History-enriched spaces for shared encounters

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1 Introduction

Today, people create and interact with digital media in various places using mobile phones, digital cameras, notebook computers, public displays, and so on. Moreover, historical data about people, places, and physical objects are increasingly captured and accumulated in various forms. We can use such data to effectively support verbal and non-verbal communications in encounters if we can provide the 'right' information at the 'right' time, at the 'right' place, in the 'right' way, and to the 'right' people.

We discuss the uses of historical data to support shared encounters based on our experience of deploying social network displays that respond to RFID conference badges. When people introduce themselves to strangers at social events such as academic conferences, they sometimes reveal their historical information by telling brief stories about past experiences. Historical data can similarly be revealed on personal devices or public displays to support existing practices such as self-introduction. Moreover, historical data may support awareness about opportunities of meaningful conversations before people engage in face-to-face communications with strangers, thereby supporting the process of shifting from unfocused to focused interactions (Goffman, 1963).

Historical data, such as academic publication databases, blog archives, web and email log files, product purchase records, music playlists, and location tracking data, may collectively reflect temporal patterns of social relations that influence risks and meaningfulness of encounters. However, extracting human relationships from all kinds of historical data would cause serious privacy problems. Privacy is a complex issue as people have simultaneous need to disclose their information and protect privacy, and

privacy implications of historical data change when they are processed and presented in different ways, in different context. One may disclose her personal data if there is a clear value proposition. However, it is generally difficult to control privacy-sensitive data once they are digitally captured.

Instead of dealing separately with privacy, we explore a holistic view (Dourish & Anderson, 2006) of shared encounter practices to understand everyday context in which people disclose and acquire information. We first take a closer look at spatial patterns of social practices in public spaces, and argue that naive uses of historical data could undermine "the power of constraints" (Erickson & Kellogg, 2000) that physical spaces provide. The richness of people's spatial patterns suggests that supporting shared encounters is more than just detecting people in proximity and establishing digital communication links. It also concerns with the process in which individuals become "accessible, available, and subject to one another" (Goffman, 1963:22), and technologies of course should not force people to be friends with each other.

Weakly-involved interactions are an important element of public spaces in which shared encounters take place. Strangers act in awareness of others even when they are not talking with each other. For example, without engaging in face-to-face interactions, people could improve a sense of belonging through a means to increase awareness of familiar strangers (Paulos & Goodman, 2004). Wear and tear of library books and black streaks on guardrails are collective, incrementally accumulated information that informs and influences people.

Based on these considerations, we also discuss an approach to designing a history-rich awareness tool for pedestrians, and describe our prototype that utilizes mobile blogs and an RFID-based distance sensing mechanism.

2 Supporting Social Encounters in Academic Conferences: A Case Study

Encounters take place in different physical and social settings. Some settings, such as a busy sidewalk, are full of strangers who rarely talk with each other. In other settings, such as a conference banquet, people are more likely to meet and begin relationships.

Different settings provide a different amount of information about the people in them. For example, we may know more about strangers at a conference banquet than strangers in a busy sidewalk. What physical and social spaces inform us about their people is an important resource for *assessing* the interactions with strangers (Karp, Stone & Yoels, 1991:101).

By blending digital information with physical and social spaces, we can make more resources available for such assessment. Digitally-augmented spaces could in effect reduce some uncertainties in interacting with strangers. They could also increase clues for discovering opportunities of meaningful encounters.

An important challenge then is to blend the 'right' information in the 'right' spaces in the 'right' way and thereby increase the 'right' encounters in our everyday lives. Our first step towards addressing this challenge is to examine a system that supports shared encounters in academic conferences. We additionally discuss specificities and commonalities of encounters in different physical and social spaces.

2.1 *DeaiExplorer*

Academic conferences offer many benefits that virtual meeting tools cannot easily offer: rich, interactive presentations and demonstrations, various opportunities to socialize and make new friends, serendipitous discoveries of relevant ideas, people and projects, and so on. *DeaiExplorer* [1] (http://www.tkl.iis.u-tokyo.ac.jp/socialnet) is a system that enhances conference experiences using the data accumulated through a research community's history (Konomi et al., 2006). The system allows colocated conference participants to easily display and examine relevant social networks (see Figure 1), which is derived from DBLP (Digital Bibliography & Library Project) (Ley, 2007), a publication database covering major computer science journals and proceedings. It responds to RFID conference badges, automatically displaying relevant social networks for individuals and groups.

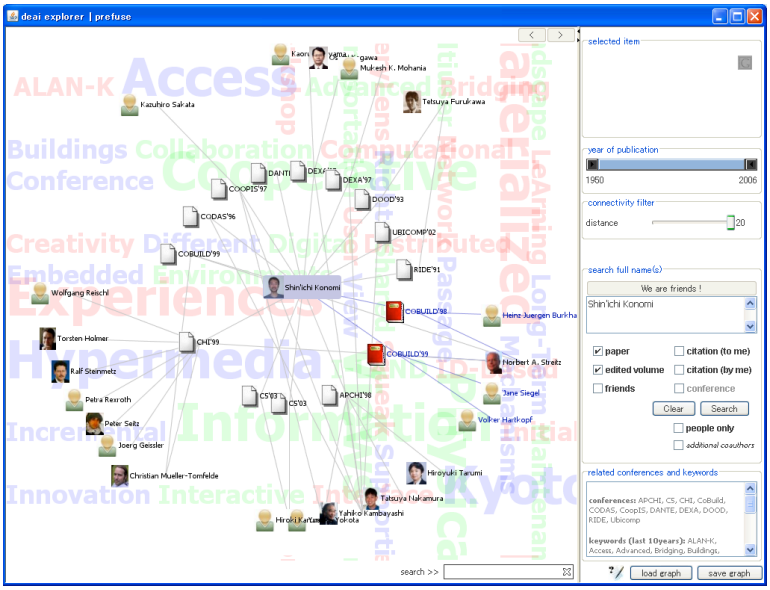
DeaiExplorer was first deployed at the 21st International Conference on Data Engineering (ICDE 2005) that took place in Tokyo during the second week of April 2005. We used this opportunity to conduct a user study (Konomi et al., 2006) and iteratively improved the system by additionally deploying and testing it at the following conferences: the 6th International Conference on Web Information Systems Engineering (WISE 2005), the 7th International Conference on Mobile Data Management (MDM 2006), and the 9th International Conference on Asian Digital Libraries (ICADL 2006).

[1] *Deai* is a Japanese word for encounter.

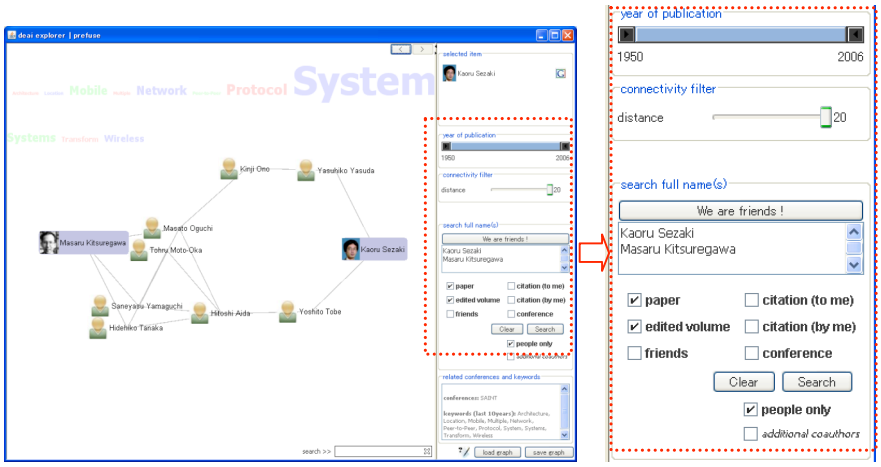
Figure 1. People using *DeaiExplorer* at the 21st International Conference on Data Engineering (ICDE 2005). Two RFID readers are connected to each public display, which responds to RFID conference badges and shows relevant social networks.

As shown in Figure 2, the latest version of the software additionally displays research keywords using a tag-cloud format. When an individual uses the system, it computes a *personal view* (Figure 2a) that combines her research keywords and egocentric social network. Likewise, when a group uses the system, it computes a *small-world view* (Figure 2b) that visually combines the group's common research keywords and 'group-centric' social network showing shortest paths between its members.

Users can passively view or actively explore the social network visualization. Using simple mouse operations, one can zoom in and out, navigate the networks, display additional information in a popup window, and search the web for more information. Moreover, users can examine historical evolution of their academic social networks by using the range slider labeled "year of publication". Figure 3 shows a sample use of the range slider. The social network became increasingly dense and connected during the period between 1995 and 2006.

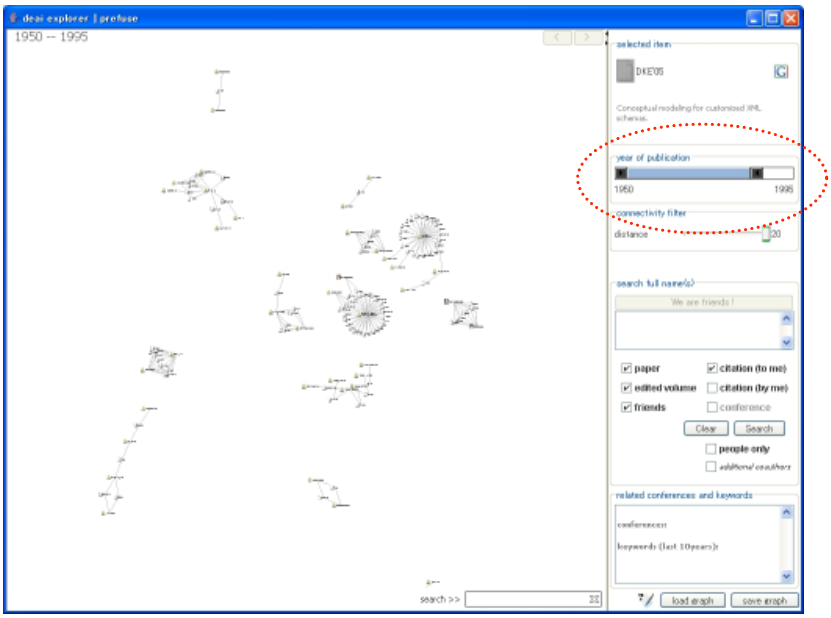


(a) *Personal view* showing an egocentric social network

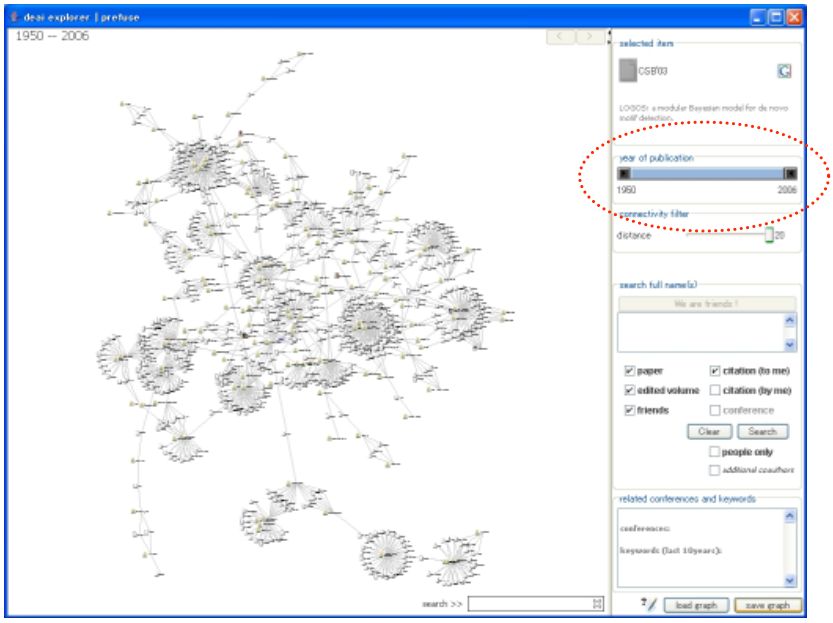


(b) *Small-world view* showing a 'group-centric' social network including the connecting paths of the two users, one on the left and the other on the right.

Figure 2. Sample screenshot of *DeaiExplorer*.



(a) Social network derived from the 1950-1995 data



(b) Social network derived from the 1950-2006 data

Figure 3. Exploring historical patterns of a social network.

Publication databases may not embody certain social relations including people who rarely publish together but chat with one another a lot, or people who just made friends with one another during a conference. The "We are friends !" button (see Figure 2b) allows people to explicitly declare a 'friend' relation. This may sound similar to "adding friends" on social network websites such as MySpace and Facebook.

The system provides various options for customizing social network computation. The check boxes (see Figure 2b) allow users to specify the relationship types that must be considered in deriving social networks: "paper" (co-authoring papers), "edited volume" (co-editing books or proceedings), "friends" (declaring "We are friends !" relations), "citation" (citing other researchers' papers), and "conference" (publishing in the same conference proceedings). The "people only" check box hides document icons in the visualized network.

During the second, the third and the fourth deployments, we provided the service without using RFID conference badges. Therefore, the cost of these three deployments was much lower than the first deployment. The largest drawback was that users had to manually input their names using a keyboard. This did not seem to put off users so much in our particular settings (i.e., technical conferences in computer science), however, could be problematic in other settings.

2.2 Issues of Supporting Social Encounters

In our experiences with *DeaiExplorer*, some issues emerged around the quantity and quality of contents as well as the complexity of social processes. We summarize how these issues came into play based on our data from the first deployment (Konomi et. al, 2006) and anecdotal evidences from the other three deployments. Moreover, we discuss similarities and differences between academic conferences and other public settings.

2.2.1 Quantity and Quality of Contents

We appropriated a publication database as the contents for supporting shared encounters. Publication databases of course do not embody all kinds of human relations; however, they describe certain types of relations very well, such as the ones based on coauthoring and citing. These relations are often of interest to conference participants, and therefore their visual representations could complement physical and social spaces of a conference.

Contents are indeed critical for successfully supporting social encounters in our service. Quantity of contents alone can substantially influence user experiences. For example, since *DeaiExplorer* computes social networks based on each user's publication records, it may display small, rather trivial networks for newcomers of a research community, and large, overwhelmingly complex networks for highly experienced researchers. Since too little or too much information can disappoint or frustrate users, we added certain features to improve user experiences. For example, the system now allows people to use the "We are friends !" button so that newcomers can immediately populate their networks without writing papers[2].

It should be easy for users to make sense of the visualized relations. The current version of the system is implemented by using the *prefuse* visualization toolkit[3] (Heer, Card, & Landay, 2005) and allows users to interactively explore and make sense of complex social networks using animated effects as well as various mouse and keyboard operations. It displays 'group-centric' social networks using a force-directed layout algorithm, and egocentric social networks using a radial layout algorithm (Ka-Ping et al., 2001). Also, users often asked which journals and conferences our system incorporates so that they can correctly interpret the displayed social networks. It was not too difficult for us to answer such questions since the system uses a well-structured publication database, rather than arbitrary information on the web.

We have to think carefully about what people might feel about sharing their contents in public spaces. This is undoubtedly a critical issue when we talk about sharing what users normally consider private. From our experiences, we learned that this can also be an issue when we talk about sharing *public* data. Privacy implications change when information is processed, aggregated, or presented in different ways. Even though we only used publicly available data from a publication database, the way the system visualizes the data clearly shows the amount of papers one has published. Anecdotal evidences suggest that some people could have been intimidated or unwilling to use the system especially when the information is displayed on a public display. It is not only the contents but also uses and context that influence privacy perceptions. Given the diversity of public spaces and the social encounters that take place in them, general-purpose solutions would be quite limited in terms of preserving privacy and supporting encounters.

[2] The system visualizes different types of relations by using colors and icons.
[3] http://www.prefuse.org

2.2.2 Complexity of Social Processes

Settings can facilitate or inhibit social encounters. It is uncommon that someone overhearing strangers' conversations in a crowded elevator easily joins the conversations even if he is interested in the topics. People are more likely to break in and interact with strangers in a party or a coffee break of an academic conference. Also, extraordinary events such as an earthquake are likely to facilitate strangers to interact with each other.

Settings help define the meanings of behaviors. They may also provide some information about the identities and biographical details of people in them. They can then reduce perceived risks in social encounters, and indeed *some settings may reduce substantially the uncertainties normally accompanying interactions with strangers* (Karp, Stone & Yoels, 1991:101). Digital contents can augment physical and social spaces and enhance settings of social encounters in terms of time and space. However, digitally-augmented settings may not effectively support encounters unless it is integrated with human interaction processes and social conventions.

We can easily capture, store, retrieve, and use a large amount of historical data in digitally-augmented spaces. For example, *DeaiExplorer* accumulates and uses historical data to support social encounters, i.e., the system uses historical social networks in a publication database as well as the "We are friends !" button that incrementally captures social relations during conferences. These mechanisms can enhance people's presentation of self and communication in social encounter processes. Moreover, historical data may influence the meaning and atmosphere of a setting through aggregation and collective visualization.

Digital media allow for communication across distances. Though this statement may invoke the image of geographically distributed people using email or video communication tools, we would like to examine digital media's impact around much smaller distances, such as the ones across which people can talk, walk, and identify others. In particular, ubiquitous computing technologies change our 'abilities' in the space that immediately surrounds us. For example, Bluetooth technology may allow people to 'see' everyone in a crowded room and search the best nearby people to speak to, and mobile social networking tools such as *dodgeball.com* may allow one to announce her presence to 'friends' in the walking distance.

As humans, we develop our abilities to use various physical and social distances in the real world (Hall,1966). Therefore, we can view digital technologies as something that can not only remove some distances but also extend and complement distances. Our experiences with *DeaiExplorer* suggest the importance of *social translucence* (Erickson & Kellog, 2000) in supporting social encounter processes. For example, in our user study,

some people stood at a distance and passively observed others using *DeaiExplorer*. We could extend the system by installing a video camera so that observers can view the screen anywhere. Alternatively, we could support the passive observers so that they can eventually be involved (or not involved) in social interactions by developing mechanisms that exploit their familiar distances.

After gaining information from the setting, people may decide to interact with one another. They often begin with nonverbal gestures to interactively probe others' willingness to respond. Then, there could be ritualized verbal exchanges about unimportant issues so as to again probe others' willingness to engage in conversations on more important issues. When strangers use *DeaiExplorer* without RFID conference badges, they sometimes say things like: "How does this work?", "Let's try together, shall we?", or "May I ask your name?" With RFID conference badges, the system allows people to display social networks without such verbal exchange. Strangers can exchange useful data to make informed decisions on weather or not to engage in conversation. When they come to decline, their reluctance can be communicated without discrediting or embarrassing others. However, informed decisions may not always be the best decisions if the information is not 'right' (e.g., erroneous, irrelevant, or incomplete information) or users don't have the 'right' skills to use the information.

Using RFID badges, we could potentially keep track of familiar strangers (Paulos & Goodman, 2004) as well as friends. However, a question remains about how much details we should remember about them. Besides privacy implications, digital traces may create unbalanced situations in terms of familiarity. Suppose users can use their personal computers to redisplay the (egocentric) social networks of everyone they use *DeaiExplorer* with. User A may not display B's information even when B displays A's information many times, which makes A familiar to B but B unfamiliar to A. If users can only display collective familiarity levels of a place using anonymous historical traces (Paulos & Goodman, 2004), such discrepancy might not be exacerbated as much. This seems to be one of the points where digitally- and physically-based social spaces diverge. The question about what we should remember about past encounters (and how we should use it) suggests a critical design parameter when we must carefully consider the ramifications of a key issue of shared encounters: lack of coherency and fragmentation in the sense of a shared space of community.

3 Towards History-Enriched Spaces

We now explore three complementary approaches to addressing the issues of supporting social encounters: (1) embedding historical data in embodied interactions, (2) designing for weakly-involved interactions such as social navigation, and (3) designing for privacy.

3.1 Embedding Historical Data in Embodied Interactions

Historical information is encoded in our everyday environments, influencing social encounters that take place in them. For example, interactions around greeting rituals allow one to express various feelings and thoughts while revealing some historical information. When we shake hands with elderly people, the tangible feeling of their hands may tell us something about the nature of their historical experiences. Simultaneously, we may mutually communicate willingness to engage in conversation by firmly shaking hands, making eye contact, and smiling. Note that interpretations of these actions depend on cultural context.

Historical data reduce perceived risks and uncertainties in stranger encounters. However, we cannot easily increase historical data in our everyday environment because existing physically-based media cannot store so much information. Digital media can remove such limitations; however, introduce the problems of information overload and privacy. We therefore need a framework to embed historical data in embodied interactions so as to provide integrated experiences that alleviate information overload and privacy problems. This embedding must reflect the use patterns of our immediate space and time, and it can exploit not only public but also personal and intimate devices including body-worn sensors.

We acknowledge that successful social encounters require certain human skills. These skills include not only the ability to passively assess interactions with strangers but also the ability to actively make interactions a success. We therefore consider learning as a critical element that makes history-enriched spaces meaningful. Critic agents (Fischer et al., 1990; Fischer et al., 1993), which provide feedback and suggestions as users go about their ordinary tasks, could potentially be useful for facilitating learning in situated embodied actions.

We could use the notion of distances (Hall, 1966) and context to create a framework that blends relevant human, sensing, and computational mechanisms together. To build on human abilities to use various distances in different context, we could align sensing and computational mechanisms with these distances. If it is difficult to perfectly align distances of

humans and machines, we can at least make people aware of the discrepancy.

3.2 Designing for Weakly-Involved Interactions

The provision of historical data about people, things and places can positively or negatively impact social encounters. Like wear and tear of library books or black streaks on guardrails, historical data can be collective, anonymous, and unintentional. Other historical data may be individual, traceable, and deliberate like resumes and pedigrees.

Interestingly, there are various weakly-involved interactions, which are much less costly than making friends. It can be argued that such interactions could meaningfully be augmented with context-aware technologies and historical data. For example, history-rich tools (Hill et al., 1992; Waxelblat & Maes, 1999) enable social navigation, which can be viewed as a type of lightweight interactions and is particularly useful for supporting newcomers to an environment. Without engaging in focused interactions, people could improve community solidarity and a sense of belonging through a means to increase awareness of familiar strangers (Paulos & Goodman, 2004).

3.3 Designing for Privacy

Privacy mechanisms define the boundaries of the self. Identity is a notion that is inseparable from privacy. Technology-mediated communication complicates regulation of the self/non-self boundary (Palen and Dourish, 2003). It changes the ways we perceive who is receiving information, what is received, and how it is received.

People have simultaneous need to disclose their information and protect their privacy (Smith et al., 2005). Privacy implications of historical data change when they are processed and presented in different ways. People would not want their personal data collected without a clear value proposition. There are technologies for preventing unwanted data capture; however, it is extremely difficult to control how data are processed and used once they are captured. Privacy again is a critical issue and it could potentially conflict with the interest to build history-rich tools for supporting shared encounters.

4 Going Everywhere

Inspired by the experience of *DeaiExplorer*, we designed a history-enriched framework for supporting pedestrians' awareness about relevant things, people, and information in a reachable distance, and implemented a prototype awareness tool using mobile blogs and an RSSI[4]-based technique to sense simple copresence patterns.

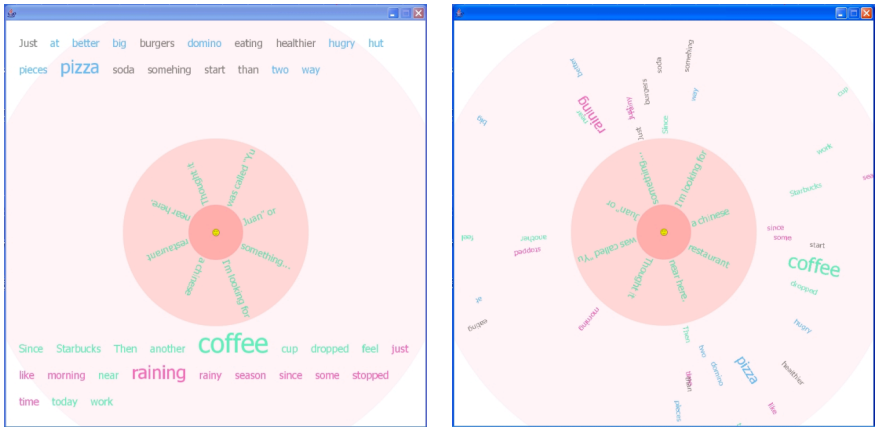
We developed a few scenarios in which downtown pedestrians visit various shops of their interest, or look for a lost child. We then designed a proxemics-based (Hall, 1966) awareness support framework that includes pedestrian devices and location markers. A pedestrian device has multiple communication ranges, each of which provides different visibility and controllability of relevant pedestrian-generated contents. Ranges can be defined by using radio coverage (and signal strengths), distance sensors, and positioning devices. Moreover, a pedestrian device can detect its movement by using these technologies. Pedestrians can exchange information, implicitly and explicitly, using ad hoc networks. One can access information about people, places, and things in her "social range" (< 3 m). Her device supports awareness about people, places and things in her public range (< 10m), through information filtering, summarization and abstract visualization. Finally, the framework considers not only physical distance and movement patterns but also cognitive and social patterns, which are embodied in location-relevant blogs and social networks, so as to support colocated pedestrians.

We developed a prototype awareness tool using an RFID-based technique for sensing simple copresence patterns. Our pedestrian device uses a small active RFID reader (RF Code™ Spider V Mobile Reader 303MHz) that can be inserted into a PC card slot. Active RFID tags (RF Code™ Spider V) are used as location markers as well as RSSI-based range beacons for pedestrian devices. The software component uses Processing and Twitter API to detect pedestrians in the user's social and public ranges, and anonymously visualize their recent mobile blog messages. Messages from the public range are decomposed and aggregated into a tag-cloud format, allowing the user to "smell" things that are ahead of and behind her. Figure 4 shows two users passing by each other. Figure 5 shows sample screen shots of the prototype awareness tool. Messages from the social and public ranges are displayed in the inner and outer circles, respectively. The tool displays public-range messages in two different ways. In (1), "pizza" is frequently mentioned ahead of the user; "coffee" and "raining"

[4] Received Signal Strength Indicator

behind the user. (2) displays words using a revolving animation effect, and is used when pedestrians' orientations are unknown.

Figure 4. Four copresence patterns of two pedestrians



(1) Tag-cloud visualization (2) Animated visualization

Figure 5. Sample screenshots of the prototype awareness tool.

We are conducting a user study to improve and extend the framework. As our initial experience suggests a limitation of RSSI in stably detecting ranges, we might possibly test a hybrid tagging device that combines RFID, Motes, and/or WiFi, and explore distance sensor-based and location-based range demarcation techniques as well. We also envision a mobile phone-based awareness tool using GPS and bluetooth. Continuous uses of a mobile awareness tool could produce historical data that can be used as resources for future services.

5 Conclusion

We examined our experiences with *DeaiExplorer* and discussed the implications of historical data in supporting shared encounters. Of course, aca-

demic conferences are just one of the diverse settings of shared encounters. Therefore, our understanding of the geographical, social and cultural diversity of encounter processes may still be limited. Moreover, it is not always the goal for people to socially encounter and develop relations. There are situations in which one wants to plausibly ignore others or talk with someone only once (e.g., when asking for directions). Another concern related to the use of historical data is that it could potentially reduce opportunities of surprising and inspiring encounters that existing data do not suggest.

To find the right way to capture, manage, and use historical data for supporting shared encounters, we must understand not only how people encounter today but also how people could encounter with the support of pervasive context-aware technologies. As technologies and practices of shared encounters co-evolve, new forms of social relations and ties could potentially emerge, greatly impacting fundamental mechanisms of our society.

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