Md Abdur **Rahaman**

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Education

Georgia Institute of Technology, GA, USA

Ph.D. in Computational Science and Engineering | Expected August 2024

University of New Mexico, NM, USA

M.S. in Computer Science, July 2019

Research Interests

Machine learning, Deep Learning, Computer Vision, Pattern Recognition, Multi-modal learning, NLP, Computational Neuroscience

Experience

**Center for Translational Research in Neuroimaging and Data Science (TReNDS) -
a joint research lab among Georgia Tech, Emory, and Georgia State University**
Georgia, U.S.A

GRADUATE RESEARCH ASSOCIATE
Jun. 2019 - present

- Roles: Developing computational frameworks for learning discriminative and semantically meaningful patterns from big data

Nokia Bell Labs
New Jersey, U.S.A

DATA SCIENCE RESEARCH INTERN
Sep. 2021 - Dec. 2021

- 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.

Mind Research Network at the University of New Mexico
New Mexico, U.S.A

GRADUATE RESEARCH ASSITANT
may. 2017 - Apr. 2019

- Developed an automated preprocessing pipeline for brain images (MRI).
- Designed exhaustive biclustering and tri-clustering algorithms for sparse data by relaxing the specification of the model order (k).

Research Projects

Bi-clusformer: a Transformer based end-to-end biclustering framework.

- Leveraged transformer's self-attention across feature and sample dimensions to generate coherent submatrices.
- A two-dimensional attention mechanism to approximate 2D homogeneity.

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 meta-heuristic for two-dimensional cluster assignment of samples and features.

Statelet: a summarization framework for time series data

- Discovers a set of 'k' most recurrent and explanatory motifs from a collection of the brain's functional network connectivity time series.
- Novel implementation of 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.

BrainGraph: a graph convolutional neural network (GCN) for disease classification

- 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.

N-BiC: a greedy biclustering approach
- Constraint depth-first search (DFS) to semi-exhaustively explore all possible combinations of instances.
- Doesn't require the specification of the number of clusters (k).

mriCAV: Concept activation vector (CAV) for model interpretability
- Introspect the fully trained deep models by finding active concepts - orthogonal vectors towards learned features.
- Allows testing model's inclination towards pre-defined concepts
- Neuroimaging concepts include brain networks, activation, and connectivity patterns associated with neuropsychiatric disorders or behavioural traits.

IBRNN: Information-theoretic introspection for Recurrent Neural Networks (RNNs)
- CBOW for word2vec embedding of the text corpus and bi-LSTM for the downstream task.
- Inspired by information Bottleneck theory, compute mutual information (MI) around labels, features, and layers and quantifies feature compression

Skills

Programming	Python, C/C++, Scala, JAVA, C#, JavaScript, Jquery
Tools	Visual Studio, Free Surfer, FSL, SPM, Git, MATLAB, Anaconda
Cloud Technologies	AWS, Google Cloud, Docker, Spark, Containers
Libraries	PyTorch, TensorFlow, OpenCV, Stanford CoreNLP, NLTK, Scikit Learn, Hugging Face

Selected Publications

- **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.
- 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.
- 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.
- **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
- **Rahaman, M. A.**, Damaraju, E., Turner, J. A., Van Erp, T. G., Mathalon, D., Vaidya, J., … & Calhoun, V. D. (2022). Tri-clustering dynamic functional network connectivity identifies significant schizophrenia effects across multiple states in distinct subgroups of individuals. Brain connectivity, 12(1), 61-73.
- Dolci, G., **Rahaman, M. A.**, Galazzo, I. B., Cruciani, F., Abrol, A., Chen, J., … & Calhoun, V. D. (2023, June). Deep Generative Transfer Learning Predicts Conversion To Alzheimer'S Disease From Neuroimaging Genomics Data. In 2023 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 & Awards

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

2011	**5th position**, Inter University Programming Contest	*Bangladesh*
2018-2019	**President**, Bengal United Sports Club (BUSC) at the University of New Mexico (UNM)	*New Mexico, U.S.A*
2018	**Organizing Secretary**, UNM Computer Science student conference	*New Mexico, U.S.A*
2007	**Higer secondary**, Bangladesh Government Scholarship for Academic Excellence	*Bangladesh*
2017	**Graduate Education**, Bangladesh-Sweden Travel Trust Fund for Higher Education	*Sweden*
2008-2013	**Undergraduate Scholarship**, Chittagong University of Engineering and Technology	*Bangladesh*