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Early Prediction of Sepsis from Clinical Data Using Artificial Intelligence

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Abstract - Nowadays, Sepsis has become a common life-threatening condition to the people all around the globe. It is caused when the response of the body to an infection causes damage to the tissues and organs of the body itself. It is a huge concern regarding the health of the public with morbidity, death, and the expenses of the healthcare. If the sepsis is detected early and treated with antibiotics, outcomes will be surely improved. However, there is also an issue because even though the highly recognized professionals of the societies that have critical care units have put forth a new clinical criteria which will help in recognition of the sepsis, the early detection of sepsis and treatment of sepsis which are fundamental is purely unmet. To solve this problem, many researchers and scientists have responded by creating algorithms for early detection of sepsis. But the problem arises when the direct comparing of these algorithms has not been possible for them because of different reasons. Those reasons include various cohorts of patient, the clinical variables and the criteria of sepsis, tasks for prediction, evaluation metrics, and many other differences. Ignored to solve these issues, we have developed an artificial intelligence- based early warning and therapeutic decision support system for the early detection and treatment of sepsis using RNN and LSTM algorithm.

Key Words: RNN (Recurrent neural network Algorithm) and LSTM (Long short-term memory)

1. INTRODUCTION

Sepsis is one of the most dangerous life-threatening illness which is caused due to the fatal response of the body to an infection. The immune system of our body protects us from various diseases and infections caused by the foreign bodies, but even though our immune system protects us, in some cases, it is also possible for the immune system to go into overdrive during its response to an infection. On a brief note, Sepsis is developed when the chemicals that are released by the immune system into the bloodstream causes inflammation throughout the entire body instead of fighting against the infection. Medical emergency occurs when the severe cases of sepsis leads to septic shock. According to the Centers for Disease Control and Prevention (CDC), there are more than 1.5 million cases of sepsis every year. There are three stages of sepsis. First stage is the sepsis, second stage is the severe sepsis and the final stage is the septic shock which is the deadliest stage. Sepsis can also happen while the patient recovering from a procedure is still in the hospital, but this is not the case always. It is very important for the patients to seek medical attention immediately if they have any of the symptoms like high fever, higher heart rate, higher breathing rate and any probable or confirmed infection. The earlier the patients seek treatment, the greater are their chances of survival. That is why, we have developed a software which gives digital solution uses artificial intelligence to detect patient deterioration before it's too late and trigger notifications to clinicians and care teams. Train healthcare providers and front-line staff to quickly recognize symptoms to identify sepsis and treat patients at the earliest. Also, educate preventing infections in health care settings and the community so that infections that can lead to sepsis can be stopped before they happen. Provide guidelines to follow infection control requirements (e.g., Hand hygiene) and ensure one to receive recommended vaccines (e.g., Flu and pneumococcal, etc.).

1.1 Related works

In [1] Big data analytics is applied to healthcare which will use specific health data of a population or a particular individual and will potentially help to prevent and cure the sepsis.

In [2] they used SIRS which is a targeted and a sensitive screening tool used for early care and prevention of cases that are missed. They also used sofa which is the identification of specific patients those who are at higher risk of death, and it could help clinicians in deciding on required care and treatment.

In [3] an integrated data mining approach which includes the utilization of the most refined data analysis tools inorder to find the previously unknown, valid relationships and patterns in large data sets for monitoring of real-time clinical data and deterioration warning.

In [4] using physiomarkers in real-time continuous physiological data streams which is used to predict sepsis onset in adults earlier than the clinical practice.

1.2 Architecture

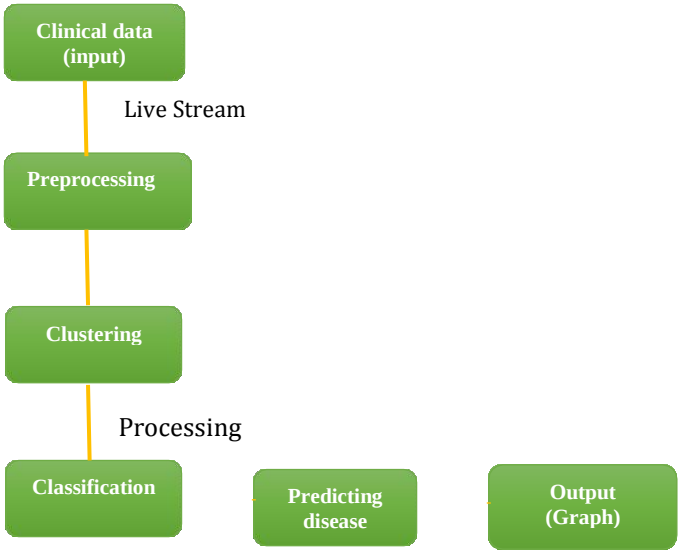

Figure: 1

Clinical Data

Clinical vital signs such as heart rate (HR), pulse primary (O2Sat), temperature, systolic BP (SBP), mean arterial pressure (MAP), diastolic blood pressure (DBP), respiration rate, end tidal carbon dioxide (EtCO2) and other laboratory values are taken as the clinical data which will then undergo the procedure of preprocessing and the clinical suspicion of infection is noted and other clinical procedures are followed.

Preprocessing

Data Preprocessing is a procedure which is used to convert the raw data that is obtained from the previous clinical procedures into a clean data set. In other words, the data collected from various different sources is taken in raw format and the required specific data is chosen for further processes and the other data which are not feasible for the analysis are removed.

Clustering

Clustering is the technique of splitting the population or data points into a different number of groups such that data points in the same groups should have similar properties and features whereas the data points in the other group should have highly different properties and features. In simple words, the aim is to separate groups with similar traits and group them into clusters.

Classification

Classification is the problem of identifying to which of a set of sub-populations a new observation belongs in machine learning, and it is based on the training set of clinical data containing observations whose category membership is already known. We prefer classification process because this can be performed on both structured and unstructured data.

2. PROPOSED SYSTEM

Clinical decision support systems have emerged as Background: tools providing intelligent decision making to address challenges of critical care. We proposed new definitions for sepsis but the fundamental need to detect and treat sepsis early still remains, and basic questions about the limits of early detection remain unanswered. So that we applied the early detection of sepsis to RNN and LSTM algorithm to achieve the early prediction of sepsis.

Algorithm Used

Recurrent Neural Network (RNN) are a type of Neural Network where the output from previous step are fed as input to the current step. In traditional neural networks, all the inputs and outputs are independent of each other, but in cases like when it is required to predict the next word of a sentence, the previous words are required and hence there is a need to remember the previous words. Thus RNN came into existence, which solved this issue with the help of a Hidden Layer. The main and most important feature of RNN is Hidden state, which remembers some information about a sequence.

Long short-term memory (**LSTM**) is an artificial recurrent neural network (RNN) architecture used in the field of deep learning unlike standard feed forward neural networks, LSTM has feedback connections. It can not only process single data points (such as images), but also entire sequences of data (such as speech or video). For example, LSTM is applicable to tasks such as unsegmented, connected handwriting recognition, speech recognition and anomaly detection in network traffic or IDS's (intrusion detection systems).

A common LSTM unit is composed of a **cell**, an **input gate**, an **output gate** and a **forget gate**. The cell remembers values over arbitrary time intervals and the three *gates* regulate the flow of information into and out of the cell.

Output

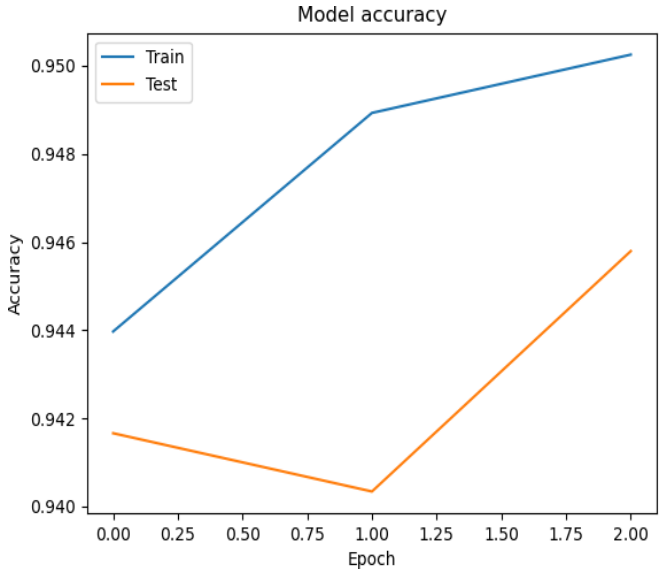

Figure: 2

Accuracy is one metric for evaluating classification models. Informally, efficiency is the fraction of predictions our model got right. Formally, the ability has the following

Definition

Accuracy= Number of correct predictions Total Number of prognostications

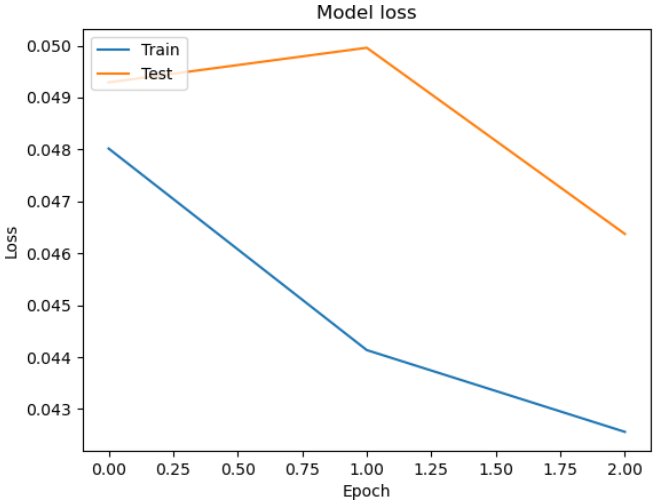

Figure: 3

Loss is a number indicating how wrong the model's prediction was on a single example. If the model's prediction is perfect, the damage is zero; otherwise, the loss is more significant. The goal of training a model is to find a set of weights and biases with low loss, on average, across all examples.

3. CONCLUSIONS

In this paper, we are using a forty thousand patient data set to train our system using the recurrent neural network Algorithm and Long short-term memory method. The purpose of using this massive amount of data set is to clear understanding of patient history, which will help us to improve the overall performance score by using this algorithm. The proposed algorithm shows better performance than the existing algorithms available in the literature. The following are some of the avenues for further research.

We are thinking of extending our ideas by implementing all the features like detecting the individual patient record whether they have the sepsis and which stages are they, which will be useful for the doctor to confirm whether the patient has sepsis or not by identifying each patient. Further, we are planning to create a complete module that will be useful for the doctor to detect the patient whether their test cases were positive are not.

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