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Formal criteria for the classification of service based on the value-creation model

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Abstract

With the aim of providing a scientific methodology for studies of services, the value-creation model, which classifies service models in three classes on the basis of the relationships among service providers, was proposed in the 2000s. However, the model lacks formal criteria for classifying service models in scientific way. Therefore, in this study, we first consider the activity of service design as an activity of designing "service mechanism" in reference to mechanism design, which is an area in economics and game theory. Then, we develop formal criteria for the classification of the service mechanism based on the value-creation model.

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Keywords: Service mechanism; Value-Creation Model; mechanism design; formal criteria.

1. Introduction

Since most of service studies depend heavily on individual research subject and contain a humane element, there is great difficulty in understanding the structure and complexity of the service and constructing a methodology for the service design.

The value-creation models proposed by Ueda et al. [1, 2] describe the design problem of service as a co-creation decision-making problem that creates an effective solution through mutual interaction among varieties of agents, such as provider (producer), receiver (consumer), environment, and services (products). Depending on the nature of the mutual interaction, the models were classified into three models, Providing Value Model, Adaptive Value Model, and Co-creative Value Model. In the process of the development of this model, Ueda thought that it is essential to consider service not only as an engineering subject but as a scientific subject. However, formal criteria for classifying service models in scientific way have not been given yet.

Therefore, in this study, we first discuss the possibility of considering the activity of service design as an activity of designing "service mechanism" by applying the formal framework of mechanism design, which is a mathematical theory in economics and game theory. Then, we develop a formal criterion for the classification of the service mechanism based on the value-creation model.

2. Mechanism Design

Mechanism design is concerned with rule settings where a social designer faces the problem of aggregating the announced preferences of multiple players into a collective decision when the players exhibit strategic behavior [3]. Each player's objective is to maximize expected value of his/her own payoff measured in some utility scale. Mechanism design can be viewed as reverse engineering of games or equivalently as the art of designing the rules of a game to achieve a specific desired outcome. In this view, the goals of the designer are to design institutions or rules that meet social or designer's own objective. Modeling the problem of service design in the framework of mechanism design is to formulate the design problem of service whether the result of the interaction between varieties of players — provider, receiver and environment — achieves a social or designer's own objective in the designed rule settings.

In this study, we examine how we can formulate the problem of services mechanism using a formal framework of

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mechanism design. Here, we start by explaining the formal setting of mechanisms called indirect mechanisms [4]. A formal description of the elements of indirect mechanism is provided below.
Definition 1.

(a) A set of finite number N of players $I = \{1, 2, \dots, n\}$ (e.g., a set of consumers or bidders at auction).

(b) Players' type spaces $T_1, \dots, T_n$, where the parameter T_i is referred to as player i's type, and $t_i \in T_i$ generally contains the preference information on a set of outcomes A shown blow.

(c) Players' action spaces $X_1, \dots, X_n$. This X_i is a collection of possible actions that i can take (e.g., who to vote or how much to bid).

(d) A set of outcomes A (e.g., a winner of the election or a result of an auction).

(e) Players' valuation functions $v_i: T_i \times A \to \mathbb{R}$, where player i evaluate the "value" of outcome $a \in A$ by referring privately to his/her own type t_i and assigns $v_i(t_i, a)$ to it.

(f) An outcome function $g: X_1 \times \cdots \times X_n \to A$.

(g) Players' payment functions $p_i: X_1 \times \cdots \times X_n \to \mathbb{R}$, where $x_1, \dots, x_n$ in the payment $p_i(x_1, \dots, x_n)$ is the action which i takes.

(h) Player i's strategy function $s_i: T_i \to X_i$, where player i have private information about type $t_i \in T_i$ and he/she chose an action from his/her action spaces X_i based on the private information.

(i) Player i's utility function $u_i: T_i \times X_1 \times \cdots \times X_n \to \mathbb{R}$, where $u_i(t_i, x_1, \dots, x_n)$ is the utility achieved by player i, when his/her type is t_i and the profile of actions taken by all players $(x_1, \dots, x_n)$.

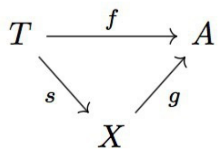

Fig. 1. A diagram of indirect mechanisms.

Using the notions above, the definition of indirect mechanisms is given as followings.
Definition 2. Let outcome function $g: X_1 \times \cdots \times X_n \to A$, player i's utility function $u_i: T_i \times X_1 \times \cdots \times X_n \to \mathbb{R}$, and $u_i(t_i, x_1, \dots, x_n) = v_i(t_i, g(x_1, \dots, x_n)) - p_i(x_1, \dots, x_n)$. Then indirect mechanisms is defined by $\mathcal{M} = (X, g, p)$, where $X = X_1 \times \cdots \times X_n$.

In the above settings, the designer faces a problem called preference aggregation problem, i.e., 'for a given players' type spaces profile $T = (T_1, \dots, T_n)$, which outcome $a \in A$ should be chosen?'[3] To deal with the preference aggregation problem, mechanism design attempts implementing desired social choices function in a strategic setting.

Definition 3. Function $f: T_1 \times \cdots \times T_n \to A$ is called a social choice function.

Designer tries to aggregate the different preferences of players $t = (t_1, \dots, t_n) \in T$ toward desired single joint decision $f(t_1, \dots, t_n) \in A$. To illustrate how mechanism design works, we show a famous example of indirect mechanism: Vickrey's second price auction.

2.1. Vickrey's Second Price Auction

In a Vickrey's second price auction, bidders are asked to submit sealed bids [4].

An auctioneer wants to sell a good among n bidders. Each player i has a private information $w_i > 0$ about the value of the good, that is, he/she is "willing to pay" for it. The bidder i decides the amount w_i by referring privately to his/her actual type t_i. If i wins the good, but has to pay some price $p \neq w_i$, then i's utility is $u_i = w_i - p$. If someone else wins the good, then i's utility is 0. The bids are opened by the auctioneer and the bidder with the highest bid gets the good and pays to the auctioneer an amount equal to the second highest bid. The other bidders pay nothing.

In this auction, mechanism the auctioneer employs is an indirect mechanism $\mathcal{M} = (X, g, p)$, where $w_i \in X_i \subseteq \mathbb{R}^+$ is i's bid, $g: X_1 \times \cdots \times X_n \to A$ is outcome function given by $g(x) = (y_1(x), \dots, y_n(x), p_1(x), \dots, p_n(x))$ where $x = (x_1, \dots, x_n)$. The functions $y_i: X_1 \times \cdots \times X_n \to \{0,1\}$ is known as winner determination rules and the function $p: X_1 \times \cdots \times X_n \to \mathbb{R}$ is payment function.

Let $w^{(k)}$ be the kth highest bid in $(w_1, \dots, w_n)$ and $(w_{-i})^{(k)}$ be the kth highest bid in $(w_1, \dots, w_{i-1}, w_{i+1}, \dots, w_n)$, then the winner determination rule and the payment function will be as followings.

$$\begin{aligned} y_i(w) &= \begin{cases} 1 & \text{if } w_i = w^{(1)} \\ 0 & \text{(otherwise)} \end{cases} \\ p_i(w) &= -(w_{-i})^{(1)} y_i(w). \end{aligned} \tag{1}$$

If we assume that any two bidders do not bid the same bid value in the auction, the following proposition holds [4].
Proposition 4. For every $w_1, \dots, w_n$ and every w'_i, let u_i be i's utility if i bids w_i and u'_i be i's utility if i bids w'_i. Then,

$$u_i \geq u'_i.$$

Proof. Assume that i wins by bidding w_i and the second highest bit is $p^* = (b_{-i})^{(1)}$, then $w_i = w^{(1)}$ and i's utility $u_i = w_i - p^* \geq 0$.

Now, if i strategically manipulates the auction by changing his/her bid w'_i such that $w_i > w'_i > p^*$, i still wins and have to pay p^*, thus i's utility is still $u'_i = w_i - p^* = u_i$. If i bids w'_i such that $p^* > w'_i$, then i loses the auction, thus $u'_i = 0 \leq u_i$. On the other hand, if i bids w_i and loses, then $u_i = 0$. Assume $j \neq i$ is the winner in above case, then $w_j > w_i$. If i changes his/her bid to w'_i such that $w_j > w'_i$, i still loses the auction, thus $u'_i = 0 = u_i$. When i bids $w'_i > w_j$, i wins and pays w_j, thus i's utility is $u'_i = w_i - w_j \leq 0 = u_i$. □

Note that even the bidders try to maximize their own benefit by referring their private information, the outcome achieves the social welfare.