Analysis of Supervised Machine Learning Classifier Techniques used in Gesture Classification

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Abstract. In the digital era, in the field of computer science to perform any task based on complex data, we need to arrange and pre-process that data because real-world data may be noisy, complex, and unclassified. Therefore, to make our task easy and to get accurate results, we must classify our data. Classification plays a major role in Human-Computer Interaction (HCI). In HCI Hand Gesture is a broadly used method for interaction with the system. In the classification of gesture data in machine learning, different classifiers like Naïve Bayes, KNN, Decision Tree, Support Vector Machine (SVM), Multilayer Perceptron (MLP), etc. are used. In this study, we compare the different classifiers and concentrated on the central principles of each technique and its advantages and drawbacks.

Keywords: Human-Computer Interaction (HCI), Machine Learning, Classification, Decision Tree, Support Vector Machine (SVM), Multilayer Perceptron (MLP), Naïve Bayes.

Introduction

Nowadays, to perform any operation we need the appropriate data in which we want to work.Without sufficient and classified data, we can't achieve the correct and desired result. The real world data may be incomplete, noisy, heterogeneous and may be complex and it may be inaccurate, and unreliable. In such conditions, some classification techniques and methodologies would have to be used to handle such kinds of complex data. The process of using these techniques to classify the data is Data Classification. Classification plays an integral role in the field of artificial intelligence where we interact with smart devices using gestures. Conventional strategies for connection with the computers are constrained i. e. console, mouse, etc. Presently a day's motion strategy is utilized in numerous areas like mechanical autonomy, educational sector, gaming division, shopper electronic sector, smartphones, etc. Hand Motion could be a way to communicate with such sensing gadgets and the client doesn't need to utilize any extraordinary physical equipment. A gesture can be characterized as a physical movement of the hands, arms, confront and body with the expectation to communicate data or meaning[10]. Data classification arranges the data into different desired labels or classes. Data classification is an important task in gesture classification to label the class of data. An attribute or characteristic is the part of the

information that applies to a task or operation. many interesting research papers compare different machine learning algorithms and figure out robustness, deficiency, and parameter-based recommendations concerning specific tasks[5,14]. In this paper, we compare five different classifier techniques which are used in gesture data classification in machine learning based on their parameters. Since a particular classifier may or may not work well for a particular classification task, it is important to conduct a comparative study of different classifiers to achieve maximum and optimal performance. Various classifier methods include Multilayer Perceptron (MLP), Back Propagation (BP), Naive Bayes classifiers, Support vector machines (SVM), and Decision tree classifiers.

Data Classification

Classification is one of the data mining techniques, which is mainly used to analyze a given dataset and get each instance of it and assign that instance to a specific class, thereby minimizing classification errors. Classification deals with the large and complex dataset to simplify the data and arrange them into the different class labels. A model of a single-layered complex esteemed artificial neural network is utilized for the classificatory issue. Here the modern enactment capacities are utilized. In Classification, preparing illustrations are utilized to memorize a demonstration that can classify the information tests into known classes [11].

Machine Learning

Machine learning is an approach to achieve Artificial Intelligence. In the other sense, machine learning is a part of AI which uses different algorithms to work with the historical data and make some predictions and provide accurate outcomes. Learning provides the capability to the devices to learn from their working environment and improve their performance. Machine learning uses a wide variety of mathematical algorithms for classification. Machine learning approaches include support vector machines (SVMs), Naïve Bayes, artificial neural networks, KNN, etc. [16,17].

Supervised Learning

The key idea between the supervised learning is working with the training pair, training pair is a set of input vectors and target output vectors. During the learning process, the result is an actual output value which is compared with the target output to check the accuracy of the result. The main role of supervised learning is to find a mapping between the input and the output[2]. Classification tasks have been broadly studied since the last few years and seem to be making rapid progress in this field, including Bayesian classifiers, decision trees, K-Nearest Neighbors (KNN), Support Vector Machines (SVM), neural network and other machine learning methods are a type of supervised learning techniques used for classification.

Artificial Neural Network Technique

Artificial neural networks are the highly interconnected information processing system constructed to model the human brain. Artificial Neural Network (ANN), is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information[6]. They are designed to perform highly complex problems and work on large datasets at a faster rate than traditional systems. Fig.1 shows a simple neuron architecture.

The working procedure and structure of the neural network are inspired by the biological neuron aka the human brain. Just as the human brain can decide on its own to perform any task in the same way neural networks are also implemented on the complex problems to make decisions to find out the result with high accuracy using the learning process. It is structured with highly interconnected processing elements called neurons. An artificial neural network is divided into three basic layers in which the whole process is done- an input layer, output layer, and one or more hidden layers.
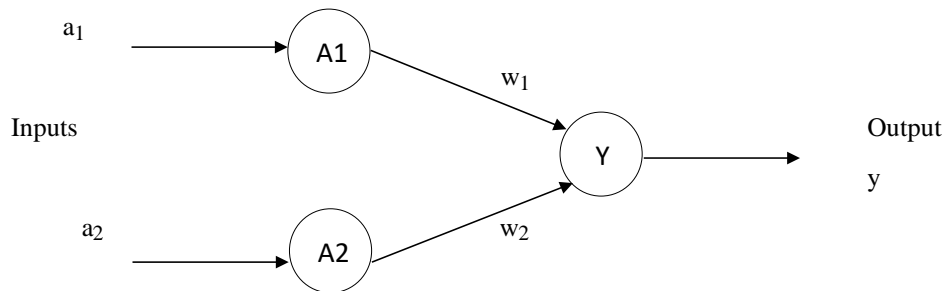
Fig. 1. The architecture of a simple Neuron

An ANN-based model was designed for the recognition of static gestures in ISL alphabets and numerals automatically. The proposed system translates fingerspelling in ISL to textual form. The gestures included English alphabets (26 letters) and numerals (0-9). They used the YCbCr model and also applied filtering and morphological operations for hand segmentation. The proposed method had a low computational complexity. A recognition rate of 91.11% was achieved[8].

Multilayer Perceptron (MLP)

A multilayer perceptron consists of multiple layers of two-state sigmoid processing elements connected using weighted connections. An MLP is a universal approximator: it can be shown that any continuous function can be approximated arbitrarily by putting together a sufficiently large hidden layer with suitable coefficients[22].

It is used where a quick evaluation of the learned objective function is required. Problems in ANNs are represented by attribute-value pairs.

Back Propagation (BP)

Back-propagation is a method of training multilayer artificial neural networks which use the procedure of supervised learning. Backpropagation is one of the most imperative improvements in a neural network. This is often connected to the feed-forward network comprising of the processing components with persistent differentiable activation functions [21]. The traditional Backpropagation Neural Network (BPNN) Algorithm is widely used in gesture classification. A backpropagation-based model has been proposed in which hand gesture recognition has been performed using BPNN based on visual tracking in a real-time environment. The experiments on each hand gesture appeared that our proposed calculation can reach the great execution of recognition rate with high accuracy result[1]. It is an algorithm that applies the linear least-squares is proposed. It combines linear-least squares with gradient descent. It improves the learning rate of the basic back-propagation algorithm in several orders of magnitude while maintaining good optimization accuracy[13]. This classifier is used for the classification of Landsat data[19]. Another form of ANN with back-propagation is used for multispectral image classification[20].

It is a method which not require prior knowledge about the network and it also does not require any parameters. It is a widely used algorithm because it is easy to perform. The learning quality of BP makes it a very powerful technique. One drawback is that here performance depends on the size of the dataset.

Support Vector Machines (SVM)

Support vector machines (SVMs) are supervised learning methods that generate input-output mapping functions from a set of labelled training data [12]. The Support Vector Machine (SVM) Classifier is broadly utilized for classification and relapse testing. SVM preparing calculation builds a demonstration that predicts whether a modern case falls into one category or another[16].

Support vector machines use one or more hyperplanes in a high dimensional space, which can be used for classification, regression, and other tasks see Fig.2. In SVM a good separation is achieved by the hyper-plane that has the largest distance to the neighbouring data points of both classes.

Concerning gesture phase segmentation, a particular errand inside gesture phase segmentation has been performed in which SVM is utilized to classify each layout as either rest position or signal unit. Movement arrange division was performed by utilizing heuristics to recognize the hold stages and accentuation diagrams, and Back Vector Machines (SVM) to recognize the course of action, stroke, and retraction[7].

Support vector machines classify the pattern with a very clear margin of separation using the hyperplane and are highly used for high dimensional spaces. SVM gives the best prediction accuracy with both continuous and categorical data. The major drawback is that it is quite expensive and it needs a better kernel.
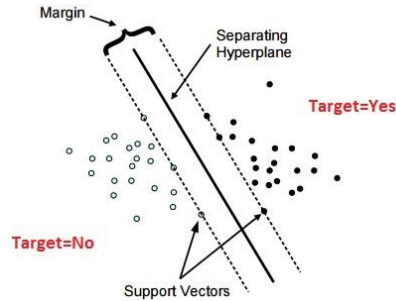
Fig.2. Support Vector Machine (SVM)

Naïve Bayes

Naïve Bayes classifier is a supervised learning technique based on the Bayes theorem see equation (1), it is highly recommended for large datasets and it performs quick predictions. In this technique, each node of the network represents the random values and the connections between the node represent the probabilistic dependencies among these random values.

It is based on follows when there are two events A and B.

$$P(A|B) = \frac{P(B|A)\ P(A)}{P(B)}$$

(1)

Where,

- P(A|B) is Posterior probability: Probability of hypothesis A on the observed event B.

- P(B|A) is Likelihood probability: Probability of the evidence given that the probability of a hypothesis is true.

- P(A) is Prior Probability: Probability of hypothesis before observing the evidence.

- P(B) is Marginal Probability: Probability of Evidence.

A classification strategy utilizing Gabor Filter-based features and a Bayesian classifier have been presented in which the hand motion segmentation in this method plays an exceptionally vital part. If the segmentation is good, the results of signal classification progress moreover. The classification accuracy is gotten over 90% with the assistance of the Bayesian and Naïve Bayes classifier[3]. A strategy was presented for signal acknowledgment utilizing overlapping subwindows and characterized them with a nearby introduction histogram feature description showing the removal from the canonical introduction. This makes the handle generally strong to the commotion, but exceptionally time-consuming indeed [15].

Decision Tree

A Decision Tree is a tree-structured classifier that implements the divide & conquers approach, it is generated from the training set which is based on the objects which are belonging to a class. In a decision tree, the decision is made by the internal nodes of the tree whereas the result is generated by the leaf node. The root node is splitting into branches based on certain conditions see Fig.3. A survey has been done using a decision tree in which, several statistical and empirical 233 rule quality measures [11]. In the graphical representation of the decision tree, the if-then rule is applied to select the appropriate branch for the result.

Here the root Course is split into two branches UG & PG, If the student is under the UG course then the result is measured according to the condition, and similarly, for the PG students, the condition is applied on the if-then rule.

A decision tree-based earlier model m provides a new approach for hand gesture recognition at the level of individual fingers. It could be used in various kinds of applications, such as sign language recognition, game controlling, human-robot interaction, etc. The model was implemented on two groups of gestures and give the result with 94.33% and 95.01% accuracy [9].
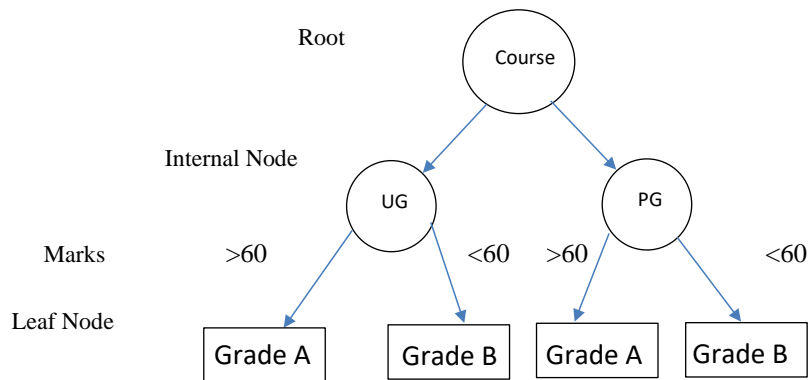
Fig.3. Decision Tree

A decision tree can be easily split into branches based on the conditions. The task of the decision tree does not affect by the incomplete data. Data normalization is also not required. The drawback is that its numerical computation consumes more memory. It is also quite expensive to create each node in the tree.

Table 1. Comparison of Different Algorithms

Algorithm	Predictors	Classification Speed	Regression	Normalization	Primary Problem	Classification Accuracy
MLP	Numeric	High	Yes	Yes	Binary	High
BP	Numeric	High	Yes	Yes	Binary	High

SVM	Numeric or Categorical	High	No	Yes	Binary	Highest
Naïve Bayes	Categorical	High	No	Required	Multiclass or Binary	Low
Decision Tree	Numeric or Categorical	High	Yes	No	Multiclass or Binary	Medium

Conclusion

This paper describes and surveys five different classification algorithms which are used in machine learning. These algorithms are popular and widely used for the classification of large and complex datasets. This paper gives a simple introduction to the five classification algorithms which are Multilayer Perceptron (MLP), Back Propagation (BP), Naive Bayes classifiers, Support vector machines (SVM), and Decision tree classifiers.

References

[1] Sugandi B.; Octaviani S.E.; Pebrianto N. F. (2020). Visual tracking-based hand gesture recognition using a backpropagation neural network. International Journal of Innovative Computing, Information and Control. Vol. (16)1.

[2] Mohamed A. E., (2017). Comparative Study of Four Supervised Machine Learning Techniques for Classification. International Journal of Applied Science and Technology, Vol. (7) 2.

[3] Ashfaq T.; Khurshid K., (2016). Classification of Hand Gestures Using Gabor Filter with Bayesian and Naïve Bayes Classifier. International Journal of Advanced Computer Science and Applications, Vol. (7)3.

[4] Jadhav A.; Asnani R.; Crasto R.; Nilange O.; Ponkshe A. (2015). Gesture recognition using support vector machine. International journal of electrical, electronics and data communication, ISSN: 2320-2084. Vol. (3).5

[5] Xu, D.; Tian, Y. (2015). A comprehensive survey of clustering algorithms. Annals of Data Science, 2(2):165–193.

[6]Sonali; Maind B.; Wankar P. (2013). Research Paper on Basic of Artificial Neural Network". International Journal on Recent and Innovation Trends in Computing and Communication.1: 96 – 100.

[7] Madeo R.; Lima C.; Peres S. (2013). Gesture unit segmentation using support vector machines: Segmenting gestures from rest positions. In Proc. of 28th Annual ACM Symp. on Applied Computing. ACM.114–121.

[8] Adithya V.; Vinod P. R.; Gopalakrishnan U. (2013). Artificial neural network based method for Indian sign language recognition. Information & Communication Technologies (ICT). IEEE Conference on JeJu Island.1080-1085.

[9] Chang G.; Jaewan P.; Chimin O.; Lee C. (2013). A Decision Tree based Real-time Hand Gesture Recognition Method using Kinec. Journal of Korea Multimedia Society. 1393-140 Vol. (16)12.

[10] Rautaray S. S.; Agrawal A. (2012). Vision Based Hand Gesture Recognition for Human Computer Interaction: A Survey. Springer.

[11] Amin M. F.; Murase K. (2009). Single-layered complex-valued neural network for realvalued classification problems Euro computing.72(4-6):945-955.

[12] Olson, D. L.; Delen, D. (2008). Advanced Data Mining Techniques. USA. Springer Publishing:978-3-540-76916-3.

[13] Bertha G.; Oscar F. R.; Beatriz P.S.; Paula F. (2007). A linear learning method for multilayer perceptron's using least-squares. 8th international conference on Intelligent data engineering and automated learning. pp365–374.

[14] Kotsiantis, S. B. (2007). Supervised machine learning: A review of classification techniques. In Proceedings of the 2007 Conference on Emerging Artificial Intelligence Applications in Computer Engineering: Real Word AI Systems with Applications in eHealth, HCI, Information Retrieval and Pervasive Technologies, IOS Press. pp3–24.

[15] Zhou, H.; Lin, D.J.; Huang, T.S. (2004). Static hand gesture recognition based on local orientation histogram feature distribution model. In: Proc. IEEE CVPR Workshop. 161.

[16] Daelemans, W.; Hoste, V. (2002). Evaluation of machine learning methods for natural language processing tasks. In Proceedings of the LREC 2002 Third international conference on language resources and evaluation; European Language Resources Association (ELRA), Las Palmas de Gran Canaria, Spain, 29–31; pp6.

[17] Desouza, K.C. (2001). Artificial intelligence for healthcare management In Proceedings of the First International Conference on Management of Healthcare and Medical Technology Enschede, Netherlands: Institute for Healthcare Technology Management.

[18] An A.; Cercone N. (2000). Rule quality measures improve the accuracy of rule induction: an experimental 1035 approach." Lecture notes in computer science, vol. (1932):119–129

[29] Bischof H.; Schneider W.; A. J. Pinz.(1992), Multispectral classification of Landsat-images using neural networks. IEEE Trans. Geosci. Remote Sens., vol. (30)3, pp.482–490.

[20] Heermann P. D.; Khazenie N. (1992). Classification of multispectral remote sensing data using a back-propagation neural network. IEEE Trans. Geosci. Remote Sens. vol. (30)1, pp.81–88.

[21] Bryson. E.; Ho Y. (1969). Applied optimal control: optimization, estimation, and control. Blaisdell Publishing Company or Xerox College Publishing.481.

[22] Rosenblatt, Frank, (1957). The Perceptron--a perceiving and recognizing automaton. Report 85-460-1. Cornell Aeronautical Laboratory.