Kyphosis Disease Prediction Using Deep Neural Networks

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Abstract - **Kyphosis may be a spinal disorder within which an excessive outward curve of the spine ends up in an abnormal miscalculation of the higher back. Deep learning is often thought-about as a set of machine learning. It is a field that's supported learning and up on its own by examining computer algorithms. Deep learning plays a crucial role within the field of bioscience in resolution health problems and identification numerous diseases. Therefore, during this paper, Deep Neural Networks (DNN) algorithmic program was applied to create models to predict the absence or presence of kyphosis disease supported a historical tending and private records of spinal disorder patients once they need undergone surgery. The developed DNN learning model relies on deeper multilayer perceptron design with regularization and dropout using deep learning. Stratified K-Fold cross validation was performed for analysis of DNN model. Overall, in terms of accuracies, the projected DNN model achieved 87.72% and 87.64% supported the 5-Fold and 10-Fold stratified cross validation severally. Therefore, it is recommended that DNN model ought to be accustomed observe and predict kyphosis disease once a patient had undergone surgery or operation.**

Keywords: Artificial Intelligence, Machine Learning, Deep Learning, Deep Neural Networks, Kyphosis, K-Fold Cross Validation

I. INTRODUCTION

Artificial Intelligence (AI) is that the broader umbrella below that Machine Learning and Deep Learning come back. Machine learning may be a subfield of computer science that permits a computer system to be told from the atmosphere, through re-iterative processes and improve itself from expertise [4]. Deep Learning may be a subfield of machine learning involved with algorithms impressed by the structure and performance of the brain known as artificial neural networks. Deep learning is an approach wherever multiple hidden layers are accustomed reveals the key within the info [2]. Deep learning has enabled several sensible applications of machine learning and by extension the field of computer science & AI.
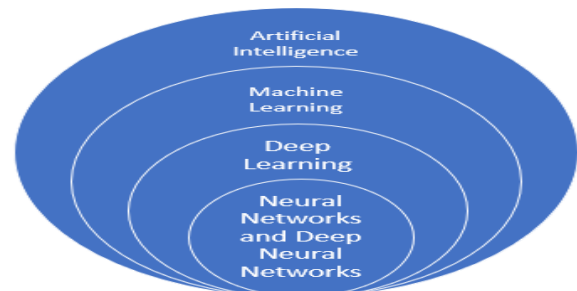

Figure 1: Artificial Intelligence and its subfields

While machine learning uses less complicated ideas, deep learning works with artificial neural networks, which are designed to imitate however humans suppose and learn. Deep Learning was developed with the concept of enhancing performance of the prevailing machine learning algorithmic program [7]. With increase in size of knowledge set, Deep Learning methodology started gaining momentum and accuracy is get vital edge over all alternative older learning algorithms.
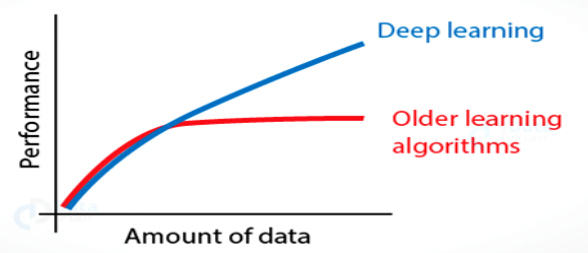

Figure 2: Comparative graph regarding nature of Deep learning vs. older learning algorithms

Kyphosis may be a medical condition that causes a forward curvature of the backside. Spinal curvature will occur at any age, however is common throughout adolescence. Age-related spinal curvature is commonly because of weakness within the spinal bones that causes them to compress or crack. Alternative styles of spinal curvature will seem in infants or teens because of malformation of the spine or wedging of the spinal bones over time. Severe spinal curvature will cause pain and be disfiguring. Treatment for spinal curvature depends on your age and therefore the cause and effects of the curvature. Additional significantly,

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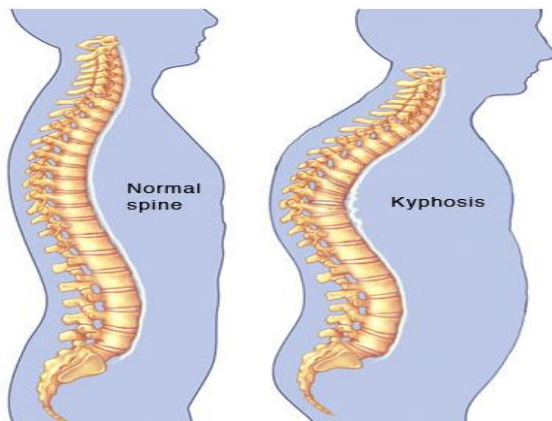detective work kyphosis disorder at the first stage in youngsters can stop abnormal spinal vertebrae issues [4].

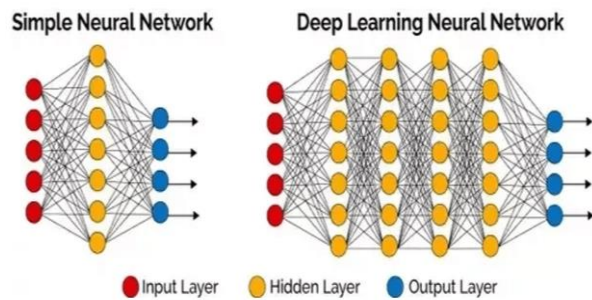Figure 3: Normal spine (without Kyphosis) vs. abnormal spine (Kyphosis)

S.No.	Attribute	Description
1	Kyphosis	Whether the Kyphosis condition was present or absent after the operation
2	Age	Age of the patient in months
3	Number	Number of vertebrae involved in the operation
4	Start	Number of the first or topmost vertebrae that was operated on

There are several patients who get operated for spinal curvature and even once the operation the disorder is also present. So, the matter at hand is to predict watching the assorted factors of the patient whether or not the patient still has spinal curvature disorder once the operation or not. Since it's a classification task, a well approach to this problem is by Deep Neural Networks

Deep neural network uses stacked neural network i.e. network with many layers and every layer having many neurons. Deep learning uses artificial neural network having additional hidden layer. Neural Network is organized within the cascading pattern to method non- linear information set, i.e. cascading layers of non-linear process units. In deep neural network every layer will switch between on or off wherever output of 1 layer act as input for layer in forward direction. Deep neural network varies from alternative neural network in range of hidden layer whereas artificial neural network consists of 1 input and 1 output layer and most 1 hidden layer however deep neural network should have higher than 1 hidden layer [5, 7].

Figure 4: Simple neural network vs. Deep learning neural network

All major machine learning algorithms like SVM, Decision Tree and Random Forest are accustomed building network for predicting presence of kyphosis disorder in patients once the operation or not. Every methodology has its own deserves and demerits. It's ascertained once literature survey there's slope of art of effort, relating to aspects like lack of accuracy, higher generalized scope.

In this analysis, a sophisticated deep neural network approach is developed and used to predict presence of kyphosis disease in patients and increase prediction accuracy with classification and prediction models supported deep learning [2, 3]. For this analysis, the developed classification and prediction models contain 2 parts: a deep neural network learning-based training model and a prediction model. The training model is initial created with deep learning algorithmic program supported additional deeper multilayer perceptron with regularization and dropout in architecture [6]. Based on the training model, the prediction model is then used to predict whether or not patients have kyphosis disease once the operation. Stratified K-Fold cross validation was performed for analysis of DNN model because of tiny sample size of data set. The importance of this current analysis is to contribution to the medicine community however deep learning algorithmic program has been applied to classify and predict kyphosis disorder supported medicine information.

II. MATERIALS AND METHODS

This section presents the dataset, the data preprocessing and the deep learning neural network algorithmic program. The preprocessing of the data and the implementations of the models were achieved with the Python environment. Python 3.8 was used because the version in writing the codes, that was achieved through the Google Colab notebook.

A. Data Set

kyphosis dataset [1] was obtained from kaggle. (https://www.kaggle.com/abbasit/kyphosisdataset)The dataset has eighty one rows and four columns that represent records on patients who had corrective spinal surgery. The attributes of dataset are explained within the Table 1 given below:

Table 1: Dataset description

Figure 5: Screenshot of Kyphosis disease dataset

B. Data Preprocessing

In order to model the data, the processing of the data has done in a format wherever the models are often trained. The preprocessing of the data was achieved the with the Scikit-Learn library. The Label Encoder imported from the sklearn library was used to remodel the kyphosis column into 0′s and 1′s as shown in Figure 6, wherever (1) represents presence of the disorder and (0) represents absence of the disorder.

Figure 6: Screenshot of the Kyphosis data (First 10 records) after preprocessing

In order to get better performances by the models, data was standardized with the StandardScaler function as a preprocessing tool that was imported from the sklearn library.

C. Deep Neural Network Architecture

The designed deep learning model, which incorporates 2 subsystems: A deep neural network training classification model and a deep neural network prediction model for prediction of presence of kyphosis disease. The deep learning training classification model relies on a deeper multilayer perceptron using additional deeper range of hidden layers, regularization and dropout, a sigmoid function for binary classification with deep learning technologies. A hyper-parameter standardization not solely enabled adjustment of a group of hyper parameters however conjointly controlled the batch size and the range of epochs throughout the training of the deep neural network classification model. The no. of

epochs in deep learning represent the no. of times within which all training data pass through the training algorithmic program to regulate the deep neural network weights. Once completion of the training for the DNN classification model, the ultimate weights were fed into the deep neural network prediction model [6]. Then, the DNN prediction model was accustomed to predict kyphosis disease patterns for outcome predictions of future patients throughout the testing method. The implementation of the DNN model was achieved with Keras model.

Figure 7: Architectural Structure of the DNN model with 961 trainable parameters

D. Deep Neural Networks Model Evaluation

According to K-Fold Cross-Validating Neural Networks [8], it is often helpful to learn from K-Fold cross-validation once addressing a tiny sample size. Therefore, the projected DNN model was evaluated with stratified K-Fold cross validation. during this current work, each 5-Fold and 10-Fold cross validation were performed to evaluate the projected DNN model because of supported empirical proof that 5-Fold or 10-Fold cross validation ought to be most popular [9].

III. ANALYSIS

Exploratory analysis showed that there has been 79% patients' reportable showing absence of kyphosis disorder whereas 21% patient's reportable showing presence of the kyphosis disorder shown in Figure 8. From Figure 9, some correlation between kyphosis disorder and the number (the range of vertebrae involved) representing 0.36 might be seen. The patterns of the kyphosis sickness being absence or presence are often seen from Figure 10 derived from the features of the patients. It are often seen that separating the 2 categories would be a simple task supported the patterns known. Outlier detection was additional performed by employing a boxplot as shown in Figure 11, Figure 12 and Figure 13. Some outliers were also detected within the data as shown in Figure 13. This problem is resolved by normalizing the dataset.
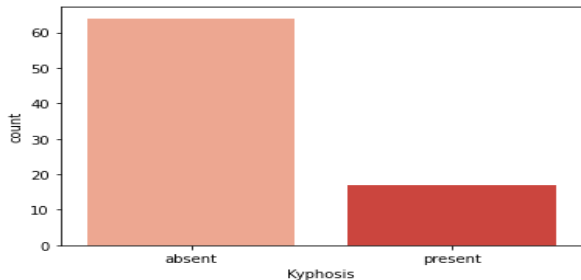
Figure 8: Distribution of the Kyphosis disease representing absent or present
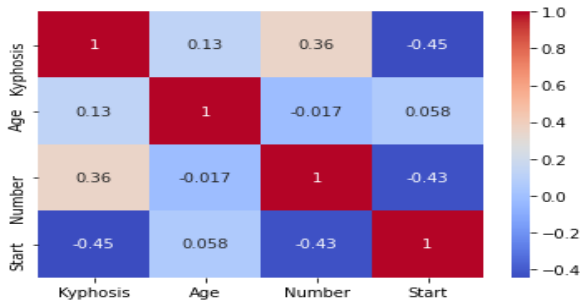

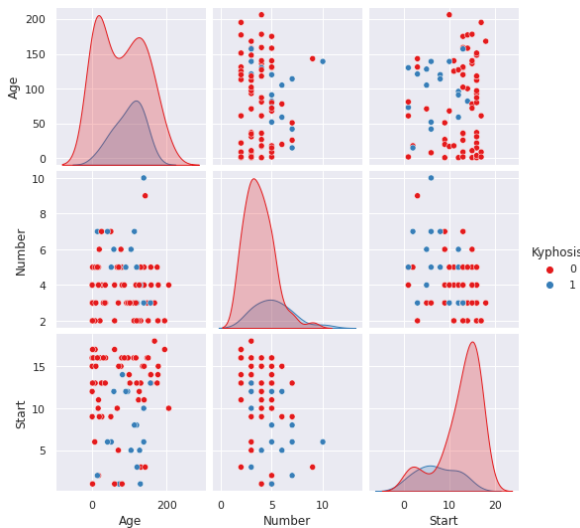**Figure 9:** Correlations between the features in the data

Figure 10: Patterns of the kyphosis identified among the three input features (Age, Start and Number)
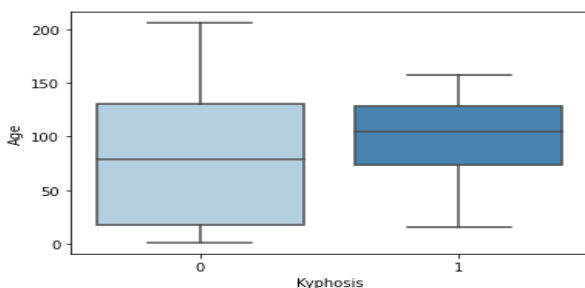

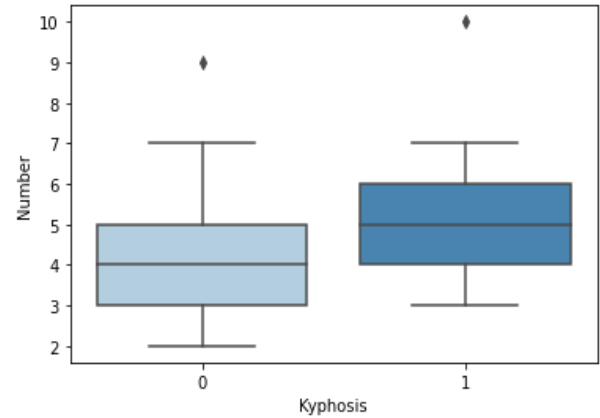**Figure 11:** The boxplot of kyphosis against Age feature to detect outliers

Figure 12: The boxplot of kyphosis against Number feature to detect outliers
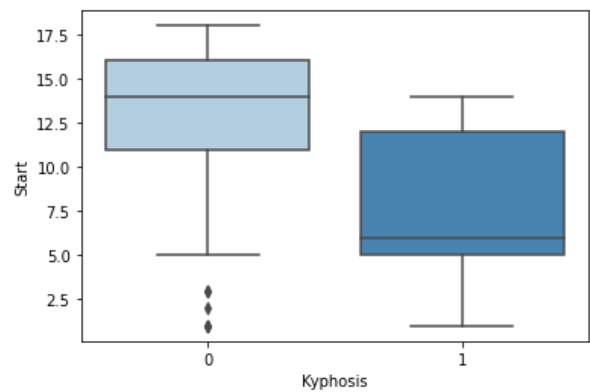

Figure 13: The boxplot of kyphosis against Start feature to detect outliers

IV. RESULTS AND DISCUSSIONS

After training the DNN model, by performing 5-Fold cross validation, Table 2 shows the accuracies by the assorted K-Folds. The best accuracy was detected at Fold 3 (Iter3) that achieved 100% as pictured in Figure 14. The DNN model achieved a mean accuracy of 87.72% and a standard deviation of 0.0774 supported 5-Fold stratified cross validation.

Stratified K-Fold	Accuracy
Iter1	82.35%
Iter2	81.25%
Iter3	100.00%
Iter4	81.25%
Iter5	93.75%
Mean: 87.72%	Std: 0.0774

Table 2: Accuracies achieved by performing 5-Fold stratified cross validation on the DNN model
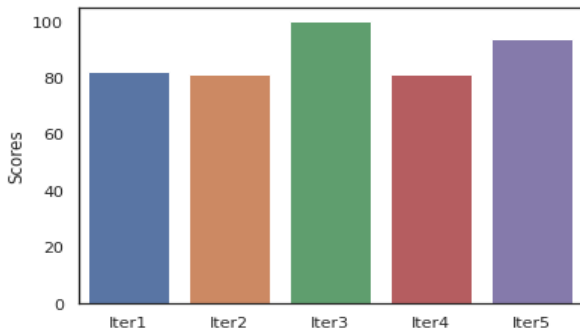
Figure 14: Accuracies achieved by the Folds after performing 5-Fold stratified cross validation on the DNN model

After additional training the DNN model, by performing 10-Fold cross validation, Table 3 shows the accuracies by the assorted K-Folds. The best accuracy was detected at Fold 10 (Iter10) that achieved 100% as pictured in Figure 15. The DNN model then achieved a mean accuracy of 87.64% and a standard deviation of 0.0561 supported the 10-Fold stratified cross validation.

Stratified K-Fold	Accuracy
Iter1	88.89%
Iter2	87.50%
Iter3	87.50%
Iter4	87.50%
Iter5	87.50%
Iter6	87.50%
Iter7	87.50%
Iter8	75.00%
Iter9	87.50%
Iter10	100.00%
Mean: 87.64%	Std: 0.0561

Table 3: Accuracies achieved by performing 10-Fold stratified cross validation on the DNN model
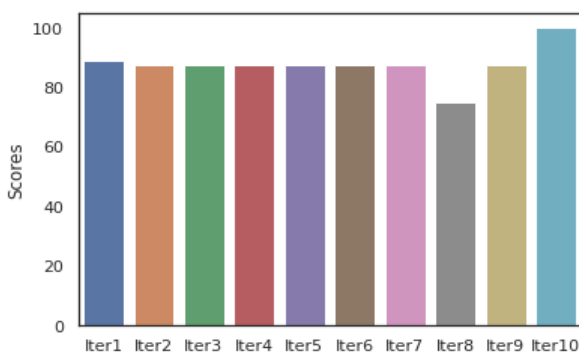

Figure 15: Accuracies achieved by the Folds after performing 10-Fold stratified cross validation on the DNN model

The proposed DNN model performed higher supported the stratified 5-Fold cross validation as compared with the stratified 10-Fold cross validation once the values of the batch size, epochs were ten and fifty severally, learning rate of 0.0005, twenty fifth percent dropout, rectified linear unit activation functions initially 3 layers, sigmoid activation perform at final layer and the optimizer was adam.

Overall, in terms of accuracies, the proposed DNN model achieved 87.72% and 87.64% supported the 5-Fold and 10-Fold cross validation severally. Based on the findings of the deep learning neural network algorithmic program, target of this work to predict kyphosis disease was achieved. Due to the tiny sample size employed in this work, advantage of stratified K-Fold cross validation was taken to evaluate the models.

V. CONCLUSION

In this current analysis work, Deep Learning Neural Networks (DNN) Model was developed to predict presence of kyphosis disease. The accuracies of the proposed DNN model was as 87.72% and 87.64% supported the 5-Fold and 10-Fold stratified cross validation severally. The findings of results show that, by performing 5-Fold cross validation can truly bring out the finest model with the marginally higher accuracy than 10-Fold cross validation. The proposed DNN model is capable to observe and predict kyphosis disease once a patient had undergone surgery or operation. These results exceed those of presently revealed analysis in various research papers. Therefore, it is recommended that deep neural networks, as deep learning algorithms, ought to be accustomed observe and predict kyphosis disease once a patient had undergone surgery or operation.

The current work is a chance for alternative researchers to boost upon the accuracies further on explore the prophetic power of the deep learning algorithms. In future works, additional deep learning algorithms are often tested so as to boost on the accuracy in predicting kyphosis disease. Deep learning model may also be extended to form alternative clinical predictions with huge data, so on additional observe and compare the performances of the deep learning models as confined during this current work.

REFERENCES

[1] M.C John, J.H. Trevor, Statistical Models in S; Wadsworth and Brooks/Cole: Pacific Grove, CA, USA, 1992.

[2] J. Schmidhuber, "Deep Learning in neural networks: An overview", Neural Networks, Vol. 61, pp. 85-117, Jan 2015.

[3] J. H. Miao and K. H. Miao, "Cardiotocographic diagnosis of fetal health based on multiclass morphologic pattern predictions using deep learning classification," International Journal of Advanced Computer Science and Applications, Vol. 9, No. 5, pp. 1-11, 2018.

[4] Stephen and Wenfeng Zheng, Special Issue on Using Machine Learning Algorithms in the Prediction of Kyphosis Disease: A Comparative Study, Appl. Sci. 2019, https://doi.org/10.3390/app9163322

[5] S. Palaniappan and R. Awang, Intelligent heart disease prediction system using data mining techniques, IEEE/ACS Int. Conf. Comput. Syst. Appl., pp. 108–115, 2008.

[6] Kathleen H. Miao, Julia H. Miao, Coronary Heart Disease Diagnosis using Deep Neural Networks, International Journal of Advanced Computer Science and Applications, Vol. 9, No. 10, 2018.

[7]   Mohd Ashraf, M. A. Rizvi and Himanshu Sharma, Improved Heart Disease Prediction Using Deep Neural Network, Asian Journal of Computer Science and Technology, Vol.8 No.2, pp. 49-54, 2019

[8]   K-Fold Cross-Validating Neural Networks. Online: https://chrisalbon.com/deep_learning/keras/k-fold_cross-validating_neural_networks/

[9]   Cross-Validation: Evaluating Estimator Performance. Online: https://scikit-learn.org/stable/modules/cross_validation.html