Pearly UIs for Cloud Computing: First Experience in Health Care IT

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RESEARCH CONTEXT AND PROBLEM

Moving away from a classic and monolithic computing model based on local resources, Cloud computing pushes the boundaries to fully rely on online resources, and thus invites to inventor reconsider interaction metaphors for cloud-based environments. As Cloud computing combines and leverages existing technologies already available in data centers (huge storage and computation capacities, virtualized environments based on high-speed data links) (Zhang et al. 2010), users now have an ubiquitous access to on-demand services in a pay-as-you-go manner (Mell and Grance 2009): "Virtualization makes it possible for cloud computing's key characteristics of multi-tenancy, massive scalability, rapid elasticity and measured service to exist" (Carlin and Curran 2012).

This evolution raises several issues in HCI, such as: How to cope with offline situations (loss of connectivity, failures) (England et al. 2011; Stuerzlinger 2011; Terrenghi et al. 2010; Vartiainen, and Väänänen-Vainio-Mattila 2011)? Which persuasive technologies would foster sustainability and power energy savings (Pan and Blevis 2011)? To which extent would migration from a conventional desktop to a cloud web-based setting fragment User eXperience (UX) and impact UIs consistency (England et al. 2011; Pham 2010)? Are privacy, trust and data ownership UX issues (Armbrust et al. 2010; England et al. 2011; Odom et al. 2012)? Which plasticity capabilities must UIs have to support the dynamic and ubiquitous provision of services? Which design would appropriately address traceability, control of data and sharing issues raised by the

socialization of cloud services and online activities (Odom et al. 2012; Zhang et al. 2010)? This work focuses on the two last issues.

This work investigates how to make the desktop metaphor evolve so that to integrate cloud-based services and activities, and thus to support the convergence of Cloud and Social computing (Pham 2010). Currently, the classic desktop metaphor is still single-user, data-centered, and designed for the use of local resources. As a first approach, we consider the social dimension of the desktop, and agree on representing the relationships between data, people, activities and services (Väänänen-Vainio-Mattila et al. 2011; Zhang et al. 2010) so that to promote the social worth of data. However, the classic hierarchy-based folder metaphor does not suit anymore for online repositories supporting social sharing (Odom et al. 2012; Shami et al. 2011). This paper proposes the concept of Pearly UIs for Cloud and Social Computing. It first browses the state of the art, and then reports the invention, implementation and evaluation of Pearly UIs in the context of health care.

RELATED WORKS

This section covers the convergence of Cloud and Social computing. We identify three classes of research: the social desktop for the cloud to deal with online resources and the socialization of services; the social navigation and sharing to deal with privacy and traceability issues; and information seeking/re-finding to deal with big data and scalability.

Social Desktop for the Cloud

The application-centric model of the traditional desktop is progressively fading away: more and more applications and services are deployed in clouds and made available as web applications. However, moving to a full web-based environment breaks down the guaranty of consistent UIs

and leads to a fragmented UX (England et al. 2011; Pham 2010).

A possible explanation of this failure (Pham 2010) may be that the current desktop metaphor "heavily reflects" the local nature of resources, "grounded firmly in hierarchy and physical locations" and "evolved very little to support sharing and access control". As a consequence, the "social desktop" was proposed based on the concept of user-created groups. This concept extends the folder metaphor to encompass files, people, and applications. Compared to the usual folder metaphor, a unique instance of an object may be included in different groups, thus providing a lightweight means to allow sharing and access: as a group is associated to users, access is implicitly granted to the members of the group, allowing file sharing.

Similarly, CloudRoom (Terrenghi et al. 2010) is a new desktop metaphor for the cloud, focusing on storage and data retrieval issues. CloudRoom partitions the desktop into three separate areas (planes in a 3D space) to organize data: (1) a long-term and persistent storage; (2) a timeline overview; and (3) a temporary storage for work-in-progress activities. CloudRoom allows session sharing with contacts.

Before the advent of Cloud and Social computing, when email, voicemail or Instant Messaging were considered as prevalent communication tools supporting social networking, Whittaker et al. (Whittaker et al. 2004) first pointed out the limits of the current desktop to support social interfaces. ContactMap is a social software application primarily designed to support communication-oriented tasks. The social desktop is the central element of ContactMap: similarly to shared workspaces, it allows to structure and to visually represent social information as groups of contacts.

In Computer-Supported Cooperative Work (CSCW), Voida et al. (Voida et al. 2008) advocated moving away from a document- and application-centric desktop to an activity-centric desktop,

encompassing collaborative activities, and thus the social dimension. In particular, the Giornata interface includes a contact palette allowing users to manage contacts (individuals or groups) and providing a lightweight means for file sharing.

(Grudin 2010) observed that CSCW is slowly moving towards CSCW as "Collaboration, Social Computing, and Work", which, from a user-centered point of view, is a foundation of Cloud computing.

Social sharing and browsing

« Online social networks have become indispensable tools for information sharing » (Kairam et al. 2012). Still, it is difficult for users to target specific parts of their network. Google+'s Circles are similar to Pham's user-created groups: user's social network is structured into circles allowing selective information sharing with parts of his/her social network. However, there is a lack of awareness to trace shared information from circles to circles.

(Shami et al. 2011) focuses on social file sharing in enterprise, considering the social worth of files. Social metadata are added to files as extra attributes. Such metadata allow a non-hierarchical file organization. In addition, metadata facilitate pivot browsing (i.e. parameterized browsing based on metadata). To do so, the authors have developed the Cattail file sharing system. The system is able to reveal social activity around files using a time-based stream of recent events. Access is supported through three levels of sharing: private, confidential and public.

Several works have explored metadata to promote different and more efficient file organizations. In particular, (Dourish 2003) introduced the concept of placeless document, a paradigm based on document properties that cover both external (e.g. creation date) and internal properties (e.g. it is a photo of me and my son).

Social information seeking and re-finding

Information seeking is another facet of the convergence of Cloud and social networking. For instance, the social worth of data is also considered to improve web search engines (Muralidharan et al. 2012): web search is augmented with social annotations. The goal is “to make relevant social activity explicitly visible to searchers through social annotations”. Such an approach is similar to social metadata. In particular, social annotations are another contextual key to facilitate and improve information re-finding (i.e. orienteering). For instance, for local file storage, (Sawyer et al. 2012) have developed a system that detects people and groups present at the time a piece of information is used or created. Therefore, files are tagged with information (i.e. social orbits) about the present physical context of the social interactions. Thus social orbits are similar to Pham’s user-created groups.

From this broad state of the art, let us conclude that, although in HCI research about Cloud computing is still in its infancy, very recent works show a growing interest for this topic. It appears that big data, social networks for data sharing, communication, and collaborative activities are becoming central and firmly linked. However, cloud services are still under-explored. Therefore, we propose the "Pearl" metaphor to present to users socially augmented entities as well as the services available in the cloud.

CASE STUDY: HEALTH CARE IT

Health is particularly interesting for Information Technologies (IT). With the evolution of practices and legislation, medical practitioners increasingly need tools for the production of images and the follow-up of medical records. Gastroenterology, the domain under study in this work, strongly relies on endoscopic images for decision-making, evaluation of practices as well

as for education and research. A medical challenge is to export endoscopic images outside the operating room, in the cloud for instance.

In order to understand medical practices and to identify users needs, a thorough study of the field has been conducted in three phases: (1) meetings with doctors and secretaries, (2) analysis and modeling of their needs, (3) validation of this work with different actors. This study resulted in several models of the patient care process in gastroenterology (17 use cases, 10 tasks models, and 29 UML diagrams). The models have been validated by medical practitioners, and thus make explicit a strong know-how in the field. .

The models revealed not only the importance and variety of medical data, but also a crucial need for medical software applications that better support the social dimension of medical activities: sharing medical data, easier communicating with colleagues to get advices, better capitalizing medical knowledge, and better supporting medical decision-making. More precisely, medical practitioners expand four socio-professional networks: (1) health workers, including colleagues, experts and friends; (2) academics and students; (3) health workers involved inpatients follow-up; and (4) institutions. However, in practice, information sharing is still informal (e.g. by phone), in particular for medico legal reasons, depriving practitioners from peer-based decisions, and giving them the feeling of being alone.

Based on these findings, we first improved the usability of the software (named Syseo) used by the practitioners (giving rise to Syseo* - Figure 1), and then retargeted it for the cloud (giving rise to the PearlyDesktop running prototype – Figure 3). The redesign of Syseo* was driven by two requirements: the improvement of health care quality, and the ability to trace and evaluate professional practices. Scenarios (Rosson and Carrol 2002) written with experts in gastroenterology were used to support the design process. Three gastroenterologists and one

developer of medical information systems validated the Syseo* prototype.

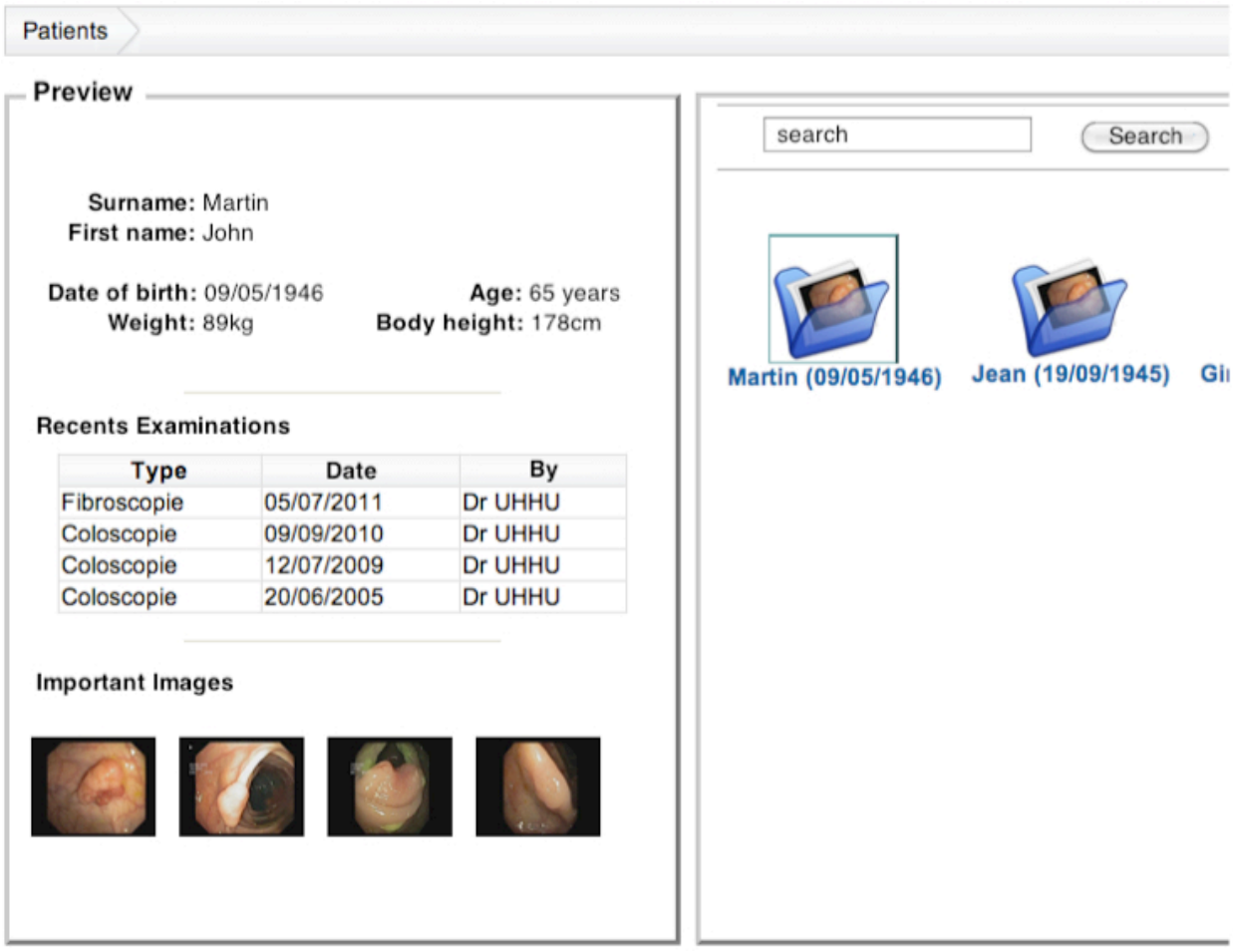

Figure 1: Syseo*, a data-centered management of medical data.

As shown in Figure 1, the UI of Syseo* is data-centered, i.e. centered on medical records. A medical record is a collection of data about a patient, notably endoscopic images. In gastroenterology, endoscopic images are key, at the heart of practices, diagnostic and therapeutic approaches.

However, Syseo* supports the social dimension along three functionalities: the sharing of medical data either privately between two doctors or publicly for capitalization (e.g. teaching); the request of expert advices; the management of the practitioner's professional network. Information is stored on the cloud, making it possible for medical practitioners to manage

medical data and professional relationships within a unique application. Online cloud-based services are envisioned for improving the quality of medical cares: sharing confidential medical data among practitioners; requesting advices from experts to improve diagnoses; taking benefit from online services, such as endoscopic image analysis or 3D reconstruction.

THE PEARL METAPHOR: PEARLY UI

The pearl metaphor is based on two principles: (1) in terms of abstraction, modeling socially augmented entities instead of classical entities only (actors, data and tasks); (2) in terms of presentation, using the sets of actors and data (i.e., the pearls) to visualize social relationships. This metaphor is generic, applicable to several fields such as cloud-based email services. In this paper, it is applied to health care.

The abstraction of Pearls: Socially augmented entities

Lahire (Lahire 2010) claims that sociality is not restricted to social interactions between groups. He defines sociality as a relationship between two human beings. A document, and thus a data, as a communication trace between two human beings, may represent such a relationship (Pédauque 2003). Therefore, a data has a social status. Based on these observations, we propose to transpose the social relationships from the real world to the digital world. This gives rise to a taxonomy of Socially Augmented Entities (Figure 2) based on core entities (data, actor and task as modeled in HCI and CSCW (Van Welie et al. 1998), and their intra versus inter relationships. Data cover the information that is manipulated by an actor while achieving a task. In our case study, data can be a medical record, an endoscopic image, etc. Cloud services, such as image analysis or 3D reconstruction, could be applied to them.

Actors denote the stakeholders involved in the system: they manipulate data and perform tasks.

In our case study, actors are doctors, secretaries and medical students. Cloud services, such as medical workflow management, would apply to them.

Tasks describe the goals actors are intended to achieve. They are usually decomposed into sub-tasks. In our case study, the main task is the patient follow-up. This means for the doctor to perform tests, capture images, communicate with colleagues, etc. Cloud services, such as best practice recommendation, would be applicable to them.

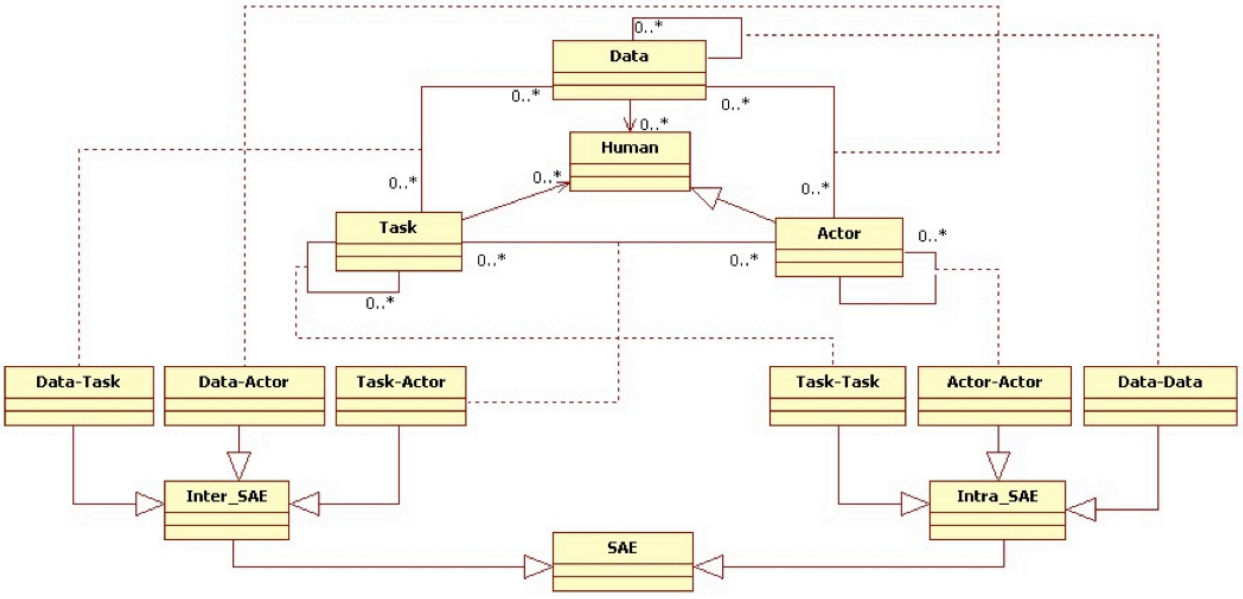

Figure 2: Taxonomy of Socially Augmented Entities.

Relationships between these entities constitute extra information that enriches these entities and create Socially Augmented Entities. Relationships may be intra or inter. “Intra” makes reference to relationships between entities of the same type:

- *Actor–Actor*: Social proximity between actors (e.g., frequent collaboration between two doctors, the patient-doctor relationship) may enhance the Actor entity and thus may be considered as a socially augmented entity. Mailing services based on cloud would apply to these SAE.
- *Data–Data*: Data may be socially augmented instead of just being logically linked

together (hierarchy, database, etc.). The decoration of a relationship with its type is a good example (e.g. genealogical relationship between a father's and a son's medical records for the prediction of hereditary pathology). Cloud services, such as family history research would apply to these SAE.

- *Task–Task*: Enhancing the tasks with experts' practices is an example of this category. This extra information could be presented to the doctor to serve as an advice. Cloud services such as expert systems would apply to these SAE.

"Extra" makes reference to relationships that involve entities of different types:

- *Data–Actor*: Both are socially linked. Actors produce or use data to achieve their goals, giving them a social status (private, confidential, public). Conversely, data may embed social information about these different actors. In our case study, a medical record (data) is associated to a patient (actor) and, at least, to a practitioner (actor) who takes care of this patient. A medical record can also be associated to a student (actor). This relationship may also in addition give rise to indirect relationships between actors as these actors (patient and student) do not necessarily know each other, but share data. Cloud services such as sharing information (confidential or anonymous) or correlating medical records would apply to these SAE.
- *Data–Task*: Tasks are socially linked to data as the social status of data may influence the task execution. For example, updating (task) a medical record (data) by another practitioner, as the referring doctor, is allowed if this medical record is shared. Conversely, performing tasks implicitly augments data with social data (e.g., the production (task) of an endoscopic image (data) added to the medical record available to the patient and the doctor; sharing (task) an image (data) for an expertise). Services such

as traceability of medical activity (last exam, last appointment, last update, etc.) available in the cloud would apply to these SAE.

- *Task–Actor*: Actors may achieve a same task in different social contexts. For instance, decision-making can be done during a multidisciplinary meeting involving several specialists, or during an examination with just the surgeon. Cloud services such as requesting an advice or sharing information would apply to these SAE.

This taxonomy provides a powerful support for identifying and selecting the relevant socially augmented data for cloud-based applications. SAE inspired the proposition of Pearly UIs.

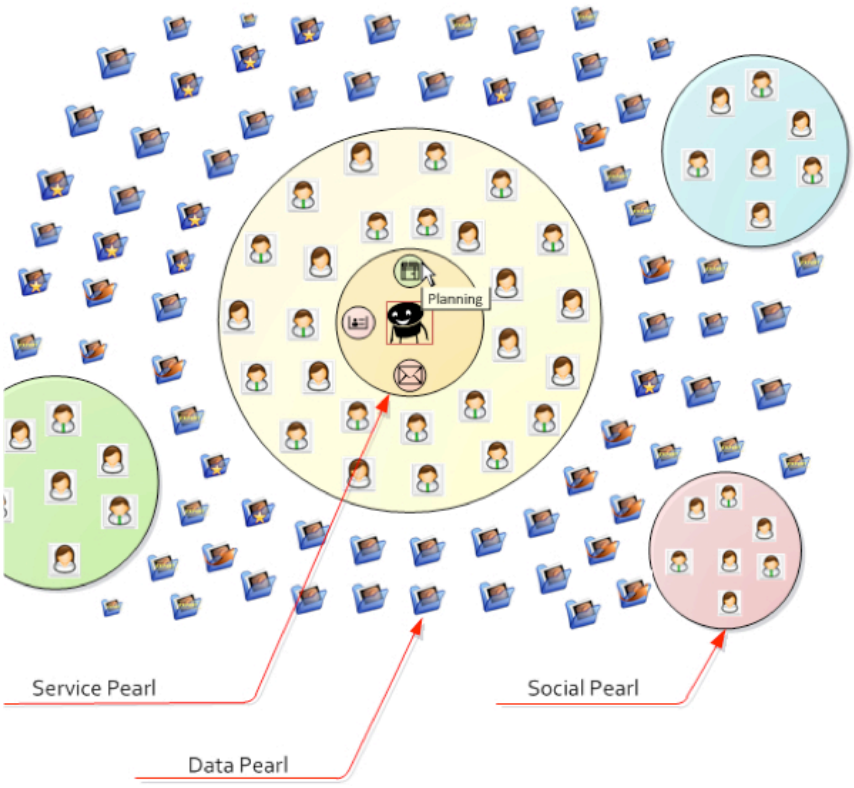

Figure 3: The PearlyDesktop: user- and data-centric view.

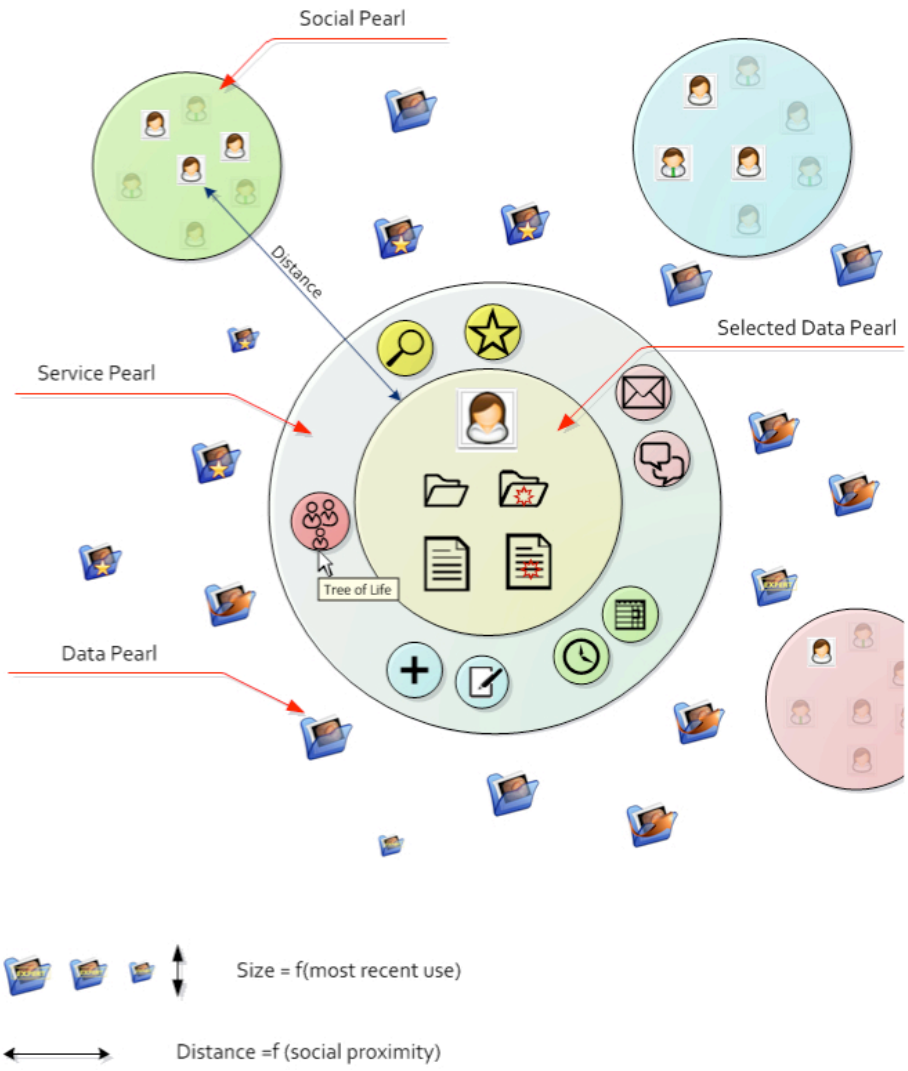

Figure 4: The PearlyDesktop: user- and service-centric view.

Figure 3 represents the socio-professional network of the user (at the center). Data Pearls are represented by an icon symbolizing a folder and gravitate around these social pearls. Figure 4 represents a selected data pearl (at the center). Other data pearls are distributed around the selected data pearl according to their "Intra" relationship (i.e. correlation between two data pearls).

The presentation of Pearls: towards Pearly UIs

The Pearl metaphor revisits the classical desktop to support interactive visualization of socially

augmented data related to data, actors and tasks.

Three kinds of pearls are identified (Figure 3 and 4):

- Data: they are collections of data about people or groups of people. They embed a part of their history. They can be shared, stored, annotated, etc. and may be influenced by the context.
- Social relationships: are communities (friendly, professional, familial, etc.), created by the user.
- Services: the services that apply to data (respectively to actors) are displayed as pearls around the data (respectively the actors) pearl.

Data history is represented by the size of the icon: the bigger icon is, the more recent data is.

The "Extra" relationship is represented by several ways:

- The spatial proximity of a data pearl (Figure 3) with regard to two actors (or communities) indicates its level of sharing.
- Only actors who have a relationship with the data pearl are highlighted in the different social pearls (Figure 4).
- The services offered in the service pearls depend on data (respectively on actors) and their relationships.

PearlyDesktop: the running prototype

We chose to first represent the relationships between actors using a network-based visualization as it is suitable for social networks (Henry and Fekete 2010). Figure 5 represents the socio-professional network of Dr Roger (at the center). It depicts different kinds of socially augmented data: direct and indirect social relationships between actors (grey lines), as well as professional communities related to Dr Roger (the colored pearls, e.g. orange for colleagues, green for

institutions, etc.). The distance between icons indicates the social proximity between actors. For instance, doctors' community (orange pearl) is the closest to Dr Roger.

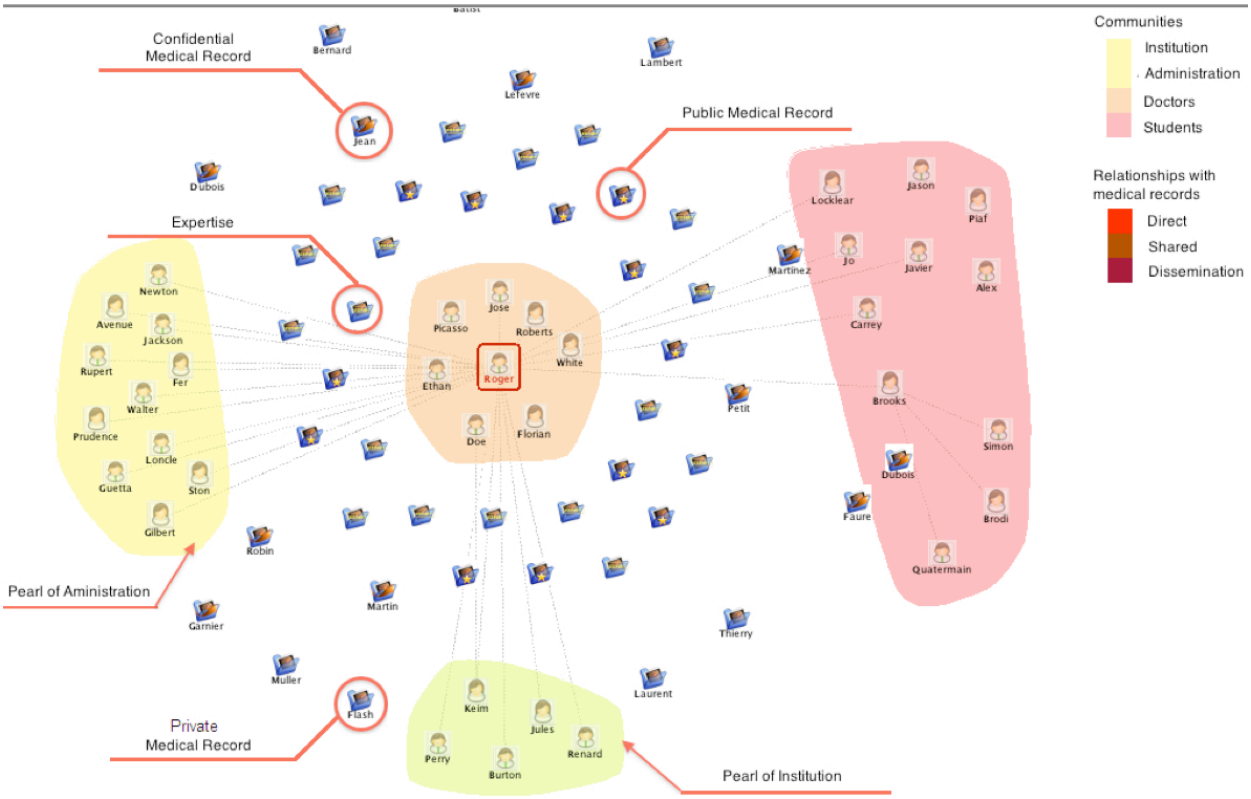

Figure 5: Pearly UI.

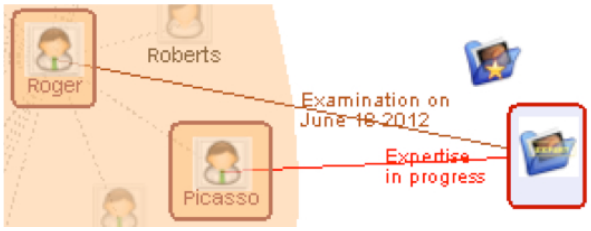

Figure 6: An inter Actor-Data relationship.

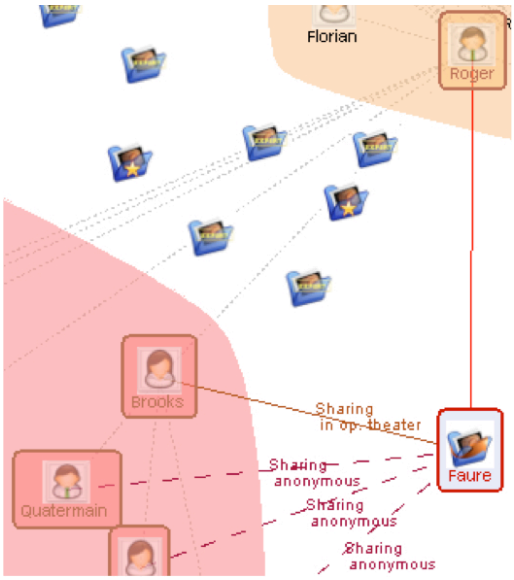

Figure 7: Indirect relationships.

In our case study, data pearls are medical records. Their social status is visible on the icon. It may be (Figure 5):

- *Private*: only a patient and his referent doctor have access to it;
- *Confidential*: sharing is restricted (e.g. to family doctor or patient's relatives);
- *Public*: the record is anonymously shared, for instance, for pedagogical use.

As shown in Figure 6, links between records and actors are labeled to indicate the current status of medical activities.

Three categories are considered:

- Most recent tasks or next tasks to achieve (e.g. last or next examination).
- Sharing status: as shown in Figure 6, the state of an expertise request or the state of a medical record for an hospital admission is indicated.
- Traceability: direct or indirect sharing. For instance, sharing a private medical record with a colleague, a student or the administration is direct. Conversely, the dissemination of anonymous medical records (e.g. between two students) is indirect. Such relationships

between actors are represented using dashed lines. For instance, Figure 7 shows that Mr. Faure's medical record is directly shared between Dr Roger and Brooks (grey line between Brooks and Dr Roger). However, this record is indirectly and anonymously shared between Dr. Roger (via Brooks) and three other students: purple dashed lines are displayed between Mr. Faure's medical record and students (e.g. Simon) who have access to this record. Such visualization is powerful for displaying the dissemination network. This is crucial in health care where security is key.

When clicking on an entity (actor or medical record), details are provided at the right side of the UI. Using check buttons at the bottom of the UI, the user may filter information depending on the social status of the medical record or on the state of expertise.

FIELD STUDY

Based on an iterative user-centered approach, we conducted two successive qualitative experiments to evaluate the pearl metaphor. For that purpose, we implemented the PearlyDesktop as a Java prototype based on the Prefuse (Heer et al. 2005) and Vizster (Heer and Boyd 2005) software libraries devoted to interactive visualization.

Protocol

Four experts were recruited: three doctors (participants P1, P3 and P4) to validate the characterization of socially augmented data and the relevance of their presentation, and one specialist of medical information systems for gastroenterology (participant P2). Fifty medical records were put in the database.

Each interview lasted about one hour, and was divided into three parts: (1) presentation of the prototype, (2) playing scenarios, (3) filling a qualitative questionnaire. All interviews were

recorded and then transcribed.

The first part consisted in presenting the main features of the UI. We chose to represent the fictive professional network of Dr. Roger filled with fictive medical records.

For the second part, participants had to perform three different kinds of tasks identified as representative:

(1) Search for an expertise,

(2) Search for a private medical record shared with a student,

(3) Control the dissemination of a sensitive medical record.

At the end of this part, users were invited to provide comments about the prototype (usability, utility, etc.).

At the end of the interview, in order to identify and understand more precisely their vision of socially augmented data, participants had to fill in a qualitative questionnaire. This questionnaire is divided into four sections, articulated on: (1) actors, (2) data, (3) tasks, and (4) relationships between these concepts.

Findings

In this section, we summarize the main results related to participants' perception of social data and their pearl-based representation.

Pearly UI: a social desktop for the Cloud

Gastroenterologists were eager to play with PearlyDesktop.

As ephemeral (e.g. related to students) or persistent (e.g. colleagues) medical networks are important aspects of their activity, participants appreciated the network-based visual representation (P1, P2, P3 and P4). "The structure of the interface is fine: the visualization at the center and the details displayed in the panel on the right. Legends and filters are meaningful and

easy to use. They provide a better understanding and are useful to filter at a finer grain" (P2)."We can view our closest contacts and shared folders. [etc.] It's interesting to see the referent doctor of a medical record or the specialist to contact for an advice"(P1). Participants suggested improvements such as the visualization of the "relationships within families to better detect hereditary diseases" (P2, P3, P4), or of "similarities between medical records to find the right dosage of a medicine drug or to improve medical decision-making" (P4). They also mentioned scalability as critical: how to represent a huge set of data without disrupting the user experience? In addition, during the interview, several participants mentioned the importance of the temporal worth of data: access frequency to a medical record, creation date of medical records, or doctor's schedule. They also suggested improvements including an alphabetical sorting of medical records (P2), or "a grouping of contacts [within a community] as concentric circles around the center" (P1). Another improvement is to make a clear distinction between "active medical records and medical records of dead patients or patients that will never come back" (P2).

Social sharing and browsing

Participants very much appreciated the possibility to share data and thus to support a better communication among stakeholders: "situations of information sharing are numerous: between practitioners about a patient, with laboratories, with the hospital for admissions, [etc.]" (P4). Lack of sharing today is a real problem: "we do not know who see whom" (P4). "We do not have a full access to information about a patient which is crucial to know, for instance, what the different medical treatments are, or to know if the process care for a patient is well managed: our colleagues have difficulties to share data" (P3, P4). This issue may be explained by "the fear of loosing control of their data" (P3), especially with the shift to cloud-based solutions.

Thus, the pearl metaphor was found useful to support sharing and communication activities, thanks to a visualization that merges a view on medical data with the professional network. Participants also pointed out the ability of the metaphor to support traceability. It offers “a better visibility of the medical activity” (P2), and allows “controlling the dissemination of data which gives a feeling of safety" (P3). "For confidential medical records shared with a student, it is essential to always know what happens to this medical record. With another gastroenterologist, the responsibility is shared "(P3). However, if a student “decides to share this medical record with anyone, the doctor is responsible of.” (P3).

Browsing medical records is another issue. A gastroenterologist manages about 90 medical records every month, about 50 records every day (P4). During his/her entire career, a practitioner usually collects “between 15,000 and 30,000 medical records” (P2, P4). Adding the social dimension to medical data may facilitate the browsing. Indeed, participants underlined the fear of browsing a huge amount of medical data, in particular when asked for an “advice by phone” (P1, P3).

Social information seeking and re-finding

Participants appreciated the organization of the workspace according to the communities. However, participants also pointed out some issues: “This representation is fine because the pearl is small [to find a medical record]. If the pearl is small, we glance through the different medical records, but if the pearl is larger, how to find easily a medical record?” (P1). Currently, doctors do not have time to waste for medical record searching (P1).

It therefore seems necessary to allow users searching using more attributes similarly to pivot browsing: “by age range, by type of examination or pathology, by place of examination” (P3). “When we search for a patient by its name, it’s because there is no relevant criteria for this

medical record, or pathology has not been informed" (P1)."We do not necessarily remember patient names, but rather a time, a date or a place." (P3). For these situations, our metaphor appears meaningful, as the social worth of data constitutes additional criteria. This idea seems very suitable for "young doctors or doctors managing a large number of patients" (P3).

DISCUSSION AND IMPLICATIONS

Participants' feedbacks are very positive. Still, it raises issues that must be addressed by future research.

Social desktop for the Cloud: Pearly UI

The experimentations point out the limits of data-centered metaphors: information is fragmented and distributed across different services – email services to manage contacts (actors), health care information systems to manage medical records (data), etc. Our PearlyDesktop prototype appears as a promising answer to (partly) satisfy the needs of health care professionals.

Similarly to Pham's user-created groups (Pham 2010), we promote an enlarged folder metaphor to integrate the social worth of data. Although Pham's proposal is based on a visualization that only focuses on relationships among actors, our approach merges two views: data and actors. In addition, depending on the social status of actors and data, and on the social relationships among actors, the view on data may be restricted or enlarged. For instance, while access to medical records would be restricted for students, a referent doctor may have a full access to a medical record managed by a gastroenterologist.

Compared to CloudRoom (Terrenghi et al. 2010) that relies on different and disconnected views to access data, we foster a metaphor that reveals the context of data such as the social orbits of (Sawyer et al. 2012) (e.g. physical location related to data such as an operating room or a

medical office). The temporal dimension constitutes another means to reveal such a context. However, we have to revisit the interaction to comply with Schneiderman's mantra: "Overview, zoom and filter, details-on-demand": "We should see data, cluster, relationships and gaps of data. [...] The user zooms in on what he wants to see, filter it does not want and click on the item for which he wants information" (Schneiderman 2010). Currently, we investigate how to combine this user-centered representation with a time line, to allow users to zoom and filter, that preserves the representation of the social context of data.

Social sharing and browsing

Thinking Cloud is far from being easy for users. They are not familiar with this way of organizing data (Mell and Grance 2009; Odom et al. 2012). Obviously Dourish's concept of « Placeless document » (Dourish 2003) is fully relevant: neither absolute paths nor hierarchical organizations make sense anymore.

The health community is strongly constrained by the need of medical confidentiality. Despite the diversity of solution in the medical field, there is a fear of loosing data control, which limits the sharing between medical professionals. Such as circles in Google+ (Kairam et al. 2012), the pearls (communities) allow an easier and faster sharing. We are taking the pearls concept a step further by providing a graph representation. This approach allows the user to become aware of these past and future exchanges, and gives a feeling of trust to the users.

Currently, data is presented as a list that doctors do not browse. They search only by keywords. The fear of browsing a huge amount of medical data also appears with this visual representation. We propose to enhance data with the social dimension to support pivot browsing, as proposed by Dourish. Socially augmented will make it possible to parameterize the browsing.

Social information seeking and re-finding

During these experiments, the visual representation as well as filters appeared as sufficient for the addressed research scenarios. Surprisingly the users did not use the search entry. Similar to the social orbits (Sawyer et al. 2012), this reorganization of the workspace according to communities facilitates information seeking.

As proposed by Muralidharan (Muralidharan 2012), the social worth of data is used to make relevant the medical activity on record (i.e. patient appointments with a specialist). To indicate the status of activities (the last exchange, the last appointment, etc.), we proposed to label relationships.

In the future, we plan to integrate the context into our taxonomy so that to ensure a situated interaction. By context, we mean all the environmental information (e.g. social, physical) that may influence the user while performing his/her task.

Context may be a means for filtering information as well as pushing the right information at the right time. This opens research on user interface plasticity.

CONCLUSION

This paper presents a new metaphor targeted for the cloud. The contributions are twofold: on one hand, a taxonomy of socially augmented entities; on the other hand, the concept of Pearl for empowering users with these socially augmented entities. We consider the social dimension as an approach to provide a first answer to the issues raised by Cloud computing. For instance, highlighting the social status of entity constitutes a means to represent sharing of data and traceability. Our application domain, gastroenterology, illustrates this: as underlined by the medical practitioners we have met, this feature is highly relevant about medical confidentiality.

Early feedbacks from medical practitioners encourage pursuing. As underline, there are several issues to address in order to improve the metaphor and thereby our prototype.

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