# Trailblazing Precision: Dealership Recommendations fortified by Blockchain

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***Abstract*—In the realm of recommendation systems, which are widely employed for user preferences, a prevalent vulnerability exists despite their common usage. This study introduces an enhanced content-based recommendation system for addressing vehicle-related user complaints in the automotive industry. Incorporating blockchain for enhanced security and traceability, this system mitigates vulnerabilities commonly found in recommendation systems. Through TF-IDF vectorization, converting textual data into numerical representations, the system ensures precision in recommendations. Rigorous evaluation, employing cosine similarity and K-Nearest Neighbors (KNN), underscores the system's accuracy and efficacy in addressing vehicle-related concerns, with the added layer of security and traceability provided by blockchain integration.**

***Index Terms*—Blockchain, Cosine Similarity, Data, KNN, Recommendation system, TD-IDF.**

## I. Introduction

Recommendation systems find extensive application across diverse domains such as energy preservation, e-commerce, healthcare, and social media. These applications demand the examination and extraction of substantial volumes of diverse user data, encompassing demographics, preferences, social interactions, and more [1], [2]. In the pursuit of crafting precise and effective recommender systems, the datasets integral to their development often harbor sensitive information. Regrettably, the prevailing emphasis on achieving model accuracy has resulted in a notable oversight regarding security and the preservation of user privacy within the realm of recommender systems [3], [4]. Despite concerted efforts to mitigate these challenges through diverse risk reduction techniques, none have thus far achieved comprehensive success in ensuring both cryptographic security and the robust protection of users' private information [5]. This underscores a persistent gap in the existing methodologies, where the imperative to enhance system accuracy has inadvertently led to an underestimation of the paramount importance of addressing security and privacy concerns. Consequently, the quest for an optimal balance between precision and user data protection remains a focal challenge in the ongoing evolution of recommender systems [6].

To address this disparity, the introduction of blockchain technology emerges as a promising strategy to enhance security and privacy preservation in recommender systems. This proposition is founded not only on the inherent security and privacy features of blockchain but also on its resilience, adaptability, fault tolerance, and trust characteristics [4]. The impetus for this project stemmed from the aim to develop a content-based recommendation system tailored to recommend service operations to dealership customers based on operation codes. The overarching goal included implementing blockchain technology to fortify the security and transparency of the recommendation system data. The contribution of this work is:

- To classify these complaints and establish connections with operation codes, the ultimate aim is to reduce the inconsistencies present within the dataset.
- To store the data that came directly from the recommendation system to the blockchain for enhanced security and transparency is a crucial step in data management.
- To evaluate both the recommendation system and the smart contract used in the blockchain, a comprehensive analysis is undertaken to gauge their effectiveness and impact.

## II. Proposed System

An innovative approach was used in the field of deep learning framework recommendation systems, combining blockchain technology, content-based filtering, and cosine similarity to provide users with accurate service operation recommendations in dealership industry. The next two subsection will dive deeply into the flow of the proposed system.

### *A. Data Filtering and Processing*

Utilizing NumPy and pandas, this Python system adeptly manages inconsistent data, showcasing remarkable adaptability. Its primary objective is to link user car complaints with specific operating codes, enabling tailored recommendations. Notably, the system excels in accurately determining operating codes based on user complaints, enhancing its efficacy in the recommendation process. The dataset, generously provided by "Meta Monkey," encompasses diverse vehicle aspects, and two pivotal columns—labor complaints and operation codes—were meticulously selected for integration into our recommendation algorithm. TF-IDF transformation facilitated factorization and weighting during careful dataset processing. The system further leverages cosine similarity and blockchain technology to merge these vectors, establishing a robust foundation for enhanced security and transparency in our recommendation system.

### B. Blockchain Implementation

The smart contract implements a blockchain-based recommendation system on the Ethereum network with Solidity. It includes a user registration feature where users can register, emitting a "NewUserRegistered" event. Registered users are granted access to submit complaints using the "submitComplaint" function, while the "onlyRegisteredUser" modifier ensures that only registered users can interact with complaint-related functionalities. The contract tracks user complaints with details stored on the blockchain, and a "NewUserComplaint" event is emitted upon each submission. The "getComplaintDetails" function allows users to retrieve information about a specific complaint. The contract is owned by an administrator, and specific functions are restricted to the owner using the "onlyOwner" modifier. This blockchain-enhanced system aims to provide a secure and transparent platform for managing user complaints and service recommendations in the automotive industry. The proposed system securely stores recommendation data through Ethereum-powered smart contracts on the Georli test network, implemented with Remix IDE and developed in Solidity. Truffle was used for testing.

## III. Result discussion

Table I visually summarizes the outcomes of cosine similarity evaluations between test samples and their K-nearest neighbors. It highlights a notable level of similarity, approaching 1.0, emphasizing the consistency across different K-nearest neighbor configurations. This underscores the robustness of our approach in accurately identifying close matches.

TABLE I
Comparison of Cosine Similarity between Test Samples and Their Respective K-Nearest Neighbors

| | KNN 0 | KNN 1 | KNN 2 | KNN 3 | KNN 4 |
|---|---|---|---|---|---|
| **1** | 0.9998 | 0.9994 | 0.9992 | 0.9992 | 0.9992 |
| **2** | 1.0000 | 1.0000 | 1.0000 | 0.9999 | 0.9999 |
| **3** | 0.9998 | 0.9979 | 0.9923 | 0.9899 | 0.9899 |

Additionally, table II provides a concise overview of the gas costs associated with various functions within the smart contract. Gas costs, representing the computational effort required to execute each function on the Ethereum blockchain, are crucial metrics for evaluating efficiency and cost-effectiveness. Impressively, the gas costs for essential functions like 'registerUser' and 'submitComplaint' are relatively low at 51,655 and 164,023, respectively. Notably, functions such as 'complaintCount', 'getComplaintDetails', 'owner', 'userComplaints', and 'users' incur zero gas costs, indicating their minimal impact on the overall computational expenses. This emphasizes the cost-efficiency of the smart contract, making it an economical and practical solution for implementing blockchain-enabled recommendation systems.

TABLE II
Gas Cost Metrics for Blockchain-Enabled Recommendation System Functions

| Function | Gas |
|---|---|
| registerUser | 51,655 |
| submitComplaint | 164,023 |
| complaintCount | 0 |
| getComplaintDetails | 0 |
| owner | 0 |
| userComplaints | 0 |
| users | 0 |

## IV. Conclusion

Recommendation systems have become increasingly vital in the automotive industry, where tailoring solutions to individual user needs is paramount. Our focus on linking user complaints to specific operating codes has yielded a recommendation system that excels in accurately determining codes based on user input, elevating its effectiveness. Incorporating blockchain technology, we've fortified the system's security and transparency. The successful fusion of TF-IDF transformation, cosine similarity, and blockchain lays a robust foundation. Moving forward, our envisioned future work involves the development of a decentralized application (DApp) to enable direct customer interaction with the system, fostering a more seamless and user-friendly experience in the realm of automotive service recommendations.

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