

Institute of Technology of Cambodia

Mathematical Modeling
Project Report

Topic: Temperature Prediction

Lecturer: SIM Tepmony (Course)

LUEY Sokea (TD)

Student: SROY Liza , ORN Vanda, YENG Keang, CHHEANG Udomveasna

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1. Introduction

Temperature prediction plays a crucial role in understanding climate patterns and informing decision-making processes in various sectors such as agriculture, energy, and urban planning. This project focuses on predicting temperature trends in Phnom Penh, Cambodia, utilizing historical weather data and mathematical modeling techniques. The use of advanced forecasting methods like Prophet allows for precise and interpretable predictions, making this study highly relevant in a rapidly urbanizing region.

2. Objective

The primary objective of this project is to develop a reliable predictive model for temperature trends in Phnom Penh. The model aims to:

1. Provide accurate temperature forecasts.
2. Analyze historical weather patterns.
3. Simulate potential future scenarios based on observed trends.

3. Equipment for Experiment

- **Dataset:** Historical weather data from `weather_PhnomPenh.csv`, containing fields like Time, Temperature, Weather, Wind, Humidity, Barometer, Visibility, and Date.

	Time	Temp	Weather	Wind	Humidity	Barometer	Visibility
Date							
2024-07-01	0:00	28 °C	Passing clouds.	4 km/h	94%	1009 mbar	9 km
2024-07-01	Mon, 1 Jul	NaN	NaN	NaN	NaN	NaN	NaN
2024-07-01	0:30	28 °C	Passing clouds.	2 km/h	94%	1009 mbar	9 km
2024-07-01	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2024-07-01	1:00	28 °C	Passing clouds.	4 km/h	94%	1009 mbar	9 km

- **Programming Language:** Python.
- **Libraries:**
 - Pandas for data manipulation.
 - NumPy for numerical computations.
 - Matplotlib and Seaborn for data visualization.
 - Prophet for time-series forecasting.

- `scikit-learn` for evaluation metrics.

4. Perform Experiment

Data Preparation

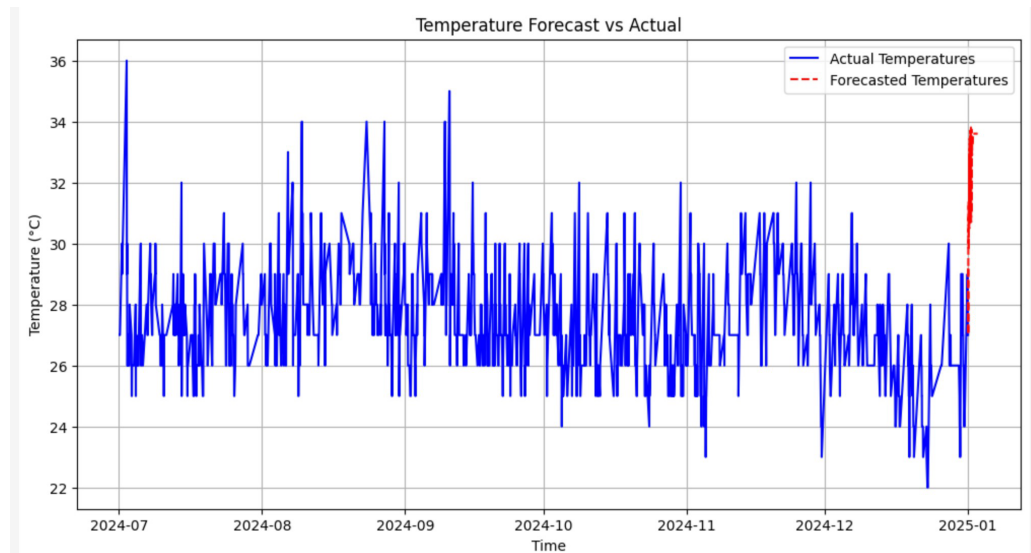
- Imported the dataset and selected relevant fields.
- Checked and handled missing values to ensure data quality.
- Transformed the "Date" column into a datetime format and set it as the index.

	Temp	Weather	Wind	Humidity	Barometer	Visibility
Datetime						
2024-12-31 21:30:00	28.0	Passing clouds.	7.0	66.0	1011.0	9.0
2024-12-31 22:00:00	28.0	Passing clouds.	7.0	66.0	1011.0	9.0
2024-12-31 22:30:00	28.0	Passing clouds.	6.0	66.0	1011.0	9.0
2024-12-31 23:00:00	28.0	Passing clouds.	6.0	66.0	1011.0	9.0
2024-12-31 23:30:00	27.0	Passing clouds.	6.0	70.0	1011.0	9.0

>The dataset after cleaning.

Modeling

- Train and evaluate by using XG-Boost classifier model.
- Utilized the `Prophet` library for time-series modeling. Prophet is particularly wellsuited for data with strong seasonal and trend components.
- Split the dataset into training and testing sets.
- Fit the model to the training data, focusing on temperature as the target variable.



> Here is the graph plot shows the relationship between Actual Temperature and Forecasted Temperature.

5. Descriptive and Conclusion

The problem was defined as forecasting daily average temperatures in Phnom Penh using historical weather data to support better urban and environmental planning.

- The Prophet model was trained on cleaned data to learn patterns and seasonal effects.
- Hyperparameters such as changepoint prior scale and seasonality were fine-tuned for optimal results.

Experimenting and Simulating the Model

- Predictions were made for a 30-day period using the trained model.
- Simulated scenarios included variations in seasonal and trend parameters to understand potential future deviations.

Analyzing and Interpreting Results

- **Model Accuracy:** The Root Mean Squared Error (RMSE) was calculated to assess prediction accuracy. 0.7527 is low relative to the target range, it suggests good accuracy.
- **Visualizations:** Forecast results and their confidence intervals were plotted to highlight trends and seasonal variations.
- The model successfully captured temperature patterns, aligning with real-world observations.

Future work could explore:

- Incorporating additional variables like precipitation and wind speed.
- Comparing Prophet with other models like ARIMA or LSTM to enhance accuracy.
- Expanding the dataset to include more years of historical data for improved generalization.

References

Dataset source:

<https://www.timeanddate.com/weather/cambodia/phnompenh/historic?month=9&year=2024>

Model source: <https://www.tableau.com/analytics/what-is-time-series-analysis>