# Users Ranking in Online Social Networks to Support POI Selection in Small Groups

Antonio Caso[1] and Silvia Rossi[2] *

[1] Dipartimento di Fisica, University of Naples "Federico II", Napoli - Italy
antonio.caso@unina.it
[2] Dipartimento di Ingegneria Elettrica e Tecnologie dell'Informazione
University of Naples "Federico II", Napoli - Italy
silvia.rossi@unina.it

**Abstract.** The process of content personalization in planning of a city tour requires taking into account the presence of small groups of users. In this context, social network analysis may play an important role both in evaluating users' common interests, and in determining users' relationships. In particular, cohesion, dominance and mediation can be helpful in the design of automatic processes to help users in reaching a consensus. This paper provides initial insights towards this goal and cues to derive simple models of user dominance through intra-group ranking.

**Keywords:** small groups, activity networks, decision support systems.

## 1 Social Interaction and Decision Making

The long-term goal of our research is to provide tourist users with recommender systems and decision support applications. An example of such applications is a city tour planner. When tourists visit a city, they are usually aggregated in small groups and stay in the city only for few days. Hence, it is necessary to choose certain Points of Interest (POI) that maximize the group satisfaction, taking into account that the members' preferences can be different.

Group recommendation approaches rely either on building a single user profile, resulting from the combination of users' profiles, or on merging the recommendation lists of individual users, at runtime, using different group decision strategies. Many of these techniques do not consider the social relationships among group members [1], while the design and implementation of Group Recommendation Systems, and, more generally, of Decision Support Systems, should take into account the type of control in the group decision-making process [2]. For example, there may be cases where the participants follow a democratic process in order to find a possible solution, and cases where the group is supported by a human leader or mediator. Following to this idea, the work of [1] starts to evaluate the group members' weights, in terms of their importance or influence, for TV recommendations.

* The research leading to these results has received funding from the Italian Ministry of University and Research and EU under the PON OR.C.HE.S.T.R.A. project.

In this work we provide initial insight towards the evaluation of small group relationships (leadership and mediation) with the aim to use such analysis to automatically generate a consensus function. In particular, we take concepts from research on users connectivity in order to identify key users in Online Social Networks (OSNs). OSNs interaction analysis can provide a viable way to obtain information about the social relationships and pattern of activities among the group of visitors, without bothering the users with questions.

### 1.1 A Popularity Ranking in Online Social Networks

The analysis of relationships through OSNs relies on several centrality measures, as formalized in [3]. However, the basic definitions of these measures are only designed for binary networks, with symmetric relationships of equal value between all directly connected users, while, in reality, an individual has relationships of varying qualities [4].

In our work, to compute the users' centrality, we took cues from the PageRank algorithm [5]. The idea behind this choice is to use a simple, but effective, algorithm to evaluate the rank of a person, interpreted as an index of popularity in a small group of friends. According to [6] concepts of popularity and leadership are highly correlated in close groups. A similar approach was used in [7], where the authors defined a centrality measure for undirected graphs. Instead, in this work, we present another variant that use directed and weighted graphs. In our opinion, the degree of activity of a person and the directionality of specific communication activities provides meaningful information on the social relationships. Our ranking is defined as follows:

$$R(x) = \frac{1-d}{|F|} + d\sum_{i \in F} \frac{w_{i,x}}{w_i} R(i) \tag{1}$$

where, $|F|$ is the total number of Friends in the group $F$ and d (with $0 \leq d \leq 1$) is a dampening factor (set to 0.85). According to Eq. 1, the user $x$ inherits a proportion of popularity from other $i$ group's members. This is calculated considering both the $i$-th friend's popularity and the weight of the communication activity of the $i$-th friend towards the user $x$ ($w_{i,x}$), normalized with respect to the total communication activity of the $i$-th friend with the group ($w_i$). Such weights are calculated considering some of the communication activities between two users on the OSN *Facebook.com*, collecting a combination of data arising from [8]. In particular, we use the number of posts and links published on the wall of the user $x$ by the user $i$; the number of comments and likes from the user $i$ on the posts published by the user $x$; the number of tags of user $x$ inserted by $i$. Finally, the same computation is done with the comments, likes and tags from the user $i$ on the photos of the user $x$. Note that the friend contribution is normalized with respect to its global activity with the group (as in PageRank). However, PageRank assumed only one link between pages $x$ and $i$ (hence, $i$ equally contributes to the centrality of all the pages it points to), while, here, we represent the weight of the directed connections from $i$ to $x$ determining the level of one-sided communication.

| % Sim | Leader | Average | Mediator | Lead & Med | Lead No Med | LNM Low STD |
|---|---|---|---|---|---|---|
| Average | 61 ± 17 | 59 ± 11 | 63 ± 13 | 53 ± 15 | 73 ± 10 | 75 ± 10 |

Table 1: Cumulative results in the pilot study.

## 2 A Pilot Study

We conducted a pilot study with real users planning a trip in the city of Naples in order to gather useful information on social network relationships vs. face-to-face interactions. In our first pilot study we evaluated the behavior of 14 groups composed, in the average, of 3.4 people. 46 users took part in the experimentation (26 male and 20 female). The average age was 27.3 with a graduate education. In half of the groups there was a mediator, which was identified as the person to whom we asked to create the group and to help the group in performing the experiment. The leader of each group was identified as the member with the highest score according to Eq. 1.

Each person was asked to register on a specific web site using the credentials of *Facebook.com*. Once registered, it was asked to imagine to plan a one-day visit to the city of Naples (Italy) and to select from a checklist of ten items only three activities (places to visit) for the day. After that, it was asked to select two places to eat (from a check list of eight). Since we do not want the user to be involved in strategic reasoning, we did not ask the user to express ratings and preferences among the selected choices. The group was, then, asked to discuss, face-to-face, in order to obtain a shared and unique decision for the group.

Table 1 summarizes the cumulative data of all groups involved in the experiment. For each group, the following data are calculated: the similarity percentage between the choices of the leader and the group final decision (Leader); the similarity percentage between the choices of the mediator, if applicable, and the group final decision (Mediator); the similarity percentage between of the choices of each users and the group final decision (Average).

From the amount of analyzed interactions, with a very high standard deviation, we can conclude that the groups' behaviors on the OSN were very different and with a good value of cohesion (Average = 59%). Considering the aggregated data, the average similarity value of the leader choices (Leader) is on average 61%, which is comparable with the Average similarity, and the Mediator similarity (63%) with the final decision of the group. Apart from the aggregated data, that shows similar results on the average, what is interesting, from our point of view, is to compare the behavior of groups with a mediator with groups without this specific role. We observed that in the case of a member of the group acting as mediator the similarity of the group decision w.r.t. the leader was on average 53% (Lead & Med); instead, in the second case, the similarity with the leader was, on average, equal to 73% (Lead No Med). The p-value, calculated on these two sets, is 0.0058, which means that such difference is not due to chance. Finally, we analyzed the standard deviation of the leadership values (evaluated according to Eq. 1) for the set without a mediator and subdivided it in two sets (with low and high standard deviation). The groups with low standard deviation (LNM Low STD), which is interpreted as a measure of cohesion and similarity in the behavior of the group members, showed a similarity of the leader choices with the group final decision of 75%. Hence, we can infer that, in case there is not a mediator, the leader got a much more important role in the consensus making, especially in close groups where the popularity index, we evaluated, better identifies a possible leader.

## 3 Conclusions and Future Works

In this paper, we started to analyze the users' interactions in a social network in order to gather useful information to help groups in decision-making. In particular, we were interested in the role of cohesion, dominance and mediation for reaching a consensus. We showed that it is possible to derive a simple model of user dominance, through intra-group ranking, and such a role is fundamental in the absence of a mediator.

In this pilot study we used a small number of alternatives for planning only a single day in a delimited neighbourhood of a city. The scalability of our results, increasing the number of choices with more complex real settings, have to be deeply analyzed, including also the possibility to express an explicit ranking on the selected choices. Moreover, we limited our groups to people (mainly friends) without any hierarchical relationships between them, while also social intra-group roles have to be taken into account.

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