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PROCEEDINGS OF JOHOR INTERNATIONAL INNOVATION INVENTION COMPETITION AND SYMPOSIUM 2024 (JIIICaS 2024)



*“Flourish and Nurturing Sustainable
Innovation for a Prosperous Nation”*

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Preface

In the name of Allah, the Almighty who gives us the enlightenment, the truth, the knowledge and with regards to Prophet Muhammad (peace be upon him) for guiding us to the straight path. We thank to Allah for giving us guidance and strength to write this e-book.

This e-book compiles the extended abstracts that submitted to Johor International Innovation Invention Competition and Symposium 2024 (JIIICaS2024), where JIIICaS2024 is a virtual platform for all creative minds to share and present their invention and innovation. Each abstract gives a brief background on the innovation or project.

We hope that this e-book will help the readers to get to know the innovation done by the students and get some ideas to develop future innovation products.

Foreword Rector



Assalamualaikum warahmatullahi Wabarakatuh,
Salam Sejahtera, Salam Malaysia MADANI and
Salam UiTM Dihatiku.

In the name of Allah, the Most Gracious, the Most
Merciful.

It is a great honor to welcome you to the Johor
International Innovation, Invention, Competition, and
Symposium 2024 (JIIICaS 2024). This event

connects various disciplines, focusing on education and engaging educators,
students, researchers, and innovators from all walks of life.

Innovation is not just about ideas; it demands perseverance, creativity, and
determination to turn those ideas into reality. The remarkable projects
showcased today highlight the dedication and spirit of all participants.
Initiatives like this not only explore new technologies but also cultivate skills
and leadership among our youth. At Universiti Teknologi MARA (UiTM) Johor
Branch, we are fully committed to fostering a dynamic culture of innovation,
promoting the commercialization of new products, and encouraging
meaningful collaborations with industry and society.

As we celebrate this event, I would like to extend my heartfelt gratitude to all
sponsors, judges, the College of Computing, Informatics and Mathematics,
UiTM Pasir Gudang Campus as the event organizer, as well as to the
researchers and participants for their hard work in making this event a
success. Let us continue striving for innovation and excellence. May the
ideas presented today inspire us and lay the groundwork for future
achievements.

Thank you.

Associate Professor Dr. Saunah Zainon
Rector
Universiti Teknologi MARA (UiTM)
Johor Branch

(A-ST188) CLASSIFICATION APPROACH FOR COVID-19 ICU ADMISSION USING RANDOM FOREST AND XGBOOST

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Abstract— COVID-19 has had a deep and far-reaching influence on global health, economics, and society, focusing on the crucial necessity of collaboration, scientific developments, and resilient healthcare systems in managing and mitigating infectious disease concerns from blood or any sort of human organs. The problem that exists nowadays in classification towards diseases, cancers and any sort of illness require a better accuracy from machine learning. However, there are multiple methods are available in finding best machine learning for classification area that has hard field in determine the best machine learning. Machine learning has showed potential in detecting, classifying and categorising unknown various type of data and threats. In this research, the propose in using machine learning classifiers to identify ICU admission. The classifiers used are Random Forest and XGBoost, which are well-known and commonly used in machine learning. For evaluate the efficiency of the technique, we first gather and pre-process a dataset gathered. Dataset are gathered from Kaggle and will be used to train and test the selected classifiers. The performance of these classifiers on the dataset is then examined, and their capacity to identify and classify Covid-19 for ICU is evaluated. We evaluate the performance of Random Forest and XGBoost to have the better approaches for classifying Covid-19 for ICU admission. The result will show that the suggested classifiers efficiently identify and classifying Covid-19 ICU for admission, outperforming existing approaches. Using machine learning classifiers for Covid-19 ICU admission, these can improve bioinformatics by leveraging continuous learning, algorithmic optimisation, feature engineering and iterative development processes. In conclusion, this research is an important step towards making accurate predictions and classifications, enabling data integration, and propelling research forward.

Keywords — Covid-19, blood, XGBoost, machine learning algorithm, random forest

I. INTRODUCTION

The COVID-19 epidemic has stretched healthcare systems globally, necessitating effective resource allocation, particularly for intensive care unit (ICU) beds. Predicting

which COVID-19 patients will require ICU admission is critical for improving patient care and healthcare resources. Machine learning algorithms like Random Forest and XGBoost have shown to be effective tools for this predictive position since they can analyse large data sets and detect patterns to produce accurate predictions.

Machine learning algorithms have recently demonstrated encouraging outcomes in a number of medical applications, including predicting, classifying and forecasting illness disease and risk. As a possible tool for early management and prevention, the application of machine learning algorithms for Covid-19 ICU admission prediction has garnered attention as it is still happening until today. In this overview of the literature, the recent work on machine learning-based Covid-19 ICU admission prediction. This work will review the benefits and drawbacks of previous research, spot gaps in the literature, and suggest new lines of inquiry.

Recent studies have shown the value of machine learning models, particularly Random Forest and XGBoost, in predicting ICU admissions for Covid-19 patients. Using data from the Mass General Brigham healthcare database, researchers discovered that ensemble models like this surpassed other algorithms in predicting ICU admissions and 28-day death rates [1]. Another comparative study discovered that Random Forest models consistently performed better in early risk and resource allocation. These findings show the potential of modern machine learning approaches to improve healthcare outcomes by offering reliable, data-driven predictions to help clinical decision-making during a pandemic [2].

Predicting ICU admission for COVID-19 patients is difficult due to health changes and the limits of current classification approaches. Machine learning approaches such as Random Forest and XGBoost have the potential to enhance outcomes by integrating different clinical data. This study will analyse and compare their usefulness in predicting COVID-19 ICU admission with the objective to improve clinical care and resource allocation. [3].

II. LITERATURE REVIEW

Several research has demonstrated encouraging outcomes when employing machine learning algorithms to predict Covid-19 ICU admission of going inadequate. For instance, a Random Forest was utilized in a recent study that was published in the Journal of BioMed Central to predict Covid-19 for the purpose of ICU admission.

Random Forest (RF) is another ensemble method that performed well in the current study. It got equivalent results to XGBoost in terms of key metrics, indicating its ability to handle the dataset's complexity [4]. The result for RFs on past research obtained with the percentage score of accuracy of 0.90, precision of 0.89, recall of 0.90 and F1-Score of 0.89. RF's performance may be provided to its ability to properly handle categorical and numerical information, as well as its resistance to overfitting [5]. The study highlights the potential of RF for enhancing the accuracy of COVID-19 illness prediction, particularly when compared to other algorithms such as DT and SVM. The performance of RF highlights the importance of ensemble approaches for handling complicated datasets and enhancing prediction accuracy.

Decision Trees (DT) are a basic machine learning method utilised in this work to predict COVID-19 ICU admission. The performance of DT was evaluated using a range of metrics, including accuracy, precision, recall and F1 score. While DT performed nicely, it did not outperform competing algorithms like as XGBoost and Random Forest on important criteria [6]. The result for DTs on past research obtained with the percentage score of accuracy of 0.85, precision of 0.83, recall of 0.84 and F1-Score of 0.83. However, DT may still be effective in identifying essential aspects and offering insights into the decision-making process using approaches such as SHAP.

XGBoost, an effective ensemble approach, was the best-performing algorithm in the present study. It scored great accuracy, precision, recall and F1 score, proving its ability to handle the complexity of the COVID-19 dataset. The result for DTs on past research obtained with the percentage score of accuracy of 0.92, precision of 0.91, recall of 0.92 and F1-Score of 0.91. XGBoost's effectiveness is due to its ability to handle both category and numerical information well. Additionally, its hyperparameter adjustment capabilities via cross-validation enabled optimal model performance. The study highlights the potential of XGBoost to improve the accuracy of COVID-19 illness prediction, particularly when compared to other algorithms such as DT and SVM [7].

1. Random Forest

During training, each Random Forest decision tree is developed by recursively splitting the data based on multiple feature parameters. The divides are developed to maximise data gathering or impurity reduction at each node, accordingly. The Random Forest's ultimate predict is the result of combining the predictions of all the distinct trees. Random Forest reduces the potential of overfitting while increasing the model's generalizability by providing a range of decision trees.

2. XGBoost

XGBoost (Extreme Gradient Boosting) is another effective machine learning algorithm that emphasises efficiency, flexibility, and performance. It uses machine learning methods inside the Gradient Boosting framework and is known for its speed and accuracy. XGBoost uses regulation to avoid overfitting, effectively manages sparse data and missing values, and allows parallel processing, making it better than many other boosting methods. The above features make XGBoost ideal for handling the complex and high-dimensional data important for predicting ICU admissions for COVID-19 patients.

3. Confusion Matrix

In this research, the confusion matrix is an important tool to evaluate the successful performance of Random Forest and XGBoost models in predicting COVID-19 ICU admission. The prediction provides a clear separation of true positives, true negatives, false positives, and false negatives, allowing for the computation of measures like as accuracy, precision, recall, and F1 score. These metrics provide findings into the model capability to properly classify patients who require ICU admission in opposition to those who do not, allowing clinicians to draw better decisions about patient evaluation and resource allocation during the COVID-19 pandemic.

4. Random Forest Classifier

Random Forest classifier to predict COVID-19 ICU admission using several types of clinical data. The durability of it consists of aggregating predicts from several decision trees, successfully managing complicated data relationships, and making accurate predictions. Random Forest classifier improves accuracy in detecting patients at risk of ICU admission, allowing healthcare practitioners to intervene better and enhance.

5. Feature Selection

Feature selection choose a subset of features from a large data set in order to maximize their relevance and informativeness for the target group based on the demographic information, clinical history, symptoms and vital signs [4]. Due to their success in handling the problem of result stability in feature selection, ensemble feature selection techniques have gained a lot of attention in recent study. Stability is the capacity of a feature selection algorithm to produce predictable results when the training set changes. By combining the findings of numerous ensemble techniques for feature selection, this issue is resolved.

III. METHODOLOGY

Before beginning a research project, it is essential to gather materials and data. Finding references for this research is done at this stage. Typically, data and resources are gathered from the Internet using a browser like Google Scholar, which offers materials relevant to this topic from academic and professional sectors. The next step is to get journals primarily from BioMed Central and conference papers primarily from ScienceDirect. These sources are well-known around the world. For this research, the database chosen is Kaggle Sirio Libanes ICU Prediction dataset. The dataset consists of 1925 patients record. In this research the performance measurement for prediction of ICU admission is measured based on accuracy, precision, recall and f1 score. Below is the research framework.

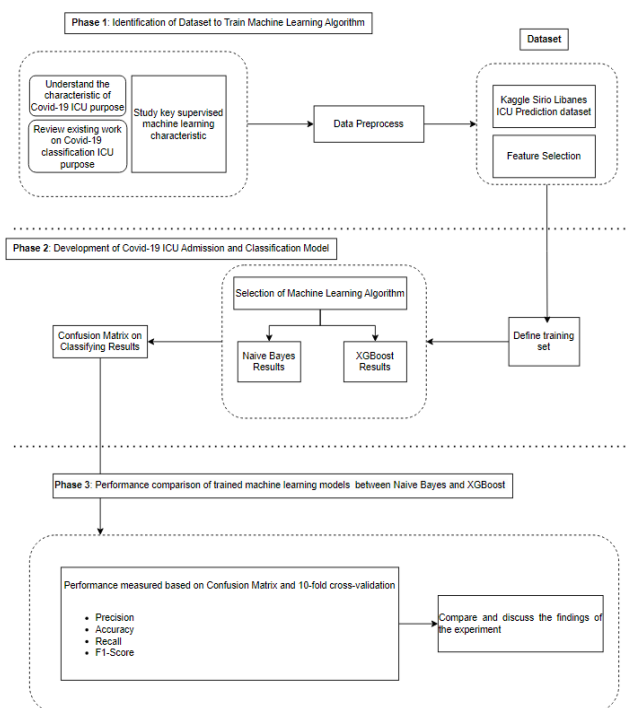


Figure 1.1: Research Framework

IV. MACHINE LEARNING METHOD

1) Random Forest, a popular ensemble learning algorithm, comprises multiple decision trees trained independently on random subsets of features and data samples. Each decision tree serves as a self-contained prediction model. During training, these trees learn from different subsets of the data and make individual predictions. The final prediction in Random Forest is determined by aggregating the predictions of all the trees, typically through voting for classification or averaging for regression. This proposed method helped to ensemble approach helps to mitigate overfitting and enhance the model's accuracy and generalization performance, making Random Forest a powerful tool for various machine learning tasks

B. The Proposed Method

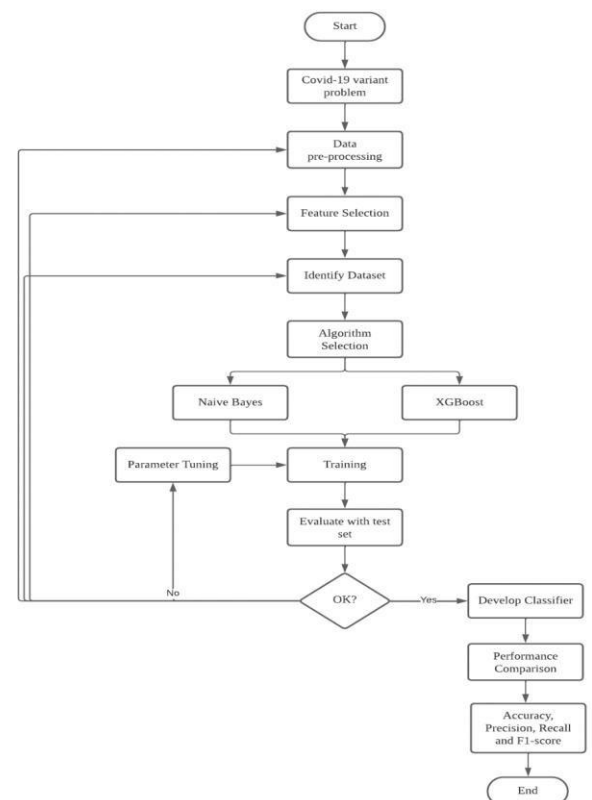


Figure 2: Proposed Methodology

C. Model Training Performance

	AGE_ABOVE65	GENDER	DISEASE GROUPING		DISEASE GROUPING		DISEASE GROUPING		DISEASE GROUPING		HTN	DIABETES	RESPIRATORY_RATE_DIFF	TEMPERATURE_DIFF	OXYGEN_SATURAT.
			1	2	3	4	5	6	7	8					
0	1	0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	...	...	-1.000000	-1.000000	...
1	1	0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	...	...	-1.000000	-1.000000	...
2	1	0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	...	...	NaN	NaN	...
3	1	0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	...	...	NaN	-1.000000	...
4	1	0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	...	...	0.176471	-0.238095	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1920	0	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	...	-1.000000	-1.000000	...
1921	0	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	...	-1.000000	-1.000000	...
1922	0	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	...	-1.000000	-1.000000	...
1923	0	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	...	-1.000000	-1.000000	...
1924	0	1	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	...	...	-0.847059	-0.547619	...

Figure 3: Model Training Performance

C. Equations

Table 1: Performance Evaluation Metrics

Performance Evaluation Metrics	Formula
Accuracy (3.1)	$TP+TNP+FP+FN+TN \times 100$
Recall (3.2)	$TP+TP+FN \times 100$
Precision (3.3)	$TNTN+FP \times 100$
F1 score (3.4)	$(2 \times (TNTN+FP \times 100) \times (TP+TP+FN \times 100)) / ((TNTN+FP \times 100) + (TP+TP+FN \times 100))$

This research showed some important requirements for minimizing processing time, particularly for developing and implementing machine learning algorithms for Covid-19 ICU admission. This research requires a PC with an Intel Core i3 CPU, Windows 10, and 16 GB of RAM memory.

Besides that, software such as google collaboration are also being used to test and analyze the data. Python is being used to create and process the data. Microsoft excel is being used to make sure data are obtained from there and the data are not scattered around and make sure it is organized. Google drives are being used as backup of the data in case of any data loss in the process.

		medium, low
3	RESPIRATORY_RATE_DIFF	High
4	BLOODPRESSURE_DIASTOLIC_MIN	High, low
5	RESPIRATORY_RATE_MIN	High, medium, very low
6	RESPIRATORY_RATE_DIFF_REL	High, medium, very low
7	RESPIRATORY_RATE_MEDIAN	High, low
8	BLOODPRESSURE_SISTOLIC_MAX	High, low
9	BLOODPRESSURE_DIASTOLIC_MEDIAN	High, medium, low
10	BLOODPRESSURE_DIASTOLIC_MEAN	High, medium, low

Table 2: Top 10 Feature Importances

In summary, this chapter provides an overview of the research framework and the activities conducted in each phase to obtain the final results for predicting Covid-19 ICU admission based on top 10 feature importances processed using machine learning algorithms. It also includes details about the dataset utilized in this study. The performance measurements of the findings are discussed to assess the effectiveness on the level of significances of the developed algorithm. Furthermore, the hardware and software requirements for the research are specified. The following chapter provides an extensive overview of the proposed machine learning algorithm approach for Covid-19 ICU admission.

V. RESULTS AND DISCUSSIONS

The dataset is conducted through Random Forest classifier and XGBoost. Each are separated with table on the metrics score obtained for both machine learning. The dataset being tested and compared using with random forest and XGBoost. The results for each experiment were collected based on accuracy, precision, recall and F1 score.

N o	Selected Features	Significances
1	RESPIRATORY_RATE_MAX	High
2	RESPIRATORY_RATE_MEAN	High,

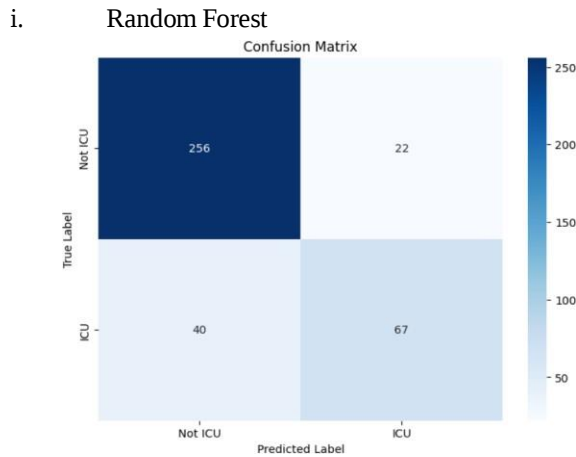


Figure 4: Random Forest Confusion Matrix (Top 10 Result)

Table 3: Random Forest Evaluation Metrics (Top 10 Result)

Accuracy	0.8389610389610389
Recall	0.7528089887640449
Precision	0.6261682242990654
F1 score	0.6836734693877551

The evaluation metrics from the test method provide insights into how well the model predicts ICU admissions. With an accuracy of 83.9%, the model correctly predicts ICU and non-ICU cases most of the time, showing overall reliability. Its precision of 75.3% indicates it identifies patients not needing ICU admission quite well, though with some risk of false positives, crucial for avoiding unnecessary ICU treatments. The recall of 62.6% means the model detects around 63% of patients who truly do not need ICU care but also indicates a notable number of false negatives, where patients who require ICU may not be identified. The F1 score of 68.4% balances precision and recall, suggesting room for improvement, particularly in reducing false negatives to optimize ICU resource use. These metrics underscore the model's accuracy and precision, emphasizing the need for enhancements to better distinguish between patients who do and do not require ICU care, thereby improving clinical decisions and patient outcomes.

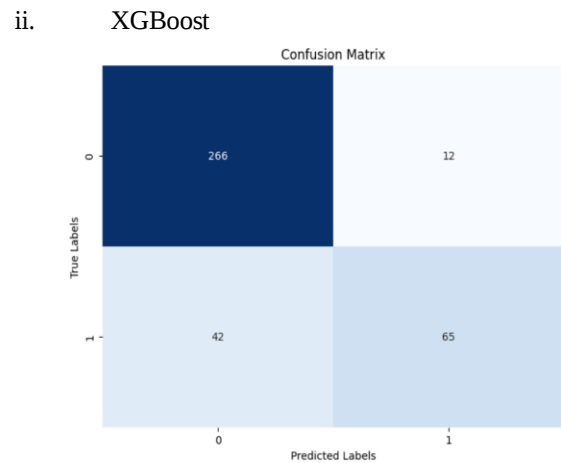


Figure 5: XGBoost Confusion Matrix (Top 10 Result)

Table 4: XGBoost Evaluation Metrics (Top 10 Result)

Accuracy	0.8597402597402597
Recall	0.8582222971833362
Precision	0.8582222971833362
F1 score	0.8518963081732039

The evaluation metrics obtained from the XGBoost model, which correlate to the confusion matrix, give an accurate indication of its effectiveness in predicting ICU admissions. The model's accuracy of 85.97% implies that it properly predicts ICU and non-ICU admissions the majority of the time, demonstrating strong overall dependability. With a precision of 85.82%, the model is extremely good at properly identifying patients who do not require ICU treatment, reducing the number of false positives and preventing unnecessary ICU admissions. The recall of 85.97% demonstrates the model's ability to reliably identify non-ICU patients, demonstrating a high percentage of true positive identifications. The F1 score of 85.19% balances accuracy and recall, indicating that the model strikes an accurate compromise between eliminating false positives and finding real non-ICU patients. These measures show that the XGBoost model is effective at selecting between patients who require ICU care and those who do not, ensuring optimum allocation of ICU resources and improving patient outcomes. However, ongoing refining is required to eliminate false negatives and false positives, hence improving the

model's predicted accuracy and dependability in clinical contexts.

D. Overall Results

1) Based on result on Random Forest and XGBoost from their metrics score, by looking on the percentage obtained from XGBoost, it concludes that XGBoost had way better and further in exceeding expectation result from the accuracy, precision, recall and F1 Score than Random Forest which indicate that XGBoost ability to handle complex relationships, execute effective regularisation, and scalability for large data sets make it a better choice than Random Forest in many machine learning applications.

Table 5: Overall Result Comparison between Random Forest and XGBoost

Comparison Aspect	Random Forest (Top 10 Features)	XGBoost (Top 10 Features)
Accuracy	83.90%	85.97%
Precision	75.28%	85.82%
Recall	62.62%	85.97%
F1 Score	0.6837	0.8519

2) For The reason XGBoost is superior is because it is capable of identifying intricate patterns in data better, which enables it to provide predictions that are more accurate. Additionally, it utilises methods to prevent overfitting, assuring that its predictions perform well on fresh, clean data. Large amount of data work can be handled more quickly and effectively using XGBoost as it can be scaled over multiple machines and is highly effective at processing huge datasets. For numerous types of machine learning applications, XGBoost is the better choice because it has better accuracy, robustness, and efficiency.

- i. **Handling Complex Relationships:** XGBoost excels in capturing intricate relationships between features and the target variable, crucial for modeling complex datasets accurately.
- ii. **Regularization Techniques:** XGBoost's integrated regularization techniques help prevent overfitting and improve generalization performance compared to Random Forest.
- iii. **Performance and Scalability:** XGBoost is more efficient and scalable, making it suitable for handling large datasets and achieving faster training times compared to Random Forest.

3) For the chapter summary, XGBoost's ability to handle complex relationships, regularisation techniques to prevent overfitting, and optimised computational efficiency make it a better choice than Random Forest for many predictive modelling tasks, including ICU admission prediction using healthcare data. These elements work together to provide XGBoost a higher accuracy, precision, recall, and F1 score than Random Forest in many practical situations.

E. Performance of Machine Learning

Based on the evaluation metrics provided for the XGBoost model using the top 20 features, the results indicate a solid performance in predicting ICU admissions. The model achieved an accuracy of 83.90%, indicating its overall correctness in classifying both ICU and non-ICU cases in the test dataset. A precision of 75.28% highlights the model's accuracy in predicting cases as "Not ICU" (negative class), minimizing false positives and ensuring that patients predicted as not needing intensive care generally do not require it based on the selected features. However, with a recall of 62.62%, the model shows moderate sensitivity in identifying actual ICU cases, suggesting there is room for improvement in capturing all patients needing intensive care. The F1 score of 0.6837 balances precision and recall, indicating a reasonable trade-off but also pointing to potential enhancements to achieve a more robust performance in predicting ICU admissions. These metrics collectively underscore the XGBoost model's effectiveness in healthcare decision support, demonstrating its ability to assist in identifying patients who require intensive care with a high degree of accuracy while also highlighting areas for refinement to enhance its predictive capabilities further.

VI. CONCLUSION

Hair In conclusion, XGBoost demonstrates superior performance over RandomForest in predicting ICU admissions, achieving higher accuracy, precision, recall, and F1 score. Its ability to effectively classify patients who require ICU care while minimizing false positives and negatives underscores its reliability and potential in healthcare decision-making.

Looking ahead, future enhancements could focus on integrating real-time data streams to ensure the model adapts promptly to changing patient conditions. Implementing explainable AI techniques would enhance transparency and trust in the model's predictions among healthcare professionals. Additionally, exploring advanced ensemble learning approaches and refining feature engineering methods could further enhance predictive accuracy and robustness. These advancements aim to optimize ICU resource allocation and improve patient outcomes by ensuring more precise and reliable predictions in clinical settings.

VII. ACKNOWLEDGMENT

It was a challenging work to create this thesis. Despite the hurdles, I met a wide range of people, professors, and researchers in the domains of bioinformatics. They have aided in the completion of my study in a variety of ways, most notably by widening my limited experience in this area of interest.

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