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## Data Classification Methodologies: A Survey

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**ABSTRACT:** The problem of classification may be one of the greatest colossal considered in the data mining and intelligent retrieval system. The classification tasks have been studied by researchers from several domains from decades. Applications of classification accommodate a wide area of dilemma like text, social networks, multimedia and biological data. Furthermore, the problem may perhaps encounter in a number of different scenarios such as streaming of uncertain data and certain data. This is because the problem trying to construct the mapping between a couple of feature variables and a target variable of interest. In classification, we do the separation which is done on the basis of a training data set, which changes smart information about the association of the groups in the kind of a target variable. As an outcome, the classification problem is mentioned as supervised learning. In this survey we studied an assortment of data sorting methods and Algorithms.

**KEYWORD:** Gravitational search algorithm, Particle swarm optimization, FNN Neural network

### I.INTRODUCTION

Now a day, making intelligent and smart equipment through expert systems is predominantly innovative concepts for present research [11]. Therefore exploring expert system with the help of data mining and its learning algorithms has lots of scope for research work. In machine learning, the extraction of meaningful data and classifying bulk data is comparatively better for producing precise, speedy and straight forward results and hence among several methods of expert systems, selected technique has been classification. Machine learning symbolizes transformation in the ideology that is flexible in a way that they enable the system to do the same work more productively the next time. In past years many successful intelligent retrieval applications have been developed, reaching from data mining platform that learn user reading preferences to autonomy. Intelligent retrieval system is also utilized in various fields of real life application like, statistics, artificial intelligence, biology, cognitive science, computational complexity and control theory, medical, finance, engineering, aeronautic, philosophy, information theory.

Data classification is a branch of Artificial Intelligence and has verified itself very useful in developing a content-based image recovery system. For classifying the data an imperative role is played by data classification. Data categorization is basically an attempt of labeling a class to the suitable identifiers. It's essential to specify area of concern for the creation of identifiers. This requirement can be comprehensive, like considering arbitrarily taken pictures (say, the ones from the internet) for the classification, may limit to some specific domains, like medical images or geographical images (remotely sensed images). Image tagging is a kind of image annotation, in which includes labeling or indexing the image in semantic manner[1]

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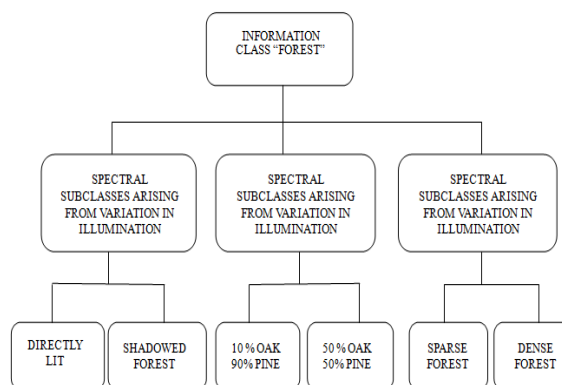


Figure 1: Example of Classification [2]

The definition of classification according to charu C Agrawal [1] is

*Given a pair of training data points along with associated training labels, determine a class label for an unlabeled test instance.*

So, several variations of classification problem may be defined over different parameters. Some extraordinary indications on data sorting may be found in [3]. Classification algorithms typically contain two phases:

- Training Phase: It's a phase, where a model is primed from the training samples.
  - Testing Phase: This phase has the model which is used to entrust a label to an unlabeled test in
- The output of a classification algorithm may be presented for a test instance in one of two ways:
1. Discrete Label: In this a label is given for every test instances.
  2. Numerical Score: For each class label and test instance combination a numerical value is given.

Note that the numerical score can be converted to a discrete label for a test instance, by picking a class which possess highest score for that test instance. The advantage of second method used for a test instance is that it now becomes possible to compare the relative liability of different test samples to belong to a peculiar class of importance, and rank them if needed. Such methods are used often in rare class detection problems, where the original class distribution is highly imbalanced, and the discovery of few classes is more relevant than rest.

## II. RELATED WORK

Some of the conventional systems used in data classification are decision trees, rule-based methods, probabilistic methods, SVM methods, instance-based methods, and neural networks.

### A. DECISION TREE.

In Decision tree based on feature values the instances are sorted and classified. In Decision tree each node contains the characteristic of instances which is needed to be classified and each branches holds a value assumed by each node. Sorting is done from the root node depending on feature values. Training data is sorted by root node which holds the best feature value. There are various ways for finding the characteristic that excellently splits the preparing data for instance, information gain and gini index. Though, a bulk of studies has presumed that there's no single best method. Comparison of individual methods may still be important when deciding which metric should be used in a precise dataset. The similar process is then recursively applied on every division of the distributed data, which results in the creation of sub-trees as far as the training data is dislocate into subsets of the similar class In order to avoid the issue of over fitting training data two ordinary way that decision tree algorithms can apply, First option is to end the training

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algorithm before it reaches a point at which it absolutely fits the training data and the Second option is where the induced tree can be snipped. If the experiment incorporated by the two trees are similar and are contains the mirror or similar correctness in calculation, then the tree with the lesser leaves is generally considered fuzzy topology method hence we can say that the Decision trees are trees that categorize instances by sorting them based on feature values.

## B. SINGLE LAYERED PERCEPTRONS.

A single layered perceptron in brief describe as follow: If input feature values are from  $x_1$  to  $x_n$  and connection weights are from  $w_1$  to  $w_n$  (normally real numbers in the interval of  $[-1, 1]$ ), then perceptron calculate the sum of weighted inputs  $\sum_i x_i w_i$  and output goes through an adjustable threshold: if the sum is above threshold, output is 1; otherwise result is 0 The generic way where this algorithm is utilized for learning from a batch of training instances is to execute the algorithm recursively through the training set until it explores a prediction vector which holds true for the entire training set [10]. This forecast instruction is then used for predicting the labels on the test set is used for learning from a batch of training instances Hence as mentioned above that the way where we can use this algorithm for learning from a batch of training instances is to execute the algorithm again and again through the training set until it explores a prediction vector which holds true for the entire training set. Now, to sum up, we have discussed perceptron-like linear algorithms with focuses on their superior time complexity when dealing with irrelevant features. This can be a achievement or we can call it the advantage when there are many features, but only a few relevant ones.

## C. PROBABILISTIC METHODS.

Probabilistic methods are the most fundamental among all data classification methods. Statistical interference is a method used to discover the best class for any instances in Probabilistic classification algorithm. In accumulation of merely passing on the best class like other categorization algorithms, probabilistic classification .Algorithms will yield a equivalent posterior probability of the experiment instance being a part of each of the likely classes. Bayesian network (BN) is a directed acyclic graph for probability relationships among a set of variables (features). It is used to establish one –to-one communication between the nodes. In Bayesian network the arcs correspond to casual influences among the features also the unavailability of possible arcs in Bayesian network encodes conditional independencies. The working of the Bayesian network can be understood by focusing upon two important things first DAG structure and second determine the parameters. By learning the conditional independence relationships between the features of a dataset one can easily know the structure of BN and apply these correlations as constraints to create a BN.

## D. STATISTICAL LEARNING ALGORITHMS

Statistical accesses are not only known for its classification techniques but are also characterized by having a clear underlying probability model, which gives a possibility that an instance belongs in each class. Two simple methods are used in statistic and in expert system to know the linear combination of features that can excellently detach two or more classes of object, they are Linear discriminant analysis (LDA) and the related Fisher's linear discriminant methods. In 1999, Mika proposed an equivalent technique to LDA to deal with categorical variables because LDA works only when the measurements made on each observation are continuous quantities. Another one of the common method used to estimate probability distribution from data is Maximum entropy. One of the most important principles in this method is overriding principle which states that distribution should be uniform as much as possible unless and until we get required or known values. Statistical learning algorithms are excellently represented by Bayesian Network. [6].

## E. RULE-BASED METHODS.

Rule-based methods are strongly correlated to decision trees, except that they do not create a strict hierarchical partitioning of the preparation data. Rather, overlaps are allowed in order to create greater robustness for the training model. In decision tree any path is considered as rule which assign a test example to a particular label. Compare to

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decision tree Rule-based classifiers is seen as more general models. In decision trees induced rule sets are used for non-overlapping, while rule-based classifiers create rules that probably conflict with additional to one another for a specific test instance. Therefore, it is significant to design methods that can effectively determine a resolution to these conflicts. The method of resolution depends upon, whether the rule sets are ordered or unordered. If the rule sets are ordered, then the top matching conventions can be used to make the prediction. If the convention sets are unordered, then the rules can be used to vote on the test instance.

## F. SVM CLASSIFIERS.

A new method that can categorize land data is Support vector machine which based on supervised classification. Different functions like regression Classification and outlier detection are done by this classifier which is based on supervised classification. In SVM we get accurate and reliable result when we use limited number of test instances since it has its roots in Statistical Learning Theory and has gained prominence value. Based on inaccuracy pace achieved on the preparation sets and on an intrinsic property of classifier, the inaccuracy probability of SVM is restricted by a number which is one of the important demerits of Statistical Learning Theoryses.

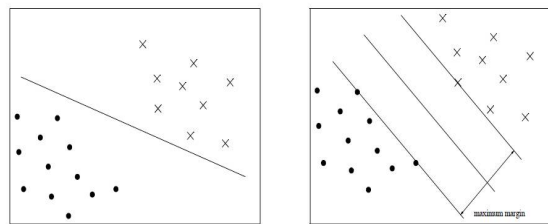


Figure 2: Hyper planes separating the two classes.

As shown in the above figure both the hyperplanes separate the given training examples. The hyperplane on the right hand side has larger margin and hence is expected to give better generalization is the optimal separating hyperplane. When the number of variables are small, it can solve using Quadratic Programming technique.

## G. CART AS CLASSIFICATION METHOD.

This is very important even for analyzed dependencies of known nature where researchers are able to set up some a priori functional forms and becomes extremely important while performing explorative data mining of complex high dimensional structures. When no data structure hypotheses are available, non-parametric analysis becomes merely the single effective data mining tool. Moreover, when building such a model one should not make any additional assumptions concerning model errors distribution which becomes a substantial obstacle when sample errors distribution does not match the required one [4]. CART algorithm will itself identify the most significant variables and eliminate non-significant ones. To test this property, one can include insignificant variable and compare the new tree with tree, built on initial dataset. Both trees should be grown using the same parameters (splitting rule and N parameter) [4]. This means that from a given subset of variables constituting a learning sample CART will automatically select the most significant ones in some sense. Hence even if learning sample holds some irrelevant information due to e.g. measurement errors or misspecification, the model will choose correct splits by itself and hence account for disturbances automatically [4].

## H. NEURAL NETWORK BASED Classification

Artificial neural network (ANN) is also referred as simply "Neural Network" (NN) that is a process model supported as biological neural networks. They consist of an interconnected collection of artificial neurons. An artificial neural network is an adjective system that changes its structure supported information that flows through the artificial network during a learning section. In NN it is tried to find the parameters which minimizes the mean square error prediction

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error with respect to a set of training examples. This is done by using stochastic gradient descent optimization (a method for minimizing an objective function that is written as a sum of differentiable functions). The training of the neural networks and statistical classifiers is done on the basis of the Empirical Risk Minimization principle in which the training phase is aimed at achieving the minimum of the error rate on a given training set [9]. The ANN is based on principle of learn by example. There are, however the 2 classical types of the neural networks, perceptron and also the multilayer perceptron, where we target to execute the perceptron algorithm. The basic concept of perceptron algorithm is to determine a linear function for the feature vector  $f(x) = w^T x + b$ , resulting  $f(x) > 0$  for the vectors of one category [27], and  $f(x) < 0$  for the vectors of another. The vector  $w = (w_1, w_2, \dots, w_m)$  is the vector of the coefficients (weights) for the function, and the supposed bias is  $b$ . If we denote the categories as +1 and -1, then we can state that it is required to find a decision function  $d(x) = \text{sign}(w^T x + b)$ . The algorithm of perceptron learning is completed iteratively. This starts with at randomly chosen parameters ( $w_0, b_0$ ) for the decision and iteratively, updates them. In the  $n^{\text{th}}$  iteration of the rule the training sample  $(x, c)$  is so chosen that the decision function is not able classify the sample properly (i.e.  $\text{sign}(w_n x + b_n) \neq c$ ). Then, the parameters ( $w_n, b_n$ ) are updated using the following rule:

$$\begin{aligned} w_{n+1} &= w_n + cx \\ b_{n+1} &= b_n + c \end{aligned}$$

This algorithm is stopped when such a decision function is found that classifies all training samples correctly.

## EVOLUTIONARY ALGORITHMS FOR CLASSIFICATION.

PSO is too a population-based stochastic optimization technique and is well adapted to the optimization of nonlinear functions in multidimensional space. It models the social activities of bird flocking or fish schooling... PSO is successfully applied in solving several real-entity based problems thus it became popular in the field of research several real-world problems [14]. In PSO, a group of particles works by moving around in search domain by updating their current position and velocity as well following the current optimum particle. The position of a particle gives the possible solution which needs to be optimized. It provides the fitness of each particle after optimization. Based best solution of current particle achieved so far (particle best) and the best of the population (global best) the current position and velocity of each particle is updated. In search space, population of particles try to find best particle among themselves and based on the information so far obtained after each iteration they will get a local best solution. Now the particle starts moving towards good area in the search space by spreading information to the swarm [12].

## III . DATA STREAM DISCUSSION

With the increment in the collection of unlike types of large amount data, the problems of amount have become a task to the classification process. Clearly, larger data sets allow the creation of more accurate and sophisticated models. If one is computationally constrained by problems of scale. Data streams and big data analysis have different challenges. The real time processing creates challenges, the problem is created by the fact that computation and data access over extremely large amounts of data is inefficient. It's frequently challenging to compute summarized information from large volumes, because the access requires to be done in a distributed way, and it is too costly to compute large amounts of data around. The capabilities to continuously collecting and processing large volume of useful information have led to the acceptance of data streams [7]. In the streaming scenario, two primary problems arise in the construction of training models .One-pass Constraint: Since data streams have very large volume, all processing algorithms need to perform their computations on its own by passing of time. Concept Drift: The data streams are typically created by a generating process, which may change over time. This results in concept drift, which brings changes in given stream patterns over time. Massive Domain Constraint: The streaming scenario often contains discrete attributes that take on millions of possible values. This is because streaming items are often associated with discrete identifiers. Conventional classification algorithms have to be appropriately modified so that aforementioned challenges can be address.

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## IV. EVALUATING CLASSIFICATION ALGORITHMS

To classify the data the prominent parameter that is passed is that of estimation of classification algorithms. Two primary parameters that arise in the evaluation process are as below described: Methodology used for evaluation: Classification algorithms require a training stage and a testing stage, in which the test examples are cleanly divided from the training data. Various tactics are possible, such as hold out, bootstrapping and cross-validation, out of that the first is the simplest to implement, and the last provides the ultimate accuracy of implementation [8]. In the hold-out approach, a stable proportion of the training examples are “held out,” and not used in the training. Quantification of accuracy: This is deals with the dilemma of quantifying the error of a classification algorithm. At first sight, it would seem that it is most beneficial to use a degree for instance the absolute classification accuracy, which directly computes the portion of examples that are correctly classified.

## V. EXPERIMENTAL RESULTS

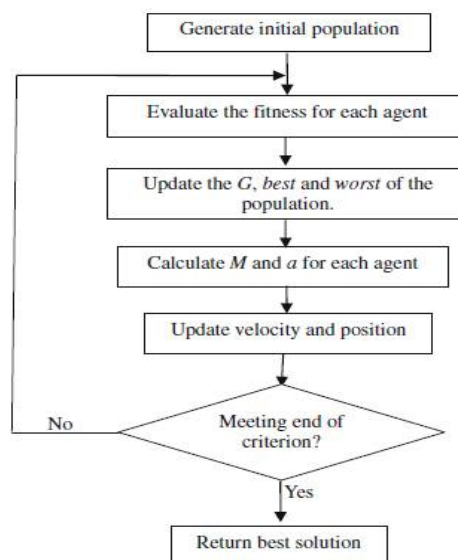
Here Iris dataset is classified using FNN-PSO, FNN-GSA and then classification result is compared with proposed methodology FNN-GSA-PSO, whose efficiency is found better than PSO & GSA alone for the classification of data.

Following table shows the efficiencies of different algorithm used for data classification .Proposed algorithm is also used to classify cuckoo dataset and some randomly selected dataset.

Data classification methods	Iris Dataset classification competence (in %)	Cuckoo Dataset Classification Efficiency(%)	Random Dataset Classification Efficiency(%)
FNN-PSO	94.03%	93.5%	75.0%
FNN-GSA	95.4%	94.5%	78.33%
FNN-GSA-PSO	98%	97.66%	80.1%

Through this table its clear that the proposed algorithm shows the efficiency of 98% for classification of dataset used here such as Iris dataset and some of the randomly selected dataset like cuckoo dataset ,glass dataset. Proposed algorithm used here is the hybrid of PSO & GSA whose working is shown below .

PROPOSED ALGORITHM: Proposed algorithm working is shown with the help of flow chart





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## VI. CONCLUSION

The data classification problem is appropriate in the perspective of a variety of data types, such as text, multimedia, network data, time-series and sequence data. Probabilistic data is new kind of data which is uncertain and may necessitate a different kind of processing to regulate the use of uncertainty as a first-class variable. Dissimilar kind of data may have unlike way of representations and contextual dependencies. This requires the design of methods that are well adapted to the dissimilar data types. Because of variations in classification problems the use of human interventions or additional training data is allowed to get the accurate result. Approximately in each situation meta algorithm is used to get the desire results. During data classification one of the important concerns is scalability. This is because data sets continue to increase in size, as data collection technologies have improved over time. There's huge data stream due to continuous accumulation of data sets. Even in cases where very great amount of data are collected, big data technologies are essential to be planned for the classification process.

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