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An Ontology-based Approach for User Interface Adaptation

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Abstract. With the evolution of a wide variety of mobile devices, computing is not limited to the desktop mode. The traditional User Interface (UI) is often not appropriate for ubiquitous computing and mobile applications and thus new challenges are emerging. The concept of Adaptive User Interface (AUI) is a new search direction in the field of human-machine interaction that aims at supporting the interaction between the user and the interface. In fact, AUI is an interface which adapts itself according to user's profile, platform and environment. Most of the existing work in adaptation of UI relies on manual declarative rules definition using combinations of context criteria (user experience, user motivation, age, etc.) and the interface characteristics (density, color, etc.). However, there is no standard definition of context criteria based on their interface characteristics. In fact, the same interface attributes could be associated with many context criterion. This paper presents an ontology of UI adaptation process and how it is used for the personalization container of user interfaces by using SWRL rules. We evaluate our approach on AUIs of project called HandicraftWomen. It aims to support handcraft women in their business activities. The obtained results confirm the efficiency of our technique with an average of more than 77% of precision and recall.

Keywords: Adaptation, Adaptive Course, Fuzzy logic, Evaluation, Adaptive User Interface (AUI).

1 Introduction

In the recent years, smartphones have been in an ever-increasing development. According to the "International Data Corporation (IDC) Worldwide Quarterly Mobile Phone Tracker", shipments reached 355.2 million smartphones in the third quarter of 2015. In addition, the number of mobile applications increases exponentially with more than 1.43 million mobile applications available on Google Play, 1.21 million on the App Store, and 300,000 applications available on Amazon. All these devices and applications are intended to be used by different users in various contexts. This creates new challenges as users want to have adaptives interfaces that fit their needs and preferences.

The concept of interface adaptation is defined as the process of user interface adjustment based on knowledge about context of use (user, platform, environment) [1]. In this respect, interface adaptation becomes a necessity to improve the interaction between users and the system which enhances the usability of interface by making it more efficient, effective and easy to use. [2].

Lavie, T et al [3] define the adaptation of user interfaces as the process that adapts the display of interfaces to the user's goals. This adaptation is based on context criteria such as the experience, age, motivation, level of study, etc. The diversity of these criteria should be a driver to obtain the most adaptive interface to user profile, and ensure the user's satisfaction. Most of the existing works in adaptation of UI relies on manual declarative rules definition using combinations of context criteria (user experience, user motivation, age, etc.) and the interface characteristics (density, color, etc.). However, there is no standard definition of context criteria based on their

interface characteristics. In fact, the same interface attributes could be associated with many context criterion. In the existing proposals, the mapping between context elements and knowledge of the domain application requires a deep experience of developer in order to choose which interface characteristic should be mapped with context criteria. In our work, we use the correlation coefficient to map the context criteria and interface characteristics.
Several ontological approaches for adaptive system design have been proposed [4-8]. They automatically generate the content of adaptive user interface. However, little research studies tackled the problem of evaluating AUI interfaces. The quality of container presentation personalization, such as ergonomic, screen size personalization is not considered in these approaches/tools.
To address the above mentioned challenges, we propose in this paper a novel an ontology-based approach to suggest automatically AUIs according to the context of user using SWRL rules, while ensuring personalization quality by the reasoner of ontology. This evaluation of container presentation adaptation quality is based on equivalents classes that use necessary and sufficient conditions.
We evaluate our approach on AUIs of project called HandicraftWomen. It aims to support handcraft women in their business activities. The obtained results confirm the efficiency of our technique with an average of more than 77% of precision and recall.
The rest of the paper is organized as follows. Section 2 provides the necessary background about user interface adaptation and some of existing works concerning context of use modeling. Section 3 presents the overview and the functional architecture of the proposed approach. Section 4 discusses the results of the evaluation of our approach, and section 5 presents some related works and discusses our findings and possible limitations of our work. Finally, Section 6 presents our conclusions and some perspectives.

2 Background

1.1 User Interface Adaptation

Adaptive User Interface (AUI) aims to improve the interaction between users and system by constructing a user model [2]. The idea is to simplify the using of the interactive applications by presenting the expected information for users and by reducing its complexity [3]. The adaptation of user interface (UI) refers to the ability of system to generate intelligent and personalized interface according to the user's need [2]. Adaptation is the process of selection, generation or modification of content (e.g., text, image, etc.) to suit the user's profile, its interaction platform and its computing environment. The adaptation of the user interface has been promoted to solve usability problems and to satisfy users' needs and preferences, because it can be performed on the interface container's presentation, such as layout, colors, sizes, and other design elements, and also on the content like data, information, and document.
There are two categories of UI adaptations: the adaptability and the adaptivity. For Moisuc [9], the adaptability is the capacity of the user interface to personalize itself according to the user's need. With the adaptability process, the system can be customized and the adaptation decisions are taken by the user based on the explicit user intervention. Similarly, the customization is a user-initiated and user-driven process. It uses adaptable UI components which users can tailor to their specific needs. This system uses static profiles, which may be changed by the user [10]. However, the UI adaptivity refers to its capacity to meet the needs of the user without an explicit intervention from him. In this case, the process of UI adaptivity performs adaptation automatically without intervention of the user. In fact, the adaptation decisions are taken by the system itself. Adaptivity requires the monitoring of user behavior by the system in order to adapt automatically UI. So, the user profiles are changed dynamically by the system. Furthermore, it aims to provide informations which are specially adapted to the needs of an individual or group of individuals. Hirsh et al. [11] define the UI adaptivity as "self-customizing" of user interface. The difference between these two concepts is the participation of the user. In the adaptation, the user is active; he is responsible for filtering of information by adapting UI. However, in the adaptivity or personalization, the user is passive; the obtained information's are filtered by his profile.

1.2 Context Awareness

The adaptation criteria (attributes) constitute the context of use which is a source for UI adaptation. We give here three frequently used definitions. According to Dey [12], context, is any information that can be used to characterize the situation of a user and his location of use that is considered relevant to the interaction between this user and an system. In this way, Chen and Kotz [13] define context as a set of environmental states and settings that determines a system's behavior. In fact, when there is change in the "context", adaptation of UI

occurs. A three of contextual dimension, user, location and platform are associated with context. Indeed, each user has specific characteristics that may be associated to physical and cognitive factors such as preferences, interests, skills, experience, education level, etc. This user interacts with system using interaction platform which has different characteristics such as memory, CPU, network, screen, virtual machine, operating system, etc.). In addition, the environment where the interaction between the user and the platform takes place can has an impact on the interface adaptation. In our work, a context of use is a combination of user, platform and environment criteria. In this paper, we present the criteria that are most commonly used in the personalization of UI field. For each criterion, an example of a set of values used for providing adaptation is presented (table 4).
Several works have been proposed to model the context of user in order to personalize the interface [11-13]. These studies focused on the definition of user profile models to perform adaptation. Many of them use some basic information about the user, and/or an analysis of contextual data (historical information) to identify the preferences, and characteristics of the user (experience, motivation, interests, preferences, etc.). Schilit et al. [14] represent a context as a simple list of attributes with values (named Key-Value model). Key-value pairs are easy to use, but lack capabilities for sophisticated structuring for enabling efficient context retrieval algorithms. Calegari et pasi [15] consider user profile as an ontology employed in order to have more structured user profile representation. It allows representing knowledge about user's preferences as a set of concepts. The proposed ontological context model can benefit from the ontology strengths such as knowledge sharing, normalization and formality, its logic inference and knowledge reuse capabilities. However, the majority of these works focus only on the context of user modeling as ontology that can be used by an adaptation process. In fact, these works separate the user modeling step and the adaptation decision. In our work, we propose to model an adaptation rule as ontology. The idea is to marry context of use modeling and personalization reasoning step.

3 The proposed approach

This section shows how the adaptation process can be represented as ontology. Ontology is defined as an explicit specification of the conceptualization of problem domain [16]. It is a description of concepts and their properties and constraints expressed via axioms. It allows defining the concepts of a domain and their relationships explicitly and formally. Ontology has also the potential to clarify domain's structure of knowledge and to enable reasoning about domains. Therefore, representing adaptation process as ontology provide sufficient flexibility and extensibility of the adaptive system and also improve the reusability of adaptation components based on the adaptation rules.
In this paper, we are interested in the adaptation of the UI using domain ontology. We also describe how this ontology is used to adapt user interface. As described in figure 1, the context criteria (e.g., age, education level, interests, motivation, etc.), the interface characteristics (e.g., density, grouping, sequence, workload of interface, guidance, etc.) are used to generate the adaptive user interface based on ontology reasoner. Our method has three phases (Fig. 1): (1) correlation of context criteria and interface's characteristics, (2) ontological modeling of adaptation process and (3) ontological reasoning for adaptation of AUI.

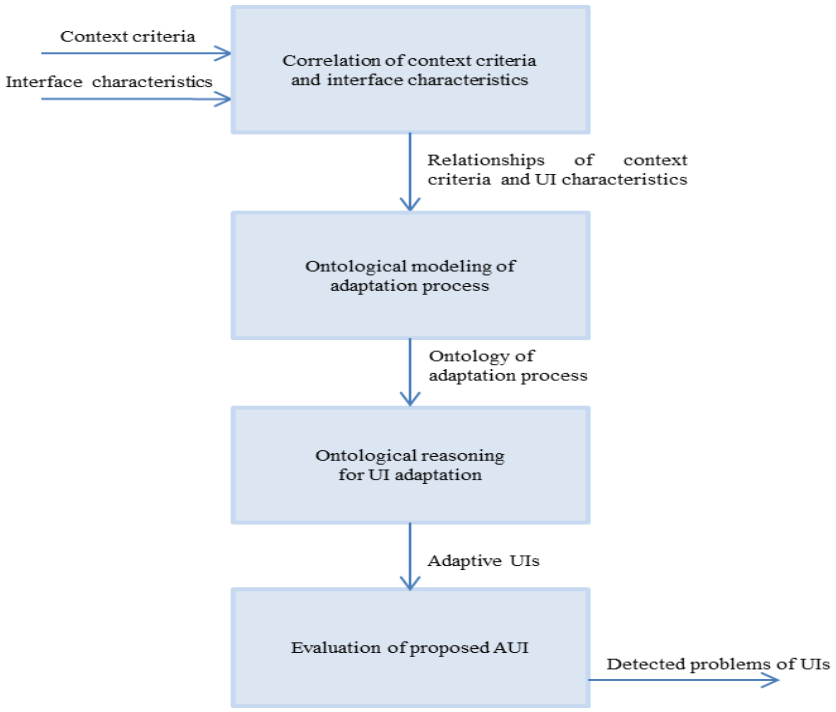

Fig. 1. Approach overview

3.1 Correlation of context criteria and interface characteristics

The first phase consists in finding the correlation between the context criteria and the interface characteristics. In fact, each context criteria corresponds to an interface characteristic. For example, the user's experience is associated to the interface guidance. The idea is to associate to domain ontology of context of use to allow adaptation. To this end, we use the correlation coefficient to verify if two variables are related to each other. The correlation coefficient has a value between -1 and +1. +1 indicates a perfect positive correlation. For example, when a user motivation increases, the value of interface density increases.-1 indicates a perfect negative correlation. For example, when a user experience increases, the guidance of the interface decreases. A correlation coefficient near 0 indicates no correlation.

$$\text{Correlation}(CC, IC) = \frac{\sum_{i=0}^{n}(CC_i - \overline{CC})\,(IC_i - \overline{IC})}{\sqrt{\sum_{i=0}^{n}(CC_i - \overline{CC})^2 \sum_{i=0}^{n}(IC_i - \overline{IC})^2}}$$

With: CC_i: context criteria, IC_i: interface characteristics, n: number of context criteria

3.2 Metadata for UI description Ontological Modeling of Adaptation Process

Ontology is an explicit specification of the conceptualization as a problem of a domain. In our work, we propose to model the adaptation task (process) of user interface as an ontology. The idea is to map context criteria and interface characteristics. Formally, it is described as 5-tuple O = {C, P, H_C, H_R, and R}.

- C represents the concepts (classes).
- P: represents the properties (relations).
- H_C: Hierarchy of concepts, HC (C1, C2) ≡ C2 is a subclass of C1.

-Hp: Hierarchy of properties: object properties are relationships between two individuals and data type property links individuals to data values.

- R: SWRL adaptation rules (Semantic Web Rule Language).

1) Identification of the concepts

The concepts, called also classes, are a core components of ontology. They represent a group of different individuals that share common characteristics, which may be more or less specific. Within the proposed ontology, each class may have further sub-classes (child classes) forming a hierarchy of related information about one unique individual. This means that if A is a subconcept of B, then any individual of type A will also be an individual of type B. The proposed concepts are defined in the following table. The concepts may also share relationships with each other; these describe the way individuals of one concept relate to the individuals of another.

- Adaptation Process: The main class of our ontology.
- Context of use: It is a subclass of adaptation process. It represents the context of use conditions.
- Adaptive UI: It is a subclass of adaptation process. It represents the interface reaction when changing the context of use.
- User Profile: It is a subclass of context of use. It contains informations about user.
- Platform: It is a subclass of context of user. It is the interaction device such as smartphone.
- Environment: It is a subclass of context and describes all information about the environment.
- Computer Skill: It is a subclass of user profile. It represents user experience about the computing interaction.
- Motivation: It is a subclass of user profile. It describes the physiological state when interacting with computer (blood pressure, injury, etc.).
- Education: It is a subclass of user profile which can be school graduate, bachelor's degree, and Master's degree.
- Activity: It is a subclass of user profile.
- Ability: It is a subclass of user profile. It refers to proficiency or capacity of user (ability to hear, to talk, to see, etc.).
- Interactivity: It is the dialog that occurs between a user and a computer.
- Software: It is a subclass of platform. It refers to all applications installed on the platform.
- Operating System: It is a subclass of platform. It represents software characteristic of the platform such as Windows7, Android, etc.
- Hardware: It refers to all platforms ‘characteristics.
- Type: Each platform has a well-defined type (eg., PC or smartphone, … etc.
- Screen: It is a subclass of platform. It indicates the height and width of the interface and its image resolution.
- Battery: It is a subclass of hardware. It is a device that is placed inside a platform to supply it with electricity.
- Memory: It refers to the RAM size of the platform. It is a subclass of hardware.
- Time: It is a subclass of environment which indicates the moment of interaction includes year, month, day, morning, evening, public holiday, etc.
- Location: It is a subclass of environment which refers to the place that can be described through the geometric data (GPS coordinates, city, street, etc.).
-Luminosity: It is a subclass of environment. It is a measurement of brightness or light.
- Guidance: User guidance refers to the means available to advice, orient, inform, interact, and guide the users when interacting with computer (message, alarm, label, etc.).
- Ergonomic: It is an interface characteristic. These values are: low or medium or high.
- Density : It is the set of information presented to the user.
- Modality: It isa communication mean that can be used to interact with application such as writing, vocal interaction, etc.
- Evaluation: It consists of ensuring that the system provides adaptive user interfaces according to the context of use. It allows detecting problems related to adaptation quality.

2) Definitions of the properties

The properties are the relationships associated with proposed concepts that can be classified into two types (object properties and data type properties). The object properties specify relationships between two individuals and data type properties link individuals to data values. For example, we define HasDensity and HasExperience as object property, and LevelAge as well as data type property. Each object property or data type property must have a domain and a range. Table 1 and table 2 present the domain and the range of the proposed properties.

Table 1. Domain and range of object properties

Object property	**Domain**	**Range**
IsRelatedTo	Guidance	CompuerSkill
HasDensity	Motivation	DensityOfInformation
HasAdaptation	ContextOfUse	Adaptive UI
HasAdaptationAction	AdaptationProcess	Adaptive UI
HasDensityOfInformation	Adaptive UI	DensityofInformation
HasEnvironment	ContextOfUse	Environment
HasComputerSkill	UserProfile	Experience
HasErgonomic	Adaptive UI	Ergonomic
Hasguidance	Adaptive UI	Guidance
HasLevelOfEducation	UserProfile	LevelOfeducation
Hasmotivation	UserProfile	Motivation
HasPlatform	ContextOfUse	Platform
HasUserProfile	ContextOfUse	UserProfile
RelatedTo	ComputerSkill	Cuidance
HasAge	UserProfile	Age
HasAuditorCapacity	Ability	AuditorCapacity
HasContext	AdaptationProcess	ContextofUse
HasImputModality	Modality	ImputModality
HasLocation	Environment	Location
HasModality	Adaptive UI	Modality
HasMovingCapacity	Ability	MovingCapacity
HasOputModality	Modality	OutputModality
HasOperatingSystem	Platform	OperatingSystem
HasPremaryLanguage	UserProfile	Language
HasTolkingCapacity	Ability	TolkingCapacity
HasPlatformType	Platform	Type
HasVisualCapacity	Ability	VisualCapacity
Partof	ComputerSkill	ContextOfUse
RelatedTo	ComputerSkill	Cuidance
HasPreferences	UserProfile	Preferences
HasIntercativity	UserProfile	Intercativity
HasActivity	UserProfile	Activity
HasAbility	UserProfile	Ability

Table 2. Domain and range of object properties

DataTypeProperty	**Domain**	**Range Type**
LevelAge	Age	Integer
Preferences	MediaPrefrence	Image, video, text
LevelAudotoryCapacity	AudotoryCapacity	good, low, moderate
LevelDensityInformation	DensityOfInformation	high, low, medium
LevelExperience	Computer Skill	expert,medium, novice
LevelGuidance	Guidance	high, low, medium
LevelInputModality	InputModality	string
LocationOfUser	Location	String
LevelLuminosity	Luminosity	String
LevelMotivation	Motivation	low, medium, high
LevelMovingCapacity	MovingCapacity	good, low, moderate
Interactivity	InteractivityLevel	low, medium, high
LevelOfFacilityLearning	FacilityOfLearning	low, medium, high
LevelOflighting	LevelOflighting	high, low, medium
LevelOfNoise	Noise	high, low, medium
LevelOfSimplicity	Simplicity	String
LevelOperatingSystem	OperatingSystem	Windows7, Android
LevelOutputModality	OutputModality	Displing,Audio
LevelPhysicalCapacity	PhysicalCapacity	Audotory, Moving, Talking, Visual
Level of education	LevelOfStudy	Schoolgraduate, Bachelor's , and Master's
LevelTalkingCapacity	TalkingCapacity	good, low, moderate,
LevelTime	Time	dateTime
TypeOfDevise	Type	PC, smartphone
LevelVisualCapacity	VisualCapacity	good, low, moderate

3) Definition of the restrictions

The restriction allows defining the concepts and the relations. OWL proposes various types of restrictions such as quantifier restriction and cardinality restriction.
The quantifier restriction is classified in two categories:
-**Existential restriction** describes a class of individuals that are related through property with at least an individual member of the specified class. For example figure 6, hasAdaptationAction some AdaptiveUserInterface describes all of the individuals that have at least one relationship along the hasAdaptationAction property to an individual that is a member of the class AdaptiveUserInterface, all of the individuals that have at least one AdaptiveUserInterface.
-**Universal restriction** describes classe of individuals that are related through property only with individuals members of the specified class. For example figure shows an example of the universal restriction (HasDensityOfInformation Only (high or low or medium)).This means that if individual is a member of the class Density of information, it is necessary for it to be a kind of Adaptive User Interface and it is necessary for it to only (∀ universal quantifier) have density of information that are kinds of low or kinds high, or kinds of medium.
-The cardinality restriction describes the class of individuals that have at least (min), at most (max) or exactly a specified number (Exactly). For example, the class ContextCondition contains the following characteristics: LevelExperience max 1,LevelAge max 1, LevelMotivation max 1, LevelOfStudy max 1,LevelOfComputing max 1

4) Definition of SWRL rules

SWRL is an acronym for Semantic Web Rule Language. SWRL is intended to be the rule language of the Semantic Web. It is based on OWL: all rules are expressed in terms of OWL concepts (classes, properties…). The semantic aspect of the ontology is defined by the SWRL rules which has the following structure:

A combination of concepts and properties ***then*** A combination of concepts and properties

5) Definition of the instance

Individuals also known as instances who are the base f ontology. They are the elements that the ontology describes or potentially could describe. Individuals are a formal part of ontology and are one way of describing the entities of interest.

3.3 Ontological reasoning for adaptation of AUI

This step consists on proposing the adaptive interface according to the handicraft woman profile. This inferred process based on a set of adaptation rules that are represented as SWRL rules. At this level, the reasoner determines the appropriate adaptation for each handicraft woman profile and generates an interface adapted to the selected woman profile.

3.4 Evaluation of adaptation

This step consists of evaluating the proposed AUI by the reasoner. It is based on equivalents classes that use necessary and sufficient conditions. For example, if class workload interface is defined using necessary and sufficient conditions (level of density of information is high and motivation level is low), we can consider that if an individual is a member of the class workload interface it must satisfy the conditions and we can consider that if any individual satisfies these conditions then it must be a member of class workload interface. The idea is to classify the detected problems related to adaptation quality. This clustering is one of the major benefits of ontology.

4 Validation

We assess the performance of our approach by finding out whether it could generate meaningful AUIs.

4.1 Research questions

Our validation is conducted by addressing the following research questions.
RQ1: How accurately the proposed approach can generate adaptive user interface?

RQ 2: To what extent can the association of context criteria and interface's characteristics improve the generation of AUI?

To assess the accuracy of our approach, we answer RQ1 by measuring precision and recall which are originally defined in the domain of information retrieval.

Precision: The precision measures the capacity of the system to reject all the irrelevant adaptations. It is given by the fraction between correctly proposed adaptation and all proposed adaptation.

$$\text{Precision} = \frac{\#\text{Correctly proposed adaptation}}{\#\text{all proposed adaptation}}$$

Recall: The recall measures the system capacity to find all the relevant adaptations answering a request. It is given by the fraction between correctly proposed adaptation and all expected adaptation.

$$\text{Recall} = \frac{\#\text{Correctly proposed adaptation}}{\#\text{all expected adaptation}}$$

To answer RQ2, we used correlation to associate the criteria and interface's characteristics. The correlation coefficient (has a value between -1 and +1) is used to determinate the most related variables.

4.2 Studied project

This work is a part of a Tuniso-algérien project concerning the use of women technologies (Internet, network social, etc.) by the Tunisian and Algerian handicraft women in their activity sector. It concerns the social context of the handicraft women. The idea is to help the handicraft women in the e-marketing of their articles by proposing adaptive user interfaces. To this end, we propose to propose AUIs based on ontological reasoning.

4.3 Experimental setting

The evaluation of the studied project aims to improve the adaptivity of the user interfaces and to enhance the satisfaction of the users.

1) Subjects

The participants were 634 females which have different profiles. They have different ages, where 66% of participants were in [18-35] and 32% were in [35-50] and 2,6% of participants in [50-70]. The participants who are majoring in computer science were 34 % and 33% have medium experience and 32% having low experience in these skills. The data that were collected about the participants show that 24% of participants reported having low motivation, 37,8 % having a medium motivation and 37,8 % having high motivation. Concerning the level of education, 20% of participants having school graduate, 37% of participants having bachelor's degree and 42% having master's degree.

2) Scenario

The subjects were invited to fill a questionnaire that aims to evaluate the proposed AUIs of our studied project. This questionnaire was divided into two parts: (1) user profile which contains the profile of the users and (2) the evaluation that contains the user answers concerning some of questions after testing the project. The subjects were first asked to fill out the first part of the questionnaire which concerns the user profile. Then, they are asked to express their satisfactions after testing the AUIs. The collected data are organized in base of examples.

4.4 Results

1) Results for Research Question 1

The found results show the low rate of error in our system. In fact, guidance criteria has the highest value of precision which is 93% .When, modality criteria has the lowest value which is 70%. This explains the good performance of our system. The stability of these measures is justified by the precision of criteria.

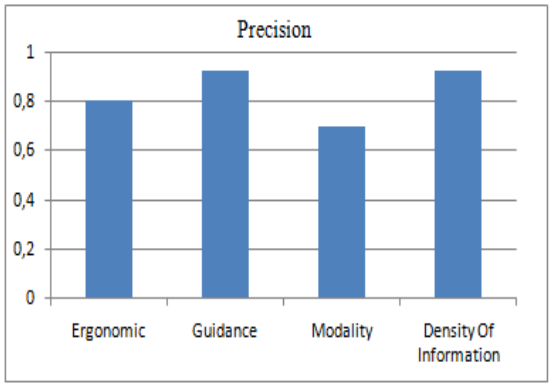

Fig. 2. Precision values interface characteristic

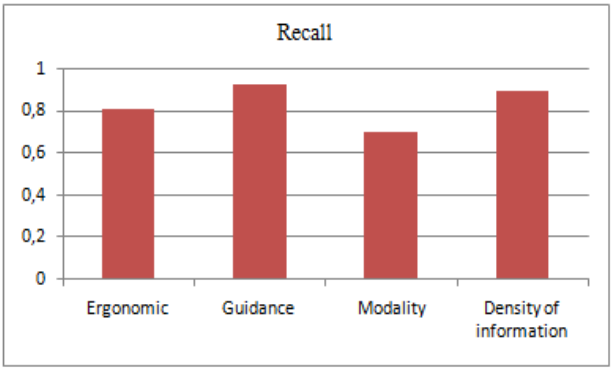

Fig. 3. Recall values of interface characteristics

The found results show that all the result are correct, the recall values for all the criteria are near to 1. It explains that our ontology always gives the correct result.

2) Results for Research Question 2

In our work, the adaptation decision is based on the correlation between the context criteria and the interface characteristics. In fact, each context criteria corresponds to an interface characteristic. For example, the user's experience is associated to the interface guidance. To this end, we use the correlation coefficient to verify if two variables are related to each other. The correlation coefficient has a value between -1 and +1. +1 indicates a perfect positive correlation. For example, when a user motivation increases, the value of interface density increases.-1 indicates a perfect negative correlation. For example, when a user experience increases, the guidance of the interface decreases. A correlation coefficient near 0 indicates no correlation. The results of figure 4 are based on the positive correlation between the criteria motivation and density of information with value = 0,81. +1 indicates a perfect positive correlation. For example, when a user motivation increases, the value of interface density increases.

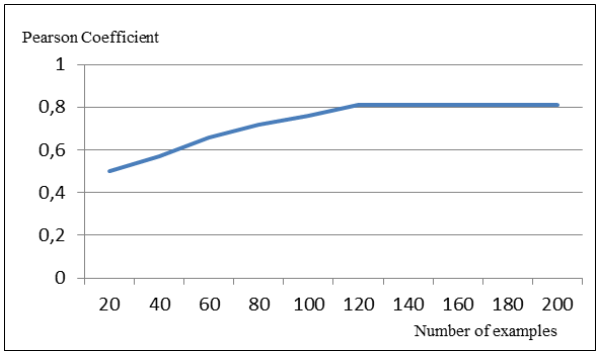

Fig. 4. Positive correlation of motivation and density

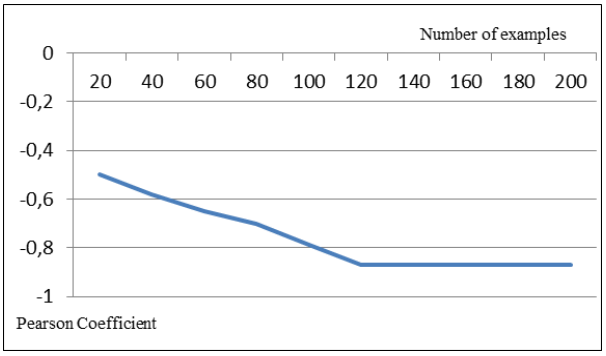

Fig. 5. Negative correlation

The result of figure 5 are based on the negative correlation between the criteria experience and guidance with value = - 0, 87. -1 indicates a perfect negative correlation. For example, when a user experience increases, the guidance of the interface decreases.

5 Related Work

Several methods are proposed in literature for UI adaptation. Abascal et al. [6], proposed adaptive system which aims to generate adaptive mobile user interfaces and to provide people with disabilities with access to ubiquitous services. In this system, the user model and resources have been modelled as ontology. The idea, is to select automatically a suitable user interface using different types of resources (text, video, audio or images). Nevertheless, Universal Control Hub technology presents a limitation due to the low number of devices compliant with U C H. [5] have proposed also an approach called Dante in which Web pages are annotated manually with semantic information for transforming the original pages to obtain pages more easily accessible

for visually disabled users. Similarly, Oliveira et al. [8], proposed a domain ontology to personalize user interfaces for transportation interactive systems. The concepts, properties and axioms of transportation ontology are exploited during the semi-automatic generation of personalized content presented in UI. One of the limitation of these proposals is the mapping between context elements and knowledge of the domain application which requires a deep experience of the application domain in order to choose which concept should be mapped with which context element and how it should be mapped. However, once this mapping has been done, this knowledge can be reused for the development of several AUIs. In our work, we use the correlation coefficient to map the context criteria and interface characteristics.
Sangineto et al., [4] proposed an adaptive e-learning platform which generates adaptive courses by assembling course materials. The learning content is adapted to a student based on static and statistical knowledge about learner. Similarly, Jovanovic et al., [6] proposed also an intelligent learning environment for adapting learning content according to learner's level of knowledge and learner's preferences. It uses ontologies for the automatic decomposition of learning objects into reusable units (personalized learning objects). These works focus on automatically generation of content personalization in user interface. However, to the best of our knowledge, the container presentation adaptation, such as fields, screen resolution or screen size personalization is not considered in existing approaches/tools. In our work, we focus on UI container presentation.

6 Conclusion

The AUI is a new challenge in the Human-Computer Interaction (HCI) field. The aim is to improve the interaction between the users and the system. In fact, AUI is an interface which adapts itself according to user's profile (experience, motivation, preference, interests, etc.), platform (operating system, type of platform, etc.) and environment (location, time, noise, etc.). Several works are proposed about AUI generation. In this way, we proposed an approach to model the context of use as ontology. We also describe how this ontology is used to adapt user interface. The goal of our approach is to propose AUI according to the context of use based on ontology reasoning and using SWRL rules. As part of our future work, we will extend our validation to assess the performance of our approach about detection of problems types related to adaptation quality and compare the proposed approach with other existing approaches. An interesting future direction to our work would be the automatic generation of adaptation rules by evolutionary algorithm such as , NSGA-II. The aim is to maximize the number of detected problems and minimize the number of evaluation rules by solution.

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