NEURAL NETWORK FOR WINTER WEATHER PRECIPITATION TYPE PREDICTION

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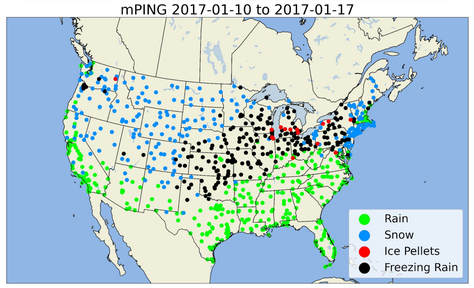
INTRODUCTION



Winter weather events can be dangerous and cause numerous injuries and deaths every year, especially due to the impact of winter precipitation on roadways. We aim to use machine learning techniques, in this case artificial neural networks, to predict four winter weather precipitation types: rain, snow, ice pellets (sleet), and freezing rain.

METHODS

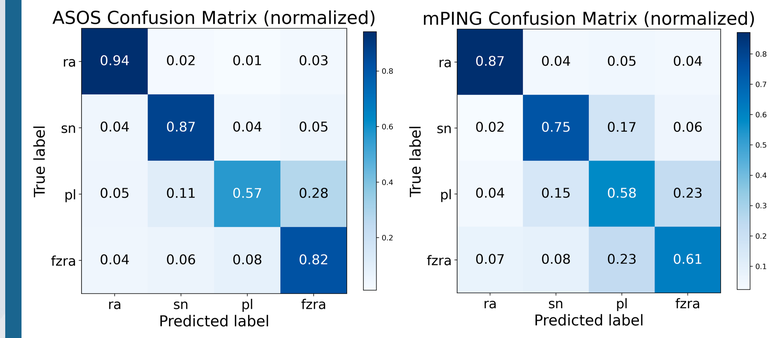
Data and Model Structure

- Input data: Rapid Refresh (RAP) model data (temperature, dew point temperature, and wind velocity components at various heights)
- The model predicted on data from ASOS, a system of automated weather stations, or mPING, a mobile application where users submit reports
- The neural network consisted of an input layer, several hidden layers of the same size, and an output layer

Hyperparameter Optimization

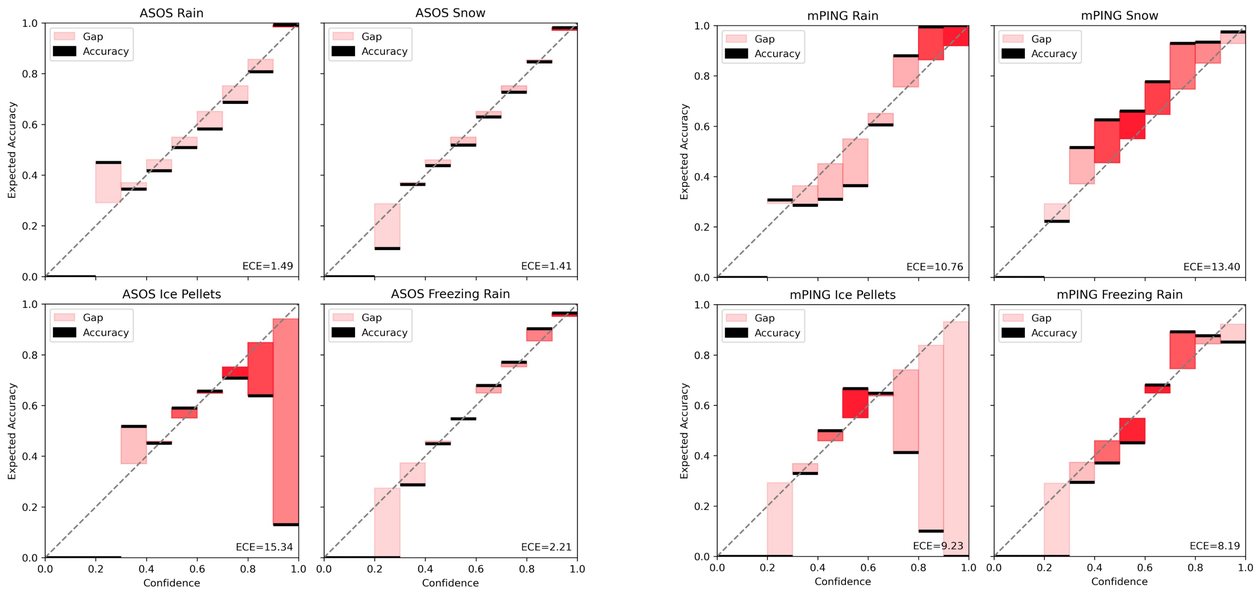
- Earth Computing Hyperparameter Optimization (ECHO): Tree-structured Parzen Estimator approach
- Goal: maximize validation average accuracy

TRAINING RESULTS



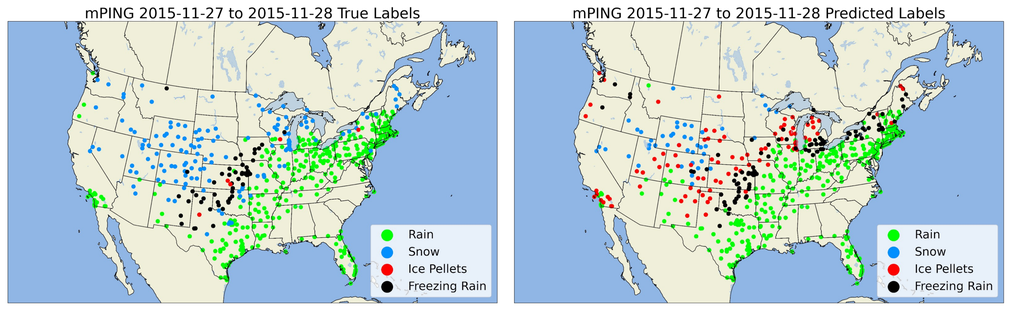
- ASOS: high accuracies (above 80%) for rain snow and freezing rain
- mPING: high accuracies (at or above 75%) for rain and snow but low accuracy for freezing rain
- Both models were unable to predict ice pellets well
- ASOS average accuracy: 80%
- mPING average accuracy: 70%

RESULTS



- Expected Calibration Error (ECE): weighted sum of the deviations of expected accuracy from confidence
- The ASOS model had an overall ECE of 1.41 and the mPING model had an overall ECE of 8.31
- The ASOS model was well calibrated (low ECE) for rain, snow and freezing rain
- The mPING model had a higher ECE than the ASOS model for all p-types except ice pellets
- In both models, ice pellet accuracy decreased significantly when confidence approached 1

CONCLUSIONS



- ASOS: well calibrated model that predicts rain, snow, and freezing rain with high accuracy but fails to predict ice pellets well
- mPING: significantly less calibrated model that tended to be underconfident and could only predict rain and snow with high accuracy
- Case studies, such as Nov. 2015 above, show both models get the spatial distribution of precipitation types largely correct
- In the future, we will further the development of a neural network that can predict its own evidential uncertainty

REFERENCES

Earth Computing Hyperparameter Optimization (ECHO). https://github.com/NCAR/echo-opt
Elmore, Kimberly & Grams, Heather & Apps, Deanna & Reeves, Heather. (2015). Verifying Forecast Precipitation Type with mPING. Weather and Forecasting. 30. 150313123347003. 10.1175/WAF-D-14-00068.1.
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