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Gaussian Kernel Based Customer Loyalty Prediction using SVM

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Abstract— this paper presents the Gaussian kernel based Customer Loyalty Prediction using Support vector machine (SVM). Concepts of loyalty and their associated measures are related to the values of organization if they can be used to predict behavior such as customer recommendation, product features. These are termed as loyalty outcomes because of such features to predict the customer loyalty. In every business application the customer loyalty prediction models plays the important role in business development .It analyzes the customer requirement and it use this data for future purpose. Finding such a loyal customer is a critical task that requires data mining and analysis of big amount of data with huge volume of customers. In this paper we use Gaussian kernel based scheme to classify the data and then use this data to predict customer loyalty using Support vector Machine (SVM).

Index Terms: Customer Loyalty, SVM, Data mining, Classification, Gaussian kernel

I. INTRODUCTION

The Customer Loyalty is a concept with some measures having some values if it is used to predict the behavior of customer such as customer recommendation, customer approaches, visits to sites, reduced search for alternatives and customer retention which can be termed as Loyalty outcomes. The issue addressed here is how well different measures of loyalty predict these loyalty outcomes. Finding loyal customers in hospitality is one such problem that requires mining & analysis of huge amount of data. Here we present a Customer Loyalty prediction model using Gaussian kernel based Support vector Machine for business application. In any business application prediction models plays the main role in business development by analyzing the customer requirement. For this reason we use supervised machine learning method i.e Support Vector Machine (SVM). Supervised machine learning is used for the search regarding algorithms that reason from externally supplied instances to produce general hypotheses, which then make predictions about future instances.

Finding loyal customer in hospitality sector is a critical industry requirement. However due to various factors involved such as customer preferences, competitor offering, market scenario etc. And huge volume of Customers involved. Finding such loyal customers is not an easy task. In the Past various prediction methods from Skyline queries to neural network have been used to solve this problem but with limited sector. This is mainly because of constraints and parameters used to develop mathematical model of prediction. In the paper we have carefully chosen Gaussian kernel based prediction Using SVM has preferred method for finding such loyal customers.

Support vector machine (SVM) is one the most important learning machine algorithm that has been used for customer churn prediction .SVM approach is a classification technique which is based on neural network using supervised learning theory .The SVM used because its important reason it gives Optimal solution for predictive performance. It gives accurate performance for parameter selection procedure. Support vector machine provides a higher accuracy rather than other classification methods. Support vector is most prominently used binary classification methods.

II. RELATED WORK

In Novel Profit Maximizing Metric for Measuring Classification Performance of Customer Churn Prediction Models [1] that there are no of classifications Methods has been developed for business application. So there is need to measure the adequate performance of Classification methods. In this paper, a cost-benefit analysis framework is used in such way as in formalized way in order to define performance measures which are specifically used with the main objectives of the end users, i.e., profit maximization. The new performance measure is maximum profit criterion. Here this framework used for customer churn problem with its cost benefit structure. It helps to all companies to choose a proper classifier which maximizes the profit.

In A Hierarchical Multiple Kernel Support Vector Machine for Customer Churn Prediction Using Longitudinal Behavioral Data [2] that the availability of abundant data posts a challenge to integrate static customer data and longitudinal behavioral data to improve performance in customer churn prediction. Usually, longitudinal behavioral data are transformed into static data before being included in a prediction model. In this study, a framework with ensemble techniques is presented for customer churn prediction directly using longitudinal behavioral data. Here a new approach is used which is called as the hierarchical multiple kernel

Support vector machine (H-MK-SVM) is formulated. The author has developed and implemented A three phase training algorithm for the H-MK-SVM .The H-MK-SVM constructs a classification function by estimating the coefficients of both static and longitudinal behavioral variables in the training process without transformation of the longitudinal behavioral data.

In Support vector machine classifier for diagnosis in electrical machines: Application to broken bar" [3] that it presents a support vector machine (SVM) classifier for broken bar detection in electrical induction machine. It is a reliable online method, which has high robustness to load variations and changing operating conditions. For classification task support vector machine is used due to its good robustness and generalization performances. A comparative analysis of linear, Gaussian and quadratic kernel function versus error rate and number of support vectors is done.

In "SUPPORT VECTOR MACHINE-A Survey" [4] that Support vector machine (SVM) is one of the most important machine learning algorithms that has been implemented mostly in pattern recognition problem, for e.g. classifying the network traffic and also in image processing for recognition.

In Handwritten digit Recognition using Support Vector Machine [5] that it develops an approach which improve the efficiency of handwritten recognition using artificial neural network and SVM it Handwritten Numeral recognition plays a vital role in postal automation services especially in countries like India where multiple languages and scripts are used discrete Hidden Markov Model (HMM) and hybrid of Neural Network (NN) and HMM are popular methods in handwritten word recognition system.

A Practical Guide to Support Vector Classification [6] gives useful technique for data classification that is Support vector machine (SVM). It's very easier for user than to use neural network. SVM finds a linear separating hyper plane with the maximal margin in this higher dimensional space.

In Bankruptcy prediction using support vector machine with optimal choice of kernel function parameters [7] author uses SVM to predict the bankruptcy problem with some kernel functions. it will compare the SVM with other classification methods. It shows that SVM has the higher Accuracy than other methods and it support different kernel functions which are used for the prediction purpose.

III. PROGRAMMER'S DESIGN

1) Mathematical Model

In the proposed system we aim to develop new mathematical model around Gaussian kernel and SVM by considering some additional features Such as

- Customer preferences
- Current product feature
- Competitors product feature
- Customer analysis

In our system first we consider additional parameters such as customer preferences, product purchased by customer, amount spent by customer, positive recommendation by customer, visits by customer during relationship. We then build a training set using these parameters and build support vector table. We use this table to generate H plane and build the model to minimize test error. We then input the test data for prediction and then label each data set whether it is loyal or not. Mathematical model is based SVM optimization function. This mathematical model is given as bellows:

Here the Gaussian kernel on two samples

Represented as feature vector in some input space is defined by, It is a squared equal distance between two feature vectors

-------Eqn. (1) as it is measures the value of Gaussian kernel decreases with distance and is always between 0and 1.

Feature space of a kernel has an infinite number of dimensions for

$$a \times a'$$

And expression is

$$k(a, a') = exp\left(-\|a - a'\|_2^2 / 2\sigma\right) where \|a - a'\|_2^2$$

-------Eqn. (2)

Here the Gaussian kernel has find out the nearest value towards the hyper plane which is loyal or not loyal.

The SVM optimization function is given by

$$exp(-1/2\,\|x - x'\|_2^2) = \sum_{j=0}^{\infty} x^T x' exp(-1/2\,\|x\|_2^2) exp(-1/2\,\|x''\|_2^2)$$

-------Eqn. (3)

In this Equation the Gaussian kernel function is finding predicting on training data sets that customer is loyal or not loyal. Here the beta is nothing but nearer value find out by the Gaussian kernel which is the distance between two vectors.

2) Algorithm of proposed Method

Step1: for any customer management software build a training set of records with following attributes

- Customer Acquisition date
- Current date
- Total visits by customer during relationship

- Total product purchased by customer during relationship
- Total amount spent by customer during relationship.
- Total positive recommendation by customer during relationship.

Step 2: Classify the training set into loyal and disloyal set and use equation 1, 2, 3 for extracting features from the training sets
Step 3: Input the test data for prediction.
Step 4: Using equation 3 predict the loyal customers.

2.1) Algorithmic Complexity of System

The number of iterations required to solve a SVM problem is not known for any of the solvers it very much depends on the data (i.e. the surface of the cost function and the constraints). QP is the optimization of a quadratic function subject to linear equality and inequality constraints. From experimental observations, the number of iterations is of O(N) Hence the complexity of solving the QP problem in the SVM training can be approximated as $O(N^4)$. When the number of training data points exceeds a few hundred, the computation cost for the SVM training will be unacceptable. From the results, the training duration for larger training data sets can be estimated as in Table1.

Table no. 1

QP Sub Problem	Estimated Training Duration
640	4 Hr
1280	64 Hr
2560	1024 Hr
5120	16800 Hr
10240	262200Hr

Complexity of the System:

N is the total number of training data points
D is the number of dimensions for each data point
Q is the size of the working set (i.e. |B|)
S is the number of support vectors
qp(Q) is the complexity of the QP sub-problem (qp(Q) is estimated to be .
From the above definition, the complexity of each iteration of the decomposition algorithm is :

$$\mathbf{O(QND+N^2D+ Q^4)} \ .$$

3) Feasibility Analysis

1) The problem finding customer loyalty with respect to various parameters is an NP-hard problem in finding customer loyalty SVM algorithm has to find all possible hyper planes i.e, values of equation coefficients.

For example: if hyper plane line is

ax+by =c,

the SVM function has to find all possible hyper planes with values a & b therefore search space might look like decision tree as below

ax+by =c

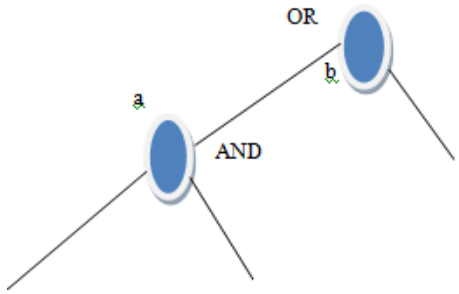


Fig.1. Example of NP –hard with And-OR Graph

This tree based searching of input space will grow with increase in time and thus our SVM based mathematical model is NP hard problem.

4) Architecture of Gaussian kernel based Customer loyalty model using SVM:

4.1) SVM Function: Support Vector Machines are the concept of decision planes which are used to define decision boundaries. A decision plane is used to separate between a set of objects having different class memberships. The

diagram example is shown as below. In this example, the objects belong either to class GREEN or RED. The separating line gives a boundary on the right side of which all objects are GREEN and to the left of which all objects are RED. Any new object (white circle) falling to the right is labeled, i.e., classified, as GREEN (or classified as RED should it fall to the left of the separating line).

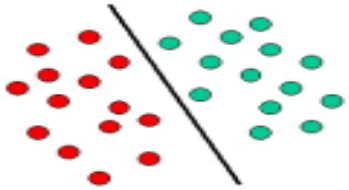


Fig.2 SVM Function - classification

4.2) SVM W Minimization Heuristic:

For SVM, training involves the minimization of the error function:

$$\frac{1}{2} w^T w + C \sum_{i=1}^{N} \xi_i$$

Subject to the constraints:

$$y_i \left(w^T \phi(x_i) + b \right) \geq 1 - \xi_i \text{ and } \xi_i \geq 0, i = 1, \ldots, N$$

where C is the capacity constant, w is the vector of coefficients, b is a constant, and ξ_i represents parameters for handling non separable data (inputs). The index i labels the N training cases. Note that $y \in \pm 1$ represents the class labels and xi represents the independent variables. The kernel ϕ is used to transform data from the input (independent) to the feature space. It should be noted that the larger the C, the more the error is penalized. Thus, C should be chosen with care to avoid over fitting.

4.3) Learned Function: The illustration below shows the basic idea behind Support Vector Machines. Here we see the original objects (left side of the schematic) mapped, i.e. rearranged, using a set of mathematical functions, known as kernels. The process of rearranging the objects is known as mapping (transformation). here in this new setting, the mapped objects (right side of the schematic) is linearly separable and, thus, instead of constructing the complex curve (left schematic), all we have to do is to find an optimal line that can separate the GREEN and the RED objects. Classifying data is a common task in machine learning. Suppose some given data points each belong to one of two classes, and the goal is to decide which class a new data point will be in. In the case of support vector machines, a data point is viewed as a p-dimensional vector (a list of p numbers), and we want to know whether we can separate such points with a (p − 1)- dimensional hyper plane. This is called a linear classifier.

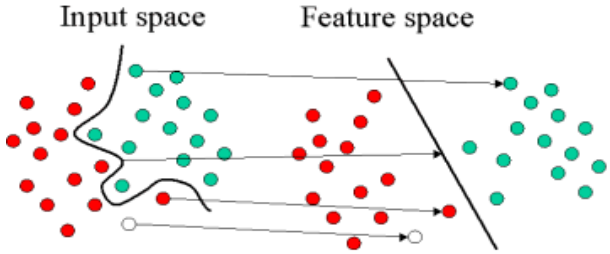


Fig.3 Learned Function

There are many hyper planes that might classify the data. One reasonable choice as the best hyper plane is the one that represents the largest separation, or margin, between the two classes.

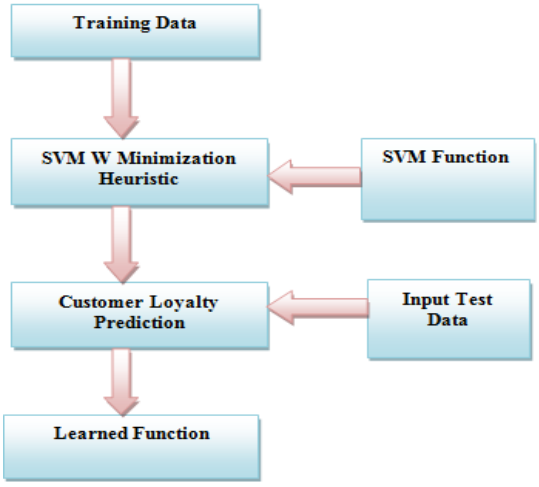


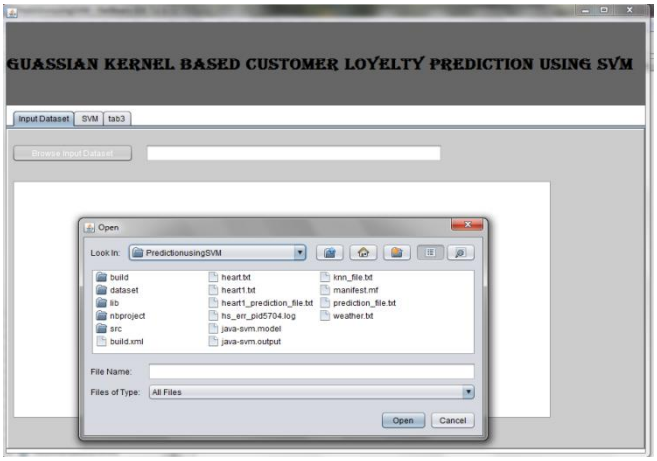
Fig.4 Architecture of Gaussian kernel based Customer loyalty prediction model using SVM

Gaussian kernel is used to find out the distance between two sample vectors. As it find out it is nearer to hyper plane or not. It will decide that it is loyal or not loyal.

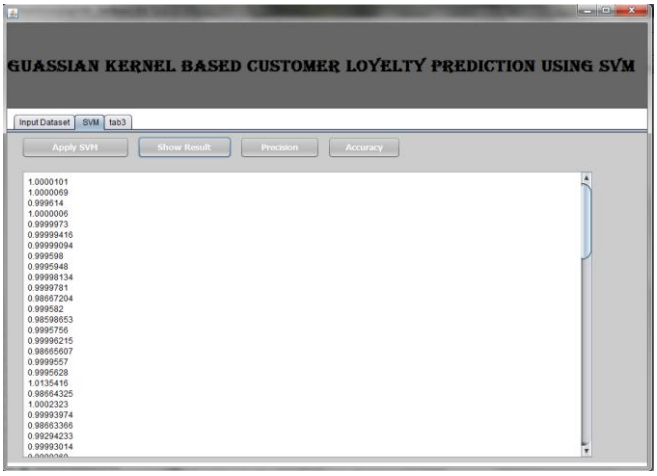
IV. RESULTS EXPECTED

A gaussian process has been used broadly for regression and classification problems that contain complex relationship between features and the target Function. The Gaussian kernel and SVM function is used to predict the customer is loyal or not loyal. Through the new mathematical model we can check out the customer loyalty by using some training data set. As the volume of customer is huge for the sample test we can use some test data to analyze and predict the output data. Here we have given that the problem is NP hard but the new mathematical model work is in processing. Here we have compared features on some training data sets and it can be detected by rate of good classification on the test data sets using Gaussian kernel. As the Implementation work is in process the changes in the testing results can be possible. The Ultimate Results work is in process.

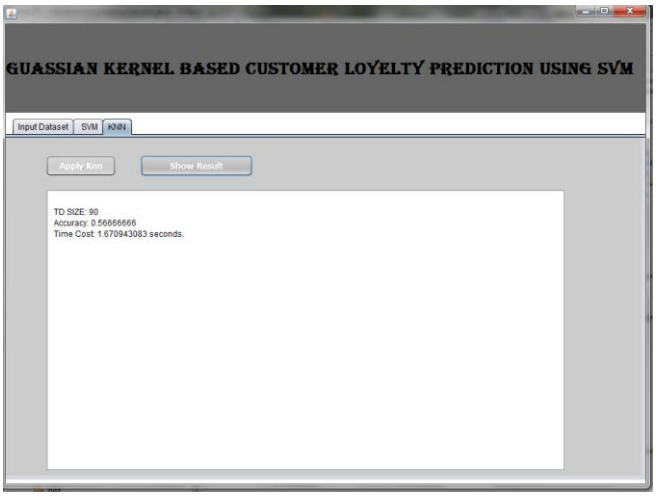
Input dataset from user



Input dataset preprocessing with svm



Input dataset preprocessing with Knn



System Performance

V. CONCLUSION AND FUTURE SCOPE

As we have created and discussed new mathematical model with Gaussian kernel and SVM function to predict the Customer Loyalty in various sector like hospitality ,telecom sector etc. As Customer Loyalty is a basic and important problem for any service providing sector. The method chosen to help for predicting loyalty because it gives output in higher accuracy. This implementation gives us one hybrid method which is the combination of SVM and Gaussian kernel with

other additional Features and most importantly it can be used in any sector where huge volume of customers is connected. These accurate predictions will helps to company for maximizing the profit. As the customer volume is in huge manner which is a NP hard problem. But we have tried to solve prediction accuracy problem as much as possible. In future we can extend this Customer loyalty prediction with different features which are not available at every software for different application to increase the profit of company.

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