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Forming time-stable homogeneous groups into Online Social Networks

Pasquale De Meo[d], Fabrizio Messina[b,a,*], Domenico Rosaci[a], Giuseppe M.L. Sarné[c]

[a] DIIES, Università "Mediterranea" of Reggio Calabria, Italy
[b] DMI, University of Catania, Italy
[c] DICEAM, Università "Mediterranea" of Reggio Calabria, Italy
[d] University of Messina, Italy

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ABSTRACT

In this work we investigate on the time-stability of the homogeneity – in terms of mutual users' similarity within groups – into real Online Social Networks by taking into account users' behavioral information as personal interests. To this purpose, we introduce a conceptual framework to represents the time evolution of the group formation in an OSN. The framework includes a specific experimental approach that has been adopted along with a flexible, distributed algorithm (U2G) designed to drive group formation by weighting two different measures, mutual trust relationships and similarity, denoted by compactness. An experimental campaign has been carried out on datasets extracted from two social networks, CIAO and EPINIONS, and the results show that the time-stability of similarity measure for groups formed by the algorithm U2G based on the sole similarity criterion is lower than that of groups formed by considering similarity and trust together, even when the weight assigned to the trust component is small.

1. Introduction

Most of the existing Online Social Networks (OSNs) platforms target at connecting as many people as they can and it is not surprising that OSNs are became mainstream communication medium.[1] To increase the fruition of the social platforms, OSNs allow the creation of thematic *groups* (e.g. more than 100,000 groups per day only on Facebook [12]). Group formation, as well as their evolution, encompasses the dynamics underlying human interactions in forming and spreading opinions and decisions [3]. A key issue – widely investigated in the latest years – is that of forming "homogeneous" groups in OSNs and, consequently, selecting the best groups a user could join with [5,8,24]. Indeed, users basically need to look for those groups which are potentially able to best satisfy the expectations of a user, as well as the utilities that the other groups members can receive in accepting him/her into a group.

A considerable number of works focused on understanding the driving forces modeling group formation and their evolution, to design effective algorithms to find right groups. Some of these studies [3,11] relates Complex Networks to OSNs, use

* Corresponding author at: DMI, University of Catania, Italy.
E-mail address: messina@dmi.unict.it (F. Messina).

[1] Almost a billion of daily active users on average on June 2015 on the sole Facebook. http://newsroom.fb.com/company-info/

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diffusion processes to model formation and evolution of OSNs groups or highlight as some topological network properties, are reliable indicators to predict if a user will join with a group or if a group will survive in a particular time frame.

1.1. Main motivations underlying our proposal

A crucial problem in the study of group formation and evolution is *time stability* [3,15], i.e. the *aptitude of a group to retain its members*. It is easy to realize that time-stability constitutes a major factor in decreeing the success (and, then, the survival) of a group or, vice versa, its failure (and, then, its extinction).

Due to its practical relevance, it is not surprising that several researchers were interested in studying the evolution of OSN groups in order to understand the mechanisms driving their growth [2,14,16]. Nevertheless, none of the aforementioned approaches investigates the limitations of using user-to-user similarity alone in the process of forming groups. To illustrate these limitations and their practical impact, let us consider the problem of recommending groups to user. If we would rely only on similarity, we should consider user personality traits, features and behaviors at the time instant t to calculate to what extent user features match the overall interests of a group. We would recommend our target user to join the group $g^{\star}$ if $g^{\star}$ best fits the interests of our target user. However, user behavior and preferences may rapidly vary in relatively short time frames and, thus, we are no longer confident that $g^{\star}$ is still the best option for our target user at the time instant $t + \Delta t$. Our paper aims at addressing the limitations above: in detail, we target at studying techniques to form time-stable groups and, to this extent, we suggest that user-to-user similarity alone is not enough to ensure time stability.

1.2. Our contribution

In this paper we present the results of an experimental campaign aimed at understanding the main factors affecting the time-stability of OSN group homogeneity, in terms of internal similarity between the members of the group. Below we describe the main contributions that our work provides.

1. Our first contribution is providing an answer to the following question: “How much time-stable is the homogeneity of those OSNs groups formed on the basis of the users’ similarities?” By using the data of two real OSNs, i.e., EPINIONS and CIAO [23], we had the opportunity to verify, in different time frames, the time-stability of the homogeneity of the groups formed within the OSN basing on the similarity. As we discuss in Sections 7 and 8, the experimental results have shown that group formation driven by similarity does not guarantee a time-stability of the homogeneity, especially when uncorrelated users behavioral components, i.e. aspects of the user behavior that can be considered mostly random, as preferences with respect to group privacy rules, level of participation in group activities, etc., included in the computation of similarity, assume a relevant weight. In other words, the sole similarity criterion seems not sufficient to form OSN groups which will eventually assume a stable homogeneity, in terms of similarity.
2. Given the aforementioned results, our second contribution consisted of solving also another question, namely: “Is it possible to improve the time-stability of the homogeneity in terms of similarity into OSNs groups?” In this respect, we acknowledge that recent studies on group formation processes did not consider the similarity as the sole key criterion to form groups. In fact, frequently an increasing relevance is given also to the *trust* as a crucial factor to keep the level of user’s engagement into a group high enough over time and prevent group failures [22]. Here we use the term *trust* that a user a has in another user b in the following, classical meaning: a trusts b if a commits to an action based on a belief that b’s future actions will lead to a good outcome [7].
   It is not surprising the importance of trust in social networks, because we can note as OSNs users are more motivated to stay in groups with members they trust, likely we observe in other social contexts as, for instance, the multi-agent communities [20,21].

1.3. Differences and novelty with the state of the art and our previous work

With respect to the two research questions defined above, we observe that approaches reviewed in [22] highlight the importance of using trust measures in forming groups. These approaches, however, do not face the problem of combining trust with similarity. In a previous work we proposed an approach for integrating similarity and trust in a unique measure to form groups and finding those most suitable a user can join with [6]. However, in [6] we did not consider changes in user similarity occurring over time and, as such, we did not consider how changes in user similarity impact on the formation of groups.

In this paper, we extend our previous work by introducing a conceptual framework to represent the time evolution of the group formation in an OSN. Our approach takes both similarity and trust measures into account in forming groups, and, unlike existing approaches, it also considers the changes that these measures undergo over time. We expect that our choice does not produce a starting group formation representing the best clustering of the users, since the goal of the actual objective function is to maximize the overall internal similarity of the groups, while in our approach we will form the group by exploiting an objective function which combines similarity and trust.

Then, we have used the new conceptual framework that we have introduced for performing an extensive set of experiments on real data coming from the social networks CIAO and EPINIONS.