ISSN: 2582 - 6379
IJISEA Publications
International Journal for Interdisciplinary Sciences and Engineering Applications
IJISEA - An International Peer- Reviewed Journal
2026, Volume 7 Issue 2
www.ijisea.org

Hospital Readmission Prediction System Based on Electronic Health Records (Ehr) Data

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Doi:- 10.5281/zenodo.19641382

ABSTRACT

Predicting ICU readmissions is critical for improving healthcare outcomes and reducing costs. This study employs a data-driven approach to analyze electronic health records (EHRs) and predict ICU readmissions using preprocessing techniques such as age mapping, normalization, and binary encoding. The dataset includes key patient attributes such as demographics, medical history, and treatment data. A robust preprocessing pipeline ensures clean and normalized inputs for predictive modelling. This approach enables the effective handling of missing values, categorical variables, and feature scaling. By transforming raw EHR data into a structured format, the study lays the groundwork for advanced machine learning models to enhance predictive accuracy and improve patient management

Keywords: ICU re-admission, electronic health records, data preprocessing, predictive modelling, healthcare analytics.

I. INTRODUCTION

1.1 BRIEF INFORMATION ABOUT THE PROJECT:

Recently, there has been a growing interest in employing the blockchain technology to promote medical and e-health services [1], [3]. Blockchain with its decentralized and trustworthy nature has demonstrated immense potentials in various e-health sectors such as secure sharing of Electronic Health Records (EHRs) and data access management among multiple medical entities [1], [4]. Therefore, the adoption of blockchain can provide promising solutions to facilitate healthcare delivery and thus revolutionize the healthcare industry [2]. With the emergence of innovative technologies, including Mobile Cloud Computing (MCC) and Internet of Medical Things (IoMT), the healthcare industry has witnessed significant changes in e-health operations [5]. Patients now can collect their personal health information at home based on mobile devices and share on cloud environments where healthcare providers can access instantly to analyze medical records and provide timely medical supports [5]. This smart e-health service allows healthcare providers remotely monitor patients and offer ambulatory care at home, which not only facilitates healthcare delivery but also brings economic benefits to patients. Further, the availability of complete EHRs on clouds also helps healthcare providers track patient health and offers proper medical services during diagnosis and treatment processes. Besides all these great advantages,

However, the trend of EHRs storage on clouds also poses security challenges which hinder the deployment of e-health applications [4]. Unauthorized entities may gain malicious access to EHRs without consent of patients, affecting data integrity and privacy [4]. Moreover, patients may find it difficult to track and manage their health records shared among healthcare providers on clouds. It therefore is necessary to propose efficient access control solutions for mobile cloud EHRs sharing systems.

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Traditional access control approaches assume that cloud servers are fully trusted, which leads to serious information leakage issues [6]. Blockchain-based access control provides advantages such as immutability, transparency, and decentralized authentication using smart contracts [1], [6]. The cloud sever will honestly perform the data requests, but meanwhile will obtain personal information without consent of users, which leads to serious information leakage issues and network security, accordingly. More importantly, conventional access control systems mainly rely on a predefined point of access, i.e. a centralized cloud server, and this can lead to the 1 central point of failure for e-health networks. Meanwhile, blockchain based access control provides various new security features for e-health with great advantages over conventional access control solutions. First, the blockchain constructs immutable ledgers of transactions for data sharing system. This means that transactions recorded in the blockchain cannot be modified or altered by any entities and transactions are only written to blockchain while recovery actions are not permitted. This guarantees high system trustworthiness and integrity. Second, access control using blockchain can achieve the transparency property with the ability of solving effectively the issue of data leakage which can be caused by curious servers. Any illegal access of servers and other entities to data storage will be reflected on the blockchain and broadcast to all network participants. In this way, any blockchain users can control data access and detect such malicious transactions for preventive actions. Third, the use of blockchain-based smart contract can achieve the authentication and user verification property. By enforcing strict access control policies, smart contracts can authorize effectively user access to health data storage as well as detect and prevent effectively potential threats to health networks in a distributed manner.

Final, blockchain coupled with the smart contract technology eliminates the reliance on central servers to ensure fairness among transaction parties. As the smart contracts are public on the blockchain, all the connected entities on the blockchain network will have a copy of them, which provide an equal right to control all contract operations. Specially, blockchain based access control with its distributed nature can work well when any party fails without loss of data, risks and trust concerns.

1.2 MOTIVATION AND CONTRIBUTION OF PROJECT:

Generally, EHRs mainly contain patient medical history, personal statistics (e.g. age and weight), laboratory test results and so on. Hence, it is crucial to ensure the security and privacy of these data. In addition, hospitals in countries such as U.S. are subject to exacting regulatory oversight. There are also a number of challenges in deploying and implementing healthcare systems in practice. For example, centralized server models are vulnerable to the single-point attack limitations and malicious insider attacks, as previously discussed. Users (e.g. patients) whose data is outsourced or stored in these EHR systems generally lose control of their data, and have no way of knowing who is accessing their data and for what kind of purposes (i.e. violation of personal privacy). Such information may also be at risk of being leaked by malicious insiders to another organization, for example an insurance company may deny insurance coverage to the particular patient based on leaked medical history. Meanwhile, data sharing is increasingly crucial particularly as our society and population become more mobile. By leveraging the interconnectivity between different healthcare entities, shared data can improve medical service delivery, and so on. Overcoming the “Information and Resource Island” (information silo) will be challenging, for example due to privacy concerns and regulations. The information silo also contributes to unnecessary data redundancy and redtape. In this case, the Health Insurance Portability and Accountability Act (HIPAA) was enacted by the United States Congress and signed in 1996. It established policies for maintaining the privacy and security of individual health information and created several programs to control fraud and abuse within the healthcare systems, including five rules:

- **Privacy Rule**. Regulations for the use and disclosure of patient health information in healthcare treatment and operations.

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- **Transactions and Code Sets Rule**. Requirements for all health plans to engage in the healthcare transactions in a standardized way to simplify healthcare transactions.
- **Security Rule**. The security rule complements the privacy rule, including controlling access to computer systems and securing the communications over open networks from being intercepted.
- **Unique Identifiers Rule**. Only the National Provider Identifier (NPI) identifies covered entities in the standard transactions to protect the patient identity information.
- **Enforcement Rule**. Investigation and penalties for violating HIPAA rules. Decentralization. Compared with the centralized mode, blockchain no longer needs to rely on the semi-trusted third party.
- **Security**. It is resilient to single point of failure and insider attacks in the blockchain based decentralized system.
- **Pseudonymity**. Each node is bound with a public pseudonymous address to protect its real identity.
- **Immutability**. It is computationally hard to delete or modify any record of any block included in the blockchain by one-way cryptographic hash function.
- **Autonomy**. Patients hold the rights of their own data and share their data flexibly by the settings of special items in the smart contract.
- **Incentive mechanism**. Incentive mechanism of blockchain can stimulate the cooperation and sharing of competitive institutions to promote the development of medical services and research.
- **Auditability**. It is easy to keep trace of any operation since any historical transaction is recorded in the blockchain.

Hence, if blockchain is applied correctly in the EHR systems, it can help to ensure the security of EHR systems, enhance the integrity and privacy of data, encourage organizations and individuals to share data, and facilitate both audit and accountability.

1.3 OBJECTIVE OF THE PROJECT

This project mainly focuses on to design a trustworthy access control mechanism based on smart contract to ensure users for efficient and secure EHR sharing. This access control can identify and prevent unauthorized access of electronic health system to achieve aimed level of data privacy and network security.

II. LITERATURE REVIEW

Literature survey is the most important step in software development process. Before developing the tool it is necessary to determine the time factor, economy and company strength. Once these things are satisfied, ten next steps are to determine which operating System and Language can be used for developing the tool.

An energy-efficient transaction model for the blockchain-enabled Internet of Vehicles (IoV)," Blockchain is a safe, reliable and innovative mechanism for managing decentralized systems [1]. However, scalability and energy efficiency remain major concerns in blockchain based systems [2]. To resolve this, an efficient model is presented in this letter which is capable of handling the energy demands of the blockchain enabled Internet of Vehicles (IoV) by optimally controlling the number of transactions through distributed clustering. Numerical results suggest that the proposed approach is 40.16% better in terms of energy conservation and 82.06% better in terms of the number of transactions required to share the entire blockchain data compared with the traditional blockchain.

"On scaling decentralized blockchains,"
The increasing popularity of blockchain-based systems has made scalability a primary concern, limiting throughput and increasing latency [2]. Our results suggest that reparameterization of block size and intervals should be viewed only as a first increment toward achieving next generation, high-load blockchain protocols, and major advances will additionally require a basic rethinking of technical approaches. offer a structured

perspective on the design space for such approaches. Within this perspective, enumerate and briefly discuss a number of recently proposed protocol ideas and offer several new ideas and open challenges.

"A low storage room requirement framework for distributed ledger in blockchain,
Traditional centralized commerce on the Internet relies on trusted third parties to process electronic payments. It suffers from the weakness of the trust-based model. A pure decentralized mechanism called blockchain tackles the above problem and has become a hot research area. However, since each node in a blockchain system needs to store all transactions of the other nodes, as time continues, the storage room required to store the entire blockchain will be huge. Therefore, the current storage mechanism needs to be revised to cater to the rapidly increasing need for storage. Network coded (NC) distributed storage (DS) can significantly reduce the required storage room. 5 This paper proposes a NC-DS framework to store the blockchain and proposes corresponding solutions to apply the NC-DS to the blockchain systems. Analysis shows that the proposed scheme achieves significant improvement in saving storage room.

"Distributed storage meets secret sharing on the blockchain,
Blockchain systems establish a cryptographically secure data structure for storing data in the form of a hash chain. Use a novel combination of distributed storage, private key encryption, and Shamirs secret sharing scheme to distribute transaction data, without significant loss in data integrity. Additionally, using Shamirs secret sharing scheme on the hash values and dynamic zone allocation, further enhance the integrity. In this Project highlight the tradeoff in storage cost and data loss probability with varying zone size choices. Then, formulate code design, given a probability of data recovery and targeted corruption, as an integer program. Using the coding scheme establish a mechanism to insure data, for instance in blockchain-based cloud storage systems, based on the value of the data, by understanding the costs involved for the service provider.

"Efficient local secret sharing for distributed blockchain systems,
Blockchain systems store transaction data in the form of a distributed ledger where each peer is to maintain an identical copy. Blockchain systems resemble repetition codes, incurring high storage cost. Recently, distributed storage blockchain (DSB) systems have been proposed to improve storage efficiency by incorporating secret sharing, private key encryption, and information dispersal algorithms. However, the DSB results in significant communication cost when peer failures occur due to denial of service attacks. In this letter, a new DSB approach based on a local secret sharing (LSS) scheme with a hierarchical secret structure of one global secret and several local secrets. The proposed DSB approach with LSS improves the storage and recovery communication costs.

III. PROPOSED SYSTEM

In this, instead of saving entire transaction of blocks are saving only one block. To provide security to block author converting that block in to SHAMIR share and then all SHAMIR share will be distributed between all available nodes. While reconstruction application will obtain all shares from nodes and then apply SHAMIR SECRET to recover original block data. If any share missed or return incorrect value then reconstruction will be failed. SHAMIR secret will work based on random polynomial and prime number while generating secret polynomial will be applied on block data and while getting original value will perform reverse polynomial.

Advantages of Proposed System

- This can effectively work.
- Security is more.

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3.1. System Architecture

Consider an e-health scenario on a mobile cloud platform where patient records are gathered from a network of local gateways and stored on a public cloud for sharing with healthcare providers as shown in Fig. E-health records may include personal information and medical history which are provided by patients. Patients have their own patient ID PID and are classified based on their current living area with an area ID AID.

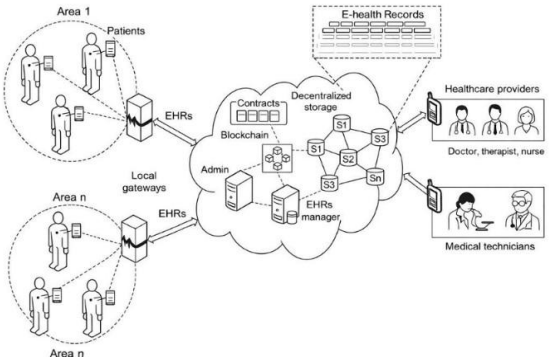


Fig 1: System Architecture

3.2 Use case Diagram

A use case diagram at its simplest is a representation of a user's interaction with the system and depicting the specifications of a use case. A use case diagram can portray the different types of users of a system and the various ways that they interact with the system. This type of diagram is typically used in conjunction with the textual use case and will often be accompanied by other types of diagrams as well.

- Providing a high-level view of what the system does.
- Identifying the users ("actors") of the system.
- Determining areas needing human-computer interfaces.

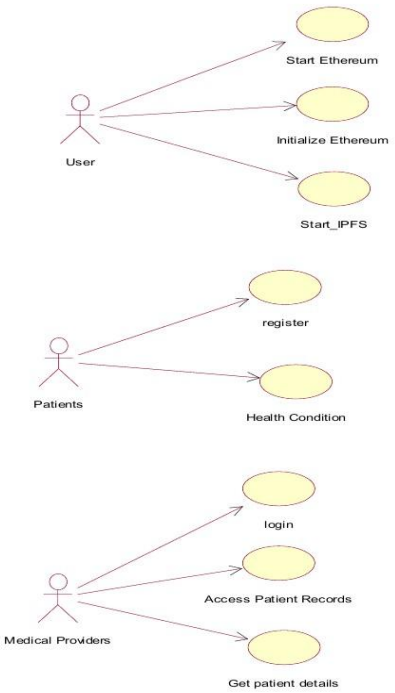


Fig 2: Use Case Diagram

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3.3 Class Diagram

The class diagram is the main building block of object oriented modeling. It is used both for general conceptual modeling of the systematic of the application, and for detailed modeling translating the models into programming code. Class diagrams can also be used for data modeling. The classes in a class diagram represent both the main objects, interactions in the application and the classes to be programmed.

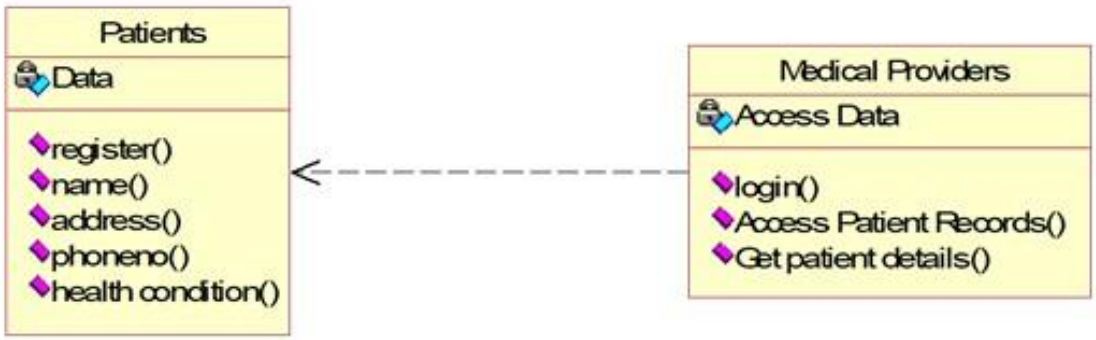
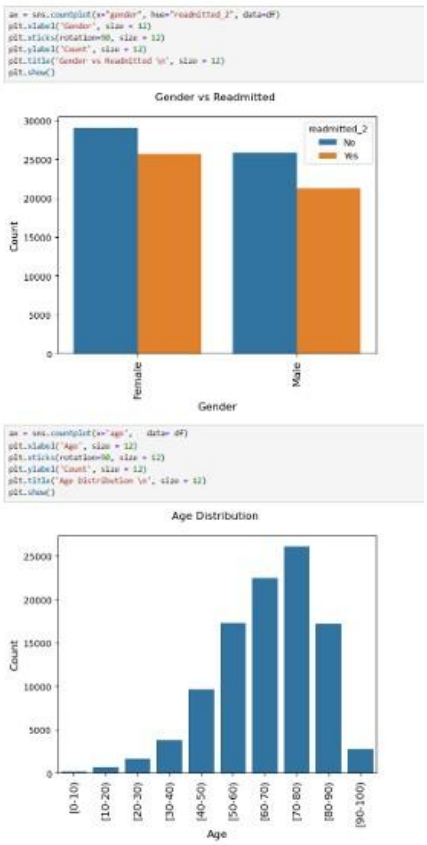


Fig 3: Class Diagram

IV. RESULTS

Screenshot for 'start_eth'

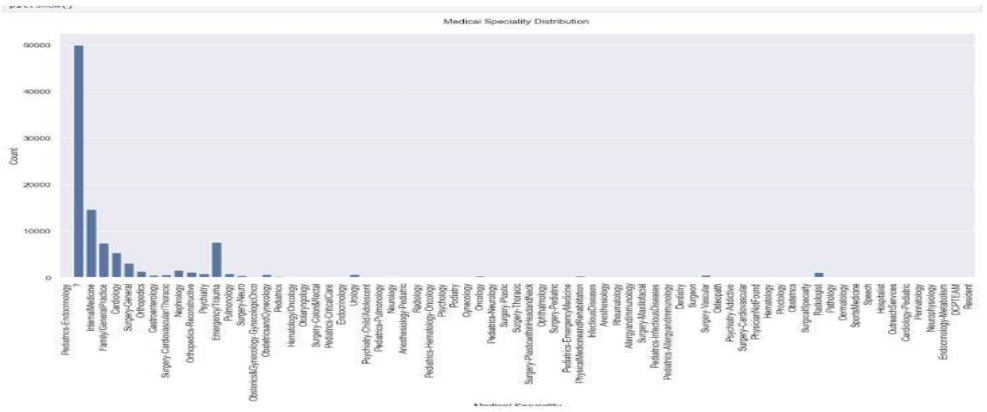


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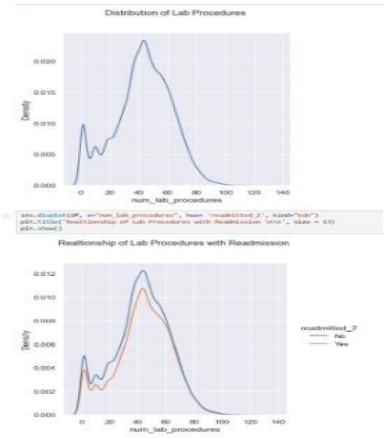
Screenshot for 'initialize_eth.bat'



Screenshot for 'Start_IPFS.bat'



Screenshot for 'run.bat' file'



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Screenshot for Patients

	race	gender	age	admission_type_id	discharge_disposition_id	admission_source_id	time_in_hospital	num_lab_procedures	num_procedures	num_medications
0	2	0	0	5	23	0	1	41	0	1
1	2	0	1	0	0	6	3	59	0	18
2	0	0	2	0	0	6	2	11	5	13
3	2	1	3	0	0	6	2	44	1	16
4	2	1	4	0	0	6	1	51	0	8
...	...	...	...	...	...	...	...	...	...	...
101758	0	1	7	0	2	6	3	51	0	16
101759	0	0	8	0	3	4	5	33	3	18
101760	2	1	7	0	0	6	1	53	0	9
101761	2	0	8	1	2	6	10	45	2	21
101762	2	1	7	0	0	6	6	13	3	3

101763 rows × 35 columns

Screenshot for Patients Details

```
df_[['time_in_hospital', 'num_lab_procedures', 'num_procedures', 'num_medications',
   'number_outpatient', 'number_emergency', 'number_inpatient', 'number_diagnoses']].corr()
```

	time_in_hospital	num_lab_procedures	num_procedures	num_medications	number_outpatient	number_emergency	number_inpatient	number_diag
time_in_hospital	1.000000	0.318429	0.191497	0.466137	-0.008919	-0.009683	0.073619	0.2
num_lab_procedures	0.318429	1.000000	0.058105	0.268176	-0.007606	-0.002282	0.039225	0.1
num_procedures	0.191497	0.058105	1.000000	0.385761	-0.024813	-0.038175	-0.066226	0.0
num_medications	0.466137	0.268176	0.385761	1.000000	0.045198	0.013180	0.064196	0.2
number_outpatient	-0.008919	-0.007606	-0.024813	0.045198	1.000000	0.091457	0.107334	0.0
number_emergency	-0.009683	-0.002282	-0.038175	0.013180	0.091457	1.000000	0.266557	0.0
number_inpatient	0.073619	0.039225	-0.066226	0.064196	0.107334	0.266557	1.000000	0.1
number_diagnoses	0.220153	0.152737	0.073769	0.261529	0.094148	0.055536	0.104703	1.0

Screenshot for Patients Details Screen Submit

```
2545/2545 ━━━━━━━━━━━━━━━━━━━━ 20s 8ms/step - accuracy: 1.0000 - loss: 4.6794e-13 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 11/20
2545/2545 ━━━━━━━━━━━━━━━━━━━━ 20s 8ms/step - accuracy: 1.0000 - loss: 2.2148e-12 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 12/20
2545/2545 ━━━━━━━━━━━━━━━━━━━━ 21s 8ms/step - accuracy: 1.0000 - loss: 4.0971e-12 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 13/20
2545/2545 ━━━━━━━━━━━━━━━━━━━━ 20s 8ms/step - accuracy: 1.0000 - loss: 0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 14/20
2545/2545 ━━━━━━━━━━━━━━━━━━━━ 21s 8ms/step - accuracy: 1.0000 - loss: 0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 15/20
2545/2545 ━━━━━━━━━━━━━━━━━━━━ 20s 8ms/step - accuracy: 1.0000 - loss: 0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 16/20
2545/2545 ━━━━━━━━━━━━━━━━━━━━ 21s 8ms/step - accuracy: 1.0000 - loss: 0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 17/20
2545/2545 ━━━━━━━━━━━━━━━━━━━━ 21s 8ms/step - accuracy: 1.0000 - loss: 0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 18/20
2545/2545 ━━━━━━━━━━━━━━━━━━━━ 22s 9ms/step - accuracy: 1.0000 - loss: 0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 19/20
2545/2545 ━━━━━━━━━━━━━━━━━━━━ 21s 8ms/step - accuracy: 1.0000 - loss: 0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
Epoch 20/20
2545/2545 ━━━━━━━━━━━━━━━━━━━━ 21s 8ms/step - accuracy: 1.0000 - loss: 0.0000e+00 - val_accuracy: 1.0000 - val_loss: 0.0000e+00
637/637 ━━━━━━━━━━━━━━━━━━━━ 3s 4ms/step
                        precision    recall  f1-score   support

     Not Readmitted       1.00      1.00      1.00     20353
Readmitted <30 Days       0.00      0.00      0.00         0
Readmitted >30 Days       0.00      0.00      0.00         0

           accuracy                           1.00     20353
          macro avg       0.33      0.33      0.33     20353
       weighted avg       1.00      1.00      1.00     20353
```

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Screenshot for User Login

```
Training Logistic Regression...

Logistic Regression Classification Report:
              precision    recall  f1-score   support

Not Readmitted       0.61      0.80      0.70     11016
    Readmitted       0.63      0.41      0.50      9337

      accuracy                           0.62     20353
     macro avg       0.62      0.60      0.60     20353
  weighted avg       0.62      0.62      0.60     20353


Training Random Forest...

Random Forest Classification Report:
              precision    recall  f1-score   support

Not Readmitted       0.64      0.78      0.70     11016
    Readmitted       0.65      0.48      0.55      9337

      accuracy                           0.64     20353
     macro avg       0.64      0.63      0.63     20353
  weighted avg       0.64      0.64      0.63     20353


Training XGBoost...

XGBoost Classification Report:
              precision    recall  f1-score   support

Not Readmitted       0.67      0.72      0.69     11016
    Readmitted       0.63      0.57      0.60      9337

      accuracy                           0.65     20353
     macro avg       0.65      0.65      0.65     20353
  weighted avg       0.65      0.65      0.65     20353
```

V. CONCLUSION

In this project proposes a EHRs sharing scheme enabled by mobile cloud computing and blockchain. To identify critical challenges of current EHRs sharing systems and propose efficient solutions to address these issues through a real prototype implementation. In this work, our focus is on designing a trustworthy access control mechanism based on a single smart contract to manage user access for ensuring efficient and secure EHRs sharing. To investigate the performance of the proposed approach, deploy an Ethereum blockchain on the Amazon cloud, where medical entities can interact with the EHRs sharing system via a developed mobile Android application. Integrate the peer-to-peer IPFS storage system with blockchain to achieve a decentralized data storage and data sharing.

VI. FUTURE SCOPE

1. The system can be improved by using advanced machine learning or deep learning models for better accuracy.
2. It can be integrated with real-time hospital databases or EHR systems for live predictions.
3. A mobile application can be developed so doctors can access predictions anywhere.
4. The model can be enhanced by including more patient data features like lifestyle, diet, and medical history.
5. The system can be extended to predict other diseases or complications, not just diabetes readmission.
6. Adding a doctor recommendation system based on patient risk level can improve decisionmaking.
7. The application can include alert systems (notifications/sound alerts) for high-risk patients.
8. Cloud deployment can be done for scalability and wider access across hospitals

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