1. JBR1 TFE ACADEMIA ELEC/IG Federated Learning and Blockchain for Edge Computing

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This is a research project that combines blockchain technology and machine learning, specifically federated learning, within the context of edge computing. The aim is to explore the synergistic benefits of these technologies to enhance data security, privacy, and processing efficiency in distributed systems. The scope of this project is vast and its potential impact on both academia and industry is significant. By combining our expertise and resources, we can advance the state-of-the-art in these fields and open new avenues for research and development.

Context. Our research will focus on the practical implementation of blockchain and federated learning, two cutting-edge technologies with immense potential to revolutionize how data is processed and secured. Federated learning, a decentralized approach to machine learning, allows models to be trained across multiple devices or servers that hold local data samples, without exchanging them. When combined with blockchain, a decentralized and immutable ledger technology, the integrity and privacy of data can be ensured, making this a powerful combination for edge computing environments. Specifically, we will investigate how federated learning can be integrated with blockchain to enable distributed model training and inference on edge devices while ensuring data privacy and security. This research will contribute to the development of robust, secure, and efficient edge computing systems capable of meeting the increasing demands of modern applications.

Objectives. Investigate the integration of federated learning with blockchain to enable secure and efficient distributed model training and inference on edge devices. Develop robust algorithms and systems that ensure data integrity and privacy without compromising the performance and scalability of edge computing environments. Explore the practical applications and benefits of combining federated learning and blockchain in real-world edge computing scenarios. Contribute to academic knowledge and industry practices in the fields of distributed systems, data security, and decentralized technologies.

The technologies we will leverage in this project include the following:

1. **Docker**. To containerize applications, ensuring consistency across different environments and facilitating the deployment of microservices.
2. **Blockchain**. To create a secure, decentralized ledger for tracking transactions and ensuring the integrity of data exchanged between edge devices.
3. **Cryptography**. To protect data privacy and ensure secure communications between devices and nodes in the network.
4. **Security and Privacy**. To address the challenges inherent in distributed systems, focusing on protecting data integrity and confidentiality.
5. **Machine Learning**. To develop algorithms that can be trained on decentralized data, improving the accuracy and efficiency of models without compromising data privacy.
6. **Distributed Systems**. To design and implement systems that operate across multiple nodes, ensuring reliability, scalability, and fault tolerance.
7. **Edge Computing**. To process data closer to where it is generated, reducing latency and bandwidth usage while enabling real-time decision-making.

Tasks:

1. **Literature Review:** Conduct a comprehensive review of existing research on federated learning, blockchain, and their applications in edge computing.

2. **Design and Implementation.** Develop a system architecture that integrates federated learning with blockchain for edge computing. Utilize Docker to containerize applications, ensuring consistency and facilitating microservice deployment.

3. **Algorithm Development.** Create machine learning algorithms that can be trained on decentralized data while preserving privacy. Implement cryptographic techniques to secure data exchanges between edge devices.

4. **System Security and Privacy.** Address security and privacy challenges in the proposed system. Develop mechanisms to protect data integrity and confidentiality in distributed environments.

5. **Testing and Evaluation.** Deploy the system in a simulated edge computing environment. Evaluate the performance, scalability, and security of the proposed solution.

6. **Documentation and Reporting.** Document the research process, methodologies, and findings. Prepare and submit a detailed research paper/master's thesis outlining the results and contributions of the project.

Students: 2

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