Pricing Social Goods*

One Page Abstract

Alon Eden
Tel Aviv University, Israel
alonarde@gmail.com

Tomer Ezra
Tel Aviv University, Israel
tomer.ezra@gmail.com

Michal Feldman
Tel Aviv University, Israel
Microsoft Research, Israel
michal.feldman@cs.tau.ac.il

ABSTRACT

Social goods are goods that grant value not only to their owners but also to the owners' surroundings, be it their families, friends or office mates. The benefit a non-owner derives from the good is affected by many factors, including the type of the good, its availability, and the social status of the non-owner. Depending on the magnitude of the benefit and on the price of the good, a potential buyer might stay away from purchasing the good, hoping to free ride on others' purchases. A revenue-maximizing seller who sells social goods must take these considerations into account when setting prices for the good. The literature on optimal pricing has advanced considerably over the last decade, but little is known about optimal pricing schemes for selling social goods. In this paper, we conduct a systematic study of revenue-maximizing pricing schemes for social goods: we introduce a Bayesian model for this scenario, and devise nearly-optimal pricing schemes for various types of externalities, both for simultaneous sales and for sequential sales.

To study this problem, we consider a setting with a single type of good, of unlimited supply, and a set of n agents; each agent $i \in [n]$ has a non-negative valuation v_i for purchasing the good, drawn independently from a distribution F_i. We denote the product distribution by $\mathcal{F} = \times_{i\in[n]} F_i$. An agent i who purchases the good derives value v_i from it.

If an agent does not purchase the good, but the good is purchased by others, then this agent derives only a fraction of her value, depending on the set of agents and the type of externality the good exhibits on the agent. This type of externality is captured in our model by an *externality function* $x_i : 2^{[n]} \to [0, 1]$, where $x_i(S)$ denotes the fraction of v_i an agent i derives when the good is purchased by the set of agents S. We assume that x_i is publicly known (as it captures the agent's externalities), monotonically non-decreasing and normalized; i.e., for every $T \subseteq S$, $x_i(T) \leq x_i(S)$, $x_i(\emptyset) = 0$, and $x_i(S) = 1$ whenever $i \in S$.

We consider three structures of the function x_i, corresponding to three types of externalities of social goods. (a) *Full externalities* (commonly known as "public goods"): in this scenario all agents derive their entire value if the good is purchased by any agent. Therefore, $x_i(S) = 1$ if and only if $S \neq \emptyset$. This model captures goods that are non-excludable, such as a coffee machine in a shared office. A special case of this scenario, where valuations are independently and identically distributed, has been studied in [1]. (b) *Status-based externalities*: in this scenario, agent i's "social status" is captured by some *discount factor* $w_i \in [0, 1]$, which corresponds to the fraction of the value agent i derives from a good when purchased by another party. This model captures settings that exhibit asymmetry with respect to the benefit different agents derive from goods they do not own (*e.g.*, a fast food restaurant might benefit from any traffic in the shopping mall, whereas more specialized stores may benefit from as campaigns that draw customers interested in a similar kind of products). (c) *Availability-based externalities*: in this scenario, the availability of a good increases as more agents purchase a good, and therefore, an agent derives a larger fraction of her value as more agents purchase a good. This is captured by a monotonically non-decreasing function $w : \{0, \ldots, n-1\} \to [0, 1]$ with $w(0) = 0$. Examples of such scenarios include objects that are often shared by neighbors (e.g., snow blowers, lawn mowers), office supplies, etc.

We provide the following results: (i) We devise poly-time pricing schemes for settings with full externalities that give a constant factor approximation to the optimal pricing scheme, for both simultaneous and sequential sales. Moreover, these results can be achieved using a non-discriminatory price, despite asymmetry among buyers. (ii) We devise poly-time pricing schemes for settings with status-based externalities that give a constant factor approximation to the optimal pricing scheme, for both simultaneous and sequential sales. (iii) We devise a poly-time pricing scheme for sequential sales with availability-based externalities, that gives a logarithmic factor approximation to the optimal pricing scheme.

CCS CONCEPTS

• **Theory of computation → Algorithmic mechanism design**; **Computational pricing and auctions**; *Network games*;

KEYWORDS

Public Goods; Posted Prices; Revenue Maximization; Externalities

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