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Socio-cognitive Grids: The Net as a Universal Human Resource

OSCAR DE BRUIJN

DEPARTMENT OF COMPUTATION, UMIST

P.O. BOX 88, SACKVILLE STREET, MANCHESTER M60 1QD, UK

KOSTAS STATHIS

DEPARTMENT OF COMPUTING , CITY UNIVERSITY

NORTHAMPTON SQUARE, LONDON EC1V 0HB, UK

Abstract :

We present the vision of a new form of complex system that we call *socio-cognitive grid*. We define what a socio-cognitive grid is and we exemplify the use of such a system with two different scenarios. We also outline a research strategy, which we argue will produce socio-cognitive grids by transforming the existing internetworking and web technologies into a human resource that will be accessible by anyone, at anytime, and anywhere in support of their everyday activities.

Keywords: Semantic Web, Disappearing Computer, Ubiquitous Computing, Software Agents, Cognitive Science, WWW

Introduction

On the one hand, we are increasingly witnessing all kinds of people using the Internet (or the Net) as an essential resource for their everyday information needs. The current *Semantic Web* effort [1] aims to support this further by giving content a well-defined meaning, enabling the common activities of searching, retrieving and filtering of content available through the Net to become more efficient. For example, the Semantic Web already allows the synergy with technologies such as *software agents* to synthesize disparate data into what is uniquely meaningful to a particular user.

On the other hand, what we are also witnessing is the fact that although the Net provides a very rich computing infrastructure, there are still large numbers of people that are excluded from using it. For example, not everybody feels comfortable with using a direct manipulation interface based on the *home page* metaphor. What we need is a Net that people can use, not just for their specific information needs and under a specific mode of use. In other words, we want the Net to act as a medium that offers a range of social and cognitive resources necessary for facilitating people's everyday activities and enhancing their social experiences through the use of a wide range of information appliances, devices, services and interfaces.

In our efforts to achieve this vision, we do not want to undermine the current research and development effort in internetworking and Web-based technologies. On the contrary, we want to acknowledge their importance in the opportunity arising from the convergence of a number of recent technological developments. What we have in mind here is recent work into context aware pervasive and ubiquitous computing applications, wireless and ad-hoc networks, the anytime and anywhere nature of the near-future Web with a semantic structure, light-weight distributed protocols such as SOAP, service-based technologies such as .Net, JINI, and Cooltown, P2P platforms such as JXTA, and intelligent software components such as agents.

What we think is missing, however, is a common vision for the nature of the applications that build upon these existing technologies to give people a Net that supports and empowers. For this we need a high-level framework that describes the necessary social and cognitive resources and acts as a common language for the interdisciplinary efforts required for realizing this vision.

By building upon the idea of the Net that is ubiquitously available to everybody through embedded artifacts, we propose a new area of interdisciplinary research concerned with the development of socio-cognitive grids in order to foster and integrate the many important current developments into a single and powerful effort.

Socio-cognitive grids

Informally, we can think of a socio-cognitive grid as a complex system offering an environment that people can use for the successful and efficient execution of their everyday activities. Much like an electrical grid that provides the power for electrical devices to operate, a socio-cognitive grid provides *cognitive* and *social resources* that people can access on electronic devices in support of common activities such as shopping, traveling and socializing. Cognitive resources are needed when people engage in complex cognitive activities such as navigation, remembering and problem solving. Social resources are needed when people are engaged in social activities such as interacting with other members of a local community or finding recommendations for a local restaurant when on a holiday abroad.

The idea of socio-cognitive grids originates from our participation to the EU i3 project LiMe (*Living Memory*) [3, 6], investigating the roles of agents and interaction in digitally connected communities. The particular question asked was how we design systems in which agents need to anticipate and satisfy the needs of lay people, who may use a range of different devices to access and share an evolving and situated collective memory pertaining to their neighborhood.

One of the lessons we learned in LiMe was that the interaction design of social (collaborative) systems need take into account not only the interactions with the various devices that people use, but also interactions between the people themselves (possibly mediated through the roles of software agents). Moreover, the interactions between the various kinds of software agents that reside in different devices, whose effective interactions are necessary to achieve the desired flow of information and accessibility to local community information, are equally important. All these interactions need to seamlessly complement each other in order to achieve the enhancement of social interaction between people within the connected community that the LiMe project ultimately aimed for. Therefore, the task of designing information systems for use by

lay people in support of their activities as members of a community and in which software agents are intrinsically embedded, is a very special challenge indeed.

Apart from LiMe the idea for socio-cognitive grids has also been supported by our more recent work. One line of this work is related to socio-cognitive grids by trying to support particular modes of interaction, such as *opportunistic browsing,* with both personal handheld and public embedded devices [2, 4]. The other line of this work can be related to the management of socio-cognitive grids by using societies of intelligent software agents, with the primary objective to specify and implement intelligent entities like agents using computational logic tools and techniques [e.g., 7].

Examples of Socio-cognitive Grids

To exemplify the kind of interactions that we envisage for the use of socio-cognitive grids we present two scenarios. The first scenario exemplifies the use of socio-cognitive grids in a local community context and is taken from our work in [3]. The second scenario exemplifies the use of socio-cognitive grids in global contexts to support location-awareness and is taken from our work in [5].

The 'Chess Tournament' scenario

You are having a coffee and a chat with some friends in your local café, when, suddenly, your eye catches some of the information that comes flowing by along the edge of the screen that forms part of the table at which you are sitting (Figure 1). It is an announcement of a chess tournament organized by the local chess club and you wonder if this is an event in which you might like to participate. You place your finger on top of the moving image on the screen and by sliding your finger across the screen you drag the item into the middle of the table where the full text of the announcement becomes visible.

After reading the text you notice a link to the electronic entry form for the tournament. You proceed to drag the announcement onto the icon representing the Coffee Table Agent - a piece of smart software that subsequently retrieves all the necessary information to enter and take part in the tournament. After some time has elapsed, during which you talked with your friends about the film you saw last night, you notice

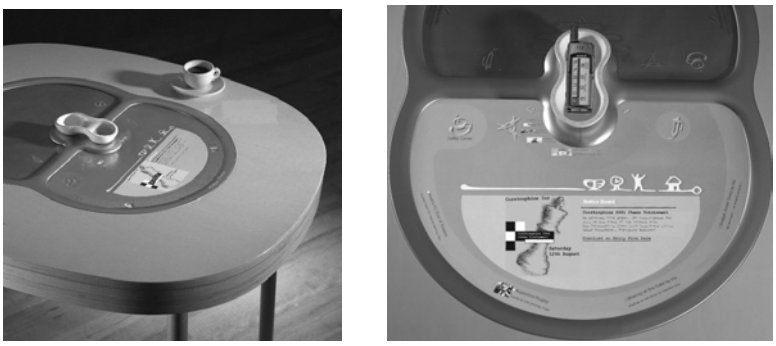

Figure 1: Pervasive information provision through an interactive coffee table and opportunistic browsing

an icon representing a hyperlink to the electronic entry form flowing by on the coffee table screen. You do not want to interrupt the conversation with your friends, so you simply store the hyperlink on your mobile phone, which you have placed in the middle of the table, so you can have a look at the form when you get home. The smart software agent in your mobile phone realizes that your regular chess partner might also be interested in taking part in the tournament, so it suggests forwarding the entry form to your friend. After you indicate to the agent that you think this is a good idea, the agent proceeds to send the form to your friend's home terminal.

The coffee table is still active and the Coffee Table Agent subsequently retrieves all the information it can find related to the chess tournament, such as the history of the local chess club and some pictures of the pub where the tournament will be held, and sends this information to your television set at home where you can browse it later.

The 'Leaving San Vincenzo' scenario

Frank Martin is an English engineer whose business trip to Tuscany in Italy is coming into an end. After preparing his suitcase, he has just closed the door of his hotel room, and he is heading downstairs at the reception to catch the taxi from hotel Belvedere (where he stayed for a few nights) to the train station of San Vincenzo (a Tuscan holiday resort where the hotel is situated). He has a train at 2:00pm going to Rome and the time is 1:30pm. When the door of the lift opens at the level of the reception, Frank sees a long queue of customers checking out. He has only started to be concerned about catching his train to Rome, when the noise of a message arriving from his *personal service agent* (PSA) attracts Frank's attention. By looking at the screen of his

communicator, Frank realizes that his PSA has already initiated the checkout process. The message reads:

> - I am trying to check you out automatically. Your bill has now been printed, I paid with the company's American express, and reception is now waiting for the card's authorization. Reception knows you are waiting nearby and informs me that your taxi is outside the hotel's entrance.

A minute later, the receptionist is calling Frank; at the same time he is typing the room number of a customer that he is currently checking out from the long queue:

> - Mr. Martin! Here is your passport and your receipt. Thank you and have a nice trip.
>
> - Many thanks. Have a nice day.

As he moves towards the exit, the taxi driver salutes Frank and picks-up Frank's suitcases.

> - You are going to the station, right?

says the taxi driver while loading the suitcases at the boot of the taxi.

> - Yes, please.

The driver opens the back door of his car for Frank to enter. He then starts the car, presses the button for starting the meter for the job, and drives away to the station. On his entry to the taxi, Frank inserts his mobile communicator to the backrest console behind the passenger's seat. A minute later Frank notices a message from his PSA saying:

> - Your train is 10 minutes late. We may or may not catch the 5:15 train to Fiumicino Airport. At the moment no other changes in the travel-plan.

Five minutes later Frank removes his communicator from the console, the taxi has arrived at the station. Frank pays the driver, thanks him, and starts walking towards the station's entrance. Upon entry to the station Frank finds the ticket office closed. By looking around he sees a ticket machine, and he moves towards it to buy the ticket to Rome. To his surprise he finds that the machine is out of order. He looks at his watch: it is 1:45.

-“ I still have twenty-five minutes to find a place from where I can buy a ticket”, he thinks to himself. Only if there was a soul to ask for advice, but then again, what could one expect on a Sunday afternoon, lunchtime, in a holiday resort. At that point he takes out his communicator, and enters “BUY TICKET” in the PSA console and hopes for the best (Figure 2).

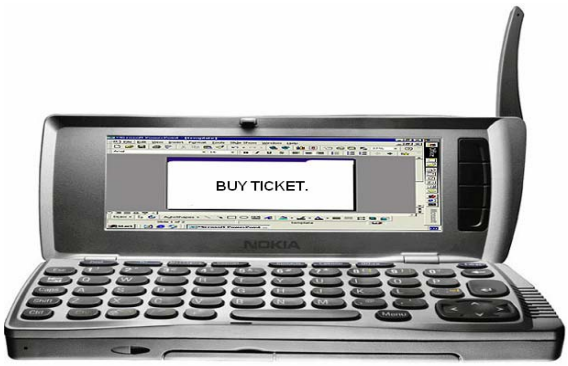

Figure 2: Frank enters the command BUY TICKET on his PSA console.

A couple of minutes later his PSA comes up with the message:

> - If you enter the door opposite the ticket machine, you are on platform 1. On the right hand-side at the end there is a coffee bar called *Bar La Stazione*. This place is now open. Go there and ask for a kilometric ticket. A kilometric ticket in Italy is a rail ticket for pre-specified distance of, say, fifty kilometers from the point of departure. Such a ticket allows a passenger to legally embark a train, if all other means of buying a ticket have failed, like it is the case with you now. Locals typically buy such a ticket for a short distance, say twenty kilometers. This will allow you to use the train, show the ticket to the inspector, while on the train, and then pay the rest of the fare to the inspector by cash or by credit card. Do not forget to validate the ticket in one of the yellow machines you see on the platform. The typically cost is 0.25 Euro for each kilometer first class (or 0.10 Euro second class).

A minute later the PSA comes up with another message:

- In Italian you can ask this as follows: Vorrei un biglietto kilometrico, prima classe, per venti kilometri per favore[1].

Frank eventually buys his kilometric ticket and has time to drink a coffee as well before his departure from the station.

The challenges ahead

To develop technologies that support people's everyday activities, such as those exemplified by the scenarios presented in the previous section, the research strategy proposed is to build socio-cognitive grids, which will transform the Net (existing internetworking and Web technologies) into a human resource that is accessible by anyone at anytime and anywhere. For this purpose socio-cognitive grids will need to offer ubiquitous mechanisms for accessing, intelligent techniques for managing, and trusted channels for delivering cognitive and social resources.

Motivated by the discussion so far, the rationale for the socio-cognitive grid programme is to bring together an interdisciplinary group of people who approach these issues at different levels, from design to implementation, and to establish a lingua franca for developing the envisaged applications at narrative (design), computational and implementation levels. This task is not easy and in some cases intractable because it often entails the need to integrate diverse professional languages and distinct ideologies.

Despite the difficulties ahead we envisage that the following areas of research will benefit the research agenda of socio-cognitive grids in the future:

1. The formulation of theories and guidelines for designing adaptive interfaces based on people-centric metaphors, natural interaction techniques, and clear computational models.

2. The visualization and animation of interactivity, including interactions between agents.

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[1] Can I have a kilometric ticket for 20 kilometers please?

3. The definition, classification and management of resources based on clear semantic representation of resources and context.

4. The provision of electronic services supported by interaction models such as negotiation and collaboration.

5. The development of computational models of interaction where security, trust, and privacy are important considerations.

6. The development of formalisms for providing computable but logical specifications that people can understand, if needed.

7. Intelligent software agents, and complex societies of such agents to manage cognitive and social resources that people need in their everyday activities.

8. Embedded systems that allow devices in the form of everyday objects to communicate with each other, and create an electronic environment that supports a physical one.

9. Platforms that will allow connectivity and communication with socio-cognitive grids and amongst socio-cognitive grids, including the software agents that these grids might contain.

10. Applications where context and resource awareness are the main considerations.

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