Original Article

Artificial Intelligence Assisted Decision Making in Predicting COVID-19 Patient's Path

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Abstract

Artificial Intelligence (AI) has made significant advances in all aspects of healthcare. Different studies have been investigated using AI regarding improve patient diagnosis, emergency care, and patient safety for different diseases. The coronavirus disease (COVID-19) has escalated into a global public health emergency. Different have shown clinical decisions for COVID-19 on diagnosis accuracy, severity risk, and so on. Moreover, few studies have focussed on clinical decisions for COVID-19.

The fact global pandemic of corona poses a big challenge for clinicians, this research intends to detect a coronavirus patient path based on the virus' biological traits and presents an adequate mechanism for the efficient decision support system that assists doctors in predicting a COVID-19 patient. To train and test our model, we used 311 patient data which are 214 (69%) male and 96 (31%) female. Data were collected and maintained from three centers of Ethiopian Hospitals from Nov 2021 to March 2022 with the age range of 21 up to 67. The experiments were performed with three Machine Learning (ML) algorithms, namely Naïve Bayes (NB), Artificial Neural Network (ANN), and Support Vector Machine (SVM). The model was validated using input variables (n=10) which achieved better involvement in the virus symptoms identification and based on the evaluation metrics, ANN achieved 97%, 96%, 85%, and 98.3% for recall, precision, and F1-measures respectively. Our results demonstrated that the SVM algorithm achieved a 91.3% average accuracy and the other two methods had 87.75% and 96.05% respectively. In this research, ANN does better than the NB classifier by 8.3% on average and better than SVM by 4.75%. In addition, using more prediction algorithms and a larger dataset includes more parameters used to estimate patients.

Keywords: Decision Support System, Machine Learning, COVID-19.

1. INTRODUCTION

The use of artificial intelligence (AI) in the health sector has significantly benefited stakeholders in the health profession and the academia by utilizing available knowledge to enhance clinical decisions [1], [2]. Machine learning (ML) techniques in particular are well-suited to dealing with increasing challenges in healthcare by helping clinicians with the difficulties of risk in stratifying patients for treatments and weighing several modest outcomes to improve overall patient outcomes [3], [4]. Particularly during the COVID 19 era, the method was used for a number of problems. To name a few applications, it was used to forecast mortality risk [5], predict reparatory decompensation in 19 patients [6], and predict the disease based on no symptoms. Accurate and timely identification of COVID-19 patients is critical for reducing the risk of hospital overcrowding, maximizing hospital resource use, and lowering the pandemics mortality rate.

Particularly, in developing countries such as Ethiopia and Nigeria, existing medical facilities were overburdened at the peak of the pandemic, with emergency rooms, floor units, and intensive care units (ICUs) stretched beyond capacity and resources [7]. Because of the unique nature of this disease, healthcare professionals and providers have had to make critical and difficult decisions quickly with little information due to the unique nature of this disease. With thousands of potential outcomes, hundreds of potential causes, and hundreds of potential connections with disease symptoms, many of which are unpredictable, medical decisions are initially difficult [8], [9]. Additionally, as the cost of medical care increases, new problems arise that the conventional methods are unable to handle [10]. To solve the issue and take on these new challenges, new solutions must be developed.

Inspiring studies have made an effort to address issues related to the COVID 19 pandemic. One study that examines the

emergency decision-making model that takes patient care and admission schedule into account is study [11]. They make an effort, based on their research, to distribute a group of patients among various scarce resources, such as rooms, time slots, and beds, in accordance with predetermined restrictions like disease severity, waiting time, and disease types. Authors in [12] investigated methods to determine which patients should be treated first in order to address these difficulties. Hospitals are having trouble accommodating all patients due to the high number of people who are being exposed to COVID-19 at the same time. As a result, they must set up a priority scale to decide which patients should be treated first. After being admitted to the hospital, the patient must undergo diagnostic testing by medical professionals to determine whether or not ICU care is necessary given the disease's symptoms. However, due to the clinical similarities between COVID 19 and other illnesses like the flu and the common cold [13], a thorough investigation of disease symptoms is required. Guangyao et al. [14] used a machine-learning model to detect clinical features on severity risk assessment and screening for COVID-19 patients upon hospital admission. Based on their investigation, they discovered that elderly COVID-19 patients who were male, not employed by a hospital, had hypertension, diabetes, cardiopathy disease, COPD, cerebrovascular disease, renal disease, hepatitis B virus infection, lower body temperature, and chest tightness were more likely to experience a severe illness at an early stage of the disease. Despite the fact that they were able to pinpoint the feature that was most susceptible, more research is still needed to help doctors use the parameter.

Therefore, key decisions made by clinicians include assessing signs and symptoms to develop a diagnosis, determining whether or not additional tests are necessary, and choosing a course of treatment. Clinicians must comprehend how each potential treatment will impact all of the outcomes that a patient deems crucial in order to select the best course of action [15-19]. However, here is no standardized method for identifying and assessing patient preferences, and there is a lot of misinformation about how a treatment affects outcomes. Due to the complexity of the disease, AI systems, in particular ML algorithms, are able to understand and resolve specifics of their contents of symptoms and procedures that human clinicians are unable to [20].

As a result, this study introduces the creation and use of technologies that aid physicians in making decisions about how to predict the patient's course. The main objective of this research is to create and assess a machine-learning model based on COVID-19 clinical features for determining acute risk and classifying COVID-19 patients upon admission to the hospital. Consequently, the study's aim is to provide answers such as:

(1) What is the patient's approximate likelihood for ventilator support or ICU admission based on historic data?

(2) How do clinicians predict patient risk with the use of AI, and how does deploying artificial intelligence be a solution to the issues?

In addition to its scientific value, the study helps hospitals or health sectors by reducing resource shortages for patients who require proper admission and by assisting doctors in handling complex issues that are difficult for them to handle on their own.

The rest of this study is divided into the following sections: Section two discusses the materials and methods, and Section three discusses the findings and their implications. Section four will then provide a conclusion and recommendations for the future.

2. MATERIALS AND METHODS

To conduct our study, we used an experimental research design. This study's experiment makes use of the whole data set to train and test the classifiers. We used different machine learning classifiers and each of them are experimented on test dataset, the results are analyzed individually, and then an overall analysis is performed to synthesize the findings.

We gathered data of 311 patients, with 214 (69%) of them that are male and 96 (31%) female. The data was collected bwteen November 2021 to March 2022 from three Ethiopian hospitals' health centers with patients aged range 21 up to 67. The collected patient data are admitted for more than three days in the hospital and those who have similar indicators or symptoms of COVID-19 disease.

Authors identified ten input variables for their measurements to predict COVID-19 patient paths including age (year), Gender (m/f), Disease Group (Diabetes, Blood Pressure, Fever/Cough, Allergy of any kind, Asthma, Smoking), Glucose Level(mg/dl), Systolic Blood Pressure(mmHg), Diastolic Blood Pressure (mmHg), Heart Rate (bpm), Body Temperature (°C), SpO2 Level (%) and Length since admitted to the hospital (hrs or day). Physicians discuss all variables to determine their minimum, maximum, and normal values. 80 percent of the data from 248 patients of whom 173 are men and 75 are women was used to train our model. Even though only 231 patients correctly fulfilled ten variables of COVID-19 and the remaining 17 data were rejected the training. On other side, to test the model we used total of 63 patients with 41 men and 21 females.

Initialy, model was developed for training and testing the patient dataset. Three machine learning algorithms, namely: ANN, SVM, and NB classifiers were used to achieve this goal. Their performance is assessed during the training phase using the entire training set, which comprises a total of 80% of the 311 patient risk datasets. During the model setup for each technique in the training phase, 10-fold cross-validation was applied to the various parameters. The testing phase that comes after involves calculating each model's accuracy and gauging how well it performs on the test dataset. Finally, developed algorithms and the trained patient risk dataset are stored for later use. To ascertain whether a patient has been admitted to or discharged

from the hospital, the algorithm with the highest accuracy is used. The user uploads their user data to the user interface in order to use the developed model, AI decision-making system. The system then forecasts the necessary patient risk data and presents the outcome to the doctors after checking and evaluating the uploaded data against the patient risk data database that was previously stored. The proposed system design's overall perspective is summarized in Table 1. The proposed model is shown in Figure 1.

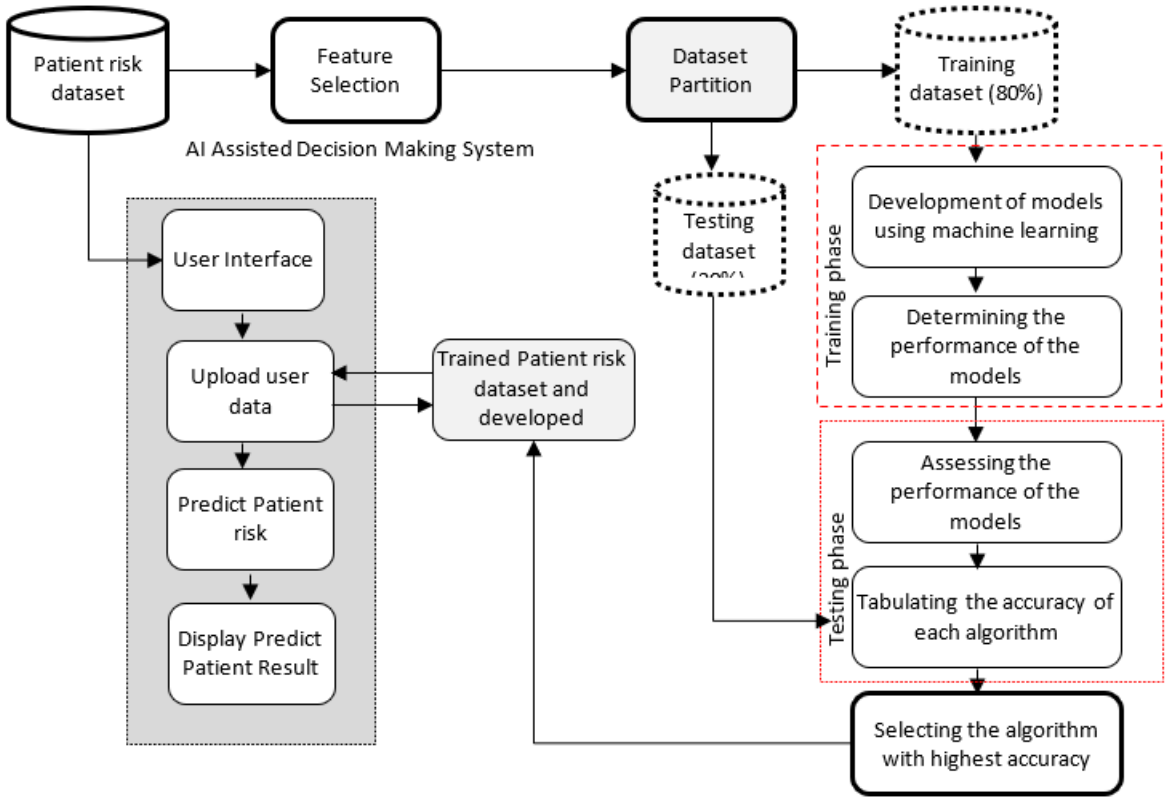


Figure 1: Model Development.

After the development of the model, we used four evaluation metrics to evaluate the model's effectiveness on a COVID-19 patient's path. These metrics include Accuracy, Precision, Recall, and F1-score. Python V 3.7 was used for implementing the system. The frontend is built using Streamlit, an open-source app framework. Aside from that, the packages Keras, TensorFlow, and sklearn are used.

3. Results and Discussion

We examined 46 patients who required ICU admissions based on test data that met the criteria (n=10) of the COVID-19 predictor to hospital admission. In the no-need ICU, only 17 patients had limited disease indicators (n=6). In order to assist doctors in predicting a COVID-19 patient's course, independent NB classifier, ANN, and SVM models are examined and contrasted on the dataset. Figure 2 shows the results of each experiment after being examined separately. According to the performance analysis, the SVM algorithm had an average accuracy of 91.3%, while the average accuracy of the NB and ANN algorithms was 87.75% and 96.05%, respectively. The ANN algorithm outperforms both NB and SVM. The minimum and maximum error rates in this study's strongest classifier, the ANN, were 3.2% and 4.7%, respectively.

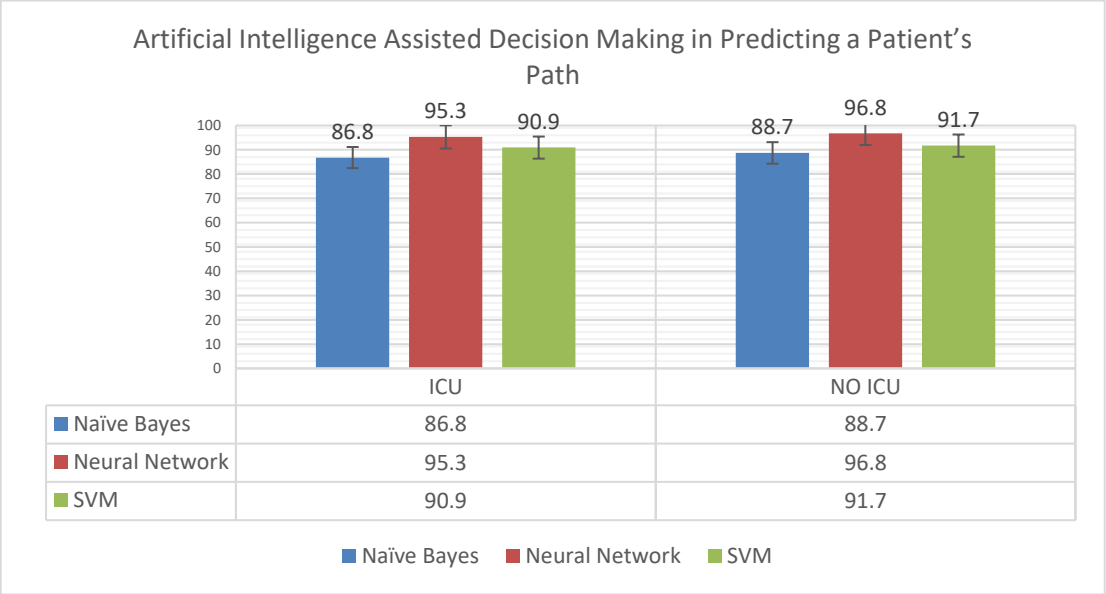


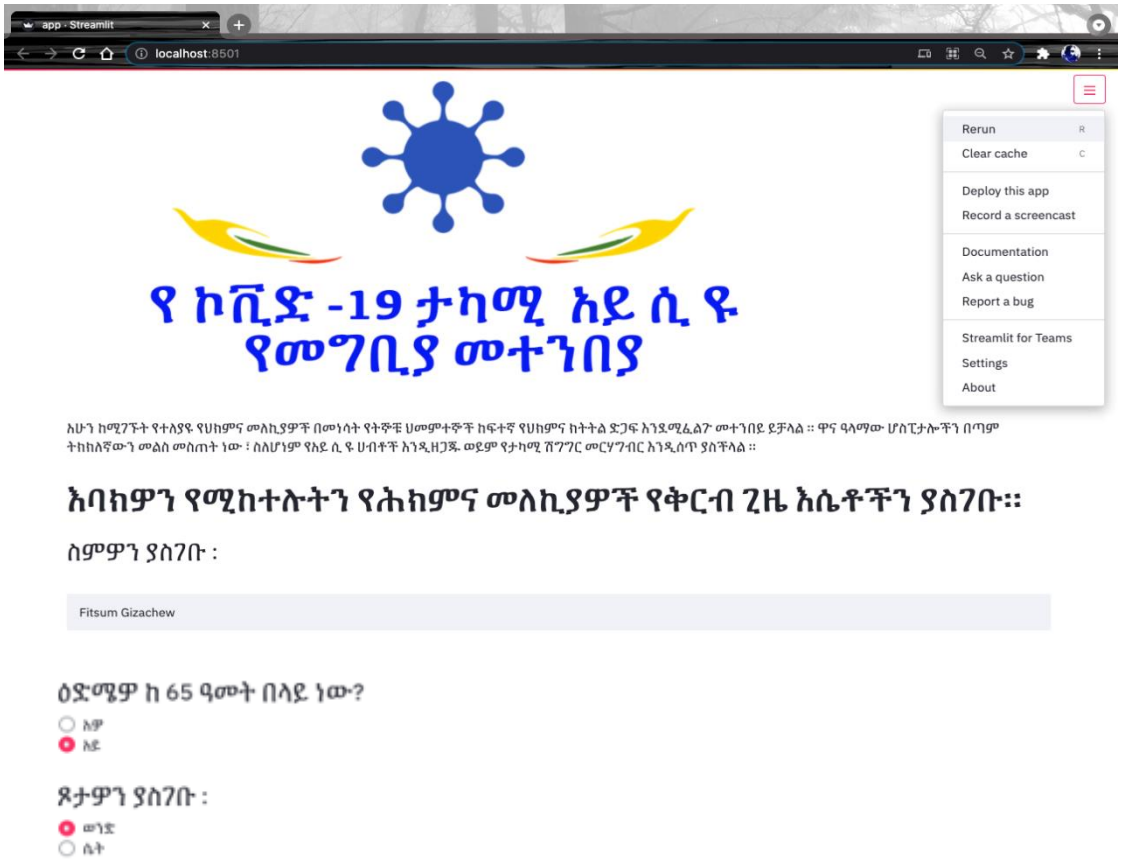
Figure 2. Evaluation (Accuracy) on test data of model on Naïve Bayes, Neural Network, and SVM classifiers.

Based on the evaluation metrics in Table 1 of the testset on each model, ANN achieves 97%, 96.85%, 98.3% for recall, precision, and F1-measures respectively.

Table 1: Results of 10-fold cross-validation test of all machine learning models.

	Accuracy	F1-score	Precision	Recall
SVM	0.9130	0.9745	0.9277	0.8903
NB classifier	0.8775	0.9102	0.9218	0.9064
ANN	**0.9605**	**0.9830**	**0.9684**	**0.9700**

Figure 3 depicts screenshots from the Decision Support System (DSS) built (Amharic user interfaces) to assist doctors in utilizing ANN to anticipate the path of a COVID-19 patient.



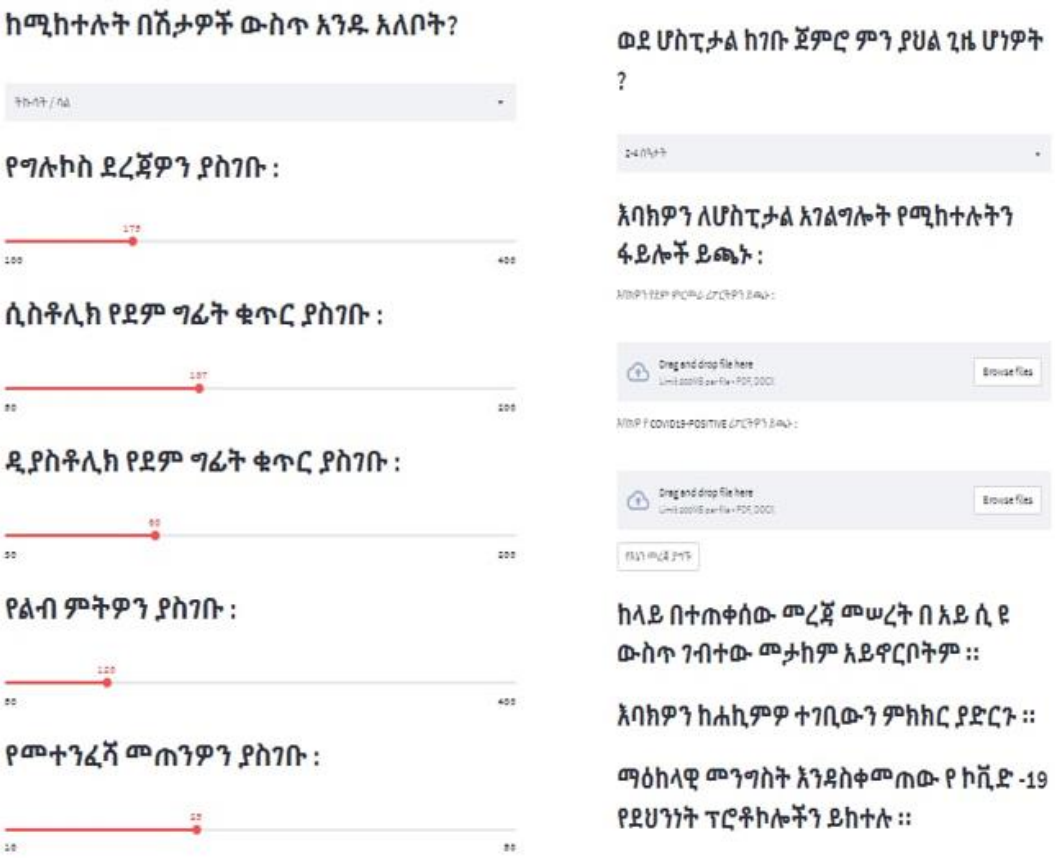


Figure 3. Decision Support System User Interface (in Amharic).

4. Conclusion and Future Work

In this study, a suitable mechanism for an efficient decision support system that assists doctors in predicting a COVID-19 patient's path was presented. The dataset used in the study was collected from three public hospitals. Three methodologies taken into consideration were NB, ANN, and SVM algorithms. A test dataset is used to measure the prediction accuracy of the classification approaches used in this study. The classifiers are written in Python. The models' accuracy and error rates are calculated in order to evaluate their performance. In the study, a combination of cross-validation and K-folds cross-validation is used to select the best model for each technique. The ANN approach outperforms both NB and SVM when it comes to predicting a COVID-19 patient's path using the best classifier in the study, which is the ANN approach. When compared to the two other algorithms, SVM and Bayes, the lowest error rate was 3.2% and the greatest error rate was 4.7%. The results of this research are beneficial and can be used in any of the areas of decision support applications. The research findings provide statistical grounds that assist doctors in their decision-making by predicting a COVID-19 patient's path with the help of AI. The results of this research can therefore be used by anyone interested in this area of research since it can be used as a baseline for further studies on AI-assisted decision making to be considered in Ethiopia, Nigeria, and other developing countries.

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