Kavita Parekh - INST414

Improving Hyperlocal Temperature Forecasting Using Machine Learning

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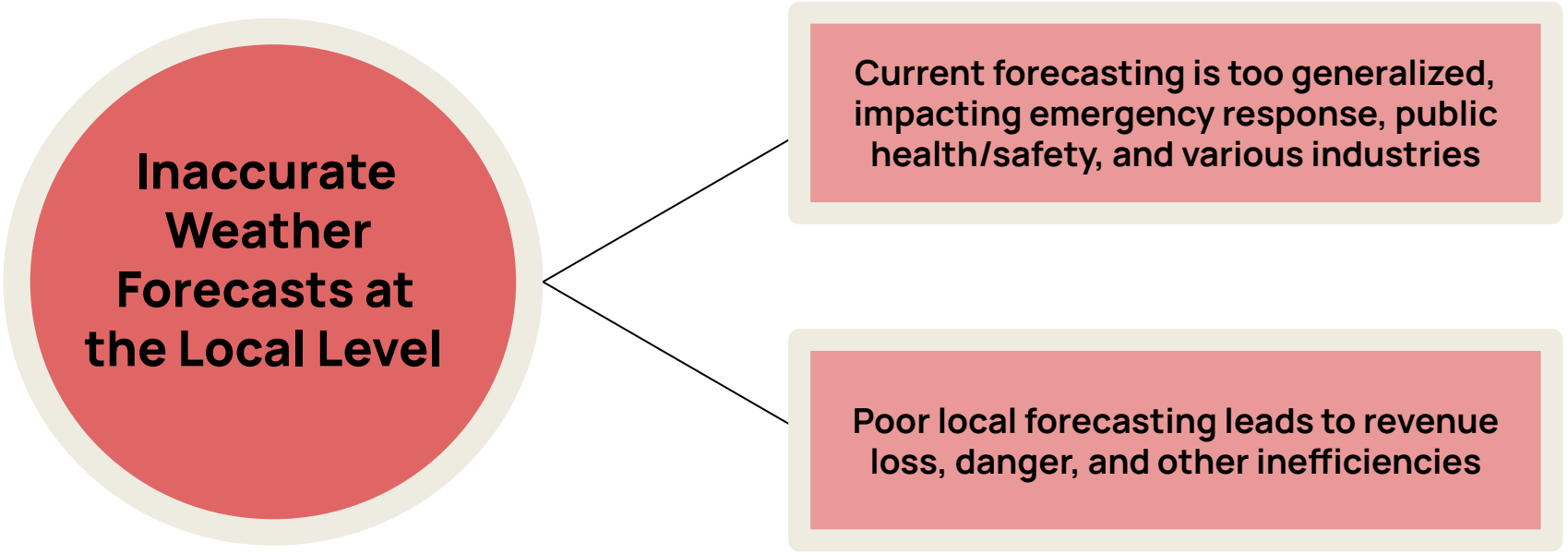
The Problem:


Inaccurate Weather Forecasts at the Local Level
Current forecasting is too generalized, impacting emergency response, public health/safety, and various industries
Poor local forecasting leads to revenue loss, danger, and other inefficiencies

Solutions Approach:

Goal: Build ML models that provide hyperlocal, accurate, short-term temperature forecasts

Data Sources

Forecasts: National Weather Service (NWS)

Actuals: METAR station at Newark Airport (NOAA)

Preprocessing

Merged timestamps with merge_asof

Handled missing data and outliers (IQR)

Feature engineering

Models Used

Ridge Regression (L2 regularization)

Random Forest Regressor (nonlinear ensemble model)

Model Performance:

Ridge Regression: Lower MAE, higher R^2, more stable across 5-fold CV

Random Forest: Captured nonlinear trends but less consistent

Best Model = Ridge Regression

- Accurate, generalizable, less risk of overfitting

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Ridge Regression Model Performance:
Mean Absolute Error (MAE): 0.0123
Mean Squared Error (MSE): 0.0003
R-Squared Score (R2): 0.9994

Random Forest Model Performance:
Mean Absolute Error (MAE): 0.0142
Mean Squared Error (MSE): 0.0005
R-Squared Score (R2): 0.9989

Cross Validation Scores:
Ridge Regression: 0.9921
Random Forest: 0.9382
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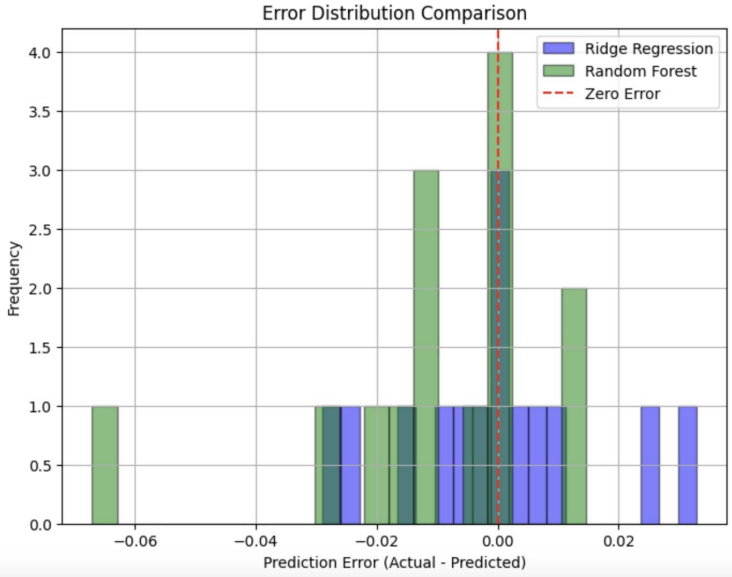

Value of Results:

Operational Value	Real World Impacts
• Enables public agencies to issue localized alerts	• Cost Savings: enables more efficient resource allocation
• Helps businesses optimize operations like construction or agriculture	• Increased Public Trust: provides more accurate, localized forecasts
• Reduces safety risks and enhances preparedness	• Smarter, Safer Communities: supports proactive decisions and improves public safety

Ethical Considerations & Future Work:

Limitations

- Difficult to access free data and short timespan of dates
- METAR Station only accesses one location at a time

Ethical Practices

- Needs transparency and interpretability
- Plans to add SHAP and counterfactual explanations

Next Steps

- Gather data from more sources and locations
- Develop an interactive dashboard for public agencies and businesses

THANK YOU

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