Demo: Urgent Task Assignment for Mutual Help in Mobile Social Networks

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Abstract

Although the quality of task completion is related to the level of participants, the cost of cooperation among participants is more important for a collaborative task, especially in an urgent situation. In this demo, we study the urgent task assignment problem for mobile social networks. Based on Formal Context theory, we propose a clique-based team formation scheme with minimum communication cost for urgent tasks. Simulation results verify that the proposed scheme can provide good performance in terms of success ratio, cardinality of chosen teams, running time and coverage.

1 Introduction

Execution of a complex task requires the cooperation of participants, especially for a collaborative task. To accomplish tasks with special skills, participants with high skill level have priority to be chosen. However, in an urgent situation, e.g., caught by a car crash after night shift, friends, even acquaintances nearby often can be our helpers. Thus, social connection is our first consideration. Intuitively, most of people with strong ties are trustworthy, and result in less communication cost.

In this Demo, we focus on urgent task assignment for mutual help in Mobile Social Networks. Existing works studied the team formation problem with strong ties, and proposed a few metrics to evaluate the level of cooperation cost of final teams. In [3], Lappas et al. introduced two concepts, i.e., the minimum spanning tree (MST) and the maximum diameter of the team, as metrics, and then proposed a heuristic algorithm to form teams. In [2], Kargar et al. proposed an algorithm to form a team with a leader. Unfortunately, the heuristics algorithm can only achieve locally optimal solution. Furthermore, MST-based heuristic algorithm has poor adaptability and performance because of lacking of global view.

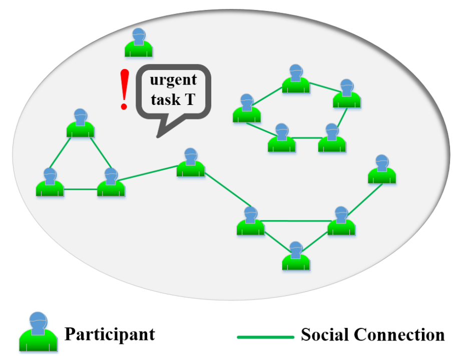

Figure 1. A Logical Structure of Mobile Social Network

In this Demo, based on Formal Context theory, we propose a team formation algorithm for urgent tasks in mobile social networks. With cliques, we can find quickly the most qualified person with desired skill.

2 The Proposed Algorithm

We consider a mobile social network, as shown in Figure 1. To accomplish the urgent task, we search all cliques from the mobile social network by taking advantage of Formal Context theory. Instead of selecting participants iteratively based on the communication cost, we directly utilize found cliques to form teams with strong ties for urgent tasks. We refer to the team formation problem with strong ties as TFP-ST in this paper. Figure 2 is an overview of our proposed algorithm.

We summarize major parameters and their definitions in Table 1.

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Table 1. Symbols and Definitions

Symbols	Definition and Description
$G=(V,E)$	the social network, an undirected and weighted graph, $\|V\|=n$
$i \in V$	a participant
$V' \subseteq V$	team V' is a subset of V
T	task T=$\{s^1, s^2, ..., s^p\}$
s^k	the kth skill in the system
M_i	skill mapping for participant i, $M_i = \{f_i^1$,..., f_i^k,... , $f_i^m\}$, m is the cardinality of skills
C	the set of cliques $C=\{c_1, ..., c_q\}$, $\|C\|=q$
f_i^k	proficiency of participant i in skill s^k
f^k	the success ratio of a team V' for skill s^k, $f^k = 1-\prod_{i\in V'}(1-f_i^k)$
S^k	the requirement of skill s^k by task T

2.1 The Target Problem

In this paper, our objective is to find a team, which gains minimum communication cost and satisfies skill requirements for every urgent task. Mathematically speaking, our problem can be formulated as:

Minimize:

$$MST(V') \tag{1}$$

Subject to:

$$V' \subseteq V, E' \subseteq E \tag{2}$$

$$\forall s^k \in T, f^k \geq S^k, f^k = 1-\prod_{i\in V'}(1-f_i^k) \tag{3}$$

2.2 Clique-based Task Assignment Algorithm

A small group of closely connected people form a clique. In a clique, everyone is connected to everyone else. Based on cliques, we propose a urgent task assignment algorithm. Firstly, we transform the undirected and weighted graph, G, into a formal context FC(G), and then use the method, which is described in [1], to find clique set C in G. For $\forall c_i \in C$, and $c_i = \{c_{i1}, ..., c_{ij}, ..., c_{in}\}$, if $c_{ij}=1$, it represents that c_i has node j in V; Otherwise, on the contrary. We obtain skill matrix of c_i according to Equation (4), g_{ik} is the proficiency of c_i in skill s^k. For task T, we obtain the solution $V' = \bigcup_{j\in V}\{j|c_{xj}=1\}$ of task T which satisfies $f^k \geq S^k$, and $\forall s^k \in T$, intuitively, f^k of V' is equal to the value of g_{xk}.

$$g(c_i) = \{g_{i1}, ..., g_{ik}, ..., g_{im}\} \tag{4}$$

where,

$$g_{ik} = 1-\prod_{j\in V, c_{ij}=1}(1-c_{ij}\cdot f_j^k) \tag{5}$$

3 Simulation and Performance Evaluation

In this section, we evaluate the performance of the proposed algorithm, referred to as Clique-based in the following figures. We implement the greedy heuristics algorithm, as the benchmark for comparison. We use the DBLP data set, used in [4], which contains the information about papers

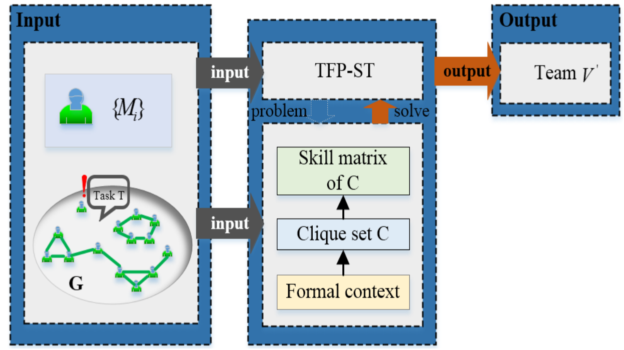

Figure 2. Overview of Our Proposed Algorithm.

and authors. we use a graph representing the social network, including 854 nodes and 3279 edges. The task set includes the top 100 skills with the largest number of candidates.

We compare our proposed urgent task assignment algorithm with the benchmark in terms of communication cost, average cardinality of final teams, running time and coverage. We assume that every project has four tasks, every task requires three random chosen skills. Figure 3 (a), (b), (c) and (d) illustrate that our proposed algorithm has better performance than the benchmark.

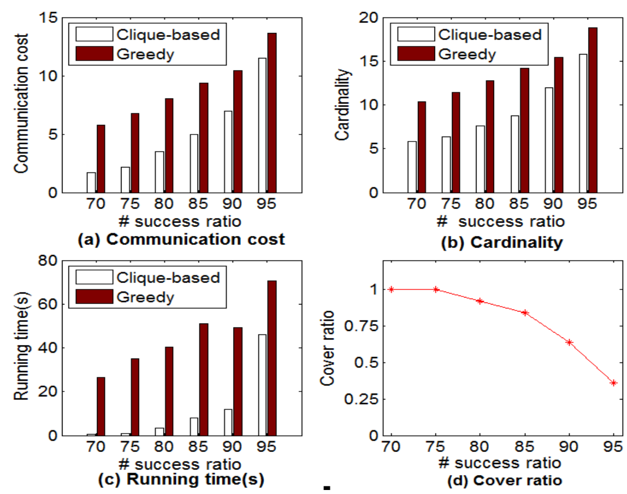

Figure 3. Simulation Result

4 References

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A Appendix 1

Setup

Our experiments are executed on a PC with an Intel Core i5 CPU, an RAM of 8GB and a 64-bit Windows 7 OS. The algorithms are implemented in Java. No special equipment is required.