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Enhancing Scalability in Ethereum Network Analysis: Methods and Techniques

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Abstract : The rapid growth of the Ethereum network has brought forth the urgent need for scalable analysis methods to handle the increasing volume of blockchain data. In this research, we propose efficient methodologies for making Ethereum network analysis scalable. Our approach leverages a combination of graph-based data representation, probabilistic sampling, and parallel processing techniques to achieve unprecedented scalability while preserving critical network insights. Data Representation: We develop a graph-based data representation that captures the underlying structure of the Ethereum network. Each block transaction is represented as a node in the graph, while the edges signify temporal relationships. This representation ensures efficient querying and traversal of the blockchain data. Probabilistic Sampling: To cope with the vastness of the Ethereum blockchain, we introduce a probabilistic sampling technique. This method strategically selects a representative subset of transactions and blocks, allowing for concise yet statistically significant analysis. The sampling approach maintains the integrity of the network properties while significantly reducing the computational burden. Graph Convolutional Networks (GCNs): We incorporate GCNs to process the graph-based data representation efficiently. The GCN architecture enables the extraction of complex spatial and temporal patterns from the sampled data. This combination of graph representation and GCNs facilitates parallel processing and scalable analysis. Distributed Computing: To further enhance scalability, we adopt distributed computing frameworks such as Apache Hadoop and Apache Spark. By distributing computation across multiple nodes, we achieve a significant reduction in processing time and enhanced memory utilization. Our methodology harnesses the power of parallelism, making it well-suited for large-scale Ethereum network analysis. Evaluation and Results: We extensively evaluate our methodology on real-world Ethereum datasets covering diverse time periods and transaction volumes. The results demonstrate its superior scalability, outperforming traditional analysis methods. Our approach successfully handles the ever-growing Ethereum data, empowering researchers and developers with actionable insights from the blockchain. Case Studies: We apply our methodology to real-world Ethereum use cases, including detecting transaction patterns, analyzing smart contract interactions, and predicting network congestion. The results showcase the accuracy and efficiency of our approach, emphasizing its practical applicability in real-world scenarios. Security and Robustness: To ensure the reliability of our methodology, we conduct thorough security and robustness evaluations. Our approach demonstrates high resilience against adversarial attacks and perturbations, reaffirming its suitability for security-critical blockchain applications. Conclusion: By integrating graph-based data representation, GCNs, probabilistic sampling, and distributed computing, we achieve network scalability without compromising analytical precision. This approach addresses the pressing challenges posed by the expanding Ethereum network, opening new avenues for research and enabling real-time insights into decentralized ecosystems. Our work contributes to the development of scalable blockchain analytics, laying the foundation for sustainable growth and advancement in the domain of blockchain research and application.

Keywords : Ethereum, scalable network, GCN, probabilistic sampling, distributed computing
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