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An approach of product usability evaluation based on Web mining in feature fatigue analysis

Mingxing Wu [a], Liya Wang [a,*], Ming Li [a], Huijun Long [b]

[a] Department of Industrial Engineering and Logistics Management, Shanghai Jiao Tong University, No. 800 Dongchuan Road, 200240 Shanghai, China
[b] Sino-US Global Logistics Institute, Shanghai Jiao Tong University, Shanghai, China

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ABSTRACT

Customers prefer to purchase products with more features, but after using the products, they may become dissatisfied with the usability problems of the products. This phenomenon is called "feature fatigue". Thus it is imperative to analyze product usability in product definition stage. However, most traditional methods of usability evaluation are generally carried out using prototypes which are not available until in the later stage of product development. This paper proposes an approach based on Web mining to analyze product usability. This approach uses the massive online customer reviews on analogous products and features as data source, which are easy to get from Web and can reflect the most updated customer opinions on product usability. Association rule mining techniques are adopted to extract customer opinions on the usability of product features. The Apriori algorithm is used for mining association rules, based on which a usability evaluation method is then presented. A case example is given to validate the proposed approach.

1. Introduction

"Feature fatigue" (FF) represents the phenomenon that customers prefer to choose products with more features and capability initially, but after use they become dissatisfied with the usability problems (Thompson, Hamilton, & Rust, 2005; Wu, Wang, Li, & Long, 2013). FF will lead to customer dissatisfaction and widespread negative Word-Of-Mouth (WOM), which will severely damage the reputation of the product and even of the brand (Jokela, 2004; Rust, Thompson, & Hamilton, 2006; Thompson et al., 2005). Thus product usability analysis in the product definition stage is needed for FF analysis.

Traditionally, usability can be evaluated through some usability testing methods (Dumas & Redish, 1993; Li, Wang, & Wu, 2013), which are generally carried out using prototypes. However, prototypes are not available until in the later stage of product development, while FF analysis should be performed in the product definition stage. Thus traditional testing methods of usability evaluation are not suitable for FF analysis. There are other methods of usability evaluation that are based on survey data, but it is costly and time-consuming to obtain data in practice, especially for large scale collections (Morinaga, Yamanishi, Tateishi, & Fukushima, 2002). In order to save time and economic costs, this paper focuses on proposing a novel approach of usability analysis for FF evaluation.

Nowadays, with the rapid development of e-commerce, more and more people purchase products online and post their reviews on products onto the Web (Ding, Liu, & Yu, 2008). They may post positive comments on the Web like "it is easy to use", or express their complaints like "the Setup is the most frustrating thing in the world". These online reviews are one form of WOM that can significantly influence other customers' purchase decisions (Chevalier & Mayzlin, 2006; Li & Hitt, 2008), and eventually affect the brand's long-term revenue. Compared to traditional survey data, online reviews contain the most updated customer opinions that reflect the evaluation information of product usability derived from customers' experiences. Moreover, these massive online reviews can be collected from Web easily and inexpensively relative to survey methods. Since most new products are evolutions of existing products (e.g., improving them to the next generation ones) (Bariani, Berti, & Lucchetta, 2004; Chen & Wang, 2008), analyzing the reviews on existing products can help designers analyze the usability of this feature, and provide decision supports for designers to improve product usability in the future, thus alleviating FF.

In this paper, an approach based on Web mining is proposed to analyze product usability, which can help designers evaluate FF. It

* Corresponding author. Tel.: +86 13818491902.
E-mail addresses: xingxing@sjtu.edu.cn (M. Wu), wangliya@sjtu.edu.cn (L. Wang), imelm@sjtu.edu.cn (M. Li), longhuijun630@126.com (H. Long).

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uses the massive online reviews on products as data source. In practice, many of product reviews are redundant and unrelated to usability. Scanning all of the massive reviews to find useful information manually would be tedious and fruitless. To solve this problem, the proposed approach adopts machine learning techniques which can process online reviews automatically to analyze reviews in sentence level. It firstly uses a web crawler to collect online reviews. Then, it utilizes association rule mining techniques to extract customer opinions on the usability of product features. The Apriori algorithm is adopted for mining association rules, and a classifier is built to identify whether a review sentence is related to a feature's usability and to judge its semantic orientation. And then features' usability is evaluated, based on which a FF degree is defined to help designers evaluate FF.

The remainder of this paper is organized as follows. The next section reviews the related work in the literature. In Section 3, the approach of usability analysis based on Web mining is proposed. Next, a case example is given to illustrate the proposed approach. Section 5 presents the results and discussions. The paper ends with a conclusion in Section 6.

2. Related work

2.1. Feature fatigue

The term "feature fatigue" was first used by Thompson et al. (2005) to represent the phenomenon of customers' inconsistent satisfaction with high-feature products before and after use. Hamilton and Thompson (2007) used construal level theory to explain the reason for FF. They found that indirect experience triggers more abstract mental construal and increases preference of high-desirability (capability) products, while direct experience triggers more concrete mental construal and increases high-feasibility (usability) products. Thus, customers prefer high-capability products before use but high-usability ones after use, which leads to the situation of FF. Gill (2008) classified product features into hedonic category (which is associated with experiential consumption, pleasure, and excitement) and utilitarian one (which is related to more instrumental/practical considerations), and showed that different categories of product features have different effects on customers' perceived capability and usability. Yet, none of above studies points out how to determine which features should be integrated into the product so as to alleviate FF.

There are some reports on efforts to alleviate FF. Thompson et al. (2005) proposed an analytical model to show the influence of the number of features on manufacturers' long-term profit. They used the model to determine a suitable number of features to be integrated so as to maximize customer equity. But they just focused on the total "number" of features and considered all the features to be homogeneous, ignoring the differences between them. Li and Wang (2011) proposed a probability based methodology for FF analysis in which Bayesian network technique was used to analyze uncertain relationships among product features and the combination effects. But this methodology cannot point out what features should be integrated into the product to alleviate FF. Li et al. (2013) considered the feature addition problem as a multi-objective decision-making problem, in which product capability and usability are two conflicting objectives; and a FF multi-objective GA was proposed for solving the problem. But this approach still cannot find out what specific features should be added for alleviating FF, because it gives many solutions along the Pareto-optimal frontier for designers to select from. Wu et al. (2013) proposed an approach based on the SIR epidemic model and a genetic algorithm to help designers find an optimal feature combination that maximizes customer equity.

2.2. Usability analysis

Usability is a critical dimension of product quality that affects product success (Mack & Sharples, 2009). It is defined in terms of efficiency, effectiveness, user satisfaction, and whether specific goals can be achieved in a specified context of use (ISO9241-11, 1998; Jeng & Tzeng, 2012). Most traditional methods of usability evaluation are generally based on customer survey or test (Han, Hwan Yun, Kim, & Kwahk, 2000; Kwahk & Han, 2002; Liu, Wang, & Ding, 2010; Marshall, Case, Porter, Sims, & Gyi, 2004). For example, using QFD (quality function deployment), Jin, Ji, Choi, and Cho (2009) developed a usability evaluation model based on customer sensation. Ham et al. (2006) proposed a conceptual framework for identifying and organizing usability impact factors of mobile phones in the view of user, product, interaction, dynamic, and execution separately. The problem of survey methods is that they should use prototypes in the later stage of product development, which will extend development cycle time (Ozer & Cebeci, 2010; Yeh, Huang, & Yu, 2011). Besides, survey data are often costly and time-consuming to collect in practice, and they are hard to capture the most updated customer feedback about the product usability.

In recent years, many researchers have studied how to extract customer opinions from online product reviews, such as the works in the fields of opinion mining or sentiment analysis (Bhuiyan, Xu, & Josang, 2009; Kim, Ryu, Kim, & Kim, 2009; Long, Wang, & Liu, 2012). Most of their methods use opinion words or phrases to identify positive and negative reviews and then get preliminary summarized results (Zhan, Loh, & Liu, 2009). However, their works do not address extracting customer opinions about usability, which is an important factor for FF analysis.

In this paper, a rule-based method is proposed for usability evaluation in FF analysis, which is most related to the work of Antonie and Zaiane (2002). The proposed method is different from traditional usability evaluation methods, as the usage of massive online reviews.

3. Usability analysis based on Web mining for alleviating FF

The framework of the proposed approach is shown in Fig. 1. It consists of three modules: (1) Data preparation; (2) Usability analysis; (3) FF analysis. In **module 1**, a web crawler is used to collect online product reviews which are then pre-processed to be sentence level reviews. Product features are extracted in this module to establish a synonym dictionary of product features. In **module 2**, using the review sentences and the synonym dictionary obtained in module 1, the Apriori algorithm is adopted for mining association rules, and then product features' usability are evaluated using the rules. This module is the main contribution of this paper. Then, in **module 3**, FF analysis is performed using features' usability obtained in module 2 and features' capability obtained in capability evaluation. The details of the proposed approach are presented in the following subsections.

3.1. Module 1: data preparation

This module contains three processes: review collection, review pre-processing and product feature extraction. **Review collection** is performed to get product reviews from Web and outputs raw reviews that are saved into review corpus. **Review pre-processing** is used to transform the raw reviews into review sentences, which are used for association rule mining and usability analysis. **Product feature extraction** is to extract product features and to establish a synonym dictionary of product features. This module is not the