A Multi-Dimensional Scheduler Supporting Critics

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ABSTRACT

Traditional scheduling software enforces a single model of describing events – the time stream. However, studies of activity and information management show that people's conception of time and events is richer. We describe a scheduling system based on multiple parallel forms of description. In addition to a richer description language, this scheduler also supports the use of critics as active elements in the scheduling process.

Keywords

Personal Information Management, ubiquitous computing.

INTRODUCTION

Increasingly, electronic schedulers are playing the role previously played by personal paper calendars. Their design has also generally followed the design of paper schedules. "Pages" of the schedule are laid out by day, week, month or year, and the user adds an event at a particular time or on a particular day. However, studies of both activity management and information management in everyday life point to some interesting questions surrounding this approach.

For example, Sellen et al. [4] explored the question of "prospective memory" – how people remember intentions to do things. One interesting element of this study is its focus on aspects other than time as a way of organizing intentions. So, some future events might be scheduled in terms of time ("at 9:30am tomorrow, I should attend the planning meeting"), while others might be organized in terms of people ("remember to tell Dick about the new deadline"), or in terms of locations ("don't forget to check my mailbox when I'm coming back from Debra's office.).

In the domain of electronic information, this observation is backed up by Bellotti and Smith's [2] study of the practice of personal information management. One of the things that they noted was that personal information management is not handled by a single application or device (e.g. a PDA), but rather is distributed across a whole range of applications and documents that people use. So, for example, email messages may be stored as reminders of actions or as easy ways to access someone's phone number; a Word document on the desktop might act as a reminder about an outstanding deadline; and a browser open on a bank web page may act as a reminder to pay a bill.

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What these studies demonstrate is that time-based scheduling, in practice, is more than just a matter of time. Scheduling, as it occurs in daily life, is the surface manifestation of a complicated balance between different needs and different dimensions of action. We wanted to explore the ability of electronic media to do more than copy the design of a paper schedule, by supporting some of this complexity.

A MULTI-DIMENSIONAL APPROACH

The primary focus of our attention was on *time* as the dominant organizing principle for calendar systems. In our system, which we call MultiScheduler, time is simply one of a number of dimensions. Like a normal scheduler, it allows users to indicate upcoming events according to the time when those events will take place. However, it also provides other dimensions according to which future events can be classified. Location is another dimension; future actions can be scheduled according to where those actions should take place (e.g. in particular rooms, around particular resources, etc.). Events can also be scheduled according to the People who are involved. So, for example, it is possible to schedule an event for an indeterminate time, but according to the people who must be present. These other dimensions of People and Locations are not subordinate to the conventional dimension of Time, but operate alongside it. Events can be scheduled according to the most meaningful dimension.

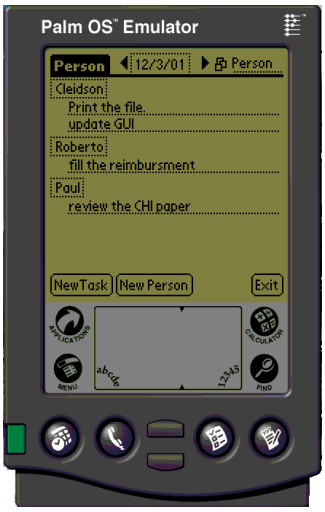

Figure 1: Events organized by Person.

Relationships Among Dimensions

Naturally, most events occur on multiple dimensions. Most meetings, for example, occur not only at a particular time but also in a particular place and involve particular people. Similarly, events whose primary characteristic is a Person

might none the less also have a location or a time component. Allowing people to specify related events according to dimensions other than Time allows them to express their needs more naturally. But it also allows the dimensions to be used as different ways to group events. So, a user can look at the same set of meetings in various ways – laid out in time, laid out in space, and laid out according to the other people involved. This ability to draw relationships across dimensions, based on a more elaborate specification of events, is also the basis of a critic-based approach to recommendations, discussed below.

Using the Scheduler in a UbiComp Context

One issue that we are exploring is the use of the scheduler in a ubiquitous computing environment. The goal of the design was to allow users to specify events in a form that was both richer and more intuitive. However, it is also interesting to consider that the alternative dimensions – Location and People – might also be a means of generating reminders. Like the prospective memory aids outlined by Sellen et al., the scheduler would be able to remind users of activities relevant to locations they are approaching, or to people who are nearby. Currently, this remains future work; for the moment, we are more concerned with the representational issues.

ELABORATING TEMPORAL RELATIONS

The introduction of alternative dimensions in addition to the traditional dimension of Time allows a richer description of events. A second concern that arises from examinations of event scheduling in the everyday world is the interrelationships between events, even those characterized primarily by time. In our model, sets of tasks (or appointments) can be associated with events. For example, a conference can be defined as a referential event to which many tasks can be associated. Examples of such tasks include: "book the hotel reservation", "pay the registration", "submit the reimbursement form" and so on. Those tasks can then be arranged with respect to this event (conference), i.e., some tasks have to be performed *before* the event (booking the hotel), others *after* (requesting reimbursement) and some of them *during* this event (paying the registration). These two elaborations of the temporal dimension – associating multiple appointments with a single event, and allowing events to be scheduled by relative time rather than absolute time – provide users with a richer way to describe events and their relationships.

USING CRITICS TO INTEGRATE ACROSS DIMENSIONS

Clearly, of course, one problem with a more elaborate specification language is the potential overhead of creating these events, and the potential complexity of making the most effective use of it. In part, this can be alleviated by appropriate form design, which allows users to specify people and locations associated with temporal events in ways that can be easily interpreted, or that allows them to use existing events as a basis for describing new ones by relative orderings. However, the notion of multiple dimensions means that, whenever a user approaches the system through one dimension, there are others that are not directly visible, and we were concerned to provide some mechanism that would allow the consequences for inter-dimensional references to be addressed.

One avenue that we have been exploring is the use of critics [3], human or machine agents capable of analyzing the user input. Computer-based critics are implemented as sets of rules or procedures for evaluating different aspects of a product. They are used embedded into a critiquing system, which monitors the user's actions and triggers a signal when any action violates or activates a critic rule. For example, a critic might look for appointments with similar dimensions in order to suggest the user to schedule these appointments together, according to one of the available dimensions, or at a similar moment in the time schedule. This critic will be activated wherever the user inputs an appointment to the application.

IMPLEMENTATION

Our implementation, in Java for the Palm Pilot, is integrated with the Palm OS PIM platform. Java's portability allows integration with different kinds of devices, from desktop PCs to small portable devices as cell phones and pagers. This characteristic facilitates the use of our application in the UbiComp context.

CONCLUSIONS AND FUTURE WORK

We have introduced a richer model of event description and specification, embedded in an early prototype scheduling system, which attempts to capture a more elaborate relationship between information and activity. It was inspired on observations of the multiple dimensions at work in scheduling and personal information management. Critics offer a means to control the complexity that the more elaborate model introduces. Especially in a ubiquitous computing context, we feel this model may have value.

ACKNOWLEDGEMENTS

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REFERENCES

1. Bellotti, V. and Edwards, K. 2001. Intelligibility and Accountability: Human Considerations in Context-Aware Systems. Human Computer Interaction, 12(2-4).
2. Bellotti, V. and Smith, I. 2000. Informing the Design of an Information Management System with Iterative Fieldwork. Proc. ACM Conf. Designing Interactive Systems DIS 2000, 227-237. New York: ACM.
3. Silverman, B.G. 1992. Survey of expert critiquing systems: Practical and theoretical frontiers. Comm. ACM, 35(4):106-127.
4. Sellen, A., Louie, G., Harris, J., and Wilkins, A. 1997. What Brings Intentions to Mind? An in-situ study of prospective memory. Memory, 5(4), 483-507.

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