Mostofa Rafid Uddin

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Research Interests & Expertise

Research Topics of Interest: *High Expertise:* Unsupervised, Self-supervised Representation Learning, Contrastive Learning, 3D Computer Vision, Structural Bioinformatics, Object detection and Segmentation.
Moderate Expertise: Domain adaptation, Domain Generalization, Deep Generative Models, Probabilistic Graphical Models, Vision Foundation Models, Geometric Learning, Computational Genomics.
Datasets of expertise: Scene-centric images, 3D tomographic images, Microscopy images, 3D data with various representations (mesh, point-cloud, SDF, voxels, Gaussian Splat), Biological Sequence Data (Protein, DNA, RNAseq, ATAC-seq, ChIP-seq).

Education

2021- Present	**Doctor of Philosophy (Ph.D), School of Computer Science**, Carnegie Mellon University, Pittsburgh, PA 15213, USA **Advisor: Min Xu** **Distinctions**: CMLH Fellowship for Digital Health 2023, OutStanding Research Accomplishment Award 2024.
2021- 2024	**Master of Science (M.Sc.), Computational Biology- Advanced Study, School of Computer Science**, Carnegie Mellon University, Pittsburgh, PA 15213, USA (Awarded during Ph.D.) **Relevant Coursework**: Machine Learning (Ph.D.) level, Computer Vision, Probabilistic Graphical Models, Computational Genomics, Cell and Systems Modelling, Computational Structural Biology.
2014 -2018	**Bachelor of Science in Computer Science and Engineering**, Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh. **Academic distinctions**: Deans list awards, University merit scholarships. **Relevant Coursework**: Computer Graphics, Object-oriented Programming, Structured Programming, Pattern Recognition, Digital Image Processing, Machine Learning, Artificial Intelligence, Discrete Mathematics, Concrete Mathematics.

Work Experience

2021 - Present	**Graduate Research Assistant**, Computational Biology Department, School of Computer Science, Carnegie Mellon University, PA, USA
2022	**Graduate Teaching Assistant**, Computational Biology Department, Spring 2022 CMU 02-620: Machine Learning for Scientists Fall 2022 CMU 02-740: Bioimage Informatics
2019- 2020	**Lecturer**, Department of Computer Science and Engineering, East West University, Dhaka, Bangladesh.

Selected Research Publications

A few representative publications are mentioned here.

- **Mostofa Rafid Uddin**, Gregory Howe, and Min Xu. Harmony: A Generic Unsupervised Approach for Disentangling Semantic Content from Parameterized Transformations.*Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, 2022, pp. 20646-20655. (H5-index: 356). [paper link] [news link]. Skills: Unsupervised Learning, Representation Learning, Deep Generative Models, Bio-image Analyses.
  - In many real-life image analyses, particularly biomedical research domains, objects in the images undergo several parameterized transformations.

  - I developed an unsupervised method to disentangle the transformations from image contents and demonstrate that it significantly facilitates many downstream tasks.

- **Mostofa Rafid Uddin**, Sazan Mahbub, M Saifur Rahman, and Md Shamsuzzoha Bayzid. SAINT: Self-Attention Augmented Inception-Inside-Inception Network Improves Protein Secondary Structure Prediction. *Bioinformatics*, 2020 Nov 1; 36(17):4599-608. (H5-index: 136, Impact Factor: 6.937) [paper link]. Skills: Neural Machine Translation, Structural Bioinformatics, Dense Prediction.
  - Predicting 8-state (Q8) secondary structure from amino acid sequences of protein is an important but challenging problem.
  - Developed a self-attention augmented inception-inside-inception network that improves state-of-the-art protein secondary structure prediction and recovers insights of protein folding through interpretable attention features.

- Sayali Onkar, Jian Cui, Jian Zou, Carly Cardello, Anthony R Cillo, **Mostofa Rafid Uddin**, April Sagan, Marion Joy, Hatice U Osmanbeyoglu, Katherine L Pogue-Geile, Priscilla F McAuliffe, Peter C Lucas, George C Tseng, Adrian V Lee, Tullia C Bruno, Steffi Oesterreich, Dario AA Vignali. Immune landscape in invasive ductal and lobular breast cancer reveals a divergent macrophage-driven microenvironment. *Nature Cancer*(Impact Factor: 23.18). [paper link] Skills: Statistical Image Analysis, Applied Science Research.
  - Developed a pipeline for spatial cell neighborhood analysis in multispectral tumor microenvironment images.
  - Demonstrated the role of different cell phenotypes in tumor microenvironment from spatial analysis.

Other Publications

For a full and up-to-date list, please visit my google scholar link.

- Hmrishav Bandyopadhyay, Zihao Deng, Leiting Ding, Sinuo Liu, **Mostofa Rafid Uddin**, Xiangrui Zeng, Sima Behpour, and Min Xu. Cryo-shift: reducing domain shift in cryo-electron subtomograms with unsupervised domain adaptation and randomization. *Bioinformatics*, 2022 Feb 15; 38(4):977-984. (H5-index: 136, Impact Factor: 6.937) [paper link].
- Tianyang Wang, Bo Li, Jing Zhang, Xiangrui Zeng, **Mostofa Rafid Uddin**, Wei Wu, Min Xu. Deep Active Learning for Cryo-Electron Tomography Classification. *International Conference on Image Processing*. 2022; pp. 1611-1615. [paper link]
- Xiangrui Zeng, Ziqian Lin, **Mostofa Rafid Uddin**, Bo Zhou, Chao Cheng, Jing Zhang, Zachary Freyberg, Min Xu. Structure Detection in Three-Dimensional Cellular Cryoelectron Tomograms by Reconstructing Two-Dimensional Annotated Tilt Series. *Journal of Computational Biology*. 2022; 29(8): 932-941. [paper link]
- Tarun Gupta, Xuehai He, **Mostofa Rafid Uddin**, Xiangrui Zeng, Andrew Zhou, Jing Zhang, Zachary Freyberg, Min Xu. Self-supervised learning for macromolecular structure classification based on cryo-electron tomograms. *Frontiers in Physiology*. 2022; p1757. [paper link]
- Hannah Kim, **Mostofa Rafid Uddin**, Min Xu, and Yi-Wei Chang. Computational methods toward unbiased pattern mining and structure determination in cryo-electron tomography data. *Journal of Molecular Biology* 2023; 16806. [paper link]
- Najibul Haque Sarker, Zaber Abdul Hakim, Ali Dabouei, **Mostofa Rafid Uddin**, Zachary Freyberg, Andy MacWilliams, Joshua Kangas, and Min Xu. Detecting anomalies from liquid transfer videos in automated laboratory setting. *Frontiers in Molecular Biosciences* 2023; 1147514. [paper link]

Technical Skills

Languages: Python, Java, C, C++. **HPC Computing:** AMD Cluster, Oracle Cloud, AWS.
Frameworks: Pytorch, Detectron, Tensorflow, OpenCV, Numpy, Scipy, Scikit-learn.

Grants & Awards

- **Center for Machine Learning and Health (CMLH) fellowship in Digital Health, 2023** CMLH fellowships, around 100,000 USD worth, are awarded each year to several (around 10) outstanding digital health-related

research proposals by CMU PhD students. I received the award in 2023 with my proposal *"Leveraging Cryo-ET Imaging Technology to Improve Patient Care for Neurodegenerative Diseases by Identifying Subcellular Biomarkers"*. [link] Skills: Grant Writing, Independent Research.

- **Outstanding Research Accomplishment Award** This award is given each year to one CMU PhD student from the Computational Biology Department who has contributed significant research during his time in the PhD program. Skills: Independent Research.

  [*link*]

- Won best poster award at 3rd International Conference on Networking, Systems and Security (NSysS 2017). Poster Title: *Archiving Medical Records in DNA Sequence*[*pdf*] Skills: Precision Health, Electronic Health Records
- **Dean's list scholarship** (awarded for CGPA above or equal 3.75 out of 4.00 in an academic year) in all academic levels during undergraduate studies at BUET.
- **University merit scholarship** (awarded to top 10 ten students with highest GPA in a semester) during undergraduate studies at BUET.
- **Champion**, Hacathon for environmental migrants 2018 organized by Wageningen University, the Netherlands. [*pdf*]
- **Runner up**, Bracathon 2017 organized by Brac. *Category: Networking for Young Apprentices* [*event*]
- **Second Runner up**, National Hacathon 2016 organized by ICT Division, Bangladesh Government. *Category: Qualified Teachers in Education.* [*event*]
- **Second Runner up**, Buet Website Design Competition 2015 organized by IICT, BUET.

Services

- Serve as a member of the Diversity, Equity, and Inclusion (DEI) committee at the Computational Biology Department at Carnegie Mellon University.
- Regularly serve as a reviewer in top AI and vision conferences such as NeurIPS, CVPR, ICCV, ECCV, WACV, AAAI, etc.
- Served as a reviewer for Expert Systems with Applications Journal.
- Worked as a mentor in CMU AI Mentoring Program, where I mentor CMU undergraduate students coming from underrepresented communities interested in AI research
- Gave research talk on IEEE Applied Imagery Pattern Recognition (AIPR) Workshop (virtual), October 2021, Washington, DC, US.
- Worked as a moderator of East West University Electronics, Programming, and Robotics Club from January 2020-December 2020 in Bangladesh.
- Designed and developed a responsive website for International Conference on Networking Systems and Security(NSysS). [*link*]
- Participated in reviewing National Information and Communications Technology (ICT) books designed for high-school students.
- Worked as an organizer of BUET CSE Festival in 2018, the largest university level computer science festival in Bangladesh.

Mini-Research Projects

♢ **Design of Phase-separated Protein Sequences using Adaptive Sampling and Active Learning** Developed a probabilistic approach for designing in silico proteins with a high propensity for liquid-liquid phase separation (LLPS) and droplet formation. [*github*] Skills: Probabilistic Graphical Models, Protein Design, Optimization.

♢ **Pytorch Implemented Local Energy Minimizer** Implemented the local energy minimizer module of OpenMM software by modifying pytorch autograd mechanics. [*github*]

♢ **Edge prediction: Predicting Edge in Academic Citation Networks** Predicted how likely an academic article is to cite another particular article using an intelligent and novel feature engineering pipeline that could generate highly accurate predictions with relatively simpler models. [*github*]

♢ **Predicting age from lung single cell data** Applied multiple feature extraction models and classifiers to predict biological age from scRNA-seq data of multiple control patients. [*github*]

♢ **Onubadok: Bangla to English Machine Translation Using Seq2Seq Model with Attention Mechanism.** In this project on Neural Machine Translation(NMT), I observed that using Bahdanau's attention with a vanilla encoder-decoder model improves BLEU score for Bangla to English translation. [*github*]

♢ **Arduino based Posture Corrector.** Developed a posture corrector android application that could detect unusual bending of user wearing a device containing flex sensor. [*youtube*]