Privacy Preservation and Data Mining

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ABSTRACT

The growing popularity and development of data mining technologies bring serious threat to the security of individual's sensitive information. An emerging research topic in data mining, known as privacy preserving data mining (PPDM), has been extensively studied in recent years. The basic idea of PPDM is to modify the data in such a way so as to perform data mining algorithms effectively without compromising the security of sensitive information contained in the data. Current studies of PPDM mainly focus on how to reduce the privacy risk brought by data mining operations, while in fact, unwanted disclosure of sensitive information may also happen in the process of data collecting, data publishing, and information (i.e., the data mining results) delivering. The author is trying to reduce the privacy risk brought by data mining operations. Privacy among the data provided is maintained. That is by preventing the any data leak, data movement or any third party access to it. Also maintain the refresh rate for third party access and performed the data mining using the k-means clustering. The collected data is showed in graph format which shows the histogram of average improvement of structure.

Keyword: - *PPDM , Data Mining, K-means Clustering, Privacy Preservation*

1. Introduction

In modern days organizations are extremely dependent on Data Mining results to provide better service, achieving greater profit, and better decision-making. For these purposes organizations collect huge amount of data. Data Mining deals with automatic extraction of previously unknown patterns from large amounts of data sets. This data includes sensitive data about Individuals or organizations. While running Data Mining algorithm against such data, the algorithm not only extracts the knowledge but it also reveals the information which is considered to be private. The real threat is that once information gets exposed to unauthorized party, it will be impractical to stop misuse. Privacy can for instance be threatened when Data Mining techniques uses the identifiers which themselves are not very sensitive, but are used to connect personal identifiers such as addresses, names etc., with other more sensitive personal information. Privacy is very important for trusted collaboration and interactions. Because of these privacy and data security concerns in data mining, the data owner hesitates while sharing data for data mining activities. And this creates barrier in data mining task. Privacy preserving data mining technique gives new direction to solve this problem [1].

Solution to this problem is provided by Privacy preserving in data mining (PPDM). PPDM is a specialized set of Data Mining activities where techniques are evolved to protect privacy of the data, so that the knowledge discovery process can be carried out without barrier. The objective of PPDM is to protect sensitive information from leaking in the mining process along with accurate Data Mining results. In PPDM, new techniques are invented to provide privacy for the knowledge discovered in Data Mining. It also takes care that knowledge discovery process should not be banned because of privacy reason [2].

2. System description

The data miner applies mining algorithms to the data provided by data collector, and he wishes to extract useful information from data in a privacy-preserving manner. PPDM covers two types of protections, namely the protection of the sensitive data themselves and the protection of sensitive mining results. With the user role-based methodology proposed, it is consider that the data collector should take the major responsibility of protecting sensitive data, while data miner can focus on how to hide the sensitive mining results from untrusted parties. To perform data mining on the available information in this project we used the k-means clustering algorithm on the data available to us.

The system architecture is composed of three parts, it’s also called as Three-tier architecture. It is a well-established software application architecture that organizes applications into three logical and physical computing tiers:

I] Presentation tier (JSP)

The presentation tier is the user interface and communication layer of the application, where the end user interacts with the application. Its main purpose is to display information to and collect information from the user. This top-level tier can run on a web browser, as desktop application, or a graphical user interface (GUI), for example. Web presentation tiers are usually developed using HTML, CSS, JSP.

II] Application tier (Servlet)

The application tier, also known as the logic tier or middle tier, is the heart of the application. In this tier, information collected in the presentation tier is processed - sometimes against other information in the data tier - using business logic, a specific set of business rules. Servlets, through JDBC, can interact with database systems. Uses SQL for queries, and JDBC drivers handle the specifics of interacting with each database system.

III] Data tier (PostgreSQL)

The data tier, sometimes called database tier, data access tier or back-end, is where the information processed by the application is stored and managed.

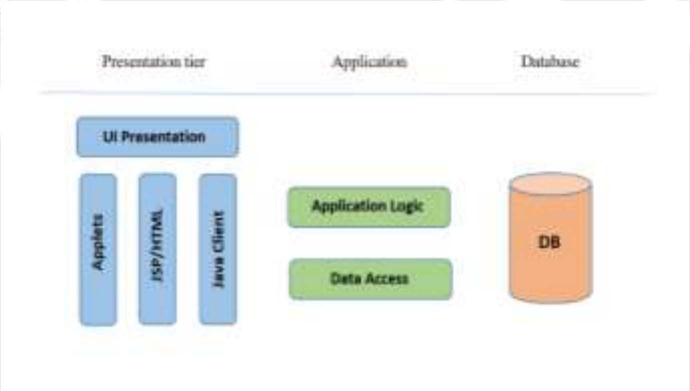


Fig -1: System Architecture

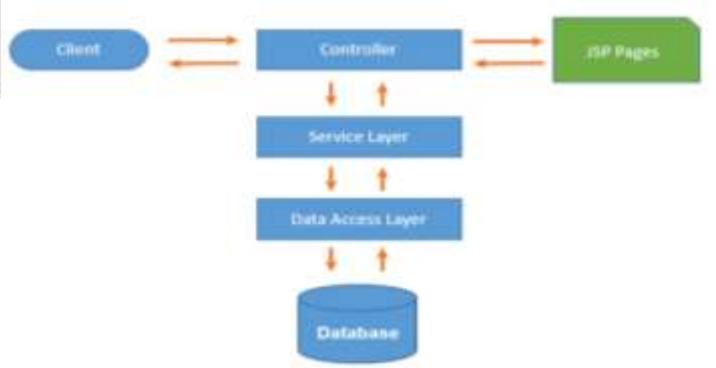


Fig -2: Workflow

2.1 k-means clustering

K-means clustering is one of the simplest and popular unsupervised machine learning algorithms. A cluster refers to a collection of data points aggregated in together because of certain similarities. The K-means algorithm in data mining starts with a first group of randomly selected centroids, which are used as the beginning points for every cluster, and then performs iterative (repetitive) calculations to optimize the positions of the centroids.

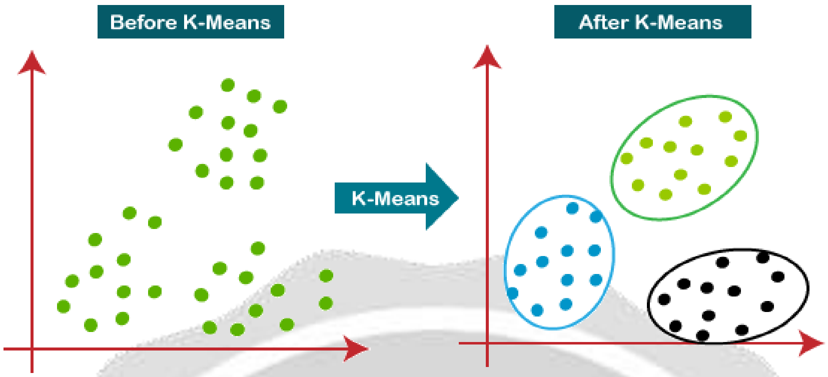
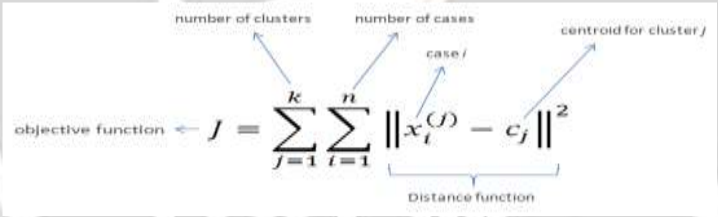


Fig -3: K-means Clustering

The working of the K-Means clustering algorithm:
Step-1: Select the number K to decide the number of clusters.
Step-2: Select random K points or centroids. (It can be other from the input dataset).
Step-3: Assign each data point to their closest centroid, which will form the predefined K clusters.
Step-4: Calculate the variance and place a new centroid of each cluster.
Step-5: Repeat the third steps, which means reassign each data point to the new closest centroid of each cluster.
Step-6: If any reassignment occurs, then go to step-4 else go to FINISH.
Step-7: The model is ready.



$$J = \sum_{j=1}^{k} \sum_{i=1}^{n} \underbrace{\left\| x_i^{(j)} - c_j \right\|^2}_{\text{Distance function}}$$

3. Result

Admin and user both are allowed to create the website by which means they are providing the data, making them the data provider. Privacy among the data provided by them is maintained. That is by preventing the any data leak, data movement or any third party access to it. The data available is of smaller amount and the distributed database improves the efficiency of the algorithm and reduces the time complexity of algorithm.

By using java library of the k-means clustering algorithm, the time spend by user on the particular site is collected from database and showed in mini session which is access by admin. The collected data is showed in graph format which shows the histogram of average improvement of website structure.

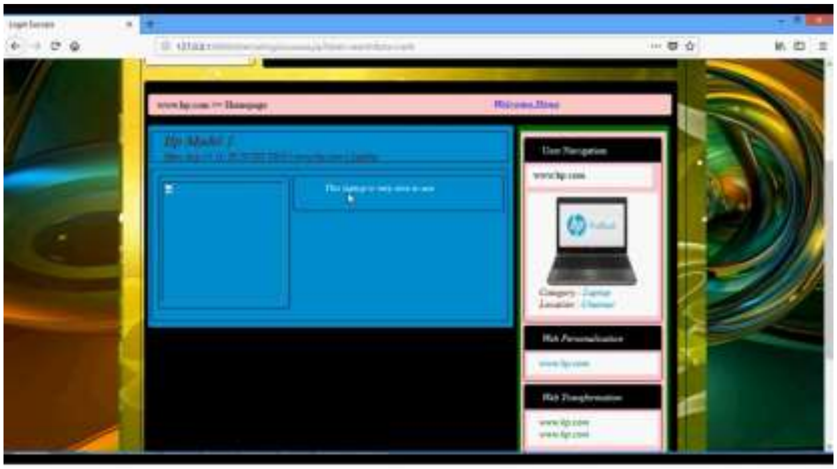
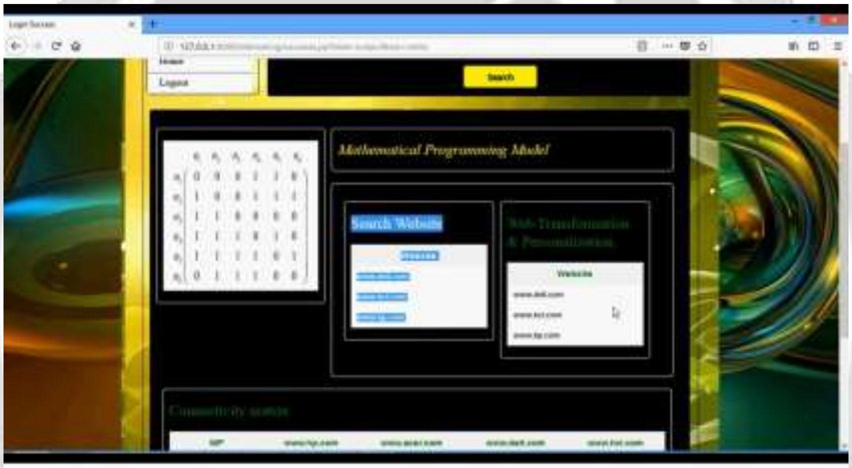
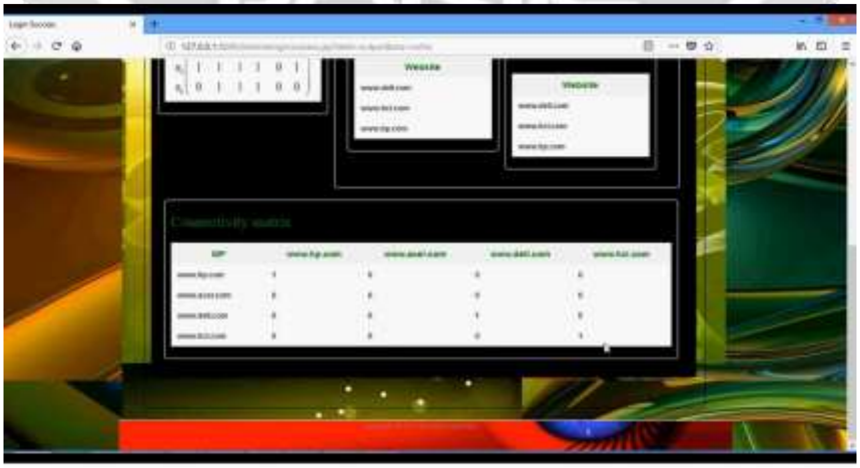


Fig -4: User searched page.



$$\begin{array}{c|cccccc} & e_1 & e_2 & e_3 & e_4 & e_5 & e_6 \\ \hline e_1 & 0 & 0 & 0 & 1 & 1 & 0 \\ e_2 & 1 & 0 & 0 & 1 & 1 & 1 \\ e_3 & 1 & 1 & 0 & 0 & 0 & 0 \\ e_4 & 1 & 1 & 1 & 0 & 1 & 0 \\ e_5 & 1 & 1 & 1 & 1 & 0 & 1 \\ e_6 & 0 & 1 & 1 & 1 & 0 & 0 \end{array}$$

Fig -4: Mathematical Programming model



SIP	www.hp.com	www.asus.com	www.dell.com	www.hcl.com
www.hp.com	1	0	0	0
www.asus.com	0	0	0	0
www.dell.com	0	0	1	0
www.hcl.com	0	0	0	1

Fig -6: Mathematical Programming Model

Fig -7: Mini Session

Fig -8: Mini Session

4. CONCLUSIONS

How to protect sensitive information from the security threats brought by data mining has become a hot topic in recent years. We differentiate four different user roles that are commonly involved in data mining applications, i.e. data provider, data collector, data miner and decision maker. Each user role has its own privacy concerns, hence the privacy-preserving approaches adopted by one user role are generally different from those adopted by others: For data provider, his privacy-preserving objective is to effectively control the amount of sensitive data revealed to others. To achieve this goal, he can utilize security tools to limit other's access to his data, sell his data at auction to get enough compensations for privacy loss, or falsify his data to hide his true identity.

Also there is no guarantee that every participator will follow the protocol or truthfully share his data. Interactions among different participators need to be further investigated. Considering the nature of the data miner, game theory may be a proper tool for such problems. Some game theoretical approaches have been proposed for distributed data mining.

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