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Classification of Brain Signals in Mindfulness Meditation

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Abstract: In this paper we present an fundamental overview of the mindfulness meditation and the different types of classification also Support Vector Machines (SVMs) and K-Nearest Neighbour (KNN). SVMs are supervised learning machines that can be studied theoretically using ideas from computational learning theory while being able to acquire good fulfilment when applied to real-world problems. It contains the comparative study of results of the meditative data using SVM and KNN.

Keywords: Mindfulness Meditation, Types of Classification. Structure of Classification, SVM, KNN.

INTRODUCTION

In this paper, we will basically focus on Support Vector Machines and K-Nearest Neighbour as used in Meditation and non-Meditation data. In the first section we will introduce mindfulness meditation. We will then proceed to see overview of types of classification and simple linear machines on which SVMs are based how SVMs are able to go beyond the limitations of linear learning machines by introducing the kernel function. Again, we will then proceed to see the KNN basics and their functions. Finally, we summarize it all up and mention outcomes of the meditative and non-meditative data in which Support Vector Machines and K-Nearest Neighbour have been applied and given excellent results.

MINDFULNESS MEDITATION

Generally our mind is concerned with the past as well as the future things and we miss the wealthy moments of the present day. If we want to concentrate on the current moment permits us to aware and believe with a new clarity. Mindfulness meditation increases our capability to manage ourselves, others as well as globe around us with a thought of openness, peculiarity and acceptance. It allows us the capability to separate from rhythms of ideas that can influence our happiness of life, disturb our sleep or even affect our mental as well as physical health. It allows us to select more cleverly how we acknowledge to situations. In order to evolve mindfulness, we practise along meditation, an activity for which we all have a natural extent. Meditation is a point of our consciousness on somewhat, most frequently on the breath; it is that easy – still it is an efficiency that needs practice and determination. Mindfulness meditation gives us a proper way of living life in different way, developing our skills to survive with life's challenges. Mindfulness Meditation is also useful in stress reduction and assists to long-term changes in mood, happiness levels and mental and physical happiness. . It is also helpful in improving performance in various sports professionals. [1][7][9][10][11][12][13][14]

TYPES OF CLASSIFICATION

There are two fundamental parts of classification: supervised classification and unsupervised classification. In supervised classification, studies of a set of input are identified with class names. In unsupervised classification, studies are not tagged or determined to a perceived class.

Supervised Classification: Generally, Supervised classification technique is used for the biology and medicine related research work. For training the classifier the class name data is permit inside the dataset. This kind of classification belongs to supervised classification, in which a supervisor requires the classifier throughout the establishment of the classification representation. Supervised system supposes that the training set has been supplied, containing of a set of occurrences that have been properly named by hand with the accurate outcome.[2][3][15][16]
In the supervised learning system, there are couples of instances in the stated training dataset which can be demonstrated as D={(x1, y1), (x2, y2),....., (xN, yN)}. Here, x1, x2,.....,xN are the reviews and y1, y2,.....,yN are the class names of the observations. For example, if the problem is filtering spam, then xi is some depiction of an email and yi is either "spam" or "non-spam". The observations can be any vector, whose components are determined from a set of characteristics. For empirical considerations, we normally have real valued observations and it is elementary to assume $x \varepsilon X$. Also, one can select some kind of representation for the class names. For simplicity, they are generally constituted as real numbers that is $y \varepsilon Y$. Therefore, in supervised classification technique, the purpose is to notice the transformation between the feature space X and the class name space Y, i.e. $f : X \rightarrow Y$. If the class space has a finite number of elements, i.e. $y\varepsilon \{1,2,....., L\}$ then the problem is evaluated as a classification detail. For the instance of a binary classification problem, the classes are decomposed into two classes, such as the target and non-target classes. For clarity as well as conformity with the literature, these classes are represented as $Y = \{-1,+1\}$ where the negativity represents the non-target instance.

Algorithms for the classification depend on the kind of label outcome, on whether learning is supervised or unsupervised, and on whether the algorithm is statistical or non statistical in nature. Statistical algorithms can be further classified as generative or discriminative. The algorithms in supervised classification system forecasting absolute labels are Linear discriminant analysis (LDA), Support vector machine (SVM), Decision trees, Naive Bayes classifer, Logistic regression, K-nearest-neighbor (kNN) algorithms, Kernel estimation, Neural networks (NN), Linear regression, Gaussian process regression, Kalman filters etc. In a typical supervised classification procedure, the dataset is decomposed into two, training set as well as testing set. Applying the training set, a classifier is erected. Then the achievement of the classifier is assessed using the testing set. Assessment is sometimes replicated for various parameters of the classifier established. By that way the parameters of the classifier is improved efficiency. After that optimization, the classifier is set to allocate class names to the characteristics with unspecified class names. The aim of the learning system is to maximize this test reliability on a "typical" testing set.[15][16]

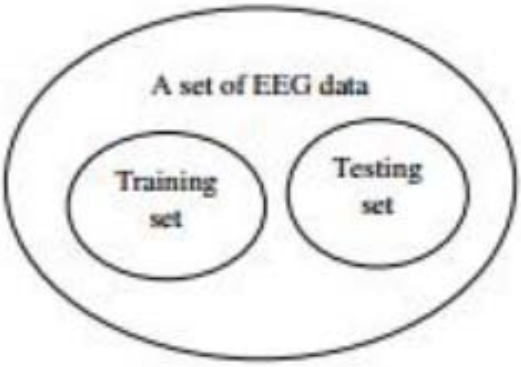

Figure.1 Mutually exclusive training and testing set.

Classifications usually mention a supervised system. In this study, we have used supervised system in the classification of EEG signals. throughout the experiment, we decompose each EEG dataset into two mutually exclusive categories training set as well as testing set **as shown in Figure 1** The reasoning for having the sets differentiated can be connected to memorization as well as generalization. The training set is used to instruct the classifier, during the testing set is utilized to analyse the fulfilment of the classifier.

Unsupervised Classification

Unsupervised classification is used to manage computation time, check number of iterations, to choose number of clusters required, to select the lower or upper limit of clusters in the system. The user does not direct alternatives about where clusters should be or what the characteristics of a cluster should be. The need of unsupervised classification is for exploring the image dataset getting awareness of the clustering in the data in characteristic space. Whenever observational data deficiency exists for the image leaves unsupervised classification as an optimum solution. In unsupervised classification generally needs only a small size of elementary input from the analyst. The reason is that clustering does not need training data. [4][15][16]

Structure of classification: Fundamentals of pattern recognition include the steps: the main characteristic of the signal is feature extraction. Classifier is used to classify the specific class of a signal formed on its extracted features. In the on which the signal is to be classified must be interpret features that could be extracted from the signal for the desire of classification. In the classification step decide that to which class the signal includes. The outcome of the classification structure, in which the class part of the loaded signal is established, can afterwards be used to conclude what event in the real world process arised to construct the input signal. The idea of signal classification can be illustrated in Figure 2

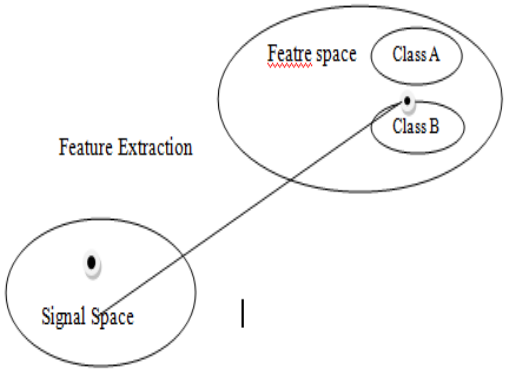

Figure 2 The process of signal classification

Figure 3.3 illustrates a system of how signals with various groups are classified, releasing characteristics from primitive input in pattern recognition domain. From this figure, it is seen that sutable features are extracted from the signal extent as well as generate a feature space. In the feature extent, the features are decomposed into two classes (class X and class Y). Finally, a classifier tries to recognise the extracted features throughout the classification. In this research work, we utilize Support Vector Machine (SVM) and K-Nearest Neighbour (KNN) classification technique for classification.

SUPPORT VECTOR MACHINE (SVM)

Vladimir Vapnik started the study of Support Vector Machines (SVMs) in the half of seventies [17]. Nevertheless it was only until the half of nineties that the subject began to acquire growing attention [18]. Statistical learning theory is used in the Support Vector Machines that can be used for pattern recognition as well as regression. Statistical learning theory can recognize preferably exactly the factors that require to be taken into account to learn victoriously sure easy kinds of algorithms, however, real-world requisitions generally want more complex representations and algorithms (such as neural networks), that produces them much rigid to analyse theoretically. SVMs can be seen as relaxing at the intersection of learning theory as well as practice. They build systems that are complex adequate and further that are easy enough to be analysed mathematically. The reason of this is an SVM can be seen as a linear algorithm in a high-dimensional extent. [8][19]

The classification problem can be straited to contemplation of the two-class problem lacking loss of generality. In this problem the aim is to divide the two classes by a function which is influenced from convenient specimens. This linear classifier is entitled the optimal separating hyperplane. Intuitively, we would predict this boundary to generalise well as anticipated to the other feasible boundaries.
The training data is T
n = number of sample

$$D = \{(x_i, y_i) | x_i \in R^p, y_i \in \{-1,1\}\}_{i=1}^{n}$$

We can sight this Training data, by process of the separating hyperplane, which grabs

$$w.x + b = 0 - - - -(1)$$

Where b is scalar and w is p-dimensional Vector.
The vector w points perpendicular to the dividing hyperplane . Including the offset parameter b permits us to expand the margin. Parallel hyperplanes can be expressed by equation

$$w.x + b = 1$$
$$w.x + b = -1$$

If the training data are linearly separable, we can choose these hyperplanes so that there are no points between them and then try to maximize their distance.
By geometry, We find the distance between the hyperplane is $\frac{2}{|w|}$. So we want to minimize $|w|$. To send data points, we need to ensure that for all I either $w.x_i - b \geq 1$ or $w.x_i - b \leq -1$
This can be written as,

$$y_i(w.x_i - b) \geq 1, \quad 1 \leq i \leq n - - - - - - -(2)$$

K-NEAREST NEIGHBOUR

All existing cases and classifies current cases based on a uniformity measure stores by using KNN simple algorithm. we compare each of the features in our training set as a different dimension in some space, and take the value an observation has for this feature to be its coordinate in that dimension, so getting a set of points in space. We can then consider the similarity of two points to be the distance between them in this space under some suitable metric. The way in which the algorithm determines which of the points from the training set are indistinguishable sufficient to be evaluated when selecting the class to foresee for a new observation is to collect the k nearest data points to the new observation, and to take the most usual class between these. In this algorithm also use the statistical estimation as well as pattern recognition in the start of seventies.
We select nearest neighbour if K=1.
If K>1, for classification select the most frequent neighbour and for regression compute the average of K neighbours.
Complex problems can be solved by using KNN. It is also suitable for small data. K-nearest neighbours utilizes the local neighbourhood to get a prediction. The K memorized cases more indistinguishable to the one that is being classified are recovered. A distance function is required to differentiate the cases similarity. [5][6][8]

- Euclidean distance $(d(x_j, x_k) = \sqrt{\sum_i (x_{j,i} - x_{k,i})^2})$
- Mahnattan distance $(d(x_j, x_k) = \sum_i |x_{j,i} - x_{k,i}|)$

The Support vector machine and KNN classification techniques are appealed on the meditative and non-meditative EEG data. The outcomes of these classification techniques are as shown in below table.

Table 1. SVM and KNN classification accuracy of meditators and non-meditators

Classification Technique	Mediator	Non-Mediator
SVM	87	62
KNN	79	66

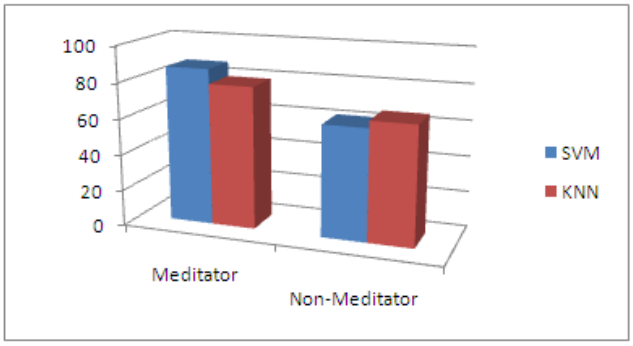

Figure 3. SVM and KNN classification performance of meditators and non-meditators

CONCLUSION

In this paper we studied the types of classification also the fundamentals of the supervised and unsupervised classification techniques also the mindfulness awareness. Mindfulness meditation makes human being's life very positive and it reduces most of the mental and physical health problems. Meditation performance on brain can be studied using SVM and KNN classification techniques. Using SVM technique the meditative data accuracy is 87 percent and for non-meditative data it is 62 percent. When using KNN technique the meditative data accuracy is 79 percent and for non-meditative data it is 66 percent.

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