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A User-adaptive Reminding Service

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Abstract. Applications of innovative technologies for elderly care in the home environment are gaining increasing popularity. A whole area of research investigates how to help older adults to maintain functional capabilities, to enhance their security, to prevent their social isolation and to support them in maintaining the multifunctional network of contacts. Particularly for people affected by a decrease in cognitive performance, cases of poor adherence to medical treatments are not uncommon, yet constitute a significant cause of physical deterioration and treatment failure. Some of the Ambient Assisted Living (AAL) tools contain functionalities to remind people to take their medications that are, usually, relatively simple time-based alarm systems that end up being not particularly effective. Their ineffectiveness can be sought in their reduced capacity to adapt to the different dynamic needs of individual users. This paper explores the possibility of designing personalized end-to-end services, giving special attention to user tailored reminding services that continuously adapt to the individual's needs. In particular the paper presents recent results from the GIRAFFPLUS project in which a basic reminding functionality is scaled up to obtain an adaptive version able to personalize the service to single users on the basis of the information continuously provided by a sensor network deployed in the living environment. The basic algorithmic aspects are described and working examples discussed.

Keywords. Ambient Assisted Living, Personalized Interactive Services, Long-term Data Monitoring, Older People Support.

1. Introduction

In parallel with the increase of life expectancy in recent years goes a growing attention on the topic of "prolonging independent living". Initiatives to use technology as a key element to support ageing well are manifold, most of which fall under the Ambient Assisted Living (AAL) area and the initiatives in this area funded by the European Commission. Goal of such investments is the development and use of new technologies to enable elderly and disabled to live better at home, improving their autonomy, facilitating daily activities, ensuring safe conditions, as well as monitoring and treating sick people. The widespread application of AAL technology could avoid, in many cases, the admission to hospitals or nursing homes, allowing a better quality of life and savings for the community.

Although following different paths and techniques, most of the AAL projects are concerned to acquire data from the environment and from users, taking advantage of

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the many sensors provided by the available technologies. Subsequently, the acquired data undergo some further elaborations that clean them up and propose an high level format to final users. In some cases a semantic abstraction is applied on raw sensorial data collected in the environments for example to recognise activities. In general the main goal of the systems remain the one of presenting information to some external observing users. More limited are the investigations to pursue a proactive role towards primary users for such systems. Examples of services have been restricted to simple tools having the goal to reminding important repetitive activities to be performed such as taking medicines. In general the studies aiming to customise autonomous activities into intelligent environments to enhance support toward the user (for example using any artificial intelligence techniques) have been very limited. In the majority of cases AAL systems are just passive tools to support healthcare professionals in carrying out their tasks, often simple and repetitive.

The GIRAFFPLUS project[2] [5] aims to develop and evaluate a complete system able to collect elderly daily behavior and physiological measures from distributed sensors in living environments, as well as to organize the gathered information, so as to provide customizable visualization and monitoring services for both the old person and the associated caregivers. Additionally the project has the ambitious goal to offer an infrastructure for performing realistic stress test for different types of intelligent services on top of a state-of-the-art continuous data-gathering infrastructure, including a consistent attempt to integrate personalised services. This paper specifically describes how initial interactive services described in [3] have been enhanced with news functionaries to create an instance of highly user-adaptable reminding services for continuous use inserted in loop with continuous data analysis.

The paper is organized as follows: Section 2 introduces the problem of personalised interaction and describes some of the current reminding systems; Section 3 contains an outline of the GIRAFFPLUS project providing a description of the interactive and personalization services provided by the current GIRAFFPLUS intelligent environment. Finally, Section 4 describes the adaptive reminding system we have developed and integrated in the system, introducing also some example of use. A concluding section ends the paper.

2. Personalized interaction and reminding services: related works

Since not all the individuals are the same, the need to provide personalized services has soon figured as a key aspect in the elderly care and, indeed, has been highlighted several times by the health care professionals involved in the GIRAFFPLUS project. The importance to reach an agreement with the elderly on which information can be shown, and who can access to them, is a critical issue to consider. More specifically, relatives are not supposed to know everything about older users life since elderly, understandably, may not want to easily give up their privacy [2,7]. Also, providing too detailed information to non-professional users may cause confusion in the data interpretation with possible unwanted consequences, such as exaggerated fright reactions, that can undermine the quality of life of fragile elderly users. In this respect, data presented to users should be customized according to the kind of information actually needed as well as depending on the user and his/her current needs.

[2] http://www.giraffplus.eu

As regards the interaction with the caregiver, it has been proved to be important to strongly consider the daily routine of the old person. More than current activities, it turned to be important to detect *deviations* in the daily behaviour of the monitored persons. Such changes in lifestyle may be symptoms of underlying problems that could require further investigation by medical staff. The significance of such deviations from the default attitude, can be detected automatically and can be used to prioritize primary users, offering to the caregivers those who are recognized as the most at risk before than the healthy ones. The automatic detection of those users who are recognized as at risk could significantly reduce the effort required by caregivers in performing daily health care activities.

On the other hand, an example of personalized interfaces towards elderly are the reminding systems. Most of the current reminding tools [1,8,10] have been developed mainly for reminding users for taking medicines. Periodically, these systems send a signal to the user, not worrying about his/her current status or possible changes that may have occurred since the service configuration. In the long term, these systems may become repetitive and tedious, with the risk for the user to ignore signals or, even, to leave them. An intelligent service, for instance, should verify the actual taking of medicines, decreasing with time the intensity of reminders and reintensifying them in case of need.

Literature presents many attempts to overcome these difficulties [12,11,9,13]. Although following different approaches, these context aware reminding systems slightly adapt to the current status of the user avoiding annoying situations (i.e., when the user is sleeping or at the phone) and/or choosing the most appropriate device for prompting (i.e., the closest one to the user). Predictably, these approaches are more successful than simple time-based reminders keeping the user affiliated to the system. However, at the best of our knowledge, none of these systems take into account the user's psycho-physiological state and, also, they do not adapt to possible changes of it. In other words, these systems are not able to proactively adapt new messages according to relevant changes occurring in the state of the users.

3. The GiraffPlus concept and current system

As said before, the work described in this paper is part of the GiraffPlus project. The general idea behind the project is given in Figure 1. The figure offers a conceptual schematization of the components of the system and allows to identify some key concepts relevant in our work and for the current paper.

First of all we can identify the human actors which are the target of the services given by the intelligent environment: (a) the *primary user* is the older adult living at home, mostly alone, that the system is supposed to actively support; (b) the *secondary users* are a network of people who participate in the support of the older adult from outside his/her home. Such users can be formal caregivers (a doctor, the nurse, etc.), informal caregivers (a son, generic relatives, etc.) or simply friends that want to maintain a contact with the old person.

The GiraffPlus system is basically composed by 4 parts: (1) a network of sensors deployed in the home that continuously gathers data; (2) a data management infrastructure that guarantees data gathering in a permanent data store or directly to some external user in real time; (3) a telepresence robot (the Giraff) that guarantees communication between people outside the house and the primary user inside the house, enriching the

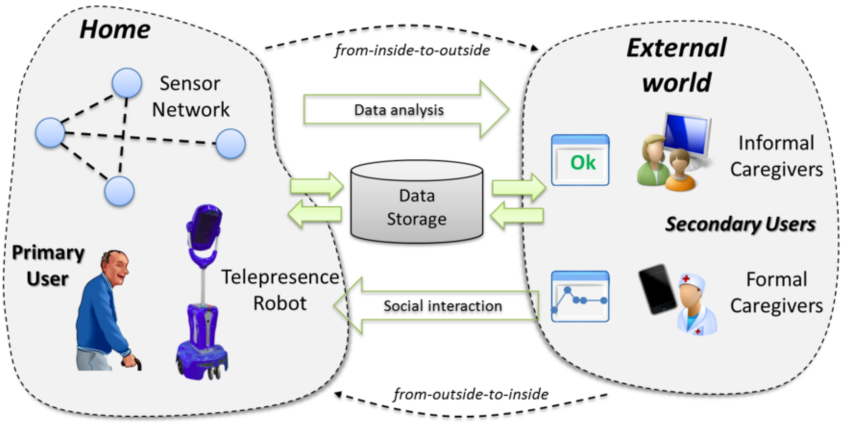

Figure 1. The GIRAFFPLUS project concept

dialogue with the possibility of moving in the home environment and performing visual monitoring through a camera connected to the robot [4]; (4) a personalizable interaction front-end that allows to visualize data generated in the house and, also, to call the robot from outside the house.

Given these ingredients, a key aspect for creating a useful tool for real people are the services that the complete system can deliver to the different users. More specifically, it is important to highlight that there are two different relevant data flows: from inside the house to outside, and viceversa.

If we consider the *from-inside-to-outside* flow we can say that mainly we are: (a) exporting data for a long term data analysis (storing them first in a data storage service). Notice that secondary users are usually heterogeneous people having different "social goals" toward the old person, hence a doctor may be more interested in physiological data and general information on the daily activities connected to health, an informal caregiver may be more interested in a daily report that says "everything is OK", "the windows were left open", etc. (b) exporting data for a real time use (hence, for example, for issuing alarms). Indeed, the system can rise alarms and/or send warnings, for instance, in case of falls or in case of abnormal physiological parameters. Here a problem exists of delivering them timely and to the right person.

On the other hand, if we explore the *from-outside-to-inside* path we can say that: (c) the communication through the telepresence robot is the basic media for social communication from outside into the house; additionally (d) having such a general set up, the system offers now a channel from secondary to the primary users for messages and reminders created through the visualisation front-end and delivered on the robot screen (also other media are possible but here we are focusing on the basic GIRAFFPLUS components). This information exchange is stored by the data storage service for subsequent analysis.

In addition, it is worth underscoring how there are also other services that are possible given the infrastructure in Figure 1: (e) long term data from the home sensor network are available in the data storage and can be also shown, after some processing, to the primary user; (f) having the home sensor network and a communication media in the home through the robot screen opens up the possibility of reasoning on those data and synthesize different messages (for the moment we assume precompiled messages) triggered by such a reasoning (for example, to react to some information contained in the data). Let us make a simple example here: if the elder likes the window shut by 9:00pm and one day the balcony windows are still open at 9:30pm we could deliver a message "do not forget to close the balcony windows, they are still open".

The messages and the information open up an interesting spectrum of possibilities that should be coordinated by some possibility of personalisation because different people would like different delivery of the information to each of the human actors connected to the dialogue with the GIRAFFPLUS system.

3.1. The @Office and the @Home services

The *Data Visualization, Personalization and Interaction Service* (DVPIS) is the part of the system responsible for the interaction with users in the large. As described earlier, this is the part that directly has in charge the user services, bringing data in the right form to each category of users. To this purpose, the project has developed two modules: the *@Office service*, devoted to the secondary users, and *@Home service*, dedicated to the primary users. The basic benefit pursued by the GIRAFFPLUS system is twofold: secondary users are supported by a flexible and efficient monitoring tool; primary users can access the information on their own health condition, enabling them to better manage their health and lifestyle. Both these modules are composed of a **back end** part, devoted to organize the content of the information to be shown to the users and to offer different services tailored to classes of users, and a **front end** part, responsible for presenting the information and services to the different categories of users.

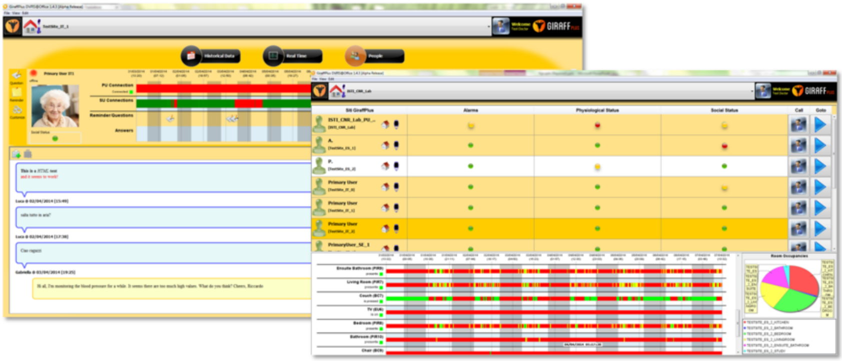

Figure 2. The Home Page of the @Office service and the environment for the network of secondary users and the primary user

In this section we mention some of the most relevant features that have been included in the more recent release of these services. Figure 2 (foreground) shows the layout of the home page of the @Office service. Specifically, the module contains a list of assisted user with a brief and immediate information on their status in terms of three main indicators: **Alarms**, **Physiological** and **Social** aspects. For each of such dimensions, an immediate feedback is given with a judgement on the level of each indicator (we will see soon how to compute these values): *green* = *good*; *yellow* = *warning*; *red* = *risk*. In this way a secondary user can easily and quickly judge if he/she needs to urgently intervene on some specific situations and in general he/she can modulate and prioritize the visit to the different patients thanks to an immediate feedback without the need of investigating for further details of each home.

Another relevant feature in the current version of the @Office module is the presence of a panel aiming at fostering the discussion among the *network of persons* related to a primary user. Specifically, the environment allows the different actors, involved in the care of a primary user, to exchange information and opinions so as to maximize the overall care for the old person at home. Figure 2 (background) shows this environment where both the primary user and his/her network of secondary users can share opinions and comments. Specifically, this environment represents a dialogue space to allow the social networking of people who assist the same primary user. Through this environment it is possible to exchange messages among a group of people or in a peer to peer modality. Additionally it is possible to send messages and/or set reminders to the primary users at home that will be delivered through the Giraff telepresence robot as we will show in the next section.

As mentioned before, the data gathered from the environmental and physiological sensors can also be shown to the old user at home. This is done according to the ethical principle that the primary user, as "data producer", should maintain a level of understanding on the GIRAFFPLUS operations. Such functionality is currently obtained enlarging the capabilities of the telepresence robot. In fact, we decided to use the telepresence robot as a means to provide services to the primary users and this is also in line with what emerged from the feedback gathered during iterative evaluation sessions.

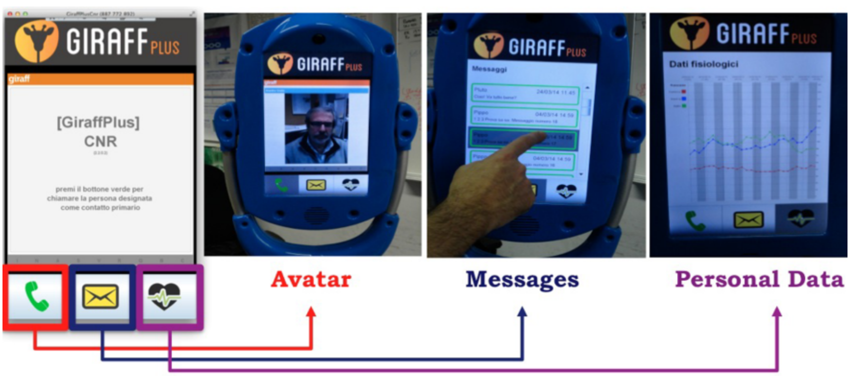

Figure 3. The @Home service

The @Home module has been endowed with a sub-component dedicated to the visualization of this data toward the primary users. Figure 3 shows the main services provided to primary users through the @Home:

- *Avatar*: this functionality preserves the "traditional telepresence" service that the Giraff robot provides. The Giraff application has been indeed embedded within the @Home module so as to maintain the possibility for secondary users to visit the older user's apartment through the telepresence robot.
- *Messages*: an additional environment has been added to allow the primary user to receive messages from secondary users or reminders and recommendations. Messages and reminders are provided in both textual and spoken form. Specifically we have developed a message listener that collects messages coming from the middleware and gathers them with a specific panel that "mimic" the functionality

of a mail client or a messenger on a smartphone. In addition to adapting the font size to the user we have decided to integrate an off-the-shelf text-to-speech translator to give the user the possibility to "read aloud" the messages and to re-read them again and again (most older adult have sight/hearing problems).

– *Personal Data*: this environment is intended to allow primary users to visualize personal data (e.g., physiological measures) and, more in general, to endow the system with a shared space between the primary user and the secondary users that could foster a discussion on the health status and habits of the old person. The general aim is to improve his/her awareness and also to encourage responsible behaviors for increasing his/her well being. The idea is that a secondary user (e.g., an Health care professional) calls a primary user via the Giraff robot and then uses this environment to discuss about the health related data to both explain them to the assisted person and possibly deepen the understanding of them through questions to the old person.

It is worth emphasizing that this module has been produced according to the user requirements elicitation and a first run of evaluation in real homes. The complete GIRAFFPLUS system, indeed, has been deployed in six test sites, specifically 2 in Italy, 2 in Spain and 2 in Sweden, which are been active for some months now. We are starting now a more intensive evaluation, both within the test sites and with ad-hoc evaluation sessions in the lab, in order to better validate the current achievements and to receive additional feedback for further improvements.

4. Adaptive Reminding in GIRAFFPLUS

In addition to the data visualization service described above, another aspect of the GIRAFFPLUS system is the provision of personalized and proactive interaction services. The DVPIS back end is indeed responsible for preparing the "personalized information to the users" and for offering support for different types of services like *reminders*, *reports*, *proactive suggestions*, *warnings* and *alarms*. This section describes an instance of a reasoning service provided by the GIRAFFPLUS infrastructure that can be considered as an example of the personalized services for users. By reasoning on dynamic parameters of the primary user, we pursue a "proactive reminding" service modulated by the user model information. The broad idea is to create a proactive service at home, by reasoning on user personal data and modulating system messages, directed to primary users. The possibility to deliver "system generated" messages to the primary user through the @Home interface is a basic enabler.

The monitored features are a combination of: (a) a *static user profile*, considered immutable during the care process, describing not only general data (e.g., his/her age), medical condition (a chronic disease), but also his/her attitude toward interaction and technology (for example, these are used to avoid flooding a person with undesired information or recommendations he/she is not willing to accept); (b) a *dynamic user profile*, whose components are extracted from the physiological monitoring and other continuous data flows. (c) an *internal status*, determined acting on the user profiles by performing a classification process and used to trigger planning of stimuli toward the involved users. This classification, for example, identifies the set the "color based" indicators previously shown in Figure 2. The status of such indicators is again a trigger for a strategy to decide which messages and appropriate frequency should be selected for the users. For example observing value transitions (e.g., when the physiological status change from good to warning) we can send simple questions like “have you taken your daily pill?”, or issuing dietary suggestions like “avoid salt while cooking”. These alerting messages can be sent, more or less often, both inside the house, to reassure or advise the primary user through the telepresence robot, and outside the house, to send an alerting message to a designated care person, etc.

This kind of behavior is obtained by exploiting a particular temporal planning approach, known as timeline-based (we will adapt terminology from [6]), which allows us to easily depict information in time, enhanced with a classification system, which enables us to include complex domain knowledge inside the system, as described in the following.

4.1. User modeling and timelines

A *timeline* is, in generic terms, a function of time over a finite domain. Events on timelines are called *tokens* and represent information units over temporal intervals. For this purpose, tokens are represented through predicates extended with extra arguments belonging to the Time domain $\mathbb{T}$ (either real or discrete).

Definition 1. *A* token *is an expression of the form:*

$$n\,(x_0,\ldots,x_k)\;@\;[s,e,\delta]$$

where n is a predicate name, $x_0,\ldots,x_k$ are constants, numeric variables or object variables, s and e are temporal variables belonging to $\mathbb{T}$ such that $s \leq e$ and δ is a numeric variable such that $\delta = e - s$. A token $n\,(x_0,\ldots,x_k)\;@\;[s,e,\delta]$ *asserts that $\forall t$ such that $s \leq t \leq e$, the relation $n\,(x_0,\ldots,x_k)$ holds at the time t.*

Given the mutable nature of the user dynamic information and of their classifications in time, we have addressed the user modeling problem by making use of two timelines for each primary user that represent, respectively, their dynamic information and their current internal status classification. The use of different parameters allows to model different aspects of the dynamic information (such as current physiological parameters) and user profiles (such as current social profile, current physiological profile, etc.).

Figure 4 shows the personalization timelines of a sample primary user. In particular, in the sketched example we have used: (a) a predicate *StaticProfile* (age, cc, pt)[3] to represent the user static profile (characterized by *age*, *chronic condition* and *personality trait*), (b) a predicate *DynamicProfile* $(sbp, dbp)\;@\;[s,e,\delta]$ to represent dynamic features (characterized by *systolic blood pressure* and *diastolic blood pressure* from time *s* to time *e*) and (c) a predicate *Internal Status* $(ps, ss)\;@\;[s,e,\delta]$ to represent the user classification (characterized by *physiological status* and *social status* from time *s* to time *e*).

Following the representation in Figure 4 it is possible to notice how the changing of the user’s dynamic information, in particular his/her blood pressure, is associated to a change in his/her physiological status resulting in a transition from *good* to *warning*. This transition can automatically trigger a message to the primary user such as “did you take the blood pill today?” as we were mentioning before. In general state transitions can make the system recognizing dangerous situations and requiring a more significant

[3] Since this feature is constant in time, its timeline never changes value hence the predicate has no temporal arguments.

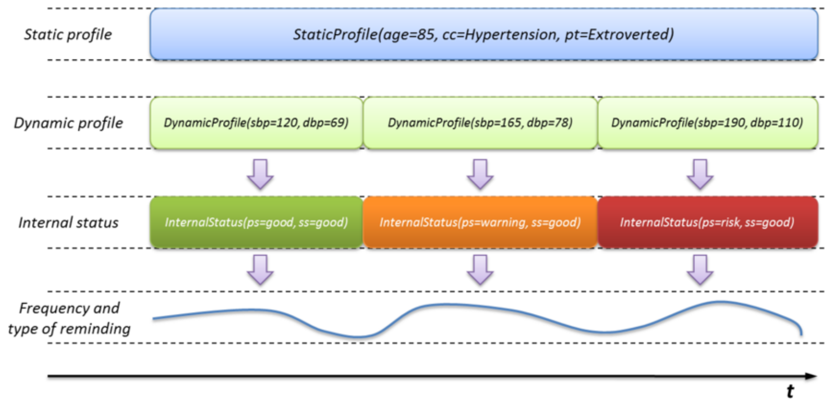

Figure 4. User modeling through timelines

intervention sending, for example, a reassurance message for the primary user together with an alert for the associated caregiver describing the current status of the old person.

This kind of "rules of behaviour" are generalized in a concept usually called *compatibility* (the causal knowledge in temporal planning).

Definition 2. *A* compatibility *is a tuple* $c = (name(c), R(c))$*, where:*

- $name(c)$ *is the* master *(or* reference*) predicate and is an expression of the form* $n(x_0 \dots x_k)$*, where n is a unique predicate symbol with respect to a timeline (i.e., no two compatibilities in a given timeline can have the same predicate symbol), and* $x_0 \dots x_k$ *are its associated variable symbols.*
- $R(c)$ *is a* requirement*, i.e. either a* slave *(or* target*) predicate, a constraint among predicates or a conjunction of requirements.*

Compatibilities define causal relations that tokens should comply to in order, for the plan, to be valid. Specifically, predicates can be used to represent specific events such as profile/status transitions, primary user's answers to specific questions, environmental configurations, etc. By adding slave predicates to compatibilities and by temporally constraining them it is possible to associate complex consequences to such events, up to enable the system to automatically follow the rehabilitation process associated with a therapy established by the caregiver. Once one of these events occurs, the associated compatibility is applied generating new stimuli for the old person such as new messages and/or new reminders. The timeline-based technology will be responsible for placing these stimuli in time and for dispatching them when the moment comes. Compatibilites can be defined by secondary users by means of a simple editor provided by the @Office service allowing the GIRAFFPLUS system to be tailored to specific needs of different caregivers.

An example of constraint among predicates that is worth to be described is the one that links static parameters and dynamic parameters with the internal status of the user. In order to achieve this elicitation, the current implementation makes use of *naive Bayes classifiers*[4] for extracting different features of the user profile. We have seen that this kind of classifier performs quite well with the training data set currently provided by

[4]Simple probabilistic classifier based on applying Bayes' theorem with strong (naive) independence assumptions.

caregivers. Furthermore, these classifiers can handle numeric parameters thus allowing us to include temporal aspects inside the classification (e.g., the social status could make a transition from "good" to "warning" in case the social interaction with the primary user does not occur for a long time). Although the collection of this data is still an ongoing process, we have been able to gather different training sets for different classifications.

As an example, in order to clarify this aspect, physiological classification follows a schema like $\langle age, cc, ms, bphour, sbp, dbp, hr, class\rangle$ associating the parameters *age*, *chronic condition*, *taken medicines*, *blood pressure measurement hour*, *systolic blood pressure*, *diastolic blood pressure* and *heart rate* to a *class* having values among "good", "warning" and "risk"[5].

4.2. Putting personalized reminders at work

The high-level interpretation of raw data provided by the sensors in the past, carried out thanks to machine learning techniques, combined with the ability to generate stimuli in the future, put into effect by the planner, enables us to model all the interaction elements required by a complex AAL system like GIRAFFPLUS. The combination of these two aspects allows the GIRAFFPLUS system to have an accurate understanding of the environment in which the intelligent system acts and, simultaneously, to produce a plan of interaction with users, reacting (or adapting) to any change in the environment.

A step by step example may help to clarify the underlying reasoning process that we have implemented. Let us suppose we are taking care of an 85 years old person suffering from slight hypertension and, for this reason, taking some diuretics (this situation is the one described in figure 4). Since the old person is forgetful, the caregiver has activated on the GIRAFFPLUS system a daily reminder for remembering him/her to take the diuretic pill [6]. The resolution process analyzes the new incoming goal applying the associated compatibility and thus producing the reminders and placing them in time. As long as the situation remains stable, the caregiver can skip the visit to the old person reducing his/her required effort in carrying out daily activities.

A first example. Now suppose the primary user measures his/her blood pressure obtaining dangerous levels like 190 for systolic blood pressure and 110 for diastolic blood pressure. A change in the dynamic profile of the person is assessed resulting in a new goal for the planing process. Now, the compatibility associated to this profile change "constrains" the Bayes classifier (considering both static and dynamic parameters) to conclude that the user is in a risky state. Again, a "risk" value is enforced on a new token for the internal status timeline (having a predicate such as $InternalStatus\,(ps = risk, ss = previous\_value)$) requiring the application of a new compatibility and thus resulting in the generation of a reassurance message, sent by the telepresence robot, to the old person (e.g., "You're fatiguing too much, rest a little"), as well as an alerting message for the caregiver, sent by different communication channels such as mails, mobile messaging tools and @Office service, describing the current status of the old person and possibly fostering the user to take some action.

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[5] An instance of training data, corresponding to the "risk" state of figure 4, is $\langle 85, \text{“}Hypertension\text{”}, \text{“}Diuretics\text{”}, \text{“15 : 30”}, 190, 110, 80, \text{“}risk\text{”}\rangle$. A similar instance would produce an alarm for the caregiver.

[6] GIRAFFPLUS allows this by creating a *goal* having an associated compatibility whose requirements represent a reminder for each of the days the therapy lasts as $\{rp : remind\_pills, at\,(rp, 10:00)\,, period\,(rp, 1day)\}$.

At this point, it is up to the doctor to take the right (and prompt) decision. Supported by historical data of the old person provided by GiraffPlus, the caregiver could change the therapy associated to the elder, maybe, prescribing some beta-blockers. It is worth noting how the whole service is based on the other layers of the intelligent environment that are currently deployed and a combination of reasoning techniques that allows to create a new reminding service that goes beyond the simple "message for pill" which is part of almost all the AAL systems. This stimuli modulation technique is quite general and can be used in various active ageing scenarios.

A more complex example. Since the GiraffPlus system is highly customizable, it allows us to explore several different possibilities. When no relevant activity is triggering any planning process, a periodic timer updates the current status of the user generating statistics on common activities that can be analyzed and exploited to foster different forms of reasoning. This process allows the extrapolation of information on the user's social status and/or information about deviations in the daily behavior of the monitored person.

Let's suppose, for example, that the primary user usually tends to be extroverted and thus socially active. Suppose also that the telepresence robot usage statistics show a reduced use of robot during the last days. This fact highlights an anomalous deviation from the default behavior that could be a symptom of some underlying problem and which, at least, should be further investigated by caregivers. Just like in the previous example, this statistical data constitute an input for a "social" classifier. Since a reduction in the social activity of the old person may very well be linked to temporary minor problems, the system classifies the internal status as a social warning, resulting in a new goal for the planner. The replanning process is than triggered and a new compatibility is applied which, in turn, generates a support message to the old person by the telepresence robot (e.g., "Did you called your grandchildren today?"). With a similar reasoning, if the isolation of the primary user continues to persist even after several days, the system could classify the person as socially risky, exhorting the person to communicate with relatives and/or friends on a daily basis through daily reminders and, possibly, also sending a warning message to the associated caregivers, describing the current status of the elder.

5. Conclusions

This paper introduces the user-adaptable reminding service of the GiraffPlus system. The paper describes the current @Office and @Home services, responsible for the interaction with the different users, with a particular attention to their back-end modules, in charge of organizing the data and providing personalized services to the different users.

Starting from the basic services we have created the adaptive reminding service integrating some artificial intelligence tools. It is worth underscoring how the use of artificial intelligence techniques allows to filter out most of the useless reminders focusing only on the most important messages, producing a less invasive technology that does not bore the user but which, however, is able to intervene when risky situations are detected by sending warning messages to the appropriate people and/or modulating reminders toward users. Although the secondary user still remains the ultimately responsible for the care of the elderly person, his/her workload is lightened thanks to the classification of primary users that provide an immediate sight of the status of the elders, yet allowing standard AAL tools for data analysis for a more accurate understanding of the activities carried out by the primary users.

The GIRAFFPLUS intelligent environment has been currently deployed in six different homes (2 each in Italy, Spain and Sweden) and the number of how will be further enlarged with nine additional test cases. The adaptive reminding is currently under test in a laboratory installation. One of the next steps will be to perform a deployment it in a living laboratory (a house with real people we use for technology experiments), according to results we will deploy in the real test homes.

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