

Personalizing Support to Older Adults who Look for a Job with the SpONSOR Platform ^{*}

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Abstract. Nowadays the loss of job of people close to retirement and in general in old age is a reality shared by many European countries. This condition causes serious difficulties for older employees when returning to the job market and inevitably leads to a deterioration of their emotional state and well-being. On a different perspective, following the concept of active aging, the fact that older people continue to perform volunteering activities exploiting their skill and abilities is extremely positive for their well being. Volunteering job is, however, known for being very volatile and dynamic with people leaving activities, often, after a relatively short period of time. The SpONSOR project tries to help this particular segment of population by creating a platform that facilitates the effective match between demand and offer of work integrated with services particularly tailored for older people. A specific contribution is related to the personalization of support to workers obtained by specializing plan-based technology to generate interactions over time able to adapt to users and give them a sense of care. The paper contains an overview of the project by presenting hints from the user requirements analysis and an overview of the software architecture. Additional details are given on a module called “Personalized Interaction over Time” (PIT) dedicated to synthesize tailored suggestions for users during their long lasting interactions with the software platform.

1 Introduction

The *Active and Assisted Living* (AAL) Joint Program is a European funding initiative aiming at promoting the synthesis of new ICT solutions for supporting

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people to age well. The program (active since 2008 with the previous extended name of *Ambient Assisted Living*) is now strongly focusing on the fact that older adults should remain active as long as possible in order to preserve their role in the society longer. The annual Call number 6 (2013) for project proposals specifically asked for “the development of ICT-based solutions which enable older adults to continue managing their occupation at work in an office, in a factory and in any working environment; in a first or subsequent career, in paid or voluntary occupation including local social activities while preserving health and motivation to remain active”. Additionally, the specific call was looking for solutions that promote, enhance and sustain:

- paid activities (including for example professional, entrepreneurial/small business and self-employment)
- unpaid activity (e.g., volunteering, knowledge sharing, counseling).

Today’s older adults have a positive self-image and bright expectations for their future. Some of them would like to continue working, preserving room for leisure time; some intend to increase their voluntary engagement, while others wish to change their field of activity and take up a completely new profession or career. Yet, in many cases, the active older adult is still confronted with a “deficit model of age” that – often unsubstantiated – assumes that occupational efficiency and general learning ability decline with age. This implies that older adults are less innovative, less productive and less able to work under pressure than their younger colleagues.

The SpONSOR project is one of the selected proposals for the above-mentioned call. The project aims at developing, testing and implementing an ICT platform that facilitates the posting, browsing and exchange of key information between competence-offering seniors and search-based requests, from competence-demanding organizations from the public, private and voluntary sectors. SpONSOR aims at enhancing senior persons’ access to a wide range of occupational positions



Fig. 1. An initial view of where the SpONSOR platform is expected to work.

meeting, in this way, the aims of the Call. The initial schematization created in the project is given in Figure 1. The perspective taken is the one of supporting Organizations that favour occupation (upper part of the figure) creating a software platform that facilitates contact between people who offer their work and people in need of support (lower part). Indeed during the development of the project we have particularly focused on the relation between producers of work (the Organizations) and the consumers (the older workers). The third group of people (those in need for a work support) will be de-facto integrated inside the role of the organizations.

Additionally, from the user requirement analysis it clearly emerged that losing job when at an higher age is really problematic. The older people feel abandoned, marginal in the society and at high risk of depression. One of the characteristics that emerged from user requirement analysis is the need for functionalities able to give the sense of continuous assistance to people when they interact over time. In the paper, after a general presentation of the project, we specifically report on some personalization characteristics that we have added using intelligent interactive technology based on a plan-based internal representation.

2 User Requirement Elicitation

The first step for user requirement elicitation envisaged a study of the state of the art with the main aim to investigate the existence of any sort of previous platform designed with the same intention of SpONSOR. Further efforts have been spent in order to get in contact with users and associations involved in seeking occupation opportunities for seniors in the countries partners of the project (Italy, Luxembourg, Switzerland and Ireland).

State of the art

Within the European landscape, some realities exist whose aim is to foster the exchange between demand and supply specifically among seniors. Some of them did not have success, but all of them can provide valuable suggestions for SpONSOR. Some example are the following:

Competence-senior.com The company Competence seniors Sàrl, based in the Canton of Geneva, created a website [2] in support of their mission to facilitate senior employment, providing space and profiling options for posting *offers* (seniors proposing their competences or searching for job positions) and *demands* (organizations proposing job positions), with some advisory indications and a press release section as marketing extension. The whole website was functioning as a profiling and match making mechanism for advertisements, which was supposed to facilitate, on both sides, successful job search/job recruitment options. Unfortunately, this association shut down the website in 2014 because of a low number of users.

RetiredButAble.com The website Retiredbutable.com provides for the UK territory a profiling and posting service supporting senior work with a huge list of service categories and preemptive geographical requests. It is also “Facebook active”. The website [8] started very well, attracting a lot of postings, but ending up in rather poor search results, and after a few months, the number of postings gradually decreased.

SeniorsAvotreService.com This new portal [10] seems to be supported by a lot of institutional and even political alliances and, as a matter of fact, shows a lot of hits. It looks promising, slightly more appealing than Competence-seniors.com while encompassing a broader set of options from micro-trading

options to job positions. It presents some stimulating posting examples (and also a very “French-focused” job-related advisory check list).

From the experiences described above, we can assume that (1) some match-making capabilities are necessary, but (2) they have to be produced within a stimulating in-flow of senior- and occupation-relevant information, including linkages with social networks, (3) they have to be open to a wide variety of occupational forms, (4) they have to be mediated by organizations dedicated to support these activities and the possibility for seniors to be involved, and (5) they have to incorporate provisions for iterations, examinations of alternatives, adaptations and updates, evaluation and mentoring regarding the output of the types of match-making processes.

Other platforms do not perfectly fit with the SpONSOR aims, but are worth being mentioned. **Give&Take** [5] is an AAL project which tries to facilitate service exchange among seniors, with quite a complete match-making capacity through a digital platform, creating new opportunities for senior citizens to contribute to the society as volunteers and caregivers in their local communities. In the same perspective, we can also mention a platform aimed at facilitating, within the French-speaking constituency, forms of activities of many kinds for seniors willing to share their interest with others: **Quintonic** [7]. These two examples are not as ambitious, from the job focus perspective, as SpONSOR, but they are nevertheless providing a match-making mechanism, with supportive services and, in the last case, a rather appealing interface. They have been, therefore, a source of inspiration for SpONSOR. Finally, although they are not strictly senior-oriented, there are two reality worth to be mentioned. **Vicker** [12] is a new Italian service that is active since early 2016 and is growing up at national scale. It is a platform for Computers, Smartphones and Tablets that allows people to find a service provider on one side, and to offer their own competence, on the other. It specifically supports the exchange of one-shot jobs among citizens by ensuring competence, and safety and fair payments. Service beneficiaries can also provide feedback to their providers in order to foster their skills upon the platform. Finally, **TimeRepublik** [11] is a platform, active at international level, which fosters the exchange of services among people with the peculiarity that the trading currency is represented by time (TimeCoin) instead of money.

User involvement

Beside the analysis of the state of the art in terms of existing solutions, an additional effort has been carried out in order to get feedback from users. Focus groups and semi-structured interviews have been organized around a guided discussion on post-retirement jobs, meant both as paid and volunteering activities, that involve old people. Users who could possibly benefit from the SpONSOR platform have been involved in order to get their opinion on the services that the platform should provide and to collect the perspective from users on their needs and what are the characteristics of the system. Additionally, also jobs for those who are near retirement and have lost their job has been considered as a topic

addressed within the focus group since this kind of users could also represent possible beneficiaries of the platform.

Participants have been recruited among: (1) associations aiming at fostering active aging for retired persons; (2) associations with the aim to support older adults in finding jobs in order to reach the retirement age; and (3) elderly communities. In total, 50 members from 21 associations among Italy (Figure 2),



Fig. 2. Pictures from the focus group in Italy for the user requirements elicitation.

Luxembourg, Ireland and Switzerland have been involved in this preliminary investigation. Participants have been asked about the associations they belong, so as to get a better understanding of their mission, and about the idea of post retirement (or near too retirement as well) occupation, in order to understand the difficulties and the related needs.

Moreover, participants have been exposed to the scope of the SpONSOR project and encouraged to investigate possible ways to overcome difficulties and the emerged needs through a digital platform.

Indications for developers

In order to produce effective indications for the developers, the transcriptions of focus groups has been subject to a critical analysis with the aim to synthesize a detailed list of user requirements. The whole amount of works carried out in order to analyze the user requirements coming from focus group is deeper described in [9]. This section attempts to summarize the most interesting findings. It emerged, indeed, that the SpONSOR platform should necessarily address key requirements in the following areas:

Profiling of users competences. *User profiling beyond professional qualification:* SpONSOR is supposed to support user profiling by including more than formal aspects as educational qualifications. Skills and competencies acquired beyond the professional background have to be taken into account, as well as social skills. *Intelligent analysis of user's competence:* SpONSOR should offer a service that supports a “human selector” to better analyze the user's competences in order to provide an optimized matching with vacant activities/jobs by, for instance, showing different aspects of the persons that could fit with a range of jobs.

Privacy and Ethical issues. *Ensuring of not discriminatory announcements:* SpONSOR should rely its reasoning and criteria for the matchmaking on individual skills and competences or any similar valuable characteristic linked

to the person and not on discriminatory factors like age, gender and race. *Privacy on sensitive data:* SpONSOR must apply all the needed procedures to keep sensitive data protected and disclosing its protection scheme to the users. *Security Clearance:* SpONSOR should indicate whether police vetting is required for a position and/or a project, and how to go about getting it.

Profiling of job opportunities. *Efficient and effective categorization of roles representing job opportunities and actual tasks to be performed:* SpONSOR should be able to classify required roles in order to facilitate matchmaking with user profiles based not only on educational qualification, or professional background, but also on other skills and competencies of the person, as well as on other personal characteristics. *Assistance, guidelines to define profiles:* SpONSOR should provide a service giving a methodology, tips, pitfalls to avoid and reference cases for profiling issues. *Help in orienting the users seeking a job:* The platform should be organized in a way that the persons receive support to find the roles that better fits his/her competences/qualities/talents. *Include an expression of interest form:* SpONSOR should allow people to express their interest in a particular job/advertisement or declare (occupational) areas of interest, even if they have not been matched to it.

Usability, accessibility and portability. *Simple and easy terms:* The SpONSOR platform should use simple terms since it has to be used by non expert users. Whenever possible, technical terms have to be avoided, *Portability:* SpONSOR should be available for use on different devices (smart phones, tablets are seen as the best solution but also PC application versions should be available). *Accessibility:* SpONSOR should make it possible for seniors to easily read the text on web site. (i.e. proper font size).

Social Interaction. *Implementation of a forum for exchanging information:* SpONSOR shall provide the possibility to the subscribers, individual or collective, to interact with each others. A dedicated space within the platform where users can exchange information, including experience, best practice suggestions on specific topics and also areas of interest is needed. *Provision of services linked to communities:* SpONSOR shall organize services on local basis or facilitate ways of already existing local community support forms. The territory is based not on political boundaries (i.e. municipalities), but on social boundaries (i.e. communities, people networks).

Metrics and Validation. *Assessment of the level of update for each job advertisement:* SpONSOR should allow monitoring how long each advertisement is active on the platform and provide a clear feedback if the job is still vacant or not. *Successful matchmaking rating visualization:* SpONSOR should provide the possibility to track the success of matchmaking between demand and offer. *Feedback to job respondents:* SpONSOR should allow the organization to provide feedback to any person who has applied for a job at any stage of the recruitment process, i.e. expression of interest, informal chat, and interview.

The above mentioned requirements represent operative indications for the platform developers in order to design an ICT solution by accomplishing with users' needs and suggestions. Nevertheless, it is fundamental not to lose some insights coming from the meetings with the senior-oriented associations. Actually, in most cases the associations already rely on any sort of matchmaking solution, digital or manual, in order to recruit people and, because of this, they have been able to provide useful suggestions with regard to this function of SpONSOR, in terms both of what can be useful and what should be avoided. Nevertheless, interesting reflections emerged referring to a portion of population which results to express peculiar needs beyond the mere service of matchmaking.

The personalization issue

Although the involved associations are engaged in different areas with retired or near-to-retirement people, the manifested needs barely differ according to their specificity, and a pervasive need of personalized services emerged in all cases. In fact, the user requirements claimed for an ICT solution able to adapt, throughout time, according to individual and contextual changes. A common element that emerged from user requirement gathering is the fact that the SpONSOR platform should provide personalized services according to each single user specificity and dynamically interact with the users by adapting to different personalities and preferences. This should represent the main characteristic which makes SpONSOR the successful solution beyond the state of the art. In fact, this platform should be a means through which the senior is able to leverage on his/her individual characteristics and aptitudes, beside skills and learned competences. On this basis, SpONSOR should be able to provide personalized services to the person by fostering the motivation of pursue a goal, namely finding an occupation. In this perspective, it becomes crucial the possibility to provide SpONSOR with proactive capabilities and the possibility to modulate through time its behavior according to upcoming environmental events or changes in the users status and preferences.

3 The SpONSOR Architecture

The analysis of the user requirement has led to the definition of a software architecture able to supply the required services to the different users. Specifically, the different components are glued together in an high level architecture that supports the scenarios emerged from the elicitation of the user requirements.

A first distinction worth being captured concerns the different SpONSOR users (see Figure 3). The intelligent environment offers services to different targets. Specifically, the involved actors are: (i) **Main Users (MU)**, senior-supportive organizations which have all sorts of name. Such organizations include public and private agencies, NGOs and local associations. In order for being qualified as being part of this category, organizations must just involve some certain

level of institutionalization (formal membership or legal framing), a clear mission of support regarding seniors and some experience already in that respect on which we can build. Such organizations may make use of senior occupation one way or another: for example, they can be private firms looking for specific kinds of employees.

(ii) **Subsidiary Users (SU)**, Seniors themselves, envisaged as (not being “organization-related”) individuals, who in the experimental build-up of SpONSOR, played a specific catalyzing role for the progression of the project and are of course, in spite of the organization channel chosen to develop SpONSOR, always legitimate for a direct access to the platform.

The seniors should always be the real beneficiaries of SpONSOR support, but in order to be able to fulfill that capacity, intermediate steps have to be explored and experimented, involving all sorts of senior-supportive organizations.

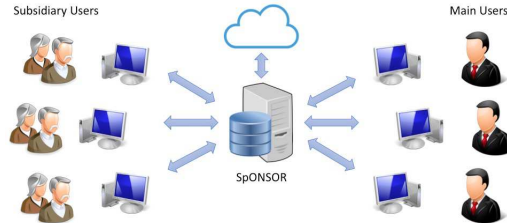


Fig. 3. The different users of the SpONSOR solution.

In addition to the above mentioned users, some intermediaries have developed quite sophisticated means to match user profiles for different demand-and-offer configurations, and some of them might become useful “stakeholders”, however, their status regarding “usage” has still to be defined (partners, advisors?). So far, we have found intermediaries in the job mediation portal business, in the consultancy arena and also in the umbrella company sector (or other forms of work support mediations). Others may still come up during the duration of the project. Among additional interesting users worth considering, let us highlight those involved in co-working and micro-trading activities, to which senior-supportive or senior-sensitive organizations, as well as non-affiliated individual seniors may be related, thus allowing, provided we gradually integrate this category of users and usages, covering quite a large spectrum of domains, talents and services. These users are not the main target of the SpONSOR definition and development phase, but they may come into the picture as the platform gets more consistent.

Summarizing, although SpONSOR claims to be useful for many categories of stakeholders, it is worth highlighting that Main Users (MU), namely, senior-supportive organizations of all kinds, and Subsidiary Users (SU), namely, individual seniors willing to use SpONSOR, are the main target actors of the project and, therefore, of the SpONSOR platform and its services. Nonetheless, the architecture is readily adaptable to other types of users as, for example, tiers 2 (formal carers) and tiers 3 of all kinds (including “non senior” individuals, asking for services which seniors may possibly deliver, thus functioning as subsidiary substitute of a formal job offering organization) may be useful and supportive, even though they may be indirectly benefiting from SpONSOR platform services

(provided, of course, that they are concerned by senior occupation support one way or another). Such users might be allowed to perform the same operations as subsidiary users and, in addition, similarly to main users, they can manage their associated users (members).

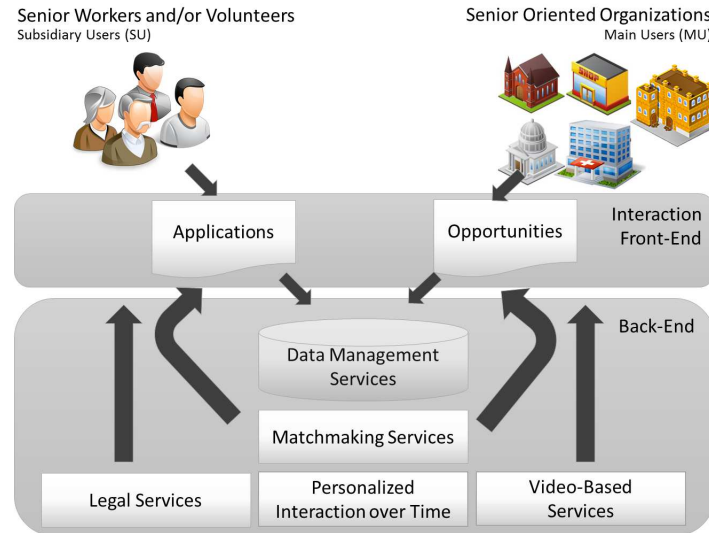


Fig. 4. The SpONSOR architecture.

Once described the possible users to which the solution is addressed, we deal with the high-level architecture of the SpONSOR system. To facilitate reading, in Figure 4 we identify two main subparts:

SpONSOR Front-end representing the parts that directly interact with human users (both main and subsidiary)

SpONSOR Back-end containing the *intelligent* modules of the system that guarantee added-value services.

In the simplified representation of Figure 4 we see the main information streams in SpONSOR: the Organizations *post* Opportunities while the potential Workers (or Volunteers) *post* applications for certain Opportunities. These two basic interventions become part of the data management services. This basic data store service is then manipulated by specialized SpONSOR modules: (a) the *Matchmaking* facilitates the Opportunities/Applications matching offering a first level of suggestions to the Front-End functionalities; (b) the *Personalized Interaction over Time* is a module responsible for enriching interaction with the user (at present, mainly, the workers); (c) the *Legal Services* is a module that flexibly supplies information of the legislations in different countries situated with the particular job opportunity considered in an interaction; (d) the *Video-Based Service* is a specialized module aiming at facilitating the CV entry by Workers as well as the Organizations' descriptions. For the sake of space, modules (c) and (d) are not part of this paper description.

Addressing more technical issues, the main software interfaces, which allow information interchange between the two sub-components, are (see Figure 5): a **BackEndAPI**, allowing the software clients to create, read, update and delete “content”, a **ProfileAPI**, allowing the software clients to update users’ profiles, and a **NotificationAPI**, allowing the software clients to produce notifications to be displayed, following a push strategy, on the SpONSOR website. In the following, we detail the sub-components of these two main modules, linking them to some usage scenarios and, consequently, to the user requirements.

From a technical point of view, it is worth noticing that both the **BackEndAPI** and the **ProfileAPI** can be accessed by the front-end side either for retrieving data or for notifying updates to data. For this purpose, these software interfaces have been implemented by means of *web services*, allowing, among other things, a simple extension to other media such as, for example, smartphones and tablets. On the contrary, the **NotificationAPI** is intended to produce events that should be captured by the users through a push strategy, that is, without the need for the users to reload web pages. To that end, we opted for a *WebSocket* based technology which, among other things, allows real-time messaging capabilities.

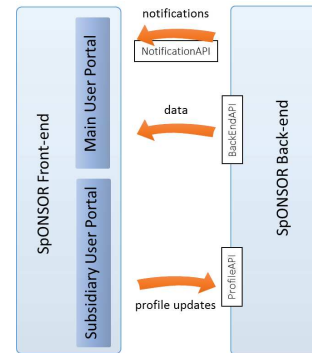


Fig. 5. Basic front-/back-end data exchange.

SpONSOR Front-end

The main user interface (or front-end) for the different users is constituted by the SpONSOR Website (top side of Figure 4). From an architectural point of view, it is mainly composed of two different subcomponents representing two distinct, although following an uniform schema, websites: (a) the **Main User Portal**, dedicated to Main Users, and (b) the **Subsidiary User Portal**, dedicated to Subsidiary Users. The content of the two portals is retrieved by the back-end, following a pull strategy, through the **BackEndAPI**. Specifically, when a user accesses the SpONSOR front-end, the system makes requests through the **BackEndAPI** for retrieving data stored by the back-end component. In addition, the **BackEndAPI** offers services for creating, deleting and updating content. Among the content that can be managed by the SpONSOR system we find users, messages, job offerings, training offerings, volunteering offerings, recreational activity offerings, job interviews and many others, like legal advisory contents, for instance.

When accessing the SpONSOR website, the web application retrieves initial, relevant and common interest information by the back-end in order to encourage visitors to subscribe to the system. Whenever a new user decides to subscribe to the system, the **BackEndAPI** is invoked by the web application for retrieving subscription options and, once the user has chosen his/her available roles, the information is communicated to the back-end for the persistent storage of the

new user related information. In addition, the **BackEndAPI** also provides an interface for basic communication, allowing the retrieval of stored messages as well as sending new ones, for example, for mentoring purposes.

The **BackEndAPI** constitutes the main entry point for managing different kinds of content. Through the **SpONSOR** front-end, the main users use the **BackEndAPI** for creating different kinds of opportunities (e.g., job offerings, volunteering offerings, training courses, recreational activities, etc.), for managing applications and job interviews as well as for managing their associated users. Similarly, through the front-end, subsidiary users might check for available opportunities (e.g., job offerings, volunteering offerings, training courses, recreational activities, etc.), properly filtered and/or sorted by the back-end, and manage their accepted applications.

In addition to the **BackEndAPI**, the back-end component offers a **ProfileAPI** allowing subsidiary users to edit their profile. Since dynamic profiling capabilities constitute an innovation point with respect to previous similar platforms, we have chosen to separate this API from the **BackEndAPI**. Specifically, the **ProfileAPI** allows users to retrieve their profile information and to update it in terms of bio, personal info, work experience, interests etc. It is worth to emphasize that, by dynamically updating profile information, reasoning capabilities of the **SpONSOR** back-end might be triggered for possibly generating information both for the subsidiary users, whose profile has changed, as well as for the organizational main users, who might take decisions according to new available information. We will provide further examples of this type of information exchange in Section 4.

From the **SpONSOR** Website point of view, the **NotificationAPI** offers a service for displaying in real-time notifications generated by the **SpONSOR** back-end. Such notifications include newly received messages, relevant dynamic changes of users profiles as well as profile update requests like questions, questionnaires or other forms of gamification strategies. The main role of this software interface is to generate events by transmitting data in real-time. Just to provide an illustrative example, a main user, by means of his/her dedicated portal, retrieves stored messages by means of the **BackEndAPI**. Again, by means of the **BackEndAPI** sends a new message to a group of subsidiary users. These latter users retrieve stored messages still by means of the **BackEndAPI** however, in real-time, they also receive a notification of the just sent message by the main user through the **NotificationAPI**.

SpONSOR Back-end

The **SpONSOR** Back-end represents the container of all the persistent storage services as well as intelligent services offered by the **SpONSOR** platform (bottom side of Figure 4).

The *data management module* offers services for storing and retrieving stored data for other sub-components and, consequently, to back-end clients (namely, the **SpONSOR** web application). Stored data includes users information, exchanged communications, opportunities (including job offerings, volunteering

offerings, training courses, recreational activities, and other kinds of activities), subsidiary users applications and relations between users (e.g., associated users for associations). In addition to the above mentioned services, the data management module keeps track of mentoring messages, as well as work-flow information and organization-related specific matchmaking parameters. Finally, the data management module hides to other sub-components the connection with external sources (including Facebook, LinkedIn, Google, Twitter, etc.) and ontologies, providing clients the required data according to a uniform and consistent schema.

In order to provide services required by the end users, the *matchmaking service* exposes interfaces for dynamically editing profiles in relation with the different steps of the recruiting process and, according to stored information, for performing match-making between subsidiary users and required activities. In addition, in order to properly provide dynamic profiling capabilities, the match-making service could possibly require temporal reasoning capabilities linked, for instance, to organizational specific constraints, offered by the *personalization over time* module. Specifically, the personalization over time module provides capabilities for the management of temporal workflows and internal organization processes as well as agenda and temporal notification services (e.g., reminders). Finally, the personalization over time service could possibly (and autonomously) produce requests to the matchmaking service resulting in changes to the user profiles and consequent notifications to the interested users.

In other words, the matchmaking service and the personalization over time module work in cooperation in order to provide dynamic profiling capabilities. From their collaboration derives the temporal extension required by the match-making services for guaranteeing the vision of “matchmaking as a process” and, consequently, allowing the reproduction of the complex scenarios such as those described in Section 4.

4 Personalized Interaction over Time (PIT)

The demand for more complex services, compared to a simple matchmaking mechanism, requiring temporal reasoning aspects, has motivated the introduction of the Personalized Interaction over Time (PIT) module. Specifically, the PIT module is responsible for providing personalized services, modulated with respect to temporal aspects and user models. As an example, the PIT module can be exploited for sending messages (e.g., alerts, reminders, suggestions, etc.) to the different SpONSOR users at proper time. The content of such messages might be *context dependent*, offering customized services that take into account both aspects related to the curriculum vitae of the users as well as their psychological status. To this purpose, it is worth highlighting the fact that the SpONSOR platform is targeted to aged users which, although might have a great experience in performing a particular task, resulting from a life spent to do the same activities, might be tired of continuing to carry it. To this end, it is

important to keep into account psychological aspects, aiming at optimizing the overall well-being of the SpONSOR users.

We have built PIT services making use of a particular type of automated planning called timeline-based (for further details, refer to [6]). This kind of planning allows the modeling of complex domains which require the use of both temporal reasoning and scheduling features. For this reason, timeline-based planning has been an obvious choice.

In essence, timeline-based planning approaches planning by modeling the problem by means of a set of relevant *features* of the domain which need to be controlled to obtain a desired temporal behavior. Timelines model entities whose properties may vary in time and which represent one or more physical (or logical) subsystems which are relevant to a given planning context. The planner/scheduler plays the role of the controller for these entities, and reasons in terms of constraints that bound their internal evolutions and the desired properties of the generated behaviors.

In timeline-based planning, the main data structure is the *timeline* which, in generic terms, is a function of time over a finite domain. Events on timelines are called *tokens* and are represented by temporally scoped first-order predicates (i.e., predicates endowed with extra arguments belonging to the Time domain \mathbb{T} , either real or discrete). From a formal point of view, we have that

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

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

where n is a predicate name, x_0, \dots, 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 $n(x_0, \dots, x_k) @ [s, e, \delta]$ asserts that $\forall t$ such that $s \leq t \leq e$, the relation $n(x_0, \dots, x_k)$ holds at the time t .

Similar to what has been done in [4], although the context is slightly different, we can use tokens for representing information that must be communicated to the users at proper time. For example, by introducing a token like *message(sender, recipients, content) @ [s, e, δ]*, we might represent a message sent by *sender* to a collection of *recipients*, having a specific *content* at time s . Since we do not need durations for representing messages, we can consider $s = e$ and, consequently, $\delta = 0$.

It is worth to notice that, in general, tokens' arguments are variables and, as such, can be *constrained* so as to make them assume desired values. We can use this expedient to place the tokens at desired times, generating a messaging system capable of supporting the processes of the organizations.

Given the mutable nature of the user dynamic information in time, we have addressed also the user modeling problem by making use of timelines for each user representing both their psychological state as well as their dynamic skills evolving in time. In this regard, we have adapted the work already done in [1, 3] in which timeline-based planning was adopted for modeling users in a crisis training domain. It is worth noting that the profile of a user is *dynamic* and,

therefore, might change over time. Once changed, however, the profile of the user is fully known. This means that although tokens are added dynamically into the plan, their predicate’s arguments are, actually, constants.

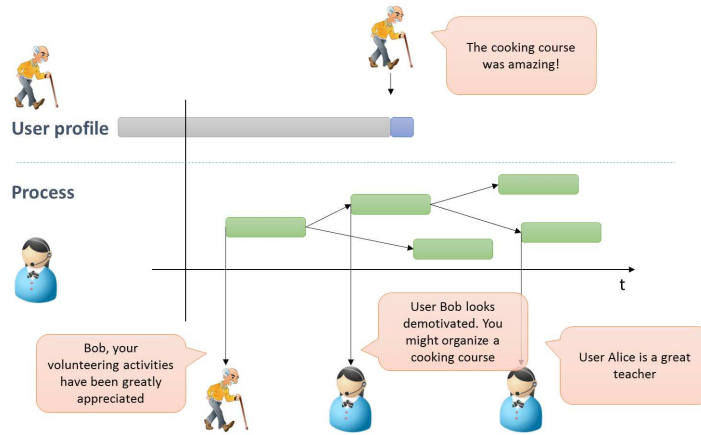


Fig. 6. Temporally extended services provided by the SpONSOR solution.

As an example, consider the process depicted in Figure 6. This example describes a single subsidiary user, depicted at top, associated to an organization having a single main user, depicted at the bottom. In this example, for sake of space, we have packed all user profile timelines in a single timeline and we have neglected the state of the main user in order to make the example more accessible. A set of stimuli, represented through tokens, are planned in time, depicted on the abscissas, so as to be sent to the different users involved. For example, the content of the first message in time (i.e., “Bob, your volunteering activities have been greatly appreciated”) constitutes a positive reinforcement for the activity currently performed by the subsidiary user. Roughly speaking, the aim of this message is to improve the user’s psychological state. At planned time, the message is sent to the subsidiary user which might find it in his/her mail in-box. Despite the positive reinforcement message, a second message is sent after a while to the main user notifying him/her about the demotivated state of the subsidiary user. In addition, the message contains a suggestion about some possible ways to recover the situation. Following the intervention of the main user, a cooking course is organized and attended by the subsidiary user which, by means of the subsidiary user portal, provides feedback about the course to the system. This feedback is interpreted by the system as an update to the profile of the user and the overall process is adapted to meet the new state’s needs. As a consequence, new stimuli are planned providing feedback to the users as, for example, a message for the main user notifying him/her about the good skills of the cooking course teacher.

The “rules of behaviour”, required by the planner to react to user stimuli, are generalized in a concept which we call *rule*. More in general, rules represent the

tool for describing the causal knowledge in the timeline-based planning. From a formal point of view,

Definition 2. a rule is a tuple $c = (\text{name}(c), R(c))$, where:

- $\text{name}(c)$ 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 rules 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, a conjunction of requirements or a disjunction of requirements.

Rules define causal relations that tokens should comply to in order to be valid. In other words, every token should be supported by a rule. It is worth underscoring that these rules may often involve predicates defined on different timelines, thus allowing to synchronize concurrent values on different domain components. Through the use of disjunctions within such rules, it is possible to build different temporal evolutions of the messages (involving, possibly, different content). By exploiting the natural flexibility offered by the timeline-based approach, such evolutions are adapted (or, sometime, “filtered out”) according to the current psychological state of the involved users, giving the feeling to the end-users to follow a custom behavior which takes into account the organization’s specific process as well as the psychological state of the users. Going back to the proposed example, indeed, it is worth highlighting that the planned messages are a result of the combination of the current profiles of the users with the predefined natural evolution of the associated organization specific processes. As an example, the suggestion for organizing a cooking course is offered to the main user as a consequence of the psychological state of the subsidiary user which, thanks to the application of the rules by the planner, is recognized as interested in dealing about cooking.

Since the same data-structure (i.e., the timelines) is used for maintaining an internal representation of the different users involved in the system, in the following we will provide an explanation with a greater detail of how the users are modeled within SpONSOR and of how the timeline-based plan, representing the planned stimuli, is adapted to the dynamically evolving state of the users. A first example of the ongoing personalization process is depicted in Figure 7. This example can be temporally located a few weeks after the example of Figure 6 however, compared to the previous example, the profile of the user is now further detailed, in order to better explain the idea underlying the dynamic personalization. In this example, indeed, the dynamic state of the users is modeled by means of two timelines, representing respectively the cooking skills of the subsidiary user and his/her abilities in playing the guitar. As a result of having attended the cooking class, the cooking skills of the subsidiary user are updated. This update is performed by adding new tokens to the related timelines which in turn, by applying associated rules, result in an update of the planned stimuli. As a consequence, a cooking activity is assigned to the subsidiary user

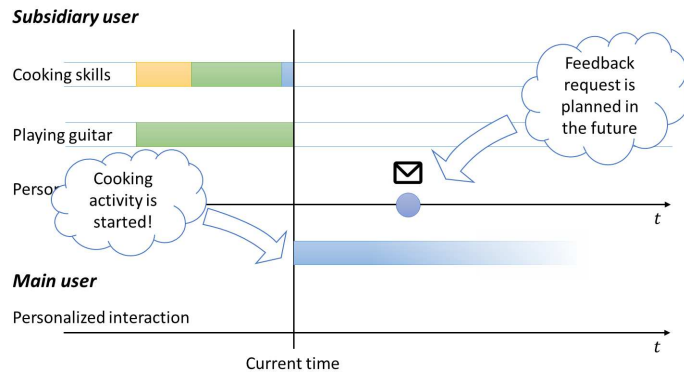


Fig. 7. A first example of ongoing process personalization.

and a feedback request is planned after some months, in order to monitor user performance.

With the passing of time, the user continues to perform the cooking activity till the planned request for feedback is reached. At this time, the feedback request is sent to the subsidiary user which might find it in his/her mail in-box. When the request is checked by the subsidiary user it is visualized as a five-level Likert scale. In the example of Figure 8, the user answers with a value of two. The system notices that the user did not perfectly adapted to the new ongoing activity. As a consequence, a reinforcement message is planned for the subsidiary user, in order to encourage him/her in continuing to perform the new activity. At the same time, a new message is planned for the main user notifying him/her about the poor performance of the cooking activity, with the objective of stimulating an human intervention aimed at affecting positively the user status.

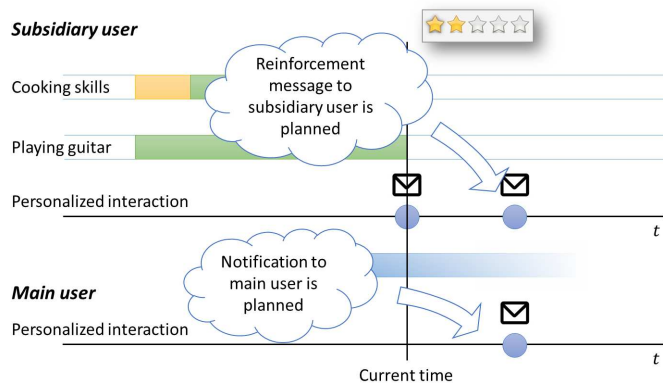


Fig. 8. A second example of ongoing process personalization.

5 Conclusions

Concluding, the paper has given an overview of the SpONSOR project. The project activities have produced an early prototype during the second year of activities that integrated several of the proposed platform modules. Currently a more robust release, which will be used to test specific pilot cases so as to perform validation with real users, is under development.

We have focused our attention on the general schema followed by the architecture that reconciles organizations and senior workers/volunteers. From the point of view of the organizations, the key issue is to serve customers (like people in need) as better as possible, but it is also important to manage the workforce according to their capabilities, so as that people is doing the right thing for them in a specific time frame of their life (being late occupation or retirement). A special attention is given to support the difficult and dynamic business of managing volunteers, an area where maintaining people at work is particularly challenging.

It is worth underscoring how the specific aspect we have described here (i.e., the issue of personalized interaction) is motivated by a specific user requirement that emerged from several of the explorations done in focus groups: the sense of being abandoned that several people feel when looking for a job at an older age. Hence, the direction we have pursued is strongly motivated by having the workers “choose the right thing” and “never feel alone”, but rather “feel helped in adapting to reality by pursuing new capabilities”. The PIT module is an example of AI-based subsystem that contributes new system capabilities. Such demonstration paves the way to a wider use of dialogue-based techniques to strengthen the sense of engagement of and personalization of interaction with different users.

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