MLNova: Interactive Learning Platform for Machine Learning

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Abstract. MLNova is a structured platform designed to bridge the gap between theoretical knowledge and practical application in machine learning. Focused on enhancing student learning, the platform offers a path for beginners to explore key concepts in data preprocessing and model evaluation. Through interactive modules, MLNova delivers pre-recorded lessons and real-world projects, allowing learners to experience hands-on engagement. This paper outlines the platform's design, methodology, and the impact of interactive learning on improving comprehension of machine learning principles. Early feedback indicates a significant improvement in user engagement and learning outcomes.

Keywords. Machine Learning, Data Preprocessing, Interactive Learning, Educational Platform

1 INTRODUCTION

Machine learning is rapidly expanding across industries and is integral to the future of technology. However, many beginner and intermediate learners struggle with grasping foundational concepts, particularly in data preprocessing and model evaluation, due to limited access to hands-on resources. Targeted at this demographic, MLNova provides a structured and interactive platform designed to bridge these gaps. Through practical data processing exercises, structured learning paths, and real-world projects, MLNova allows students to build a stronger foundation and gain confidence in their ability to apply machine learning techniques effectively.

2 RESEARCH METHODOLOGY

MLNova was developed following a structured, user-centered design approach, beginning with user research to pinpoint gaps in existing platforms like Kaggle and Udemy. Key criteria in platform development included accessibility, real-time feedback, and ease of use, which led to the selection of Django for backend stability and React.js for a responsive frontend experience. The platform uses MongoDB and Firebase for efficient data handling, ensuring real-time updates in interactive modules where learners manipulate datasets. Machine learning models are implemented using Scikit-learn for simplicity, while Plotly and D3.js facilitate high-quality data visualization. This combination of technologies supports an engaging, interactive experience for users.

3 THEORY AND CALCULATION

The platform covers essential machine learning algorithms, focusing on the practical application of theoretical concepts. Lessons include algorithms such as linear regression, decision trees, and random forests, with a special emphasis on data preprocessing techniques like handling missing values, normalization, and feature scaling. Each topic is broken down into theory followed by hands-on coding exercises where students implement these algorithms on real datasets.

3.1 Mathematical Expressions and Symbols

In the data preprocessing module, learners explore mathematical techniques such as Z-score normalization and the standard deviation formula used for feature scaling:

$$□ = \frac{□ - □}{□}$$

This formula represents Z-score normalization, essential in scaling features for machine learning models. Additionally, the platform covers cost function minimization using gradient descent for linear regression:

$$J(\theta)=\frac{1}{2□}\sum_{□=1}^{□} (h_□(□^{(□)}) - □^{(□)})^2$$

4 RESULTS AND DISCUSSION

Early feedback from MLNova users indicates an improvement in understanding data preprocessing techniques. Surveys conducted post-use reveal that 80% of learners found the interactive modules helpful in comprehending previously challenging topics. Comparisons between MLNova users and students using traditional methods suggest that the platform's practical projects significantly enhance engagement. In this section, we discuss the outcomes of early testing and highlight the platform's impact on student learning, demonstrating how interactive learning environments contribute to greater retention of machine learning concepts.

Objective	Achievement
Develop an interactive ML platform	MLNova launched with interactive modules, offering learners real-time feedback on coding exercises.
Provide hands-on learning in data preprocessing	Enabled users to practice data handling techniques, such as missing data imputation and feature scaling, enhancing their practical skills.
Improve understanding of ML algorithms	Included tutorials and exercises on essential algorithms, improving comprehension of decision trees, linear regression, and more.
Offer real-time feedback	Integrated a feedback mechanism that allows learners to instantly see the impact of their code, boosting engagement and understanding.

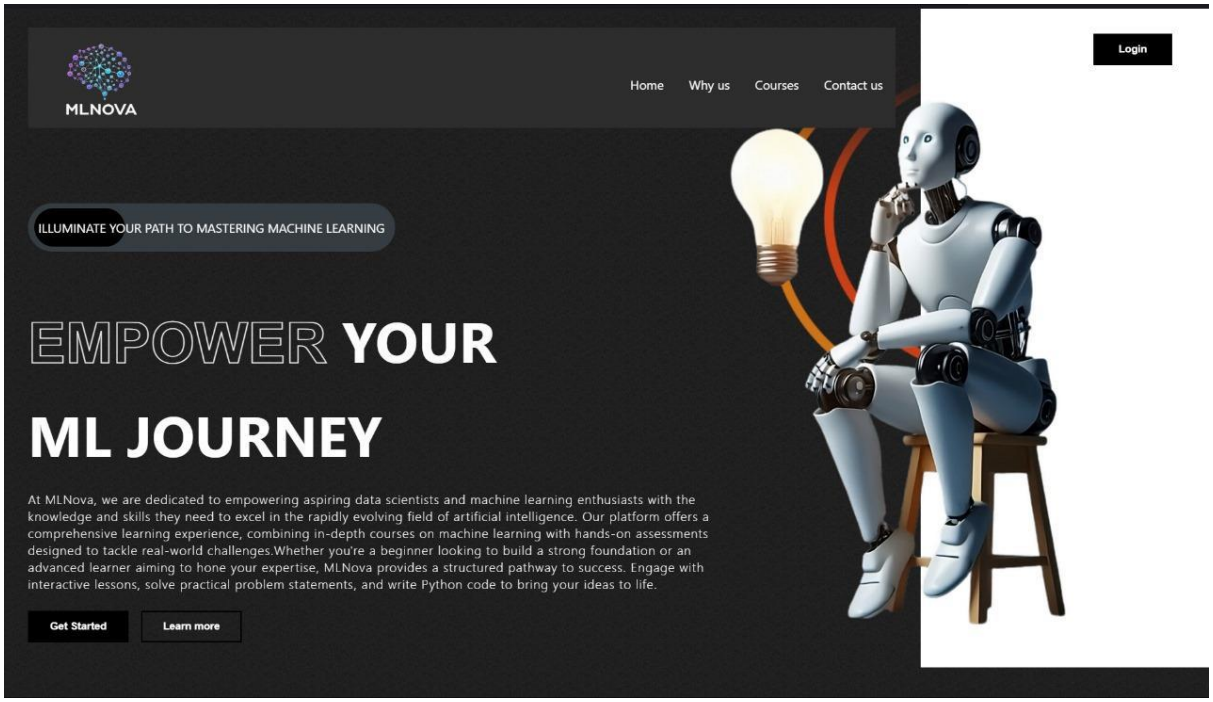

Figure 1: Initial User Interface of MLNova

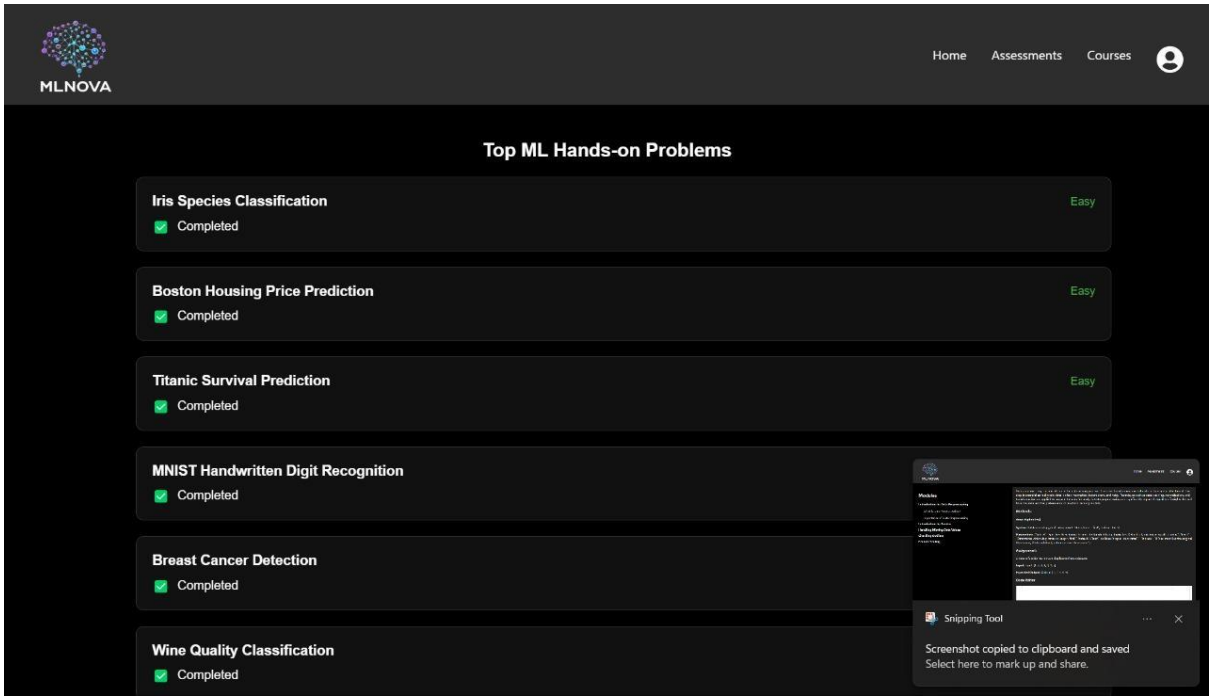

Figure 2. Page viewing problems for practice

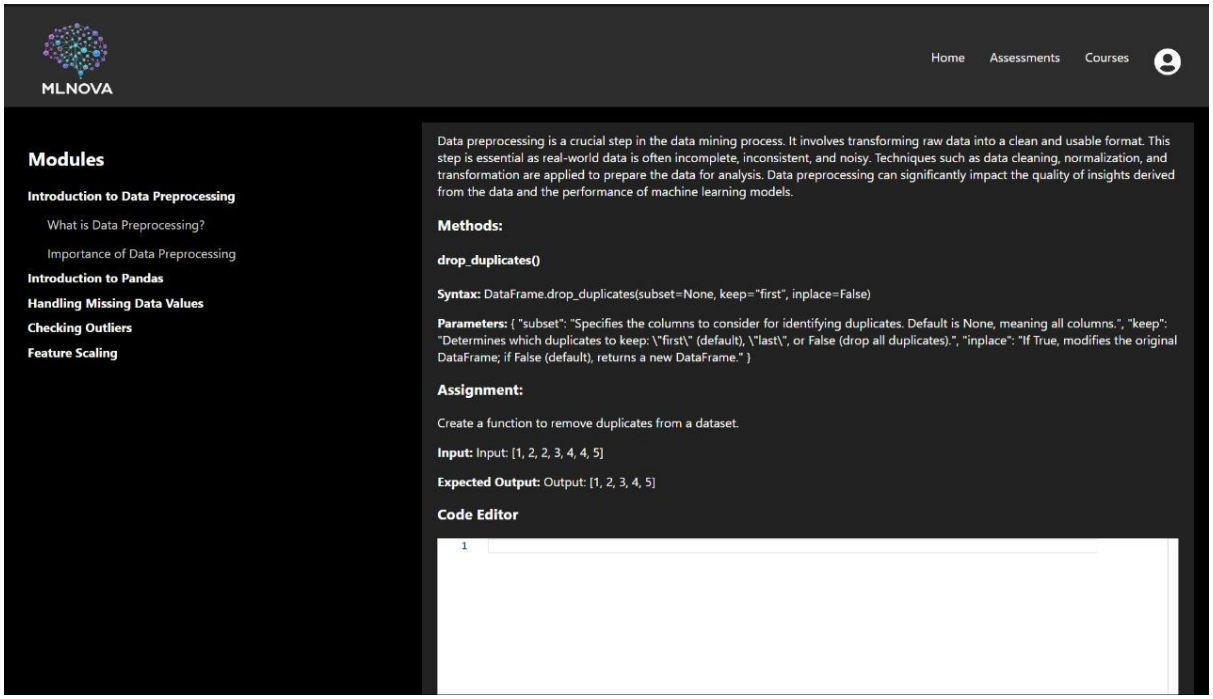

Figure 3: Structured Learning path with examples

4.1 Preparation of Figures and Tables

Figures in MLNova are embedded throughout the lessons to visualize key concepts, such as decision tree structures and confusion matrices. Each figure is numbered and referred to within the text, making it easy for students to connect theory with visual representation. Similarly, tables compare various machine learning algorithms and their performance across datasets, giving students insight into model evaluation metrics.

4.1.1 Formatting Tables

Tables in MLNova are used to organize information such as dataset statistics or model comparison metrics. For example:

Algorithm	Accuracy	Precision	Recall
Decision Tree	85%	80%	82%
Random Forest	89%	86%	85%

***Table 1**: Performance metrics comparison for Decision Tree and Random Forest algorithms on a sample dataset.*

These tables allow students to easily interpret performance metrics for different algorithms.

4.1.2 Formatting Figures

Figures used in MLNova maintain a high resolution to ensure clarity and effectiveness in illustrating key concepts. For example, learning curves and confusion matrices are used to explain model performance, and these figures are placed at appropriate points within the modules to provide visual aids that complement the theoretical explanations.

5 CONCLUSIONS

MLNova successfully addresses the need for practical, hands-on learning in machine learning. The platform provides a structured learning path that helps students understand and apply data preprocessing techniques and machine learning algorithms in real-world scenarios. By offering interactive modules and real-time feedback, MLNova enhances the learning experience and equips students with the skills necessary to succeed in a tech-driven environment. Future work will focus on expanding the curriculum to include more advanced topics and refining the user interface based on ongoing feedback.

5 DECLARATIONS

5.1 Study Limitations

MLNova is currently limited to introductory machine learning topics and has not yet incorporated more advanced subjects such as deep learning, reinforcement learning, or unsupervised learning techniques. Additionally, the platform operates without live instructor support, which may limit personalized guidance for learners requiring more in-depth assistance. Future updates will aim to address these limitations by expanding the curriculum and exploring options for live mentoring sessions.

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5.3 Funding source

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5.4 Competing Interests

The authors declare no competing interests.

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