# End-User Personalization of Context-dependent Applications in AAL scenarios

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## Abstract
The design and development of flexible applications able to match the many possible user needs and provide high quality user experience is still a major issue. In ambient-assisted living scenarios there is the need of giving adequate support to elderly so that they can independently live at home. Thus, providing personalized assistance is particularly critical because ageing people often have different ranges of individual needs, requirements and disabilities. In this position paper we introduce a solution based on an End-User Development environment that allows patients and caregivers to tailor the context-dependent behaviour of their Web applications in order to facilitate patients' life. This is done through the specification of trigger-action rules to support application customization.

## Author Keywords
Personalization, End-User Development, AAL.

## ACM Classification Keywords
H.5.2 User Interfaces.

## Introduction
Nowadays, we are surrounded by a multitude of interactive devices and smart objects. In this situation, applications need to adapt to continuous changes of contexts, but only end users know the specific

adaptations that they would like to have in their applications. However, it is nearly impossible to identify and anticipate all the requirements at design time because user needs continuously change/evolve over time. In this paper we present an environment enabling end users to customize the context-dependent behaviour of their AAL Web applications by using an intuitive trigger-action paradigm (a first proposal, yet usable only by professional developers, was presented in [1]). The environment has been used in the AAL domain, where the emergence of tools for older adults based on ambient intelligence paradigm has been identified [2], as well as of tools helping elders reach their goals with IT products by working with helpers (see [4] for an example). Our idea is that caregivers and patients (having some familiarity with technology) can be effectively empowered to facilitate the management of typical tasks concerning configuration of reminders, alarms, messages, medication adherence, and monitoring functionalities. Compared to current approaches which offer predefined levels of application customisation, this solution allows for adding new personalisation possibilities not foreseen at design time.

## The Architecture of the Solution

The *AAL Personalisation Rule Editor* loads a AAL specific context model (developed with the support of expert caregivers) and provides users with a representation of contextual elements indicating events and conditions to associate with triggers that they want to consider. Likewise, actions are identified starting from a generic classification and then customized for the specific application considered (defining changes in the user interface or application functionalities). The rules are sent to the Adaptation Engine, a software service that subscribes to the *Context Manager* for being notified about the occurrence of events associated to the rules received in the current context. The Context Manager is composed of a server and various delegates installed in various devices (e.g. a smartphone can host a software detecting the environment noise through the device microphone). The delegates collect data and pass them to the server, which stores/analyses them. Data are gathered from e.g. sensors (temperature, noise, light, doors/windows state, etc.) or external services (e.g. weather forecast). When a previously subscribed event and condition occur, the Context Manager notifies the *Adaptation Engine*, which extracts the list of actions from the concerned *adaptation rules* and sends them to the application for execution.

*Adaptation rules*

The structure of an adaptation rule is: *IF <trigger_expression> DO <action_expression>*. The *trigger_expression* defines the event(s) and the condition(s) that activate the rule application. The *action_expression* defines action(s) to carry out when the rule is triggered. *Trigger_expression* and *action_expression* can be elementary or composite ones (through Boolean operators AND/OR).

*Triggers* refers to the elements identified in the contextual domain-specific model, and at the highest levels considers the following aspects (see also Figure 1): characteristics of the user, aspects related to the environment, aspects related to technology, those associated with social aspects. We have also carried out a classification of the *actions* that can be handled within personalization rules, and we identified action types associated with: *appliances* (to change the state of some actuator); *UI modifications* (to change the presentation, content or navigation of the application UI); *UI distribution* (how the application UI should be

distributed across multiple devices); *functionalities* (to access externals services e.g. weather forecast service); *alarms* (to highlight some potentially dangerous situations); and *reminders* (to indicate tasks that should be accomplished). In the customization phase such actions are tailored to address the specific services, devices and appliances available, so that they are able to determine updates in the AAL application (e.g., reorganizing the layout, activating functionalities, etc.) and/or changes in the state of the appliances (e.g., switch on the TV, vary the light intensity, etc.).

## The AAL Personalisation Rule Editor

The editor is Web-based and responsive (it can be used on many devices, including mobile ones), and enables the creation of trigger-action rules in an intuitive manner. It is flexible in the order in which rules can be created i.e. users can start either from triggers or from actions (see Figure 1). In order to create new rules, it is possible to reuse as a starting point previously specified/saved rules. Indeed, enabling users to save the rules for future use in a different context has found useful in a recent study on EUD in rehabilitation clinics [3]. In the editor, the selection of the relevant concepts is performed by navigating in the hierarchy of concepts associated with each contextual dimension, which is refined by going through a number of conceptual levels until basic elements are reached. Figure 1 shows an example in which the Environment dimension is expanded into its elementary attributes (noise, weather, time). When a basic element is chosen, the tool highlights with a different colour the selected element and shows the possible attributes, operators and relevant values to build the trigger of the concerned rule. A continuous feedback is shown describing the current edited rule in an easy-to-understand subset of natural language. In a similar style users can specify the desired actions. When one of the main action types is selected, the tool shows the supported corresponding application-dependent actions. Figure 2 shows an example application that can be used to monitor/control the situation in elderly home, e.g. to display current values of sensors and control domotic appliances. In particular, a caregiver can build a rule to be alerted when the patient's stress level goes beyond a specific threshold, while a deaf-impaired elderly can set up a rule specifying that when someone passes home door's entrance the room light blinks for 5 seconds.

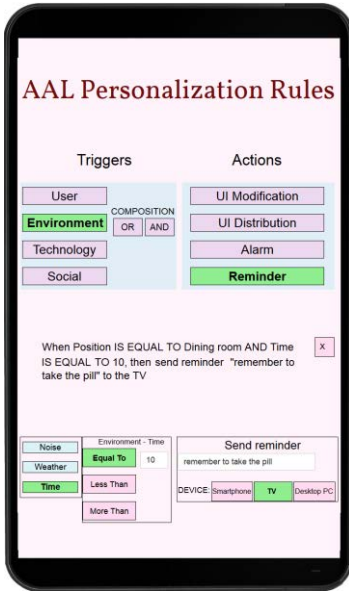


Figure 1: The AAL personalization rule editor

## Adaptation Rules

In the AAL scenario considered, we identified a number of rules classified according to their main focus/goal.

*Rules regarding reminders/alarms/compensatory strategies*. They aim at providing relevant notifications to users when critical situations are about to occur. An example is: IF <time to take a pill has passed> AND < the elderly has not yet taken the pill> AND <it is a weekday> DO <send reminder through the TV> otherwise DO <send reminder through the smartphone>. Indeed, over the weekend the elderly could have different routines than during the week.

*Rules regarding motoric/physical behaviour*. Temporal or permanent motor/physical disability can affect the way in which elderly can e.g. interact with the system/environment. An example is: IF <user has a temporary physical injury to a leg> AND <user is waking up at night> DO <turn on the light in the bedroom>. An elderly can decide setting up this rule to decrease the risk of falls if in the bedroom there is no clear path from bed to the light switches.

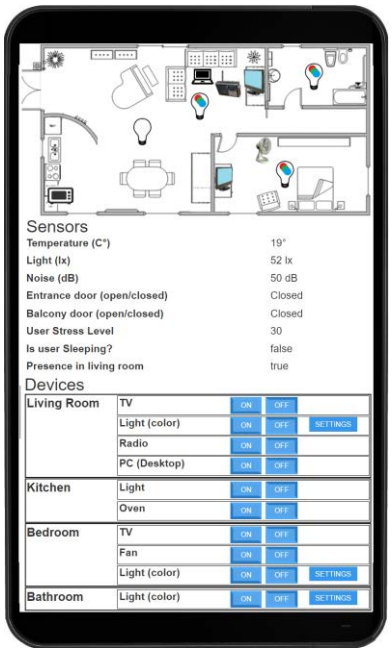


Figure 2: An Example Application

*Rules regarding perception*. They aim at overcoming problems users can have due to perceptual disability. One example rule, which could be specified mainly by caregivers on the basis of monitoring data provided by the system is: IF <the elderly activates frequently the zoom-in functionality> AND/OR <the elderly is sight-impaired> DO <enlarge the fonts> AND/OR <change interaction modality to vocal>. Another example could be to set up a rule carrying out proper UI modifications so that a patient can have a comprehensible view of his/her current health condition report even on a mobile device (i.e. much more simplified than the detailed/technical one provided to caregivers).

*Rules regarding motivation/reinforcement/health information*. They should improve elderly's motivation to follow healthy behaviour, an example is: IF <the elderly has not achieved a daily goal OR was not very active recently> AND <signs of user discomfort are detected> DO <send the elderly an appropriate message of encouragement>. In this case the system is detecting early signs of elderly's unhealthy habits (e.g. eating disorders in patients with diabetes): thus, the caregiver can set up persuasive messages to encourage the elderly to change their current lifestyle. Thus, by using our editor, effective messages can be identified by caregivers taking into account the intimate knowledge they have of people they care for (e.g. build messages evoking positive emotions if weight is lost).

*Rules regarding social interaction*. They deal with aspects related to user's social contacts and networks. An example is: IF <a social event of potential interest for the user is about to occur in elderly's house surroundings> AND <the level of social activity was low recently> DO <suggest elderly taking part in it>.

## Conclusions

In this paper we introduce a personalisation environment supporting customisation of AAL applications by end users[1]. The users of the tool are both elderly (having some familiarity with technology) and caregivers, who are facilitated in the management of typical tasks such as configuration of reminders, alarms, messages, prescriptions and monitoring functionalities.

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