

Research Interests

My research interests lie in the area of machine learning with an emphasis on data/information fusion, deep learning, computer vision, and image processing. To date, my contributions include:

- **Deep learning:** Neuronal representation of aggregation operators and decision level fusion of deep neural network (DNN) architectures for object detection and land-cover classification;
- **Aggregation:** New mathematical and algorithmic extensions of the fuzzy integral for uncertain (e.g., missing) data, computationally efficient approximations of aggregation operators, data-driven compression of fusion and its learning for homogeneous and heterogeneous data, efficient evolutionary algorithm for the fuzzy integral;
- **Computer vision:** Deep morphological hit-or-miss transform neural network, semantic segmentation for off-road trail detection in autonomous driving, and object recognition;
- **Hyperspectral image processing:** Dimensionality reduction using visual clustering, contiguous band grouping, and feature level fusion for classification task in remote sensing.

Education

Mississippi State University

Mississippi, USA

Ph.D. in Electrical and Computer Engineering

August 2018

- Dissertation: Efficient Data Driven Multi Source Fusion
- Advisors: Derek T. Anderson, Ph.D. and John E. Ball, Ph.D.

Bangladesh University of Engineering and Technology

Dhaka, Bangladesh

B.Sc. in Electrical and Electronic Engineering

June 2005

Professional Experience

Assistant Professor, **Dept. of ECECS, University of New Haven (UNH)**

September 2020 - present

Graduate Coordinator, **MS in Data Science Program, UNH**

2020 - 2022

Visiting Assistant Professor, **Dept. of CS, Montclair State University**

January 2020 - June 2020

Research Assistant Professor, **EECS, University of Missouri-Columbia**

March 2019 - January 2020

Postdoctoral Associate, **Center for Advanced Vehicular Systems, Mississippi State University (MSU)**

August 2018 - March 2019

Grant Proposals

Building Learning-friendly Software Security Patterns and Rules for Vulnerability Education National Science Foundation. Under Review.

- PI M. Islam at the University of New Haven. PI K. Sultana and Co-PI A. Varde at Montclair State University(lead institution).

Book Chapter

- [1] D. T. Anderson, G. J. Scott, **M. Islam**, B. Murray, and R. Marcum, "Fuzzy choquet integration of deep convolutional neural networks for remote sensing," in *Computational Intelligence for Pattern Recognition*, Springer, 2018, pp. 1–28.

Journal Articles

- [1] **M. Islam**, B. Murray, A. Buck, *et al.*, “Extending the morphological hit-or-miss transform to deep neural networks,” *IEEE Transactions on Neural Networks and Learning Systems*, vol. 32, no. 11, pp. 4826–4838, 2021. doi: 10.1109/TNNLS.2020.3025723.
- [2] **M. Islam**, D. T. Anderson, T. C. Havens, and J. E. Ball, “A generalized fuzzy extension principle and its application to information fusion,” *IEEE Transactions on Fuzzy Systems*, vol. 29, no. 9, pp. 2726–2738, 2021. doi: 10.1109/TFUZZ.2020.3006574.
- [3] B. J. Murray, **M. Islam**, A. J. Pinar, *et al.*, “Explainable ai for the choquet integral,” *IEEE Transactions on Emerging Topics in Computational Intelligence*, 2020.
- [4] S. K. Kakula, A. Pinar, **M. Islam**, D. Anderson, and T. Havens, “Novel regularization for learning the fuzzy choquet integral with limited training data,” *IEEE Transactions on Fuzzy Systems*, 2020.
- [5] **M. Islam**, D. T. Anderson, A. J. Pinar, T. C. Havens, G. Scott, and J. M. Keller, “Enabling explainable fusion in deep learning with fuzzy integral neural networks,” *Special Issue on Deep Fuzzy Models, IEEE Transactions on Fuzzy Systems*, 2019, issn: 1063-6706. doi: 10.1109/TFUZZ.2019.2917124.
- [6] S. Sharma, J. E. Ball, B. Tang, D. W. Carruth, M. Doude, and **M. Islam**, “Semantic segmentation with transfer learning for off-road autonomous driving,” *Sensors*, vol. 19, no. 11, p. 2577, 2019.
- [7] **M. Islam**, D. T. Anderson, J. E. Ball, and N. H. Younan, “Fusion of heterogeneous bands and kernels in hyperspectral image processing,” *Journal of Applied Remote Sensing*, vol. 13, no. 2, 2019.
- [8] **M. Islam**, D. T. Anderson, F. Petry, and P. Elmore, “An efficient evolutionary algorithm to optimize the Choquet integral,” *International Journal of Intelligent Systems*, 2018. doi: 10.1002/int.22056.
- [9] **M. Islam**, D. T. Anderson, A. J. Pinar, and T. C. Havens, “Data-driven compression and efficient learning of the Choquet integral,” *IEEE Transactions on Fuzzy Systems*, 2017, issn: 1063-6706. doi: 10.1109/TFUZZ.2017.2755002.

Conference Articles

- [1] **M. Islam**, C. Veal, Y. Goudu, and D. T. Anderson, “Attribution modeling for deep morphological neural networks using saliency maps,” in *2021 International Joint Conference on Neural Networks (IJCNN)*, 2021, pp. 1–8. doi: 10.1109/IJCNN52387.2021.9534344.
- [2] G. J. Scott, J. A. Hurt, A. Yang, **M. Islam**, D. T. Anderson, and C. H. Davis, “Differential morphological profile neural network for object detection in overhead imagery,” in *2020 International Joint Conference on Neural Networks (IJCNN)*, IEEE, 2020, pp. 1–7.
- [3] A. R. Buck, D. T. Anderson, J. M. Keller, T. Wilkin, and **M. Islam**, “A weighted matrix visualization for fuzzy measures and integrals,” in *2020 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)*, IEEE, 2020, pp. 1–8.
- [4] B. Ruprecht, W. Wu, **M. Islam**, *et al.*, “Possibilistic clustering enabled neuro fuzzy logic,” in *2020 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)*, IEEE, 2020, pp. 1–8.
- [5] C. Veal, A. Yang, A. Hurt, *et al.*, “Linear order statistic neuron,” in *2019 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)*, Jun. 2019.
- [6] B. Murray, **M. Islam**, A. J. Pinar, *et al.*, “Transfer learning for the choquet integral,” in *2019 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)*, Jun. 2019.
- [7] W. Meadows, C. Hudson, C. Goodin, *et al.*, “Multi-lidar placement, calibration, co-registration, and processing on a subaru forrester for off-road autonomous vehicles operations,” in *Autonomous Systems: Sensors, Vehicles, Security, and the Internet of Everything*, International Society for Optics and Photonics, 2019.
- [8] B. Murray, **M. Islam**, A. J. Pinar, T. C. Havens, D. T. Anderson, and G. Scott, “Explainable AI for understanding decisions and data-driven optimization of the Choquet integral,” in *2018 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)*, Jul. 2018.

- [9] **M. Islam**, D. T. Anderson, X. Du, T. C. Havens, and C. Wagner, “Efficient binary fuzzy measure representation and Choquet integral learning,” in *2018 17th International Conference on Information Processing and Management of Uncertainty in Knowledge-Based Systems*, Springer, Jun. 2018.
- [10] M. Davis, L. Cagle, C. Morgan, *et al.*, “Hydra: a modular, universal multi-sensor data collection system,” in *Autonomous Systems: Sensors, Vehicles, Security, and the Internet of Everything*, International Society for Optics and Photonics, 2018.
- [11] **M. Islam**, D. T. Anderson, F. Petry, D. Smith, and P. Elmore, “The fuzzy integral for missing data,” in *2017 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)*, 2017, pp. 1–8.
- [12] A. J. Pinar, T. C. Havens, **M. Islam**, and D. T. Anderson, “Visualization and learning of the Choquet integral with limited training data,” in *2017 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)*, 2017, pp. 1–6.
- [13] D. T. Anderson, **M. Islam**, R. King, *et al.*, “Binary fuzzy measures and Choquet integration for multi-source fusion,” in *2017 International Conference on Military Technologies (ICMT)*, 2017, pp. 676–681.
- [14] **M. Islam**, D. T. Anderson, J. E. Ball, and N. H. Younan, “Fusion of diverse features and kernels using lp-norm based multiple kernel learning in hyperspectral image processing,” in *2016 8th Workshop on Hyperspectral Image and Signal Processing: Evolution in Remote Sensing (WHISPERS)*, 2016, pp. 1–5.
- [15] **M. Islam**, D. T. Anderson, J. E. Ball, and N. H. Younan, “Clodd based band group selection,” in *2016 IEEE International Geoscience and Remote Sensing Symposium (IGARSS)*, Jul. 2016, pp. 36–39.
- [16] **M. Islam**, D. T. Anderson, and T. C. Havens, “Multi-criteria based learning of the choquet integral using goal programming,” in *2015 Annual Conference of the North American Fuzzy Information Processing Society (NAFIPS) held jointly with 2015 5th World Conference on Soft Computing (WConSC)*, 2015, pp. 1–6.

Poster Presentation ---

- [1] Y. Malhotra and **M. Islam**, “Gated context aggregation network for image dehazing and de-raining,” Graduate Student Showcase Competition, University of New Haven, 2022, Won an award.
- [2] **M. Islam**, D. T. Anderson, A. Pinar, T. Havens, G. Scott, and J. Keller, “The choquet integral neuron, its pytorch implementation, and application to decision fusion,” *IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)*, 2019.
- [3] B. Ruprecht, C. Veal, B. Murray, *et al.*, “Fuzzy logic-based fusion of deep learners in remote sensing,” *IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)*, 2019.

Students Mentored ---

Research Assistants

- Current Students: Siri Haralahalli Gangadharaiah
- Graduated: Yashaswini Gouri, Ashmita Dhage (selected as the best DS Graduate Student in Research for 2021), Pushpa Latha Vudatha, Sujana Bhusal, Sai Rekha Unnam

Thesis/Dissertation Committee Member

- Current Students: Bibek Upadhyay(PhD), Binesh Kumar Sadanandan (PhD).
- Graduated: Bibek Upadhyay (MS), Milan Zinzuvadiya (MS)

Teaching Experience

Assistant Professor, **University of New Haven**

- Deep Learning: Fall 2020 to present
- Computer Vision: Spring 2024
- Natural Language Processing: Fall 2020 to Spring 2023 except Spring 2022
- Machine Learning: Spring 2022
- Data Science Capstone Project: 2021 Fall, 2022 Spring, 2023 Fall, 2024 Spring
- Data Science Internship: Fall 2021 to Summer 2022, Fall 2023 to Summer 2024
- Intro to Applied Math for Computing - Spring 2021

Visiting Assistant Professor, **Montclair State University**

- Discrete Mathematical Structures, Spring 2020

Instructor, **Mississippi State University**

- Electromagnetics I (junior-level course), Spring 2018
- Electromagnetics II (junior-level course), Summer-I and Fall, 2017

Professional Services

Graduate Coordinator

2020 - 2022

- Restructured the Data Science program with emphasis on machine learning and AI
- Reviewed students application and made admission and scholarship decision
- Developed a new course, Computer Vision, for CS and DS graduate students
- Conducted orientation sessions with incoming students and information sessions with prospective domestic and international graduate students
- Enrollment grew tenfold from tens to a hundred students during my tenure
- Advised students about study plan and provided administrative support
- Planned course schedule for the program
- Prepared program evaluation report for accreditation to New England Commission of Higher Education (NECHE)
- Organized internship sessions in collaboration with Career Development Center

Committee Member

2023 - 2024

Data Science Tenure Track Faculty Search

Committee Chair

2021 - 2022

Data Science Non Tenure Track Faculty Search

Students' Research Proposal Reviewer

June 2022

Tagliatela College of Engineering (TCOE) Endowed Graduate Fellowship

Member

2022 - present

Senate, University of New Haven

Council Member

2020 - 2022

Graduate Council, University of New Haven

Session Chair

- Special Session on Fuzzy Algorithms, IEEE International Conference on Fuzzy Systems, New Orleans June 23- 26, 2019

Conference Reviewer

- International Joint Conference on Neural Networks 2022 - present
- IEEE International Conference on Fuzzy Systems 2016 - 2021
- IEEE Congress on Evolutionary Computation 2016 - 2020
- Signal Processing in Medicine 2017 - 2018

Journal Reviewer

- IEEE Transactions on Neural Networks and Learning Systems 2021
- IEEE Transactions on Fuzzy Systems 2016 - present
- Journal of Applied Remote Sensing 2017 - 2021
- Remote Sensing 2019
- International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems 2019
- Electronics 2019
- Artificial Intelligence Review (AIRE) 2018
- Journal of Ambient Intelligence and Humanized Computing 2018
- ISPRS International Journal of Geo-Information 2018
- IEEE Transactions on Geoscience and Remote Sensing 2017

Member

- IEEE
- IEEE Special Technical Community on Data Engineering, Autonomous Driving Technologies, and Cybersecurity

Research Projects

Deep morphological neural networks

2021 - present

- Working on creating an artificial neuron to perform morphological operation that enables training of deep networks.

Decision theoretic approaches to explaining neural networks

2022 - present

- Investigating decision theoretic approaches to explaining the intricate decision making process in a neural network.

Dense learning and pruning of residual neural networks

2021 - 2022

- Residual learning is sparse and, hence, underutilized. Currently, my work is focused on understanding the learning dynamics to enhance model efficiency.

Data Driven Agriculture (DDAg) Initiative, MU

April 2019 - January 2020

- Data Driven Agriculture (DDAg) is an initiative taken by the MU informatics institute in an aim to foster innovation in sensors and novel platforms, explainable artificial intelligence, and data translation for implementation in agriculture (<http://ddag.missouri.edu>).
- Wrote grant proposals to seek internal and external funding.

Center for Advanced Vehicular Systems, MSU

Off-Road Autonomous Driving

January 2018 - March 2019

- Led the perception group of this project. Directed two Ph.D., one Masters, and one undergraduate student. The perception group focused on academic research and industrial applications. Topics explored include sensor fusion, deep neural network based object detection, semantic segmentation of point cloud, off-road trail detection, localization, occupancy grid, and free space mapping.

Technical Skills

- Programming Languages: C/C++, Python, R, and Matlab
- High Performance Computing: MPI, OpenMP
- Deep Learning: Tensorflow, PyTorch
- Robot Operating System (ROS), Windows, Linux