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Abstract

[Hier ein Beispiel für ein Abstract. Ihr Abstract sollte 150-250 Wörter haben] We investigate how each of the two steps that are typically supported by purchasing platforms filtering and joint evaluation affects the success of a prosocial microlending platform. Users of such platforms lend money interest-free to people in need, such as small-scale entrepreneurs from developing countries. We hypothesize that while attribute-based filtering can reduce the decision effort and provide guidance, which is often perceived as helpful in purchasing decisions, it may be perceived as inappropriate and restrictive in the prosocial microlending domain, thereby reducing users' choice satisfaction. Building on evaluability theory, we further hypothesize that joint evaluation is a double-edged sword: Jointly evaluating more than one alternative increases choice satisfaction by facilitating evaluability, as alternatives can serve as reference points, and because not being able to compare alternatives could feel restrictive. However, jointly evaluating alternatives also highlights conflicts and tradeoffs between alternatives and thereby decreases users' willingness-to-contribute to the alternative they finally choose. We test our hypotheses in an incentivized lab experiment, using real prosocial lending decisions. Our findings suggest that offering attribute-based filters does not increase a platform's success, and confirm that joint evaluation is a double-edged sword. Platforms have to trade off decreased choice satisfaction with increased willingness-to-contribute.

Inhaltsverzeichnis

Keywords

Duplicate Elimination
Genetic Algorithm
Greedy Heuristic
Integer Program
Meta-Heuristic
Multi-Dimensional Knapsack Problem
Multi-Unit Combinatorial Auction
Phenotypic Distance
Winner Determination Problem

Abbildungsverzeichnis

Tabellenverzeichnis

Abbreviations

CA	combinatorial auction
VCG	Vickrey-Clarke-Grooves

1. Introduction

Bitte konsultieren Sie das Richtliniendokument auf der Professur Webseite. Hier werden nur LaTeX spezifische Regeln vorgestellt, sowie einige Beispiele gezeigt.

In Bachelor-und Masterthesen können Sie für jeden dieser Abschnitte den Befehl *chapter* wählen. In Seminararbeiten verwenden Sie stattdessen bitte *section*.

2. Figures and Tables

Hier finden Sie nun Beispiele für das einfügen von Grafiken und Tabellen. Für Tabellen können Sie auch Umgebungen wie *tabularx* und *longtable* verwenden. Eine Auflistung an guten Paketen findet sich in der *master.tex* Datei.

We performed experiments for three different product categories ranging from commodity products (energy-saving lamps) over hotel rooms to capital goods (washing machines). A lower average price of the products represents a lower perceived risk. We used energy-saving lamps as rather low priced products (avg. price: 7.57€), hotel rooms as medium priced products (avg. price: 249.50€) and washing machines as rather high priced products (avg. price: 524.33€). For each category, we collected data for 40 products. Each product is described by five attributes. Specifically, we extracted frequently used attributes from Amazon product descriptions (energy-saving lamps, washing machines) or descriptions in the hotel booking platform HRS. Table 2.1 summarizes products and product attributes[1].

Let us give an example. We assume a choice scenario with five different cameras (see Table 2.2). Product attributes are photo resolution ph, zoom factor zf, and price pr. All consumers have the same preference for the attribute level order: they prefer lower to higher prices, and higher photo resolutions and zoom factors to lower ones. Table 2.2 lists the five exemplary cameras with their corresponding attribute levels as well as single-attribute values v_i for each attribute $a_i \in \{ph, zf, pr\}$. Camera E has the best price, but the worst photo resolution. In the product domination graph, E has hence no outgoing edges with respect to price, but four outgoing edges with respect to photo resolution. Figure 2.1 shows the resulting product domination graph.

Eine Tabelle finden Sie in Tabelle 2.1 oder 2.2.

[1] For washing machines and energy-saving lamps, consumer ratings are from Amazon; for hotel rooms, consumer ratings are from hrs.com. The attribute level order for washing machine brands is based on the brands' average sales rank on Amazon.

Tabelle 2.1.: Products and their Attributes

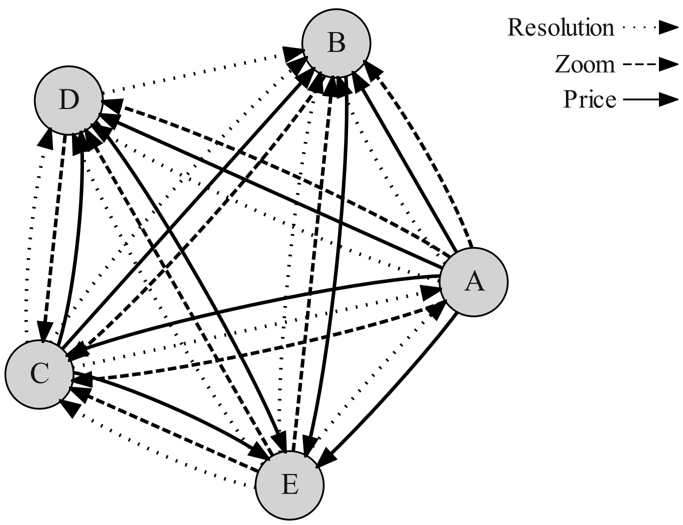
Product	Attribute	Unit	Attribute Level Order
Energy-saving	Price	Euro	Increasing
Lamp	Energy Efficiency Grade	–	A+ $\succ$ A $\succ$ B
(n=40)	Deviation from Day Light	–	None $\succ$ Low $\succ$ Large
	Durability	Hours working time	Decreasing
	Customer Rating	1-5 Stars	Decreasing
Hotel Room	Price per Night	Euro	Increasing
(n=40)	Category	Stars	Decreasing
	Distance from City Center	Kilometers	Increasing
	WLAN availability	–	Available $\succ$ Not available
	Customer Rating	1-5 Stars	Decreasing
Washing	Price	Euro	Increasing
Machine	Brand	–	Siemens $\succ$ Bosch $\succ$ AEG
(n=40)			$\succ$ Bauknecht $\succ$ Gorenje
			$\succ$ Blomberg $\succ$ LG
	Energy Consumption	kWh per year	Increasing
	Water Consumption	Liters per year	Increasing
	Customer Rating	1-5 Stars	Decreasing

$\succ$*: is preferred over*

Tabelle 2.2.: Example attribute levels and corresponding single-attribute values v_i

Camera	Photo Resolution	Zoom Factor	Price
A	$v_{ph}(12MP) = 0.60$	$v_{zf}(10x) = 0.00$	$v_{pr}(610EUR) = 0.00$
B	$v_{ph}(14MP) = 1.00$	$v_{zf}(15x) = 0.63$	$v_{pr}(470EUR) = 0.40$
C	$v_{ph}(10MP) = 0.20$	$v_{zf}(18x) = 1.00$	$v_{pr}(540EUR) = 0.20$
D	$v_{ph}(13MP) = 0.80$	$v_{zf}(15x) = 0.63$	$v_{pr}(470EUR) = 0.40$
E	$v_{ph}(9MP) = 0.00$	$v_{zf}(10x) = 0.00$	$v_{pr}(260EUR) = 1.00$

Abbildung 2.1.: Example Product Domination Graph



3. Combinatorial Auctions

Die ist der Ausschnitt eines Beispielkapitels.

Combinatorial auctions (CAs) are a part of electronic market design. Research in electronic market design joins two disciplines: economics and computer science. Economical research focuses on game theoretical aspects by analyzing strategic behavior of self-interested agents. From the viewpoint of computer science, computational problems are addressed, such as finding the optimal allocation in auctions. As this work concentrates on computational aspects, we assume that the reader has a stronger background in computer science than in economics. Thus, in this chapter we will point out the main ideas of the economical perspective to provide some basic knowledge in this area.

3.1. Mechanism Design

3.1.1. Definition

Mechanism design was introduced by Hurwicz (1960). It aims at implementing system-wide solutions to problems in non-cooperative environments with multiple self-interested agents. Such problems can be political elections, public projects in which the participants themselves have to invest money, or allocation problems. Given that agents hold only private information about their preferences, a structure has to be chosen in which in equilibrium each agent behaves according to the designer's or principal's intentions. The designer can either act on behalf of the society, for example when collecting taxes for a public project, or she can pursue self-interests when, for instance, being an auctioneer.

Since the agents' information is private, the principal faces the problem that the agents might lie about their real valuations in order to influence the outcome according to their preferences. In most cases, whenever such manipulations occur, they damage the resulting system-wide welfare (Nisan & Ronen, 2000). Thus, simply asking the participants to reveal their preferences is unfavorable. Therefore, the principal has to define other rules which lead to the desired outcome. The most common solution to this problem is to introduce monetary transfers providing incentives for the agents to behave truthfully.

In mechanism design two economic areas are joined: *game theory* and *social choice theory*. In game theory the agents' strategies are analyzed, and in social choice theory an outcome is selected according to a set of agents' preferences. The outcome in social choice theory is determined by a social choice function, which is to be implemented by a mechanism. Formally we have a set of possible outcomes O and agents $i \in I$, $|I| = n$. Each agent i has a type $\theta_i \in \Theta_i$ reflecting the possible preference sequences the agent can have. The type captures all of the agent's private information relevant to her decision. The agent's utility $u_i(o, \theta_i)$ over each outcome depends on her type; while $u_i(o_1, \theta_i) > u_i(o_2, \theta_i)$ means that the outcome o_1 is preferred over the outcome o_2. The social choice function maps from the space of all types Θ to the space of all outcomes O,

$$f : \Theta_1 \times \Theta_2 \times ... \times \Theta_n \to O. \tag{3.1}$$

Examples for such social choice functions are allocation problems or political voting protocols in which a candidate or a party is chosen. The most common objective of a social choice function is the maximization of the social welfare, the so called *allocative-efficiency* (Parkes, 2001). It maximizes the sum of all utilities over all agents:

$$f(\theta) = \arg\max_{o \in O} \sum_{i \in I} u_i(o, \theta_i). \tag{3.2}$$

Another objective is *individual rationality*; the agent's payoff is never less when participating in the mechanism than her payoff without participating. Additionally there is *Pareto optimality*. An outcome is Pareto optimal whenever none of the agents could perform better without causing another agent to perform worse than in the current situation.

So far, we have learned what a social choice function is, and what typical objectives for the choices of outcomes are. Now, a mechanism has to be found which implements a given social choice function with one or several of these objectives. For this purpose, the agents' possible strategies have to be specified together with an outcome function based on these strategies. The mechanism should guarantee an implementation despite the self-interest of the agents (Parkes, 2001). Mathematically, a mechanism M is defined on the strategy spaces S_i of the agents:

$$M = ((S_1, ...S_n), g(\cdot))g : S_1 \times ... \times S_n \to O, \tag{3.3}$$

where g is an outcome function and S_i denotes all strategies or actions an agent i is allowed to take. A mechanism implements a social choice function if there is an equilibrium strategy profile $s^*(\cdot) = (s_1^*(\cdot), ..., s_n^*(\cdot))$ of the game induced by M so that

$$g(s_1^*(\theta_1), ..., s_n^*(\theta_n)) = f(\theta_1, ..., \theta_n), \quad \forall(\theta_1, ..., \theta_n) \in (\Theta_1, ..., \Theta_n), \tag{3.4}$$

where $s_i^*(\theta_i)$ is the strategy agent i with type θ_i plays in the equilibrium. Please note that the equilibrium concept is not specified in this definition. It could, for example, be a Nash equilibrium. In this case, given the other players j, $j \neq i$, conform to the equilibrium strategies $s_j^*(\theta_j)$, no other player i has an incentive to unilaterally deviate from her equilibrium strategy. Other examples are the dominant strategy or the Bayes-Nash strategy equilibrium. The dominant strategy equilibrium facilitates it for the agents since the optimal strategy for an agent is independent of any strategies the other agents could play. Thus, the agents do not need to speculate about the way the others might behave. Informally, we could say that the concept of dominant strategies "removes game theory from the problem"Parkes (2001, p. 5). The Bayes-Nash equilibrium is similar to Nash equilibriums, but assumes that agents have incomplete information about the opponents' types. Therefore, agents use probability functions to speculate about the other agents' preferences (Osborne & Rubinstein, 1994).

3.1.2. Revelation Principle and Gibbard-Satterthwaite Theorem

In equation 3.3, we see that a mechanism defines the available strategies and the function for selecting an outcome. It is necessary that these strategies are kept simple so that they can be applied by the agents. The easiest strategies occur when choosing a *direct mechanism* asking the agents to report their types directly to the principal, $S_i = \Theta_i$. Direct mechanisms lead to a centralization of the problem as agents report their types to a center that determines the outcome and reports it back to the agents. On the contrary, when applying *indirect mechanisms* agents have to think about how to transform their type into a strategy and the latter is reported to the mechanism. In other words,

> ”the computations that go on within the mind of any bidder in the non-direct mechanism are shifted to become part of the mechanism in the direct mechanism”. McAfee und McMillan (1987, p. 712)

When applying these direct mechanisms agents may still lie about their true types. Mechanisms which, in contrast, succeed in establishing an equilibrium in which all agents tell the truth, are called *incentive-compatible*. In this case, it is in the interest of all agents to report their true types, $s_i^*(\theta_i) = \theta_i, \ \forall \theta_i \in \Theta_i$. Further, if telling the truth is a dominant strategy, the mechanism is called *strategy-proof*. As will be shown later on, this can be achieved by the *Vickrey-Clarke-Grooves* (VCG) mechanism.

We learned that the equilibrium strategy profile $s^*(\cdot)$ does not determine the concept of equilibrium. Some equilibrium concept must be chosen and implemented together with the mechanism. In the worst case, in order to find out if a certain social choice function can be implemented by a certain mechanism with, for instance, dominant strategies, one would have to consider all possible mechanisms. However, research on mechanism design led to the *revelation principle* as a solution to this. It states that for any mechanism, there is a direct, incentive-compatible mechanism with the same outcome (McAfee & McMillan, 1987). An intuitive explanation for this principle consists in: the transformation from types into strategies, which occurs in the agents’ minds in indirect mechanisms, and which is used as a filter in the direct mechanism. That is, the direct mechanism first filters all reports of the agents and simulates the indirect mechanism with the filtered input. This principle is valid for the optimal mechanism as well. Thus, the search for a mechanism can focus on direct mechanisms. Therefore, if no direct mechanism can implement a given social choice function, then no indirect mechanism will do so.

In contrast to the positive result of the revelation principle, there also exists a negative result, the *Gibbard-Satterthwaite* theorem. According to it, it is impossible to find a mechanism with certain positive characteristics. To understand the theorem, first note that a social choice function is *truthfully implementable* if and only if the dominant strategy is to reveal the truth. Furthermore, a social choice function f is *onto* if for each $o \in O$ at least one element in Θ exists so that f maps to o. Finally, a social choice function f is *dictatorial* whenever there is a dictator j among the agents so that for all outcomes, o_j is strictly preferred to another outcome o_k whenever the dictator j strictly prefers o_j to o_k. Obviously, this is an unwanted characteristic. It turns the Gibbard-Satterthwaite theorem impractical for real-life mechanisms since they allow manipulation.

Gibbard-Satterthwaite Theorem: *Given O is finite, $|O| \geq 3$, and the social choice function f is onto, then f is truthfully implementable in dominant strategies if and only if f is dictatorial.*

According to the theorem it is impossible to elicit the truth if dominant strategies exist. However, despite this result, the theorem can be circumvented by placing restrictions on the agents' preferences, the way it is done in the VCG mechanism.

3.1.3. Vickrey-Clarke-Grooves Mechanism

The VCG mechanism combines the following important virtues by introducing a special payment scheme. First, it implements social choice functions in dominant strategies. Thus, agents do not have to speculate which strategies the other agents might play, and they do not need to waste resources on learning about their competitors' strategies. Second, the mechanism does not have to make any assumptions about the information agents have on each other. And, third, the VCG mechanism is allocative-efficient (see equation 3.2), strategy-proof and non-dictatorial.

AND SO ON...

4. Conclusions

Auf Deutsch: Fazit. Je nach länge des Fazits, müssen sie dieses nicht weiterunterteilen.

4.1. Summary

Auf Deutsch: Zusammenfassung

Die Zusammenfassung der Arbeit ist optional. Sollten Sie die Arbeit noch einmal zusammenfassen wollen, so halten Sie dies bitte eher kurz und wiederholen Sie sich nicht zu sehr.

4.2. Limitations and Future Research

Auf Deutsch: Limitationen und Ausblick

Es ist sinnvoll, jede Limitation an eine Idee zu knüpfen, wie diese in zukünftigen Arbeit zu adressieren waere.

4.3. Contribution

Auf Deutsch: Beiträge

Was sind die Beitraege Ihrer Arbeit sowohl für die Wissenschaft (und Theorie) als auch für die Praxis? Hier sollten Sie versuchen über den Tellerrand hinauszuschauen und einen eher weiten Blick einnehmen.

Insgesamt wurden 1945 Wörter gezählt. Dies entspricht ca. 6.48 Norm Seiten.

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A. Appendix

Tabelle A.1.: Size of the search space for BASIC strategies ($n = 4$).

m	s	search space size
4	1	64
	2	4096
	3	262,144
	4	16,777,216
	5	1,073,741,824
7	1	262144
	2	16777216
	3	68,719,476,736
	4	2.81E+14
	5	1.15E+18

Selbstständigkeitserklärung

Hiermit versichere ich, die vorgelegte Thesis selbstständig und ohne unerlaubte fremde Hilfe und nur mit den Hilfen angefertigt zu haben, die ich in der Seminararbeit angegeben habe. Alle Textstellen, die wörtlich oder sinngemäß aus veröffentlichten Schriften entnommen sind, und alle Angaben die auf mündlichen Auskünften beruhen, sind als solche kenntlich gemacht. Bei den von mir durchgeführten und in der Thesis erwähnten Untersuchungen habe ich die Grundsätze guter wissenschaftlicher Praxis, wie sie in der „Satzung der Justus-Liebig-Universität zur Sicherung guter wissenschaftlicher Praxisext“ niedergelegt sind, eingehalten. Gemäß §25 Abs. 6 der Allgemeinen Bestimmungen für modularisierte Studiengänge dulde ich eine Überprüfung der Thesis mittels Anti-Plagiatssoftware.

Gießen, den DD.MM.YYYY

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