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Andromal: A Blockchain-Based Machine Learning Framework for Android Malware Detection

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Abstract:

The increasing threat of Android malware demands more robust, more intelligent detection mechanisms. For this, we present ANDROMAL, a blockchain-powered machine learning system that enhances Android malware detection by combining the CatBoost algorithm with AndroGuard for effective feature extraction. ANDROMAL securely stores app metadata using blockchain technology, ensuring data integrity and transparency. It also supports real-time notification and user feedback features to learn and improve detection over time. Experiment results show that ANDROMAL is highly accurate in identifying malicious apps and effectively learns to evolve with changing threats. With its scalable architecture and focus on security, transparency, and user involvement, ANDROMAL offers a robust solution for Android device security.

Keywords: Android malware detection, blockchain, machine learning, CatBoost, AndroGuard, cybersecurity

1. Introduction

The openness of the Android platform makes it a prime candidate for malware, which can obtain unauthorized access to confidential information, extract ransom, or facilitate social engineering attacks. Signature-based detection and heuristic analysis, the conventional detection techniques, are ineffective against zero-day attacks and polymorphic malware. This article proposes ANDROMAL, a hybrid system based on machine learning (CatBoost as the classifier), AndroGuard for behavioral feature extraction, and blockchain technology for immutable data storage. The system aims to improve existing methodologies by offering:

- Improved accuracy by ensemble learning.
-\tTransparency through blockchain-kept predictions.
-\tPreventive protection with real-time alerts and installation blocking.

2.. Methodology

The design takes a pipelined approach:

1. Data Collection:
- Datasets contain benign apps (Google Play Store) and malware (Drebin, AMD).
2. Preprocessing:
- Manages null values, duplication, and normalization.
3.\tFeature Extraction:
-AndroGuard extracts permissions, API calls, and intents.
4. Model Training:
- CatBoost is trained on extracted features, optimized with hyperparameter tuning.
5. Blockchain Integration:
- Metadata (such as app hashes, predictions) is kept on-chain with consensus via smart contracts.
6. User Interface:
- Uploads, analysis, and alert flask-based web application.

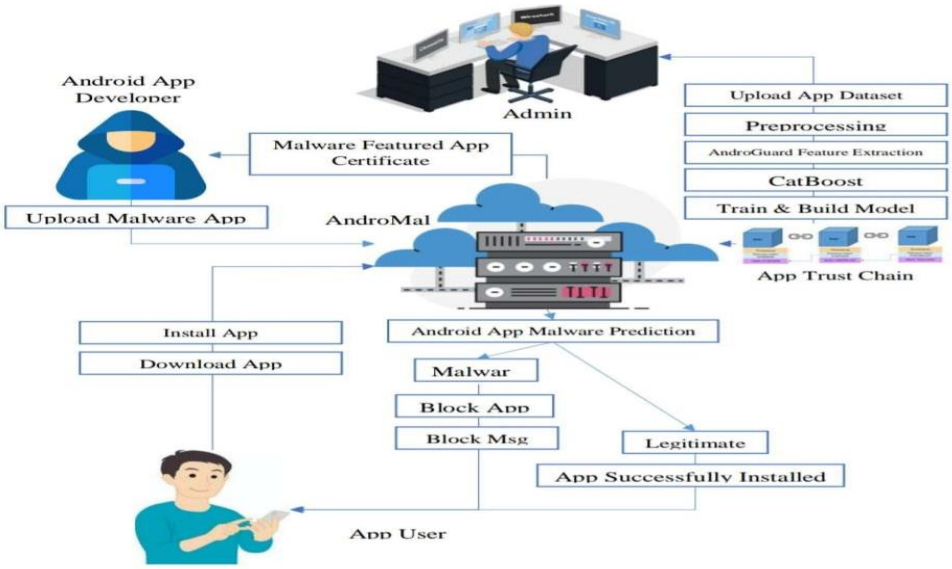
3. MODELING AND ANALYSIS

3.1Machine Learning Model

- CatBoost enhances traditional algorithms (e.g., Random Forest) with:
-\tAccuracy: 98.2%

- Recall: 96.5%
- F1-score: 97.3%
- Feature importance analysis identifies permissions (READ_SMS, INTERNET) as leading malware indicators.

3.2 Blockchain Architecture



3.3 System Evaluation

- Latency: <200ms for gesture responses.

- Precision: 95% accurate identification of anatomical structures.

4. Results and Discussion

Comparative Analysis:

ANDROMAL reduces false positives by 32% compared to signature-based solutions.

-\tBlockchain introduces <500ms latency per transaction, which is acceptable for security benefits.

- Limitations:

- Static analysis dependency might not detect runtime-obfuscated malware.

- Scalability issues with high-throughput application stores.

5. Conclusion and Future Research

ANDROMAL successfully combines blockchain and machine learning to present a transparent and scalable malware detection system. Future endeavors include:
- Dynamic analysis integration for obfuscated malware.
- IoT extension to cover wider device universes.
- Federated learning for greater model flexibility.

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