from **98 pristine Bragg-peak energies**, benchmarking against measurements, heterogeneous digital phantoms, and multi-site patient plans; built uncertainty profiles highlighting limits in highly heterogeneous regions.
- Advanced a **deep reinforcement learning framework** for VMAT machine-parameter optimization, producing deliverable prostate plans in **3.3s** and automated TPS refinement in **77s**; on a 15-patient external cohort, RL+TPS reduced mean rectum dose vs clinical plans (**17.4 vs 21.0 Gy**, p=0.024) while maintaining target coverage.

- Integrated RL-generated optimization with a commercial treatment-planning system to create a **hybrid automated + human-in-the-loop pipeline**, operationalizing ML methods into clinical workflows and demonstrating production-grade feasibility.

Research Assistant 2017 – 2023

State University of New York at Buffalo *Buffalo, NY*

- Analyzed longitudinal two-photon calcium imaging to reconstruct session-wise functional connectomes during motor-skill learning; identified a **biphasic rewiring trajectory** (early expansion then pruning) and discovered stable L2/3 hub assemblies encoding movement.
- Integrated portable fNIRS and EEG with electric-field–informed GLMs to model cerebellar tDCS response in stroke; uncovered **0.07–0.13 Hz hemoglobin–EEG coupling signatures** predictive of responders and interpretable non-response patterns.
- Developed the **FARCI** MATLAB toolbox for fast connectome inference using OASIS spike deconvolution and partial correlations; outperformed existing spike-inference algorithms on NCC and NAOMi benchmarks in accuracy and scalability.
- Demonstrated that low-frequency coupling between frontal HbO (0.07–0.13 Hz) and EEG (1–12 Hz) tracks consciousness in acute brain injury; AMICA embeddings + k-NN achieved $>$**90% accuracy** distinguishing conscious vs unresponsive patients and $>$**99% accuracy** predicting failure to recover consciousness.
- Built a multi-sensing cerebral organoid platform integrating Vis–NIR spectroscopy (mitochondrial CCO) with MEA-derived spectral exponents; quantified maturation-linked decreases in **30–50 Hz slope** and CCO activity, enabling functional screening of metabolic–electrophysiological coupling.
- Modeled photothermal vs photobiomodulation mechanisms using Monte Carlo photon transport + bioheat modeling at 630/700/810 nm; predicted $<$**0.25°C scalp** and $<$**0.04°C cortical** heating at 810 nm, supporting safety and highlighting CCO-mediated photobiomodulation as the primary mechanism.

PUBLICATIONS

[1] M. Bhattacharya, C. Reamy, H. Li, J. Lee, and W. T. Hrinivich, "A python package for fast gpu-based proton pencil beam dose calculation," *Journal of Applied Clinical Medical Physics*, 2025.

[2] W. T. Hrinivich et al., "Clinical vmat machine parameter optimization for localized prostate cancer using deep reinforcement learning," *Medical physics*, vol. 51, no. 6, pp. 3972–3984, 2024.

[3] S. Meamardoost et al., "Rewiring dynamics of functional connectomes during motor-skill learning," *Data Science in Science*, vol. 2, no. 1, p. 2 260 431, 2023.

[4] S. Meamardoost et al., "Farci: Fast and robust connectome inference," *Brain sciences*, vol. 11, no. 12, p. 1556, 2021.

[5] M. H. Othman et al., "Resting-state nirs–eeg in unresponsive patients with acute brain injury: A proof-of-concept study," *Neurocritical Care*, vol. 34, no. 1, pp. 31–44, 2021.

[6] Z. Rezaee et al., "Feasibility of combining functional near-infrared spectroscopy with electroencephalography to identify chronic stroke responders to cerebellar transcranial direct current stimulation—a computational modeling and portable neuroimaging methodological study," *The Cerebellum*, vol. 20, no. 6, pp. 853–871, 2021.

[7] A. Dutta et al., "A proof of concept 'phase zero'study of neurodevelopment using brain organoid models with vis/near-infrared spectroscopy and electrophysiology," *Scientific Reports*, vol. 10, no. 1, p. 20 987, 2020.

[8] M. Bhattacharya and A. Dutta, "Computational modeling of the photon transport, tissue heating, and cytochrome c oxidase absorption during transcranial near-infrared stimulation," *Brain sciences*, vol. 9, no. 8, p. 179, 2019.

TALKS & PRESENTATIONS

As Presenter / Speaker

- HubXChange AI in Drug Discovery, Boston, MA 2025
- *Development of a Python package for fast GPU-based proton pencil beam dose calculation*, American Association of Physicists in Medicine (AAPM), Houston, TX 2023
- *Stability of Motor Cortex Decoders during Learning*, Society for Neuroscience (SfN) Annual Meeting, San Diego, CA 2022
- *Does Learning Alter Neural Decoders of Motor Cortex?*, Society for Neuroscience Global Connectome, Virtual 2021
- *Computational modeling of neural activation during transcranial photothermal stimulation*, Society for Neuroscience Annual Meeting, Chicago, IL 2019
- *Development of bidirectional 'mini-Brain' computer interface (mBCI) to modulate functional neural circuits*, Society for Neuroscience Annual Meeting, San Diego, CA 2017

As Co-author

- *MultiTIE: Sanofi's Multi-Specific Target Immune Engine*, International Systems for Molecular Biology (ISMB) & European Conference on Computational Biology (ECCB), Liverpool, UK 2025
- *HSID: An Integrative Target Discovery Framework for Hidradenitis Suppurativa*, Federation of Clinical Immunology Societies (FOCIS), Boston, MA 2025
- *Meta-analysis of Genome-wide Association Studies of Asthma Exacerbation*, Federation of Clinical Immunology Societies (FOCIS), Boston, MA 2025
- *Understanding Neuronal Network Dynamics during Motor Skill Learning through a Model-Free Connectome Inference Method*, Society for Neuroscience Global Connectome, Virtual 2021

Honors & Awards

- Member, Institute of Electrical and Electronics Engineers (IEEE) 2015–Present
- Member, The AI Consortium 2025–Present
- Winning Solution, Biomedical Knowledge Graph Hackathon, BioLabs Heidelberg, Germany & Sanofi 2025
- Finalist, 3 Minute Thesis Competition 2022

Teaching

Course Instructor

- *Biomedical Circuits and Signals* Fall 2017, 2018, 2019
- *Biomedical Engineering Biosignals Lab* Spring 2018, 2019

Professional Service

Peer Review

- Applied Sciences (MDPI) 2023–Present
- BioMedInformatics (MDPI) 2023–Present
- Engineering Applications of Artificial Intelligence (Elsevier) 2023–Present
- Heliyon (Elsevier) 2023–Present
- International Journal of Molecular Sciences (MDPI) 2024–Present
- Mathematics (MDPI) 2024–Present
- Symmetry (MDPI) 2024–Present
- Genes (MDPI) 2023–Present

Departmental & University Service

- Graduate Student Ambassador, Dept. of Biomedical Engineering, State University of New York at Buffalo 2018–2019

Community Service

- MIT Undergraduate Practice Opportunities Program (MIT UPOP), Mentor Panelist 2024–Present
- Hopkins Biotech Network Mentor Match Program, Mentor Panelist 2024