

Ontology-Based Adaptive and Customizable Navigation Method in Online Retailing Websites

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Abstract. Different users need different navigation designs to facilitate effective communication. Simplifying the navigation interfaces and help consumers find and purchase products with ease is a big challenge. This work proposes a novel navigation method integrating adaptive and customizable approaches. The proposed method comprises the metadata and a set of conflict detection rules. The metadata defines the structure of adaptation and customization rules. The conflict detection rules analyze inconsistencies between adaptation and customization rules. Ontology is the theoretical foundation in the proposed navigation method. Navigation module ontology, webpage area ontology, priority ontology, role ontology, and personal characteristics ontology are used in this method to provide semantic information for conflict detection rule execution. A scenario of checkout process in an online store is also provided in this paper. In the expectation, this method can provide a convenient way for online retailing websites to simplify navigation interfaces according to evolving organizational and personal knowledge.

Keywords: Adaptive interface · Customizable interface · Navigation system · Personal characteristics · Ontology

1 Introduction

Online retailing is a channel for consumers to buy products. Navigation interfaces are important to help consumers to arrive somewhere to find and purchase products (Dailey 2004). Simplifying user interfaces and avoiding complexity are essential for a good user interface (Ramachandran 2009). However, such simplification is a challenge considering diversity of users.

Two approaches are common in providing an appropriate interface to different users: adaptive and customizable user interfaces. Adaptive user interfaces controlled by administrators consider the diversity of users to simplify the user interfaces and help users complete their tasks with ease (Ramachandran 2009). Adaptive user interfaces

provide flexibility to administrators in dealing with such issue. Customizable user interfaces controlled by users involve various layout setting and configuration, such as changing color and content on web pages (Levene 2010). Customization means that the user deliberately tailors user interfaces by choosing options (Sundar and Marathe 2010). Rules are used in configure adaptive and customizable user interfaces.

Role is an essential element to classify users in online retailing websites. Using role-based approach to control information access is common in business. For example, Role-Based Access Control (RBAC) is very popular for information security in companies. Role is also applied in adaptive web interfaces, such as a health care application (Ramachandran 2009). In practice, role-based approach are widely used in online retailing websites.

Personal characteristics are another important element to classify users in constructing adaptive user interfaces. There is a lot of literature discussing the relationships between personal characteristics and user interfaces. For example, old and young users have different preferences to operate user interfaces in mobile devices (Hölzl and Schaffer 2013). Wholistic users prefer one webpage comprising all steps and analytical users prefer step-by-step approach in checkout processes in online retailing websites (Belk et al. 2014). The literature of Elaboration Likelihood Model (Wang et al. 2009) implies that high and low involvement consumers needs different navigational information in online retailing. Therefore personal characteristics of users should be considered in providing an appropriate navigation interface to different users.

This work proposes an adaptive and customizable navigation method based on role and personal characteristics in online retailing websites. The proposed navigation method provides interface flexibility to administrator by means of adaptive navigation mechanism and to users by customizable navigation mechanism. The proposed navigation method comprises the metadata and conflict detection rules. The proposed the metadata reveals what information should be considered in adaptation and customization rules for navigation interfaces. For example, an adaptation rule metadata comprises six elements: navigation module, webpage area, online retailing website, priority, personal characteristics, and role. Therefore an adaptation rule can be: Step-by-step checkout process (navigation module) in checkout area (webpage area) of online music store (online retailing website) has 1st priority (priority) to support analytical (personal characteristics) customer (role). The proposed conflict detection rules are used to detect inconsistencies in adaptation and customization rules.

Ontology is the theoretical foundation of the proposed navigation method. Ontology is an explicit and shared conceptual model to represent a domain knowledge (Gruninger and Lee 2002). Ontology can provide semantic information to execute rules automatically (Liu 2012).

The reminder of this paper is structured as follows. Section 2 discusses related works about navigation mechanisms. Section 3 proposes the navigation method comprised of method overview, metadata, and rules. Section 4 provides a scenario about checkout process in an online retailing store. The final conclusion section includes research contribution and further works.

2 Related Work

Several related works in the literature are summarized in Table 1. All these navigation mechanisms provide several navigation interfaces to different users. Most of these works do not provide the configuration function for flexibly specifying adaptive navigation rules. Only two works (Ramachandran 2009; Martin and Ivan 2013) provide configurable adaptive navigation rules in their mechanisms. One work (Martin and Ivan 2013) uses ontology. None of these works provide a conflict handling function including rule conflict detection and resolution. And none of these works focus on the

Table 1. Related navigation mechanisms

	Navigation approach description	Configurable navigation rules	Ontology and conflict handling	Applied context
Brusilovsky (2003)	Providing different adaptation techniques for different knowledge level students	Not revealed	Not revealed	Educational hypermedia
Ramachandran (2009)	Using XML to provide adaptive navigation and presentation techniques for different roles	Yes	Not revealed	Health Care applications
Hölzl and Schaffer (2013)	Providing adaptive helping system and book-oriented application design for novice elderly users	Not revealed	Not revealed	Smart phones
Deshpande et al. (2013)	Providing and evaluating various web interfaces for different learning task's complexities	Not revealed	Not revealed	e-Learning
Martin and Ivan (2013)	Providing adaptive web environment according to user, domain, goal, and context models	Yes	Ontology is applied The conflict handling issue is not revealed	Adaptive hypermedia
This work	Using adaptive and customizable rules to present navigation interfaces	Yes	Yes	Online retailing websites

electronic commerce context. Hence this work proposes an ontological navigation method based on role and personal characteristics which are concern about the above issues.

3 Proposed Adaptive and Customized Navigation Method

This work proposes a novel adaptive and customizable navigation method including five step in Fig. 1. The five steps in the proposed navigation method are introduced as follows. In step 1, the administrator models the organizational knowledge comprising adaptation rules and ontologies. The organizational knowledge stores adaptation rules. All concepts used in adaptation rules are also stored in ontologies. Then step 1 uses ontologies to detect conflicts between adaptation rules. The administrator uses priorities to resolve conflicts between adaptation rules.

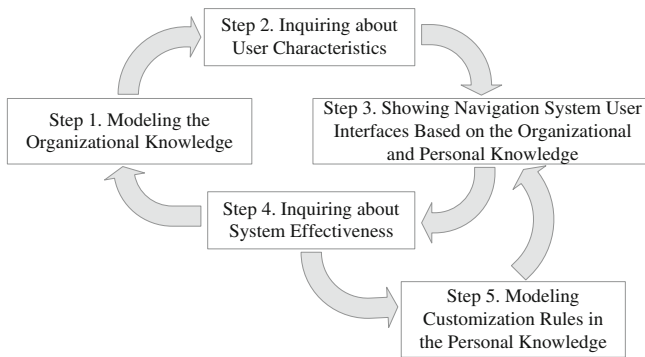


Fig. 1. Adaptive and customizable navigation method overview

In step 2, each user fill in the questionnaire to describe personal characteristics in personal knowledge. This questionnaire is developed to describe user characteristics according to the personal characteristics ontology in organizational knowledge, such as wholistic and analytic cognitive styles. Step 3 shows navigation system user interfaces according to both organizational and personal knowledge. In step 4, users are asked to fill in the questionnaire to measure the navigation system's effectiveness. In other words, the system effectiveness questionnaire is developed to inquire user satisfaction about the navigation system. If a user does not satisfy the navigation system, step 5 will be executed. In step 5, a user model his or her own customization rules in the personal knowledge to configure his or her own navigation system user interfaces. For conflicts handling, step 5 detects and resolves conflicts between customization rules in the personal knowledge. Step 5 also detects and resolves conflicts between an adaptation rule in the organizational ontology and a customization rule in the personal ontology. Then step 3 is executed according to the organizational and personal knowledge.

The core elements in the proposed adaptation rule metadata are six-folds: navigation module, webpage area, online retailing website, priority, personal characteristics,

and role. These elements are depicted in Fig. 2. The adaptation rule metadata offers the administrator to specify adaptation rules in the organizational knowledge. For example, adaptation rule A is “One page checkout process (NM_{AR1}) in checkout area (WA_{AR1}) of online games store (ORW_{AR1}) has 1st priority (P_{AR1}) to support analytical (PC_{AR1-1}) customer (R_{AR1})”.

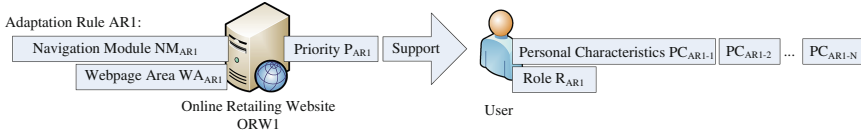


Fig. 2. Adaptation rule metadata

The proposed customization rule metadata has five elements: navigation module, webpage area, online retailing website, priority, and user. The customization rule metadata offers general users to specify customization rules in the personal knowledge to configure user interfaces. For example, customization rule B is “Top-down step-by-step checkout process (NM_{CR1}) in checkout area (WA_{CR1}) of online games store (ORW_{CR1}) has 1st priority (P_{CR1}) to support John (U_{CR1})”.

This work proposes three rules for detecting conflicts in adaptation and customization rules. These conflict detection rules are developed based on the metadata in Figs. 2 and 3. These rules are introduced as follows.



Fig. 3. Customization rule metadata

Rule_{IAR}:

IF an inequality relationship is between navigation module NM_{AR1} and NM_{AR2} , an equality relationship exists between webpage area WA_{AR1} and WA_{AR2} , an equality or kind relationship is between online retailing website ORW_{AR1} and ORW_{AR2} , an equality relationship is between priority P_{AR1} and P_{AR2} , an equality or kind relationship is between role R_{AR1} and R_{AR2} , an equality or kind relationship is between personal characteristics PC_{AR1-1} and PC_{AR2-1} , an equality or kind relationship is between personal characteristics PC_{AR1-2} and PC_{AR2-2} , ... and an equality or kind relationship is between personal characteristics PC_{AR1-n} and PC_{AR2-n} , THEN a conflict occurs between adaptation rule $AR1$ and $AR2$.

Rule_{IAR} is a conflict detection rule for finding inconsistencies between adaptation rule AR1 and AR2. Rule_{IAR} is defined as above in the if-condition-then-statement structure. The semantic relationships between adaptation rule AR1 and AR2 in the condition are depicted in Fig. 4. The ontologies in organizational knowledge provide semantic information between concepts for executing Rule_{IAR}. The administrator should prioritize adaptation rule AR1 and AR2 to resolve the conflict.

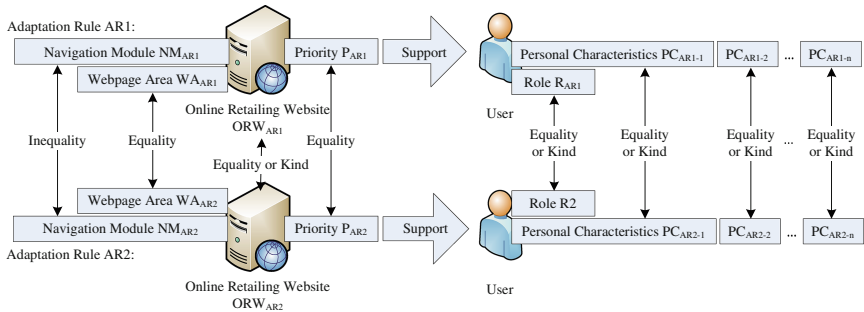


Fig. 4. Conflict detection rule for inconsistent adaptation rules

Rule_{ICR}:

IF an inequality relationship is between navigation module NM_{CR1} and NM_{CR2} , an equality relationship exists between webpage area WA_{CR1} and WA_{CR2} , an equality or kind relationship is between online retailing website ORW_{CR1} and ORW_{CR2} , an equality relationship is between priority P_{CR1} and P_{CR2} , and an equality relationship is between user U_{CR1} and U_{CR2} , THEN a conflict occurs between customization rule CR1 and CR2.

Rule_{ICR} is a conflict detection rule for finding inconsistencies between customization rule CR1 and CR2. Rule_{ICR} is defined as above in the if-condition-then-statement structure. The semantic relationships between customization rule CR1 and CR2 are depicted in Fig. 5. The ontologies in organizational knowledge provide semantic information between concepts for executing Rule_{ICR}. The users should prioritize customization rule CR1 and CR2 to resolve the conflict. Moreover, users can suggest which concepts and semantic relationship should be added in the ontologies which are managed by administrators.

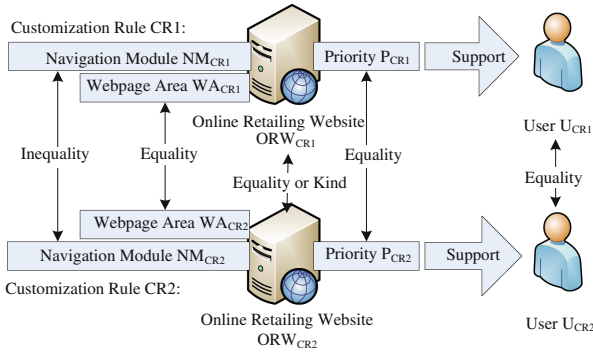


Fig. 5. Conflict detection rule for inconsistent customization rules

Rule_{ICAR}:

IF an inequality relationship is between navigation module NM_{CR1} and NM_{AR1} , an equality relationship exists between webpage area WA_{CR1} and WA_{AR1} , an equality or kind relationship is between online retailing website ORW_{CR1} and ORW_{AR1} , an equality or kind relationship is between role R_{CR1} and R_{AR1} , an equality or kind relationship is between personal characteristics PC_{CR1-1} and PC_{AR1-1} , an equality or kind relationship is between personal characteristics PC_{CR1-2} and PC_{AR1-2} , ... and an equality or kind relationship is between personal characteristics PC_{CR1-n} and PC_{AR1-n} , THEN a conflict occurs between customization rule CR1 and adaptation rule AR1.

Rule_{ICAR} is a conflict detection rule for finding inconsistencies between customization rule CR1 and adaptation rule AR1. Rule_{ICAR} is defined as above in the if-condition-then-statement structure. The semantic relationships between customization rule CR1 and adaptation rule AR1 are depicted in Fig. 6. The ontologies in organizational knowledge provide semantic information between concepts for executing Rule_{ICAR}. Personal characteristics PC_{CR-1} , PC_{CR-2} , ... and PC_{CR-n} and role R_{CR1} are identified when customization rule CR1 is executed for user U_{CR1} . Priority P_{CR1} should be set as first priority to resolve the conflict because customization rule CR1 specified by user U_{CR1} must take precedence over adaptation rule AR1 specified by an administrator.

4 Scenario of Checkout Process

This section provides a scenario of checkout process in an online retailing website. This scenario comprises five ontologies and three examples for Rule_{IAR}, Rule_{ICR}, and Rule_{ICAR}. These ontologies are navigation module ontology, webpage area ontology, priority ontology, role ontology, and personal characteristics ontology. Some ontologies which are important for demonstrating the examples are depicted in the following figures.

The following adaptive and configurable navigation system examples use the above ontologies (in Figs. 7, 8 and 9) and the metadata (in Figs. 2 and 3) to demonstrate and validate the proposed conflict detection rules (in Figs. 4, 5 and 6). The Rule_{IAR} example describes the situation of two inconsistent adaptation rules. In the Rule_{IAR} example, adaptation rule AR1 is: “One page checkout process (NM_{AR1}) in checkout area (WA_{AR1}) of online game store (ORW_{AR1}) has 1st priority (P_{AR1}) to support analytical (PC_{AR1-1}) customer (R_{AR1})”. Adaptation rule AR2 is: “Top-down step-by-step checkout process (NM_{AR2}) in checkout area (WA_{AR2}) of online game store (ORW_{AR2}) has 1st priority (P_{AR2}) to support any cognitive style (PC_{AR2-1}) customer (R_{AR2})”. In this example, Fig. 7 indicates that one page checkout process (NM_{AR1}) is unequal to top-down step-by-step checkout process (NM_{AR2}). Checkout area (WA_{AR1}) which is placed on a checkout navigation module equals checkout area (WA_{AR2}). Online game store (ORW_{AR1}) equals online game store (ORW_{AR2}). The concept of 1st priority (P_{AR1}) equals the concept of 1st priority (P_{AR2}). Figure 9 shows that the concept of analytical (PC_{AR1-1}) is a kind of the concept of any cognitive style (PC_{AR2-1}). And customer (R_{AR1}) equals customer (R_{AR2}). According to Rule_{IAR}, a conflict exists between adaptation rule AR1 and AR2.

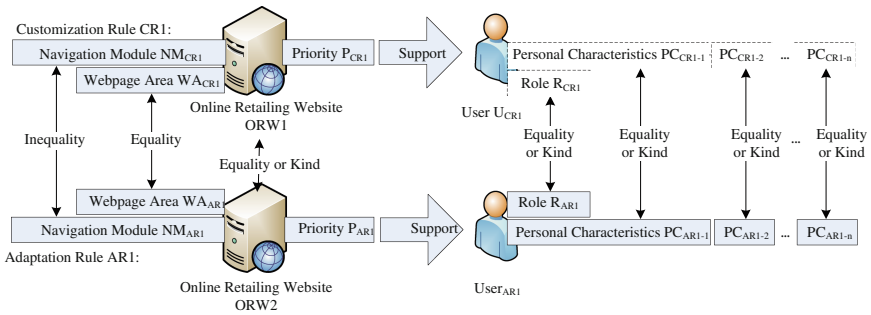


Fig. 6. Conflict detection rule for inconsistent customization and adaptation rules

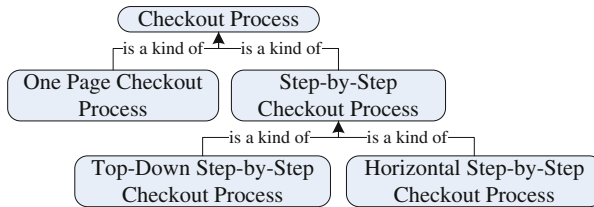


Fig. 7. Navigation module ontology

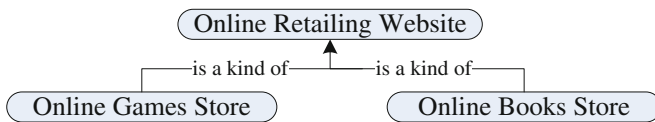


Fig. 8. Online retailing websites ontology

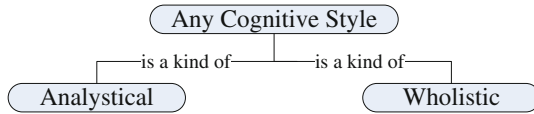


Fig. 9. Personal characteristics ontology

The Rule_{ICR} example describes the situation of two inconsistent customization rules. In the Rule_{ICR} example, customization rule CR1 is: “Horizontal step-by-Step checkout process (NM_{CR1}) in checkout area (WA_{CR1}) of online store (ORW_{CR1}) has 1st priority (P_{CR1}) to support Cynthia (U_{CR1})”. Customization rule CR2 is: “Top-down step-by-step checkout process (NM_{CR2}) in checkout area (WA_{CR2}) of online books store (ORW_{CR2}) has 1st priority (P_{CR2}) to support Cynthia (U_{CR2})”. In this example, the parent of both horizontal and top-down step-by-step checkout process is step-by-step checkout process. Therefore horizontal step-by-Step checkout process (NM_{CR1}) is unequal to top-down step-by-step checkout process (NM_{CR2}). Checkout area (WA_{CR1}) equals checkout area (WA_{CR2}). Figure 8 reveals that online books store (ORW_{CR2}) is a kind of online store (ORW_{CR1}). The concept of 1st priority (P_{CR1}) equals the concept of 1st priority (P_{CR2}). And Cynthia (U_{CR1}) equals Cynthia (U_{CR2}). According to Rule_{ICR}, there is a conflict between customization rule CR1 and CR2.

The Rule_{ICAR} example describes the inconsistency between customization and adaptation rules. In the Rule_{ICAR} example, customization rule CR1 is: “Top-down step-by-step checkout process (NM_{CR1}) in checkout area (WA_{CR1}) of online books store (ORW_{CR1}) has 1st priority (P_{CR1}) to support Anne (U_{CR1})”. Adaptation rule AR1 is: “Horizontal step-by-step checkout process (NM_{AR1}) in checkout area (WA_{AR1}) of online store (ORW_{AR1}) has 1st priority (P_{AR1}) to support Wholistic (PC_{AR1-1}) customer (R_{AR1})”. The user data collected from a personal characteristics questionnaire show that Anne is a wholistic (PC_{CR1-1}) customer (R_{CR1}). In this example, Fig. 7 indicates that top-down step-by-step checkout process (NM_{CR1}) is unequal to horizontal step-by-step checkout process (NM_{AR1}). Checkout area (WA_{CR1}) equals checkout area (WA_{AR1}). Figure 8 shows that online books store (ORW_{CR1}) is a kind of online store (ORW_{AR1}). The concept of 1st priority (P_{CR1}) equals the concept of 1st priority (P_{AR1}). Anne (Role_{CR1}) equals Anne (Role_{AR1}). Wholistic (PC_{CR1-1}) equals wholistic (PC_{AR1-1}). And customer (R_{CR1}) equals customer (R_{AR1}). According to Rule_{ICAR}, a inconsistency occurs between customization rule CR1 and adaptation rule AR2.

5 Conclusion

Simplification of navigation interfaces to facilitate effective communications is necessary for designing good online retailing websites. Adaptation and customization are two common approaches to simplify navigation interfaces. In this context, administrators of online retailing websites specify new adaptation rules for navigation interfaces according to organizational knowledge. Consumers of online retailing websites specify new customization rules according to personal knowledge. Therefore developing a flexible navigation method integrating adaptation and customization is necessary to quickly fit administrators’ and consumers’ requirements.

This work proposes an ontology-based method to provide adaptive and customizable navigation interfaces according to role and personal characteristics. The proposed method opens a new direction based on ontology theory from the individual differences perspective. This work has two theoretical contributions. The first theoretical contribution of the proposed method is applying ontology in the new phenomenon about flexible website navigation. The second theoretical contribution of this work is proposing a set of innovative rules for inconsistent rules detection. Besides, the practical contribution of this method facilitates online retailers integrating organizational and personal knowledge to simplify navigation interfaces in their websites.

Developing system architecture to support the proposed method is under way. System implementation and evaluation are also valuable directions for further works.

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