Proceedings of the International Conference on Industrial Engineering and Operations Management

Publisher: IEOM Society International, USA DOI: 10.46254/AF6.20250145
Published: April 8, 2025

An Overview of the Limitations of Traditional Greedy Tree-Based Methods

Ilyas Modni, Maissae Haddouchi, Zoubida Chorfi And Abdelaziz Berrado
AMIPS Research Team
EMI, Mohammed V University in Rabat
Rabat, Morocco
i.modni@research.emi.ac.ma, maissaehaddouchi@emi.ac.ma
chorfi@emi.ac.ma, Berrado@emi.ac.ma

Abstract

Traditional tree-based methods, such as ID3, C4.5, C5.0, and CART, have played a fundamental role in machine learning due to their simplicity, interpretability, and efficiency. These methods rely on a greedy, top-down recursive partitioning approach, which, while computationally efficient, can lead to locally optimal splits that may not reflect the best global structure of the data. One major challenge of this approach is controlling overfitting, particularly when trees grow too deep and capture noise instead of meaningful patterns. While tree depth is a tunable hyperparameter, selecting the optimal depth remains difficult, as it requires balancing model complexity and generalization. Additionally, traditional decision trees primarily rely on axis-aligned splits, limiting their ability to model complex, nonlinear relationships. Handling missing values is another challenge, as many traditional methods require imputation or heuristic-based surrogate splits, which can introduce biases. However, some implementations, like CART, provide built-in surrogate splits to address missing data. Moreover, decision trees may face scalability issues in high-dimensional spaces, where selecting optimal splits becomes increasingly expensive. To overcome these limitations, researchers have explored ensemble methods, optimization-based approaches, and hybrid models. Despite these drawbacks, traditional decision trees remain widely used due to their interpretability, ease of use, and strong baseline performance in machine learning tasks.

Keywords
Decision Trees, Greedy Algorithms, Limitations, Overfitting, Model Instability

Biographies

Ilyas Modni is a Ph.D. student at the Engineering School of Mohammadia (EMI), Mohammed V University, Rabat, Morocco, specializing in road safety through AI and the optimization of tree-based methods. His Ph.D. research addresses two major topics: the application of machine learning in road safety, and the optimization of tree-based algorithms for improved decision-making and interpretability. Ilyas presented his work, "Machine Learning Applications in Road Safety: A Comprehensive Review", at the OLA'24 conference in Dubrovnik, Croatia. Before pursuing his Ph.D., Ilyas earned a Master's in Data Science and Big Data, which provided him with a solid foundation in AI, machine learning, and data analysis. Currently, he is conducting research into optimizing tree-based methods, aiming to apply them to road safety due to their transparency and interpretability. Ilyas's research focuses on enhancing AI-driven decision-making systems, addressing challenges like overfitting, computational complexity, and interpretability, especially in road safety contexts. His work continues to explore how optimization techniques can improve the scalability and accuracy of decision tree models in real-world applications.

Zoubida CHORFI is an associate professor of Industrial Engineering at EMI School of Engineering at Mohammed V University. She received her MS/BS and PhD in Industrial Engineering from the same institution. She has more than three years of industrial experience working as process engineer and quality engineer for industrial companies. Her research interests are in the areas of Industrial Statistics, Operations and Supply Chain Modelling, Planning and Control with application in different industries. Her research work is about developing frameworks, methods and tools for systems' diagnostics, optimization and control with the aim of operational excellence.

Abdelaziz BERRADO is Professor of Industrial Engineering in EMI School of Engineering at Mohammed V University in Rabat. He was previously Deputy Director of Research and Cooperation and Industrial Engineering Department Chair at the same institution. Prior to his current position, he was a faculty member of Engineering Management at AlAkhawayn University in Ifrane. He holds a Ph.D. in Decision Systems and Industrial Engineering from Arizona State University. He researches advanced analytical methods and frameworks for knowledge generation and decision support in organizations. He focuses on data analytics for Operations and Supply Chain Modelling, Planning, Improvement and Control with applications in Healthcare, Education and other Industries. He has led several funded applied research projects with local and international impact and published research papers in renowned journals. In addition to academic work, he interacts closely with the industry through training and consulting projects. He is a fellow of IEOM Society and a member of INFORMS and IEEE. Previously, he was senior engineer and data analytics lead at Intel.