Md Mushfiqur Rahman

Machine Learning researcher and developer with 5+ years of experience in NLP and Computer Vision

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CAREER HIGHLIGHTS

- **8 peer-reviewed** articles (6 as the first author/equally contributing co-author); **2 at Q1 journals**.
- Presented at multiple conferences and workshops.
- My ML model is actively being used in **denoising images at the Hinode Spacecraft.**

EDUCATION

George Mason University (Fairfax, VA) Aug. 2021 – Present

PhD in Computer Science (CGPA: 3.90)

- **Advisors**: Dr. Kevin Lybarger and Dr. Sanmay Das
- **Research domain**: Machine Learning and Natural Language Processing in Health
- **Expected Date of graduation**: May 2026

MSc in Computer Science (CGPA: 3.88)

- **Concentration**: Machine Learning

Islamic University of Technology (Gazipur, Bangladesh) Jan. 2017 – Feb. 2021

BSc in Computer Science and Engineering (CGPA: 3.79)

- **Advisor**: Dr. Hasanul Kabir
- **Final Thesis**: StructGAN: Image Restoration Maintaining Structural Consistency Using A Two-Step Generative Adversarial Network
- Published **3 research papers** during the undergraduate studies

PROJECTS

Spectral Reconstruction of EIS Images with Conditional GAN

- Compared 4 image reconstruction/denoising algorithms (GAN, cGAN, WGAN, and Autoencoder) for EIS images.
- The cGAN **removes 93% noise** and improves image denoising capabilities of the EIS hosted in Hinode.

Analyzing Text-representation (tokenization vs non-tokenization) Modes in Cross-lingual Transfer [Code] [Paper]

- Compared tokenization-based models (`BERT`, `mBERT`) with tokenization-free models (`PIXEL`, `CANINE`). Proposed a decision aid for text-representation based on **19 source and 133 target languages** for **3 common NLP tasks**.
- The analysis underscores the **importance of non-tokenization models** for specific tasks.

Health Information Simplification and Summarization [Code] [Paper]

- Created the **first medical dataset for text simplification** based on reading level **(complex to 6th grade)**
- Benchmarked GPT4 and Llama2 (trained with RL) on this dataset. Evaluated **GPT4 in 5 different settings.**
- Created a Llama-2 variant trained with Q-LoRA (minimizing computational resource requirement by **60% for GPU usage and 90% for time**). Reduced data requirements significantly by introducing a novel SFT+PPO model (with a novel reward).

Large-scale ML Optimization for Online Continual Learning (Image Classification Tasks)

- Developed a novel algorithm to **handle catastrophic forgetting** for continual learning tasks in an online setup. When learning new a task, the model **does not lose (substantial) performance** on previously learned tasks.
- The model assumes an online setup (ie., no storage) and **achieves comparable results to a non-online setup**.

COVID Misinformation Detection

- Built a BERT-based model. Achieved **97% accuracy on Constraint2021** and **93% accuracy on CoAID** dataset.
- Extensively analyzed the effectiveness of **LLMs (GPT3) in zero-shot and few-shot settings** for this task.

Retrieval Augmented Generation (RAG) for scientific documents [Code]

- Built a **Llama-3.1 dependent RAG framework** for retrieving information from scientific documents and instrument specifications

Analyzing the Effect of Attentions in Video Captioning [Code] [Paper]

- Compared different attention mechanisms and for video captioning. Created a **video captioning model** with stacked attention that achieved **state-of-the-art performance on MSVD**.
- A **detailed ablation study of each component** of the model showed the contribution of the stacked attention in retaining semantic information.

Image In-painting and Reconstruction with GAN [Code]

- Proposed **StructGAN** enhances image restoration by using a unique structure loss, achieving higher SSIM scores than SOTA.
- The model combines advanced GAN components for refined output and semantic consistency, outperforming other models in key metrics.

EXPERIENCE

George Mason University — Fairfax, VA
Graduate Research Assistant and Graduate Teaching Assistant — Aug. 2021 – Present

- Published **5 research papers** related to NLP in the last 2 years.
- Taught “Introduction to Programming (Python)" and “Data Structures (with Java)" courses.

US Naval Research Laboratory — SW Washington, DC
Machine Learning Intern — May 2023 – Aug. 2023 & May 2024 – Aug. 2024

- Built a **GAN (Generative Adversarial Network)-based image denoiser** for the EIS (Extreme-ultraviolet Image Spectrometer) machine hosted in the Hinode spacecraft.
- The ML model is **actively being used in the Hinode spacecraft** and **removes 93% noise** from the EIS-generated images. It achieves **0.48 average test error** which is significantly better than the previous best (0.72).
- Created a **RAG** pipeline that uses private technical documents at NRL as the knowledge base and **Llama-3.1** as the generative model.

Military Institute of Science and Technology — Dhaka, Bangladesh
Faculty (Lecturer) — Mar 2021 – Aug. 2021

- Taught **Undergraduate Artificial Intelligence** course. Re-designed the course structure to fit current needs.
- Taught 3 lab courses.
- Co-supervised **3 undergraduate thesis projects** related to machine learning.

Samsung R&D Institute Bangladesh — Dhaka, Bangladesh
ML Research Intern — Nov. 2019 Jan. 2020

- Developed a deep learning model that generates **3D objects from equirectangular (box-map) images**.
- The GAN-like model (adjusted for spherical images) achieved **0.21 RMS error** for the 3-D vertices

SKILLS

- Building and maintaining ML pipelines with **Pytorch / Tensorflow / Keras / Huggingface** for data science. Building **GPT-like LLMs** with Reinforcement Learning.
- Using **cloud platforms** to run and maintain code. Writing algorithms to **minimize training resource requirements.**
- **Languages/Libraries**: Python (Pytorch, Tensorflow, Pandas, Sklearn), C, C++, Java, SQL, MongoDB, FastAPI

AWARDS AND SCHOLARSHIPS

- **Distinguished Academic Achievement Award**, from George Mason University (2024)
- **Runner-up of Inter-University App Development Contest**, 2019 ICT Fest
- **Champion of ICT4D** at 4th AUW ICT Fest 2018
- **National Topper** in Mathematics in IAS (International Assessment for Schools) by UNSW (x2) (2008, 2014)
- **National Mathematical Olympiads** Medals (x4) (2009, 2012, 2013, 2014)
- **Regional (Dhaka) Physics Olympiads** Medals (x2) (2013, 2014)

SELECTED PUBLICATIONS

[1] **[Accepted at Journal of Biomedical Informatics] Md Mushfiqur Rahman**†, Mohammad Sabik Irbaz†, Kai North, Michelle S. Williams, Marcos Zampieri, and Kevin Lybarger. 2024. Health text simplification: An annotated corpus for digestive cancer education and novel strategies for reinforcement learning

[2] **Md Mushfiqur Rahman**†, Fardin Ahsan Sakib†, Fahim Faisal, and Antonios Anastasopoulos. 2023. To token or not to token: A comparative study of text representations for cross-lingual transfer. In *Workshop on Multi-lingual Representation Learning (MRL)*. Association for Computational Linguistics

[3] Fardin Ahsan Sakib†, A H M Rezaul Karim†, Saadat Hasan Khan†, and **Md Mushfiqur Rahman**†. 2023. Intent detection and slot filling for home assistants: Dataset and analysis for Bangla and Sylheti. In *Workshop on Bangla Language Processing (BLP)*. Association for Computational Linguistics

[4] **[Shared Task]** Bin Han†, Haotian Zhu†, Sitong Zhou†, Sofia Ahmed, **Md Mushfiqur Rahman**, Fei Xia, and Kevin Lybarger. 2023. Huskyscribe at mediqa-sum 2023: Summarizing clinical dialogues with transformers. Thessaloniki, Greece. CLEF

[5] Refaat Mohammad Alamgir, Ali Abir Shuvro, Mueeze Al Mushabbir, Mohammed Ashfaq Raiyan, Nusrat Jahan Rani, **Md Mushfiqur Rahman**, Md. Hasanul Kabir, and Sabbir Ahmed. 2022. Performance analysis of yolo-based architectures for vehicle detection from traffic images in bangladesh. In *25th International Conference on Computer and Information Technology (ICCIT)*

[6] **[Q1 Journal] Md Mushfiqur Rahman**†, Thasin Abedin†, Khondokar SS Prottoy, Ayana Moshruba, and Fazlul Hasan Siddiqui. 2021. Video captioning with stacked attention and semantic hard pull. *PeerJ Computer Science*

[7] **Md Mushfiqur Rahman**†, Sabah Binte Noor, and Fazlul Hasan Siddiqui. 2020. Automated large-scale class scheduling in minizinc. In *International Conference on Sustainable Technologies for Industry 4.0 (STI)*

INVITED TALKS

- May 2024, Naval Research Laboratory: “Leveraging Generative AI for Advanced Scientific Research: Breakthroughs and Barriers"

Equally contributing authors marked with †.