Poster: Bacteria Inspired Mitigation of Selfish Users in Ad-hoc Social Networks

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ABSTRACT

In data management protocols for Ad-hoc Social Networks (ASNETs), involvement of selfish users can pose a serious threat to network performance and fairness. Therefore, it is essential to detect and mitigate their effects on other well behaving users. We contribute to this line of research by combining the benefits of users' social behavior (social tie) with a biologically inspired approach in ASNETs. We designed a bio-inspired scheme (BoDMaS) to detect and mitigate selfish users in replication operations. Its goals include providing greater accessibility and effective detection of selfish users. The proposed scheme not only guarantees accessibility and effective detection rate, but also ensures the reliability of replica allocation operations.

Categories and Subject Descriptors

C.2.1 [**Computer-Communication Networks**]: Network Architecture and Design

Keywords

Ad-hoc social networks, selfishness, replication

1. INTRODUCTION

In socially-aware networking environments, users generate large amounts of data by exploiting capability-rich mobile devices, and prefer to share them with other users with whom they have social ties or greater similar interests. Even though solutions for detecting selfish users have been explored before [1], a few fundamental shortcomings surrounding the problem have remained unaddressed, particularly in data dissemination and forwarding for Ad-hoc Social Network (ASNET) services. Among these, we attempt to design a scheme that gives each user the autonomy to exclude selfish users. In our prior works, we proposed a replica allocation scheme (ComPAS) for ASNETs that exploits social relationship of users, see [2]. We observe that considering social willingness in conjunction with a biologically inspired mechanism (chemical products of bacteria) is effective for attaining our design goal.

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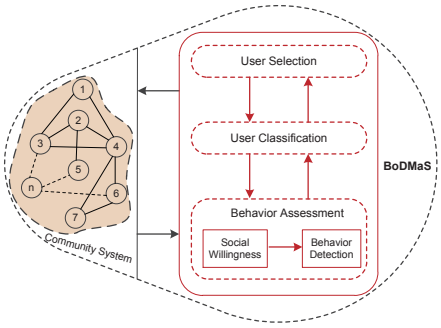

Figure 1: BoDMaS Architecture.

Bacteria is similar to a mobile user in that, it extracts information from the environment, interprets, develops common knowledge and learns from past experiences [3]. Our proposed model, considers social behavior and the characteristics observed in bacteria is deemed to be the biological mechanism. Acyl-Homoserine Lactone Autoinducers (A_i) act as a signaling chemical gradient to detect and determine the amount of bacteria in the environment, thereby allowing a collaborative behavior for the whole group to develop. The existence of social behavior in both the community and bacteria, provide a dynamic and autonomous solution named BoDMaS. Our initial results indicate that substantial gains in accessibility degree and detection can be achieved along with maximized data availability when ComPAS and BoDMaS are employed together.

2. BODMAS DESIGN

This work employs ComPAS [2] as the data management (replication) model. ComPAS is a community-partition aware replica allocation method that can significantly improve ASNETs performance. In order to maintain the reliability of replicated data, the BoDMaS scheme aims to support detection and isolation of selfish users. By assessing, classifying and selecting users that behave cooperatively, our proposed scheme denies the involvement of selfish users in replication operations (i.e. query and update). The assessment is executed by comparing social willingness level and observation of A_i represented by the amount of replica updates, query and forwards issued by users.

As shown in Fig. 1, our scheme consists of three basic components: *behavior assessment*, *user classification* and

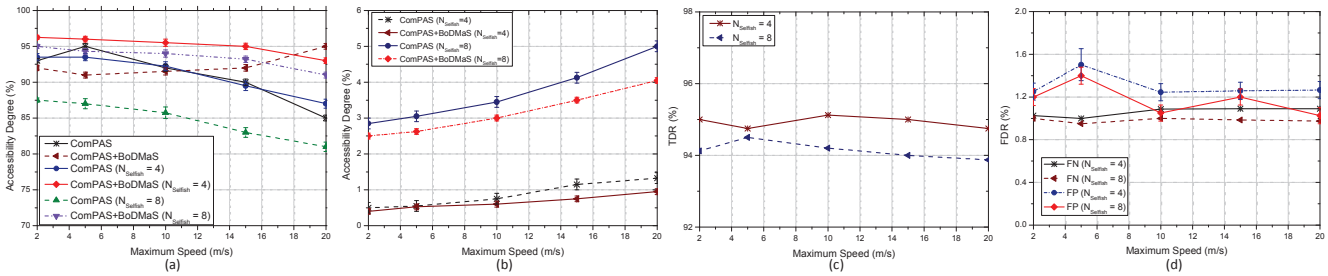

Figure 2: Accessibility degree: (a) update operations, (b) query operations, and BoDMaS detection rate of selfishness in query operations: (c) true detection rate (TDR), (d) false detection rate (FDR).

user selection. The functional interaction among these components are shown in Algorithm 1. In our context, social willingness denotes an interpersonal tie that falls into either a strong or weak category. The user is willing to provide better service to those with stronger ties than those with weaker ties, especially when there are resource constraints [1]. The UST method of appropriating social willingness was selected, as proposed by Li *et al.* [4].

3. PRELIMINARY RESULTS

The scheme is analysed considering the presence of selfish users in ComPAS operations. The network is composed of 32 users within 4 communities, and users move according to RPGM into an area of $400m^2$. The maximum speed is 2-20 m/s with a varying pause time of 10s-100s. The expected updating and querying rates are λ=80 and λ=24, respectively. The forwarding threshold $Er_{f(min)}$ is 0.2 forwards per second.

Algorithm 1: Pseudocode for functional interaction among BoDMaS components

```
begin
    ρ_id ← Social willingness level (ρ_id ∈ [0, 1]);
    Behavior assessment:
    for all direct neighboring users do
        compares ρ_id; where 1 is strongest and 0 is none;
        increment A_i(f);
    User classification:
    for all users' scores collected do
        compare a user's score to a Thr;
        if User A_i count is beyond Thr limit then
            classify the user as unwilling;
            Er_f(min) value is identified;
    User selection:
    make a decision and take action against users;
    if User score ≥ Er_f(min) then
        user is considered cooperative;
        users with lower scores are classified as selfish;
```

To check the effectiveness of employing ComPAS on the BoDMaS scheme (ComPAS⊎BoDMaS), it was evaluated without and with the presence of selfish users for accessibility degree. As depicted in Fig. 2(a), it is possible to verify the feasibility of the proposed scheme as it shows a better performance than ComPAS in terms of speed. Moreover, the use of BoDMaS shows an average improvement compared to the accessibility degree obtained by ComPAS without using BoDMaS for update operations with selfish users' participation. The number of participating selfish users and maximum speed have visible influence in ComPAS⊎BoDMaS for both (query and update) operations when compared to ComPAS. However, as depicted in Fig. 2(b), with low variation, BoDMaS presents lower results than ComPAS for query operations. This is due to the effect of selfishness on accessibility degree is less for query operations as compared to update operations.

TDR and FDR (FN and FP) obtained by BoDMaS for selfish-user detection are illustrated in Figs. 2(c) and (d), respectively. The TDR of selfish users is higher than 93.75%, as depicted in Fig. 2(c). The reason is that the proposed method assesses the selfish behavior of users and classifies it as a cooperative user again once it resumes collaboration in forwarding its query operations. Fig. 2(d) displays that FN detection rate is lower than 1.2%. This shows that just a very few selfish users are detected mistakenly in the selection. Furthermore, FP detection rate is also relatively small. On the whole, the results are quite promising.

In future work, we will consider malicious users that inject data into the process and evaluate the effectiveness of our system under expanded network environments.

4. ACKNOWLEDGEMENTS

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5. REFERENCES

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