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Heart Disease Prediction using Deep Learning Techniques

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Abstract:
Considering that heart attacks are one of the main causes of unexpected mortality, heart attack prediction is essential. With the help of treatment histories and current health conditions, the healthcare industry generates substantial volumes of data each day that can be exploited to forecast future heart attacks that could affect a patient. Eventually, when making decisions this suppressed information from the health care data can be employed. Researchers are concentrating on creating software that can aid doctors in making decisions about a patient's health, including the diagnosis and outlook of heart disease. The major goal of this paper is to foresee the likelihood of having a heart attack before it happens. By treating patients early, this can lower the risk to their lives, increase their chances of survival, and lower treatment costs. Through graphical representation of the outcomes, comparative analysis of the accuracy of deep learning algorithms like Feedforward Neural Network, Long Short-Term Memory (LSTM) and Bidirectional LSTM will be carried out.

Keywords: Deep Learning, Feedforward Neural Network, Recurrent Neural Network, accuracy, decision making, perceptron.

Introduction

Deep Learning trains computers to act like people by imitating behaviour. This technology is crucial for driverless cars to recognize a stop sign or a person. It is the key to voice control in consumer devices including phones, tablets, TVs, and hands-free speakers. Deep learning has received a lot of attention recently, and for good reason. Results that were previously unreachable are now being produced by it. Using deep learning, a computer model can perform categorization tasks directly from images, text, or sound. Modern precision can be achieved by deep learning models[6], sometimes even surpassing human performance. Models are trained using massive amounts of labelled data and neural network designs. [4].

Feed forward neural network: A Feed forward neural networks analyse data in a variety of ways using complex mathematical modeling[1]. Deep learning algorithms are stacked in a hierarchy while conventional machine learning methods are linear.

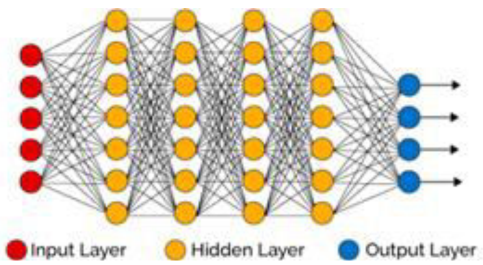

Figure 1: Feedforward Neural Network

The goal of a feedforward network is to approximate some function f*. For example, for a classifier, y = f *(x) maps an input x to a category y.

A feedforward network establishes the mapping y = f (x;) and discovers the value of that yields the best function approximation. The reason these models are named feedforward is because data moves from the input x via the function being evaluated, the calculations necessary to define f, and finally to the output y. The model's outputs cannot be fed back into it because there are no feedback connections. Recurrent neural networks are created when feedforward neural networks are expanded to

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incorporate feedback connections. The use of feedforward networks is crucial for machine learning professionals. Numerous significant commercial applications are built on them. For example, A particular form of feedforward network is utilised for object recognition from photographs called convolutional networks. Because feedforward neural networks are often depicted by piecing together a variety of functions, they are also known as networks. A directed acyclic graph illustrating the relationship between the functions is linked to the model.

For example, we might have three functions $f^{(1)}$, $f^{(2)}$, and $f^{(3)}$ connected in a chain, to form $f(x) = f^{(3)}(f^{(2)}(f^{(1)}(x)))$. This chain structure is most commonly used structure of neural networks. In this case, $f^{(1)}$ is called the first layer of the network called input layer used to feed the input into the network; $f^{(2)}$ is called the second layer called hidden layer used to train the neural network, and so on. The final layer of a feedforward network is called the output layer that provides the output of the network. The overall length of the chain gives the depth of the model and width of the model is number of neurons in the input layer. It is from this terminology that the name "deep learning" arises.

Long Short Term Memory (LSTM):
An LSTM's control flow is similar to a recurrent neural networks. It processes data and transmits information as it moves forward. The variations are in the cell operations of the LSTM. Using these techniques, the LSTM may remember or forget information [2]. Since looking at these procedures can be a little frightening, we'll go over them step by step.

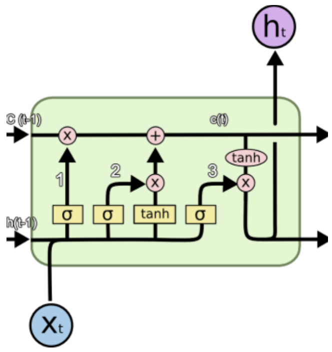

Figure 2: LSTM architecture

The cell state and its multiple gates make up the fundamental idea of LSTMs. The cell state functions as a highway for the transportation of relative information throughout the entire sequence chain. It can be regarded as the network's "memory." the cell state might, in theory, carry important information when the sequence is processed. Because of this, the effects of short-term memory are diminished. Even information from earlier time steps can travel to later time steps. Information is added to or withdrawn from the cell state through gates as it travels. The gates, which determine which information is permitted on the cell state, are various neural networks. During training, the gates might learn what information is important to remember or disregard.

Bidirectional LSTM:
A sequence processing model called a biLSTM, also referred to as a bidirectional LSTM, consists of two LSTMs, one of which gets input forward and the other of which receives it backward. The network can access more data with the use of BiLSTMs, which helps the context of the algorithm.

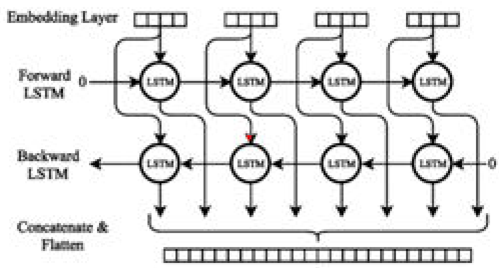

Figure 3: Bidirectional LSTM architecture

Methodology:
We choose three popular deep learning techniques considering their performance for the paper and selected heart attack dataset which is available at www.kaggle.com dataset repository. The dataset contains features like age, gender, chest pain, cholesterol etc., along with the target variable which is binary categorical data. Various classifiers are applied to the same data in order to assess the performance of learning algorithms, and the results are compared based on the misclassification and correct classification rates[3][5].

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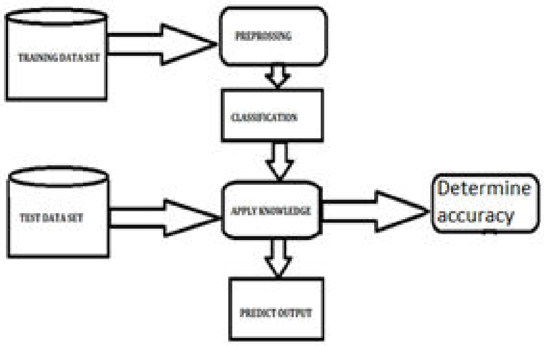

Figure 4: Heart attack prediction system architecture.

Training Data:
The enriched or labelled data that you need to train your models is what is meant by "training data." To increase the precision of your model accuracy levels, you might only need to collect more of it. However, the likelihood that your data will be used is quite low because excellent training data at a large scale is required to construct a fantastic model.

Pre-Processing:
The ability of our model to learn is directly impacted by the rich quality of the data and the more valuable information that can be obtained from it, making data pre-processing the first and most important vital step in machine learning.

Pre-Processing Steps
The following are the Pre-processing steps.

i. Handling Null Values
ii. Standardization
iii. Handling Categorical Variables
iv. Multicollinearity

Classification:
Predicting the class of a set of provided data points is done through the classification process. Targets, labels, and categories are other names for classes. Approximating a mapping function (f) from input variables (X) to discrete output variables is the problem of classification predictive modelling (y).In Classification we are using the following three models.

1. Feedforward neural network
2. LSTM
3. BiLSTM

Feedforwad NN Model
Model: "sequential_2"

Layer (type)	Output Shape	Param #
dense_5 (Dense)	(None, 16)	224
dropout_2 (Dropout)	(None, 16)	0
dense_6 (Dense)	(None, 8)	136
dropout_3 (Dropout)	(None, 8)	0
dense_7 (Dense)	(None, 1)	9

Figure 5: Feedforward Neural Network model

LSTM Model
Model: "sequential_1"

Layer (type)	Output Shape	Param #
embedding (Embedding)	(None, None, 304)	304000
lstm (LSTM)	(None, 8)	10016
dense_3 (Dense)	(None, 1)	9

Figure 6: LSTM model

Bidirectional LSTM
Model: "sequential_3"

Layer (type)	Output Shape	Param #
embedding_1 (Embedding)	(None, None, 304)	304000
bidirectional_2 (Bidirectional)	(None, None, 128)	188928
bidirectional_3 (Bidirectional)	(None, 128)	98816
dense_8 (Dense)	(None, 32)	4128
dense_9 (Dense)	(None, 1)	33

Figure 7: Bidirectional LSTM model

Test Data
The test set is a collection of perceptions used to evaluate the model's effectiveness using a minimal execution metric. It is essential that the test set contain no observations from the training set. It will be challenging to determine if the algorithm has learned to generalise from the training set or has merely memorised it if the test set does contain examples from the training set.

Accuracy
Accuracy is one factor to consider when rating categorization models. Accuracy is the proportion of forecasts that our model successfully predicted. The following is the formal definition of accuracy:
Accuracy = Number of correct predictions / Total number of predictions.

Results
The heart attack dataset we collected contains 1025 records with 13 columns

including the target variable. We split the dataset into training and test data in the ratio 80:20 respectively, so that 820 records are used for training and 205 records are used for testing the model. We build three modes Feedforward neural network, LSTM and Bidirectional LSTM and their performance are evaluated and depicted in the below graph:

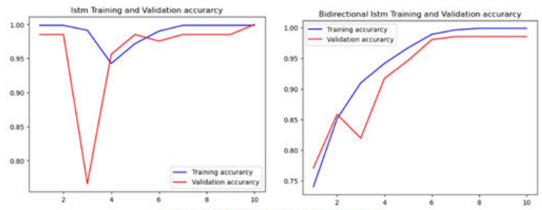

Figure 8: Accuracy of the models

By analyzing the results, we concluded that Bidirectional LSTM turned out to be best classifier for prediction of heart attack using Deep learning and this model generates accurate results with high accuracy almost 100%.

Conclusion:

This study provided a way for predicting heart attack using deep learning algorithms like feedforward neural network, LSTM and bidirectional LSTM. As a result, a comparison of various deep learning approaches for binary class classification is also produced by the offered strategies. We discovered that the Bidirectional LSTM showed exceptional accuracy for the data on identifying a chance for heart attack.

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