

M. Maruf

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RESEARCH INTEREST

My research interests are in the broad domains of Science-Guided Machine Learning and its applications. In particular, I am developing new algorithms for Graphs that allow better representation with consistent knowledge propagation.

EDUCATION

PhD Student in Computer Science Fall 2018 - present
Virginia Tech, Blacksburg, USA
Advisor: Anuj Karpatne
Expected Graduation: May, 2023

Bachelor in Computer Science and Engineering 2011 - 2016
Bangladesh University of Engineering and Technology (BUET)
Dhaka, Bangladesh

PUBLICATIONS

Conference Papers

[C01] **Maruf, M.**, and Karpatne, A., “Maximizing Cohesion and Separation in Graph Representation Learning: A Distance-aware Negative Sampling Approach”, SIAM International Conference on Data Mining (SDM), 2021. [pdf]

Journall Articles

[J01] **Maruf, M.**, and Shatabda, S., “iRSpot-SF: Prediction of recombination hotspots by incorporating sequence based features into Pseudo components”, *Genomics*, Volume 111, Issue 4, July 2019, Pages 966-972, *doi*

Workshop Presentations

[W03] Daw, A., **Maruf, M.**, and Karpatne, A., “Physics-Informed Discriminator (PID) for Conditional Generative Adversarial Nets”, NeurIPS Workshop on Machine Learning and the Physical Sciences, 2020.

[W02] **Maruf, M.**, and Karpatne, A., “Biology-Guided Neural Network for Fish Trait Discovery”, SICB Virtual Annual Meeting, 2021.

[W01] **Maruf, M.**, and Karpatne, A., “Informing Neural Networks for Drug Effect Prediction using Biological Knowledge of Protein-Protein Interactions”, 3d Physics Informed Machine Learning Workshop, 2020.

ONGOING PROJECTS

Unsupervised Graph Representation Learning (GRL)

In this work, we develop a novel Distance-aware Negative Sampling (DNS) approach that maximizes the separation (structural dissimilarity) of distant node-pairs while maximizing cohesion (structural similarity) at nearby node-pairs by setting the negative sampling probability proportional to the pair-wise shortest distances. Our approach can be used in conjunction with any GRL algorithm and we demonstrate the efficacy of our approach over baseline negative sampling methods over downstream node classification tasks on several benchmark datasets and GRL algorithms.

GAN Framework based Physics Informed Discriminator

This project is an end-result of the Science-Guided Machine Learning course. In this work, we propose a novel physics-informed GAN architecture, termed PID-GAN, where the knowledge of physics is used to inform the learning of both the generator and discriminator models to perform uncertainty quantification, making ample use of unlabeled data instances.

Fish Trait Segmentation using Biology-Guided Neural Networks

In this project, we plan to address the trait segmentation problem for fishes and use the segmentation model to discover novel biological knowledge for new fish-species. A black-box semantic segmentation model suffers from the scarcity of real-world observations to produce a consistent solution. To address this challenge, we are developing a novel approach that incorporates biological knowledge from the ontology into the black-box segmentation model by learning distinguishing patterns from a much smaller number of annotated samples.

Drug Effect Prediction using Biological Knowledge of Protein-Protein Interactions

In this project, we develop an algorithm that uses an unsupervised Graph Convolutional Neural Network approach on the multi-modal PPI-DPI (protein-protein interaction and drug-protein interaction) graph to propagate knowledge between proteins and drugs that effectively finds out the drug features (as node embeddings) without any prior knowledge of drug-drug interactions.

WORK EXPERIENCE

Graduate Research Assistant

*Discovery Analytics Center
Department of Computer Science, Virginia Tech
Advisor: Anuj Karpatne
Summer 2019 - present*

Graduate Teaching Assistant

*Department of Computer Science, Virginia Tech
Fall 2018 - Spring 2019*

PROFESSIONAL SERVICE

Co-chair for session on “Spatiotemporal Data” at SDM 2021
Reviewer for KDD 2021

HONORS AND AWARDS

Recipient of **Student Travel Awards** at SIAM International Conference on Data Mining (SDM) 2021, SICB Annual Meeting 2021.
Recipient of four consecutive **Dean’s Awards** at BUET, Bangladesh.

RELEVANT GRADUATE COURSES

- Graph Machine Learning • Deep Learning
- Advanced Machine Learning • Data Analytics
- Security Analytics • Science-guided Machine Learning

REFERENCE

Dr. Anuj Karpatne
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Department of Computer Science
Virginia Tech, USA