

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 Clustering, NLP, Computational Neuroscience

Experience

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.
- Duties: TA Office hour, Grading, Tutorial on Haskell, Scheme, GNU Emacs

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 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

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 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

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