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Collaborative Motivation Framework Leveraging Similar Interest Behavior in Semantic Web Applications

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ABSTRACT

With the growth of web technology, the semantic web offers a promising framework for online knowledge collaboration. However, trust issues can undermine users' willingness to collaborate, reduce the frequency of interaction and collaboration efficiency. This paper introduces a super node-based trust management model designed to enhance semantic networks by linking nodes through trust relationships. The model exploits the synergistic incentives of similar interest behaviours to achieve a steady construction of trust relationships. We propose a similarity filtering algorithm that calculates the similarity to filter out false, misleading, or unfair information effectively. Through simulations, we compare our model with RRGRET, Surework, and community-based approaches, and the results show that our model has good network properties, while also resisting multiple malicious attacks and guaranteeing collaboration success. This research contributes to optimizing node relationships within semantic networks and strengthening network robustness against interference.

KEYWORDS

Semantic Network, Knowledge Collaborative, Trust Management, Similar Interests, Reputation System, Filter Algorithm

INTRODUCTION

With the rapid advancement of the internet and AI technologies, collaborative approaches are increasingly used to address complex, often intractable problems (Lin et al., 2022) This requires dynamic knowledge collaboration, an extensive global knowledge system (Hund et al., 2021) and collaborative network-style collective intelligence (Wang et al., 2024) The semantic web, as a key technology for knowledge representation and reasoning(Aljamel et al., 2021), offers new solutions for enhancing knowledge collaboration. At present, it has been widely applied in collaborative network research (Bao et al., 2021; Lopes et al., 2023), enriching the theoretical framework and expanding research perspectives. However, there are still significant technical challenges in building efficient

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collaborations. The main challenges include how to increase the willingness to interact and share resources among network nodes, which is crucial for building efficient collaborative networks.

Research has shown that trust is the foundation of effective collaboration (Stout & Keast, 2021), trust relationships play an important role in improving interaction behavior and facilitating knowledge transfer (Tomlinson et al., 2020), and the establishment and management of trust have become key elements of collaborative systems (Suran et al., 2021). Currently, the industry has conducted a lot of research on trust computation, trust architecture, and trust programmability in collaborative scenarios and achieved a lot of results (Barhoun & Ed-Daibouni, 2023), but there are fewer researches on the efficient acquisition of trust data. Trust management in collaborative scenarios usually adopts a reputation-based mechanism, i.e., nodes are rated by other nodes based on their behavior in the system (Alqassab et al., 2023). However, the flood-like mechanism commonly used in large-scale distributed collaborative environments suffers from a large system overhead in obtaining node credit rating information, as well as difficulties in effective credit assessment due to insufficient interaction data (Bhasin & Rajesh, 2021). Therefore, incentivizing nodes to actively participate in high-frequency collaboration to efficiently collect and aggregate credit-rating feedback data in large-scale collaborative networks is a topic well worth investigating.

In this paper, we propose a supernode-based trust management model (SPTrust), where we divide different collaborative subjects into different clusters or groups based on their respective interests, and each group has only one subject as a supernode. In SPTrust, we define three types of trust relationships: trust relationships between supernodes, trust relationships between supernodes and general nodes, and trust relationships between two general nodes. In order to evaluate the trust between two general nodes in the same group, a model based on the reputation system is used, where the level of trust of node A toward node B depends on the local rating of node A toward node B and the reference ratings of the other nodes in the same group toward B. In the reference rating calculation, a trust dynamic update mechanism and a recommended rating-information-filtering mechanism are proposed for improving the accuracy of the reference ratings. Supernodes play a dual role in SPTrust. On the one hand, they provide resource sharing or task collaboration like regular nodes. On the other hand, they assume the management of nodes and resources in the team. Therefore, the total trust value of a supernode consists of two parts: the trust value as a node and the trust value as a group manager. For supernodes, their role as group managers is crucial to the functioning of the team, and thus is the focus of our study. Unlike existing trust mechanisms for collaborative networks, SPTrust includes four important innovations that are essential to ensure the functioning of collaborative systems:

1. We adopt an interest group-based membership management mechanism, which potentially improves the frequency of node interaction and reduces the complexity of feedback information collection, and is very suitable for the current topic-based interest group management in large-scale collaborative networks. In addition, this mechanism is highly scalable for the dynamic management of collaborative network members.
2. Compared to the static trustworthiness of recommenders in existing trust mechanisms, we propose a dynamic calculation and updating method of trustworthiness, which can efficiently distinguish reliable nodes from deceptive or unreliable nodes. In the presence of dishonest or unreliable recommenders, the negative impact of malicious ratings by detractors or co-conspirators can be greatly reduced by effectively calculating and updating the trustworthiness values.
3. The abnormal feedbacks such as unfair, false, or even malicious are uniformly defined as noise. A method of noise identification that compares the similarity of feedback information between nodes is designed, and a filtering algorithm based on the similarity of feedback information is proposed to filter out the noise, which improves the accuracy and reliability of the trust calculation.
4. Finally, we conduct simulation comparison experiments to study the effectiveness of SPTrust and analyze it in simulation comparison with three existing super-manager-based trust models.

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