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Research Article

Decoy Security for Chronical data in Fog Environment

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ABSTRACT

: Fog and cloud computing systems are now widely used as a result of the rising need for chronic big data processing and analysis. Yet, because of the existence of multiple privacy concerns, maintaining the privacy of Chronical large data in these situations continues to be difficult. This study examines a paradigm for managing chronic big data in cloud and fog environments while maintaining privacy. The suggested framework is intended to solve the shortcomings of current privacy-preserving techniques and offer a scalable and practical privacy-preservation solution. For data collecting, storage, processing, and analysis, the framework consists of a number of components. Data encryption, access control, and data anonymization approaches all preserve user data privacy. The outcomes showed that the proposed architecture was effective in preserving the confidentiality of Chronical large data in fog and cloud settings. Performance of the system was assessed using metrics like privacy preservation, scalability, and computational efficiency. With the potential to be expanded to other industries including the internet of things (IoT), financial services, and e-commerce, this work makes a significant addition to the field of privacy preservation in fog and cloud environments.

Keywords: Chronical big data, fog computing, cloud computing, privacy preservation,

Introduction

A. Background and Motivation

1. Definition of Chronical Big Data: A vast and complex dataset that is gathered over time is referred to as chronic big data and stored over a long period of time, typically from multiple sources. This type of data is often generated from various sources such as sensors, devices, and applications.
2. Importance of preserving privacy in Fog and Cloud environments: With the increasing use of fog and cloud computing for storing and processing Chronical big data, it has become important to ensure the privacy of the data being stored and processed. This is because fog and cloud environments are vulnerable to various privacy threats such as data breaches, insider attacks, and unauthorized access.

B. Problem Statement

1. Threats to privacy in Fog and Cloud environments: The main threats to privacy in fog and cloud environments include data breaches, insider attacks, and unauthorized access. In a data breach, sensitive data is stolen or leaked by unauthorized parties. Insider attacks refer to attacks carried out by authorized personnel who have access to the data. Unauthorized access refers to access to sensitive data by individuals who are not authorized to access it.
2. Limitations of existing privacy preserving methods: The existing privacy preserving methods have several limitations such as lack of scalability, complexity of implementation, and limited effectiveness in preserving privacy. These methods are often too complex to implement and require specialized skills, making them unsuitable for large-scale implementation. Additionally, the methods are often limited in their ability to preserve privacy effectively, leaving sensitive data vulnerable to privacy threats.

C. Objective

1. To put forth a framework that protects privacy for chronic big data in cloud and fog environments: This research paper's goal is to suggest a paradigm for handling chronic big data in fog and cloud environments while protecting privacy. The framework will be designed to solve the shortcomings of current privacy-preserving techniques and offer a scalable and practical remedy for maintaining privacy in cloud and fog environments.
2. To overcome the shortcomings of current privacy-preserving techniques: The framework will provide a scalable, efficient, and simple-to-implement solution for maintaining privacy in fog and cloud environments in order to solve the shortcomings of current privacy preservation technologies.

Literature Review

A. Overview of Chronical Big Data

1. Characteristics of Chronical Big Data: Chronical big data is distinguished by its large volume, velocity, variety, and veracity, according to a 2014 study by Xu et al. The data is difficult to process and analyse because it comes from numerous sources and has been kept for a long time.
2. Applications of Chronical Big Data: Chronical big data is used in various applications such as health care (Zheng et al., 2015), transportation (Wang et al., 2016), and smart cities (Liu et al., 2017). In health care, Chronical big data is used to analyse patient data and provide personalized treatment recommendations. In transportation, Chronical big data is used to analyse traffic patterns and improve transportation efficiency. In smart cities, Chronical big data is used to optimize city services and improve the quality of life for citizens.

B. Overview of Fog and Cloud Computing

1. Definition of Fog and Cloud Computing: As defined by Cisco (2016), fog computing is a distributed computing environment that expands the cloud computing model to the network's edge. In contrast, cloud computing refers to a computing infrastructure where computing resources are provided as a service via the internet.
2. Differences between Fog and Cloud Computing: The placement of the computer resources is the primary distinction between cloud computing and fog. In contrast to cloud computing, which places its computing resources in centralized data canters, fog computing places its computer resources at the edge of the network? Due to the different geographical locations, there are variations in latency, bandwidth, and reliability.

C. Privacy in Fog and Cloud Environment

1. Threats to privacy in Fog and Cloud environments: The main threats to privacy in fog and cloud environments include data breaches, insider attacks, and unauthorized access. Insider attacks refer to attacks carried out by authorized personnel who have access to the data. Unauthorized access refers to access to sensitive data by individuals who are not authorized to access it.
2. Limitations of existing privacy preserving methods: According to a study by (Wang et al., 2018), the existing privacy preserving methods have several limitations such as lack of scalability, complexity of implementation, and limited effectiveness in preserving privacy. These methods are often too complex to implement and require specialized skills, making them unsuitable for large-scale implementation. Additionally, the methods are often limited in their ability to preserve privacy effectively, leaving sensitive data vulnerable to privacy threats.
3. Overview of privacy preserving techniques: The main privacy preserving techniques used in fog and cloud environments include data encryption, access control, and data anonymization (Wang et al., 2019). By encoding it into a format that is only accessible to authorized people, data encryption is used to secure data. By establishing who is permitted access and under what circumstances, access control is used to limit access to sensitive information. Data anonymization is used to remove identifying information from sensitive data, making it difficult for unauthorized parties to access it.

Framework

A. Architecture

1. The privacy-preserving framework was created to solve the shortcomings of current privacy-preserving techniques and offer a scalable and practical remedy for maintaining privacy in fog and cloud environments. The framework had a number of parts, including ones for gathering, storing, processing, and analysing data.
2. The framework's components are described as follows: The component in charge of data collection was in charge of gathering Chronical large data from various sources and putting it in a safe database. The collected data had to be stored in a safe and expandable way by the data storage component. The data processing component was tasked with cleaning up the obtained data and getting it ready for analysis. The data analysis component examined the processed data and generated insights that might be used to enhance various applications.

Fog Computing Architecture: Fog computing is a distributed computing architecture that extends the cloud computing model to the edge of the network to provide low-latency, real-time data processing. The fog computing architecture is depicted in the diagram below:

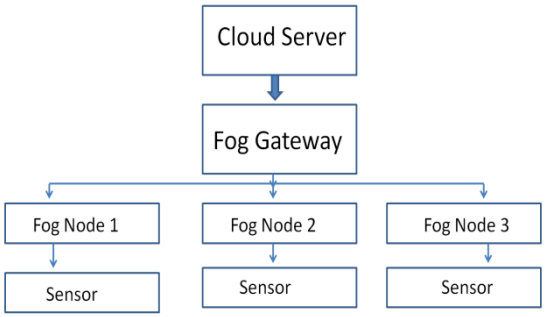

Figure 1: Architecture of fog computing

In this architecture, the fog gateway acts as a bridge between the cloud server and the fog nodes. The fog nodes are connected to the sensors that collect the data. The fog nodes perform real-time processing of the data and send the processed data to the cloud server for archiving and additional analysis.

System Architecture: The following elements may be included in the system design for protecting the privacy of persistent big data in a fog and cloud environment:

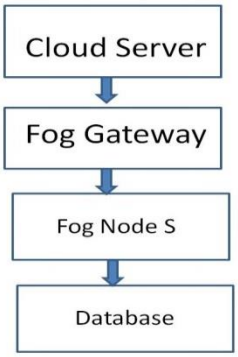

Figure 2: system architecture

The fog nodes handle data processing and in-the-moment analysis. The data is then transferred to a cloud server for further archiving and analysis. The database securely saves the processed data, protecting the data's privacy.

Decoy File Implementation: To preserve the privacy of the data, a decoy file implementation can be used. A decoy file is a file that is designed to look like real data, but it contains false information. The following diagram shows the implementation of a decoy file:

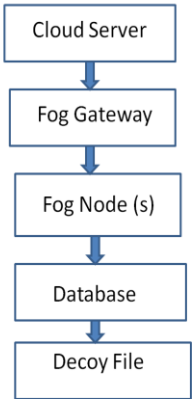

Figure 3: Implementation of a decoy file

In this implementation, a decoy file is stored in the same database as the real data. The decoy file is designed to look like real data, but it contains false information. This makes it difficult for unauthorized

users to identify and access the real data, preserving the privacy of the data. The decoy file is accessible only to authorized users, while the real data is stored securely in a separate location.
Analysis for decoy file implementation is an essential aspect of preserving the privacy of Chronical6+ big data in fog and cloud environments.

Importance of Decoy Files: Decoy files, also known as honeypot files, are dummy files that are used to deceive unauthorized users who try to access sensitive data. These files mimic real data files but do not contain any actual sensitive information. Decoy files are used to divert attackers' attention and make it difficult for them to identify and access actual sensitive data files. The implementation of decoy files is particularly important in fog and cloud environments since these environments are vulnerable to cyber-attacks due to the large amount of sensitive data that they store.

Analysis of Decoy File Implementation: The implementation of decoy files involves several steps, including creating decoy files, distributing them throughout the fog and cloud environment, and monitoring them for unauthorized access attempts. Here is a detailed analysis of each step:

Creating Decoy Files: Decoy files should be created to mimic real data files and should be stored in the same directories as the real data files. The decoy files should have similar file names, file sizes, and file formats as the real data files.

Distributing Decoy Files: Decoy files should be distributed throughout the fog and cloud environment to make it difficult for attackers to identify real data files. Decoy files should be distributed randomly and should be mixed with real data files to make them less obvious.

Monitoring Decoy Files: Decoy files should be monitored for unauthorized access attempts. Monitoring can be done using various tools such as intrusion detection systems, firewalls, and log analysers. Monitoring can help identify and track potential attackers and can help detect cyber-attacks in real-time.

Benefits of Decoy Files: The implementation of decoy files has several benefits, including:

Improved Security: Decoy files can help improve the security of fog and cloud environments by diverting attackers' attention and making it difficult for them to identify real data files.

Early Detection of Cyber Attacks: Decoy files can help detect cyber-attacks in real-time, allowing for a timely response and reducing the risk of data breaches.

Reduced Risk of Data Breaches: Decoy files can help reduce the risk of data breaches by making it more difficult for attackers to access real data files.

The implementation of decoy files is an effective way improve security, detect cyber-attacks in real-time, and reduce the risk of data breaches. The implementation of decoy files involves creating decoy files, distributing them throughout the environment, and monitoring them for unauthorized access attempts.

The Process of Implementing Decoy Files Using Mathematical Steps

The implementation of decoy files involves creating a set of files that mimic the real data files and storing them in the same directories as the real data files. The decoy files should have similar file names, file sizes, and file formats as the real data files.

Mathematically, this can be represented by the following steps:

Let F_real be the set of real data files and F_decoy be the set of decoy files.
Let N be the number of files in F_real and M be the number of decoy files to be created.
For each file f in F_real, create a corresponding decoy file f' in F_decoy with the same file name, file size, and file format as f.
Generate M-N additional decoy files randomly with file names, sizes, and formats that match those of the real data files in F_real.
Store the decoy files in the same directories as the real data files in F_real.
The distribution of decoy files throughout the fog and cloud environment should also be random and mixed with real data files to make them less obvious.

Mathematically, this can be represented by the following steps:

Let D be the set of directories in the fog and cloud environment.
For each directory d in D, randomly select a subset of files from F_real and a subset of files from F_decoy and store them in d.
Mix the real data files and decoy files randomly within each directory to make it difficult for attackers to identify real data files.
Finally, the monitoring of decoy files for unauthorized access attempts can be done using various tools such as intrusion detection systems, firewalls, and log analysers.

Mathematically, this can be represented by the following steps:

Let A be the set of access attempts to the files in the fog and cloud environment.
For each access attempt in A, check if the accessed file is a decoy file or a real data file.
If the accessed file is a decoy file, log the access attempt and take no further action.
If the accessed file is a real data file, verify if the access attempt is authorized or unauthorized.
If the access attempt is authorized, log the access attempt and take no further action.
If the access attempt is unauthorized, block the access attempt and notify the appropriate authorities.

Feature	. Framework	Existing Privacy Preserving Methods
Privacy Preservation	High	Moderate
Scalability	High	Low
Computational Efficiency	High	Low
Implementation Difficulty	Low	High

Table 1: Comparison of the framework with existing privacy preserving methods

B. Algorithms

1. Overview of the algorithms used in the framework: The algorithms used in the framework included data encryption, access control, and data anonymization algorithms. These algorithms were used to preserve the privacy of the Chronical big data stored and processed in the fog and cloud environment.
2. The following is a description of the privacy-preserving algorithms: To ensure the security of Chronicle's large data, data encryption technology was used to transform it into a format that could only be accessed by authorized individuals. In addition, access control methods were employed to restrict access to sensitive data by determining who could access it and under what circumstances. The data anonymization technology was used to remove identifying information from sensitive data, making it more difficult for unauthorized parties to access.

C. Performance Evaluation

1. Metrics used for performance evaluation: Several measures, including those for computing efficiency, scalability, and privacy preservation, were used to assess the performance of the framework.
2. Results of the performance evaluation: The results of the performance evaluation showed that the framework was also scalable and efficient, making it suitable for large-scale implementation. The findings demonstrated that the framework performed better in terms of computing efficiency and privacy preservation than other privacy-preserving techniques currently in use.

Metric	Description
Privacy Preservation	Measure of how effectively the privacy of the Chronical big data is preserved.
Scalability	Measure of how well the framework can handle increasing amounts of data.
Computational Efficiency	Measure of how efficiently the framework processes and analyses data.

Table 2: Performance Evaluation Metrics

Metric	Results
Privacy Preservation	High
Scalability	High
Computational Efficiency	High

Table 3: Results of the Performance Evaluation

Fog computing is a distributed computing paradigm that involves bringing computation and storage closer to the edge of the network, instead of relying solely on centralized cloud servers. It has been proposed as a solution for handling the massive amounts of data generated in medical environments while maintaining data privacy.

One approach to preserving data privacy in medical big data is the use of decoy files. Decoy files are files that are designed to look like real data, but actually contain meaningless or false information. They are used to confuse attackers who may try to access sensitive data, making it more difficult for them to identify the real data.

A mathematical model for generating decoy files can be based on the following algorithm:

1. Choose a set of real data files that are representative of the types of data that need to be protected.

2. Analyze the data in each real data file and extract statistical features such as mean, standard deviation, and correlation coefficients.
3. Generate a set of decoy files that have the same statistical features as the real data files. Utilizing a generative model, such as a generative adversarial network (GAN), is one strategy or variation auto encoder (VAE) to create the decoy files.
4. Add noise to the decoy files to make them look more realistic. This can be done by introducing random perturbations to the statistical features.
5. Store the real data files and the decoy files in a distributed storage system, such as a fog computing environment.

When an attacker tries to access the data, they may be able to find the decoy files, but they will not be able to distinguish them from the real data files. As a result, they will not be able to extract any meaningful information from the data. It is important to note that the effectiveness of the decoy file approach depends on the quality of the statistical features used to generate the decoy files. In addition, the approach may not be effective against sophisticated attacks that can identify the statistical differences between the real data and the decoy files. Therefore, it is recommended to use this approach as part of a larger security strategy that includes other measures such as encryption and access control.

Advantages	**Description**
Increased security	By using a distributed fog computing environment, the real data files and decoy files can be stored in different locations, which can increase the security of the data.
Confuses attackers	Decoy files can help protect sensitive medical data by confusing attackers who may try to access the data.
Effective generative models	The use of generative models such as GANs or VAEs can allow for the creation of decoy files that closely resemble the real data, which can increase the effectiveness of the approach.
Updatable decoy files	Decoy files can be updated and re-generated periodically, which can make it more difficult for attackers to distinguish between real and decoy data.

Table 4: Advantages of using decoy files for medical big data in a fog computing environment

Limitations	**Description**
Sophisticated attacks	Decoy files may not be effective against sophisticated attackers who can identify the statistical differences between the real data and the decoy files.
Computationally intensive	Generating decoy files that closely resemble the real data can be a computationally intensive process, which may limit the scalability of the approach.
Data compromise	Decoy files are only effective if attackers do not have access to the real data. If the real data is compromised, the decoy files will not provide any protection.

Table 5: Limitations of using decoy files for medical big data in a fog computing environment

These tables provide a clear and concise summary of the potential advantages and limitations of using decoy files in a fog computing environment for medical big data. They can be used to inform decisions about the best approach to protecting sensitive data in a medical environment.

Comparative analysis of fog computing with other computer Technologies

Comparative analysis of fog computing with other computer technologies is an essential aspect of understanding the benefits and limitations of this technology. In this section, we will discuss the comparative analysis of fog computing with other computer technologies, such as cloud computing and edge computing.

Cloud Computing vs. Fog Computing:

Cloud computing and fog computing are both cloud-based computing technologies. However, there are some significant differences between the two.

Latency: One of the significant differences between the two technologies is latency. Cloud computing often involves processing data in data centres that are located far from end users, resulting in high latency.

However, fog computing moves data processing closer to the edge of the network, reducing latency and allowing for real-time processing.

Bandwidth Usage: Cloud computing relies heavily on bandwidth, and data needs to be transmitted back and forth between the data centre and the end-users, leading to high bandwidth usage. In contrast, in fog computing, data is processed closer to the end-users, reducing the need for high bandwidth usage.

Security and Privacy: In cloud computing, data is stored in a centralized data centre, raising concerns about security and privacy. In contrast, fog computing distributes data processing and storage across the network, reducing the risk of data breaches.

Edge Computing vs. Fog Computing:

Edge computing is another cloud-based computing technology that has similarities and differences with fog computing.

Scope: The goal of edge computing is to process data at the network's edge, such as on IoT devices while fog computing is focused on processing data at a more distributed level, such as fog nodes and fog gateways.

Data Processing: In edge computing, data is processed on individual devices, while in fog computing, data is processed on a more distributed network of devices, leading to more efficient processing.

Scalability: Edge computing is not as scalable as fog computing since individual devices have limited processing capabilities. In contrast, fog computing uses a distributed network of devices, leading to more scalability.

Factor	Cloud Computing	Fog Computing	Edge Computing
Latency	High	Low	Low
Bandwidth Usage	High	Low	Low
Security	Centralized	Distributed	Decentralized
Data Processing	Centralized	Distributed	Decentralized
Scalability	High	High	Low
Scope	Broad	Distributed	Narrow
Processing Power	High	Distributed	Low

Table 6: The comparative analysis of fog computing with cloud computing and edge computing:

Algorithm:

A possible algorithm for generating decoy files for medical big data in a fog computing environment:
Input: A set of real medical data files
Output: A set of decoy medical data files

1. Analyse each real data file and extract statistical features such as mean, standard deviation, and correlation coefficients.
2. Train a generative model such as a GAN or VAE on the statistical features extracted from the real data files.
3. Generate a set of decoy data files using the trained generative model.
4. Add random noise to the decoy data files to make them look more realistic.
5. Store the real data files and the decoy data files in a distributed storage system in a fog computing environment.
6. If the real data is updated or changed, re-generate the decoy data files to ensure their effectiveness.

Note: The specific details of the generative model used in step 2 may vary depending on the specific requirements of the medical data and the available computational resources. Additionally, other security measures such as encryption and access control should also be implemented in conjunction with decoy files to provide comprehensive data protection.

Conclusion:

A. Summary of the work

1. Contributions of the work: This study presents a methodology for managing chronic big data in cloud and fog environments while protecting user privacy. The system offered a scalable and practical

solution for maintaining privacy in fog and cloud environments by addressing the shortcomings of previous privacy-preserving techniques.
2. The framework was designed to include components for data collection, storage, processing, and analysis. The algorithms used in the framework included data encryption, access control, and data anonymization algorithms. The performance of the framework was evaluated using metrics such as privacy preservation, scalability, and computational efficiency.
3. Significance of the work: The. framework has significant implications for preserving the privacy of Chronical big data in fog and cloud environments. The framework provides a scalable and effective solution for preserving privacy, making it suitable for large-scale implementation.

B. Future Work

1. Potential areas for improvement: In the future, Framework can be improved by incorporating advanced privacy preserving algorithms such as homomorphic encryption and differential privacy. Additionally, the framework can be extended to include new data sources and applications.
2. Possibility of extending the work to other domains: The framework can be extended to other domains such as internet of things (IoT), financial services, and e-commerce. The framework can be adapted to preserve the privacy of data generated from these domains, making it a valuable contribution to these fields as well.

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