IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
Vol. 3, Issue 5, May 2016

A Survey On Data Mining and Cloud Computing

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Abstract: Data mining techniques are very important in the cloud computing paradigm. The integration of data mining techniques with Cloud computing allows the users to extract useful information from a data warehouse that reduces the costs of infrastructure and storage. Cloud computing is an emerging computing paradigm in which resources of the computing infrastructure are provided as services of the internet. Data mining is a field where accuracy matters a lot. Data mining techniques and applications are very much needed in the cloud computing paradigm. The implementation of data mining techniques through Cloud computing will allow the users to retrieve meaningful information from virtually integrated data warehouse that reduces the costs of infrastructure and storage.

Keywords: Cloud Computing, Data Mining.

I. INTRODUCTION

The Internet is becoming a surprisingly vital tool in our daily life, both professional and personal, as its users are becoming more numerous. The Cloud, as it is often referred to, involves using computing resources – hardware and software – that are delivered as a service over the Internet. At an equally significant extent in recent years, data mining techniques have evolved and became more used, discovering knowledge in databases becoming increasingly vital in various fields: business, medicine, science and engineering, spatial data etc[1]. It is not surprising that business is increasingly conducted over the Internet. Perhaps one of the most revolutionary concepts of recent years is Cloud Computing. The Cloud, as it is often referred to, involves using computing resources – hardware and software – that are delivered as a service over the Internet. The Cloud, as it is often referred to, involves using computing resources – hardware and software – that are delivered as a service over the Internet. The use of Cloud Computing is gaining popularity due to its mobility, huge availability and low cost. Cloud computing represents both the software and the hardware delivered as services over the Internet.

The emerging Cloud Computing trends provides for its users the unique benefit of unprecedented access to valuable data that can be turned into valuable insight that can help them achieve their business objectives. Cloud Computing is a new concept that defines the use of computing as a utility, that has recently attracted significant attention. The use of Cloud Computing is gaining popularity due to its mobility, huge availability and low cost[2]. The deployment models of cloud computing are private Cloud, community cloud, public cloud and hybrid cloud. The deployment models of cloud computing are private Cloud, community cloud, public cloud and hybrid cloud. Many companies are choosi ng as an alternative to building their own IT infrastructure to host databases or software, having a third party to host them on its large servers, so the company would have access to its data and software over the Internet Cloud.

A. Combining Cloud Computing And Data Mining - Cloud Mining:

Cloud mining represents finding useful patterns or trends through large amounts of data. Data mining is defined as a type of database analysis that attempts to discover useful patterns or relationships in a group of data [1]. Cloud computing represents both the software and the hardware delivered as services over the Internet. Cloud Computing is a new concept that defines the use of computing as a utility, that has recently attracted significant attention. The analysis uses advanced statistical methods, such as cluster analysis, and sometimes employs artificial intelligence or neural network techniques. A major goal of cloud mining is to discover previously unknown relationships among the data, especially when the data come from different databases. The service models that compose cloud computing are Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). The deployment models of cloud computing are private cloud, community cloud, public cloud and hybrid cloud. Cloud computing represents all possible resources on the Internet, offering infinite computing power. Considering the varied data mining techniques and the great need for discovering patterns and trends in data that would lead to knowledge that could not be obtained otherwise, it's no wonder that data mining is used in the most varies field of activity. As it is defined by the National Institute of Standards and Technology, "Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
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Vol. 3, Issue 5, May 2016

shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model is composed of five essential characteristics, three service models, and four deployment models"[2].

II. RELATED WORKS

The cloud computing is the next evolution of internet computing which provides cost effective solutions for storing and analyzing huge amount of data. Data mining on cloud computing paradigm can benefit us to a great extent. The mining in cloud is a difficult problem as the availability of the enormous data needed to work is an issue. There has been progress in works related to data mining and cloud computing in the recent era.

B. Data Mining Works

Data mining provides methods that allow extracting from large data collections unknown relationships among the data items that are useful for decision making. Thus data mining generates novel, unsuspected interpretations of data [1] [3]. Web usage information can be analyzed and exploited to optimize information access [4].

In [5], the author Fayyad describes the various data mining techniques that allow extracting unknown relationships among the data items from large data collection that are useful for decision making. The wide-spread use of distributed information systems leads to the construction of large data collections in business, science and on the Web. These data collections contain a wealth of information, which however needs to be discovered. Businesses can learn from their transaction data more about the behavior of their customers and therefore can improve their business by exploiting this knowledge. Science can obtain from observational data (e.g. satellite data) new insights on research questions.

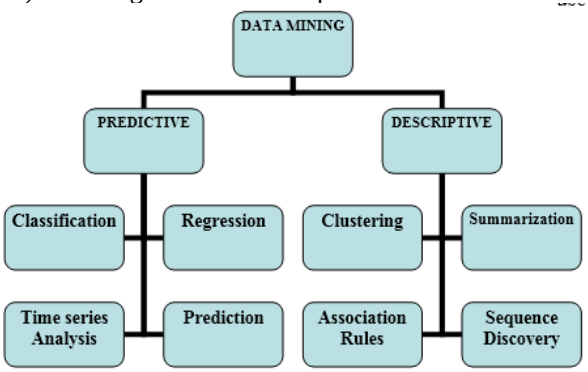

Fig.1. Data mining techniques

In practice the two fundamental goals of data mining tend to be: prediction and description as shown in figure 1.

1) Prediction makes use of existing variables in the database in order to predict unknown or future values of interest.
2) Description focuses on finding patterns describing the data and the subsequent presentation for user interpretation. The relative emphasis of both prediction and description differ with respect to the underlying application and the technique.

The methods of data mining (key techniques):

1) Association: Association (or relation) is probably the better known and most familiar and straight forward data mining technique. Here, you make a simple correlation between two or more items, often of the same type to identify patterns.
2) Classification: Piatetsky et.al[6] proposes a classification technique by providing training to various data set. You can use classification to build up an idea of the type of customer, item, or object by describing multiple attributes to identify a particular class. For example, you can easily classify cars into different types (sedan, 4x4, convertible) by identifying different attributes (number of seats, car shape, driven wheels). Additionally, you can use classification as a feeder to, or the result of, other techniques. For example, you can use decision trees to determine a classification. Clustering allows you to use common attributes in different classifications to identify clusters.
3) Clustering: G.P and MARTY et.al[7] examines in the paper, how Clustering technique is useful to identify different information by considering various examples and one can see where the similarities and ranges agree. By examining one or more attributes or classes, you can group individual pieces of data together to form a structure opinion. At a simple level, clustering is using one or more attributes as your basis for identifying a cluster of correlating results. Clustering can work both ways. You can assume that there is a cluster at certain point and then use our identification criteria to see if you are correct [8] [9].
4) Prediction: T.HASTIE et.al [10] proposes prediction method in combination with the other data mining techniques, involves analysing trends, classification, pattern matching, and relation. Prediction is a wide topic and runs from predicting the failure of components or machinery, to identifying fraud and even the prediction of company profits. By analyzing past events or instances, you can make a prediction about an event.
5) Sequential patterns: R.DUDA and P.HART [11] describes the various uses of sequential patterns for identifying trends, or regular occurrences of similar events. For example, with customer data you can identify that customers buy a particular collection of products together at different times of the year. In a shopping basket application, you can use this information to automatically suggest that certain items be added to a basket based on their frequency and past purchasing history [12].

C. Cloud Computing Works

Cloud computing has recently emerged as a new paradigm for hosting and delivering services over the Internet. Cloud computing is attractive to business owners as it eliminates the requirement for users to plan ahead for provisioning,

and allows enterprises to start from the small and increase resources only when there is a rise in service demand. However, despite the fact that cloud computing offers huge opportunities to the IT industry, the development of cloud computing technology is currently at its infancy, with many issues still to be addressed. Some of the works related to the development of cloud computing is as mentioned below.

Nattakarn Phaphoom et al. [13] provide a comprehensive review on the building blocks of cloud computing and relevant technological aspects. It focuses on four key areas including architecture, virtualization, data management, and security issues.

Gaurav Dhiman et al. [14] present v Green, a multi-tiered software system for energy efficient computing in virtualized environments. It comprises of novel hierarchical metrics that capture power and performance characteristics of virtual and physical machines, and policies, which use it for energy efficient virtual machine scheduling across the whole deployment.

Ramesh et al. [15] explains basic power management scheme in the general computing as well as grid computing. And this paper strongly performed an analysis on various categories of real time grid systems. The power consumption on various grid levels based on multiple volumes in the organization level is analyzed. The conclusion is focused the future requirement of research direction in the energy efficient system design of grid computing.

Barroso et al. [16] describes energy-proportional designs which enable large energy savings in servers, potentially doubling their efficiency in real-life use. Achieving energy proportionality will require significant improvements in the energy usage profile of every system component, particularly the memory and disk subsystems.

Aman Kansal et al. [17] describe the challenges developers face in optimizing software for energy efficiency by exploiting application-level knowledge. To address these challenges, we propose the development of automated tools that profile the energy usage of various resource components used by an application and guide the design choices accordingly.

Henri Arjamaa et al. [18] present energy consumption estimates of ICT equipment in Finland and in three important industrial countries, namely the United States, Germany, and the United Kingdom. In addition, a worldwide estimate of the energy consumption of data centers is presented. The results are then analyzed, which give answers to questions, such as how valid are the estimation methods used and are the estimation methods comparable with each other.

Christopher K. Lennard et al. [19] describe re synthesis procedures used for reducing power consumption in CMOS networks have produced poor results as they select nodes for resynthesis based upon local circuit properties. In this, a technique is presented for optimizing the choice of regions used in resynthesis. The cost function which is developed is able to predict the amount of global improvement in power expected through the resynthesis of network nodes under both zero as well as arbitrary delay assumptions.

Pinheiro et al. [20] have proposed a technique for managing a cluster of physical machines with the objective of minimizing the power consumption, while providing the required Quality of Service (QoS). The authors use the throughput and execution time of applications as constraints for ensuring the QoS. Here nodes are assumed to be homogeneous. The algorithm periodically monitors the load and decides which nodes should be turned on or off to minimize the power consumption by the system, while providing expected performance.

Srikantaiah et al. [21] have investigated the problem of dynamic consolidation of applications in virtualized heterogeneous systems in order to minimize energy consumption, while meeting performance requirements. The authors have explored the impact of the workload consolidation on the energy-per-application metric depending on both CPU and disk utilizations.

Elnozahy et al. [22] have investigated the problem of power-efficient resource management in a single web-application environment with fixed response time and load-balancing handled by the application. The two main power-saving techniques are switching power of computing nodes on or off and Dynamic Voltage and Frequency Scaling (DVFS).

Nathuji and Schwan et al. [23] have studied power management techniques in the context of virtualized data centers, which has not been done before. Besides hardware scaling and VMs consolidation, the authors have introduced and applied a new power management technique called “soft resource scaling.

Dodonov and De Mello et al. [24] have proposed an approach to scheduling distributed applications in Grids based on predictions of communication events. They have proposed the migration of communicating processes if the migration cost is lower than the cost of the predicted communication with the objective of minimizing the total execution time.

Guo et al. [25] have proposed and implemented a virtual cluster management system that allocates the resources in a way satisfying bandwidth guarantees. The allocation is determined by a heuristic that minimizes the total bandwidth utilization. The VM allocation is adapted i.e. migration is performed when some of the VMs are reallocated or power off but protocols for the migration are defined statically.

Berral et al. [26] presented a theoretical approach for handling energy-aware scheduling in data centers. Here,

the authors propose a framework which provides an allocation methodology using techniques that include turning on or off machines, power-aware allocation algorithms and machine learning to deal with uncertain information while the expected QoS is maintained through the avoidance of SLA violations.

Song et al. [27] have proposed resource allocation to applications according to their priorities in multi-application virtualized cluster. The approach requires machine learning to obtain utility functions for the applications and define application priorities.

Jie Liu et al. [28] we argue that servers can be sent to homes and office buildings and used as a primary heat source. We call this approach the Data Furnace or DF. Data Furnaces have three advantages over traditional data centers:
1) A smaller carbon footprint
2) Reduced total cost of ownership per server
3) Closer proximity to the users.

From the home owner's perspective, a DF is equivalent to a typical heating system: a metal cabinet is shipped to the home and added to the ductwork or hot water pipes.

Cloud Computing Security Based Paper Sahai et al. [29] proposed Attribute-Based Encryption (ABE) Fuzzy Identity-Based Encryption, with the original goal of providing an error-tolerant identity-based encryption [24] scheme that uses biometric identities.

Pirretti et al [30] proposed an efficient construction of ABE under the Random Oracle model and demonstrated its application in large-scale systems. Goyal et al. enhanced the original ABE scheme by embedding a monotone access structure into user secret key.

Goyal et al. [31] proposed Key-Policy Attribute-Based Encryption (KP-ABE), a variant of ABE. In the same work, Goyal et al. also proposed the concept of Cipher text-Policy Attribute Based Encryption (CP-ABE) without presenting a concrete construction. CP-ABE is viewed as another variant of ABE in which cipher texts are associated with an access.

Ostrovsky et al. [32] proposed an enhanced KP-ABE scheme which supports non-monotone access structures. Chaseet al. [29] Enhanced Sahai-Waters ABE scheme and Goyal et al. KP-ABE scheme by supporting multiple authority. Further enhancements to multi-authority ABE can be found.

Bethencourt et al. [33] proposed the first CP-ABE construction with security under the Generic Group model. In Cheung et al. [29] presented a CCA-secure CP-ABE construction under the Decisional Bilinear Diffie-Hellman (DBDH) assumption.

Waters et al. [34] proposed another CP-ABE scheme under various security assumptions. Aside from providing basic functionalities for ABE, there are also many works proposed to provide better security/privacy protection for ABE.

Goyal et al. [35] proposed a CP-ABE construction with an exponential complexity which can just be viewed as theoretic feasibility. For the same goal, these works include CP-ABE with hidden policy, ABE with user accountability and ABE with attribute hierarchy.

II. AREAS FOR SECURE CLOUD- DATA MINING APPLICATION

Governments can discern illegal or embargoed activities done by individuals, associations or other governments with the implementation of the data mining techniques. Businesses can make predictions about how well a product will sell or develop new advertising campaigns by using these new relationships reflected by the data mining algorithms. The medical sector benefits from the data mining techniques, as well as the geographical data being better analyzed by using data mining. In short, data mining has developed uses in the majority of field of activity. Cloud has been able to generate and collect large amount of information. The Internet has a great importance in the society providing information exchange and communicatio n environmentin trade relations and social interactions. The increasing use of the Internet and the fast advance of new technologies have motivated the development of the Future Internet.

Cloud computing needs to address three main security issues: confidentiality, integrity and availability. Cloud computing has transfigured the way computing and software services are delivered on demand to the clients. Due to the greater level of flexibility, the cloud has become the proliferating ground of a new generation of products and services. However, the flexibility of services of cloud imposes the risk of the security and privacy of user data. Thus, users of cloud are more concerned about the security of their data and this is becoming a major barrier to the widespread growth of cloud computing. One of the security concerns of cloud is data mining based privacy attacks that involve analyzing data over a long period to extract valuable information. In particular, in current cloud architecture a client entrusts a single cloud provider with his data. It gives the provider and outside attackers having unauthorized access to cloud, an opportunity of analyzing client data over a long period to extract sensitive information that privacy violation of clients. This is a big concern for many clients of cloud. Therefore the data mining based privacy risks on cloud data must be identified and solution such as a distributed architecture should be used to eliminate the risks. Most of the business organizations try to analyze their data to discover new patterns. Usually, analyzing such amount of data requires huge computational power and storage facilities that may not be available to theseorganizat ions. Cloud computing offers the best way to solve this problem. Storing the private data of different in the same cloud server enhances the mining process, but at the

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
Vol. 3, Issue 5, May 2016

same time, raises privacy concerns. It is, therefore, highly recommended to support privacy preserving data mining algorithms in the cloud environment. To assure privacy preserving data mining in the cloud a solution is ne eded providing an efficient and accurate cryptography-based scheme for mining the cloud data in a secure way without loss of accuracy. Many companies are opting for cloud storage; hence it is important to use an efficient and effective data mining strategy to mine the cloud storage to extract interesting patterns and relationship between variables in large databases. These data patterns may be forecasting or predictions that can be used by the companies in near future to increase their sales. The generated predictions which are result of mining should be very well secured from interception. To provide a solution for this privacy concern a Secure Cloud Mining (SCM) architecture that will generate a Secure Forecasting Report (SFR) for the company can be used.

III. DATA MINING ON CLOUD

Data mining is used by cloud providers to provide clients a better service. If the clients are not aware of the information collected through mining then the privacy of the client may be violated. If the cloud providers in any way or means misuse this information, the client privacy is endangered. Again attackers outside cloud providers may have a prohibited accessto the cloud, and gai n the opportunity to mine cloud data. Attackers can use computing power provided by cloud computing to mine data getting access to useful information from data. Cloud being a massive source of centralized data, data mining gives attackers a great advantage in extracting valuable information and thus violating clients data privacy. The implementation of data mining techniques through Cloud computing will provide the users an opportunity to retrieve meaningful information from integrated data warehouse that reduces the costs of infrastructure and storage. The important effect of data mining based cloud computing is that the customer needs to pay only for the data mining tool that he needs. Further the customer need not maintain an infrastructure of as he can use data mining through a browser.

IV. SOME ISSUES OF CLOUD COMPUTING-BASED DATA MINING

There are some problems of data mining based on cloud including-

- The design and selection of data mining algorithms.
- Using appropriate algorithms and adopting appropriate
- parallel strategy can assist in increasing efficiency.
- Setting appropriate parameters is also very important.
- Privacy protection is a very important issue.

D. Client privacy and its importance:

Companies dealing with financial, educational, health or legal issues of people are prominent targets and leaking information of such companies can do significant harm to their customers. Information in this context refers to the financial condition of a customer, the likelihood of an individual getting a terminal illness, the likelihood of an individual being involved in a crime etc. Sometimes leaking information regarding a particular company leads to a national misfortune. Data Mining as a threat to client privacy Some mining algorithms allow to extract information up to the limit that violates client privacy. For example, multivariate analysis identifies the relationship among variables and this technique can be used to determine the financial condition of an individual from his buy-sell records, clustering algorithms can be used to categorize people or entities and are suitable for finding behavioral patterns, association rule mining can be used to discover association relationships among large number of business transaction records etc. Thus analysis of data can reveal private information about a user and leaking this sort of information may do significant harm.

Thus, data mining is becoming more powerful and possessing more threat to cloud users. In upcoming days, data mining based privacy attack can be a more regular weapon to be used against cloud users. Data mining techniques and applications are very much needed in the cloud computing paradigm. As cloud computing is penetrating more and more in all ranges of business and scientific computing, it becomes a great area to be focused by data mining.

B. The main effects of data mining tools being delivered by the Cloud are:

1) The customer only pays for the data mining tools that he needs – that reduces his costs since he doesn't have to pay for complex data mining suites that he is not using exhaustive;
2) The customer doesn't have to maintain a hardware infrastructure, as he can apply data mining through a browser this means that he has to pay only the costs th at are generated by using Cloud computing.

Using data mining through Cloud computing reduces the barriers that keep small companies from benefiting of the data mining instruments. Cloud Computing denotes the new trend in Internet services that rely on clouds of servers to handle tasks. Data mining in cloud computing is the process of extracting structured information from unstructured or semi-structured web data sources. The data mining in Cloud Computing allows organizations to centralize the management of software and data storage, with assurance of efficient, reliable and secure services for their users. The implementation of data mining techniques through Cloud computing will allow the users to retrieve meaningful information from virtually integrated data warehouse that reduces the costs of infrastructure and storage.

C. Cloud mining techniques

a. Clustering: Useful for exploring data and finding natural groupings. Members of a cluster are more like each other than they are like members of a different cluster. Common examples include finding new customer segments and life sciences discovery.

b. Classification: Most commonly used technique for predicting a specific outcome such as response/ no response, high / medium / low value customer, likely to buy / not buy.

c. Association: Find rules associated with frequently co-occurring items, used for market basket analysis, cross-sell, and root cause analysis. Useful for product bundling, in store placement, and defect analysis.

d. Regression: Technique for predicting a continuous num erical outcome such a customer lifetime value, house value, process yield rates.

e. Attribute Importance: Ranks attributes according to stre ngth of relationship with target attribute. Use cases include finding factors most associated with customers who respond to an offer, factors most associated with healthy patients.

f. Feature Extraction: Produces new attributes as linear combination of existing attributes. Applicable for text data, latent semantic analysis, data compression, data decomposition and projection, and pattern recognition.

V. CONCLUSION

Cloud computing have several benefits over traditional non-cloud environment and have capability to handle most sudden, temporary peaks in application demand on cloud infrastructures.

Virtualization technology provides good support to achieve aim of cloud computing like higher resource utilization, elasticity, reducing IT cost or capital expenditure to handle temporary loads as well as cloud computing have various flexible service and deployment models which is also one of the main issue of adopting this computing paradigm. Data mining on cloud computing paradigm can benefit us to a great extent. The mining in cloud is a difficult problem as the availability of the enormous data needed to work is an issue. But yet the applications and uses of the mining in the cloud are vast.

The researches on new and improved techniques on mining in the cloud will lead to more importance and use of the next generation of the Web mining which is the Cloud mining.

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