Classification using Neural Network & Support Vector Machine for Sonar dataset

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***Abstract*— Classification of the physical properties of sonar targets is one of the difficult tasks. The increased use of sonar motivated the researcher to produce cost effective and automated process for classification. Neural Network and Online Multiple Kernel Learning (OMKL), that aims to learn a kernel based prediction function from a pool of predefined kernels in an online learning fashion. OMKL is generally more challenging than typical online learning because both the kernel classifiers and their linear combination weights must be learned simultaneously [2]. We experimented the sonar dataset for deterministic and stochastic using online multiple kernel learning. The online Support vector machine and Neural Network techniques are applied to classify sonar data..**

***Keywords*— Signal classification, support vector machine classifier, Sonar data classification.**

I. Introduction

Classification of the physical properties of sonar targets is one of the difficult tasks. The recent development of learning algorithm Gorman [4] et. al. Networks were trained to classify sonar returns from an undersea metal cylinder and a cylindrically shaped rock of comparable size In this paper, we present additional experimental data, a comparison of network classification performance to that of traditional pattern recognition techniques, and support vector classification technique.

Active sonar uses a sound transmitter and a receiver. When the two are in the same place it is monostatic operation. When the transmitter and receiver are separated it is bistatic operation. When more transmitters (or more receivers) are used, again spatially separated, it is multistatic operation. A beamformer is usually employed to concentrate the acoustic power into a beam, which may be swept to cover the required search angles. Figure 1. Shows the transmission and receiving process of sonar signals.

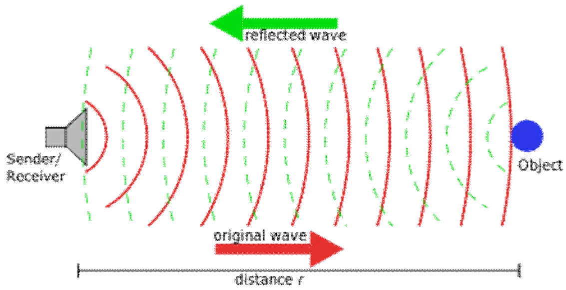


Fig 1. Principle of an active sonar

The outline of the paper is as follows. In section 2 the network architecture is described, section 3 explain the multiple kernel technique the experimental studies is described in section 4 and the paper is concluded in section 5.

II. Network Architecture

Neural network consist of parallel interconnection of simple neural processors. Figure 2 shows an example of single neural processors, or neuron. Neurons have may weight inputs, example (p1,p2,p3, p4……..pn) and has a related weight (w1,w2,w3,w4,….wn) according to their importance. Each of these input is a scalar, representing the data. They are known by many different names, such as "multi-layer perceptrons". In Feed Forward network perceptrons are arranged in layers, with the first layer is input and last layer is output layer producing outputs, and the middle layers have no connection with the external world hence are called hidden layers. Each perceptron in one layer is connected to every perceptron on the next, and this explains why these networks are called feed- forward networks, but no feedback connections are present in feed-forward network. In case of back propagation algorithm the error is back propagated to network in order to minimize the error of network.

$$F(x) = \sum_{q=1}^{Q} (t_q - a_q)\,(t_q - a_q)^T$$

Where, t : target set ; a : actual data set ; Q : targets in training set ;

Once all the weight changes are calculated the weights are updates. The entire process is repeated until a target error is satisfied. The neural network architecture is shown in figure 2.

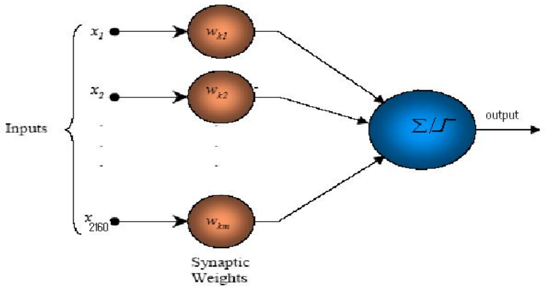


Fig 2. Architecture of Neural Network

Figure 3 shows the input layer consist of rock & metal. In hidder layer processing unit that produces the results for output layer.

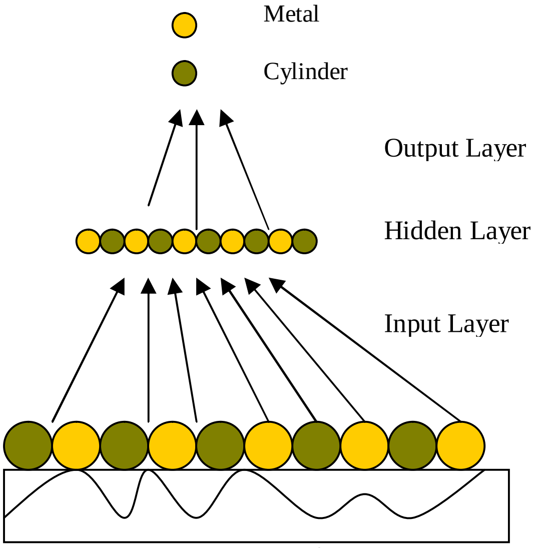


Fig 3. Architecture of Neural Network

The experiment for Neural Network classification performed in Matlab 2010a in Pentium machine. The feedback back propagation algorithm is used to classify the dataset.

TABLE 1
EXPERIMENTAL RESULT OF NN CLASSIFIER

Training Time	Testi ng Time	Training Accurac y	Testing Accuracy	Averag e Testing Accura cy	Average Training Time
4.9219	0.34 38	0.9385	0.8953	0.8325	4.9516

III. NETWORK ARCHITECTURE

Support Vector Machines, are supervised learning machines based on statistical learning theory that can be used for pattern recognition and regression. Statistical learning theory can identify rather precisely the factors that need to be taken into account to learn successfully certain simple types of algorithms [3]

Online learning and kernel learning have been studied extensively in machine learning, there is limited effort in addressing the intersecting research problems of these two important topics. As an attempt to fill the gap, we address a new research problem, termed Online Multiple Kernel Classification (OMKC), which learns a kernel-based prediction function by selecting a subset of predefined kernel functions in an online learning fashion. OMKC is in general more challenging than typical online learning because both the kernel classifiers and the subset of selected kernels are unknown, and more importantly the solutions to the kernel classifiers and their combination weights are correlated. The proposed algorithms are based on the fusion of two online learning algorithms, i.e., the Perceptron algorithm [5] that learns a classifier for a given kernel, and the Hedge algorithm that combines classifiers by linear weights. We develop stochastic selection strategies that randomly select a subset of kernels for combination and model updating, thus improving the learning efficiency. The experimental study so promising performance of the proposed algorithms for OMKC in both learning efficiency and prediction accuracy. Figure 3 shows the amplitude displays of a return from rock and cylinder.

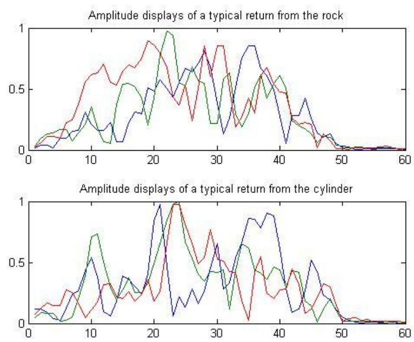


Fig 4. Amplitude display return from Rock & Cyllinder

SVM Classification algorithm works as follows [4]

Selecting a specific kernel and parameters is a trial and error method. The
following procedure is used to select the parameter [3].

1. Conduct scaling on the data
2. Consider RBF kernel ,
3. Use cross-validation to find the best parameter C and σ
4. Use the best C and to train the whole training set
5.Test And we can summarize SVM algorithm as follows:
1. Choose a kernel function
2. Choose a value for C

3. Solve the quadratic programming problem
4. Construct the discriminate function from the support vectors.

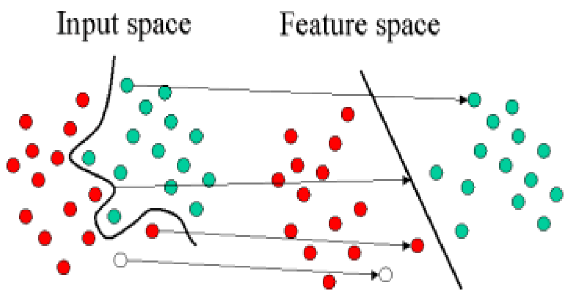


Fig 5. Linearly separable SVM Classification

Dataset – Sonar dataset [1], the dataset is multivariate dataset that consists of 60 attributes 208 instances. The dataset contains 97 patterns obtained by bouncing sonar signals off a metal cylinder at various angles and under various condition. The transmitted sonar signal is a frequency modulated chirp, rising in frequency. The dataset contains signal obtained from a variety of different aspect angles, spanning 90 degree for the cylinder and 180 degrees fro the rock. Each patterns is a set of 60 number in the range 0.0 to1.0. Each number represents the energy within a particular frequency band, integrated over a certain period of time.

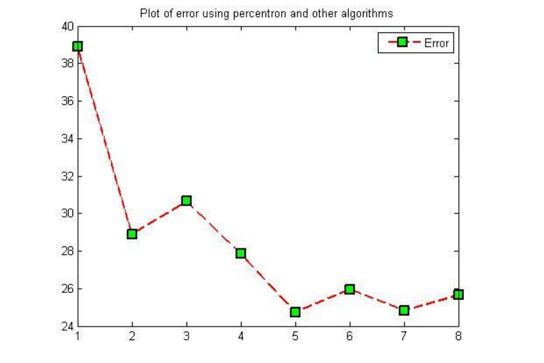
TABLE II.
Experimental Results using SVM

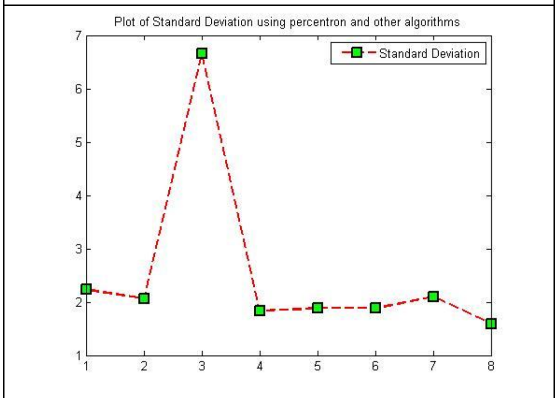
Metrics	Perceptron	Standard Error	PER(uniform)
Mistake(%)	38.89%	2.23%	28.89%
SupVec(#)	80.9	4.6	60.1
CPUtime(s)	0.0026	0.0026	0.0018

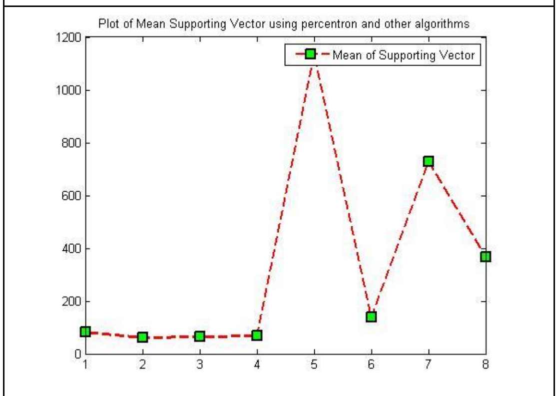
Standard Error	PER(best)	Standard Error	Online Machine2 (OnlineMKL)	Standard Error
2.07%	30.65%	6.66%	27.84%	1.84%
4.3	63.8	13.9	68.3	4.4
0.0002	0.0149	0.0036	0.0437	0.0259

deterministic update & deterministic combination algorithm		OMKC(D,S) - deterministic update + stochastic combination algorithm	
OMKC(d,d)		OMKC(d,s)	
Mean	Std	Mean	Std
24.74%	1.88%	25.96%	1.88%
1136	38.6	139	75.7
0.1119	0.003	0.1169	0.0018

stochastic update + deterministic combination algorithm		OMKC(S,S) - stochastic update + stochastic combination algorithm	
OMKC(s,d)		OMKC(s,s)	
24.83%	2.10%	25.65%	1.59%
728.1	28.5	366.9	159.6
0.1111	0.0012	0.0827	0.0024







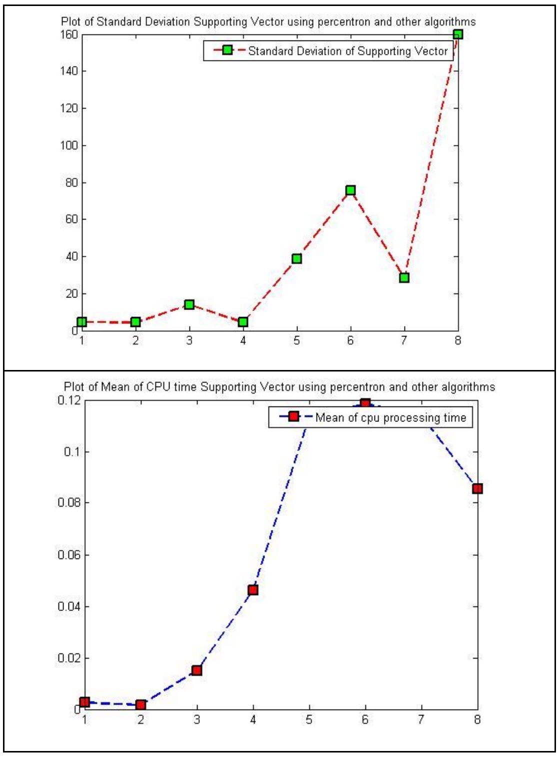


Fig 5. Mean & standard deviation of error, supporting vector and processing time

IV. Conclusions

In this paper we studied the behavior os sonar data set that consist of 97 patterns obtained by bouncing of sonar signal off metal and rock. The transmitted signal were fitted in neural network and support vector machine classifier. Using neural network we got 89% training accuracy and 83% testing accuracy. The error on perceptron, perceptron uniform, Online line kernel algorithm, deterministic and combination with stochastic algorithm are also discussed in this paper. The minimum error found using stochastic update and deterministic algorithm 24.83%.

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