Machine Learning (IS ZC464)

Assignment
Second Semester 2018-2019

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Q1. What do you understand by Artificial Neural Networks (ANN)? Explain the use of ANN in classification.
Ans:

ANN is a complex adaptive system which can change its internal structure based on the information pass through it. It is achieved by adjusting the weight of connection. Each connection has a weight associated with it. A weight is a number that control the signal between two neurons. Weights are adjusted to improve the result. Popular methods of learning are given as:

1. Supervised learning: This strategy involves a trainer which is smarter than the network.
1. Unsupervised learning: This strategy is used when there is not example data set with known answer.
2. Reinforcement learning: This strategy makes decision based on feedback from environment.

Artificial neural network is an example of supervised learning. Artificial neural network acquired the knowledge in the form of connected network unit. It is difficult for human to extract this knowledge. This factor has motivated in extracting the rule for classification in data mining. The procedure of classification is starts with dataset. The data set is divided into two parts: training sample and test sample. Training sample is used for learning of network while test sample is used for measuring the accuracy of classifier. The division of data set can be done by various method like hold-out method, cross validation, random sampling. In general learning steps of neural network is as follows:
- Network structure is defined with a fixed number of nodes in input, output and hidden layer.
- An algorithm is used for learning process. The ability of neural network to make adjustment in structure of network and its learning ability by altering the weight make it useful in the field of artificial intelligence.

Advantages and Disadvantages of Neural Networks

Let us see few advantages and disadvantages of neural networks:

- Neural networks perform well with linear and nonlinear data but a common criticism of neural networks, particularly in robotics, is that they require a large diversity of training for real-world operation. This is so because any learning machine needs sufficient representative examples in order to capture the underlying structure that allows it to generalize to new cases.

- Neural networks works even if one or few units fail to respond to network but to implement large and effective software neural networks, much processing and storage resources need to be committed. While the brain has hardware tailored to the task of processing signals through a graph of neurons, simulating even a most simplified form on Von Neumann technology may compel a neural network designer to fill millions of database rows for its connections – which can consume vast amounts of computer memory and hard disk space.

- Neural network learns from the analyzed data and does not require to reprogramming but they are referred to as black box" models, and provide very little insight into what these models really do. The user just needs to feed it input and watch it train and await the output.

▪ **CLASSIFICATION USING ANN**

The method of neural networks training is based on some initial parameter setting, weight, bias, and learning rate of algorithm. It starts its leaning with some initial value and weight gets updated on each iteration. The training of neural network is time consuming and it structure is complex. These feature made neural network less suitable for classification in data mining. Some method can be proposed to learn both the network structure and updating the weight. Adjustment of weight in ANN is combinatorial problem and to find the desired output we have to optimize the weight. Some learning methods for ANN in different classification problem are as follows:

a) Artificial neural network with back propagation
One variant of ANN with BP is proposed in give application of neural network for classification of Landsat data. The back propagation algorithm is used for training of neural network. Other variant of ANN with BP is proposed in is used for multispectral image classification. The BP is trained on classical area of image and then the neural network is used to classify the image.

b) Improved back propagation algorithm
Discuss the training of neural network with back propagation algorithm using gradient delta rule. It is highly applicable for parallel hardware architecture. The momentum factor is determined on each step rather than being held constant. Improved BP has better speed and convergence stability than conventional BP. Soft computing contains some meta-heuristic algorithms like cuckoo search, firefly algorithm, genetic algorithm, particle swarm optimization

Q 2. List the following as asked

(a) The three classification algorithms

1. Linear Classifiers: Logistic Regression, Naive Bayes Classifier

2. Support Vector Machines

3. Decision Trees

(b) The three issues in machine learning

1. Data Acquisition
Machine Learning requires massive data sets to train on, and these should be inclusive/unbiased, and of good quality. There can also be times where they must wait for new data to be generated.
2. Time and Resources
ML needs enough time to let the algorithms learn and develop enough to fulfill their purpose with a considerable amount of accuracy and relevancy. It also needs massive resources to function. This can mean additional requirements of computer power for you.
3. Interpretation of Results
Another major challenge is the ability to accurately interpret results generated by the algorithms. You must also carefully choose the algorithms for your purpose.

(c) The two types of learning
1. Supervised learning: This strategy involves a trainer which is smarter than the network.
2. Unsupervised learning: This strategy is used when there is not example data set with known answer.

(d) The three data visualization methods
1. Line Plot
2. Bar Chart
3. Histogram Plot

(e) The three performance evaluation methods for classification algorithms
1. Average Accuracy, Error Rate
2. Precision, Recall
3. Precision, Recall, F-score

(f) The three feature extraction algorithms

1. Principal component analysis
2. Multifactor dimensionality reduction
3. Nonlinear dimensionality reduction

Q 3. Design a neural network for four class classification problem in which the feature vector size is two. You can assume the data to be linearly separable by two straight lines. Illustrate using an appropriate example. Justify your choice of numbers of input, output and processing neurons. How will you obtain the weights for such neural network? Explain.
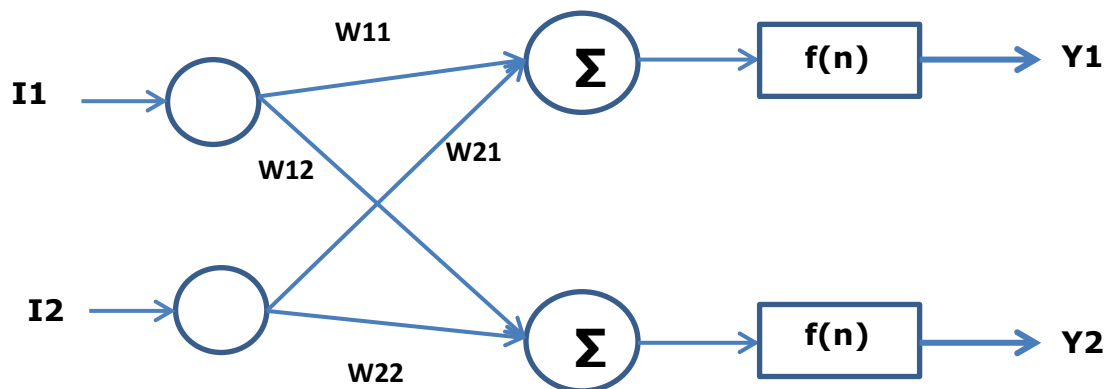
As there are 4 classes and 2 feature vectors. Using above neural network we can find out classification with 2 processing neurons and weight w11, w12, w21, w22.

•Neuron 1: −Activation Function: Step function −Threshold: 1 −Weights: <1,-1>	•Neuron 2: −Activation Function: Step function −Threshold:1 −Weights:<1,-1>

Example:

Let us have two discriminatory features <color, texture> for automatic fruit recognition.
• Let us code the attributes as 1, 2 and 3 for red, orange and yellow colors respectively.
Also let the textures be defined as 1,2 and 3 representing the degrees of smoothness in
increasing order.
• Let the training samples be

Color	Texture	Fruit (supervised learning)
1	2	Apple
3	2	Mango
2	1	Orange
1	3	Plum
1.4	2.8	Plum
2	1.5	Orange
2.5	2.2	Mango
1	2.2	Apple

To calculate weight of neural network use Optimization algorithms

1. initialize neural network

2. generate N weight vectors

3. calculate fitness values of weight vectors

4. repeat 2.-4. until some stopping criterion is satisfied

Q 4. Differentiate between the following. Give appropriate examples

    (a) Classification and Regression

No	Classification	Regression
1	Classification is the task of predicting a discrete class label	Regression is the task of predicting a continuous quantity.
2	A classification algorithm may predict a continuous value, but the continuous value is in the form of a probability for a class label.	A regression algorithm may predict a discrete value, but the discrete value in the form of an integer quantity.
3	Classification predictions can be evaluated using accuracy, whereas regression predictions cannot.	Regression predictions can be evaluated using root mean squared error, whereas classification predictions cannot.

(b) Traditional vs. machine learning

No	Traditional	Machine learning
1	Traditional learning methodologies such as training a model-based on historic training data and evaluating the resulting model against incoming data is not feasible as the environment is in a constant change.	An machine learning system is truly a learning system if it is not programmed to perform a task, but is programmed to learn to perform the task
2	In this, the first task is the creation of the most suitable algorithm and writing the code. Thereafter, it is mandatory to set the input parameters and, in fact, if an implemented algorithm is ok it will produce the expected result.	In this, data is first collected and prepared, then experimented with different algorithms to build a better model. The result is a model that can predict a new result, receiving new data as input.