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iPRICE: A COLLABORATIVE PRICING MODEL FOR E-SERVICE BUNDLE DELIVERY

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ABSTRACT

Information goods pricing is an essential and emerging topic in the era of information economy. Myriad researchers have devoted considerable attention to developing and testing methods of information goods pricing. Nevertheless, in addition; there are still certain shortcomings as the challenges to be overcome. This study encompasses several unexplored concepts that have attracted research attention in other disciplines lately, such as collaborative prototyping, prospect theory, ERG theory, and maintenance from design, economic, psychological, and software engineering respectively. This study proposes a novel conceptual framework for information goods pricing and investigates the impact of three advantages: (1) provides collaborative process that could generate several prototypes via trial and error in pricing process, (2) deliberates the belief of consumer and producer by maximizing utility and profit, and (3) offers an appropriate service bundle by interacting with consumer and discovering the actual needs.

Keywords: Information goods pricing, Collaborative Prototyping, Markov chain, ERG theory.

INTRODUCTION

Due to the unique cost structure and product characteristics1 of information goods, the possibility to follow traditional pricing strategies becomes unfeasible and the differential pricing strategy is recognized to be crucial. Varian (1995) identified two key pricing issues (price discrimination and bundling) [[14]].

The nature of price discrimination, in general, aims for optimizing the prices instead of lowering the prices, possibly from different perspectives. For instance, from the perspective of producers (i.e., maximized profits), a producer charges different users at different prices according to their different willingness-to-pay (WTP).

Myriad researchers have devoted considerable attention to developing and testing methods of information goods pricing. Nevertheless, in addition; there are still certain shortcomings as the challenges to be overcome: (1) lacks consumer involvement for pricing process, (2) only takes producer's perspective into consideration (either cost-based or profit-based oriented), and (3) places the price without interacting with consumers that based on maximum satisfaction. Thus, dynamic pricing has become an essential issue recently and is widely accepted to overcome this dilemma.

Accordingly, this study proposes a novel method for information goods pricing and investigates the intended contributions: (1) provides collaborative process that could generate several prototypes via trial and error in pricing process, (2) deliberates the belief of consumer and producer by maximizing utility and profit, and (3) offers an appropriate service bundle by interacting with consumer and discovering the actual needs.

iPRICE: A SYNTHESIZED APPROACH

System Framework

The shortcomings of extant pricing methods are addressed in the aforementioned section. Commonly, the focus is merely on specific category up to present. Seldom of researches offer a synthesized approach for information goods pricing. In addition, a critical challenge occurs in omitting the interactive pricing process under risk to elicit the needs accurately. This synthesized approach which called iPrice system comprises the GUI module, collaborative prototyping module, optimal-price estimation module, and version revisionary module as the chief components of the system (as shown in Fig. 2). Each module will be further illustrated in the following sections.

[1] Economics of IT. http://oz.stern.nyu.edu/io/pricing.html

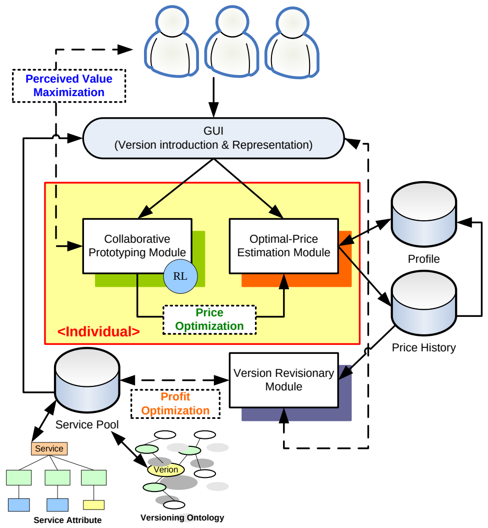

Fig. 1. System Framework

COLLABORATIVE PROTOTYPING MODULE

The collaborative prototyping module (CP Module) is the foundation among other modules; meanwhile, the aim is to co-design the bundle with the user that evolved from a selected version. There are two possible inputs for collaborative prototyping module. A selected version from GUI module is one of the inputs for this module while user's feedback is another input that will enhance the quality of collaborative process. On the other hand, an ultimate bundle and the utility are two outputs of the module. The bundle satisfies user's needs and enfolds combinational services.

Prototyping

Prototyping, which is the process of developing prototypes, is an integral part of iterative user-centered design; meanwhile, it enables designers to try out the ideas with users and to gather feedback. The main purpose of prototyping is to involve the users in testing design ideas and get their feedback in the early stage of development; thus, reduce the time and cost [[8]].Collaborative prototyping is a novel approach that based on the notion of prototyping. Collaborative environments for product development have become the new design paradigm for engineering organizations.

Collaboration permits greater information sharing, concurrent engineering, virtual prototyping and testing, and total quality management. Additionally, the anticipated benefits of a prototype in reducing risk must be weighted against the time and money required to build and evaluate the prototype [[12]].In summary, collaborative prototyping identifies user requirements and furnishes feedback on the working design against the requirements. Moreover, it provides certain of advantages: (1) reduce development time, costs and risks, (2) require user involvement to receive user feedback, (3) facilitate system implementation based on user's anticipation and satisfaction, and (4) expose developers to enhance the product in the future.

ERG Theory

ERG theory is a model of human motivation appeared in 1969 by Clayton Alderfer which extended and simplified Maslow's Hierarchy in a shorter set [2]. Meanwhile, it approaches the question of "what motivates a person to act?" and assumes that all human activities are motivated by needs. ERG theory consolidated Maslow's five need categories into three; meanwhile, the letters ERG stands for three levels of needs: Existence, Relatedness, and Growth. Further, the details for each category are described as follows:

Existence Needs: include all the various forms of material and physiological desires (e.g., food, water, air, clothing, safety, physical love and affection).

Relatedness Needs: involve relationships with significant other people (e.g., to be recognized and feel secure as part of a group or a family).

Growth Needs: impel a person to make creative or productive effects on himself and the environment (e.g., to progress towards one's ideal self).

Moreover, three relationships among different categories are identified in ERG theory, which are satisfaction-progression (moves up to higher-level needs based on satisfied ones), frustration-regression (moves back from current unsatisfied needs to lower-level needs), and satisfaction-strengthening (strengthen current level of satisfied needs iteratively).As for the implications for management, the ERG theory assists the managers to recognize that an employee has multiple needs to satisfy simultaneously. Furthermore, if growth opportunities are not furnished to employees, they may regress to relatedness needs.

Method

The core concept of CP module is the mixture of collaborative prototyping and ERG theory to furnish customized bundles via interaction. The needs could be separated into three categories which are introduced in ERG theory. We assume that the user's needs shift among three categories time by time. Namely, three different needs are identified as existence, relatedness, and growth needs. Moreover, Markov chain is employed to predict the behavioral patterns of needs (with the assumption of a user's need shifting along variant time).

Markov chain is a discrete-time stochastic process with the Markov property (only the current state is necessary for predicting a subsequent state or states and states prior to the current state are not needed if the current state is known). Markov chain enfolds certain advantages: (1) finite states, (2) time interval, (3) probability-based, and (4) dynamic. We assume our system is described at successive times the states (each of which has known a finite number of possible outcomes). At these times the system may have changed from the state it was in the moment before to another or stayed in the same state. The changes of state are called transitions. The system is with the initial state (N0) and the transition matrix (P). The possible states of need hierarchy at any time period can be determined according to the initial state and transition probabilities.

The state in a given period depends on the iteration of the state of preceding period (Nt-1) and the transition probabilities: Nt = N(t-1)P. The initial probabilities of P are derived from the user's profile and will be rectified in accord with the user's behavior. The composition of the need hierarchy can be expressed in a row vector (e.g., Nt=(E, R, G) where N represents a need hierarchy and t represents time).

Suppose we have a sequence with t frames and the states are represented by {N1, N2, N3,…,Nt}, where N represents the state at time t. The furnished bundles are denoted as {B1, B2, B3,…, BT}. Each furnished bundle is conditionally dependent on only the previous state (i.e., P(Nt+1=Bt+1 | N1=B1, N2=B2, N3=B3,…,Nt=Bt) = P(Nt+1=Bt+1 | Nt=Bt)). Accordingly, the formulation for Markov chain to forecast the next state is Nt = N(t-1)P.

OPTIMAL-PRICE ESTIMATION MODULE

The optimal-price estimation module (OPE Module) is the most significant component to estimate the optimal price for charge. The inputs of OPE module are the information of each bundle and the profile of the user. Meanwhile, the output is the optimal price that mixes and takes various inputs into account. The notion of OPE module enfolds the design of prospect theory and mental account which will be detailed in the following sub-sections.

Prospect Theory

Prospect theory (PT) was developed by Kahneman and Tversky (1979) which is concerned with behavior of decision makers under risk. The definition of prospect theory is "decision making under risk can be viewed as a choice between prospects or gambles." Unlike expected utility theory (EUT) which concerns itself with how decisions under uncertainty should be made (a prescriptive approach), prospect theory concerns itself with how decisions are actually made (a descriptive approach) [6].

Prospect theory has been successfully used to explain a range of puzzles in economics, especially for behavioral finance. Nevertheless, there are several phenomena which violate these tenets of expected utility theory such as certainty effect, reflection effect, and isolation effect. For example, if there is a problem for a person to make the decision that:

(A) 2400 with certainty

(B) 2500 with probability 0.33, 2400 with probability 0.66, and 0 with probability 0.

The result reveals that 82% of people chose (A) from the experiment. However, the rational decision maker is supposed to choose (B) with maximum utility (i.e., 2500 x 0.33 + 2400 x 0.66 = 2433) from viewpoint of expected utility theory. This demonstrates the certainty effect which stands for people tend to weight and choose outcomes with certainty. Further, the reflection effect is the second critique for expected utility theory. The reflection effect implies that risk aversion in the positive domain is accompanied by risk seeking in the negative domain from the empirical data. Ultimately, the isolation effect means people often disregard components that the alternatives share and focus on the components that distinguish them.

On the other hand, the decision maker is assumed to evaluate the prospects and choose the highest value among them according to the definition of V in terms of two scales: π and υ. The first scale, π, associates each probability p with a decision weight $\pi(p)$, which reflects the impact of p on the over-all value of the prospect. The second scale, υ, assigns to each outcome x a number $\upsilon(x)$, which reflects the subjective value of the outcome. The outcomes are defined relative to a reference point which serves the zero point of the value scale. Thus, υ measures the value of deviations from the reference point as gains and losses. In prospect theory, the mapping of real probabilities onto subjective decision weights is described by a special function called the "π" function. Further the mapping of real value onto subjective value is described by a special curve called the "S" curve, which is defined in terms of losses and gains from a status quo.

Mental Account

The mental accounting is the extension of prospect theory which divides the utility from into acquisition utility and transaction utility. Acquisition utility is a measure of the value of good obtained relative to its price, similar to the economic concept of consumer surplus. Transaction utility measures the perceived value of the deal [12]. For the analysis that follows, three price concepts are used. Let p be defined as the actual price charged for some good z. Afterwards, $\bar{p}$ is defined as the value equivalent of z for some individual. Finally, let p* be called the reference point for z. Thus, the acquisition utility is the net utility that accrues from the trade of p to obtain z which is designated as $\upsilon(\bar{p}, -p)$. On the other hand, the measure of transaction utility depends on the price the individual pays compared to some reference price (p*). Formally, it is defined as the reference outcome which means the value of paying p when the expected or reference price is p* and is designated as $\upsilon(-p: -p^*)$.

Hence, the total utility from a purchase is the sum of acquisition utility and transaction utility. The value of buying good z at price p with reference price p* is defined as w(z, p, p*) where $w(z, p, p^*)=\upsilon(\bar{p}, -p) + \upsilon(-p: -p^*)$. Additionally, the most important factor in determining p is fairness, which depends in large part on cost to the seller. In short, the concept of mental accounting applies prospect theory to move toward consumer behavior. The mental account includes other features of prospect theory such as concavity of gains and loss aversion. Meanwhile, the total utility will be estimated more accurately from acquisition utility and transaction utility which furnishes the notion of reference price. Thus, prospect theory can be linked with a great many other psychological and cognitive theories.

Method

The major components are identified in OPE module as optimal price estimation, which are design fee, number of bundles, and testing efforts. The design fee stands for the costs for customized prototypes (i.e., bundles) and is estimated by maximum utility among them. The number of bundles is related to testing efforts which considers the collaborative process is worthy and needs to be charged for the user.

The cost of a bundle stands for the costs for a sequence of services enfolded in a bundle. Accordingly, a formula emerges according to four identified components which is ***P ≧ D(U) + T(N) + C***, ***where D is the design fee function, U is the maximum utility, N is the number of bundles, T is the function of testing efforts for collaborative process, and C is the function denotes the service costs for a bundle.***

Further, it is essential for the OPE module to explore the maximum utility among bundles. The operational process for probing maximum utility is separated into two folds and formulated as ***U=υ(p)+π(p)***, which are prospect theory (the utility is equal to the value function by weight function) and mental account (the value function is the sum of acquisition utility and transaction utility). As in the foundation of prospect theory, the value function and weight function are dissimilar according to varied users. Supposedly, the value function and weight function initiate from normal distribution and adjusts by the profile and behaviors of each individual respectively. The value function is divided into acquisition utility (the value of good received that compared to the outlay) and transaction utility (the perceived merits of the deal).

Acquisition utility is the net utility (i.e., $\upsilon(\bar{p}, p)$) that accrues from the trade of p (i.e., the cost of a bundle and we assume it's equal to the price needed to pay at least) to obtain z (where is valued at $\bar{p}$) which will be coded as the integrated outcome$\upsilon(\bar{p} - p)$). Additionally, the transaction utility depends on the costs that compared to reference price p*. Formally, it is defined as the reference outcome$\upsilon(-p: - p^*)$; in other words, stands for the utility when the costs and reference price are p and p* respectively.

Furthermore, three functions in the formula are identified as design fee function (D), testing effort function (T), and cost function (C). Firstly, the design fee function is a convex and incremental function (map utility value to design fee). Secondly, the testing effort function is a concave and incremental function (map the number of bundles to testing effort). Ultimately, the cost function is a concave and incremental function (map number of services in the bundle to cost).

VERSION REVISIONARY MODULE

The version revisionary module (VR Module) is based on the theory of software maintenance. The concept of VR module is derived from software maintenance and the aim is to revise the version which may be unselected for a long time or yield lower profits among others. The inputs of VR module are price history and the versions from GUI module. The price history records the price for each bundle which is related to the original version; thus, the system can estimate the profits for each version. Additionally, the output of VR module is the revised version that may replace the original one with lower profits.

Software Maintenance

Software maintenance has become a significant issue nowadays that previous researches have focused upon the prevention and elimination of errors in newly developed software. The goal of software maintenance is to produce software closely toward error-free. Conceptually, variations in error rates are expected to be a function of either the software system or factors in the maintenance environment.

A maintenance process takes the previous version of the system as the main input; however, is affected by other factors such as the skills of maintainers. The existing system can be examined with a measurement of reliability that can identify the system's static characteristics causing higher error rates. Meanwhile, most of these characteristics can be described as software size and complexity.

In short, the maintenance model is proposed and used to identify managerially controllable factors which affect software reliability. The results reveal that high error rates may result from: (1) underwent frequent modification, (2) programmers with fewer experiences, and (3) high reliability requirements. Thus, the managers can make quantified judgments to reduce error rates via implementing a number of procedures, including enforcing release control, assigning more experienced maintenance programmers, and establishing and enforcing complexity metric standards.

Method

The error rate (λ) is modeled as a stochastic variable whose mean varies from application system to application system, specifically as a multiplicative function of several explanatory variables pertaining to those systems. In particular, the error rate is modeled as a random draw from a lognormal distribution with mean Lambda, the formula represents as λ= f(static, dynamic, environmental), where f(˙) is a multiplicative function. The lognormal distribution and the exponential distribution are widely used in the software reliability literature, both being consistent with the intuition that error rates should be distributed with an early peak and a single long tail.

The parameter value of error rate varies from application to application, based on the values of the structural variables which determine it. The following fixed effects regression model was estimated: ln $\boldsymbol{ERRORS = \beta_0+\beta_1*S +\beta_2*C +\beta_3*OF+\beta_4*V+\beta_5*Sa+\beta_6*P+\varepsilon}$, where $\beta_0 \sim \beta_6$ is the weight coefficient for each indicator andεis the residual parameter. The independent variable (ERRORS) is defined as the unselected decision among all versions (i.e., unselect or select). The system gathers the information for each version periodically and initiates the estimation of weight coefficients at a specific time. The dependent variable ERROR provides the clue to predict the discrimination among versions via the significance of weight coefficients. If the error rate is greater than an error threshold, the system terminates the computation. Meanwhile, the system rectifies the version(s) based on versioning ontology and service attribute taxonomy. Subsequently, the new version(s) will be assigned to replace the old one until all versions are verified.

Table 1. The Indicators of Error Rate

λ= f(static, dynamic, environmental) = ln ERRORS = $\beta_0+\beta_1*S +\beta_2*C +\beta_3*OF+\beta_4*V+\beta_5*Sa+\beta_6*P+\varepsilon$	
Static Indicators	
Size (S)	The number of bundles.
Complexity (C)	The number of different services in the version.
Dynamic Indicators	
Operational Frequency (OF)	The number of bundles paid last month.
Volatility (VF)	The version is subject to the number of frequent changes up to present.
Environmental Indicators	
Satisfaction (Sa)	The subjective score that is assigned by the user.
Profit (P)	The average profit for each version.

CONCLUDING REMARKS

The contributions of the new pricing method for the system are unfolded which: (1) furnishes prototypes for the user during the collaborative process, (2) predicts the need for next time period proactively and accurately, (3) generates certain of prototypes for trial, (4) estimates the optimal price based on maximum utility, and (5) revises the versions with lower profits automatically. Moreover, there are several implications for service providers which: (1) generate prototypes in order to grasp user’s feedback simultaneously, (2) grab the user’s needs immediately so as to response quickly, (3) estimate the optimal price based on user’s maximum utility, and (4) rectify the versions with mobility except the automation by the system. In short, the new pricing method for information goods fills the gap among previous literatures which only takes consumer or provider into account. Different from existing works, the new pricing method is novel in integrating distinctively important concepts yielding more benefits to consumers and profits to more providers. Thus, the method also guides and provides a roadmap for information goods pricing for future research.

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