Realizing Human Centered Systems via Socially Deliberating Agents

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Abstract

Human centered systems must focus attention in roles, users and tasks, aiming to making the full potential of computing ubiquitous. The paper proposes a generic design pattern for such systems, incorporating digital assistants and human representatives. These agents collaborate with people and deliberate socially for helping them to (a) participate in numerous physical and social contexts consistently and coherently, (b) build explicit social structures governed by social laws (i.e. agents values, permissions, preferences, contextual constraints), (c) deal with the dynamics of the activities-environment and (d) manage the distributivity of the activities and environment.

1   Introduction

Human centered systems aim to empower humans for performing their activities with respect to their cognitive and perceptual abilities, physical and social contexts, as well as according to the computational platforms that they use. Human centered computing must focus attention in roles, users and tasks, aiming to making the full potential of computing ubiquitous (Shafto & Hoffman, 2002) (Hoffman, Hayes & Ford, 2002) (ISTAG, 2001). This contrasts to the classical machine-centered approach, in which systems' design and implementation is driven by technological concerns, taking into account functional user requirements and comments of users in early systems' prototypes, but leaving out most of the human activities, capacities, norms, policies and preferences.

Human centered design takes seriously into account humans' capabilities and real-world activities, placing special emphasis on exploring and questioning requirements (Shafto & Hoffman, 2002). The aim is to "extend the scope of computer science and software engineering to include distributed systems of human and artificial agents" (Shafto & Hoffman, 2002) dealing with the complexity of the activities and environment in which these agents perform.

In (Hoffman, Hayes & Ford, 2002) it has been argued that the development of human-centered systems must take the triple *people-machine-context* as the unit of analysis. It involves studying people capacities, capabilities and goals, computational mechanisms, interface capabilities and context. Context comprises "activities conceived as identities of participation" (Clancey, 1997). It involves people organizations, roles that people play within these organizations, *intentional activities* that people follow by participating in *social activities* in the context of these organizations, *norms* and *constraints* that are inherent in these activities (Clancey, 1997), policies, procedures as well as devices and media that people use for communicating and doing their work.

Collaborative agents (either human or software) via social deliberation aim to form social structures with joint commitments towards achieving goal states, jointly. The objective of social deliberation[1] is to enable agents (a) to build explicit social structures governed by social laws (i.e. agents values, permissions, preferences, contextual constraints), (b) to deal with the dynamics of the activities-environment by deliberatively structuring agents organizations, and by revising organization structures

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[1] Social deliberation involves collaborative decision making, planning and action, as well as agents' ability to form emergent social structures and revise them according to the context of their activities and their goals.

according to goals, intentions, physical and social environment of agents, and finally, (c) to manage the distributivity of the activities-environment by deciding on the roles employed and on the assignment of agents to roles [Partsakoulakis & Vouros, 2003].

The objective of this paper is to investigate the role that socially deliberating agents can play for realizing human-centered systems. The point is that socially deliberating agents, acting as partners, help humans to participate coherently and consistently in multiple activities in different physical and social contexts, being purposeful and trustful. We propose a generic pattern for incorporating collaborative agents for realizing human-centered systems, enhancing the abilities of both, people and machines, and point on the cognitive abilities and activities of these agents.

The structure of the paper is as follows: Section 2 provides a scenario that "visualizes" the aim of our work and provides a list of key points that should be addressed for realizing human-centered systems. Section 3 describes our proposal for incorporating socially deliberating agents towards realizing human-centered systems and section 4 presents in a brief way the abilities of deliberating agents and our formalization of social deliberation. Section 5 concludes the paper with remarks and future work.

2   Representatives and Assistants

Let us consider the following scenario that reveals our considerations for the realization of human-centered systems. The scenario justifies our proposal for a generic pattern for incorporating socially deliberating agents in systems, and points on the abilities/attributes that these agents must have.

Mike, a newcomer engineer in a large company, is employed in the products design department. His work consists of getting customer orders, designing custom products by gathering the best available parts according to regulations and standards and provide instructions to the manufacturing unit for getting the final product. The design of these products involves many complexities and provides Mike with many opportunities for individual and collaborative activities. Being a newcomer, Mike is not aware of his colleagues' regular activities, has not hands-on experience on the tasks he performs and he does not posses proper knowledge on how problems are handled when they arise. In addition, Mike due to health problems has some timing limitations and also, he is involved in other activities that provide timing constraints and norms that constraint his attitudes and intentions in his working context.

Mike's abilities (e.g. possessed knowledge), permissions (e.g. access to information sources), preferences (e.g. he prefers not to be disturbed when taking lunch), physical - social context (e.g. other collaborative activities he has with other people, social structures he participates in) and intentional context (individual and shared activities, constraints and permissions related to these activities and joint/mutual mental state attitudes it holds with collaborators) drive the way Mike participates in joint activities. Mike's digital representative, holds knowledge concerning Mike's social, physical and intentional contexts, in terms of Mike's goals, activities, constraints, norms and preferences. It is this agent that (collaboratively with Mike) negotiated with company's digital assistant and helped Mike to get the job. However, Mike and his representative socially deliberate with many humans and digital assistants in various contexts of activities.

Concerning the digital assistant from the company side, it posses knowledge concerning roles' responsibilities, obligations and constraints, as well as the physical and social context in which these responsibilities are achieved. Digital assistants, Mike and his digital representative form joint-commitments towards achieving their goals, collaboratively. Towards these goals, any digital assistant may check for Mike's availability for resolving a case at hand via his digital representative, which holds Mike's schedule. The representative may arrange Mike's schedule according to its knowledge on Mike's common or individual activities, preferences and constraints. If the digital representative does not have the ability to manipulate Mike's schedule, then it requests Mike to do so, going briefly through its understanding of his availability and case's importance. Furthermore, the digital assistant may get information concerning the case and forwards it to the representative that constructs a presentation for Mike. Digital assistants, having knowledge on organization's goals and structure by means of roles interrelations and dependencies, in collaboration with digital representatives, who have knowledge on people activities and constraints, may arrange meetings and further plan people activities.

Concluding, we must emphasize that Mike and his digital representative deal with real-world activities. Therefore, they must deal with the complexity of activities and the environments in which these activities are performed with flexibility and robustness. They must collaboratively perform activities and take decisions, in mutual trust.

3 Realizing Human-Centred Systems

Although there are many methodologies for designing and modeling distributed systems, as well as, human-centered systems (Zhang et al, 2002), complimentarily to these, we propose a generic design pattern for such systems, incorporating digital assistants and representatives. This design pattern points to the importance of social deliberation for realizing human-centered systems, placing requirements on agents' cognitive abilities. Briefly, a representative socially deliberates with assistants and its human partner, forming an emergent organization of agents for achieving goal states collaboratively.

The design pattern is shown in Figure 1. According to this, systems within organizations comprise assistant agents that are aware of the organizational structures, of the roles involved, responsibilities, obligations and permissions of such roles. We must note that an organization may have a fixed organizational structure, a dynamic one constructed on the fly - depending on the problem and agents involved - or both. In either case, assistant agents solicit collaboration from representative agents in order humans to play specific roles within the organization. Although this mostly happens in working contexts (employers publish and recruit people according to their capabilities, commitments, goals, intentions etc.) the opposite is also possible. For instance, Mike's representative solicits collaboration from assistants in an educational or medical organization, which is chosen according to criteria specified by Mike.

A representative agent socially deliberates with assistants, representatives and humans, towards helping its human partner to achieve goal states. A representative is involved in any activity, only if the activity-constraints, activity-permissions and social context constraints are consistent with the constraints of the activities the agent has committed, with respect to goal preferences.
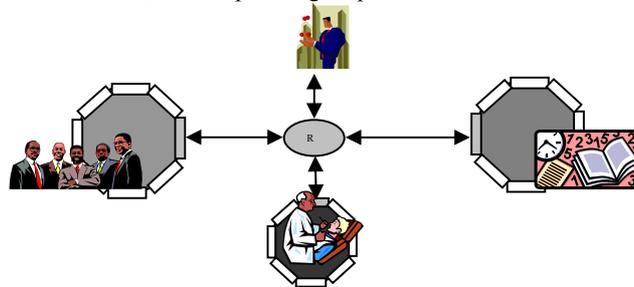
NOTATION			
	Mike		Representative agent
	Colleagues in work		Assistant agent
	Educational activities Mike is involved in		Social/Physical Contexts in which Mike is involved in collaborative activities
	Medical Treatment institution		Collaborative Activities

Figure 1. A generic pattern for realizing human-centered systems via socially deliberating agents.

Taking the triple *people-machine-context* as the unit of our analysis, we point that this generic pattern for the organization of human-centered systems incorporates people capacities, capabilities, goals and activities, computational mechanisms and interface capabilities. Specifically, as it is shown in Table 1, knowledge about people, their intentional activities, norms and constraints imposed by the social and physical contexts in which they perform their activities, is part of representative agents' knowledge. Digital assistants possess knowledge on people organizations, roles that people play within these

organizations, policies, procedures and organizations' computational platforms. The way aspects of the people-machine-context are incorporated in agents' knowledge is briefly presented in Table 1.

Table 1. Taking the People-Machine-Context triple into account**.**

	People	Machine	Context
People, Representative agent	Capabilities, capacities, goals priorities, preferences	Platforms, Interface capabilities	Physical and Social constraints, norms
Assistant agent		Computational platforms of organizations	Roles, organizational relations, organization goals, priorities, norms, procedures, policies

Finally, it must be noted that the configuration of Figure 1 may also concern a single organization, where each context (depicted with an octagon) involves intra-organization activities.

4   Socially Deliberating Agents

Table 2 presents the abilities that representative and assistant agents must have to deliberate socially.

Table 2. Requirements from the representative and assistant agents.

Representative agent	Assistant agent
*Management of knowledge about People-Machine-Contexts *Socially deliberative abilities - Recognition of the Potential for Collaboration - Collaborative decision making, planning and acting - Negotiation abilities - Multiple Contexts' constraints reconciliation abilities - Social structures' management abilities * Capabilities' matching abilities * Adaptive Information Presentation abilities * Trustful Behaviour (Restricted autonomous behaviour – acting as an appliance, showing to the user its understanding of the situation and its intentions).	*Management of knowledge about Organizations * Collaborative abilities - Recognition of the Potential for Collaboration - Collaborative decision making, planning and acting - Negotiation abilities - Constraints reconciliation abilities * Capabilities' matching abilities

To satisfy our requirements, we are implementing agents using the formal framework for role-oriented social deliberation proposed in (Vouros, 2003). The framework defines the notion of roles as abstractions of agents' responsibilities, obligations and permissions. Dependence relations among roles define the way roles can be combined for achieving common responsibilities, supporting agents to recognize the potential for collaboration among themselves, constructing common plans and forming joint commitments. Roles' permissions support agents to construct social laws, as part of agents' planned activities in social and physical contexts. A social law contains action permissions, i.e. constraints that should *not* be satisfied for granting permission to an agent to perform an action. Each action in a social law is related to at most one permission. Social laws determine the social norms under which agents act. These can be pre-specified or constructed dynamically based on agents' physical and social context. At any point of time an agent may form consistent and useful plans that it intends to perform. Any agent intends to execute each action in that plan either individually or jointly with a group of collaborators.

In this role-oriented framework, social deliberation allows representative agents to decide on the structure of a team in terms of the roles involved, on the number of agents adopting specific roles, on the multi-role recipes and plans that will be followed by the group towards achieving the joint goal, as well as on the social laws that will be adopted so as to minimize agents' interactions with respect to their responsibilities and obligations. Humans, in collaboration with their representatives, decide the social structures in which they participate, by reconciling constraints and social laws from different physical and social contexts, with respect to their intentional context.

Considering our scenario, each assistant, with whom Mike's digital representative shares joint commitments, imposes to Mike behavioral restrictions, like obligations, permissions and responsibilities and force him to accept social relationships that change the social context in which Mike lives. The representative is aware of the physical, social and intentional contexts, which it exploits when deliberating, in order to be helpful and purposeful to Mike. Therefore the representative must be

capable of explicitly reasoning about changes in Mike's context, preferences and needs, and infer the way these changes affect his current obligations, permissions, and responsibilities.

An important aspect of agency is that of *trust* (Castelfranchi & Falcone, 1998). When Mike delegates a goal or a task to his representative, he must believe that the agent is able to realize the goal, that it actually intents to achieve it, that the goal is possible to be achieved under the current context and that the effects of its actions will not conflict with his current intentions. In our agency framework, trust key capabilities are achieved via forming joint commitments towards a common goal state. Trust also imposes special requirements to the interface capabilities of the representative, which must allow people to monitor and control its state concerning *what* activity gets to be done and *how* it shall be done.

5   Conclusions

This paper investigates the role that socially deliberating agents play for realizing human-centered systems. We point on the cognitive abilities and activities of these agents and propose a generic pattern for incorporating collaborative agents for realizing human-centered systems, enhancing the abilities of both, people and machines.

Our approach differs from the approach reported in (Chalupsky et al, 2002), since it does not focus on organizational tasks, but on the activities humans are involved in, in numerous physical and social contexts, and in the unpredictable and dynamic real world. Furthermore, in contrast to (Chalupsky et al, 2002) we do not aim at making representatives autonomous, but purposeful and trustful.

6   References

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