

Improving Human Interaction in Crowdsensing (Doctoral Consortium)

Gleb Polevoy
Supervisor: Mathijs de Weerd
Delft University of Technology, The Netherlands
Delft, The Netherlands
G.Polevoy@tudelft.nl

ABSTRACT

We consider game theoretic aspects of crowdsensing projects. Commencing by studying putting effort in and sharing rewards from public projects, we continue to emotion-influenced interrelations in human society, including negotiations as a kind of such influence. These topics are also highly relevant to many applications apart from crowdsensing.

Categories and Subject Descriptors

Computer Applications [SOCIAL AND BEHAVIORAL SCIENCES]: Economics

Keywords

shared effort game; network interaction; dynamics; negotiation; emotion modeling

1. INTRODUCTION

Many (information-related) goals require cooperation and participation in large projects, such as open-source software, performing tasks for someone else, and sharing content online. We concentrate on crowdsensing [6], where people provide sensor information to answer others' requests. We study game theoretic aspects of such projects, taking into account irrational behavior [11, Chapter 1.3] and [14].

In particular, consider the SHINE project¹. In SHINE, a participant may issue weather-related requests, and the other participants who can answer these requests provide answer of some quality, perhaps for a payment. We model the deciding of choosing whether to participate in this project or in some other one as a so-called shared effort game. Each of the projects yields a reward, to be divided between the contributors. These games also model deciding how much to contribute in each project where the person participates. Next, the players who participate in a project, interact according to the laws of human behaviour, where a crucial interaction is the negotiation between two or more players about the conditions of providing a service to each other. In modeling these interactions, we also take into account the ir-

¹<http://direct.tudelft.nl/shine-117.html>

Appears in: *Alessio Lomuscio, Paul Scerri, Ana Bazzan, and Michael Huhns (eds.), Proceedings of the 13th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2014), May 5-9, 2014, Paris, France.*
Copyright © 2014, International Foundation for Autonomous Agents and Multiagent Systems (www.ifaamas.org). All rights reserved.

rational human behavior. These topics are, of course, useful not only in crowdsensing, but in other contexts as well.

2. PREVIOUS WORK

2.1 Solution Concepts for Shared Effort Games and their Qualities

In sharing effort games, each player divides her budget between a set of projects, and receives shares of the projects' total values. We focus on the case where only those who contribute at least θ fraction of the maximum contribution receive a share, namely an equal share of the project's value. The value of a project is a function of the total contribution it receives. A specific sharing game with $\theta = 1$ has been considered in all-pay auction is similar to lobbying, or contests, job promotions, (see e.g. [12]). Under very specific artificial conditions, (N -approximate Vickrey conditions) and $\theta = 0$, Bachrach et al. [2] has shown that the price of anarchy is bounded by N . We look at a more general $\theta \in [0, 1]$ sharing mechanisms, and our model [10] is not constrained by N -approximate Vickrey conditions.

2.2 Irrational Society Interrelations

We are extending the game theoretic work on human interrelations by suggesting and analyzing models of interaction where people reciprocate in a manner that depends on their characters.

There has been much research on irrationality in interaction in a society. Fokker [4] considers the current cooperation problems in P2P systems, She considers taking the human approach to motivate cooperation. To this end, she studies the successful systems and social psychology. A famous solution for the problem that people often behave emotionally is drama theory [7]. Irrationality here differs from limited rationality of Simon [13], but rather can occur even when the character has enough information and information processing capacity.

2.3 Emotions-Influenced Negotiation

We are extending the work on multi-attribute negotiation [8, 9], especially about resource allocation [1], with models of non-rational behavior. An empirical psychological study of the effects of the available negotiation time on negotiations appears in [3]. A study of role of emotions in negotiations appears in [5, 15].

We are focusing on the effects of the relationship between the interacting sides and of the emotional load of the situa-

tion on the manner people negotiate. The characters of the negotiators are taken into account as well.

3. RESEARCH QUESTIONS

1. Given a shared effort game, what are the predicted Nash equilibria and their efficiency?
2. Given two or more parties, we model a negotiation algorithm. This model will be inspired by factors like personal interrelations and trust. In this model, what protocol enables carrying out efficient and fair negotiation over concrete resource usage?

From this point on, we are given a society network where players may impact each other and gossip about these impacts.

3. What impacts will be made as the time progresses?
4. What propaganda that alters some of the system parameters allows achieving maximum social welfare and social satisfaction level?
5. Consider mutual negotiation as the only possible impacts and review the questions of behaviour and mechanism design from 3 and 4.

4. THESIS OUTLINE

4.1 Equilibria in Shared Effort Games

We provide necessary conditions for the existence of a pure-strategy Nash equilibrium in a shared effort game. In some case, we precisely characterize when a sharing game obtains a NE, and we analyze other cases through simulations. We also consider the efficiency of the Nash equilibria.

4.2 Irrational Society Interrelations and Practical Conclusions

Assume the players' objectives include emotions, and all the agents behave according to the assumed behavioral models. We then ask what impacts (influences) will be made, and when the knowledge is not perfect, what gossip about the made impacts will be spread?

We also look for a protocol for influencing the parameters of the players' objective functions, such that the maximum social welfare is achieved.

4.3 Non-rational Negotiations Design

Negotiation is an important area, that has been extensively researched. Some research also focuses on players, striving not only to obtain as much good as possible, but also to have a decently fair outcome, in some sense. That is, people are modeled to be more complex than just aiming to achieve some one-dimensional good. We use also feelings such as anger, anxiety, sympathy, nervousness, joy and so on as an inspiration for our models. Another aspect is trust to each other. Such considerations are especially relevant in negotiation in sensitive cases, such as emergencies.

We model this by modeling a negotiator's behavior, where the emotional parts depend on the person and on the situation. Having done this, we turn to predicting the results of human behavior in several negotiation mechanisms and based on that, consider what protocol leaves player feeling the best, under a definition of a good feeling?

4.4 Irrational Society Interrelations with Negotiation

Consider a network where pairwise negotiations are the only impacts players have on each other, instead of arbitrary impacts, we dealt with in Section 4.2. Now, the question of what the players will do become much more complicated, because of the two interwoven aspects: society interrelations and negotiations. We consider, which actions the players will perform while negotiating in such a network.

Acknowledgement

This work is supported by the SHINE project of TU Delft, funded by the Delft Institute for Research on ICT.

5. REFERENCES

- [1] B. An. *Automated Negotiation for Complex Multi-agent Resource Allocation*. PhD thesis, Amherst, MA, Feb. 2011.
- [2] Y. Bachrach, V. Syrgkanis, and M. Vojnovic. Efficiency and the Redistribution of Welfare. (May), 2012.
- [3] P. J. Carnevale and E. J. Lawler. Time pressure and the development of integrative agreements in bilateral negotiations. *Journal of Conflict Resolution*, 30(4):636–659, 1986.
- [4] J. Fokker. *Inducing human cooperation in decentralized networks*. PhD thesis, Delft, the Netherlands, Feb. 2013.
- [5] D. Fromm. Emotion in negotiation. *The Negotiator Magazine*, 2007.
- [6] R. Ganti, F. Ye, and H. Lei. Mobile crowdsensing: current state and future challenges. *IEEE Communications Magazine*, 49(11):32–39, Nov. 2011.
- [7] N. Howard, P. Bennett, J. Bryant, and M. Bradley. Manifesto for a theory of drama and irrational choice. *Systems practice*, 6(4):429–434, 1993.
- [8] N. Jennings, P. Faratin, A. Lomuscio, S. Parsons, M. Wooldridge, and C. Sierra. Automated negotiation: prospects, methods and challenges. *Group Decision and Negotiation*, 10(Wooldridge 1997):199–215, 2001.
- [9] G. Lai and K. Sycara. A Generic Framework for Automated Multi-attribute Negotiation. *Group Decision and Negotiation*, 18(2):169–187, July 2008.
- [10] G. Polevoy, S. Trajanovski, and M. de Weerd. Nash equilibria in shared effort games. In *AAMAS 2014*, forthcoming 2014.
- [11] A. Rubinstein. *Modeling Bounded Rationality*, volume 1. The MIT Press, 1 edition, 1997.
- [12] R. Siegel. All-pay contests. *Econometrica*, 77(1):71–92, 2009.
- [13] H. A. Simon. A behavioral model of rational choice. *The Quarterly Journal of Economics*, 69(1):pp. 99–118, Feb. 1955.
- [14] A. Tversky and D. Kahneman. Rational choice and the framing of decisions. *The Journal of Business*, 59(4):pp. S251–S278, Oct. 1986.
- [15] P. Zimmerman and J. Lerner. The emotional decision maker. *Government Executive*, In Press.