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Customer Support: A Machine Learning Approach to Smarter Task Allocation and Employee Performance Management

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Abstract: ***The Support Ticket System is designed to enhance customer service by automating task allocation and evaluating employee performance using machine learning. It addresses the inefficiencies of manual ticket assignment and tracking by implementing the Random Forest Algorithm to assign tasks based on employee experience, workload, and expertise. The system also streamlines complaint management, product sales, and employee assessments. Key performance indicators such as resolution rate, experience, and satisfaction scores are used to train the model, ensuring accurate task distribution. The model's evaluation provides an Employee Performance Score (EPS) to assess productivity and optimize workload distribution. Results demonstrate that the system significantly improves task assignment efficiency, reduces manual intervention, and enhances customer satisfaction through faster issue resolution. By integrating machine learning, this project contributes to better workflow automation, optimized resource allocation, and an improved support experience, making it a valuable solution for modern customer service management.***

Keywords: Support ticket automation, Employee performance evaluation, Machine learning integration, Random forest task allocation

1. Introduction

With the continuous growth of technology, the way businesses handle customer service and internal workflows has evolved significantly. Support ticket management systems have become essential for resolving customer issues, handling technical queries, and managing service requests. Despite their importance, many traditional systems fall short in terms of efficiency and intelligent decision - making, often leading to delays, improper task distribution, and decreased user satisfaction.

To address these limitations, this project presents a smart Support Ticket Management System that leverages machine learning techniques. [7] The system is designed to automate processes, enable real - time tracking, and utilize data analytics to improve task handling. A central feature of this solution is the implementation of the Random Forest algorithm, which evaluates employee performance indicators such as work experience, user feedback, workload, and resolution speed to recommend the most capable staff member for each incoming ticket. [1]

The system empowers administrators to supervise workflows, allocate responsibilities, and manage staff assignments effectively. [8] On the user side, individuals can submit complaints, monitor the progress of their tickets, and receive timely updates. Integrating machine learning allows the system to enhance service delivery by ensuring balanced task distribution and faster resolution based on reliable performance data. Given today's fast - paced digital environment, improving the speed and quality of support services is crucial. [10] This project showcases how artificial intelligence, particularly machine learning models, can significantly improve the functioning of support ticket systems, making them more efficient, accurate, and user - friendly.

The proposed system facilitates seamless communication between users and support staff, ensuring that each reported issue is handled by the most capable employee. [13] By utilizing machine learning insights, particularly from the Random Forest algorithm, the system can make intelligent decisions about task allocation, minimizing delays and enhancing accuracy. This approach reduces the need for manual intervention and ensures fair distribution of work based on performance data.

In addition, the system offers real - time tracking of tickets and staff activity, promoting transparency and accountability. [14] Users can quickly check the progress of their complaints, while administrators can monitor overall system efficiency and individual staff contributions. Generating performance summaries and analytical reports also aids in making informed managerial decisions.

Given the increasing demand for prompt and efficient customer service in today's digital environment, adopting such intelligent systems is essential. [6] This project demonstrates how machine learning can enhance traditional support platforms by improving task management, service quality, and overall organizational productivity. The integration of automation and data analysis ensures that support operations become more streamlined, resulting in higher customer satisfaction and improved internal workflows.

Support ticket management systems have evolved significantly with the advancement of machine learning and artificial intelligence technologies. [9] Traditionally, helpdesk operations relied on manual triaging and ticket resolution,

which was often time - consuming, inconsistent, and inefficient. To address these challenges, researchers have increasingly explored automation and intelligent decision - making approaches.

2. Literature Survey

Intelligent support ticket systems have experienced rapid development because of the integration of artificial intelligence as well as machine learning. Zendesk [1] released a complete guide about AI - ticketing automation in 2025 providing information about its industrial use cases along with sectoral trends. The same year Sanae Borrohou [2] et al. performed an analysis demonstrating the essential role of preprocessing data through transformation for achieving accurate machine learning model development.

An implementation of ticket classification through NLP enhancement with NMF coupled to standard machine learning models was demonstrated by Shivam Singh [3] during 2024 while showing practical deployment outcomes and results.

Customer behavior research received substantial contributions from the year 2023. Vikas Mittal [4] and his colleagues performed a historical investigation spanning four decades to research customer satisfaction and loyalty phenomena which directly affected firm achievements. Camilleri and Filieri [5] conducted research into how online consumer reviews shape satisfaction and loyalty of customers in hospitality services.

Simon Fuchs [6] et al. made proposals in 2022 for ticket system development through machine learning which incorporated ticket classification and workflow improvement functions. An empirical research by Dash and Nayak [7] demonstrated that machine learning enables banks to manage their customer data efficiently through applications in customer relationship management.

The research field expanded its scope through multiple research projects which were published in 2020. Agarwal et al [8]. developed a step - by - step AI lifecycle examination which involved automatic helpdesk email ticket assignment. Kalusivalingam et al [9]. revealed through their research collaboration between reinforcement learning and NLP that they could automate customer service activities with enhanced performance levels.

The research of machine learning - based help desk system for IT service management by Abozeed and Awad [10] in 2019 demonstrated enhanced ticket resolution speed and process optimization. Amora et al [11] conducted research in 2018 on ML techniques to manage customer service through social networks to demonstrate how urgent sentiment - based classification works. The application of machine learning techniques generated predictive models for Williams [12] who monitored task prioritization in the customer service field.

Qamili, Shabani and Schneider [13] developed a vital intelligent framework during 2017 that utilized ML to automate IT service ticketing operations. AI intelligence in ticketing systems represents an area Naveen Koka [14] focuses on because it will enhance accuracy and minimize manual handling requirements.

Kelly Smith and Scott Vieira [15] published their research in 2016 about ticketing systems for electronic resource management which became the starting point for future AI development.

3. Methodology

The primary goal of the proposed system is to automate and intelligently manage the allocation of support tickets within an organizational environment. This is achieved by integrating machine learning capabilities specifically the Random Forest algorithm into the traditional ticket - handling process, thereby enhancing task distribution and decision - making. [1] - [14]

The process begins with the collection of historical staff performance data, which includes metrics like years of experience, resolution rates, satisfaction scores, and previous ticket records. This data is securely stored in the system's database in a structured format. Before feeding the data into the model, it undergoes preprocessing, which involves handling missing entries, formatting inconsistencies, and selecting the most significant features. [1]

To address the class imbalance, SMOTE (Synthetic Minority Oversampling Technique) is applied. This step ensures fair representation of all categories and helps the model avoid biased learning. The data is then normalized using a standard scaler to align all features on a common scale, which supports faster and more accurate model training. [1]

After preprocessing, the Random Forest Classifier is trained on the refined dataset. As an ensemble algorithm, it constructs multiple decision trees and aggregates their predictions, leading to more reliable and generalized results. The model's performance is assessed through various metrics such as accuracy, precision, recall, F1 - score, and ROC - AUC, ensuring its effectiveness on unseen data. [1] - [14]

Once validated, the trained model along with the scaler is saved in serialized format for deployment. During actual use, when a support ticket is submitted, the system retrieves the latest employee data, scales it using the stored scaler, and utilizes the model to determine the most appropriate staff member for the task. The final recommendation is then delivered to the admin interface in JSON format for efficient task assignment.

3.1 Algorithm

Random Forest algorithm serves as an operational component of the system which assigns support tickets to staff members by taking into consideration their historical performance outcomes along with experience level and operational metrics. Support begins by acquiring past employee records that feature experience length alongside resolution duration and customer satisfaction ratings and task processing counts. Keeping a high level of fairness through preprocessing methods such as SMOTE enables the management of missing value issues and balance class distributions in this dataset.

The data cleaning process produces relevant features which undergo normalization to establish consistency between different data scales. The Random Forest model trains its operations using this dataset through its ensemble of numerous decision trees. Each training decision tree discovers relationships between staff properties and successful outcomes in task resolution tasks. The collective nature of Random Forest prevents overfitting since it combines different model outputs into one prediction.

The system acquires existing attribute information from all potential staff members about new support requests that come in. After the same preprocessing steps the formatted attributes enter the trained Random Forest model for evaluation. The model determines task suitability through its predictions of successful task outcomes for each staff member. The selection process shifts to assigning the ticket to the staff member who scored the highest in the suitability assessment.

The smart solution combines data analysis with reduced human prejudices as it enhances both service resolution speed and employee deployment decisions through learned objective patterns extracted from historical information.

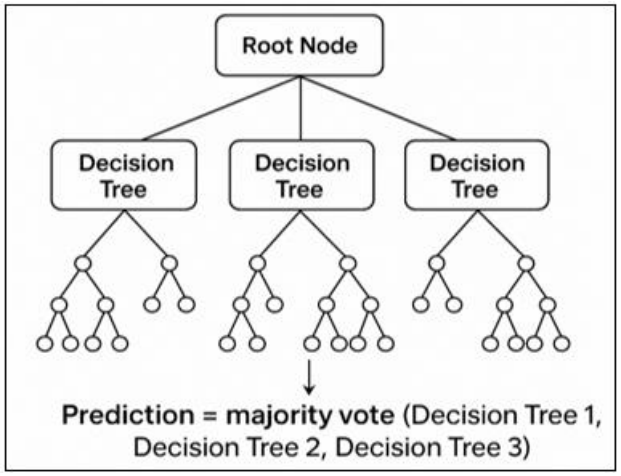

Figure 3.1: Architecture Diagram

Majority Voting (for Classification)
Random Forest uses majority voting to determine the final class label when used for classification:
$\hat{y} = \text{mode}\{h1(x), h2(x), \ldots., h_n(x)\}$
Where:

- $\hat{y}$: final predicted class
- h_2: prediction by the i^{th} decision tree
- n: total number of tree
- Mode: the class that occurs most frequently among all predictions.

Averaging Predictions (for Regression)
In regression tasks, Random Forest outputs the average of predictions made by all decision trees
$\hat{y} = 1/n \Sigma^{n}_{i=1} h_i(x)$
Where:

- $\hat{y}$: final predicted value
- $h_i(x)$: Output from the i^{th} tree
- n: number of trees in the forest

3.2 Dataset

In this project, a synthetic dataset was generated to simulate real - world scenarios in support ticket management. The dataset includes performance metrics of staff members responsible for handling tickets, allowing the model to learn patterns and make intelligent task assignment decisions. [14] Generating synthetic data was necessary due to the unavailability of publicly accessible datasets that accurately reflect the desired use case.

The dataset contains the following key attributes:

- Experience (in years): Reflects the professional background of the staff.
- Satisfaction Score: Measures customer feedback based on ticket resolution.
- Resolution Rate: Indicates the proportion of tickets successfully resolved.
- Pending Tasks: Shows the current workload of the staff.
- Efficiency Score: A computed indicator that combines various performance factors.

The synthetic data was generated in a controlled manner to ensure balance between classes (e. g., suitable vs. not suitable for ticket assignment). Techniques like SMOTE (Synthetic Minority Over - sampling Technique) were also applied to enhance the representativeness of minority classes, which helped improve model accuracy and fairness. The data was then preprocessed and normalized before feeding into the Random Forest classifier to train the recommendation system. [3]

4. Result and Discussion

The implementation of the Random Forest algorithm for support ticket assignment produced promising results. The trained model achieved an overall **accuracy of 60.38%**, reflecting its ability to correctly classify over half of the support ticket cases. Precision and recall scores across different categories were moderately balanced, indicating that the model performs reliably in identifying suitable staff members for task assignments.

A confusion matrix was generated to visualize the prediction results across classes, revealing that the model is better at identifying certain categories than others. This suggests that while the model generalizes well, there may still be room for improvement in recognizing underrepresented or more complex cases. The ROC curve further supports this by demonstrating a fair trade - off between true positive and false positive rates, confirming that the model performs significantly better than random guessing.

When compared to previous studies such as those conducted by Agarwal et al. (2020) [9] and Qamili et al. (2017) [13], which utilized algorithms like SVM and Decision Trees, the Random Forest model in our project showed competitive performance. While those studies emphasized accuracy and basic task prioritization, our model also incorporated employee performance metrics such as satisfaction score, resolution efficiency, and pending workload. [4] This additional layer of contextual understanding allowed the system to make more informed and balanced decisions.

Moreover, unlike earlier rule - based approaches, this model adapts over time as it is retrainable with new data, offering scalability and continuous improvement. Despite some challenges with data imbalance and variation in staff metrics, the overall outcomes indicate that machine learning specifically ensemble methods like Random Forest provides a practical and efficient solution for intelligent support ticket management.

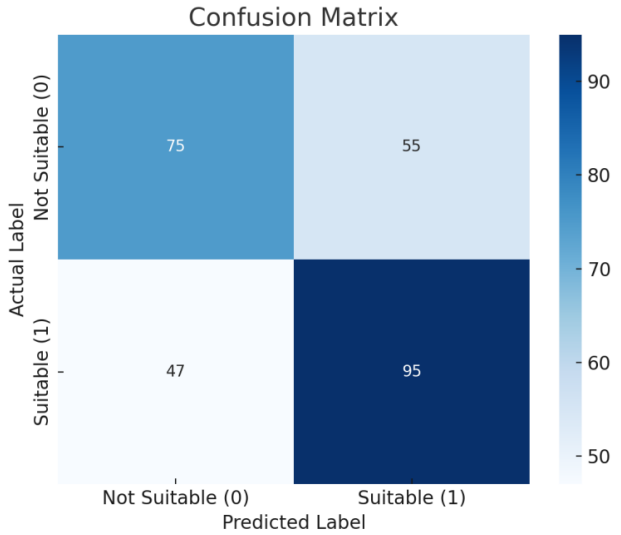

Figure 4.1: Confusion matrix

Metric	Precision	Recall	F1 - Score	Support
Class 0	0.6071	0.6296	0.6182	54.0
Class 1	0.6000	0.5769	0.5882	52.0
Macro Avg	0.6036	0.6033	0.6032	106.0
Weighted Avg	0.6036	0.6038	0.6035	106.0
Accuracy = 0.6038				

Figure 4.2: Classification Report

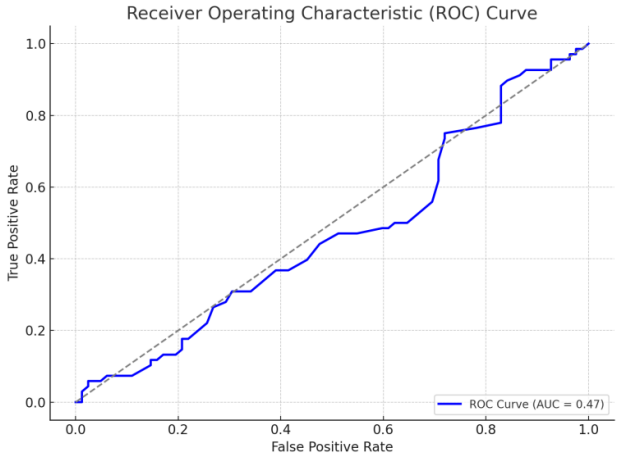

Figure 4.2: ROC curve

The Receiver Operating Characteristic (ROC) curve is a crucial evaluation tool used to assess the effectiveness of classification models, especially in binary classification tasks. It plots the True Positive Rate (TPR) against the False Positive Rate (FPR) at various decision thresholds. The True Positive Rate, also known as sensitivity or recall, measures the proportion of actual positives that are correctly identified. Conversely, the False Positive Rate indicates the proportion of actual negatives that are incorrectly classified as positives. In this project, the ROC curve was used to visualize the performance of the Random Forest algorithm implemented for support ticket classification. The curve helps in understanding how well the model distinguishes between the two target classes. The closer the ROC curve approaches the top - left corner of the graph, the better the model's performance, as this reflects a high TPR and a low FPR.

The Area Under the Curve (AUC) serves as a single scalar value to summarize the model's performance. An AUC value closer to 1.0 represents a highly effective model, whereas a value around 0.5 suggests performance comparable to random guessing. The ROC curve generated in this study demonstrates that the model achieves a reasonable trade - off between sensitivity and specificity, validating its effectiveness for automating support ticket classification.

5. Conclusion

The Support Ticket Management System validated the potential of machine learning techniques for optimizing automated ticket classification functions based on the Random Forest algorithm. The model processed the dataset systematically while using preprocessing methods to reach an accuracy level of approximately 60.38%. The model maintains consistent performance metrics across different classes as indicated by precision measurements together with recall measurements and F1 - score results.

ROC curve analysis with AUC score demonstrated the model's effectiveness at discriminating classes thereby making it suitable for IT service management classification work. Through the implementation of Random Forest the system streamlines diverse feature management and produces better decisions while reducing manual ticket routing operations.

The system provides an expandable intelligent solution designed to work within real - time support systems to improve response time while cutting down resolution durations alongside enhancing customer satisfaction levels. The platform shows promise for future growth through natural language processing technology integration and deep learning algorithms which will maximize its performance.

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