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Multi-Agent System for Weather Forecasting

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TREO Talk Paper

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Abstract

Weather forecasting is a challenging task carried out by meteorological stations throughout the globe. Traditionally, meteorologists use Numerical Weather Prediction (NWP) Models for weather prediction. This classical approach attempts to model the fluid and thermal dynamic systems for grid-point time series prediction based on boundary meteorological data. NWP solves a large system of nonlinear mathematical equations to provide forecasts. However, accurate weather prediction is challenging because of climate change and global warming. This paper proposes a novel approach for weather forecasting using a Multi Agent System (MAS). The proposed approach incorporates a deep neural network model within MAS with a hybrid Artificial Neural Network (ANN) algorithm to recognize the static and dynamic weather conditions. It uses ensemble prediction to account for indeterminism in weather conditions. Implementation challenges and advantages of MAS compared to NWP approach are discussed in this paper.

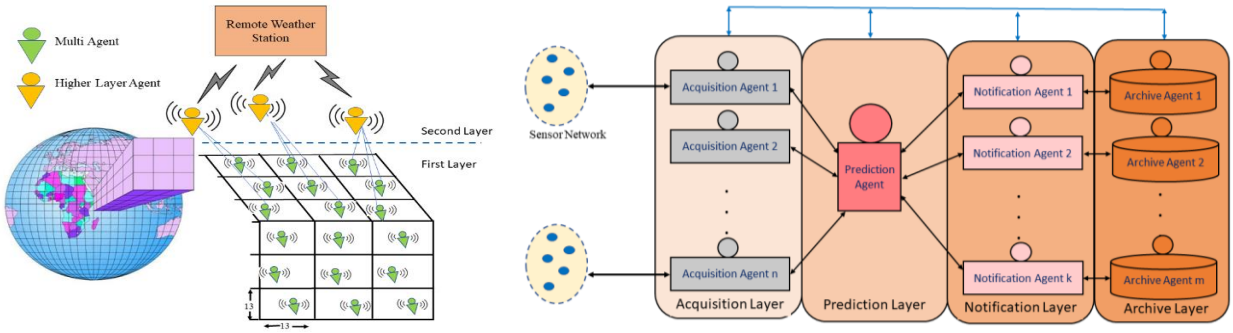

Figure 1. (a) System Model for Weather Forecasting (b) Architecture of Multi-Agent System

The proposed model shown in Figure 1(a) is applied over the grid model of NWP. It deploys MAS in two layers: First and the Second layer. MAS plays different roles in each of these layers. In the First Layer, each grid of 13 km x 13 km consists of one or more lower-level MAS to collect and process the local weather data. The Architecture of this multi-agent system is shown in Figure 1(b). First layer agents include: Acquisition, Prediction, Notification and Archive Agents. Acquisition agents collect environmental data from the sensor networks already deployed in the region of interest. The collected data (initial parameters) are fed to the prediction layer of MAS. The prediction layer uses hybrid ANN models to predict the weather based on the initial condition. It analyzes the non-linear time variant data based on the inherent static and dynamism in it. If the condition is found to be static, ANN model uses static algorithm to predict the weather. Any drastic variation in the parameters makes ANN use the dynamic model for prediction. The output is fed to the ensemble prediction system (EPS), which determines the uncertainty in prediction based on initial condition perturbations. It adjusts the predicted values based on the uncertainty. The predicted values are compared to actual values and fed back to the hybrid ANN to adjust the model for upcoming predictions.

The implementation of the prototype is currently underway using JADE where the model is trained and validated for accuracy. We have implemented first level MAS and are in the process of refining the hybrid ANN algorithm which accounts for the static and dynamic nature of weather conditions. Weather forecasting using the proposed MAS model can facilitate effective resource management and disaster preparedness.