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Machine Learning Based Patient Classification in Emergency Department for Priority Based Treatments

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Abstract: This work contains the classification of patients in an Emergency Department in a hospital according to their critical conditions. Machine learning can be applied based on the patient's condition to quickly determine if the patient requires urgent medical intervention from the clinicians or not [1]. Basic vital signs like Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), and Respiratory Rate (RR), Oxygen saturation (SPO2), Random Blood Sugar (RBS), Temperature, and Pulse Rate (PR) are used as the input for the patients' risk level identification [2]. High-risk or non-risk categories are considered as the output for patient classification. Machine learning techniques such as Gaussian NB, KNN or DT are used for the classification. We'll use a variety of supervised machine learning methods before deciding which one is best for the model. Existing systems rely on classical learning models, which are inefficient and imprecise. They aren't as accurate as the proposed model and take a little longer to process. There are many research works on this topic where they have built models and shown results generated using R language, Python language and data science tools. But all these works are just models, cannot be used as application useful in real time. In our project work we build an application with model that can predict high risk patients and low risk patients in an emergency department and provides doctors with the information of how to handle patients and treat better [5]. Proposed system is a real time medical system useful for hospitals and doctors and built using Microsoft tools such as Visual Studio tool and SQL Server tool.

Keywords: Patients, classification, high risk and low risk, doctor.

I. INTRODUCTION

The intensive care unit (ICU) is among the most critical operating vicinities in a hospital offering essential care and life assistance to patients who are severely ill or injured in an accident. The majority of ICU areas are sterilized and contain special monitoring equipment for critical patients. Due to the high cost of monitoring equipment, ICU allocations in every medical facility are limited which are looked after by expert doctors, nurses and personnel specially trained for providing clinical assistance to critical patients. Besides patients with a planned surgery, patients with severe accidents or unexpected and serious deteriorations to their health are admitted to ICU. Unless a patient is experiencing an emergency case, a referral from the medical expert is always needed for admission in this expensive and well monitored place of the medical facility having higher workforce to patient ratio. Advent in information and communication technology (ICT) has revolutionized healthcare in terms of monitoring, early diagnosis, preventive medicine, the effectiveness of certain treatments, etc. Modern ICUs have been digitized by the integration of emerging technologies. Various technologies tending in smart emerging ICUs are there. Since ICUs are equipped with various monitoring machines, therefore, an enormous amount of data termed as big data, are generated which can be stored in the cloud and processed to extract information. Artificial intelligence and data mining (DM) techniques are being widely used to extract information by analysing large sets of data in health care.

II. RELATED WORK

[1] This paper, published in 2021, addresses the challenge of optimizing ICU resource allocation by predicting patient mortality. The authors present two machine learning models—Support Vector Machine (SVM) and Linear Discriminant Analysis (LDA)—to forecast mortality based on clinical data from ICU patients. These models aim to aid in the early prediction of mortality to improve ICU management. However, the study primarily focuses on mortality prediction rather than classifying high-risk patients, and it involves significant data processing time without real-time implementation capabilities.

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[2] This paper, published in 2020, explores the critical issue of patient mortality prediction to support medical decision-making. The study compares the effectiveness of logistic regression, random forest, and SVM algorithms in predicting mortality. The primary goal is to provide doctors with tools for resource optimization and to offer an additional perspective for critical decisions, such as in cases of euthanasia. Despite its contributions, the paper focuses solely on mortality prediction, does not address high-risk patient classification, requires large datasets, and lacks real-time implementation.

[3] This paper, published in 2020, delves into the application of machine learning for predicting cancer treatment outcomes in elderly patients. This systematic review examines various machine learning approaches to improve survival predictions in this demographic, emphasizing the significance of Comprehensive Geriatric Assessment (CGA) for enhancing patient care. The study identifies gaps in existing research, particularly the lack of studies utilizing CGA. The focus on elderly cancer patients, the need for large datasets, and the absence of real-time implementation highlight the limitations of this study.

[4] This paper, published in 2021, presents a machine learning model to identify high-risk COVID-19 patients. Using historical data, including medical history, demographic information, and COVID-19-specific data, the model aims to predict patient survival likelihood, thereby aiding hospital capacity planning and timely treatment. While the method demonstrates high accuracy in detecting high-risk patients across different clinical stages, it is specific to COVID-19, requires extensive datasets, and is not implemented in real-time, limiting its broader applicability.

[5] This paper, published in 2020, investigates the application of data mining techniques to predict mortality in patients with cardiovascular disease. The study utilizes data from Mostar Hospital collected between 2011 and 2017, applying decision tree, neural network, and logistic regression methods to forecast mortality within a 12-month period. The authors aim to compare the effectiveness of these techniques in predicting patient outcomes. However, the study's limitations include prolonged data processing times, a focus on a specific disease, and the absence of real-time implementation, which restrict its practical utility in dynamic healthcare settings.

III. PROPOSED SYSTEM

System builds as real-world application with machine learning model which works for dynamic medical datasets. System major goal is to find high risk patients and low risk patients in ICU using some efficient machine learning algorithms. System is GUI based Software meant for hospitals where doctors can access using browsers. System uses medical factors such as patient age, gender, disease type, date of admission, test results etc... System makes use of datasets from kaggle.com. System applies 2 efficient machine learning algorithms to process datasets such as Random Forest, KNN algorithm or decision tree algorithm. System is an automated medical system for priority-based patient treatments. System developed as browser application using Microsoft technologies such as Visual Studio, SQL Server, C# which similar to C or C++, HTML, CSS, JS, JQuery.

IV. METHODOLOGY

A. Naïve Bayes Algorithm Steps

1. Scan the dataset (storage servers)
- Retrieval of required data for mining from the servers such as database, cloud, excel sheet etc.
2. Calculate the probability of each attribute value. [n, n_c, m, p]
- Here for each attribute, we calculate the probability of occurrence using the following formula. (mentioned in the next step). For each class(disease) we should apply the formulae.
3. Apply the formulae
- P(attributevalue(ai)/subjectvaluevj)=(n_c + mp)/(n+m)

Where:

- n = the number of training examples for which v = vj
- nc = number of examples for which v = vj and a = ai
- p = a priori estimate for P(aijvj)
- m = the equivalent sample size

4. Multiply the probabilities by p for each class, here we multiple the results of each attribute with p and final results are used for classification.
5. Compare the values and classify the attribute values to one of the predefined set of class.

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B. **Flowchart of Implementation**

This web application is implemented using object-oriented programming language. Object oriented programming is an approach that provides a way of modularizing programs by creating partitioned memory area for both data and functions that can be used as templates for creating copies of such modules on demand.

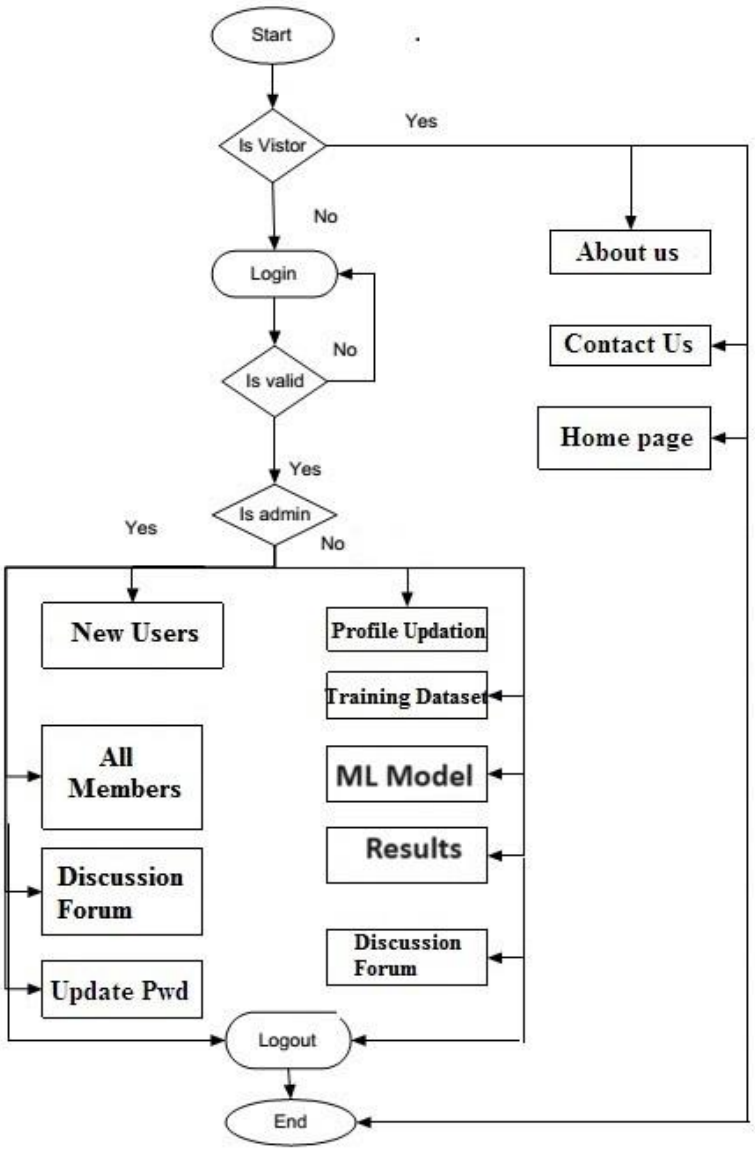

Fig. 1 Flow of implementation

V. IMPLEMENTATION

The application features two user roles: Administrator and Member (doctor) each with specific modules tailored to their needs. The Administrator maintains the entire application, with modules such as Login, where they enter their unique credentials to access the system. Once logged in, the Administrator can access the New Members Module to review and manage newly registered doctors, and the Existing Users Module to view profiles of current doctors.

The Discussion Forum module facilitates communication among doctors, with the Administrator having oversight and management capabilities. Finally, the Administrator can securely exit the application using the Logout module.

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For Members, who are doctors and service receivers, the application offers several key modules. The Registration Module allows doctors to create new accounts by providing all necessary details, ensuring they are valid users. Once registered, doctors can use the Login Module to access the system by entering their credentials. The Dataset Module empowers doctors to manage medical datasets and parameters used for predictive analytics, supporting their clinical decision-making processes.

VI. CONCLUSION

The implementation of a machine learning-based patient classification system in the Emergency Department represents a significant advancement in healthcare technology by addressing the critical need for prioritizing patient treatments based on risk levels, thus enhancing emergency medical care efficiency. This system overcomes the limitations of manual processes that rely heavily on doctors' experience and judgment by automating the classification process, which minimizes human error, reduces decision-making time, and ensures timely and appropriate care for patients based on their critical conditions. This improvement not only optimizes patient outcomes but also enhances the allocation of limited ICU resources. Distinguishing itself from prior research, this project develops a real-time, practical application using Microsoft technologies like Visual Studio and SQL Server, integrating dynamic medical datasets from platforms such as Kaggle. Unlike previous models limited to static datasets and lacking real-world applicability, this system offers a robust and scalable solution for hospitals. The deployment of this GUI-based software as a browser application ensures accessibility and ease of use for medical professionals, incorporating essential medical factors such as patient age, gender, disease type, and test results to provide comprehensive and accurate risk assessments.

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