Md Abdur Rahaman

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Education

Georgia Institute of Technology, GA, USA
PhD in Computational Science and Engineering | Expected April 2024

University of New Mexico, NM, USA
M.S. in Computer Science, July 2019

Research Interest

Machine learning, Deep Learning, Multi-modal fusion, Clustering, Pattern recognition, NLP, Computational Neuroscience

Research Experience

Graduate Research Associate – June 2019 to present.
Center for Translational Research in Neuroimaging and Data Science (TReNDS) – a joint research lab with Georgia State University, Georgia Institute of Technology, and Emory University

Roles: Designing Computational models for learning discriminative, semantically meaningful, and informative patterns from big data e.g., Neuroimaging. **Selected focus:** Biclustering, Data summarization, Model interpretability

Data Science Research Intern – September 2021 to December 2021
Nokia Bell Labs

I worked with the log analytics group and developed a log summarizer to compress the machine logs (billions of lines).
- Applied BERT models for learning log representation to detect a system failure.
- A multi-modal framework for combining system logs and user's error descriptions to route the failure alert.

Graduate Research Assistant – May 2017 to April 2019
Mind Research Network at the University of New Mexico
- Developed an automatic neuroimage preprocessing and analysis pipeline.
- Developed biclustering & tri-clustering algorithms for Neuroimaging data without specifying the model order (k).

Selected Research Projects

mBAM: deep multi-modal data fusion and classification
- A multi-modal latent space fusion using spatial and modality-wise attention inspired by the 'Bottleneck Attention Module'.
- A classifier based on functional entropy maximization that combines Neuroimages (fMRI, sMRI) and genomics data. The model is regularized with gradient blending and dynamically weighted loss.
- Empirical analysis of various deep fusion techniques.

SpaDE: Semantic locality preserving Auto-decoder for deep biclustering
- Auto encoder-based feature learning with a novel bi-clustering regularization – uncovering data point's true manifold.
- Formulated the regularization terms for semantic locality preservation (increases biological relevance) and sparsity.
- Designed a latent space-based meta-heuristic for two-dimensional cluster assignment of samples and features.

Statelet: a data summarization framework that discovers a set of 'k' representatives (shapes) from an extensive collection of the brain's dynamic functional network connectivity time course.
- Repurposed Earth Mover Distance (EMD) for motifs comparison. A Kernel Density Estimator (KDE) for smoothing motif's frequency space. The Voronoi partitions it into k-subspaces with the representatives of maximal prevalence and diversity.
- Large-scale motifs are summarized into a small subset of recurrent discriminative patterns.

BrainGraph: a graph neural network (GNN) with Transformer
- Spatio-temporal attention to representing the brain's functional connectivity as a dynamic graph with a set of nodes (brain networks) and weighted edges (Statistical dependencies known as functional connections).
- 'BrainGraph' learns the coordination among the functional hubs of the brain for better cognition.

IBRNN: Information-theoretic introspection method for Recurrent Neural Networks (RNNs) and LSTM using mutual information (MI)
- CBOW for word2vec embedding of the text corpus and bi-LSTM for the downstream task.

- Inspired by information Bottleneck theory, compute MI around labels, features, and layers and quantifies feature compression.

mriCAV: Used concept activation vector (CAV) for model interpretability

Introspect the fully trained deep classifiers by finding active concepts - orthogonal vectors towards learned features. Neuroimaging concepts include brain networks, signals, and connections associated with neuropsychiatric disorders like schizophrenia.

N-BiC: a biclustering approach needless of specifying the number of clusters (k).

Adaptation to depth-first search (DFS) to semi-exhaustively explore all possible combinations of instances.

Professional Experience

Graduate Teaching Assistant – University of New Mexico
- Assisted with Linear algebra and computer Algorithms courses designed for CS undergrad students.

Lecturer – International Islamic University Chittagong, Bangladesh
- Conducted undergraduate courses on Computer Programming languages, Object-oriented design, Data structures and Algorithms.

Reviewing - Nature Scientific Report, Nature Communication, NeurIPS 2021, ICML 2023, AAAI 2023, MICCAI 2020, ISBI 2020

Editor - "Brain Imaging Methods" in "Frontier in Neuroscience" Journal.

Skills

Languages: C++, Python, C#, Java, JavaScript, Jquery   **Tools:** Visual Studio, Free Surfer, FSL, SPM, Git, MATLAB, Anaconda
Cloud Technologies: AWS, Google Cloud, Docker, Spark **Libraries:** PyTorch, TensorFlow, OpenCV, Stanford CoreNLP, NLTK, Scikit Learn

Selected Publications

- **Rahaman, Md Abdur**, Jessica A Turner, Cota Navin Gupta, Srinivas Rachakonda, Jiayu Chen, Jingyu Liu, Theo GM Van Erp, Steven Potkin, Judith Ford, and Daniel Mathalon. 2019. 'N-BiC: A method for multi-component and symptom biclustering of structural MRI data: Application to schizophrenia', IEEE Transactions on Biomedical Engineering, 67: 110-21.
- Baker, Bradley Thomas, Noah Lewis, Debratta Saha, **Md Abdur Rahaman**, Sergey Plis, and Vince Calhoun. "Information Bottleneck for Multi-Task LSTMs." In NeurIPS 2022 Workshop on Information-Theoretic Principles in Cognitive Systems.
- **Rahaman, Md Abdur**, Jiayu Chen, Zening Fu, Noah Lewis, Armin Iraji, Theo GM van Erp, and Vince D Calhoun. 2023. 'Deep multimodal predictome for studying mental disorders', Human Brain Mapping, 44: 509-22.
- **Rahaman, Md Abdur**, Eswar Damaraju, Debbrata K Saha, Sergey M Plis, and Vince D Calhoun. 2022. 'Statelets: Capturing recurrent transient variations in dynamic functional network connectivity', Human Brain Mapping, 43: 2503-18.
- **Rahaman, Md Abdur**, Yash Garg, Armin Iraj, Zening Fu, Jiayu Chen, and Vince Calhoun. 2022. "Two-Dimensional Attentive Fusion for Multi-Modal Learning of Neuroimaging and Genomics Data." In 2022 IEEE 32nd International Workshop on Machine Learning for Signal Processing (MLSP), 1-6. IEEE.
- Dolci, Giorgio, **Md Abdur Rahaman**, Jiayu Chen, Kuaikuai Duan, Zening Fu, Anees Abrol, Gloria Menegaz, and Vince D Calhoun. 2022. "A deep generative multimodal imaging genomics framework for Alzheimer's disease prediction." In 2022 IEEE 22nd International Conference on Bioinformatics and Bioengineering (BIBE), 41-44. IEEE.
- Du, Yuhui, Zening Fu, Jing Sui, Shuang Gao, Ying Xing, Dongdong Lin, Mustafa Salman, Anees Abrol, **Md Abdur Rahaman**, and Jiayu Chen. 2020. 'NeuroMark: An automated and adaptive ICA based pipeline to identify reproducible fMRI markers of brain disorders', NeuroImage: Clinical, 28: 102375.

Leadership Experience & Awards

- Faculty Advisor at EEE Club at International Islamic University of Chittagong, Chittagong, Bangladesh (2013 to 2015)
- Academic advisor of a section of undergraduate students
- Mentored multiple groups of students to accomplish their undergraduate thesis (Spring/Fall 2013, 2014, 2015, Spring 2016)
- President – Bengal United Sports Club (BUSC) at the University of New Mexico (2018 to 2019)
- Bangladesh Government Scholarship for Academic Excellence in the 2007 Higher Secondary School Certificate.
- Bangladesh-Sweden Travel Trust Fund 2020 for Higher Education