**DESIGN ANALYSIS APPROACH FOR HOTEL BOOKING CANCELLATION PREDICTION**

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**ABSTRACT**

Hotel managers find it beneficial to predict hotel booking cancellations as it enables them to enhance room inventory management, pricing strategies, and customer satisfaction by proactively addressing potential problems. In this study, we present a machine learning-centered method for forecasting hotel booking cancellations. Overall, our proposed approach will equip hotel managers with a robust tool for predicting hotel booking cancellations and a deeper understanding of the factors influencing them. This, in turn, will enable data- driven decision making to optimize room inventory, pricing strategies, enhance customer satisfaction, and ultimately boost revenue

**Keywords:** Classification, Machine Learning, Predictive analysis, Random Forest, K-Nearest Neighbors, Decision Tree, Naive Bayes, Logistic Regression

1. **INTRODUCTION**

The hotel industry thrives on effective management of bookings and occupancy rates. Hotel managers face the challenge of optimizing room inventory and pricing while ensuring customer satisfaction. One critical aspect of this challenge is predicting hotel booking cancellations. Anticipating cancellations can enable hotel managers to proactively address potential issues, adjust pricing strategies, and make better decisions regarding room availability. In recent years, advancements in machine learning and data analytics have opened new opportunities to develop accurate prediction models for hotel booking cancellations.

This paper aims to propose and implement a Hotel Booking Cancellation Prediction Model using machine learning techniques. The primary goal is to assist hotel managers in optimizing their operations by accurately forecasting booking cancellations. By doing so, they can effectively manage room inventory, minimize revenue losses, and enhance customer satisfaction.

The proposed model will leverage historical data on hotel bookings, including information about customers, booking details, and whether the bookings were cancelled or not. Through a series of data pre-processing steps, including handling missing values, converting categorical variables into numerical form, and scaling numerical variables, the dataset will be prepared for modelling. Various machine learning algorithms will be explored and compared to identify the best-performing model. Algorithms such as logistic regression, decision trees, and random forests will be evaluated using standard evaluation metrics like accuracy, precision, and recall. Additionally, ensemble methods, which combine the predictions of multiple models, will be considered to potentially improve the model's performance.

To evaluate the model's generalization ability, a hold-out test set will be utilized. This evaluation will provide insights into how well the model performs on unseen data, determining its practical utility in real- world scenarios. Furthermore, a feature importance analysis will be conducted to identify the key factors influencing hotel booking cancellations. Understanding these factors will enable hotel managers to prioritize specific strategies to reduce cancellation rates, such as targeted marketing campaigns or early booking incentives. In conclusion, This paper aims to develop a robust Hotel Booking Cancellation Prediction Model that will assist hotel managers in optimizing their operations.

The model's accurate predictions will facilitate effective decision-making regarding room inventory management, pricing strategies, and customer satisfaction. By leveraging machine learning techniques and analyzing the factors that contribute to cancellations, hotel managers can make data-driven decisions to increase revenue and create a more streamlined booking process.

1. **METHODOLOGY**

The methodology for this research comprises three processing steps. Firstly, the collection of data is essential, ensuring the use of reliable data to enable accurate pattern identification in the machine learning model. The dataset used in this study consists of 32 attributes and 119,390 records, obtained from a trustworthy source available on KAGGLE. Secondly, the cleaning of data is performed to eliminate corrupted or erroneous records, which greatly influences the accuracy of the machine learning model. Various techniques, such as dropping duplicates, deleting columns, and transforming data into the correct format, are applied to ensure data cleanliness.

Next, the choice of models plays a crucial role in the research. In addition to the previously mentioned models, two more models are included: Naive Bayes and K-Nearest Neighbors (KNN). Naive Bayes is a probabilistic algorithm that calculates the probability of an instance belonging to a particular class based on the observed feature values, assuming independence between features. On the other hand, KNN is a non-parametric algorithm that classifies instances by comparing their feature values to the majority class of its k nearest neighbors in the feature space.

By incorporating these models into the research methodology, the study aims to achieve accurate predictions for hotel booking cancellations. The combination of Logistic Regression, Decision Tree, Random Forest, Naive Bayes, and KNN models will provide a comprehensive analysis and evaluation of various approaches, enabling insights into the most effective methods for predicting hotel booking cancellations.

**2.1 Dataset Description**

The dataset used in this project is sourced from Kaggle.com and originates from the article "Hotel Booking Demand Datasets" written by Nuno Antonio, Ana Almeida, and Luis Nunes for Data in Brief, Volume 22, February 2019. This dataset contains information about hotels located in both local and international destinations, with a majority of the data focusing on hotels in Portugal. The dataset includes two hotel categories: Resort Hotel and City Hotel, where the City Hotel refers to hotels located in urban areas, while Resort Hotel represents hotels that offer resort facilities. The dataset comprises various data points, including market segments indicating the source of bookings, hotel and revenue details such as ADR (Average Daily Rate), customer-related variables describing customer types based on their stay, and cancellation history indicating if there have been cancellations in the past. The dataset also includes specific attributes related to each data point, such as names, ADR, number of adults, age at the booking date, agent information, arrival date details, assigned room type, number of babies, booking changes, cancellation time, number of children, company information, country, customer type, waiting list duration, deposit type, distribution channel, cancellation status, repeated guest status, VIP status, lead time, length of stay, market segment, meal options, previous bookings and cancellations, previous stays, required car parking spaces, reserved room types, number of rooms, weekend and weeknight stays, total special requests, and waiting list status.

* 1. **Proposed System**

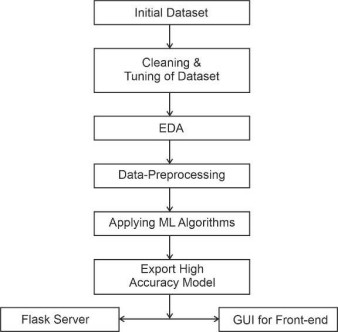


Fig1. The suggested system for predicting hotel bookings,

1. **RESULTS AND DISCUSSION**

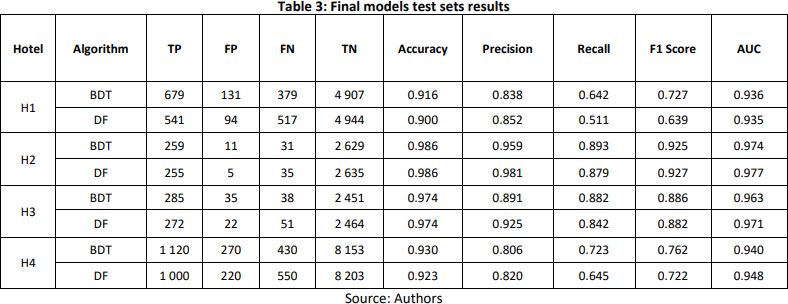
Given the different contributions and weights of features for each hotel, it was necessary to create specific models for each hotel. This resulted in non-sequential steps and iterations, following the CRISP-DM methodology. Microsoft Azure Machine Learning Studio was utilized as the tool for building these models. Different classification algorithms were employed to develop multiple models, and the algorithms with better performance indicators were selected. As the target variable "IsCanceled" had binary values, two-class classification algorithms were chosen.

The performance of each algorithm was evaluated using k-fold cross-validation, a widely used technique for model assessment. The dataset was divided into 10 folds, and performance measures were calculated for each fold. The mean and standard deviation of the results were then used to assess the overall performance of each algorithm. A fixed threshold of 0.5 was used to classify the outcomes into canceled (1) or non-canceled (0).

The cross-validation results showed high accuracy and AUC values for all hotels, indicating excellent performance. The Decision Forest algorithm exhibited the best accuracy and precision, while the Boosted Decision Tree algorithm performed well in terms of other measures like recall, F1Score, and AUC. Final models were built using these algorithms for the ultimate evaluation. The dataset was split into a 70% training set and a 30% test set, following the standard practice. The "Tune model hyperparameters" function was applied to determine the optimal parameters for each algorithm. The performance measures for the test sets are summarized in Table 3.

Based on the true rate and false rate values of spam and good message, the following graph is generated.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Hotel** | **Algorithm** | **Measure** | **Accuracy** | **Precision** | **Recall** | **F1 Score** | **AUC** |
| H1 | Boosted Decision Tree | Mean | 0.907 | 0.767 | 0.671 | 0.716 | 0.943 |
|  |  | Standard Deviation | 0.003 | 0.015 | 0.022 | 0.013 | 0.003 |
|  | Decision Forest | Mean | 0.908 | 0.817 | 0.611 | 0.699 | 0.933 |
|  |  | Standard Deviation | 0.004 | 0.015 | 0.02 | 0.016 | 0.004 |
|  | Decision Jungle | Mean | 0.882 | 0.953 | 0.34 | 0.501 | 0.906 |
|  |  | Standard Deviation | 0.004 | 0.025 | 0.021 | 0.024 | 0.009 |
|  | Locally Deep Support  Vector Machine | Mean | 0.892 | 0.853 | 0.463 | 0.599 | 0.904 |
|  |  | Standard Deviation | 0.006 | 0.039 | 0.031 | 0.029 | 0.008 |
|  | Neural Network | Mean | 0.879 | 0.664 | 0.637 | 0.646 | 0.911 |
|  |  | Standard Deviation | 0.007 | 0.058 | 0.063 | 0.014 | 0.006 |
| H2 | Boosted Decision Tree | Mean | 0.983 | 0.93 | 0.898 | 0.913 | 0.976 |
|  |  | Standard Deviation | 0.003 | 0.028 | 0.034 | 0.018 | 0.014 |
|  | Decision Forest | Mean | 0.983 | 0.96 | 0.873 | 0.914 | 0.968 |
|  |  | Standard Deviation | 0.005 | 0.027 | 0.045 | 0.028 | 0.017 |
|  | Decision Jungle | Mean | 0.982 | 0.955 | 0.86 | 0.904 | 0.98 |
|  |  | Standard Deviation | 0.003 | 0.027 | 0.039 | 0.018 | 0.011 |
|  | Locally Deep Support  Vector Machine | Mean | 0.983 | 0.954 | 0.871 | 0.91 | 0.953 |
|  |  | Standard Deviation | 0.003 | 0.023 | 0.03 | 0.019 | 0.017 |
|  | Neural Network | Mean | 0.976 | 0.888 | 0.877 | 0.882 | 0.967 |
|  |  | Standard Deviation | 0.004 | 0.034 | 0.03 | 0.02 | 0.008 |
| H3 | Boosted Decision Tree | Mean | 0.972 | 0.894 | 0.861 | 0.877 | 0.965 |
|  |  | Standard Deviation | 0.004 | 0.026 | 0.027 | 0.018 | 0.011 |
|  | Decision Forest | Mean | 0.973 | 0.938 | 0.822 | 0.876 | 0.947 |
|  |  | Standard Deviation | 0.003 | 0.015 | 0.029 | 0.019 | 0.014 |
|  | Decision Jungle | Mean | 0.972 | 0.911 | 0.843 | 0.876 | 0.962 |
|  |  | Standard Deviation | 0.003 | 0.024 | 0.017 | 0.015 | 0.009 |
|  | Locally Deep Support  Vector Machine | Mean | 0.97 | 0.93 | 0.806 | 0.864 | 0.934 |
|  |  | Standard Deviation | 0.003 | 0.019 | 0.02 | 0.018 | 0.011 |
|  | Neural Network | Mean | 0.96 | 0.838 | 0.822 | 0.829 | 0.942 |
|  |  | Standard Deviation | 0.007 | 0.056 | 0.029 | 0.027 | 0.013 |
| H4 | Boosted Decision Tree | Mean | 0.927 | 0.802 | 0.705 | 0.75 | 0.952 |
|  |  | Standard Deviation | 0.005 | 0.013 | 0.035 | 0.024 | 0.006 |
|  | Decision Forest | Mean | 0.928 | 0.835 | 0.672 | 0.744 | 0.948 |
|  |  | Standard Deviation | 0.004 | 0.02 | 0.027 | 0.019 | 0.006 |
|  | Decision Jungle | Mean | 0.898 | 0.833 | 0.443 | 0.567 | 0.924 |
|  |  | Standard Deviation | 0.01 | 0.057 | 0.105 | 0.094 | 0.008 |
|  | Locally Deep Support  Vector Machine | Mean | 0.915 | 0.814 | 0.59 | 0.684 | 0.919 |
|  |  | Standard Deviation | 0.006 | 0.033 | 0.024 | 0.023 | 0.004 |
|  | Neural Network | Mean | 0.907 | 0.71 | 0.68 | 0.694 | 0.932 |
|  |  | Standard Deviation | 0.006 | 0.029 | 0.035 | 0.02 | 0.007 |



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1. **CONCLUSION**

The study successfully achieved its main goals by using data from four hotels and applying data science techniques. They identified the important factors that predict the likelihood of a booking being canceled, finding that different factors mattered more for different hotels. They built accurate prediction models with high success rates, proving that machine learning algorithms can effectively forecast cancellations. They also discovered that each hotel needs its own model. These models help hotel managers reduce revenue loss and manage the risks of overbooking, while improving demand forecasting and allowing for more flexible cancellation policies. Implementing these models can greatly enhance decision-making in revenue management for hotels.

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