CHETRAJ PANDEY

PhD Student, Graduate Research Assistant

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Atlanta, GA

EXPERIENCE

PhD Student Researcher (Deep Learning)

Data Mining Lab (Georgia State University)

01/2021 - Present Atlanta, GA

Research in Computer Vision, Machine Learning and Explainable/ Interpretable Deep Learning for Spatio-temporal data.

- Actively researching in utilizing CNNs and variants, Attention Networks, and Vision Transformers, addressing imbalanced data challenges in predicting rare solar transient events.
- Published a novel approach for ensembling heterogeneous models trained to predict rare solar flare events in revered Journal (Frontiers in Space Physics)
- Engaged in developing explainable and interpretable deep learning models for solar flare predictions. (published 4+ conference papers and preprints).
- Engaged in developing a data preprocessing, transformation and augmentation python-based software tool specifically designed to handle solar magnetograms.

Assistant Lecturer

Tribhuvan University

04/2018 - 12/2020 Lalitpur, Nepal

Started working as an Assistant lecturer at Himalaya College of Engineering, Tribhuvan University and later got promoted to Lecturer after 2 years of experience.

- Taught courses on Computer Programming, Discrete Structure, Numerical Methods, and Artificial Intelligence (AI) to undergraduate engineering students at Dept. of Computer and Electronics Engineering.
- Mentored final-year students' major projects.
- Served as a Research Project Co-ordinator at Research and Innovation Unit at this institution.

EDUCATION

Ph.D. in Computer Science, Advisor: Dr. Berkay Aydin

Georgia State University

Jan 2021 - Present Atlanta, GA

MS in Computer Science (Degree not Conferred yet)

Georgia State University

Jan 2021 - 2023 Atlanta, GA

Bachelors in Computer Engineering

Tribhuvan University

2013 - 2017 Dharan, Nepal

SKILLS

Machine Learning | Deep Learning | Explainable AI | Space Weather Analytics

C++ | Python | Numpy | Pandas | Matplotlib | Scikit-Learn | Pytorch | Keras | High Performance Computing | Git & Github | Docker | SQL | LaTeX

CERTIFICATIONS

- **Neural Networks and Deep Learning**
  July, 2020, Coursera.
- **Improving Deep Neural Networks: Hyperparameter tuning, Regularization and Optimization.**
  October, 2020, Coursera.
- **Structuring Machine Learning Projects.**
  October, 2020, Coursera.
- **Research Administrators Conduct of Research Course 1**
  March, 2021, CITI Program.

ACHIEVEMENTS

- **Reviewer & Session Chair**
  22nd International Conference on Machine Learning and Applications (ICMLA), 2023.
- **Early-Career Travel Award**
  Recieved Early-career Travel Award for Building Upon the EarthCube Community: A Geoscience and Cyberinfrastructure Workshop, June 27-28, 2023.
- **Doctoral Fellowship**
  Recieved Second Century Initiative (2CI) University Doctoral Fellowship , Georgia State University. May 2021 - Aug 2022.
- **Full Governmental Scholarship**
  Received Full Governmental Scholarship on Merit for the study of Bachelors in Computer Engineering at Tribhuvan University, Institute of Engineering, Dharan, Nepal.

HIGHLIGHTED PROJECTS

Full-disk Solar Flare Prediction

fulldisk-spatial-analytics

- Existing research utilized region-based image patches that are limited to central locations (with $\pm 70^{\circ}$) of full-solar disk for forecasting flares. This approach excluded a significant (one-third) of the spatial information.
- We proposed a new approach utilizing a full solar disk to predict solar flares using transfer learning with standard CNN based model.
- Published 3 conference papers (IEEE BigData 2021, SimBig 2021, and ICMLA 2023). This is still an ongoing research.

Explainable/Interpretable Deep Learning Models for Solar Flare Prediction

explainingFullDisk fulldiskAttention

- Deep Learning Models created for solar flare prediction needed reliability aspect with precision. We utilized post-hoc explanation methods to explain the predictions.
- Similarly, we used a novel attention-based approach that improved the model's performance as well as added transparency visualized through attention-maps, in regard to solar flare prediction.
- Published four conference papers (ECML PKDD 2023, DSAA 2023, DS 2023, AIKE 2023).
- Currently, we are working on operationalizing the model with a novel model/explanations evaluation approach.

Novel Approach for Heterogeneous Model Ensemble

frontiersin.org/articles/10.3389/fspas.2022.897301/full

- We developed a novel technique to create a heterogeneous ensemble of two models: (i) AR-based model that utilize time-series and forecast localized prediction and (ii) Full-disk model that utilize entire solar disk images and forecasts global predictions and improved the performance.
- Published a Journal paper in Frontiers in Space Physics.

TAMAG: Magnetogram Transformation and Augmentation Library

TAMAG module is a comprehensive package designed for transforming and augmenting solar magnetogram maps using various techniques to reduce information loss and augment magnetograms for predictive modeling. It provides a collection of data transformers, each tailored for a specific transformation method.

- While solar magnetograms are high-quality raster data, runs with data quality issues. We developed a novel fixed-size sliding-kernel based cropping approach that minimizes the data loss compared to random or center cropping and provides extensive data transformation functionalities all into one data pipeline.
- We are currently testing the package and soon will be publishing in Software-X journal.

PUBLICATIONS

- C. Pandey, R. A. Angryk, and B. Aydin, "Unveiling the potential of deep learning models for solar flare prediction in near-limb regions," in *22nd International Conference on Machine Learning and Applications (ICMLA), 2023.*, 2023. DOI: 10.48550/arxiv.2309.14483.
- C. Pandey, R. A. Angryk, and B. Aydin, "Explaining full-disk deep learning model for solar flare prediction using attribution methods," in *European Conference on Machine Learning and Knowledge Discovery in Databases: ADS Track, ECML PKDD*, Cham: Springer Nature Switzerland, Sep. 2023, pp. 72–89. DOI: 10.1007/978-3-031-43430-3_5.
- C. Pandey, A. Ji, R. A. Angryk, and B. Aydin, "Towards interpretable solar flare prediction with attention-based deep neural networks," in *2023 IEEE Sixth International Conference on Artificial Intelligence and Knowledge Engineering (AIKE)*, 2023. DOI: 10.48550/arxiv.2309.04558.
- C. Pandey, A. Ji, T. Nandakumar, R. A. Angryk, and B. Aydin, "Exploring deep learning for full-disk solar flare prediction with empirical insights from guided grad-cam explanations," in *The 10th IEEE International Conference On Data Science and Advanced Analytics (DSAA)*, IEEE, 2023. DOI: 10.48550/arxiv.2308.15712.
- C. Pandey, R. Angryk, and B. Aydin, "Deep neural networks based solar flare prediction using compressed full-disk line-of-sight magnetograms," in *Information Management and Big Data*, Springer International Publishing, 2022, pp. 380–396. DOI: 10.1007/978-3-031-04447-2_26.
- C. Pandey, A. Ji, R. A. Angryk, M. K. Georgoulis, and B. Aydin, "Towards coupling full-disk and active region-based flare prediction for operational space weather forecasting," *Frontiers in Astronomy and Space Sciences*, vol. 9, Aug. 2022. DOI: 10.3389/fspas.2022.897301.
- K. Whitman, R. Egeland, I. G. Richardson, ..., C. Pandey, and et al., "Review of solar energetic particle models," *Advances in Space Research*, Aug. 2022. DOI: 10.1016/j.asr.2022.08.006.
- C. Pandey, R. A. Angryk, and B. Aydin, "Solar flare forecasting with deep neural networks using compressed full-disk HMI magnetograms," in *2021 IEEE International Conference on Big Data (Big Data)*, IEEE, Dec. 2021, pp. 1725–1730. DOI: 10.1109/bigdata52589.2021.9671322.