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## Value Estimation Method of Products / Services using Wisdom of Crowd

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### Abstract

This paper proposes a novel method to estimate appropriate values of products and services by using particle filter and local regression smoothing from many user evaluations in websites such as amazon.com, yelp.com and so on. These websites provide a service which estimates values of the products and services from many user evaluations. However, users cannot always estimate the appropriate value of the product and service. In addition, the product and service cannot always keep a same value. For example, a human being gives a different evaluation to a same dish when he / she is hungry or full. And a mobile phone rises its value by improving connectability as base stations increase. Thus, we need to estimate appropriate values of the products and services by removing noises included in both user evaluations and the value of the products and services. We investigate the effects of the proposed method through simple simulation experiments imitating a reputation information site about restaurants.

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### 1. Introduction

Websites such as Amazon.com, Yelp.com, Booking.com and so on, provide services which users can share reviews and evaluations about the products and services. These reviews and evaluations are contributed by many users who have used the products and services actually. In this study, we call these websites "reputation information sites". One of interesting points of the reputation information sites is that these websites are designed to improve the estimation accuracy of values of the products and services by using the evaluations of many novices who are not specialists like Michelin Guide investigators. Thus, these websites take advantage of wisdom of crowds [1] in a nicely way.

Reputation information sites have used simple average to estimate the appropriate values of the products and services from many user evaluations. It is known that the accuracy of an estimated value improves by the law of large numbers as the number of the observation samples increases. However, the value of a product and service is not always constant, and the reliability of a user evaluation is not always constant. For example, a restaurant might raise its value by improving the

quality of the dishes and services as chefs and waiters gain experiences. And, a mobile phone might raise its value by improving connectability as base stations increase, even if the functions of the mobile phone are same. On the other hand, people give different evaluations for a same product and service because they have different evaluation criterions. In addition, it is known that a human being gives different evaluations for a same dish when he /she is hungry or full [2], and cannot keep the consistency of evaluations as time passes. Namely, the values of the products and services, and the estimation accuracy of the user evaluation change as time passes. In addition, a user evaluation is biased.

In order to estimate the appropriate values of the products and services from many user evaluations including noises, we need to consider (a) the value fluctuations of the products and services, and (b) the biases and fluctuations of the user evaluations. Therefore, in this paper, we consider that the value fluctuation of the product and service is the variance of the system noise, and that the bias and the fluctuation of the user evaluation are respectively the mean and the variance of the observation noise. And we propose a novel method to estimate the appropriate values of the products and services by using

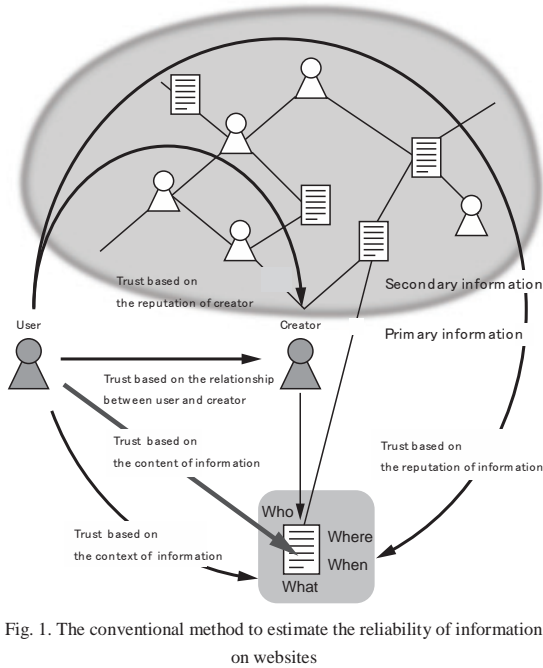


Fig. 1. The conventional method to estimate the reliability of information on websites

particle filter [3] and local regression smoothing [4] in order to remove these noises. In addition, we employ the self-organizing state space (SOSS) model to particle filter in order to estimate the parameters of both system noises and observation noises.

In next section, we describe the relationship between the conventional methods and the proposed method. Next, we model the evaluation process of a user in a reputation information site in order to reveal the mechanism of occurring the gap between a user evaluation and the appropriate value of the product and service. In fifth section, we explain the proposed method which uses particle filter and local regression smoothing. And the effect of the proposed method is investigated through simple simulation experiments. Finally, we conclude this paper, and describe a future work.

2. Related works

In this section, we reveal that the conventional estimation methods cannot use to estimate the appropriate values of products/services in the reputation information sites. The conventional methods to estimate the reliability of information on websites (Fig. 1) are classified as follows.

- (1) Trust based on the content of information  
Trust based on the evaluation of information itself.
- (2) Trust based on the context of information  
Trust based on the information associated with the information such as publication date, link source, and electronic signature.
- (3) Trust based on the reputation of information
- (4) Trust based on the reliability of creator
  - a. Trust based on the direct relationship between user and creator.
  - b. Trust based on the reputation of creator.

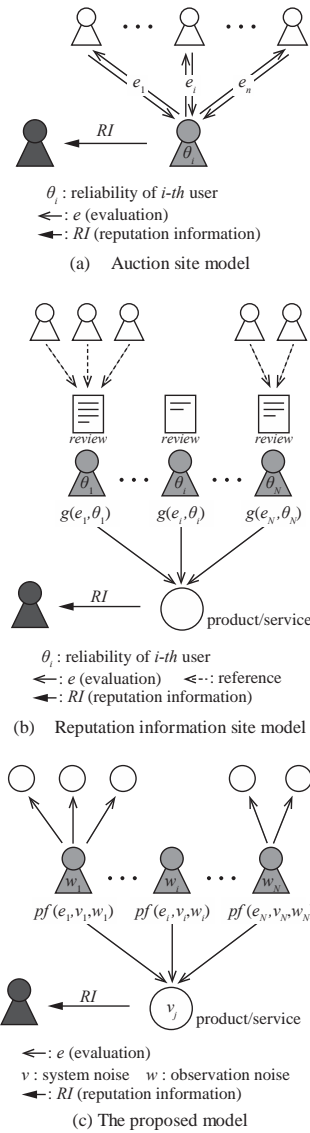


Fig. 2. Methods to estimate the values of products/services from many user evaluations.

(1), (2) and (4)-a are the methods to estimate the reliability of information from the primary information such as the direct relationship with the information creators, contexts of information and the information itself. On the other hand, (3) and (4)-b are the methods to estimate the reliability of information from the secondary information such as the reputation of information itself and the reputation of the information creators. On current websites, it is very difficult for us to directly estimate the reliability of information because many users create various information. Therefore, Google uses PageRank [5] as one of some technologies to estimate the importance of websites based on the heuristics that the site linked from many websites is important. This method is equivalent to "(3) trust based on the reputation of information".

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