Social networks and genetic algorithms to choose committees with independent members

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Organizations need representative individuals to make decisions about particular concerns. These representative individuals are appointed in committees, and we expect from his members to make decisions avoiding bias that could arise from closeness between them. In this context, the best committees are those which show the greatest independence between its members.
In this work, we present an automatic approach to the committee selection problem. Our aim is to maximize independence among members of the committee. To this end, we propose to build a social network to calculate distances between candidates, and then apply a genetic algorithm to get potential committees with the greatest distances between their members.
Independence is measured by the following fitness function (1):

$$f = \frac{\left[\left(\sum_{i,j=0}^{k} d(i,j)/k \right) \right] + m}{2 * D} \tag{1}$$

Where d is the distance function between two members, $\forall i, j / i \neq j$ and $i, j \in S$, S represents the whole nodes set, k is the number of committee members, m is the minimum distance between each pair of members in the committee, and D is the network diameter.

To evaluate our approach we present a case study where we build a social network with on-line available data extracted from a Research and Development (R&D) public agency. The social network for the case study was composed by 1,293 nodes and 4,322 ties. We compared the fitness of current committees (Admissions, Reports and Fellowship awards) with the fitness of the committees proposed by the genetic algorithm. Experimental results showed that our approach can propose committees with improved independence of their members in comparison with the current committees.

Assisting committee selection processes may be the greatest competitive advantage offered by our approach, since we have proved that the best performance groups can be selected within seconds for a real scenario. Also, the genetic algorithm generates alternative groups that can be preferred by the experts responsible for the committee appointments.

The main contributions of this work are summarized as follows. First, we propose an approach for the committee selection problem with independent members as a group selection problem in social networks. Finally, we define a novel group independence fitness function to assess the performance of groups in social networks. This fitness function was optimized by means of a genetic algorithm.

Previous works in the Target Set Selection problem share some elements with the committee selection problem. They mainly differ with our work in the use of diffusion dynamics to measure performance. Similar to the target set selection problem is the key player problem (KPP) which identifies sets of key players within social networks. The main difference with our work is on the fitness function and in the usage of the structural properties, since KPP uses set cohesion and closeness centrality and we use betweenness. Previous works in the Community Detection problem are mainly based on structural properties. This strategy denotes the impossibility to measure geodesic distances in unconnected graphs. They solve this constraint by replacing distances of disconnected pair of nodes with the largest geodesic distance in the graph. Early works on Social Network Analysis recognizes the computational constraint of uncovering groups based on proximity matrix representation. The main differences with our work are in the chromosome representation and in the fitness function. Other areas that use distance as social network structural property for group selection include recommendation, friendship likelihood and dynamics, hiring, and team selection.

Despite of the results shown in this work, more complex processes for committee member selection may include criteria other than the group independence, such as node prominence, related topics, or skills compliance in searching for fulfill certain requirements.

Future works may include other optimization strategies, in particular for scalability scenarios. Moreover, a complex social network representation will allow including other kind of network properties, such as directed ties or node attributes.

Reference

- Eduardo Zamudio, Luis S. Berdún, and Analía A. Amandi. Social networks and genetic algorithms to choose committees with independent members. Expert Systems with Applications, 43:261–270, 2016. ISSN 0957-4174. IF2014:2,240