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Agency a Unifying Concept within Distributed Artificial Intelligence and CSCW

Tutorial

1 Introduction

This paper seeks to explore the relationship between CSCW and Distributed Artificial Intelligence (DAI). In recent years a convergence of research effort has been witnessed in these two fields of research. The former concerns itself with the development of methods and tools that facilitate the collaborative work of groups of people, who may typically be distributed through, not merely a geographic plane, but also a temporal plane. The latter however, is concerned primarily with the development of a new generation of intelligent systems, which seek to encompass a multi-agent philosophy where smaller grained intelligent units or "agents" interact in a mutually beneficial manner in the solution of community goals. For a more detailed introduction to DAI the reader is referred elsewhere ([2]; [5];[10]).

Clearly each of these disciplines address the key area of distribution and the support of effective communication and collaboration within this distributed context. In the case of CSCW systems the interactions tend to be between humans whilst in the case of DAI these interactions are invariably between computational agents. Research on participative systems has sought to address the federation of both categories of agent [3].

This paper seeks to investigate the similarities and the differences between the two subject areas. It will focus upon some of the opportunities that exist for the synthesis of research concepts that would result in a mutually beneficial bi-directional exchange of ideas.

The paper draws upon experiences accrued by the author in the context of two research projects those of the Cooperative Requirements Capture (CRC) project and the ICSA (Information Cooperative for Sharing and Analysing earth observation data) project funded by the European Commission. Section 2 considers the convergence between these two disciplines whilst Sections 3 and 4 consider the CRC and ICSA projects respectively. Section 5 offers some conclusions and suggestions for further work.

2 A Convergence of Disciplines

Both DAI and CSCW contribute to a new and emerging discipline that of "Coordination Science". Within this section we will focus our attention on some key issues and consider their relevance to each discipline.

2.1 Distribution, Interoperability and Heterogeneity

Within both CSCW and DAI much attention has been paid to the distribution of data, expertise and control. Each of these bring their own particular problems. If we consider in detail the issue of distribution in the context of each discipline then interesting similarities and distinctions occur. To what extent can seamless distribution be achieved? Indeed ought it to be sought? It is often argued that the individual operating within such a computer mediated environment ought not to be made aware of its inherent distributed nature. Of course distribution can be viewed at different levels, the physical level where communication takes place across LANs and WANs and the cognitive level where expertise is distributed across intelligent artifacts.

Within the context of collaborative design systems it seems obligatory that each member of the design team be aware of the different design inputs from colleagues. The collaborative activity ought not to be polluted by such issues as Interoperability and Heterogeneity. However this nonetheless necessitates that the design of such systems ought to accommodate diversity in terms of software and hardware. Numerous authors characterise CSCW systems as "seamless systems" [6], however it is clear that such seamlessness ought not to obscure the underlying structure of the agent community. Clearly such structure needs to be abstracted away from in certain situations, whilst in others, it needs to be fully exposed.

2.2 Communication, Cooperation and Collaboration

Intrinsically important to all coordination technologies is the fundamental mechanisms which support communication. Without effective communication the higher level layers of coordination, cooperation, collaboration cannot be achieved. The relationship between communication, cooperation and collaboration is something which necessitates detailed examination. Communication has attracted the most research attention. Within DAI many multi-agent systems normalise inter-agent communication into a canonical form based upon Speech Act Theory. The genealogy of this approach can be traced back to the early work of AUSTIN and WITTGENSTEIN whose work paradoxically and felicitously, was taken as a motivation for the belief that a theory of language constitutes a theory of action. The popularisation of this dictum was largely due to the work of SEARLE who categorised illocutionary acts and associated situations, whereby they can reasonably be issued. This formalisation resulted in what is essentially a grammar for action and as SUCHMAN [12] states can be thought of as a canonical framework for the representation of communicative practices. The use of such a language action perspective within groupware has been criticised of late [12]. Many researchers believe that such approaches to reducing conversations to highly stylised aggregations of base components is fundamentally flawed and that alternative techniques such as Conversational Analysis are much more appropriate [1].

DAI and CSCW each tend to view communication from differing viewpoints. In the case of the former they are concerned with controlling the richness of the communication medium, whilst the latter is concerned with affording a full and expressive medium, often involving multi-media interfaces. DAI adopts are

ductionist approach to communication because it views communication as both influencing, and being influenced by, agent intentions.

2.3 Consensus Management

Teams of individuals with differing capabilities and objectives inevitably exhibit conflicts of opinion. Much research has addressed techniques for the resolution of such conflicts. Latterly some authors find the nomenclature of "conflict" rather negative and prefer to talk about consensus management rather than conflict resolution. The effective management of consensus is something that can guard against situations whereby opposing factions adopt entrenched positions. Such scenarios can be difficult and costly to resolve. Consensus management tends to involve the recognition of deteriorating social situations and the proactive invocation of actions that will regain social cohesion. In the case of DAI automated detection of conflicts can frequently be achieved more easily than is the case within CSCW, due primarily to the stylised mode of interaction. The manual recognition is however is much more obvious within CSCW.

Both disciplines are concerned with the maintenance of social cohesion and each draws upon such techniques as negotiation, game theory and utility theory.

2.4 System Development

The development of both classes of coordination system place many of the same demands upon the development medium. Both CSCW and DAI systems need to be developed in a modular manner. They both demand mechanisms for abstraction and information hiding. Object-oriented techniques have found considerable favour within both communities as has the associated methodology. More recently the fusion of functional and object-oriented techniques, as exemplified by CLOS (Common Lisp Object System) [4] has gained widespread acceptance.

Developments within DAI have resulted in the advocation of a new metaphor for system development, that of Agent-Oriented Programming (AOP) [11]. Agent0 is one language that embraces this philosophy [11], other languages of this genre exist whilst others are under development. McCarthy [8] for example, is developing Elephant2000 a language based upon speech act theory.

It remains to be seen as to what extent these languages can support the development of groupware systems.

3 The Cooperative Requirements Capture Project

The Cooperative Requirements Capture (CRC) Project ([7];[9]) sought to harness some of the work on "Agency". The CRC Project was concerned with the development of a system which provides effective computer support for the Cooperative Requirements Capture process. This process involves a multi-disciplinary team, who actively collaborate in the capture of system requirements, specifically in the context of this project computer systems. This team after an initial formulative meeting, thereafter return to their respective corporate positions and are as such, distributed both geographically and temporally. This contrasts with the traditional scenario in which design teams meet together frequently and discuss in a face to face setting system requirements and identify these through the use of a particular methodology.

Each team member, or "stakeholder", has a particular portfolio of skills and experiences which are of relevance to the system under design. Consequently each stakeholder has a particular objective, or set of objectives, which they are trying to preserve with a view to ensuring their adequate representation in the final agreed design.

Like all other organisations the social dynamics of the design team are highly complex and very important. Stakeholders often disagree, their objectives, of course, often conflict, individuals attempt, and sometimes succeed, in gaining dominance, others feel alienated resulting in a lack of participation, mutually beneficial allegiances are formed, and so forth. The "attitudes" of team members evolve and are revised as a result of the social interactions. These various social syndromes may be characterised through patterns of message exchanging behaviour. These can then dynamically be recognised, by analysing the evolving patterns of message exchanged and comparing these with those associated with the syndromes.

This social process must be managed effectively. In the traditional medium in which this activity takes place this is achieved by a facilitator. Whilst a facilitator will still oversee the activities of the design team within the CRC project, they will however be performing their tasks in a computer mediated environment. This medium is less "rich" and as such considerable computer support is necessitated.

Within the CRC project a software environment that of the "Cooperative Working Platform" has been developed which assists in both the management of the social process and the management of the task. A particular component of an object-oriented methodology is supported and it is within this that the team express their contributions.

The design of this platform has been greatly influenced by work within Distributed Artificial Intelligence (DAI). The concept of "Agency" was used to view the interactions of the stakeholders and their negotiations and furthermore has been used as a metaphor for the design of the underlying software platform itself. Component tools within the platform have certain skills and deductive capabilities and interact with each other in given circumstances, and consequently are perceived as agents which collectively constitute an "Active Environment".

4 ICSA

This project is concerned with the design of a coordination facility that provides access to the ever growing repository of earth observation data, with a view to supporting elaboration of, and deductions based upon, this data. Numerous discrete user communities have a need to access this data examples include, agriculture, forestry, sea and ice, climate, urban development and coastlines. Typically collaborations will emerge both amongst users within a given user community and between different user communities. It is clear that all of these user communities are intimately related. Decisions relating to European Union agricultural policy, may affect forestry and climate, which may in turn affect the sea and coastline.

The ICSA project is concerned with the analysis of the user community needs specifically with a view to gaining an understanding of the typical functions they would like supported. Thereafter an "Information Cooperative" will be designed and an illustrative component implemented. This project draws upon various areas of coordination science including DAI, CSCW and in particular workflow techniques.

Numerous workflow tools exist which seek to model the flow of activity within organisations. The ICSA project seeks to employ Action Workflow Management System licensed and marketed by Action Technologies, in order to capture inter and intra user community activity. Interestingly, Action Workflow

management system adopts and incorporates Speech Act theory as the underlying model for capturing the flow of activity.

5 Conclusions

Within this brief paper we have sought to consider the similarities between the disciplines of CSCW and DAI and to identify opportunities for synergy. We have considered but a few critical facets of coordination and pondered as to their role within each discipline.

We have in turn exemplified how a more holistic view of coordination systems can prove appropriate and beneficial. Within the context of the CRC project we have described our work toward the development of an Active Cooperative Working Platform. It is "active" in the sense that it takes cognizance of the social dynamics of the cooperative requirements capture team and provides support for the facilitator and the individual team members on this basis.

This work has incorporated Distributed Artificial Intelligence principles at two levels. Firstly the design of the platform is based on a multi-agent paradigm, with various interactions and collaborations taking place within the software agents. These software agents are collectively working toward supporting the participants in the cooperative requirements process. Secondly at the team level various techniques utilised in achieving agent coherence and resolving agent conflict are being applied to the design team.

Within the context of the ICSA project we have illustrated how novel application domains are placing demands for generations of systems that truly integrate agents, both computational and human.

It is clear that future coordination systems must harness effectively the contributions that have, and are being made, within both CSCW and DAI.

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