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**Personalising health and care: Advancing active and healthy ageing**  
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***Deliverable 4.9***  
***Social Activity Monitor***

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# Contents

<b>EXECUTIVE SUMMARY .....</b>	<b>4</b>
<b>CHAPTER 1: EVALUATION MONITORING OF THE SOCIAL ACTIVITIES.....</b>	<b>5</b>
1.1 COLLECTION OF USER'S FEEDBACKS.....	5
1.2 COLLECTION OF CPSN DATA .....	9
<b>CHAPTER 2 .....</b>	<b>11</b>
2.1 GENERATION OF FEEDBACKS.....	11
2.1 USER ROLES .....	116
<b>RELATION WITH OTHER WORK PACKAGES.....</b>	<b>17</b>
<b>BIBLIOGRAPHY .....</b>	<b>18</b>

## Executive Summary

Monitoring the users' social activities means considering two important dynamic sources of data. Firstly, the system needs to take into consideration the user's selected social activities, the user's feedback evaluations, and adapt accordingly and dynamically to the user profile preferences, likes, dislikes, etc. Secondly, it needs to take into account the information provided by the sensors and evaluate the grade of difficulty experienced by the user during the completion of the proposed activities.

In the first chapter, we document the proposed process of evaluation-monitoring of social activities and the related models developed in D2.4 "*User, activity and environmental description: Final release models for user, activity and environment*" [1].

In chapter two, we detail how the generation of the feedback process works to gather the best information possible from users' daily social activities and provide context information about them to specialists (in this case, Medical Doctors) as well as how feedback influences future recommendations as well as updating the user profile preferences and constraints dynamically.

# Chapter 1: Evaluation monitoring of the social activities

## 1.1 Collection of user's feedback

To described the selected implementation of the collection of user's feedback, we start by presenting, in Figure 1, the main overall sequence diagram for the generation and evaluation of social activities as proposed and described in detail in D2.4 “*User, activity and environmental description: Final release models for user, activity and environment*” [1].

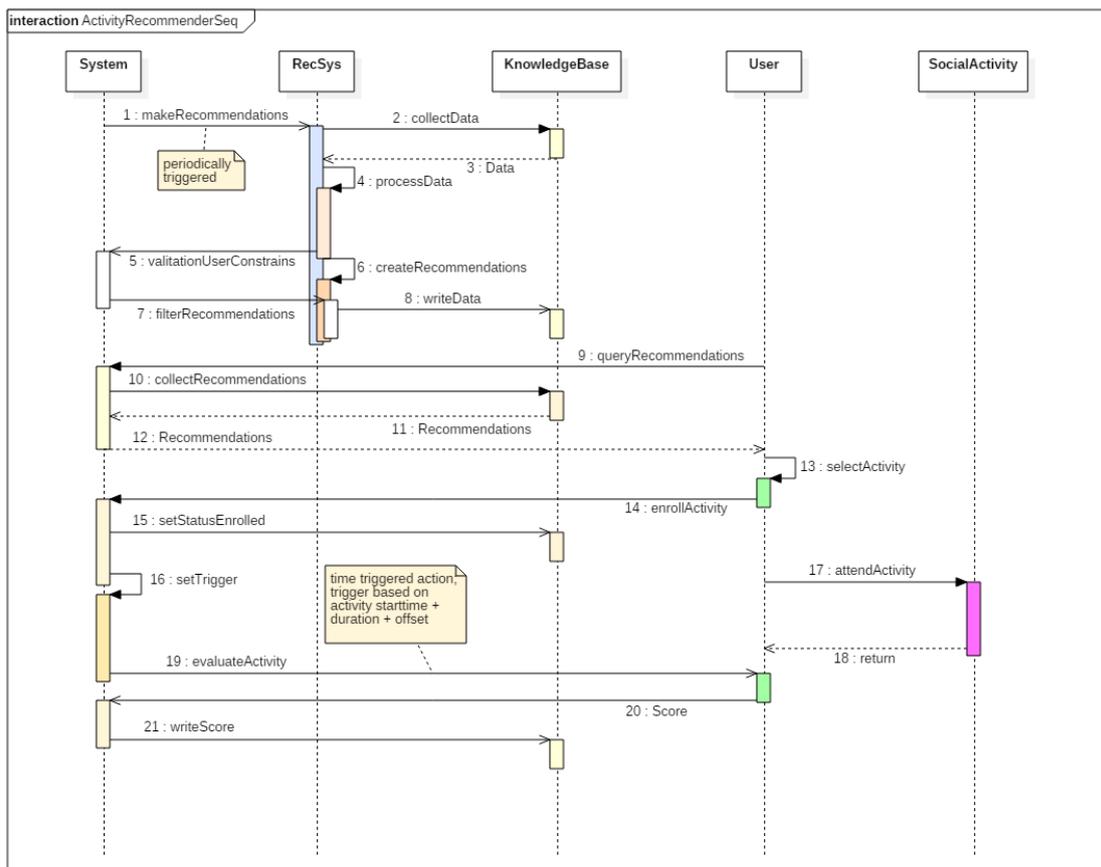


Figure 1: Recommender system process sequence diagram

Figure 1 exemplifies the overall social activity recommender sequence diagram and is used primarily to show the interactions between objects in sequential order. Briefly, the *System* periodically triggers a batch process to generate recommendations. The recommender system (*RecSys*) collects all necessary data from the *KnowledgeBase*, which it processes, creates recommendations from it and writes the data back to the *KnowledgeBase*. The *System* will query the *KnowledgeBase* and pass the collected recommendations to the *User*. The *User* chooses a recommended activity and the *System* sets the Activity status to “enrolled” in the *KnowledgeBase*. Once the activity is completed, i.e. *start time + duration + some offset* has passed, the *User* is prompted to evaluate his experience by attributing a score, which will be also stored in *KnowledgeBase*.

In the current interaction model, the *User* has the option to evaluate his/her previously executed social activity from step 19 until step 21. The user's evaluation is one of the elements used by the recommender system to improve the continuous task of recommending new social activities to the user.

After the *Activity* completion, the evaluation is collected from the user, e.g. by prompting with a dialogue from an appropriate User Interface (UI) documented in Deliverable 1.8 and stored as EVALUATES edges between his/her *UserProfile* and the completed *Activity* as shown in Figure 2.

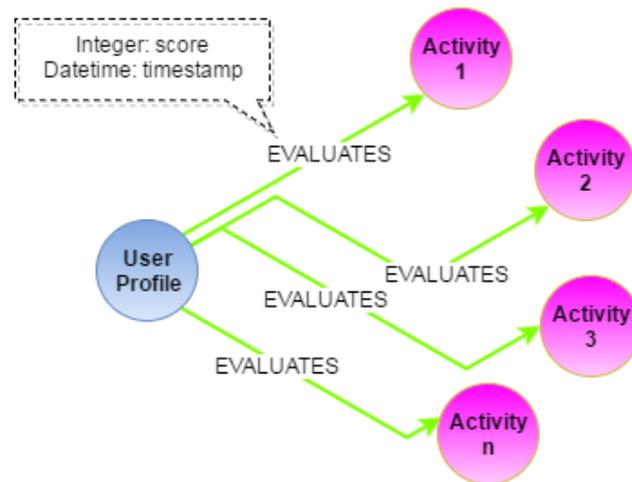


Figure 2: EVALUATES relation

The edges carry the integer score and a timestamp as properties. If a user changes his/her mind about the given score, the *Activity* can be re-evaluated and the updated score will be participating in the next cycle of recommendations.

The *Tag* nodes represent an important entity in general in both our *UserProfile* and *Activity*, but also in our evaluation model. They allow the categorization of different attributes that are part of both the *UserProfile* and an *Activity*. Tags are used for the following properties: preferences, dislikes, prescriptions and profession, categories from the *UserProfile*, and tags property from *Activity*.

Specifically, the *Activity* nodes include a name, description and long description of the activity, date and time, duration, cost of admission, location, category tags and some booleans to indicate if a FriWalk is required and whether they are available on site. It also identifies if a user can bring his friends and generally if the activity is suitable for visits in groups. Once an activity has been completed, an evaluation will be requested from the user. This Tag concept is an abstraction of the possible elements that can be evaluated, as shown in Figure 3.

Tags are used in the following objects: social profile, clinical profile, activity, and profession. The activity object includes the description of the activity, date, duration, location, tags and a Boolean to indicate if the *Friwalks* are needed. This object will be evaluated to measure the user's satisfaction.

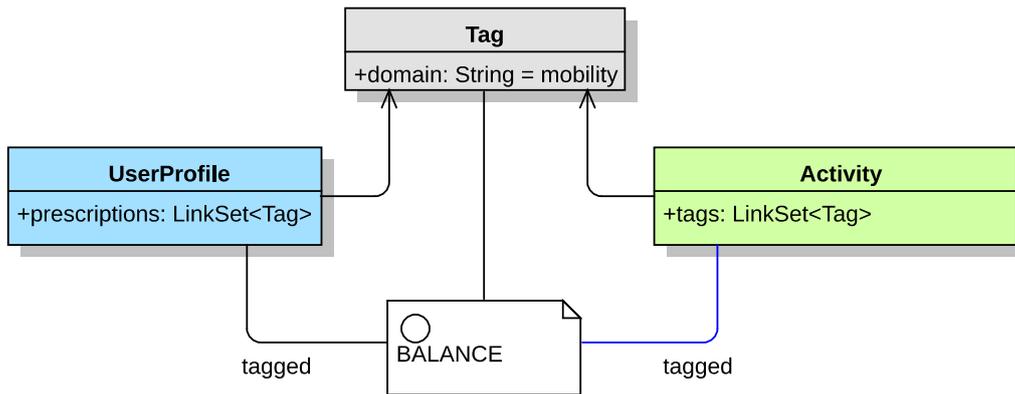


Figure 3. User Profiles, Tags and Activity relational representation.

Figure 3 illustrates the main architectural relationships between Tags and User Profiles and Activities, while Figure 4 provides the implemented main relations between User Profiles and Activities, namely:

- RECOMMENDED: when a specific activity is recommended to a UserProfile (User) based on its preferences, *MobilityProfile*, position etc.
- ATTEND: when a User attends a recommended activity
- EVALUATE: when a User provides some feedback and evaluation of the attended activity

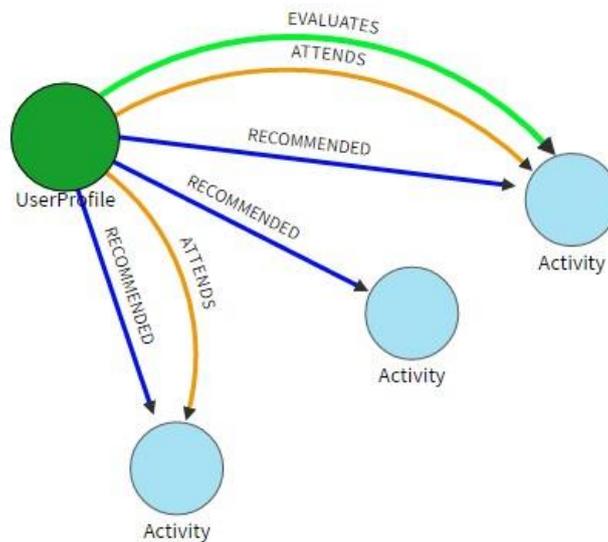


Figure 4. User Profile relations with activities.

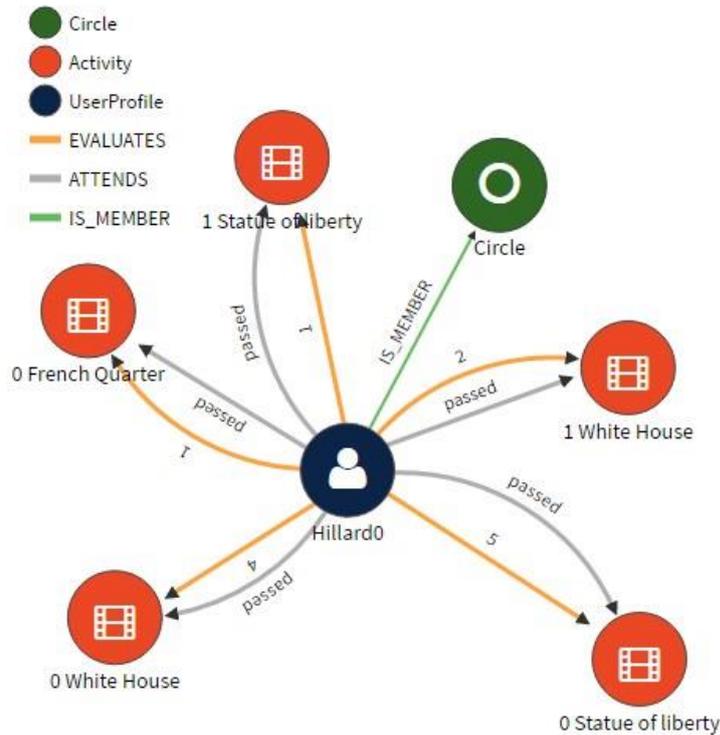


Figure 5: example of user's activities evaluations

**Example:** Figure 5 provides an example of evaluations of a number of activities proposed and executed by user Hillard0 (UserProfile), member of a specific circle (name not showed in the figure) of (fake) persons living in the USA. A number of activities (coming in this case from the synthetic datasets of activities collected and used in D4.8 “*Social activity recommendations*” for testing the recommendation system) are recommended to the Circle and therefore to the user Hillard0. In some temporal order (not shown in the figure) the recommendation system proposes that Hillard0 take part in some activities with his/her circle: (visit) French Quarter, (visit) White House, (visit) Statue of Liberty (please note that for our tests we have not use any location filter to limit the potential activities to a specific area; in a realistic recommendation system for activities we think this filtering would be useful – and easy to implement).

After the completion (i.e. fulfillment of the relationships “passed”) of the first three proposed activities, Hillard0 will be asked to provide a feedback (e.g. in a scale from 0 – bad experience - to 5 – excellent experience). This feedback will be stored as an EVALUATES edge between his/her UserProfile and the completed Activity. In the example, Hillard0 evaluated with high scores the activities (visit) Statue of Liberty (5) and (visit) White House (4). Hillard0 evaluated less activity (visit) French Quarter (1).

In the example, in a subsequent iteration of activities recommendations, the previously enjoyed activities are proposed again, while the less enjoyed ones are not. Please note that also other different and novel activities will be recommended by the system, but they are not included in the figure. In the example above, the user repeated certain activities, but did not consistently appreciate them (both White House and Statue of Liberty score less on a second evaluation) probably because they were considered less interesting after the first experience. For the next iteration of recommendations, their probability to be recommended will be also lowered.

## 1.2 Collection of CPSN data

To describe the selected implementation of the collection of data coming from the sensors and other devices of the overall Cyber Physical Social Network (CPSN) infrastructure developed in ACANTO along with the user's feedback, we start by providing the main data collected in the User State model described in detail in D3.2 "User state modelling and collaborative platform localisation" [2].

A key concept of ACANTO CPSN is to learn as much as possible about the user without requiring this information to be actively provided by the user, since we want to ease the burden for our target group and not pose an additional challenge. This has guided our approach for continuous observation and perception of the user's state. Some of the observations will be relevant only at the time of the measurement, some will be meaningful by aggregation over a longer period of time; some of them indicate physiological conditions with medical relevance (e.g. with respect to therapeutic goals) while others address the motivational level or mood of the person. In any case, the means to gather all this information are via several sensors. These sensors are either deployed on the FriWalk/FriTab or alternatively on the user using appropriate and acceptable (by the user) monitoring devices.

The purpose of user-centric sensing is at least twofold: first the derivation of automated activity analysis in the context of therapeutic exercises to support our clinical scenario, and second the aggregation of the sensory information to build up a semantically meaningful user state model that allows for automatic activity evaluation and measuring the impact of activities on the user's well-being. The data produced dynamically by the different sensing devices will be collected in the User State model developed in D3.2

In our implementation, we will present the User State model developed and stored in the ***MobilityRecord*** by WP3. The ***MobilityRecord*** entity is embedded into the *UserProfile* as a Map (*mobilityrecords* property) whose keys state the date the record is related to in 'yyyymmdd'-format. The linked document of class *MobilityRecord* has a property *date* which matches the key of the Map.

The ***MobilityRecord*** entity will store the various indices coming from the User State Model developed by WP3. This information will be used to derive some statistics as well as dynamically enrich the information used for the recommendation systems (for circles and for activities). The User State Model aims to capture, condense and evaluate the plurality of data collected by the different user-centric sensing devices and methods identified by WP3, in order to deliver semantically meaningful information that will help the activity evaluation as well as future recommendations.

In brief (more details in D3.2 [2]), the data stored in the ***MobilityRecord*** entity will include:

- ***Activity Index***: based on a number of inputs from collected data (e.g. steps, climbed floors, active versus non-active time, burned calories per day, current heart rate, the Activity Index will merge them into a numerical value from 0 (non-active) to 10 (very active)

- **Vigilance Index**: based on sleep quality, arousal (from eventual camera set-up) gait analysis, “vigilance” is also represented by a numerical value from 0 (non-alert) to 10 (highly alert)
- **Stress index**: based on time asleep, time awake between sleep cycle, arousal and pain (from eventual camera set-up), current heart rate, walking speeds etc., “stress” is also represented in our **MobilityRecord** by a numerical value from 0 (calm) to 10 (stressed)
- **Physical indication** is connected to both Vigilance and Stress index and will initially mainly focus on high current heart rate and inconsistent gait. Again, the monitored information will be merged into a numerical value from 0 (no indication) to 10 (alert for physical indication)
- **Emotional Balance** is defined in D3.2 as a feeling of personal well-being without considering short term “Physical indication”. Again, the monitored information will be indicated as a numerical value from 0 (unstable) to 10 (relaxed).

As soon as the data collected and stored by WP3 at the knowledge base in the first experimental validation of the CPSN will be available from WP8, they will be located in this **MobilityRecord** entity of the User Profile in order to improve the recommendations of circles and activities.

## Chapter 2

### 2.1 Generation of feedback

In order to find the best option to spread results and get feedback from the users, a full study was accomplished. The idea was to get the best information possible from the users' daily social activities and provide context information about them to the specialists. The generation of feedback begins at the moment some social activities are recommended to the user. The first evaluation provided by the user occurs when he receives the list of recommended social activities, checks the details and decides if he is interested in the social activity or not. The second evaluation occurs after the completion of the social activity where the user is asked to rate it. The social activity evaluator acquires the users' feedback information after the end of each social activity. The user-feedback related with the experienced social activity is obtained at the end of the activity by asking for a score (e.g. from 1-5). The user score is then stored to improve the future recommendations of new activities.

The evaluation and generation of feedback for the recommended social activities is composed of information provided by the user and of information coming from the sensors (provided by WP3). The figure below shows an example list of recommended social activities for a random user. It is important to note that the User Interfaces (UI) shown in this document are not the same as those the final user will be using – these are being developed by WP5. We used the UI that the Liferay [3] portal already has by default.

Acanto Available Activities

ID	Name	Description	Place ID	Place Name	Start Time	Duration	Status	Action
#65:23	30 French Quarter	30 French Quarter	#59:0	French Quarter	16. September 2017 at 23:00	5 Minutes	available	<a href="#">view details</a>
#65:21	28 Statue of liberty	28 Statue of liberty	#57:0	Statue of liberty	03. May 2017 at 23:00	8 Minutes	enrolled	<a href="#">view details</a>
#65:28	37 White House	37 White House	#58:0	White House	10. May 2017 at 23:00	6 Minutes	available	<a href="#">view details</a>
#65:26	34 French Quarter	34 French Quarter	#59:0	French Quarter	15. June 2017 at 23:00	5 Minutes	available	<a href="#">view details</a>
#65:24	32 Statue of liberty	32 Statue of liberty	#57:0	Statue of liberty	08. April 2017 at 23:00	8 Minutes	available	<a href="#">view details</a>
#65:22	29 White House	29 White House	#58:0	White House	21. March 2017 at 00:00	7 Minutes	available	<a href="#">view details</a>
#65:29	38 French Quarter	38 French Quarter	#59:0	French Quarter	02. September 2017 at 23:00	6 Minutes	available	<a href="#">view details</a>
#65:20	26 French Quarter	26 French Quarter	#59:0	French Quarter	16. January 2017 at 00:00	7 Minutes	available	<a href="#">view details</a>
#65:27	36 Statue of liberty	36 Statue of liberty	#57:0	Statue of liberty	15. August 2017 at 23:00	3 Minutes	available	<a href="#">view details</a>
#65:25	33 White House	33 White House	#58:0	White House	20. July 2017 at 23:00	9 Minutes	available	<a href="#">view details</a>

Page 1 of 1

20 Items per Page

Showing 10 results.

← First Previous Next Last →

Figure 2: List of available activities for the user

The social activity status is composed of the following parameters:

**enrolled** – when the user just signed up for an activity

**passed** – when the activity has passed and the user participated

**cancelled** – when the user made up its mind and chose not to go (after previously enrolling)

When the user presses the “view details” link, he will be redirected to the details page where he will be able to decide if he desires to participate or not in the social activity.

Acanto Available Activities

**Details for Activity — #65:23 30 French Quarter**

**Description:** 30 French Quarter

**Long Description:**

30 French Quarter

**Location:** #59:0 – French Quarter

**Startdate:** Sep 16, 2017 11:00:00 PM

**Duration:** 5 Minutes

**Status:** available

**Users attending:** 0

Figure 3: Example of a recommended activity for the user

After pressing the “Enroll” button the activity status will change to **enrolled** and the user will become part of the attend list of the social activity. On the other hand, if the user pushes the “Not Interested” button, the status of the social activity changes to **rejected and the activity will not appear again in the list**. Figure 5 illustrates a social activity evaluation list example where it is possible to check the user score (or “rating”) for each social activity.

Activity Evaluation

ID	Name	Start Time	End Time	Duration	Status	Due since	Due?	Rating
#65:3	4 Statue of liberty	20.02.2017 at 00:00	20.02.2017 at 00:09	9 Minutes	passed	26741 Minutes	yes	☆☆☆☆☆
#65:4	5 White House	28.03.2017 at 23:00	28.03.2017 at 23:02	2 Minutes	passed	-26471 Minutes	no	★★★★★
#65:21	28 Statue of liberty	03.05.2017 at 23:00	03.05.2017 at 23:08	8 Minutes	enrolled	-78317 Minutes	no	☆☆☆☆☆
#66:3	4 White House	20.11.2017 at 00:00	20.11.2017 at 00:05	5 Minutes	passed	-366374 Minutes	no	★★★★☆
#67:3	4 French Quarter	11.10.2017 at 23:00	11.10.2017 at 23:09	9 Minutes	passed	-310158 Minutes	no	★★★★☆
#68:3	5 Statue of liberty	27.03.2017 at 23:00	27.03.2017 at 23:07	7 Minutes	passed	-25036 Minutes	no	★★★★★

Showing 6 results.

Figure 4: Activity Evaluation list example

The classification is composed by five levels:

- 1 star: **BAD**
- 2 stars: **POOR**
- 3 stars: **FAIR**

- 4 stars: **GOOD**
- 5 stars: **GREAT**

These five levels will be taken into account for future recommendations, changing the information related to the user profile and therefore the recommended social activities in the future.

### Medical Doctor Portlet

*Liferay* portlets are the most commonly used type of plugins. The Medical Doctor portlet is basically a plugin composed of a group of views only accessible to users having the Medical Doctors *role*. These views allow a Medical Doctor to consult the social activities recommended to the user as well as other relevant information such as the evaluation and the mobility record around each social activity in which the user has participated. After logging into the Cyber Physical Social Network (CPSN) with the Medical Doctor role, the medical professional will be able to follow his list of patients. It is important to note that he will only be able to consult the details of those patients that are assigned to him. Figure 6 shows an example of the patient list view.

ID	First Name	Family Name	Birthdate	View user details
#50:6	Cleon	Cleon	Tue Jun 29 00:00:00 GMT 1954	<a href="#">Select</a>
#50:2	Theophile	Theophile	Sun Aug 12 00:00:00 GMT 1962	<a href="#">Select</a>
#52:4	Santiago	Santiago	Mon Mar 18 00:00:00 GMT 1957	<a href="#">Select</a>

**Figure 5: Patients List UI**

After pressing the “Select” link, the user will be redirected to the Patient Details view that shows the list of social activities completed by the patient. It is also possible to view the social activity evaluation, duration, status and the rating given by the sensors during the activity (column “Sensor rating”). The rating will be provided and stored in the Knowledgebase by WP3 and is based on the sensor data recorded during the completion of the activity. The User State Model provides the following five values already described in the previous section:

- **Activity Index (ai)**
- **Vigilance Index (vi)**
- **Stress index (si)**
- **Physical indication (pi)**
- **Emotional Balance (eb)**

The sensor *rating* is an aggregated indicator of the external data of how well the user passed the social activity (from 1 = stressed, emotionally or physically unbalanced, until 5 = balanced, physically or mentally). A formula will be provided by WP3 to calculate this integer score from the indicators and thus generate an evaluation of an activity. The calculation aggregates over a concrete time window – the social activity duration – and has for instance the following signature:  $f(ai, vi, si, pi, eb, starttime, endtime) = x : Integer$ ).

Medical Doctor										
Welcome to the <b>Patient Details</b> . This page shows the history and evaluation of patient's past social activities.										
<b>Patient Id:</b> #50:6										
<b>First Name:</b> Cleon										
<b>Family Name:</b> Cleon										
List of completed social activities:										
Activity ID	Name	Start Time	End Time	Duration	Status	Due Since	Due?	Sensor Rating	Rating	Activity Details
#65:6	8 Statue of liberty	25.01.2017 at 01:00	25.01.2017 at 01:06	6 Minutes	passed	154729 Minutes	yes	GREAT	●●●●●●	<a href="#">View Details</a>
#65:7	9 White House	16.09.2017 at 01:00	16.09.2017 at 01:09	9 Minutes	passed	-182173 Minutes	no	GREAT	●●●●●●	<a href="#">View Details</a>
#66:6	8 White House	23.11.2017 at 01:00	23.11.2017 at 01:01	1 Minutes	passed	-280145 Minutes	no	GREAT	●●●●●●	<a href="#">View Details</a>
#67:6	8 French Quarter	03.07.2017 at 01:00	03.07.2017 at 01:06	6 Minutes	passed	-74170 Minutes	no	GREAT	●●●●●●	<a href="#">View Details</a>
#68:6	9 Statue of liberty	06.12.2017 at 01:00	06.12.2017 at 01:06	6 Minutes	passed	-298870 Minutes	no	GREAT	●●●●●●	<a href="#">View Details</a>

Figure 6: Patient Details UI

The link “View Details”, will open the social activity details view, providing more information related to a particular social activity (Figure 8).

Medical Doctor
Welcome to the <b>Activity Details</b> . This page shows detailed information of the patient social activity.
<b>Patient Id:</b> #50:6
<b>First Name:</b> Cleon
<b>Family Name:</b> Cleon
<b>Social Activity Details:</b>
<b>Activity Id:</b> #65:6
<b>Description:</b> 8 Statue of liberty
<b>Long Description:</b> 8 Statue of liberty
<b>Location:</b>
<b>Start date:</b> 25.01.2017 at 01:00
<b>Duration:</b> 6 Minutes
<b>Mobility Record Details:</b>
<b>Activity Index:</b>
<b>Vigilance Index:</b>
<b>Stress Index:</b>
<b>Physical Indication:</b>
<b>Emotional Balance:</b>

Figure 7: Patient activity details UI

The view displays the particular social activity details (activity ID, starting date, duration, location, description and long description) and the related Mobility Record details. The Mobility Record fields (Activity Index, Vigilance Index, Physical Indication and Emotional Balance) are empty since there are still no data delivered by the sensors.

## 2.2 User Roles

To implement a basic means of control of privacy we introduce roles that can be assigned to any user of the CPSN. In Liferay, roles can be granted permissions to various functions within portlet applications. A role is basically just a collection of permissions that defines a function, such as Message Board Administrator [3]. We adopted the system of roles and extended their use to be valid for the KnowledgeBase as well. The types of roles that can be assigned to a user are *doctor*, *nurse*, *therapist*, *friend*, *user*, the latter being the default role.

Special roles, such as doctor, nurse, therapist, can be applied for during the sign-up process, but will be granted only after personal verification through a CPSN administrator. Therefore the CPSN can guarantee that only correctly authenticated persons can gain access to private information of the users.

Furthermore, a doctor needs to be linked to his patients. We are currently still collecting the requirements for this process, but we can foresee that this will be either another task for an administrator of the CPSN, or a user-user negotiation process similar to the acquisition of a friendship on a social site, e.g. the doctor looks up a patient and sends him a request to accept her as *assigned professional*. The user receives this request and, in case he recognizes the requestor, accepts it. The system then creates the link CARETAKER\_OF between the two and notifies both parties that the relation has been established. This method is also safer, because besides from having to identify herself personally to a CPSN authority, the doctor only gains access to personal data if the user approves also.

The other roles work in a similar way.

## Relation with other work packages

The work of this deliverable is strongly related to a number of other work packages.

It is related to WP1 where work is being conducted to develop a UI (D1.8) to get evaluations from the user of their completed activities. It is also related to WP2 since it uses the implementation of the final version of the user profile models developed in D2.4. “*User, activity and environmental description: Final release models for user, activity and environment*”. These models are being used as the data model for the storage of evaluation data (both collected directly from the user and from the CPSN).

Specifically, the current model and implementation allows for the collection of a user’s feedback and relevant information collected in the User State model developed in WP3 and stored in the Knowledge base. This model captures, condenses and evaluates the data collected by different user-centric sensing devices and methods in order to deliver information that will help the activity evaluation as well as future recommendations.

The final version of the user profile model implemented in this deliverable will also be the basis for testing and evaluation in a real setting in WP8 (see D8.2 for details of this testing).

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