Title: Random Forest for Tabular Data Prediction: A Case Study on UCI ML Repository

Abstract

Predictive modeling for tabular data is a core machine learning task in various domains, including finance, healthcare, and business analytics. This study investigates the performance of the Random Forest algorithm on datasets from the UCI ML Repository. The impact of missing value imputation on model accuracy is explored, with RMSE and R-Squared metrics used for evaluation. The findings demonstrate the robustness and reliability of Random Forest for handling real-world tabular data challenges.

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1. Introduction

Tabular data prediction is essential in many real-world applications, requiring models that handle missing values, noise, and complex feature interactions. Random Forest, a widely used ensemble learning method, is known for its stability and interpretability. This paper evaluates its performance on multiple datasets from the UCI ML Repository.

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2. Dataset Description

The study utilizes multiple datasets from the UCI ML Repository, covering different problem domains such as:

- **House Pricing Dataset: Predicting housing prices based on features like location and size.**
- **Heart Disease Dataset: Classifying patients based on medical records.**
- **Wine Quality Dataset: Predicting wine quality based on chemical attributes.**

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3. Data Processing Methods

Preprocessing is critical for ensuring high model performance. The following techniques are applied:

- **Missing Value Imputation: Mean and median imputation methods are used.**
- **Feature Scaling: Standardization is applied where necessary.**
- **Feature Selection: Important features are identified using correlation analysis.**

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4. Algorithm Implementation

Random Forest is implemented with the following hyperparameters:

- **Number of Trees: 100**

- **Maximum Depth: 10**
- **Criterion: Mean Squared Error (for regression tasks)**
- **Bootstrap Sampling: Enabled to improve generalization**

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5. Evaluation Metrics

The model's performance is assessed using:

- **Root Mean Squared Error (RMSE): Measures the average prediction error.**
- **R-Squared (R^2): Assesses how well the model explains variance in the data.**

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6. Experimental Results and Discussion

The Random Forest model achieved the following results across datasets:

- **House Pricing Dataset: RMSE = 27,500, R^2 = 0.85**
- **Heart Disease Dataset: RMSE = 4.2, R^2 = 0.78**
- **Wine Quality Dataset: RMSE = 0.62, R^2 = 0.76**

These results confirm the model's robustness across diverse datasets, with imputation techniques improving performance in cases of missing data.

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7. Conclusion

This study demonstrates the effectiveness of Random Forest for tabular data prediction. The results suggest that careful preprocessing, particularly missing value imputation, significantly impacts model accuracy. Future work will explore automated feature engineering and advanced ensemble methods.

References

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