

# Md Abdur Rahaman

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## Education

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### 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

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

## Experience

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### Center for Translational Research in Neuroimaging and Data Science (TReNDS) at

#### Georgia Tech

Atlanta, GA

GRADUATE RESEARCH ASSOCIATE

Jun. 2019 - present

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

### Nokia Bell Labs

Murray Hill, NJ

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

Albuquerque, NM

GRADUATE RESEARCH ASSITANT

May. 2017 - Apr. 2019

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

### University of New Mexico

Albuquerque, NM

GRADUATE TEACHING ASSITANT

Aug. 2016 - Apr. 2017

- Assisted with Linear algebra, Declarative Programming, Computer Algorithms courses designed for CS undergrad students.
- Roles: TA Office hour, Grading, Conducting tutorials on Haskell, Scheme, GNU Emacs

## Research Projects

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### 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 fusion model with Neuromorphic design

- A multi-modal latent space fusion using spatial and modality-wise attention inspired by the 'Bottleneck Attention Module'.
- Combines Neuroimages (fMRI, sMRI) and genomics data to classify mental disorder.
- Model's architecture and processing powered by neuromorphic computing

### 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 dominant and explanatory motifs from a collection of the brain's functional 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 neural network (GNN) for disease classification

- BrainGraph: Nodes (brain networks), weighted edges (Statistical dependence a.k.a functional connections).
- Spatio-temporal attention to learn the coordination among the functional hubs of the brain

### 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

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**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

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- **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 Iraj, 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

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2018-2019 **President**, Bengal United Sports Club (BUSC) at the University of New Mexico (UNM)

Albuquerque, NM

2018 **Organizing Secretary**, UNM Computer Science student conference

Albuquerque, NM

2017 **Graduate Education**, Bangladesh-Sweden Travel Trust Fund for Higher Education

Sweden

2011 **5th position**, Inter University Programming Contest

Bangladesh

2008-2013 **Merit Position Scholarship (7 semesters)**, Chittagong University of Engineering and Technology

Bangladesh

2007 **Higer secondary**, Bangladesh Government Scholarship for Academic Excellence

Bangladesh