False-name-Proof Combinatorial Auction Mechanisms (extended abstract)

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1. MODEL OF FALSE-NAME BIDS

Although the Internet provides an excellent infrastructure for executing combinatorial auctions, we must consider the possibility of new types of cheating. For example, a bidder may try to profit from submitting false bids under fictitious names such as multiple e-mail addresses. Such an action is very difficult to detect since identifying each participant on the Internet is virtually impossible. We call a bid made under a fictitious name a *false-name bid*.

False-name bids are modeled as follows.

—Each bidder can use multiple identifiers.

—Each identifiers is unique and cannot be impersonated, i.e., a bidder cannot use identifiers that belong to other bidders.

—Nobody (except the owner) knows whether two identifiers belongs to the same bidder or not.

The goal is to design a false-name-proof mechanism, i.e., a mechanism in which using false names is useless, thus bidders voluntary refrain from using false names.

The problems resulting from collusion have been discussed by many researchers. Compared to collusion, a false-name bid is easier to execute on the Internet since getting another identifier such as another e-mail address, is quite inexpensive. False-name bids can be considered as a very restricted subclass of collusion, where bidder i can collude with other bidders only if these bidders are not interested in participating the auction initially. Theses bidders act in behalf of bidder i and get some side payment.

A concept called *group-strategy-proof* is proposed to study another restricted subclass of general collusion [Muller and Satterthwaite 1985; Moulin and Shenker 1996]. Group-strategy-proof and false-name-proof are independent concepts, i.e., a group-strategy-proof mechanism is not necessarily false-name-proof, and vice versa.

2. VULNERABILITY OF VCG

Vickrey-Clarke-Groves mechanism (a.k.a. Generalized Vickrey Auction protocol) is (dominant strategy) incentive compatible, i.e., for each bidder, truth-telling is a dominant strategy (a best strategy regardless of the action of other bidders) if there

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exists no false-name bid. However, when false-name bids are possible, truth-telling is no longer a dominant strategy, i.e., the VCG is not false-name-proof.

Let us consider the following situation.

EXAMPLE 2.1. *Assume there are two goods a and b, and three bidders, bidder 1, 2, and 3. The evaluation value for a bundle is determined as follows.*

	$\{a\}$	$\{b\}$	$\{a,b\}$
bidder 1	*\$6*	*\$0*	*\$6*
bidder 2	*\$0*	*\$0*	*\$8*
bidder 3	*\$0*	*\$5*	*\$5*

By using the VCG, good a is allocated to bidder 1, and b is allocated to bidder 3. Bidder 1 pays \$3 and bidder 3 pays \$2.

Let us consider another situation.

EXAMPLE 2.2. *Assume there are only two bidders, bidder 1 and 2. The evaluation value for a bundle is determined as follows.*

	$\{a\}$	$\{b\}$	$\{a,b\}$
bidder 1	*\$6*	*\$5*	*\$11*
bidder 2	*\$0*	*\$0*	*\$8*

In this case, the bidder 1 can obtains both goods, but he/she requires to pay \$8, since if bidder 1 does not participate, the social surplus would have been \$8. When bidder 1 does participate, bidder 1 takes everything and the social surplus except bidder 1 becomes 0. Thus, bidder 1 needs to pay the decreased amount of the social surplus, i.e., \$8.

However, bidder 1 can use another identifier, namely, bidder 3 and creates a situation identical to Example 2.1. Then, good a is allocated to bidder 1, and b is allocated to bidder 3. Bidder 1 pays \$3 and bidder 3 pays \$2. Since bidder 3 is a false-name of bidder 1, bidder 1 can obtain both goods by paying \$3+\$2=\$5. Thus, using a false-name is profitable for bidder 1.

3. KEY RESULTS

The effects of false-name bids on combinatorial auctions are analyzed in [Yokoo et al. 2004]. The obtained results can be summarized as follows.

—As shown in the above example, the VCG is is not false-name-proof.

—There exists no false-name-proof combinatorial auction protocol that satisfies Pareto efficiency.

—If a surplus function of bidders satisfies a condition called *concavity*, then the VCG is guaranteed to be false-name-proof.

Also, a series of mechanisms that are false-name-proof in various settings have been developed: combinatorial auction mechanisms [Yokoo et al. 2001a; Yokoo

2003], multi-unit auction mechanisms [Iwasaki et al. 2005; Terada and Yokoo 2003; Yokoo et al. 2001b], double auction mechanisms [Sakurai and Yokoo 2002; 2003; Yokoo et al. 2005], and combinatorial procurement auctions [Suyama and Yokoo 2005].

An auction mechanism consists of an allocation rule and a payment rule. There have been several studies on characterizing strategy-proof allocation rules. Lavi *et al.* [Lavi et al. 2003] and Bikhchandani *et al.* [Bikhchandani et al. 2006] proposed *weak-monotonicity* and showed that it is a necessary and sufficient condition for strategy-proof mechanisms when several assumptions hold on the domain of types.

Similarly, we showed that if (and only if) an allocation rule satisfies a condition called *sub-additivity*, we can guarantee that there exists an appropriate payment rule so that the mechanism becomes false-name-proof, i.e., sub-additivity fully characterizes false-name-proof allocation rules [Todo et al. 2009]. Also, we examined a theoretical bound on the efficiency loss of false-name-proof mechanisms and developed a mechanism whose worst-case efficiency loss matches the theoretical bound [Iwasaki et al. 2010].

In [Ausubel and Milgrom 2005], several limitations of the VCG including the vulnerability to false-name bids are discussed. Also, in [Rastegari et al. 2007], the connection between false-name-proofness and another property called *revenue monotonicity* is discussed.

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