Q&A Brief: Conformal Prediction Project

Introduction

This document provides answers to potential questions that may arise during the presentation or discussion of the Conformal Prediction project. Topics include Bayesian and Frequentist methods, the advantages of Conformal Prediction, computational considerations, and implementation details.

Potential Questions and Answers

1. What is the main objective of this project?

The objective is to implement Conformal Prediction for news article forecasting, providing uncertainty quantification without requiring prior distributions, unlike Bayesian methods.

2. How does Conformal Prediction compare to Bayesian Inference?

Conformal Prediction ensures valid prediction intervals with finite-sample guarantees while avoiding subjective priors and computationally expensive Bayesian updates.

3. What advantages does Conformal Prediction offer over Bayesian methods?

- No need for prior distributions.

- Finite-sample validity guarantees.

- Computational efficiency and scalability for large datasets.

- Works well in real-time applications.

4. What is the computational complexity of Conformal Prediction?

- Inductive CP: $O(n)$, suitable for scalable applications.

- Transductive CP: $O(nk)$, provides tighter intervals but is computationally expensive.

- Mondrian CP: $O(n \log n)$, balances efficiency and adaptability.

5. What dataset was used for this project?

The project applies Conformal Prediction to news article forecasting across four categories:

Entertainment, Politics, Sports, and Technology.

6. How were prediction intervals constructed?

1. Train a base model (regression).

2. Compute nonconformity scores (based on residuals).

3. Estimate the threshold using empirical quantiles.

4. Construct prediction intervals ensuring the coverage probability.

7. What are the key findings from the results?

- Prediction intervals successfully captured actual article counts.

- Interval width varied across categories, reflecting different uncertainty levels.

- Execution was computationally efficient, taking ~0.11 seconds for training and prediction.

8. Can Conformal Prediction be applied to other domains?

Yes. Potential applications include:

- Medical diagnostics (uncertainty-aware predictions).

- Finance (stock market risk assessment).

- Cybersecurity (anomaly detection in network traffic).

9. What are the limitations of Conformal Prediction?

- Prediction intervals can be wide if data variability is high.

- Dependent on the base model's performance.

- Some variants (e.g., TCP) are computationally expensive.

10. What improvements could be made in future work?

- Explore adaptive nonconformity scores to refine prediction intervals.

- Compare Conformal Prediction with Bayesian inference for further insights.

- Implement deep learning-based Conformal Prediction for enhanced predictions.