Press Release

Revolutionizing Rainfall Forecasting in Odisha with Deep Learning: Enhanced Accuracy in Real-Time Predictions

Bhubaneswar, 21st October 2024: The study, titled "Augmenting the Real-Time Rainfall Forecast Skills Over Odisha Using Deep Learning Techniques," published in 'Stochastic Environmental research and Risk Assessment', addresses the challenges posed by complex and non-linear weather patterns. A further compelling illustration regarding the benefits of employing an advanced hybrid technology (i.e. the integration of conventional physics-based dynamical models with artificial intelligence frameworks) to improve rainfall forecasting at the district scale. This study has been focused on the state of Odisha. This hybrid technology serves as the guiding beacon for a new era of real time forecasting technology at district level.

India's monsoon season is heavily influenced by major rain-bearing systems forms over the Bay of Bengal—the monsoon low pressure (LPS), Monsoon Depressions (MDs) and Deep Depressions (DDs). These systems move in northwestward direction toward the mainland and account for approximately 60% of the seasonal precipitation. Odisha, situated along the eastern coast of India, is regarded as a gateway to these systems towards the central Indian region. Consequently, it is susceptible to these weather patterns, necessitating the development of precise rainfall forecasts for the region's calamity preparedness and policymaking.

However, predicting rainfall with high accuracy has long been a challenge due to the intricate nature of atmospheric processes, especially at the district level with adequate lead-time (96h). The research team has now introduced two deep learning architectures, U-Net (+A) and KU-Net (+A) (Attention-based Kernelized U-Net Architecture), to improve the spatial and categorical accuracy of rainfall intensity predictions. These artificial intelligence models (i.e. ML and DL) were trained on retrospective high-resolution rainfall forecasts generated from physics based dynamical models (WRF) over the state of Odisha at the district scale (3km) and tested for two real time cases i.e. 1 MD and 1DD for the year 2023.

Key Highlights:

i) Enhanced Accuracy: The proposed KU-Net (+A) model demonstrated remarkable improvements in district-scale rainfall forecasting in two different cases. When tested, the model reduced the Mean Absolute Error (MAE) to less than 8 mm up to Day 4 for Case 1 (MD), and to less than 15 mm for Case 2 (DD). In comparison, the WRF model showed MAEs of 25 mm and 36 mm for the same cases, respectively.

ii) Real-Time Forecasting: The results demonstrated that the DL model has consistently outperformed the traditional physics-based model (WRF) in different rainfall categories with lead time up to 96 hours (day 4). Comparatively for heavy rainfall category DL (WRF) forecast accuracy are 85.7% (52.5%) and very heavy rainfall it is 87% (56.8%) at the district scale.

These findings not only underscore the superiority of deep learning models over traditional deterministic models like Weather Research and Forecast (WRF) but also highlight the real-

world application potential of these DL models in enhancing early warning systems, improving disaster preparedness, and informing strategic administrative decisions. The improved forecasting accuracy can help district-scale planners and policymakers prepare for potential flooding, manage water resources, agricultural planning, and disaster preparedness to minimize the losses.

“We have positioned ourselves as pioneers in the development of this innovative next generation forecasting technology; this cutting-edge hybrid technology marks a paradigm shift in real-time weather prediction and has the potential to deliver substantial enhancements in forecast precision with adequate lead time, thereby has the potential to aiding in the mitigation of the adverse impacts linked to recurrent extreme weather phenomena over the Indian region in a climate change scenarios.” said Dr. Sandeep Pattnaik.

References

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