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Ml - Based Patients Classification In Emergency Department For Priority Based Treatment

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Abstract- This concept is based on patient's classification 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 the outcome for patient classification. ML algorithms such as Gaussian NB, KNN or DT are applied for the data analysis and for the classification. We'll use a many of supervised 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. Many existing topics on patient's classification where they have built models and shown results generated using R language, Python language and data science tools. All existing works are just models, cannot be applied as application useful in real time. In our project work we build an application with ML models that can classify high risk patients and non-risks patients in an emergency department and provides doctors with the information of how to handle patients and treat better [5]. Our proposed work is a real-world medical system useful for hospitals and doctors and built using trending tools such as Visual Studio code, PYTHON and MYSQL Server.

Keywords: Machine Learning, Patients Classification, Supervised learning, high risk, low risk, real time application, visual studio, SQL server, medical sector, ICU.

I. INTRODUCTION

In real time it is very important to identify high risk patients and low risk patients in ICU as the current process is manual and based on doctor experiences sometime it may result in patient's death. So we need an automated system to predict high risk and low risk patients in ICU and based on that priority-based treatment done in real time. The major objective of the proposed system is to build a real time medical software with dynamic machine learning models to analyze the medical ICU data so as to predict high risk and low risk patients. Here we build application software useful for doctors and medical departments. System preprocesses the training datasets using efficient preprocessing methods such as binning method or chi square method so as to remove the unwanted data and fetches the required to build machine learning models. System builds machine learning models to process the training datasets which are downloaded from kaggle.com, githib.com and other online sources or manually and to predict high risk and low risk patients. Machine learning models build using Random Forest algorithm or naïve bayes algorithm or decision tree algorithm. To build efficient ML models to work with dynamic datasets in real time/product. To program confusion matrix method to evaluate the machine learning models and accuracy of the algorithm will be calculated.

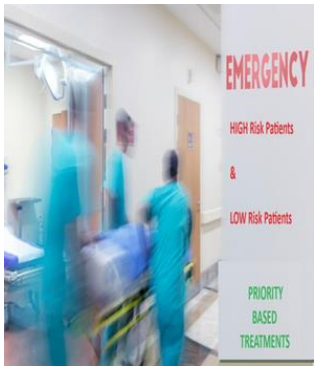

Fig 1: ICU Department

System is a real-world application software accessed by doctors and patients. System is a browser-based application accessed using real time browsers. System requires efficient 4G or 5G internet connection. System uses Microsoft technologies to develop application software for high risk and low risk patients' prediction. System can be accessed 24/7 worldwide in real time.

Further the paper is organized in highlighting related works on patient's classification and survey summary. After the literature survey we presented the methodology used for the prediction with experiment results and finally section containing conclusion and references.

II. RELATED WORK/LITERATURE SURVEY

2.1 IEEE PAPER TITLE: "Mortality Prediction in ICU Patients Using Machine Learning Models"
YEAR OF PUBLICATION: 2021
AUTHORS: Fawad Ahmad,Huma Ayub,Rehan Liaqat ,Akhyar Ali Khan,Ali Nawaz,Babar Younis
DESCRIPTION: using ICU in hospital is one the challenging tasks in the current medical sector. The intention is to save the patients in ICU department [12]. Machine learning based techniques applied for mortality prediction. Many efficient ML algorithms applied here to predict patient's mortality. Algorithms such as SVM, KNN and linear regression used.

METHODOLOGY: SVM and linear discriminant analysis methods used.

LIMITATIONS:
- In this topic patient mortality prediction is done.
- Processing time is more.
- ICU patients' classification is not done.
- No real time implementations just ML model built.

2.2 IEEE PAPER TITLE: Artificial Intelligence based Comparative Study of Mortality Prediction.
YEAR OF PUBLICATION: 2020
AUTHORS: Satyam Prasad Tiwari,Ashutosh Upadhyay, Karthikeyan S
DESCRIPTION: The patient mortality prediction becomes an important and critical prediction problem in the area of artificial intelligence [6]. The aim of machine learning algorithms is to help doctors to make critical decisions here. Mortality prediction can be very helpful for taking critical decisions which can help in optimizing the resources

available in the hospital and also an extra opinion for doctors and family members in cases of euthanasia i.e. ending life of patient to relieve pain and suffering.
METHODOLOGY: logistic regression, random forest, and SVM used.
LIMITATIONS:
- Here patients' mortality prediction is done. Not high risk patients classification is done.
- No real time implementations done.
- Huge datasets required.

2.3 IEEE PAPER TITLE: ML Based Emergency Patient Classification System
YEAR OF PUBLICATION: 2021
AUTHORS: Supattra Puttinaovarat, Siwipa Pruitikanee, Jinda Kongcharoen.
DESCRIPTION: This is one of the research paper on patient's classification. ICU department plays vital role in patient's life. This is the paper which applied ML algorithm for patient's classification. In this paper only ML model built and tested for better results.
METHODOLOGY: SVM used.
LIMITATIONS:
- Graphical outputs generated.
- Less datasets used.
- Not suitable in real time.
- No real time implementations done.

2.4. Paper Title: Machine learning algorithm in healthcare system: A Review
Authors: Pradeep Kumar Kushwaha, M. Kumaresan
Year of Publications: 2021
Methods Used: Naïve Bayes, Decision Tree, SVM, Regression and KNN algorithms.
Result: review the role of these algorithms in field of healthcare system like diabetic, detection of cancer, brain tumor, bioinformatics and many more.

Remarks: Applied for diabetic, detection of cancer, brain tumor, bioinformatics. Won't predict the mortality rates.

2.5. Paper Title: Artificial Intelligence based Comparative Study of Mortality Prediction
Authors: Satyam Prasad Tiwari, Ashutosh Upadhyay, Karthikeyan S Year of Publications: 2020

Methods Used: logistic regression, random forest, and support vector machine.

Result: We observed from performance that the logistic regression perform better, hence we selected regression model for predicting the mortality of the patients

Remarks: Mortality prediction can be very helpful for taking critical decisions which can help in optimizing the resources available in the Hospital and also an extra opinion for doctors and family members. Supervised learning algorithms used. This topic does not finds the relationship between resources with mortality rates.

2.6. Paper Title: Prediction of mortality in patients with cardiovascular disease using data mining methods
Authors: Damir Imamovic, Elmir Babovic, Nina Bijedic
Year of Publications: 2020
Methods Used: data tree mining, neural network and logistic regression.
Result: The aim of this research is to compare the effectiveness of these methods in modeling the effectiveness of Predicting mortality in patients with cardiovascular disease.
Remarks: This concept is applied for only cardiovascular disease. CNN methods used, CNN for data processing many require more time. Huge amount of data required. Less accurate results

2.7 Literature Survey Comparison

Constraints	P 1	P 2	P 3	P 4	P5	P6	Our System
More Parameters Used	No	Yes	No	Yes	No	No	Yes
Real Time Implementations	No	No	No	No	No	No	Yes
Dynamic Data	No	No	No	No	No	No	Yes
Less Datasets	Yes	Yes	No	No	Yes	No	No
Users	No	No	No	No	No	No	Yes
GUI based	No	No	No	No	No	No	Yes

2.8 Survey Summary

In the current system doctors will decide the priority of patient treatments in ICU departments. All cases are emergency but doctors based on their experiences and patient conditions will decide which patient to handle at first and so on. This process sometimes may go worst which can create patient's death. Many existing research works built efficient machine learning models using ready libraries using R language, Python and other data science tools but these works can be applied in real time.

2.8.1 Drawbacks of Existing System

Manual Process
Requires more experiences Models for static datasets
Cannot be applied in real time More time and more expensive Less Reliable and Less Efficient
No real time implementations done.

2.9 Gap Analysis

- Many existing research works presented an idea of patient classification using ML algorithms, but no implementation is done.
- Many research works use less amount of training data-sets, in the proposed system we use huge data-sets for processing.
- All existing works uses PYTHON or R Language or Ready Data science tools for prediction and which works for static datasets, but in the proposed system we implement the concept for dynamic datasets (real time application).
- All existing works are just model development, can't be used in real time. Here we build this concept as real time application using front end technology as "visual Studio code" and back-end technology as "MYSQL Server" and PYTHON as programming language.
- Proposed system is a real-world application with model using trending technologies useful for medical sector.

III. PROPOSED SYSTEM

3.1 System Functionalities

- 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 is an automated medical system for priority based patient treatments.

- System developed as browser application using trending technologies such as Visual Studio code, MYSQL Server, PYTHON, HTML, CSS, JS, JQuery.

3.2 System Architecture

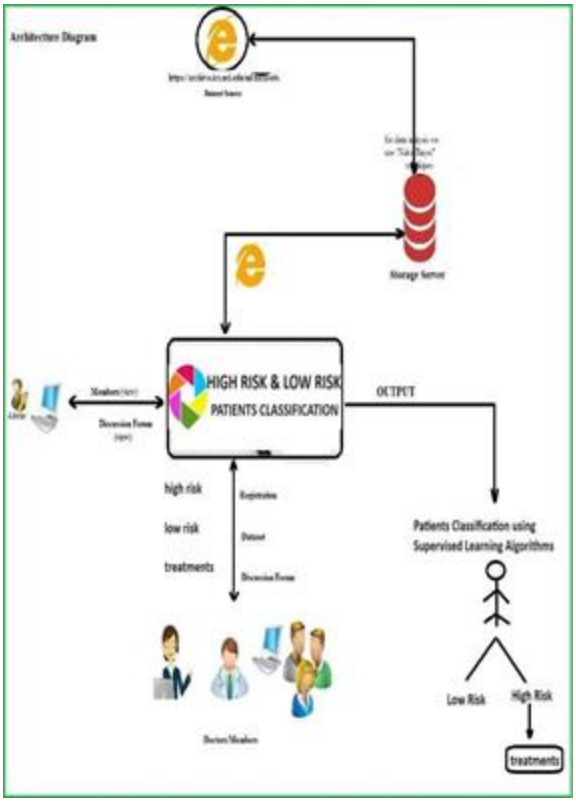

Fig 2: System Architecture

3.3 Project Implementation Procedure

Proposed system build using 3 tier architecture design. 3 tier architecture is a standard architecture design used for the project development. This architecture design can be used on any platform such as Java, PYTHON, PHP etc. In the project development basically, there are 3 types of architecture design namely;

- Single tier architecture (tight coupling)
- 2 tier architecture
- 3 tier architecture

When we are developing the project or working on real time application, it is very important to select the suitable architecture design. We have selected the architecture design in such a way that future complexity of the topic should be less.

Single Tier Architecture

Single tier architecture is also called as tight coupling. This is architecture design used for the project development. Usually, single tier architecture design is used for mini and minor projects. Single architecture design contains only one layer and we call it as "presentation layer" or "GUI layer". In the single tier architecture design database programming, GUI programming and logic programming all written in the presentation layer. We use this architecture design for project where complexity is less. If we use this architecture design for large projects, complexity will increase as we write all program in a single layer. Coding complexity will increase if we use this architecture design for major projects.

Two Tier Architecture Design

Two tier architecture design is also a standard architecture design used for the project development. 2 tier architecture design used for the average complexity project and which has average level features and modules. As the name itself says, two tier architecture design mainly contains 2 layers "Presentation Layer" and "Data Layer".

Presentation layer used to design GUI and data layer is used to connect to database and other logic written in data layer. In the two- tier architecture design the entire project is divided into mainly 2 layers "Presentation layer" and "Data Layer".

3 Tier Architecture

3 tier architecture design is the standard architecture design used for the complex project development. Usually if the project contains more functionalities and modules, we prefer 3 tier architecture design. As name itself indicates that it contains 3 layers namely "Presentation Layer", "Business Logic Layer" and "Data Layer". In the data layer all database connection programming and database queries are written and executed and in the business logic layer, it is the class file where we invoke the queries from the data layer and it contains class members and member functions and finally in the presentation layer, it contains front end and all design part, in presentation layer we invoke the functions from the business logic layer. So entire project is divided into 3 parts, presentation layer, business logic layer and data layer.

3.4 Supervised Learning Algorithms Applied

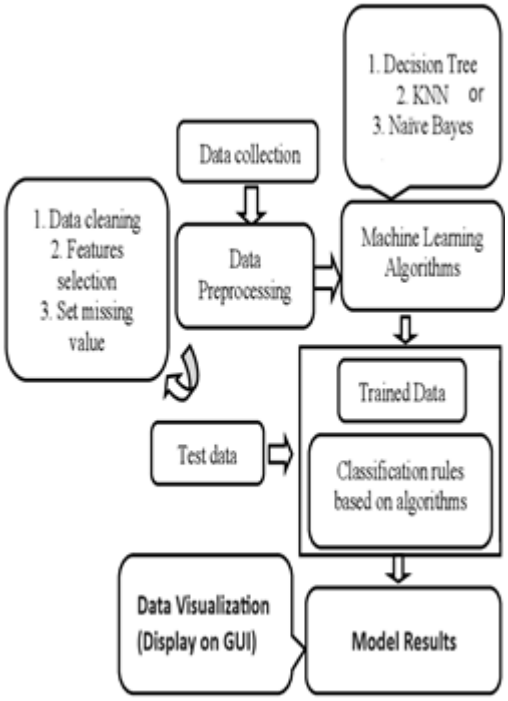

Figure 1. The working mechanism of proposed approaches

Fig: 3 Methodology Diagram

Step 1: Raw data Collected

Training datasets collected from online sources such as kaggle.com, dataworld.com and data.gov.in.

Step 2: Preprocessing of Data

In this steps missing values will be fixed and only relevant data fetched and processed.

Step 3: Training Data

After pre-processing, data converted into required format before inputting to the ML algorithm.

Step 4: ML Model

Here for patient's classification process we make use to "Bayesian Classifier or KNN algorithm" which is an efficient algorithm and works well for all different sets of parameters. It also generates accurate results.

Step 5: Results

Algorithm results checked with the accuracy using confusion matrix method. Here we validate the results generated by the algorithm "bayesian classifier" and "KNN algorithm".

Step 6: Visual Representation

Algorithm output displayed on frontend.

3.5 ML Models KNN Algorithm KNN Algorithm

- K-Nearest Neighbour is one of the most commonly used Machine Learning algorithms based on Supervised Learning technique.
- K-NN algorithm assumes the similarity between the new case/data and available cases and put the new case into the category that is most similar to the available categories.
- K-NN algorithm stores all the available data and classifies a new data point based on the similarity. This means when new data appears then it can be easily classified into a well suite category by using K- NN algorithm.
- K-NN algorithm can be used for Regression as well as for Classification but mostly it is used for the Classification problems.
- K-NN is a non-parametric algorithm, which means it does not make any assumption on underlying data.
- It is also called a lazy learner algorithm because it does not learn from the training set immediately instead it stores the data-set and at the time of classification, it performs an action on the data-set.

- KNN algorithm at the training phase just stores the data-set and when it gets new data, then it classifies that data into a category that is much similar to the new data.
- KNN Algorithm Steps
- The K-NN working can be explained on the basis of the below algorithm:
- Step-1: Select the number K of the neighbors
- Step-2: Calculate the Euclidean distance of K number of neighbors
- Step-3: Take the K nearest neighbors as per the calculated Euclidean distance.
- Step-4: Among these k neighbors, count the number of the data points in each category.
- Step-5: Assign the new data points to that category for which the number of the neighbor is maximum.

Random Forest Algorithm Steps

1. From the given dataset, multiple bootstrap samples are created by randomly selecting records with replacement.
2. Each bootstrap sample is used to build one decision tree.
3. Each decision tree is trained independently on its own bootstrap sample, which introduces randomness and reduces overfitting.
4. In a dataset where M is the total number of input attributes, only R attributes (R < M) are randomly chosen for each tree. This random selection of attributes is repeated at every split of every tree.
5. From these selected attributes, the best possible split is chosen using a splitting criterion such as the Gini Index (for classification) or variance reduction (for regression).
6. This process continues recursively until the stopping condition is met — typically when the leaf nodes are too small to split further.
7. After all trees are constructed, predictions are made:
   - For classification → Majority Voting
   - among all trees
   - For regression → Average of outputs from
   - all trees

The final Random Forest prediction is obtained by combining the outputs of all decision trees, giving a more stable and accurate result compared to a single tree.

4.4 KNN Algorithm Steps How KNN works
?

1. Determine K (no of nearest neighbors)
2. Calculate distance(Euclidean, Manhattan)
3. Detemine K-minimum distance neighbors
4. Gather category Y values of nearest neighbors
5. Use simple majority of nearest neighbors to predict value of qurey instance

4.5 KNN Algorithm Flow

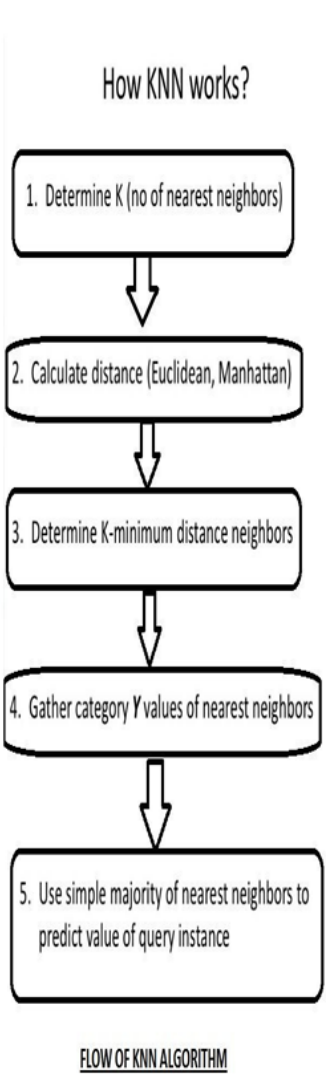

Fig 2: KNN Algorithm Flow

4.6 KNN Algorithm Pseudocode

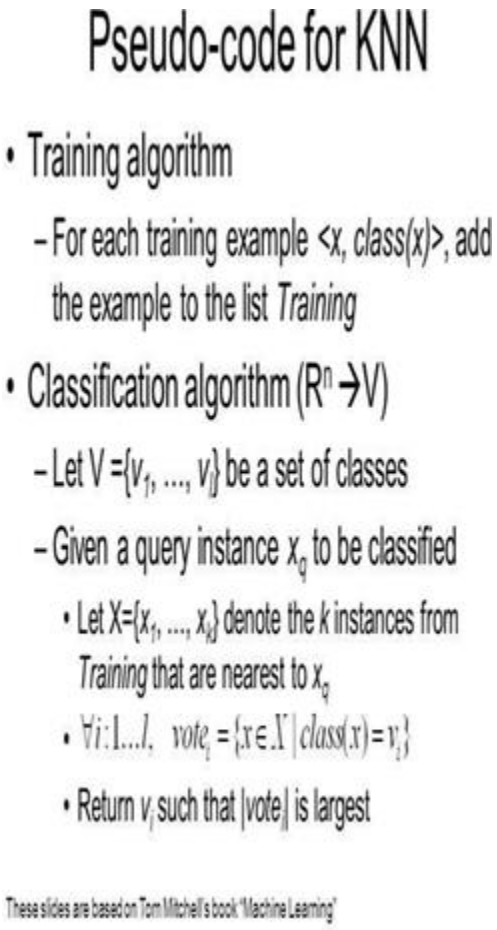

Fig 3: KNN Algorithm pseudocode

4.7 Random Forest Algorithm Steps

Operation of Random Forest

The working of random forest algorithm is as follows.

1. A random seed is chosen to facilitate the random sampling of a subset of data points from the training dataset. This ensures that the original distribution of classes within the dataset is maintained during the sampling process. From this selected dataset, a random subset of attributes is chosen based on user-defined criteria, not all input variables are considered to avoid excessive computation and reduce the risk of overfitting.

2. In a dataset with M input attributes, a random selection process is employed to choose R attributes for each decision tree, where R is a value less than M.

3. Utilizing this subset of attributes, the decision tree model is constructed by iteratively identifying the best split at each and every node based on the Gini index value. This method or recursive process continues until a stopping criterion is reached, indicating that the resulting leaf nodes are too small to further subdivide.

4.8 RF Algorithm Flow

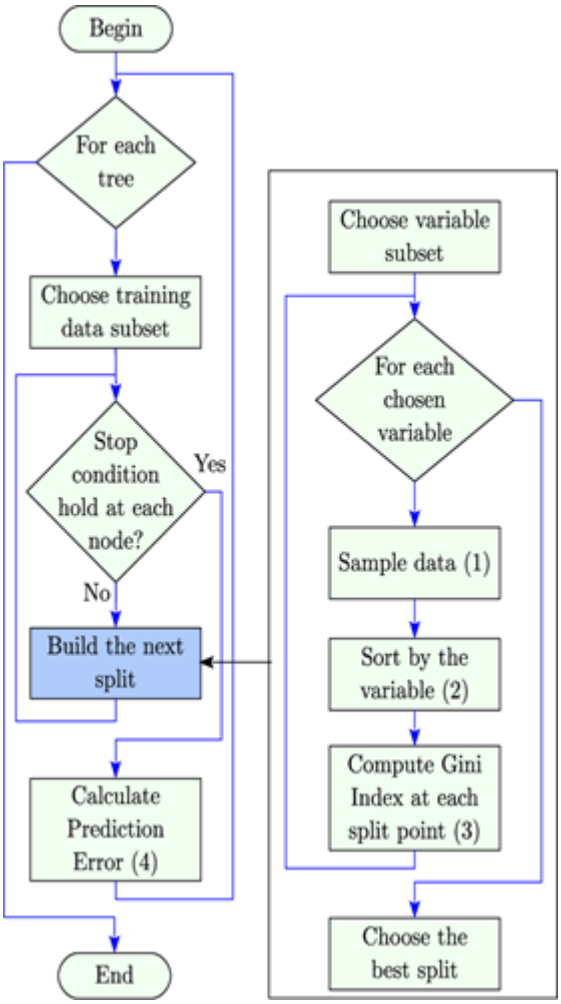

Fig 4: RF Algorithm Flow

4.9 RF Pseudocode

Fig 5: RF Pseudocode
Experiment Results PUT RESULTS HERE

V. CONCLUSION

Now a day's patient's mortality increasing in the hospitals. Too many emergency patients admitting to the hospitals due to heart problems, kidney problem, lung cancer, liver disease and other chronic diseases. It is crucial to identify such kind of diseases at early stages. Identifying low risk and high-risk patients at emergency department plays a major role in the hospital or medical sector. Proposed system uses ML models to predict high risk patients so as to provide proper treatments in time. Real time application built which helps ICU departments in knowing high risk patients.

VI. FUTURE ENHANCEMENT

In our proposed system we have used
1 efficient algorithm for patient's classification. We can apply more efficient algorithms to process medical datasets and can find better algorithm. We can add query module, where patient guardian can post queries to doctors and doctor can send replies. We can add more parameters and datasets.

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