Characterization of False-name-proof Social Choice Mechanisms

(Extended Abstract)

Taiki Todo
Graduate School of Information Science and Electrical Engineering, Kyushu University
Motooka 744, Nishi-ku, Fukuoka, 819-0395, Japan
todo@agent.is.kyushu-u.ac.jp

ABSTRACT

Mechanism Design has been developed as a significant tool to model and analyze markets, economies, and societies in the real-world. On the Internet, however, we face some unexpected problems such as false-name manipulations, and traditional mechanism design does not work sufficiently. In this thesis, we will develop mechanism design into a more applicable theory for computer sciences and economics on the Internet. Specifically, we characterize social choice mechanisms that are robust against false-name manipulations.

Categories and Subject Descriptors

I.2.11 [**Artificial Intelligence**]: Distributed Artificial Intelligence—*Multi-agent systems*; J.4 [**Social and Behavioral Sciences**]: Economics

Keywords

Mechanism Design, Algorithmic Game Theory, False-name-proofness

1. INTRODUCTION

In the Internet or some anonymous environments, agents can use multiple identifiers , e.g., multiple e-mail addresses. It has been pointed out that the existence of these *false-name* manipulations can lead to serious problems [11]. In fact, it is shown that agents can increase their utilities by bidding multiple times in VCG combinatorial auction.

Mechanism design, and also the traditional game theory, has been developed as a significant tool to analyze and model markets, economies, and societies in the real-world. On the Internet, however, we face some unexpected problems such as false-name manipulations. It is very difficult to detect such dishonest actions, since identifying each participant on the Internet is virtually impossible. Then, these theories sometimes do not work sufficiently in such environments.

In this thesis, we will develop mechanism design into a more applicable theory for computer sciences and economics on the Internet. Specifically, we characterize social choice mechanisms that are robust against false-name manipulations. In Section 3, we introduce our characterization theorems of false-name-proofness for several social choice settings. In Subsection 3.4, we discuss the connection between false-name-proofness and several other concepts in mechanism design/social choice literature.

Cite as: Characterization of False-name-proof Social Choice Mechanisms (Extended Abstract), Taiki Todo, *Proc. of 9th Int. Conf. on Autonomous Agents and Multiagent Systems (AAMAS 2010)*, van der Hoek, Kaminka, Lespérance, Luck and Sen (eds.), May, 10–14, 2010, Toronto, Canada, pp. 1675-1676

2. CHARACTERIZATION OF MECHANISMS

Social choice mechanisms that satisfy strategy-proofness have been studied for a long time. Especially, characterizing strategy-proof mechanisms has recently attracted much attention in computer science field.

In the case of auction mechanisms, in particular, a family of *monotonicity* property of allocation rules was identified to characterize strategy-proof auction mechanisms. An auction mechanism consists of an allocation rule that defines the allocation of goods for each bidder and a payment rule that defines the payment of each winner. Lavi *et al.* [3] introduced a simple property called *weak-monotonicity* on allocation rules of auction mechanisms and showed that it is a necessary and sufficient condition for strategy-proof combinatorial auction mechanisms, when several assumptions hold on the domain of types.

3. CURRENT ISSUES

First, let us introduce *false-name-proofness* of mechanisms, which is a generalization of strategy-proofness. A mechanism is false-name-proof if for each agent, reporting his true type using a single identifier (although the agent can use multiple identifiers) is a dominant strategy. Now I introduce my current issues on characterizing false-name-proof mechanisms in the following subsections.

3.1 Combinatorial Auctions

In our paper [9], we identified a property called *sub-additivity* and fully characterized false-name-proof allocation rules in combinatorial auctions when coupled with weak-monotonicity.

THEOREM 1. *There exists an appropriate payment rule p so that a combinatorial auction mechanism $\mathcal{M}(X, p)$ is false-name-proof if and only if the allocation rule X simultaneously satisfies weak-monotonicity and sub-additivity.*

In this direction, we are planning to extend our characterization theorem to much broader social choice mechanisms, such as reverse auction and combinatorial exchanges. Furthermore, it is also desirable to obtain the worst-case efficiency ratio in general (not limited to the single-minded) combinatorial auction mechanisms by utilizing sub-additivity.

3.2 Online Auctions

Furthermore, in our recent paper [10], we characterized false-name-proofness of online auction mechanisms by identifying a property called *(value, time, identifier)-monotonicity*, which is an extension of *(value, time)-monotonicity* identified by Hajiaghayi *et al.* [2].

THEOREM 2. *On a single-valued domain with no early-arrival and no late-departure, there always exists an appropriate payment rule p so that an online mechanism* $\mathcal{M}(X, p)$ *is false-name-proof if and only if the allocation rule* X *satisfies (value, time, identifier)-monotonicity.*

In this direction, we are planning to provide characterizations of strategy/false-name-proofness in *online combinatorial auction* settings, by extending the characterizations that have been provided. In the real-world environments, it is desirable to simultaneously consider both the complicated interdependent valuations and dynamic arrival/departures of agents. To the best of our knowledge, however, there is virtually no work to characterize these properties of online combinatorial auctions. The characterizations will provide us with a new framework to design mechanisms for e-commerce or decision making on the Internet.

3.3 Facility Location Mechanisms

In recent years, mechanism design without money has lately attracted considerable attention in the computer science field (see [6] as an extensive survey). In such environments, false-name manipulations may also be a serious problem. In our recent work, we characterized false-name-proofness of facility location mechanisms (while without rigorous proof and not published yet) by extending the characterization by Moulin [4].

In this direction, it would be important to analyze the performance of false-name-proof mechanisms, e.g., the lower/upper bounds of the approximation ratio that can be achieved by false-name-proof mechanisms with respect to the optimal mechanism, by utilizing the characterizations. In addition, we would like to extend our characterizations to more general social choice mechanisms without monetary payments, such as voting rules and fair allocation schemes.

3.4 Others

Besides incentive issues discussed above, a seller's revenue has also been a major research topic in auction literature. Especially, *revenue monotonicity* [5] is recognized as one of desirable properties an auction mechanism should satisfy. An auction mechanism is *revenue monotone* if a seller's revenue from an auction is guaranteed to weakly increase as the number of agents grows. Although it had been mentioned that there exists a connection between false-name-proofness and revenue monotonicity, there had been virtually no work to clarifies the connection. In our paper [8], we provided a characterization of revenue monotone combinatorial auction mechanisms and gave a theoretical consideration of the connection (Theorems 3 and 4).

THEOREM 3. *Under a natural assumption, a single-item auction mechanism is false-name-proof if and only if it is strategy-proof and revenue monotone.*

THEOREM 4. *Under two natural assumptions, there exists no combinatorial auction mechanism that simultaneously satisfies revenue monotonicity and false-name-proofness.*

Several other concepts that a mechanism should satisfy have also been introduced in mechanism design/social choice literature. In auction mechanisms, *group-strategyproofness* and *collusion-proofness* are well-known properties, which require that no group of agents can improve their utility by lying. In social choice theory (including facility location problems), besides group-strategyproofness, *population monotonicity* was introduced by Thomson [7], which generally requires that all agents initially present must be affected in the same direction by an arrival of a new agent. In addition, in voting theory, Conitzer [1] introduced a concept called *anonymity-proofness* as an extension of false-name-proofness. In this direction, it would be interesting to clarify the connections between false-name-proofness and these concepts.

4. CONCLUSIONS

I am planning to keep working on these directions during my doctoral years that will be starting from April 2010. Through these researches, I would like to contribute to the development of game theory and multi-agent systems on the Internet and networks.

5. ACKNOWLEDGEMENTS

I would like to thank Prof. Makoto Yokoo for supervising me during my master years. I also thank Atsushi Iwasaki for many helpful discussions. This work was supported by Grant-in-Aid for JSPS Fellows.

6. REFERENCES

[1] V. Conitzer. Anonymity-proof voting rules. In *WINE*, 2008.

[2] M. T. Hajiaghayi, R. D. Kleinberg, M. Mahdian, and D. C. Parkes. Online auctions with re-usable goods. In *EC*, 2005.

[3] R. Lavi, A. Mu'alem, and N. Nisan. Towards a characterization of truthful combinatorial auctions. In *FOCS*, 2003.

[4] H. Moulin. On strategy-proofness and single peakedness. *Public Choice*, 35(4):437–455, 1980.

[5] B. Rastegari, A. Condon, and K. Leyton-Brown. Revenue monotonicity in combinatorial auctions. In *AAAI*, 2007.

[6] J. Schummer and R. V. Vohra. Mechanism design without money. In *Algorithmic Game Theory*, chapter 10, 2007.

[7] W. Thomson. Population monotonic allocation rules. In *Social Choice, Welfare, and Ethics*, chapter 4, 1995.

[8] T. Todo, A. Iwasaki, and M. Yokoo. Characterization of strategy-proof, revenue monotone combinatorial auction mechanisms and connection with false-name-proofness. In *WINE*, 2009.

[9] T. Todo, A. Iwasaki, M. Yokoo, and Y. Sakurai. Characterizing false-name-proof allocation rules in combinatorial auctions. In *AAMAS*, 2009.

[10] T. Todo, T. Mouri, A. Iwasaki, and M. Yokoo. False-name-proofness in online mechanisms. working paper, 2010.

[11] M. Yokoo, Y. Sakurai, and S. Matsubara. The effect of false-name bids in combinatorial auctions: New fraud in internet auctions. *Games and Economic Behavior*, 46(1):174–188, 2004.