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ProjecTree: An AI Powered intelligent Project Management System

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Chronicle	Abstract

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To ensure projects are completed on schedule, resources are used efficiently, and teams work together smoothly, strong project management is essential. However, the intricacy of today's projects, which involve many different tasks, dependencies, and teams, frequently leads to inefficiency, delays, and poor coordination. ProjectTree is a cutting-edge, AI-powered project management system created to tackle these issues. By using Natural Language Processing (NLP), the platform analyzes project details to sort tasks into frontend, backend, and database categories, and intelligently assigns them to employees based on their skills, experience, and availability. This smart resource allocation maximizes resource utilization and reduces bottlenecks. ProjectTree also includes a real-time communication tool to improve team interaction and uses role-based access control (RBAC) to limit user access to only the necessary resources and tasks, thereby improving security and data integrity. To protect sensitive project data, the system also incorporates strong security measures. This paper details the design, structure, and implementation of ProjectTree, comparing it to current project management tools, and showing how it can improve task assignment, team coordination, and overall productivity. The results show the system's ability to lessen project delays, improve decision-making, and offer a secure, collaborative environment for modern businesses.

INTRODUCTION

The effective execution of tasks and the attainment of business objectives rely heavily on project management. However, the management of intricate projects, involving numerous stakeholders, dependencies, and evolving priorities, poses a substantial challenge [1]. Traditional project management tools often fail to adequately address the dynamic and collaborative nature of contemporary projects, leading to inefficiencies in task distribution, communication, and resource management. This deficiency has spurred the development of more sophisticated systems that utilize artificial intelligence (AI) and machine learning to automate and optimize various aspects of project management, thereby enhancing adaptability, efficiency, and collaboration. The emergence of AI-driven project management systems has revolutionized team collaboration and task management, improving task assignment, progress monitoring, and overall decision-making [2]. A significant hurdle for many organizations is ensuring appropriate task allocation to individuals based on their skills and workload. ProjectTree, an AI-powered project management system, tackles this challenge by employing Natural Language Processing (NLP) and machine learning to automatically categorize project tasks and assign them to the most suitable team members [3-5]. This reduces the time spent on manual task allocation, minimizes the potential for human error, and boosts project efficiency. A critical issue in modern project management is the lack of real-time collaboration and communication,

particularly among remote and distributed teams. ProjectTree integrates a real-time chat function to facilitate seamless communication among team members, ensuring that project updates, changes, and discussions are conducted within a centralized, easily accessible environment. Furthermore, the system implements role- based access control (RBAC) [6] to enhance security and data integrity, ensuring that only authorized individuals have access to sensitive project information.

Despite advancements in AI and project management software, challenges persist in ensuring the cohesive integration of automated task allocation, real-time communication, and secure access control [7]. Many existing systems struggle with scalability and adaptability, especially in complex, dynamic projects that necessitate rapid adjustments to workflows and resource allocation. This study presents ProjectTree as a scalable and secure solution capable of overcoming these challenges. By combining NLP-driven task categorization, AI-based task assignment, real-time collaboration tools, and role-based security, ProjectTree offers a comprehensive and effective approach to project management.

The contributions of this study are as follows:

- A robust project management framework that automates task categorization and assignment, ensuring optimal resource allocation.
- A real-time chat integration that enhances collaboration and communication within project teams.
- A role-based access control system that ensures secure, permission-based access to project resources and data.
- A scalable solution capable of managing complex projects while maintaining performance and security.

Problem Statement

Traditional project management systems often fall short in handling the complexities of modern projects, suffering from issues like inefficient manual task allocation, poor resource optimization, lack of real-time collaboration, weak security and access controls, and limited adaptability to complex, evolving projects. These deficiencies lead to delays, communication gaps, security risks, and reduced productivity. ProjectTree aims to overcome these challenges by employing AI-driven automation for task assignment and resource management, providing real-time communication tools for seamless collaboration, and implementing secure role-based access control to protect sensitive data. This comprehensive approach ensures efficient, coordinated, and productive project delivery, particularly in dynamic and complex environments.

Proposed Solution

ProjectTree addresses the shortcomings of traditional project management by integrating AI and machine learning for intelligent task allocation, ensuring the right person is assigned to the right task based on skills and workload, thereby optimizing resource utilization and minimizing delays. It enhances team collaboration through real- time communication tools, centralizing discussions and updates to prevent information loss. Security is bolstered through robust role-based access control, safeguarding sensitive data and ensuring only authorized personnel have access. The platform is designed to be scalable, adapting to projects of varying sizes and complexities, and ultimately aims to improve project efficiency, security, and overall success in today's dynamic work environments by automating processes and streamlining communication.

Objectives

ProjectTree seeks to fundamentally transform project management by developing an intelligent, collaborative, and secure platform. At its core, the system leverages artificial intelligence and machine learning to automate task allocation, ensuring that the most suitable team members are assigned tasks based on their skills, experience, and availability. This intelligent assignment process aims to minimize manual effort, optimize resource utilization, and significantly enhance overall project efficiency. To address the critical need for seamless communication, ProjectTree integrates a real-time chat feature, fostering immediate collaboration and ensuring that all team members are aligned on project updates and discussions. Security is paramount, and the system employs robust role-based access control to safeguard sensitive project data, ensuring that only authorized personnel have access to critical information. Designed with scalability in mind, ProjectTree is intended to support projects of varying sizes and complexities, adapting to the unique needs of each project. Furthermore, the platform provides AI-powered insights to help project managers identify potential bottlenecks, make informed decisions, and streamline workflows, ultimately contributing to improved project performance and successful delivery. By combining these advanced features, ProjectTree aims to create a more efficient, collaborative, and secure project management environment, driving productivity and ensuring projects are completed on time and within scope.

SCOPE OF PROJECT

ProjectTree is designed to fundamentally transform project management by integrating artificial intelligence, machine learning, real-time collaboration tools, and comprehensive security features to optimize task distribution, enhance communication, and improve project outcomes. The system will employ AI-driven task allocation to assign tasks based on team members' abilities, expertise, and availability, ensuring efficient resource utilization. Real-time chat capabilities will facilitate seamless communication among team members, enabling discussions and file sharing, thereby boosting collaboration. Role-based access control (RBAC) will ensure that only authorized individuals can access sensitive project data, adding a layer of security and confidentiality to the platform. Engineered to accommodate projects of diverse scales, ProjectTree will provide scalability for both small teams and large enterprises, offering flexibility across various industries. It will also integrate predictive analytics, using

machine learning models such as Random Forest, to provide estimates on task completion times and project costs, empowering project managers with data-driven insights. The system will feature an intuitive user interface to simplify navigation and enhance user experience, promoting high adoption rates

LITERATURE REVIEW

Project Management Tools and AI Integration

Modern project management has seen a significant shift towards integrating Artificial Intelligence (AI) to enhance efficiency and productivity [8]. Platforms like Asana and Monday.com have started incorporating basic AI features, such as automated task reminders and progress tracking. Research indicates that AI-driven project management tools can improve task completion rates by up to 30% and reduce

project delays by 20%. This highlights the potential of AI to streamline project workflows and enhance decision-making. As AI technology evolves, its integration into project management systems is expected to become more sophisticated, providing more personalized and intelligent solutions [9].

AI-Powered Task Allocation and Resource Management

AI-driven systems are transforming how tasks are allocated and resources are managed within projects. These systems leverage machine learning algorithms to analyze employee skills, availability, and project requirements, suggesting optimal task assignments. Studies have shown that AI-powered resource allocation can increase resource utilization by up to 25% compared to manual methods [10]. By delivering intelligent task assignments, these AI systems improve project efficiency, ensuring that resources are used effectively and reducing the likelihood of project delays [11].

Comparison of Existing Project Management Solutions

Several project management platforms exist in the market, each offering unique features to enhance project execution. For instance, Jira [3] provides robust task tracking and issue management but lacks advanced AI-driven task allocation. Trello offers a user-friendly Kanban board interface but does not incorporate real-time communication tools [12]. Microsoft Project provides comprehensive project planning but lacks seamless integration with modern collaboration platforms [13]. While these platforms offer valuable features, they still have significant limitations that hinder their overall effectiveness in providing a fully integrated and intelligent project management.

Table 1.
Comparison of Project Management Platforms Based on Features and Limitations.

Platform	Features	Limitations
Asana [14]	Robust task tracking, issue management	Does not always have the very granular RBAC
Trello	User-friendly Kanban board interface	No real-time communication tools.
ProjectLibre [15]	Project management and communication tool.	No of real time communication tools like chat

Gaps in Existing Systems

Despite the advancements in AI and project management software, several gaps persist in existing systems. A significant limitation is the lack of truly intelligent task allocation, as many platforms rely on basic algorithms or manual input, failing to fully leverage AI for optimal resource distribution. Additionally, there's a notable absence of seamless, integrated communication tools that facilitate real-time collaboration without relying on external applications [16]. Furthermore, robust security measures, particularly granular role-based access control, are often lacking, leaving sensitive project data vulnerable. Device and platform compatibility issues also exist, limiting accessibility for teams using diverse operating systems and devices. These gaps indicate a need for a more comprehensive, intelligent, and secure project management solution.

Our Contribution

The Project Tree system aims to address these gaps and enhance existing models by

incorporating several key features:

- AI-driven task allocation that considers employee skills, availability,
- and project requirements for optimal resource utilization.
- Integrated, real-time communication tools to streamline collaboration within the platform.
- Robust, granular role-based access control to ensure secure access to project data.
- Broad device and platform compatibility, ensuring seamless use across various operating systems and devices.

METHODOLOGY

Efficient and intelligent project management remains a challenge due to issues like inefficient task allocation, lack of real-time collaboration, and difficulties in tracking project progress. To address these challenges, ProjecTree integrates AI-driven automation and real-time collaboration tools to enhance project execution.

The proposed system is composed of two main components:

AI-Powered Task Allocation & Resource Optimization

- Implements machine learning algorithms to analyze team members' skills and workload.

- Dynamically assigns tasks based on expertise and availability, ensuring balanced work distribution.

- Provides real-time progress tracking and intelligent recommendations for project timelines.

Real-Time Collaboration & Project Monitoring System

- Enables secure role-based access control for project members.

- Facilitates real-time communication and notifications to keep teams updated.

- Integrates document and file-sharing features for seamless collaboration.

- Complete project and task management system.

Workflow of ProjecTree

The ProjectTree workflow initiates with the creation of a new project within the system. Users input project specifications, which are then processed by an AI-driven NLP model to categorize tasks into domains like frontend, backend, and database

development. The system dynamically allocates tasks to team members based on their skill sets, current workloads, and availability, thereby ensuring efficient resource deployment. Task descriptions are automatically generated using a GPT-2-based text generation model [17], providing comprehensive and detailed instructions for employees. Each team member receives immediate notifications regarding their assigned tasks and can collaborate seamlessly through integrated chat, video conferencing, and @mention functionalities. Employees can share progress updates, upload relevant documents, and manage task interdependencies within the system, fostering enhanced communication and team synergy. Extracted project data is continuously analyzed using machine learning models, such as Random Forest [18-

19], to forecast task completion timelines, project expenses, and resource allocation effectiveness. AI-driven insights empower managers to identify potential bottlenecks proactively and make informed, data-driven decisions to optimize project execution. ProjectTree also offers sophisticated project tracking and reporting capabilities, including visual progress summaries.By integrating AI-based task categorization, skill-driven task allocation, real-time collaboration tools. ProjectTree delivers an intelligent and automated project management solution that elevates productivity, minimizes manual intervention, and ensures streamlined project execution.
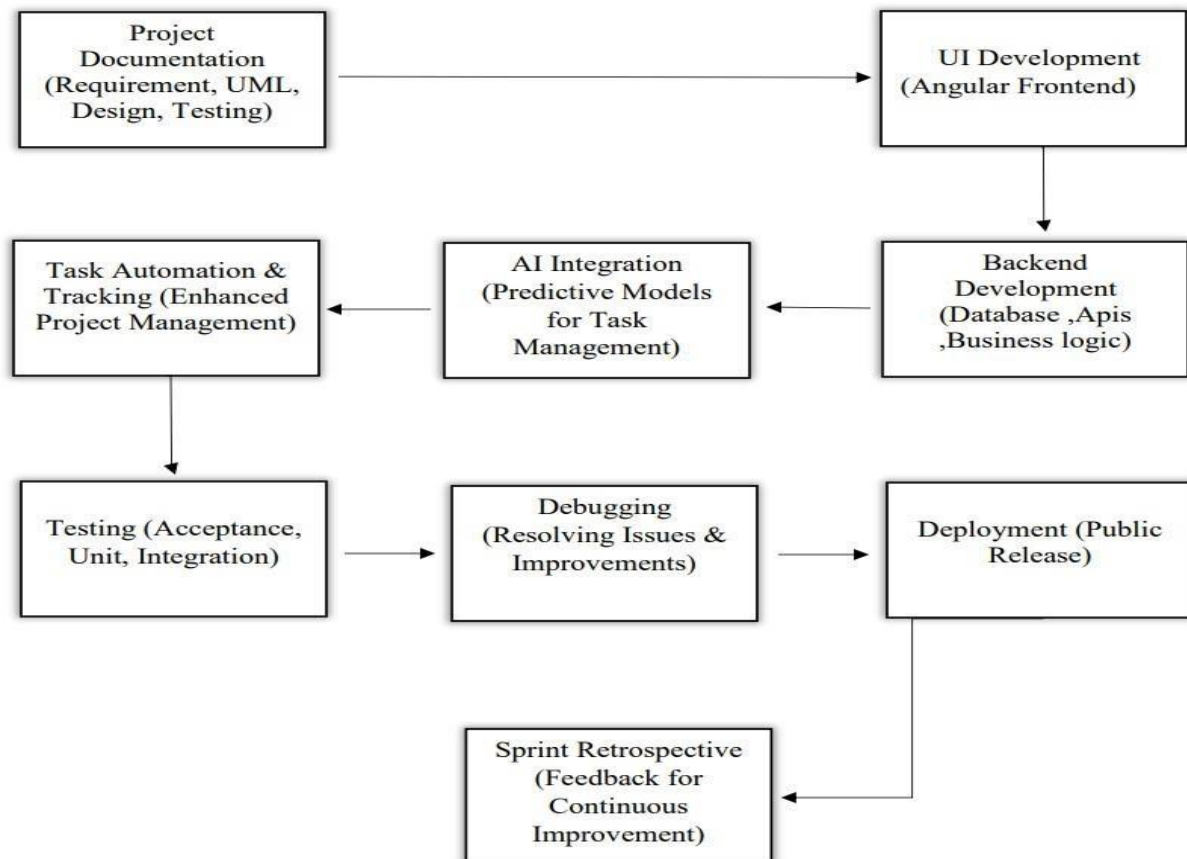
Figure: 1.
Illustrates the flow diagram of the proposed methodology

DATASET OVERVIEW

The Task Categories Dataset, is a curated resource designed for task classification and skill matching. Compiled from diverse sources like LinkedIn and Indeed datasets [20-22], it aims to streamline task allocation and talent identification. This dataset is valuable for optimizing project workflows, enhancing HR recruitment processes, and enabling AI-driven task automation.

PURPOSE AND APPLICATIONS

This dataset facilitates

Project Management: Efficient task allocation based on employee skill sets.

AI-Driven Task Automation: Development of machine learning models for automated task categorization and skill matching.

Skill Gap Analysis: Identification of skill deficiencies within teams or organizations.

Dataset Composition and Categories:

The dataset is structured with three core components:

Task Description: Concise descriptions of tasks.

Category: Task classifications (e.g., Backend, Frontend, Database).

Skill: Required proficiencies (e.g., Spring Boot, ASP.NET, Django, Kotlin, API development).

This structure enables precise task-to-professional mapping, improving productivity and automation.

Dataset Structure and Format

The dataset is in CSV format. Each row represents a task with its category and skill. Columns include: Task Description, Category, and Skill.

Preprocessing and Data Augmentation

To ensure quality and usability, the dataset undergoes:

Data Cleaning: Removal of inconsistencies and duplicates from task descriptions.

Standardization: Normalization of skill names for uniformity.

Data Augmentation: Expansion of task descriptions through variation generation for improved machine learning training.

Potential Use Cases for Machine Learning

Automated Task Assignment: AI prediction and allocation of tasks based on skills. **Job Matching Systems:** AI-driven candidate suggestions based on task requirements.
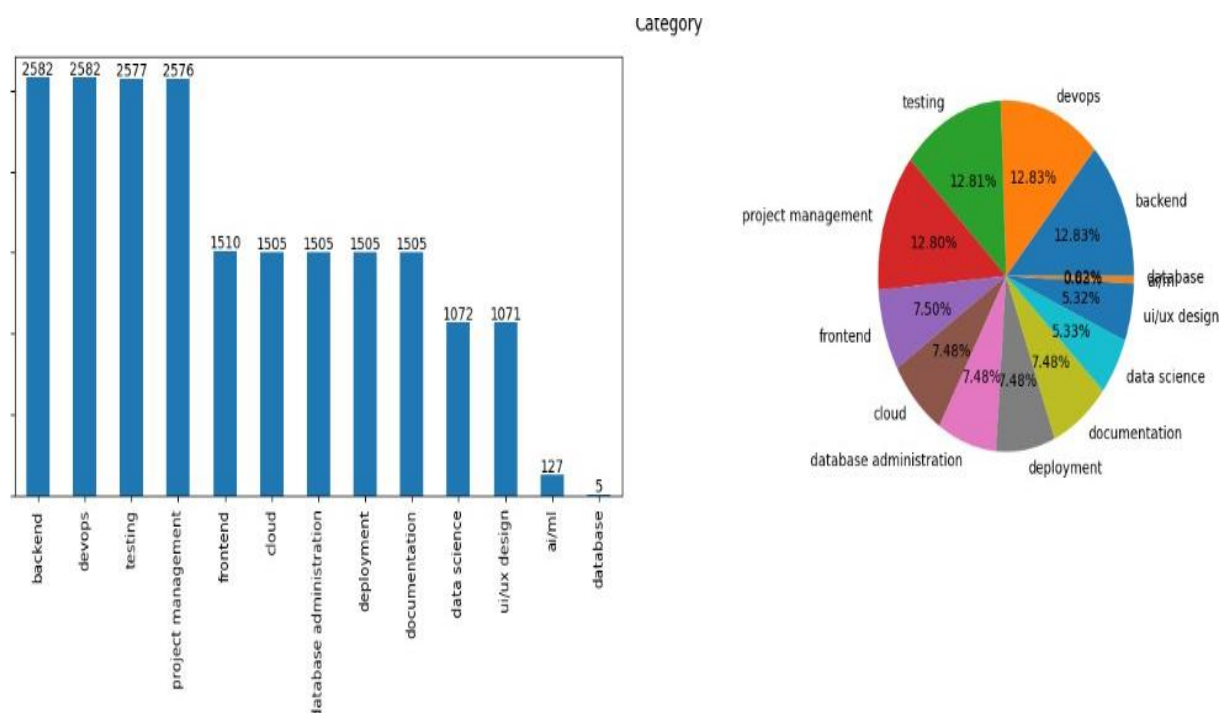
Figure 2.
Evaluate the Categories in the Datas
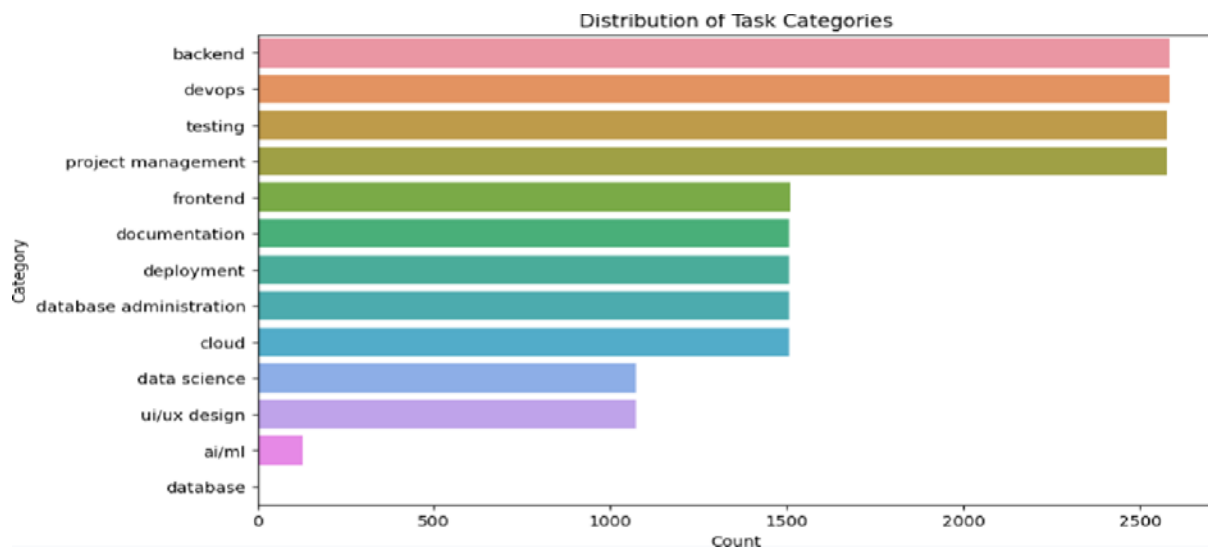
Figure3.
Evaluate the skills to understand their representation and frequency.
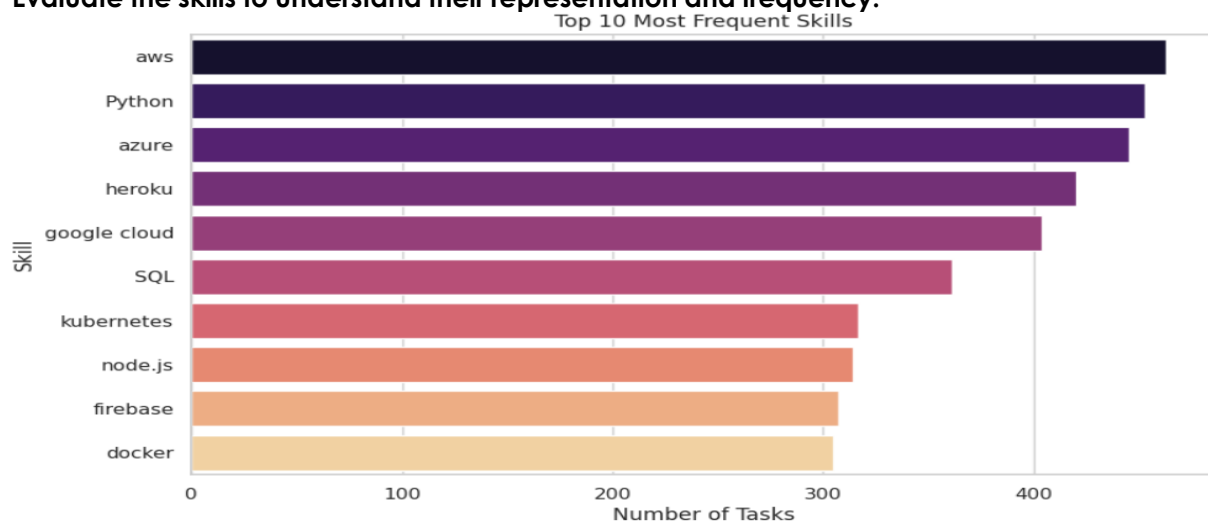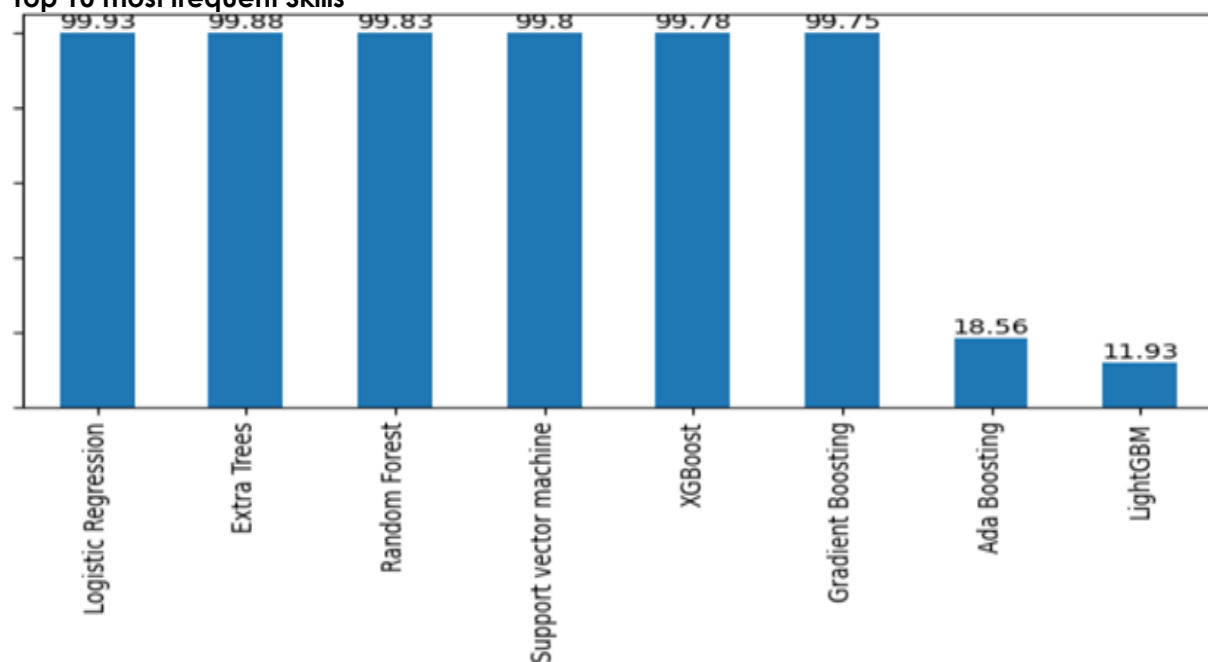

Figure 4.
Top 10 most frequent Skills

Figure 5.
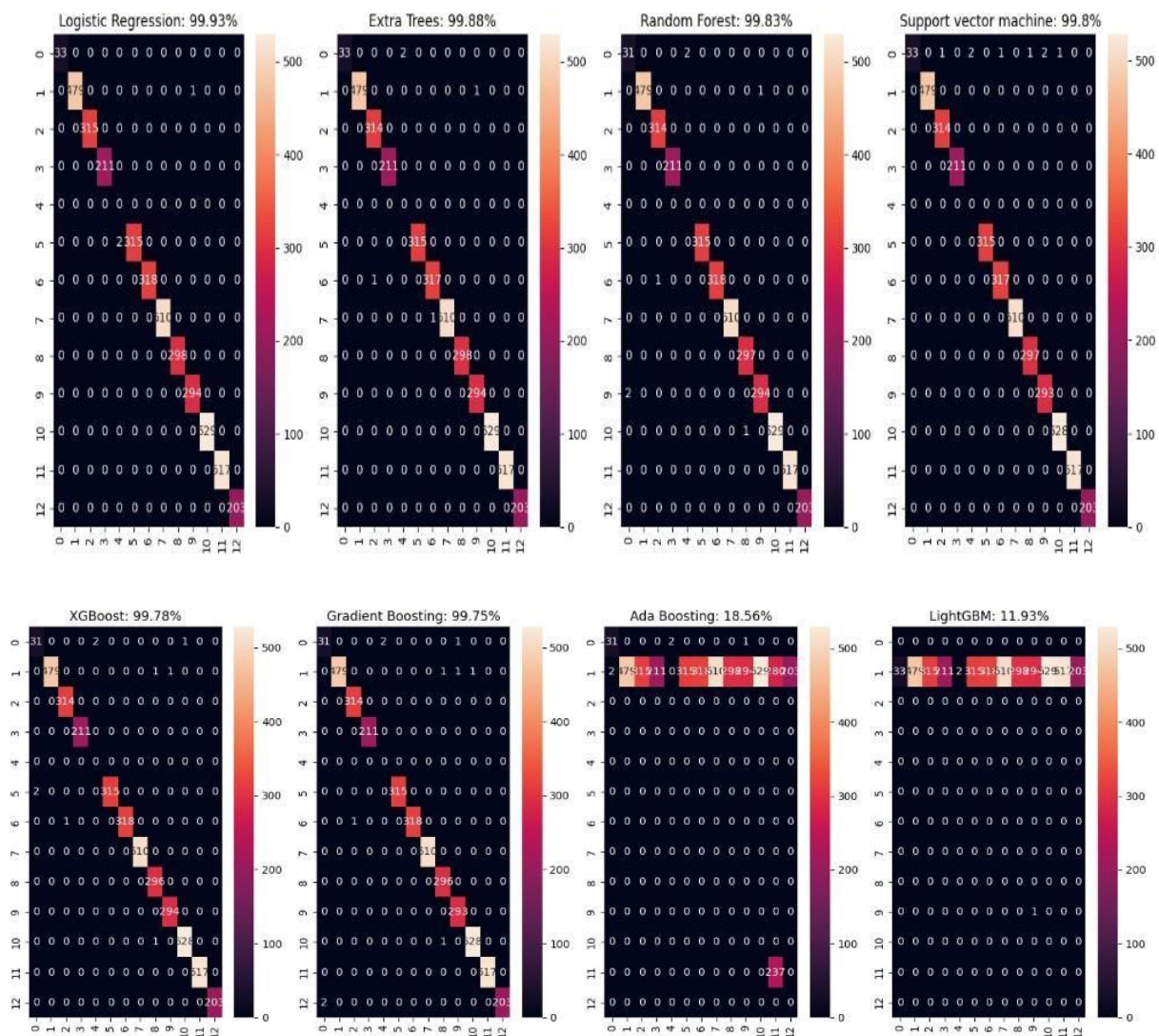**Task Category Prediction using ML algorithms - performance evaluation and assessment**.

RESULTS AND ANALYSES

Evaluation of several machine learning models for task categorization showed significant variations in their predictive accuracy. Logistic Regression achieved the highest accuracy at 99.93%. Following closely were Extra Trees (99.88%), Random Forest (99.83%), and Support Vector Machine (99.80%), as shown in the accompanying bar chart. XGBoost and Gradient Boosting [23] also performed well, with accuracies above 99.7%. In contrast, Ada Boosting (18.56%) and LightGBM (11.93%) [24] had considerably lower accuracies, indicating they were not well-suited for this dataset. The confusion matrices for the top four models showed mainly correct classifications, with strong diagonal patterns and few misclassifications across different task types.

Analyzing the dataset's composition, depicted in the graph, revealed a strong imbalance in task category representation. Backend, devops, and testing tasks were highly frequent, each with over 2500 instances, while AI/ML, UI/UX design, and database categories had fewer than 500 instances. This imbalance corresponds with the "Top 10 Most Frequent Skills" graph, where cloud platforms (AWS, Azure, Google Cloud) [25] and programming tools (Python, SQL, Node.js) were dominant, appearing

in 100 - 400 tasks. AWS was the most frequent skill followed by Python and Azure, reflecting the technical nature of the overrepresented backend and devops categories.

The observed class imbalance and skill distribution have consequences for how well the models can generalize. The high accuracy of Logistic Regression and tree-based models (Extra Trees, Random Forest) might be partly due to their ability to learn strong relationships between dominant skills and categories (e.g., AWS with devops).

Conversely, less represented categories like AI/ML or UI/UX design often linked to less frequent, specialized skills not in the top 10 likely contributed to poorer performance in those specific classes. This highlights the necessity for future improvements using techniques like resampling or weighted loss functions to reduce bias towards the more common categories and skills.

CONCLUSION

This study investigates ProjectTree, an AI-powered project management system designed to optimize task allocation, collaboration, and project monitoring through intelligent automation. The system utilizes Natural Language Processing (NLP) and Machine Learning (ML) to categorize tasks, align them with employee proficiencies, and generate comprehensive task descriptions using a GPT-2-based text generation model. Notable advancements have been achieved in integrating AI-driven task classification, skill-based task assignments, real-time notifications, and predictive analytics for project completion and cost forecasting.nFurthermore, collaborative functionalities, including chat, video conferencing, document sharing, and task dependency management, have been successfully implemented to enhance communication and team coordination.

Nonetheless, several improvements are still underway, including refining the AI model for enhanced task classification and prioritization, optimizing resource allocation efficiency, and further developing real-time project tracking with predictive insights. Attention is also being directed towards improving the system's user interface and user experience, optimizing performance for seamless operation across various platforms, and conducting final testing based on authentic user feedback. These refinements will ensure that ProjectTree evolves into a resilient, intelligent, and user-friendly project management solution, capable of addressing contemporary project execution complexities with efficiency, automation, and accuracy.

DECLARATIONS

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