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Synthesis, Characterization and Biological Activity of New Pyran Derivatives of 8-Hydroxyquinoline

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Abstract: Banking systems are depending upon many decisions and it should be corrected automatically. But this is a manual process and is error prone and time consuming due to large volume of transactional and historical data. Leading banks are using Data Mining tools for predicting payment delay, credit scoring and approval, detecting illegal transactions, etc. Inthis article I am exploring and reviewing about the various data mining techniques in the banking sector.

Keywords: DataMining, Illegal Transactions, Risk Management, Money Laundering, Fraud Detection.

INTRODUCTION

The banking industry has hugely benefited from the advancements in digital technology. Concept of data stored at branches paved way to centralized databases. The growth of information resources along with the technological change has produced huge amounts of information that often exceed the ability of managers and employees to assimilate and use it productively. Data must be categorized in some manner if it is to be accessed, re-used, organized, or synthesized to build a picture of the company's competitive environment or solve a specific business problem. In recent years, the need to extract knowledge automatically from very large databases has grown. Data mining have developed processes and algorithms that attempt to intelligently extract interesting and useful information from vast amounts of raw data. For example, Wal-Mart has one of the world's largest databases of customer transactions, with over 20 million transactions being handled per day. Wal-Mart just wants to know to whom they should mail their next advertising circular; they are not trying to prove a hypothesis. According to Edelstein, intelligent data mining discovers information within data warehouses that queries and reports cannot reveal. Data mining can help managers to make decisions. And also helps in applying more effective strategies in the organizations.

RELATED WORK

Data Mining Defined through Out Literature

a) Data mining is defined as the process of extracting previously unknown, valid, and actionable information from large databases and then using the information to make crucial business decisions – Cabenaetal.
b) Data mining is described as the automated analysis of large amounts of data to find patterns and trends that may have otherwise gone undiscovered — Fabris.
c) The objective of data mining is to identify valid, novel, potentially useful, and understandable correlations and patterns in existing data — Chung and Grey Objectives
   - Integrating retailer, suppliers and customers forgetter customer service.
   - Descriptions of customer relations patterns
d) Constantly flexing the balance between marketing, sales and service inputs against changing customer needs to maximize profit Extracting or detecting hidden customer characteristics and behaviours from large databases.

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Overview of Data Mining

What is Datamining?

It is the non-trivial process of identifying valid,potentially useful and ultimately understandable pattern in data.It refers to extracting or mining knowledge from larger databases.

What data mining can do?

Data mining can do basically six tasks. The first three are all examples of directed data mining, where the goal is to use the available data to build a model that describes one particular variable of interest in terms of the rest of the available data. The next three tasks are examples of undirected data mining where no variable is singled out.

Data Mining Techniques and Algorithms

Data mining algorithms specify a variety of problems that can be modeled and solved. Data mining functions generally classified into two categories:

1. **Supervised Learning**
   The task of inferring from a training **set**. Use feedback.It requires prior knowledge
2. **Unsupervised Learning**
   The task of inferring from an unlabelled set .Don't require prior knowledge.

Commonly used techniques are:

Artificial neural network

- Non-linear predictive models
- Learn through training.

Decision trees

- Tree-shaped structures.
- Represent sets of decisions.

Methods include

- Classification and Regression Trees (CART)
- Chi Square Automatic Interaction Detection (CHAID).

Genetic algorithms:

- Optimization techniques
- Use processes such as genetic combination, mutation based on the concepts of evolution.

Nearest neighbour method

- It is a technique which classifies each record in a dataset based on a combination of the classes of the k record(s).
- Also called as k-nearest neighbour technique.

Rule induction

- Extracting useful if-then rules from a database based on statistics.

Knowledge discovery in Datamining

KDD is a process of identifying a valid, potentially useful and understandable structure in data as knowledge analysis or pattern evolution.

Steps in KDD

Data Cleaning -Process of removing noise and inconsistent data.

Data Integration –Process of combining data from multiple sources.

Data Selection –Process of retrieving relevant data from a database.

Data Transformation –Process where data's are transformed or consolidated into appropriate forms for mining by performing summary or aggregate operations.

Data Mining –Essential process where intelligent methods are applied inorder to extract data patterns.

Pattern Evaluation –Patterns obtained in the data mining are converted into knowledge based on some intelligent methods.

Knowledge Presentation – Visualization and knowledge representation technique are used to present the mined knowledge to the user.

The following diagram shows the process of knowledge discovery.

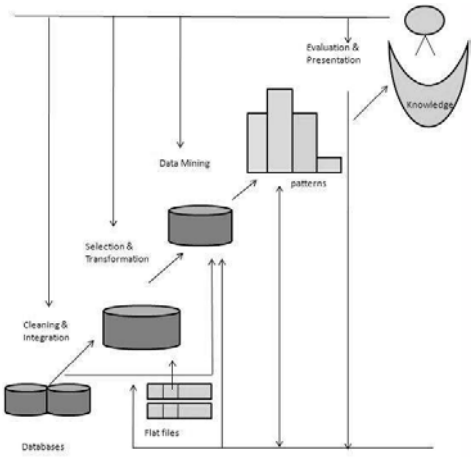


Fig.1: Steps in KDD

Data Mining in Banking Sector

Customer pays a vital role in the banking sector. DecisionTree which is implemented using CART algorithm is used for customer retention. Preventing fraud is better than detecting the fraudulent transaction later (i.e.) after its occurrence. For credit card approval, different data mining techniques such as Decision Tree, Support Vector Machine (SVM) and Logistic Regression are used. EM algorithm implemented using clustering model can be used to detect fraud.

Data Mining Techniques Used in Banking

Classification and Prediction

Most commonly applied data mining technique. It is employed where the classes of data in the volume are known. For example, in the case of detecting fraudulent banking transactions from a bank's transactions database, we have two happenings like fraudulent and non-fraudulent.

It constructs a model from the sample data items with known class labels and alsouses this model to predict the class of objects in the population whose classes are not known. Each row from the database contains one or more predicting attributes which determines the predicted class label of the tuple according to the constructed model. These models areconstructed using a decision tree model or a neural network model.

But prediction models works with continuous-valued functions. It is used to predict missing or unavailable numerical data values from the sample attribute values. Commonly used technique for prediction is regression analysis. It is a statistical methodology which is used to forecast values from existing numerical values. In banking various real world problems such as stock price predictions, credit scoring which follows complex models with many independent variables,and also further requires multidimensional regression analysis and logistic regression.

Cluster Analysis and Concept Formation

Clustering is similar to classification. But difference is that classes are not known before. Clustering is used to generate class labels. Concept formation is a closely related process to clustering.Inbanking, clustering and concept formation can be employed for classifying customers with same kind of transactions or queries to similar products or has similar risk aptitude. For example, in banking sector monthly earning (i.e. people working in organized sectors) customers tend to join investment plans with regular contributions. Knowledge about these classes will help the bankers indesigning products to each class of customers and can start doing on targeted and effective marketing campaigns.

Customer Retention in Banking Sector

Today, customers have so many opinions with regard to where they can choose to do their business. Therefore executives in the banking industry, must be aware that if they are not giving their full attention to their customers, the customer can simply find another bank.

Data mining helps in targeting 'new' customers for products and services and also in discovering a customer's previous purchasing patterns for their business success.

Losing the customers will be very expensive as to acquire a new customer. In this, I am discussing the predictive data mining techniques for the problem in banking sector. To improve customer retention(keeping), three steps are needed:

1. Measurement of customer retention;
2. Identification of root causes of defection and related key service issues;
3. Development of corrective action to improve retention.

Measurement of existing customer retention rates is the first and foremost step to improve loyalty.

Classification Methods

In this approach, risk levels are organized into two categories. For example, customers with past default history can be classified into "risky" group, whereas remaining are placed as "safe" group. Banks use this categorization information as target for prediction. These techniques can be used to build models which can predict default risk levels.

Decision Tree

Decision trees are the most popular predictive models. A decision tree is a treelike graph representing the relationships between a set of variables. To solve Decision tree models classification and prediction are used. Further, where instances are classified into one of two classes, typically positive and negative, or churner and non-churner in the churn classification case. These models are represented and evaluated in a top-down approach. Decision trees development involves two phases:

1) Tree building

Tree building starts from the root node that represents a feature of the cases that need to be classified.

2) Tree pruning

It is further divided into

Pre-pruning

Halt the construction of the tree in the early stage.

Post-pruning

Remove branches from the fully grown tree.

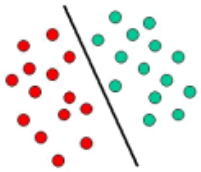
The pruning process is not only used to produce a smaller tree but also for a better generalisation. This process involves identifying and removing the branches that contain the largest estimated error rate. The main purpose of this process is to improve predictive accuracy and to reduce the decision tree complexity.

Support Vector Machine (SVM)

*Based on the concept of decision planes.

*A decision plane is one that separates between a set of objects having different class memberships

*A schematic example is illustrated below. In this example, the objects either belong to class GREEN or RED. The separating line defines 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 falling to the right is labelled (i.e.)they are classified as GREEN rest is classified as RED.



Classification SVM

Classification SVM Type 1

For this type of 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. $y \in \pm 1$ Is used to represent the class labels and xi is used to represent the independent variables. The kernel ϕ is used to transform data from the input that is independent to the feature space. Larger the C, the more the error is penalized. Thus, to avoid overfitting, C must be chosen with care.

Classification SVM Type 2

The Classification SVM Type 2 model minimizes the error function.

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

Subject to the constraints:

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

In a regression SVM, we have to estimate the functional dependence of the dependent variable Y on a set of independent variable X. Itassumes, like other regression problems, that the relationship between the independent and dependent variables is given by a deterministic function f plus the addition of some additive noise.

Regression SVM

The task is then to find a functional form for f which can correctly predict new cases that the SVM have not been presented before. This can be achieved by training the SVM model on a sample set (i.e.) a process which involves similar to classification. Depending on the definition of this error function, two types of SVM models can be recognized:

Regression SVM Type 1

For this type of SVM the error function is:

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

Which we minimize subject to:

$$w^T \phi(x_i) + b - y_i \leq \varepsilon + \xi_i^{\bullet}$$

$$y_i - w^T \phi(x_i) - b_i \leq \varepsilon + \xi_i$$

$$\xi_i, \xi_i^{\bullet} \geq 0, i = 1,\ldots, N$$

Regression SVM Type 2

For this SVM model, the error function is given by:

$$\frac{1}{2} w^T w - C\left(v\varepsilon + \frac{1}{N}\sum_{i=1}^{N} \left(\xi_i + \xi_i^{\bullet}\right)\right)$$

Which minimize subject to:

$$\left(w^T \phi(x_i) + b\right) - y_i \leq \varepsilon + \xi_i$$

$$y_i - \left(w^T \phi(x_i) + b_i\right) \leq \varepsilon + \xi^{\bullet}{}_i$$

$$\xi_i, \xi^{\bullet}{}_i \geq 0, i = 1,\ldots, N, \varepsilon \geq 0$$

There are number of kernels that can be used in Support Vector Machines models. This include linear, polynomial, radial basis function (RBF) and sigmoid.

Kernel Functions

$$K(\mathbf{X}_i, \mathbf{X}_j) = \begin{Bmatrix} \mathbf{X}_i \cdot \mathbf{X}_j & \text{Linear} \\ \left(\gamma \mathbf{X}_i \cdot \mathbf{X}_j + C\right)^d & \text{Polynomial} \\ \exp\left(-\gamma \left| \mathbf{X}_i - \mathbf{X}_j \right|^2\right) & \text{RBF} \\ \tanh\left(\gamma \mathbf{X}_i \cdot \mathbf{X}_j + C\right) & \text{Sigmoid} \end{Bmatrix}$$

Where

$$K(\mathbf{X_i}, \mathbf{X_j}) = \phi(\mathbf{X_i}) \bullet \phi(\mathbf{X_j})$$

That is, the kernel function, represents a dot product of input data points mapped into the higher dimensional feature space by transformation ϕ.

Gamma is an adjustable parameter of certain kernel functions. Most popular choice of kernel types is the RBF. RBF which is commonly used in Support Vector Machines.

EM

It is generally used as a clustering algorithm (like k-means)for knowledge discovery. In statistics, the EM algorithm iterates and optimizes the likelihood of observed data while estimating the parameters of a statistical model with unobserved variables.

How does EM help with clustering?

EM follows an iterative 3- step process:

1. **E-step:**
   It calculates the probabilities for assignments of each data point to a cluster.
2. **M-step:**
   Update the model parameters based on their cluster assignments from the E-step.

Repeat until the model parameters and cluster assignments stabilize. It belongs to unsupervised learning.

Purpose of Using EM

It's simple and straight-forward to implement. In addition, not only can it optimize for model parameters, it can also iteratively make guesses about missing data. This makes it great for clustering and generating a model with parameters.

Disadvantages of EM

*****First, EM is fast in the early iterations, but slow in the later iterations.

*Second, EM doesn't always find the optimal parameters and gets stuck in local optima rather than global optima.

Where EM Algorithm is used?

*****The EM algorithm is available in Weka.

C5.0

C5.0 builds decision trees from a set of training data in the similar way as ID3, using the concept of data entropy.

CART

*CART stands for Classification and Regression tree.

*create binary tree

*Use entropy to choose best splitting

$$\Phi(s/t) = 2\, P_L\, P_R \sum_{j=1}^{m} |\, P(C_j \backslash T_L) - P(C_j \backslash T_R)|$$

Where $P_{L,PR}$ probability that a tuple in the training set will be on the left or right side of the tree.

Automatic Credit Approval Using Classification Method

It is the most important process in the banking sector. Fraud can be prevented by taking a good decision by using the classification models based on decision trees (i.e.) C5.0 & CART, Support Vector Machine (SVM) and Logistic Regression Techniques.

Logistic Regression

Logistic regression or log it regression is a type of regression analysis used for predicting the outcome of a categorical dependent variable based on one or more predictor variables. Instead of fitting data in a straight line, logistic regression uses a logistic curve.

Application Areas of Data Mining in Banking

Banking systems contains huge volumes of data. Data's can be both operational and historical. Banks who apply data mining techniques in their decision making hugely benefit and hold an edge over others

who don't. Some of these decisions are in the areas of marketing, risk management and default detection, fraud detection, customer relationship management and money laundering detection.

$$p = \frac{e^{c_0 + c_1 x_1}}{1 + e^{c_0 + c_1 x_1}}$$

Risk Management and Default Detection

Every lending decision by bank involves certain amount of risk. Quantifying this risk can make the risk management process easier and limit the risk of financial loss to the bank. Knowing customers' capability to repay can greatly improve a credit manager's decisions.

Data mining can also help to identify which customer is going to delay or default a loan repayment. This advanced knowledge can help the bank to take corrective measures to prevent losses. For such forecasting, things to be considered are turn balance sheet figures, limit utilization, behavioural patterns and cheque return patterns. Historical default patterns can also help in predicting future defaults when same pattern are discovered.

Data mining techniques are applied to improve the efficiency of credit scores and predict default probabilities. Credit score is a value representing a borrower's credit worthiness. Behavioural scores are obtained from probability models of customer behaviour to predict their future behaviours.

Data mining can derive this score using the past behaviours of the borrower related to debt repayments by analyzing available credit history.

Money Laundering Detection

Money Laundering is the process of hiding the illegal origin of "black" money in order to regular it. Banks are commonly used as a canal to launder money. Therefore governments and financial regulators require banks to implement processes, systems and procedures to detect and prevent money laundering transactions.

Conventional rule-based transaction analysis i.e. based on reports will not be efficient to detect more complicated transaction patterns. Here data mining techniques can be applied to dig out transaction patterns that can lead to money laundering. Typically such systems take client risk assessment data, transaction risk measurement data and patterns and behaviour patterns into consideration for detecting money laundering patterns. Transactions are then grouped into clusters based on their similarities. In a large database of banking transactions, it is possible that a huge number of patterns emerge and will be classified as money laundering transactions thereby increasing false positives. Statistical false reduction methods based on decision tree classification are used to limit the number of false patterns detected.

Fraud Detection

Banks lose huge amount of money annually because of various frauds. Detecting fraud transactions can help the banks to act early and also in limiting the damages. Fraud detection is the process of identifying fraudulent transactions from genuine transactions. Mostly fraud detection takes place in the credit card products.

Clustering which is the process of grouping similar items and which won't satisfy the conditions are called as outliers which can be used for fraud detection. Clustering method which classifies customer's transactions and outliers can be used for analyzing frauds. Probability of credit card user's past behaviour can be modeled and the probability of current behaviour can be calculated to detect frauds. Patterns of customer's transactions can be discovered and alerts can be generated if any major deviations are found. Financial statement fraud detection is another area where data mining principles can be effectively used.

Top 10 Frauds in the Indian Banking Sector

The "Reserve Bank of India" maintains data on frauds on the basis of area of operation under which the frauds have been perpetrated. According to such data pertaining, top 10 categories under which frauds have been reported by banks are as follows

1. Credit Cards
2. Deposits – Savings A/C
3. Internet Banking
4. Housing Loans
5. Term Loans
6. Cheque / Demand Drafts

7. Cash Transactions
8. Cash Credit A/c (Types of Overdraft A/C]
9. Advances
10. ATM / Debit Cards

Marketing

Bank analysts can analyze the past trends, determine the present demand and forecast the customer behaviour of various services .They anticipate behaviour patterns. Data mining technique also helps to identify the customer value.

Investment Banking

Investment is an action of investing money into an asset for profit. Banks often offer investment services to their customers. K-means clustering can be applied to choose the best investments based on customer's profile. Capability to predict asset prices from historic prices can increase returns from investment tremendously. Data mining techniques for prediction like neural networks and linear regression can be employed for prediction of prices for stocks. Data mining can also be applied in time series analysis for financial applications.

Neural Network

*Have the remarkable ability to derive meaningful from complicated data and can be used to extract patterns and to detect trends that are too complex to be noticed by either humans or by other computer techniques.

Linear Regression

*A data mining function that predicts a number, income or sales can be predicted using regression techniques.

Risk Management

Data mining techniques helps to distinguish borrowers who have not repayed their loans. It also helps to predict when the borrower is at default, whether providing loan to a particular customer will be repayed or not.

CONCLUSION

Data mining is a process to extract knowledge from existing data. It is used as a tool in banking sector to enable better decision-making. It is an interdisciplinary field,a large assemblage of Statistics, Database technology, Information science, Machine learning and Visualization. It involves data selection, data integration, data transformation, data mining, pattern evaluation, knowledge presentation. Banks use data mining in different fields like marketing, fraud detection, risk management, money laundering detection and investment banking. The patterns detected help the bank to forecast future events that can result in its decision-making processes.

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