CLASSIFICATION OF LOW BACK PAIN USING DEEP LEARNING NEURAL NETWORK MODEL

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Abstract : ***Lower back pain (LBP) is a common medical problem which is suffered by many individuals during their normal lifestyles and keeps them from routine activities. Diagnosing LBP is challenging since it requires highly specialized knowledge involving a complex anatomical and physiological structure as well as diverse clinical considerations. LBP is often accompanied by hyperactivity of superficial paraspinal muscles and it has been suggested that psychological factors may affect the condition via increased spinal loading resulting from altered paraspinal muscle activity. Several measurements are taken into consideration which includes physical factors such as muscle activity, pain intensity, disability and psychosocial factors such as anxiety, depression, fear of movement etc using several numerical scales and questionnaires. Applying machine learning techniques on such data can obtain relationships between these measurements which can help in diagnosis and classification of LBP.***

This work aims at studying and analyzing the machine learning techniques for classification of LBP into major categories like normal and abnormal spine conditions. Mainly machine learning techniques such as K-Nearest Neighbors, Decision Tree, Artificial Neural Network, Support Vector Machine, Naive Bayes, Deep Neural Network were used. The results indicate the deep neural network performs better than other techniques.

IndexTerms - KNN, SVM, LBP, SVD, Deep Learning, DNN.

I. INTRODUCTION

Data mining is the predictive analytics which discovers patterns and uses these patterns to predict the future events. It uncovers the patterns from huge data sets and use that information to build predictive models.

Today, health organizations today are generating huge amount of data. Using data mining techniques, it is possible to extract the knowledge from that data and discover useful and interesting patterns. And this can be used in the proper order to improve work efficiency and enhance the quality of decision making. But, healthcare industry lags behind other industries in implementing effective analytic and data mining strategies, due to the slower rate of technology adoption and complexity of healthcare. Today, academicians are using data-mining approaches like clusters, time series, decision trees and neural networks to publish research. Some experts believe that applying data mining techniques to health-care data would significantly reduce the costs by 30% and would improve the care.

Lower back pain (LBP) is the one of such medical problems that deprives many individuals of their normal lifestyles and keeps them from routine activities. It is difficult to diagnose LBP as it requires specialized knowledge which involve a complex physiological and anatomical structure as well as various clinical considerations. Several measurements are taken into consideration, including physical factors (muscle activity, pain intensity, disability) and psychosocial factors (anxiety, depression, fear of movement etc) using several numerical scales and questionnaires. Applying machine learning techniques on such data can obtain relationships between these measurements which can help in correct diagnosis and classification of LBP.

II. PROPOSED SYSTEM

The proposed system is consist of following components.

A. Input Dataset
B. Preprocessing
C. Dimensionality Reduction
D. Classification
E. Result of Classifiers

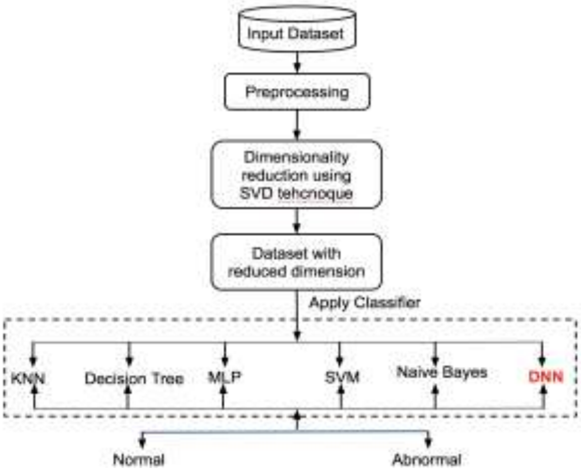


Fig 1. Architecture of proposed system

A. Input Data

The low back pain symptoms dataset is given as an input. The dataset is taken from kaggle. There are total 310 records. The dataset has the spinal measures from which the patient's spinal condition is classified as normal or abnormal. The dataset has 12 attributes which are the spinal measurements. The attributes are - pelvic_incidence, pelvic_tilt, lumbar_lordosis_angle, sacral_slope, pelvic_radius, degree_spondylolisthesis, pelvic_slope, Direct_tilt, thoracic_slope, cervical_tilt, sacrum angle, scoliosis_slope. The 13th attribute is class which has values as normal or abnormal.

The standard values for the spinal measures are as follows:

Spinal Measures	Standard Value
pelvic incidence	40° - 65°
pelvic tilt	10° - 25°
lumbar lordosis angle	30° - 50°
sacral slope	30° - 50°
degree spondylolisthesis	Grade1: 0 - 25% Grade2: 25 - 50% Grade3: 50 - 75% Grade4: 75 - 100% Grade5: >100%

Fig. 2: Standard values for Spinal Measures

B. Preprocessing

The data is highly susceptible to noise, missing values, inconsistency. The quality of data affects the results. In order to help improve the quality of the data and, consequently, of the results raw data is prepossessed so as to improve the efficiency.

The prepossessing included cleaning of data - fill in missing values, smooth noisy data, remove inconsistencies.

C. Dimensionality Reduction using Singular Value Decomposition Technique

Dimensionality reduction is the process in which the number of random variables under consideration are reduced, by obtaining a set of principal variables. It can be divided into feature extraction and feature selection. Reducing dimension of the the data reduces the time and the required storage space. Dimensionally reduced data becomes easier to visualize.

In health-care industry huge amount of data gets generated on which applying data mining process is difficult. Therefore it is used in health-care is maximally informative dimensions, which finds a lower-dimensional representation of a dataset such that as much information as possible about the original data is preserved.

D. Classification

In the proposed system, the dimensionally reduced dataset is taken and KNN, Decision tree, ANN, SVM, Naive Bayes and Deep Neural Network are used for the classification of the patients' records as normal or abnormal low back pain.

Deep-learning networks are distinguished from the more common- place single-hidden-layer neural networks by their depth; that is, the number of node layers through which data passes in a multistep process of pattern recognition. Deep is a strictly defined, technical term that means more than one hidden layer. Each layer of nodes trains on a distinct set of features based on the previous layers output. The further advancement into the neural net gives more complex features which are recognized by nodes. Since they aggregate and recombine features from the previous layer called as feature hierarchy, and it is a hierarchy of increasing complexity and abstraction. It makes deep- learning networks capable of handling very large, high-dimensional data sets with billions of parameters that pass through nonlinear functions.

Consider function f ; the data is given by $\langle X_i, f(X_i)\rangle$, where X_i is typically high-dimensional and $f(X_i)$ is in {0,1} or R. The goal is to find a function f^* that is close to f using the given data, hopefully so that you can make accurate predictions.

In deep learning, which is by-and-large a subset of parametric statistics, we have a family of functions

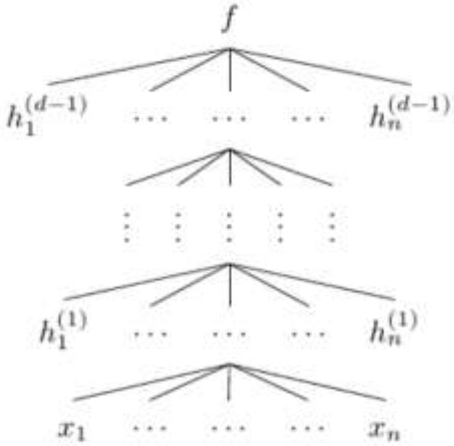
$$f(X; \theta)$$

where X is the input and the parameter (which is typically high-dimensional). The goal is to find a θ^* such that $f(X; \theta^*)$ is close to f.

In this context, θ is the network . The network is a composition of d functions

$$f^{(d)}(\cdot,\theta)\circ\cdots\circ f^{(1)}(\cdot,\theta),$$

most of which will be high-dimensional. The network can be represented with the diagram



where $h_1^{(i)}, \ldots, h_n^{(i)}$ are the components of the vector-valued function $f^{(i)}$ also called the i-th layer of the network and each $h_j^{(i)}$ is a function of $h_1^{(i-1)}, \ldots, h_n^{(i-1)}$.

In the diagram above, the number of components of each $f^{(i)}$ which is the width of layer i is the same, but in general, the width may vary from layer to layer. The d is depth of the network. Importantly, the d-th layer is different from the preceding layers; in particular, its width is 1, i.e. , $f = f^{(i)}$ is scalar-valued.

With the inputs represented by $x_1, \ldots, x_n \in$ R , the output in the model is given by

$$f(x) = g\left(\sum a_i x_i + c\right)$$

for some non-linear function g. It can be defined

$$h^{(i)} = g^{\otimes}\left(W^{(i)T} x + b^{(i)}\right),$$

where $g^{\otimes}$ denotes the coordinate-wise application of some non-linear function g.

Generally, g is the least non-linear function possible hence the common use of the RELU function g(z) = max(0,z). Other choices of g (motivated by neuroscience and statistics) include the logistic function

$$g(z) = \frac{1}{1 + e^{-2\beta z}}$$

and the hyperbolic tangent

$$g(z) = \tanh(z) = \frac{e^z - e^{-z}}{e^z + e^{-z}}.$$

E. Result of classifiers

After applying the data mining techniques, the proposed system will give the result as normal or abnormal low back pain. In this process the all the mentioned classifiers are used to calculate the class but the result depends upon the accuracy of the algorithm. The system gives the result of a most accurate classification for given dataset.

III. Results

The selected classifiers are implemented and results are compared on standard dataset. The classification algorithms - KNN, Decision Tree, SVM, ANN and Naive bayes and Deep Learning Neural Network model are applied on the low back pain Symptoms dataset. The results shows that using Deep Learning has improved the performance of the system in terms of accuracy.

The comparison between various classification algorithms are given in table1.

Table1: Accuracy comparison of different classification algorithms

Classification Algorithm	Accuracy
KNN	71%
Decision Tree	76%
SVM	83%
Naive Bayes	83%
DNN	88%

IV. Conclusion

The results of this study showed that data mining tools such as K-nearest neighbor, artificial neural networks, decision trees, support vector machine, naive bayes, Deep Learning Neural Network using keras allow for successful classification of Low Back Pain as normal or abnormal. The results show that the Deep Learning Neural Network works best for the spinal dataset. It gives 88% accuracy. Similarly, Naive Bayes and Support Vector Machine also gives satisfying results with accuracy 83%. The models developed in this study significantly reduce the time consuming job of analysis and classification performed by traditional methods. The proposed system can be used in clinical fields, with large sized datasets.

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