Mohammed Rakib

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Education

Doctor of Philosophy in Computer Science **August 2023 – Present**
Oklahoma State University (OSU) - Stillwater, OK, USA ***GPA: 3.79***

Bachelor of Science in Computer Science and Engineering **September 2017 – September 2021**
North South University (NSU) - Dhaka, Bangladesh ***GPA: 3.96***

Research Interest

• Computer Vision • Multimodal Learning • NLP • Model Compression Techniques

Academic Experience

Graduate Research Assistant **August 2023 – Present**
Complex Systems Lab, Oklahoma State University *Stillwater, OK, USA*

- Investigate modality imbalance in multimodal learning across real-world applications and benchmark datasets to ensure equitable representation of all modalities during model training.
- Refine knowledge distillation techniques to enhance cross-modal learning.
- Develop a multimodal framework integrating smartphone/edge-device captured crop/soil patch images with tabular meteorological data for improved soil moisture estimation and precision agriculture.

Graduate Teaching Assistant **August 2023 – Present**
Department of Computer Science, Oklahoma State University *Stillwater, OK, USA*

- Assist in developing and grading course materials and manage the Canvas platform.
- Provide one-on-one mentorship, maintain course websites, and participate in curriculum development meetings.
- Courses include:
  - Design & Implementation of Operating Systems I (Fall 2023)
  - Intro to Object-Oriented Programming (Spring 2024)

Research Assistant **September 2021 – September 2022**
Apurba-NSU R&D Lab *Dhaka, Bangladesh*

- Collaborate with fellow RAs to train, fine-tune, and deploy various deep learning models for image classification, OCR, ASR, sentence similarity, masked language modeling, QA, and NER.
- Conduct research in model compression techniques (pruning, quantization, and knowledge distillation), analyze findings, and present weekly reports.

Professional Experience

Data Scientist & Machine Learning Engineer **September 2022 – July 2023**
NeovoTech Ltd. *Dhaka, Bangladesh*

- Create crawlers to scrape news articles from various websites and store them in an AWS S3 bucket.
- Create, maintain, and deploy text translation and text summarization pipelines.

Machine Learning Intern **June 2022 – August 2022**
NeovoTech Ltd. *Dhaka, Bangladesh*

- Collaborate with colleagues to prepare a web crawler that crawls Swedish news text.
- Contribute to improving the Neural Machine Translation (NMT) pipeline from Swedish to English text.

Technical Skills

Programming Languages: Python, Java, C, C++, Shell Scripting, Arduino, HTML, SQL, x86 Assembly
AI & Data Science: PyTorch, TensorFlow, Keras, OpenCV, Scikit-learn, Hugging Face, Pandas, Matplotlib
Web Development: Django, FastAPI, Flask, Nginx, HTML, CSS, JavaScript
Version Control: Git, Bitbucket
Databases: MySQL, MongoDB, NoSQL, Redis
DevOps & Containerization: Docker, Kubernetes
Cloud Computing: Amazon EC2, AWS Services
Big Data Technologies: Hadoop, Apache Spark

Projects

MIS-ME: A Multi-modal Framework for Soil Moisture Estimation **August 2023 – January 2024**

Research Member

- Curated a real-world dataset of soil patch images paired with meteorological data, creating a benchmark that captures both visual and environmental factors for soil moisture estimation.
- Developed a multimodal framework that fuses tabular meteorological data with soil patch images, improving soil moisture prediction by reducing MAPE by 3.25% over meteorological models, 2.15% over image-based models, and at least 1.5% over conventional fusion models.

LILA-BOTI: Leveraging Isolated Letter Accumulations by Ordering Teacher Insights for Bangla Handwriting Recognition **June 2021 – March 2022**

Research Member

- Developed a knowledge distillation (KD) method where a student CRNN model trained on an imbalanced handwritten word-level dataset leveraged insights from a teacher model trained on a balanced printed character-level dataset to mitigate class imbalance.
- Demonstrated that LILA-BOTI improved the F1-Macro score for minor classes by up to 3.5% and increased the overall word recognition rate by up to 4% compared to the base CRNN model and conventional KD techniques.

Water Level Forecasting Using Spatiotemporal Attention-Based Long Short-Term Memory Network **June 2021 – September 2021**

Research Member

- Developed a flood forecasting system using a Spatial-Temporal Attention LSTM (STALSTM) that integrated gauge-based water level data from multiple stations to predict river flooding in Bangladesh.
- Demonstrated that STALSTM improved water-level prediction accuracy over LSTMs by 3.44% at Dhaka station.

IoT-Based Air Pollution Monitoring & Prediction System **January 2020 – April 2020**

Project Leader

- Led a group of 3 to develop an IoT-based air pollution monitoring system that collects real-time atmospheric data from multiple sensors, transmits it to a cloud storage platform, and continuously tracks air quality parameters.
- Implemented an ARIMA model to predict future pollutant levels with over 90% accuracy, leveraging 144 hourly observations to forecast next-day air quality.

An Open Source Contractual Language Understanding Application Using Machine Learning **January 2021 – August 2021**

Project Co-leader

- Co-led a team of 4 to develop an end-to-end legal contract review system that processes both digital and scanned contracts to highlight key clauses and provide contextual explanations for non-legal users.
- Fine-tuned, and optimized transformer-based models, achieving a 4% improvement in AUPR over the RoBERTa-base model and deployed the best-performing model in a resource-constrained environment for real-time contract analysis.
- Made the model publicly available on **Hugging Face**, where it receives an average of 20k downloads per month, enabling widespread use in legal document processing.

Cyclic Overlapping Lottery Ticket (COLT) – Undergraduate Thesis **November 2020 – October 2021**

Research Member

- Developed an iterative pruning algorithm that identifies a highly sparse subnetwork by leveraging overlapping weights from class-wise dataset partitions, achieving comparable accuracy to the original unpruned model.
- Demonstrated that COLTs require fewer pruning iterations than Iterative Magnitude Pruning (IMP) and can be transferred across datasets without performance degradation, showcasing their generalization capability.

My Reading Room **May 2020 – August 2020**

Individual Project

- Developed a Django-based learning management system enabling users to create classrooms, upload documents, and track reading time of enrolled users.
- Implemented face detection and recognition using OpenCV to accurately monitor user engagement with documents.

Age Estimation on AgeDB **May 2021 – August 2021**

Individual Project

- Finetuned a ResNet-152 model to achieve an MAE of 9.07 years on AgeDB, surpassing the SOTA DEX model (13.1 years) while using 20 times fewer training samples.
- Demonstrated that CORAL loss outperforms cross-entropy loss for age estimation on AgeDB, improving model accuracy.

Bangla-Wave: Improving Bangla Automatic Speech Recognition Utilizing N-gram Language Models **July 2022 – September 2022**

Individual Project

- Finetuned a pretrained wav2vec2 model on the Bengali Common Voice dataset (399 hours) to develop a state-of-the-art Bangla ASR model, achieving a WER of 4.66% and a CER of 1.54%.
- Enhanced transcription accuracy by integrating an n-gram language model as a post-processor, optimizing hyperparameters, and implementing preprocessing techniques for improved generalization.

Exploiting Adaptive Contextual Masking for Aspect-Based Sentiment Analysis **July 2023 – December 2023**

Research Member

- Developed Adaptive Contextual Threshold Masking (ACTM), a masking strategy that dynamically learns threshold values from gradients to filter irrelevant tokens in ABSA tasks.
- Demonstrated that ACTM improves aspect term extraction (ATE) and aspect sentiment classification (ASC), outperforming baseline approaches on multiple SemEval benchmark datasets.

PileUp Mitigation at HL-LHC Using Attention for Event-Wide Context **July 2024 – December 2024**

Research Member

- Proposed PUMiNet, an attention-based neural network that leverages self- and cross-attention mechanisms to model correlations between jets and tracks across an entire event for effective pileup mitigation.
- Demonstrated that PUMiNet surpasses traditional jet-level pileup mitigation, achieving $R^2 = 0.912$ for energy fraction and $R^2 = 0.720$ for mass fraction estimation, enabling improved Higgs boson mass reconstruction.

Publications (Most Recent First)

- Vaughan, Luke, **Rakib, M.**, Patel, Shivang, Rizatdinova, Flera, Khanov, Alexander, and Bagavathi, Arunkumar. (2025). **PileUp Mitigation at the HL-LHC Using Attention for Event-Wide Context**. *In Proceedings of the 29th Pacific-Asia Conference on Knowledge Discovery and Data Mining (PAKDD 2025).*
- **Rakib, M.**, Adil Aman Mohammed, Cole Diggins, Sumit Sharma, Jeff Michael Sadler, Tyson Ochsner, and Bagavathi, Arunkumar. (2024). **MIS-ME: A Multi-modal Framework for Soil Moisture Estimation**. *In Proceedings of the 11th International Conference on Data Science and Advanced Analytics (DSAA 2024).*
- Rafiuddin, S. M., **Rakib, M.**, Kamal, Sadia, and Bagavathi, Arunkumar. (2024). **Exploiting Adaptive Contextual Masking for Aspect-Based Sentiment Analysis**. *In Proceedings of the 28th Pacific-Asia Conference on Knowledge Discovery and Data Mining (PAKDD 2024).*
- **Rakib, M.**, Hossain, M.I., Mohammed, N., and Rahman, F., 2023, February. **Bangla-Wave: Improving Bangla Automatic Speech Recognition Utilizing N-gram Language Models**. *In Proceedings of the 2023 12th International Conference on Software and Computer Applications* (pp. 297-301).
- Mollah, Sabbir, **Rakib, M.**, Mashrur Wasek, AKM Shahariar Azad Rabby, Fuad Rahman, and Nabeel Mohammed. (2023). **Automated Mapping of Healthcare Concepts to a Standardized Healthcare Taxonomy**. *In Archive of Tiny Papers, International Conference on Learning Representations (ICLR 2023).*
- Hossain, M.I., **Rakib, M.**, Elahi, M.M., Mohammed, N., and Rahman, S. (2022). **COLT: Cyclic Overlapping Lottery Tickets for Faster Pruning of Convolutional Neural Networks**. *In IEEE Transactions on Artificial Intelligence (TAI).*
- Hossain, M.I., **Rakib, M.**, Mollah, S., Rahman, F., and Mohammed, N. (2022, August). **LILA-BOTI: Leveraging Isolated Letter Accumulations by Ordering Teacher Insights for Bangla Handwriting Recognition**. *In 2022 26th International Conference on Pattern Recognition (ICPR)* (pp. 1770-1776). IEEE.
- Nawar, A., **Rakib, M.**, Hai, S.A., and Haq, S. (2022, June). **An Open Source Contractual Language Understanding Application Using Machine Learning**. *In Proceedings of the First Workshop on Language Technology and Resources for a Fair, Inclusive, and Safe Society within the 13th Language Resources and Evaluation Conference* (pp. 42-50).
- **Rakib, M.**, Haq, S., Hossain, M.I., and Rahman, T. (2022, February). **IoT based air pollution monitoring & prediction system**. *In 2022 International Conference on Innovations in Science, Engineering and Technology (ICISET)* (pp. 184-189). IEEE.
- Noor, F., Haq, S., **Rakib, M.**, Ahmed, T., Jamal, Z., Siam, Z.S., Hasan, R.T., Adnan, M.S.G., Dewan, A., and Rahman, R.M. (2022). **Water level forecasting using spatiotemporal attention-based long short-term memory network**. *In Water, 14(4), p.612.*

Awards and Honors

- Summa Cum Laude Distinction at NSU for achieving a GPA of 3.96.
- Academic Excellence Award at NSU, 2017 – 75% scholarship for Bachelor's degree.
- Individual Student Fund Travel Award, 2024 - USD 400 by Graduate College at OSU
- 2nd Runner Up - Bengali ASR Competition, DL Sprint - BUET CSE Fest 2022.
- 5th Place - Project Showcasing, MIST ICT Innovation Fest 2021.

Voluntary Activities

- Conducted a **DataBytes Workshop** on Multimodal Learning at OSU
- Instructed workshops on PyTorch and Deep Learning at NSU, promoting skill development in neural networks.
- Assisted in fundraising for SCARS, a non-profit, to support the underprivileged, encouraging community support

References

Dr. Arunkumar Bagavathi
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Department of Computer Science
Oklahoma State University (OSU), OK, USA

Dr. Nabeel Mohammed
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Associate Professor
Department of Electrical & Computer Engineering (ECE)
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