College of Engineering and Computer Science
Office of the Dean
777 Glades Road, EE96, Room 308
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Announces the Ph.D. Dissertation Defense of

Md Ruhul Amin

for the degree of Doctor of Philosophy (Ph.D.)

Interpretable Machine Learning Frameworks for Detecting and Characterizing Adaptive Processes in Genomic Data

November 5, 2025, at 2 pm – 3:30 pm
EE96, Room: 405
777 Glades Road
Boca Raton, FL

DEPARTMENT:
Electrical Engineering and Computer Science

ADVISOR:
Michael DeGiorgio, Ph.D.

PH.D. SUPERVISORY COMMITTEE:
Michael DeGiorgio, Ph.D.

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ABSTRACT OF DISSERTATION

Detecting genomic regions influenced by adaptive processes is fundamental to understanding adaptation and its connection to modern human traits. Traditional summary-statistic and likelihood methods capture only simple evolutionary scenarios, while deep learning models such as convolutional neural networks, though powerful, often lose spatial information and lack interpretability. This dissertation introduces three complementary frameworks that overcome these limitations by integrating interpretable machine learning with spatially structured genomic data. The first framework, T-*REx* employs tensor decomposition to extract informative features from haplotype alignment images, enabling accurate classification of selective sweeps with classical learning models. The second framework, α-DAWG applies wavelet and curvelet decompositions to capture directional and frequency-based signatures of selection, achieving performance comparable to convolutional neural networks while remaining interpretable and robust. The third framework, *SKINET* introduces a trend-filtered kernel within a support vector machine, preserving spatial autocovariation and extending to quantitative inference of adaptive parameters. Applied to human genomic data, these frameworks not only detect classical signature of selective sweeps such as *LCT* and *MCM6* but also uncover novel candidates including *FAM177A1* and *PTPRJ* that reveal interesting disease associations. Collectively, these methods demonstrate that interpretable, structure-aware machine learning frameworks can advance the frontier of adaptive inference by combining predictive power with evolutionary insights.

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BIOGRAPHICAL SKETCH

Md Ruhul Amin was born in Naogaon, Bangladesh. He received his Bachelor of Science degree in Computer Science and Engineering from Rajshahi University of Engineering and Technology (RUET), Bangladesh. He pursued his Doctor of Philosophy in Computer Engineering at Florida Atlantic University, where his research focused on developing interpretable machine learning frameworks for detecting and characterizing adaptive processes in genomic data.

CONCERNING PERIOD OF PREPARATION & QUALIFYING EXAMINATION

Time in Preparation:

2021-2025

Qualifying Examination Passed:

Fall 2021

Published Papers:

1. **Amin, M.R.**, Hasan, M., Arnab, S. P., & DeGiorgio, M. (2023). Tensor Decomposition-based Feature Extraction and Classification to Detect Natural Selection from Genomic Data. *Molecular biology and evolution*, *40*(10), msad216.
2. Arnab, S. P., **Amin, M. R.**, & DeGiorgio, M. (2023). Uncovering Footprints of Natural Selection Through Spectral Analysis of Genomic Summary Statistics. *Molecular biology and evolution*, *40*(7), msad157.
3. **Amin, M. R.**, Hasan, M., & DeGiorgio, M. (2024). Digital Image Processing to Detect Adaptive Evolution. *Molecular biology and evolution*, *41*(12), msae242.