Medical Diagnosis System using Machine Learning

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Abstract— Machine Learning and Artificial Intelligence are being broadly studied and deployed in many fields for various applications. In the field of medicine, many algorithms and techniques of machine learning are employed for medical diagnosis. Disease prediction is the most crucial task in facilitating a medical diagnosis application. Furthermore, correct remedies and treatment for the cure of the disease must be provided. Artificial Neural Network gives highly accurate results in implementing such a system. Thus, the system takes input data of symptoms of the patient for which, neural network models predict the disease and remedy for the disease.

Index Terms-- Artificial Neural Network, Feed forward, Gradient Descent, K-Nearest Neighbours Algorithm, Linear Regression, Supervised learning, Tensorflow

I. INTRODUCTION

Machine Learning and Artificial Intelligence are technologies being used in several fields, such as digital image processing, computer vision, autonomous self- driving cars, games and recreation, military, research etc. With the evolving assortment of libraries and tools, these technologies are finding application in many more fields and domains, with improved capability of handling complex applications and providing accurate results for the application in use.

Tensorflow is a library that enables creating and training a Neural Network through its advanced libraries and APIs. Through Tensorflow Lite, machine learning models can be implemented on embedded and mobile devices. A model can be trained first using a training dataset with Tensorflow and evaluated. This model can then be converted to a Tensorflow Lite model and installed in the device. The processing and analyzing occurs locally on the users' devices itself. Hence, the need for good internet connectivity and cloud computing is eliminated. For medical diagnosis through a mobile device, this technology can be employed to obtain results of the diseases contracted and find the necessary remedies for the treatment and cure

1.1 OVERVIEW

In order to undergo a medical diagnosis, a patient is dependent on a doctor or a physician to conduct the diagnosis. In certain cases, the patient could be perhaps well aware of the disease contracted or the syndrome he/she is affected by. They may be in need of the remedies required for the treatment and cure of their medical condition. In other cases, the patient could be unable to consult a doctor due to certain reasons and in need of immediate solution to the signs and symptoms as seen in their body. In yet other scenarios, there could be unavailability of doctors for which, patients need immediate solutions, or the need of well-qualified doctors who could treat the patient in their dire need, with honesty and reasonable charges. This paper focuses on the use of machine learning models to conduct medical diagnosis upon inputting symptoms and certain values, to provide accurate, immediate and reliable solutions to patients, all of which can be possible on a mobile device of the patient/user.

A. Tensorflow Lite

TensorFlow Lite allows running TensorFlow models on a wide range of mobile, embedded and IOT devices. A TensorFlow model is contains the logic and working of a machine learning network which has already been trained to be used for an application. Hence, there is no latency in operation as the data does not have to be sent to servers for computing. Also, it allows privacy of data as data need not leave the device. Internet connection is also not required, thus saving battery and life of the devices.

B. Artificial Neural Network

An artificial neural network (ANN) is a computational model that operates similar to the human brain. An ANN is a network of highly interconnected processing elements called neurons that operate in parallel. These neurons are inspired by the neurons in a human brain. The neurons are contained in layers in a network. The first layer is the input layer, followed by one or more hidden layers and the last layer is the output layer.

Hence, there exists an interconnection between neurons in a layer and also neurons between two layers. The neural network analyzes by taking in the input data through the input layer, and produces output based on a probability threshold.

1.2 OBJECTIVES OF THE PROJECT

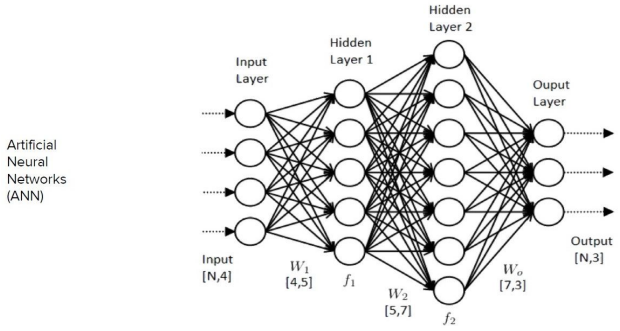
The project is aimed at providing immediate solutions to the patients through their mobile devices at their convenience. As such, the patients or users need not be entirely dependent on doctors for diagnosing. The patients or users can input their symptoms and other data in their mobile device. The computing and analyzing of this data takes place locally in the mobile device itself.

The results obtained are the disease contracted or syndrome the patient is undergoing. The patients can also obtain results about the treatment and necessary remedies for their cure.

In this manner, the users will save time and money needed for consulting a doctor. The users can consume the required remedies, treat for themselves and cure their disease or syndrome.

II. NEURAL NETWORK

Neural networks are being used widely and successfully for classification, predicting and problem solving. The proposed model uses a feed-forward and back-propagation neural network for medical diagnosis. Using Tensorflow library and keras API, three layers can be created for the neural network: the input layer, a hidden layer, and the output layer.



The dataset is split into a train data and test data. Through this training set the machine learning model trains. Training continues as long as the network continues improving on the validation set. The information moves in only one direction, forward, from the input nodes, through the hidden nodes and to the output nodes. During this process, the neurons are assigned certain weight values when they take input, and send an output as a function of its weight value to the next layer. As such, the input data passes through all neurons and have their weights assigned. This is called forward propagation or feed-forward.

$$o(\vec{x}) = \vec{w} \cdot \vec{x}$$

where, w is the weight of the neuron and x is the input value.

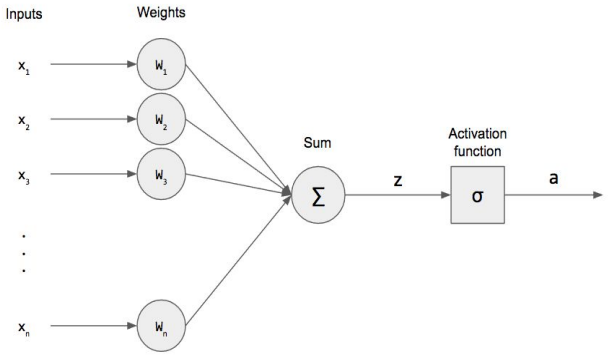
Backpropagation facilitates gradient descent so that the network parameters updates weights of the neurons to best fit a training set of input-output pairs.

A. Perceptrons

A perceptron symbolises a neuron, which takes a vector of real-valued inputs, calculates a linear combination of these inputs, then outputs a 1 if the result is greater than some threshold and -1 otherwise.

$$o(x_1, \ldots, x_n) = \begin{cases} 1 \text{ if } w_0 + w_1 x_1 + w_2 x_2 + \cdots + w_n x_n > 0 \\ -1 \text{ otherwise} \end{cases}$$

It is represented as follows:



During the perceptron training, weights are updated as:

$$w_i \leftarrow w_i + \Delta w_i$$

where,

$$\Delta w_i = \eta(t - o)x_i$$

Here, t is the target output for the current training example, o is the output generated by the perceptron, and q is a positive constant called the learning rate.

B. Gradient Descent and the Delta Rule

The backpropagation involves using the Delta Rule for gradient descent, to find the weights that best fit

the training examples. This rule is important because gradient descent provides the basis for the backpropagation algorithm, which can learn networks with many interconnected units.

It involves using a *training error* measure of a hypothesis

$$E(\vec{w}) \equiv \frac{1}{2}\sum_{d\in D}(t_d - o_d)^2$$

The vector derivative is called the gradient of E with respect to *w*, written as:

$$\nabla E(\vec{w}) \equiv \left[\frac{\partial E}{\partial w_0}, \frac{\partial E}{\partial w_1}, \cdots, \frac{\partial E}{\partial w_n}\right]$$

Therefore,

$$w_i \leftarrow w_i + \Delta w_i$$

where,

$$\Delta w_i = -\eta \frac{\partial E}{\partial w_i}$$

Hence, the weight update rule for gradient descent is given as:

$$\Delta w_i = \eta \sum_{d\in D}(t_d - o_d)\, x_{id}$$

C. Backpropagation

The backpropagation algorithm learns the weights for a multilayer network, given a network with a fixed set of units and interconnections. It employs gradient descent to attempt to minimize the squared error between the network output values and the target values for these outputs.

It updates each weight in proportion to the learning rate, the input value x_{ji} to which the weight is applied, and the error in the output of the unit.

In this way, the best set of weights are assigned to every neuron in order to maximize the neural network model's accuracy. Neural Network accuracy can also be improved by providing more dataset to learn from.

III. EXISTING SYSTEM

The Single Proton Emission Computed Tomography (SPECT) is used to obtain images of heart to operate on heart diseases. A patient is classified into either of two categories: infected and non-infected. The feed-forward and back propagation neural network is used as a classifier to distinguish between infected or non-infected person in both cases. Selected symptoms are used to learn the patterns corresponding to symptoms of the person. The results of applying the artificial neural networks methodology to acute nephritis diagnosis based upon this network.

The data obtained is separated into inputs and targets. The percent correctly classified in the simulation sample by the feed-forward back propagation network is 99% while in the diagnosis of heart disease; the percent correctly classified in the simulation sample by the feed-forward back propagation network is 95% percent.

The database of 267 SPECT image sets (patients) was processed to extract features that summarize the original SPECT images. As a result, 44 continuous feature patterns were created for each patient. The pattern was further processed to obtain 22 binary feature patterns. SPECT data has 267 instances that are described by 23 binary attributes. 80 sample used in training the network while 187 samples used in testing the network.

A technique of Computer-based clinical decision support systems (CDSSs) was proposed to address deficiencies and has been significantly improving the clinical practice over the past decade. However, they remain limited to clinics and hospitals, and do not take advantage of patient data that are obtained on a daily basis using wearable medical sensors (WMSs) that have the ability to bridge this information gap.

IV. PROPOSED SYSTEM

Neural networks are being used widely and successfully for classification, predicting and problem solving. A feed-forward and back propagation neural network is proposed to diagnose diseases. Using Tensorflow library and keras, three layers can be created for the neural network: the input layer, a hidden layer, and the output layer. The Artificial Neural Network Machine Learning model can be used for predictive analysis with high accuracy. It can be trained using supervised learning. The Neural Network is robust to noisy data and can predict the best possible solution through Linear Regression.

4.1 MAIN ADVANTAGES AND STRENGTHS:

- Reduces complexity that is usually involved in a medical diagnosis process.
- After learning from the initial inputs and their relationships, it can infer unseen relationships on unseen data as well, thus making the model generalize and predict on unseen data.
- Logic is made clearer and provides a hierarchical structure.
- Neural network learning methods provide a robust approach to estimating real-valued,

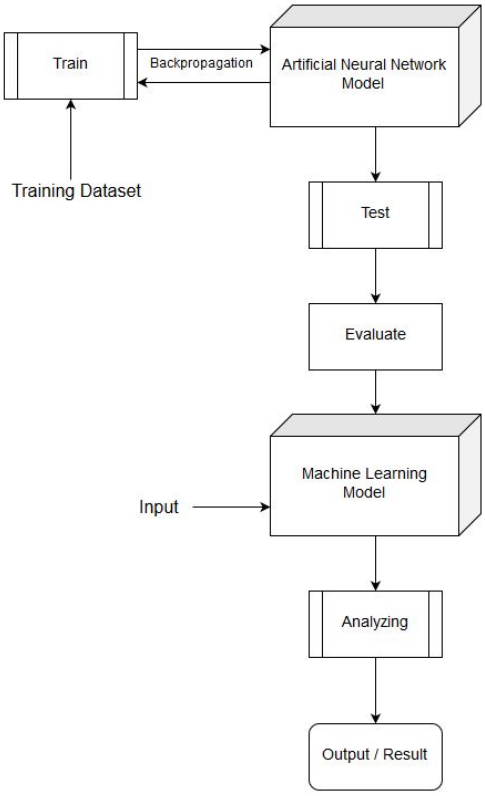
discrete- valued, and vector-valued target functions.

- Uncertainty occurred by different diagnosis system is eliminated.
- Problem occurred in other diagnosis system where grammatical labels comprehend to actual code in a period a numbers of values sensible process can be solved using this approach.

V. SYSTEM METHODOLOGY

A. Model

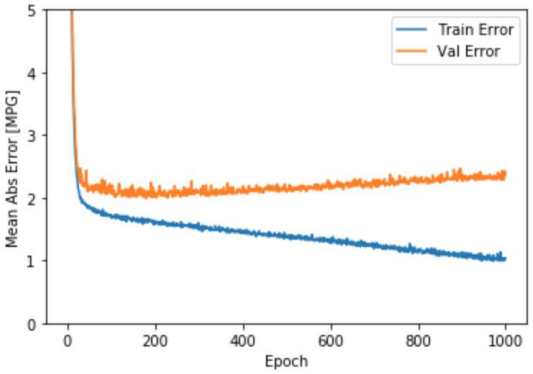
- Using Anaconda and Jupyter Notebook, a Tensorflow environment is made.
- Through this environment, several APIs and libraries have been installed.
- The most important API required is 'keras' which is used to create a neurons and a network interconnection between them.
- The 'keras' enables creating a dense connectivity between the neurons in any layer. It also allows compiling the network model once created, using a loss function, optimizer and accuracy metrics.
- The dataset containing the symptoms and the diseases is procured, and split into training dataset and test dataset. The model is trained with a training dataset and the neural network keeps updating its weight values of the neurons through back- propagation.



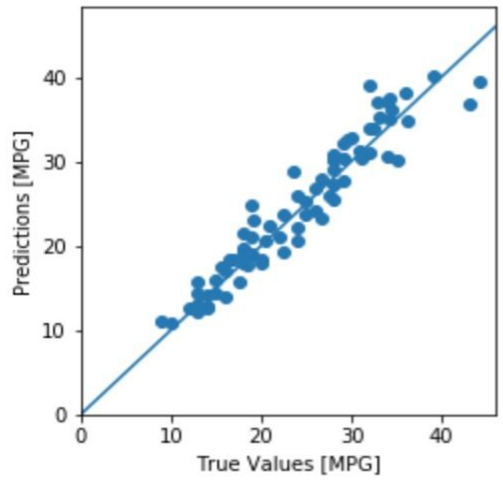
- Similarly, another model is created using keras API and is made to train on a training dataset of the remedies required for the cure of the diseases.
- With more training dataset, the models train themselves better. Through this supervised learning, more accuracy can be achieved.
- Using the test datasets of each of the datasets, the models are trained for their accuracy.

B. Evaluation

- The absolute error is obtained through root mean square through several iterations and the Mean Square Error is obtained from the diseases model.
- Since the models are predicting the best possible disease and the best remedies, they are linear regression models.
- The neural network algorithms are trained to minimize the squared error between the output predictions and the training data in order to generate output with a maximum probability.
- The solutions are not 'classified' to different outputs as such, but rather, obtained when a good probability value is obtained above a threshold.



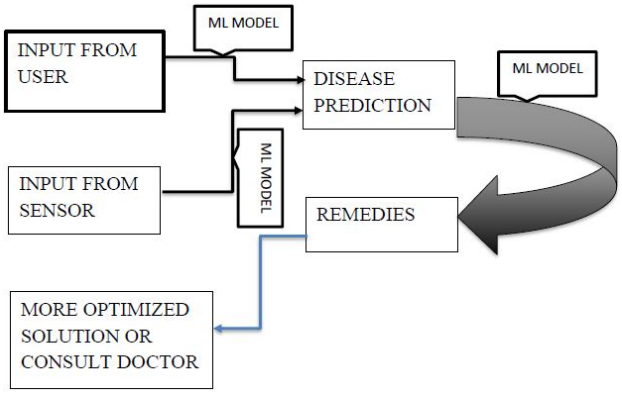
- The mean square error of the disease model is obtained.
- Both, the disease and remedies models undergo backpropagation for a gradient descent in updating the weight-values in the neurons.
- Then the remedies model is tested and evaluated through the linear regression curve. The linear regression curve helps us 'steer' the model to provide more accurate results.



- During the evaluation of the remedies-model, true values were obtained very close to the right prediction on the linear regression curve. Hence, the model can predict the remedies for the diseases obtained from the previous model with a high degree of accuracy.

C. Working

- The data is taken from the user through a GUI in a mobile application.
- The data entered by the user is sent to the trained Artificial Neural Network machine learning model for predicting the disease.
- This model has been trained using Tensorflow and evaluated for high accuracy. Then, it is converted to a Tensorflow Lite model and installed in the device.
- The model now analyses the data and the disease with the highest probability above the threshold is outputted.
- This disease obtained from this model is sent to the remedies Artificial Neural Network machine learning model to provided the remedy and cure.
- This remedy and cure for the disease is outputted based on the highest probability predicted by the model. If the probability is low, then the disease is unlikely and the user will be advised to consult a doctor.



VI. CONCLUSION

In this paper, the use of medical diagnosis system used for the medical prediction is explained. The primary focus is to obtain certain target attributes and use different algorithms to predict the disease contracted. The best means for predicting the disease and provide remedies and cure is to use Artificial Neural Network. The proposed system will be made further enhancements for accurate predictions. Using information gain and hidden layers of the neural network, we can improve the accuracy and result of the working system.

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