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Klaus Fischer
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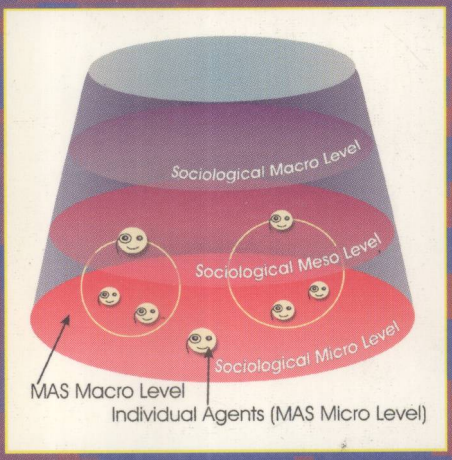
Socionics

Scalability of Complex Social Systems



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Socionics

Scalability of Complex Social Systems

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Lecture Notes in Artificial Intelligence 3413

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Preface

This book is an outcome of the Socionics Research Framework.[1] The roots of Socionics lie in the 1980s when computer scientists in search of new methods and techniques of distributed and coordinated problem-solving first began to take an engineering interest in sociological concepts and theories. Just as biological phenomena are conceived of as a source of inspiration for new technologies in the new research field of bionics, computer scientists working in Distributed Artificial Intelligence (DAI) became interested in exploiting phenomena from the social world in order to construct Multiagent Systems (MAS) and, generally, to build open agent societies or complex artificial social systems.

Socionics is driven by the underlying assumption that there is an inherent parallel between the 'up-scaling' of MAS and the 'micro-macro link' in sociology. Accordingly, one of the fundamental challenges of Socionics is to build large-scale multiagent systems which are capable of managing 'societies of autonomous computational agents ... in large open information environments' ([9, p. 112]). As more sophisticated interactions become common in open MAS, the demand to design reliable mechanisms coordinating large-scale networks of intelligent agents grows. Suitable design mechanisms may enhance the developement of 'truly open and fully scalable multiagent systems, across domains, with agents capable of learning appropriate communications protocols upon entry to a system, and with protocols emerging and evolving through actual agent interactions' ([10, pp. 3]) which is considered as the ultimate goal in fulfilling the roadmap of agent technology. With the introduction of mobile agent platforms for e-commerce applications, the quest for reliable mechanisms coordinating large-scale networks of intelligent agent programs has been put on the agenda. To illustrate the practical need for large-scale architectures and techniques, one might mention the growing demand for agent-based applications such as electronic commerce, business process management, entertainment, medical care, tele-voting, tele-shopping, real-time sports brokering, etc. (for a detailed list of agent-based applications, cf. [10]).

In relation to the Internet and the World Wide Web, scalability turns out to be crucial for DAI systems. Since achieving run-time efficiency in small environments does not guarantee achieving run-time efficiency also in large environments, it is clear that designing large-scale applications for open societies with several thousand agents differs significantly from designing small-size applications with around a hundred agent programs. With regard to open agent platforms that will have to support a new generation of e-commerce applications on the Internet, scalability as a technological desideratum is still in its infancy. What we need is to address the problem of scalability in a new way by relating specific engineering demands to general dimensions of complexity (most obvious: number and heterogeneity of agents and inter-agent linkages; less obvious: robustness, flexibility).

[1] The Socionics Research Framework SPP 1077 is funded by the German national research foundation (DFG) from 1998 to 2005 and has published several books: [1], [2], [3], [4], [5], [6], [7], [8].

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Having done that, we need to turn to sociological concepts, asking the following questions: How is coordination (by means of normative structures, power relations, and so on) achieved in human societies at different levels of aggregation (micro-interaction, meso-organisation, macro-society) and how can we translate these achievements into engineering methods and tools for social simulation? Of course, there is no such thing as the 'one best way' of posing or answering these questions, neither in sociology nor in DAI. Thus, the articles collected in this volume take different stances, exposing a wide array of sociological research approaches and a plurality of engineering perspectives, and leaving it to the reader to draw his or her own conclusions.

A book like this is the result of the successful cooperation of a significant number of people to whom the editors are now indebted. The minimum that we can do is to express our gratitude to all who were involved in making the book a realreality. First to be mentioned are the authors who actively contributed to the book with articles. However, most of the articles are results of fruitful discussion and cooperation in the context of the Socionics Research Framework funded by the DFG. We are therefore also grateful for the cooperation and support that we got from people working in this context. We further want to thank people at Springer supporting us in the publishing process of this volume. Last but not least, we would like to say thanks to the people that gave feedback to the authors by reviewing the articles and especially to Christian Hahn, who went through the trouble doing the finial editing of the master copy.

Saarbrücken, Hamburg
August 2005

Thomas Malsch
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Klaus Fischer

References

1. Malsch, T., ed.: Sozionik. Soziologische Ansichten ber künstliche Sozialität. Edition Sigma, Berlin (1998)
2. Kron, T., ed.: Luhmann modelliert. Sozionische Ansätze zur Simulation von Kommunikationssystemen. Leske + Budrich, Opladen (2002)
3. Rammert, W., Schulz-Schaeffer, I., eds.: Können Maschinen handeln? Soziologische Beiträge zum Verständnis von Mensch und Technik. Campus, Frankfurt/Main et al. (2002)
4. Ebrecht, J., Hillebrandt, F., eds.: Bourdieus Theorie der Praxis. Erklärungskraft - Anwendung - Perspektiven. Westdeutscher Verlag, Opladen/Wiesbaden (2002)
5. Burkhard, H., Uthmann, T., Lindemann, G.: Proceedings des Workshops Modellierung und Simulation menschlichen Verhaltens. Technical Report 163, Humboldt-Universität zu Berlin, Institut für Informatik (2003)
6. v. Lüde, R., Moldt, D., Valk, R., eds.: Sozionik - Modellierung soziologischer Theorie. Volume 2 of Wirtschaft - Arbeit - Technik. LIT Verlag, Münster (2003)
7. Florian, M., Hillebrandt, F., eds.: Adaption und Lernen in und von Organisationen - Beiträge aus der Sozionik. VS Verlag für Sozialwissenschaften, Wiesbaden (2004)
8. Lindemann, G., Moldt, D., Paolucci, M., eds.: Regulated Agent-Based Social Systems. First International Workshop, RASTA 2002. Bologna, Italy, July 2002. Revised Selected and Invited Papers. Lecture Notes in Artificial Intelligence. Springer, Berlin et al. (2004)
9. Huhns, M.N., Stephens, L.M.: Multiagent systems and societies of agents. In Weiss, G., ed.: Multiagent Systems. A Modern Approach to Distributed Artificial Intelligence. The MIT Press, Cambridge, Massachusetts (1999)
10. Luck, M., McBurney, P., Shehory, O., Willmott, S.: Agent Technology Roadmap Draft: A Roadmap for agent-based computing. AgentLink (2005) Electronically available, `http://www.agentlink.org/roadmap/`.

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Contribution of Socionics to the Scalability of Complex Social Systems: Introduction

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Abstract. The aim of the introduction is to provide insight into the interdisciplinary research program of Socionics and to clarify fundamental concepts like micro-macro linkage and scalability from the two different perspectives of Sociology and DAI&MAS research. Far away from the intention to offer final answers, the article rather tries to provide a framework to understand the contributions of the book as well as to relate their content to each other. The introduction also informs the reader about the scientific context of the interdisciplinary field of Socionics and deals with basic concepts and comments from the point of view of both Sociology and DAI&MAS research.

1 Motivation

The interdisciplinary field of research we call *Socionics* originated from the recognition of a shared interest between sociologists and researchers on Distributed Artificial Intelligence (DAI) in the exploration of the emergence and dynamics of artificial social systems [1]. Combining Sociology and Informatics, Socionics aspires "to form a new research discipline with the aim of developing intelligent computer technologies by picking up paradigms of our social world" and, vice versa, "uses computer technology in order to verify and to develop sociological models of societies and organizations." [1]. Based on a close cooperation between sociologists and computer scientists, it was suggested that socionic research is mainly focused on the emergence and dynamics of artificial social systems as well as hybrid man-machine societies [1]. In this context, the problem of scaling multi-agent systems (MAS), which is generally associated with the challenge of realizing *open systems* (cf. [2], [3], and [4]), aligns socionic research to "adapting solutions for the sociological micro-macro problem" by investigating "the mutual correlation of conditions and enabling mechanisms with respect to individual behaviour and higher social structures at different levels of coordination" [1]. While we agree with the fruitfulness of this enterprise we, however, feel that the DAI problem of emergence and scalability has been equated too quickly with the question of micro-macro linkage in DAI as well as on the sociological side by [1]. Before stating similarities between concepts in both disciplines, more precise ideas about definitions and basic concepts used in Distributed AI and sociology need to be developed. When

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we try to come up with such definitions, the admonition by [1] has to be taken seriously that one-to-one transformations of sociological concepts to computer models obviously will not be feasible and as an approach would even be misleading. As ([5, 156]) puts it, the central issue is "whether and how Socionics will be capable of transforming sociological theories, and not just social metaphors or naive theories of sociality, into new technological potentials." Therefore, the challenge of Socionics is to provide appropriate state-of-the-art foundations for the problems under investigation within each discipline, which moreover serve the interdisciplinary work.

This introduction tries to clarify concepts like micro-macro linkage and scalability from the two different perspectives. The article does not try to offer final answers but rather to provide a framework that should help the reader in understanding the contributions of this book as well as relating their content to each other. With this goal in mind this introduction presents basic concepts and comments from the perspectives of both Sociology and DAI&MAS research. However, we also try to capture some of the scientific context which we consider relevant.

2 Some Remarks on History and Context

It is difficult to mark exactly the starting point of the novel research paradigm of Distributed Artificial Intelligence (DAI). In the early 1980ies, various computer scientists were looking for new ways to tackle the difficulties experienced with traditional AI models in designing problem-solving systems useful in practice [6]. [7], [8], and [9] summarise early results of DAI research. Social scientists already got interested in DAI research at an early stage (cf. [10], [5]). Particularly Castelfranchi, Conte, and Star made seminal contributions to DAI research as well as to the appreciation of this research in the social science community. Since protagonists of the DAI community in the U.S.A. (e.g., Gasser, Hewitt, and Bond) had been involved in a long-standing practical cooperation with social scientists (e.g., Star, Gerson, and Suchman) from an interactionist and pragmatist background (cf. [10], [5]), "interactionist concepts have deeply influenced DAI models" [10] from the very beginning. The discipline of traditional AI needed some time to pick-up the new research topics. It took till 1994 that IJCAI introduced a specialised session on DAI into its technical programme. At this time the separation of DAI into the two primary areas of research *Distributed Problem Solving* (DPS) and *Multiagent Systems* (MAS) [7] was widely accepted.

It is reported that Les Gasser opened the AAAI workshop on *Knowledge and Action at Social and Organizational Level* in 1991 with the question *Society or Individual: Which Comes First?* [11]. Gasser's claim, related to Hewitt's perspective on *open systems*, is that we need an adequate foundation for DAI and that we must begin to lay firm *social foundations* for it. In this perspective, DAI should have autonomous basis with respect to traditional AI: DAI foundation lies in sociology (Durkheim) and in social psychology (Mead), while AI traditionally refers to cognitive science and psychology. DAI constitutes a new paradigm for AI. It is based on a different philosophy of mind in which the mind is seen as a social (not individual, mental) phenomenon. Therefore, Gasser's answer to the original question is *society comes first*. This *social foundation* is opposed to the more *individualistic and psychological approach* of (D)AI. However,

Castelfranchi and Conte [11] object against both the dichotomy and this type of social foundation. There are also many sociologists and social psychologists who are precisely in search of the individualistic basis of social action and of the microfoundational explanation of macro-social phenomena (cf. e.g. [12], [13], [14] [15]).

No matter which of these two positions we would like to subscribe to, as a matter of fact we have acknowledge that to the end of the 1990's MAS in general and especially the term *agent* got more and more attention. Interesting enough IJCAI's session names changed from sessions on DAI to sessions on MAS. It seems like the research became again more and more interested in the concept of individual agents and with that back to more traditional AI topics. However, the agents were considered to be problem solvers that are embedded in some dynamic environment which was not necessarily assumed in more traditional AI research. For example [16] as a standard text book of traditional AI does not include any topics related to the interaction of multiple agents other than assuming that such agents might hide in an anonymous environment. The ATAL workshop which was established in 1994 [17] and possibly more prominently the Autonomous Agents conference [18] which was first held in 1997 mark significant corner stones in this development. It is important to keep this development in mind when looking at the interaction of DAI research with Social Science theories.

Although it is obvious that in present days terms like "agent"[1] and "MAS" seems to be much more en vogue than other concepts of DAI, we still want to use the label DAI in the remainder of this article when referring to the whole research area. The main reason for this is that it would be quite difficult and result in clumsy phrases if we would use MAS for both concrete systems and the overall research community. So we stick with DAI when referring to the research community and stress that this does not reflect the current trends.

3 The Micro-macro Linkage in Sociology and DAI

From a sociological point of view, macro phenomena are the primary focus of attention. Unfortunately, the concepts of micro and macro "have not been systematically analysed in sociology" ([19, 86]). Diverse meanings are disseminated in the sociological literature and "these meanings are not always consistent with one another" ([20, 357]). In the 1980s, the *micro-macro linkage* as well as the relationship between *agency* and *structure* emerged as the central problems in sociological theory (cf. [21], [22], [23], [24], [25]) and it continues to be of focal concern up to now. Kemeny (in [26]) already complained that the relationship between micro and macro as levels of analysis is one of *distinction* and *mutual neglect*: the micro sociological study of face-to-face interactions has generally ignored the necessity of a systematic framework to interpret micro social phenomena in the context of macro structures and, vice versa, the study of macro social phenomena has not taken empirical findings and research at the micro level into account. Consequently, the micro-macro problem in sociology primarily refers to analytical concepts, i.e. to the problem of integrating competing sociological theories and to the link between different levels of social analysis (cf. [21, 223ff.], [27]).

[1] It is interesting to know that it is reported that Carl Hewitt in his work avoided the term "agent" because of its overuse. So opinions on this seem to change over time.

Sociological concepts of macro-social level range from "the structure of different positions in a population and their constraints on social relations" ([28]) to collective social phenomena like norms, institutions, authority systems (hierarchy), and markets (cf. [29]) to the study of societal structures, whole societies and *world-systems* ([21, 493]).[2] Generally, the macro level refers to social structures that "constitute both opportunities and constraints on individual behavior and interactions" ([20, 357]). With regard to micro-social issues many sociologists will agree that the "equation of micro with individual is extremely misleading, as, indeed, is the attempt to find any specific size correlation with the micro/macro difference" ([27, 290]). Consequently, Alexander [27, 290] claims, that there can be no empirical referents for micro or macro as such: "They are analytical contrasts, suggesting emergent levels within empirical units, not antagonistic empirical units themselves."

The definition of macro issues in sociology clearly differs from the common meaning in DAI research. All kind of social phenomena[3] are located on what is called the *macro level*. In contrast to that, individual agents mark the *micro level*. The link between agent's actions and behaviors (including internal mental or cognitive aspects of agent's cognition) and external social forces and structures is usually referred to as micro-macro link in DAI research or sometimes as micro-macro gap because even today well-understood theories that would in general explain how micro and macro level are linked do not exist. Although the micro-macro gap plays such a central role in DAI research, it cannot be considered a standard term in the literature. [30] refers to the micro and macro level as agent and group level respectively and refers to sociology to introduce the problem of micro macro linkage. [31] defines the macro level more general as everything that happens between agents but neglects the link to sociological research.

The problem of how individual action and structural rules interact in a set of agents is a foundational issue for both DAI and sociology [32]. Hence, the understanding of the link between micro and macro would mean a substantial advance in designing agents for dynamic and large-scale agent-based social simulation as well as a deeper understanding of human societies. The micro-macro problem is perceived in DAI research as a central issue, because it directly refers to problems of agent coordination and it also affects the scalability of MAS. The definition of DAI as opposed to the parent discipline of artificial intelligence heavily depends on aspects that are only introduced by problems that occur when multiple actors face the results of each others' actions [30]. Furthermore, modelling the macro aspect in agent theories is considered to be essential for DAI research, as this concept substantially contributes to the distinction between AI and DAI. For this enterprise, a scientific cooperation with sociology is of great benefit to DAI. However, it is important to note that the definitions of micro and macro

[2] Note that in sociology society is studied as a macro-social phenomenon *sui generis* that basically differs from formal organizations (meso-level) and social interactions (micro-level) with regard to time (*long-term* duration of societies) and space (*large-scaled* spatial extension of societies).

[3] A sociologist might object against using the phrase "social phenomena" for the kind of interaction that is usually going on in a MAS at least to the degree that this has been done so far. The reason for this might become clearer from the discussion in the rest of this article

in sociology differ significantly from the definitions in MAS research. The micro level that is identified in sociology actually starts at the macro level of DAI research. Moreover, it is an open research question whether the sociological macro level of human society/societies can be identified or adequately represented formally in a MAS.

Because both Sociology and DAI use the terms "micro" and "macro" but actually with regard to quite different things, we propose to clearly distinguish the different levels in sociological and DAI research and propose the following definitions:

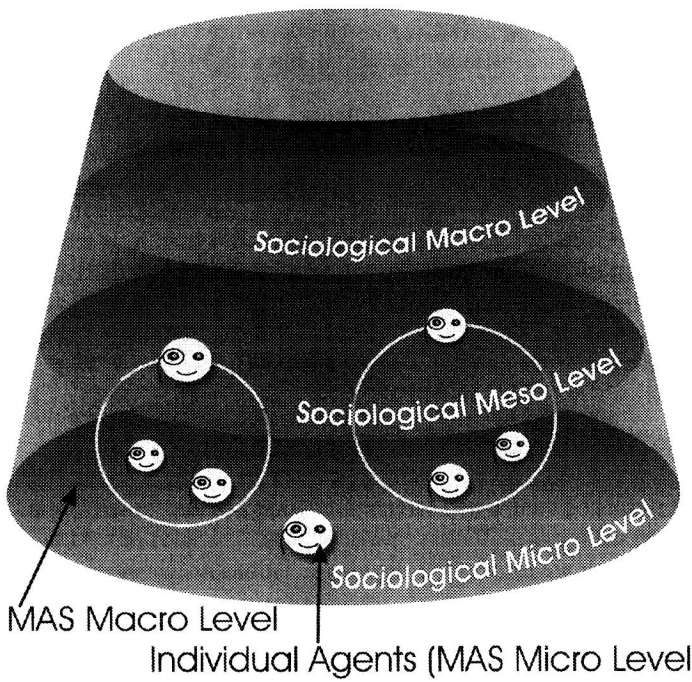

Fig. 1. Differences between Micro and Macro Level in MAS and Sociology

Agent Level (AL): Individual agents, their architecture as well as internal representations, and reasoning. This is what DAI literature usually refers to when talking about the micro level. We might use the term "MAS micro level" as a synonym when referring to this level of MAS design.

MAS Level (MASL): The interaction and communication between agents, the decomposition and distribution of tasks, coordination and cooperation, conflict resolution via negotiation, etc. (see also [31]). This defines the macro level in DAI literature and we therefore might refer to it with the term "MAS macro level" as a synonym as well.

Sociological Micro Level (SMiL): Individual actors (including their thoughts, mental preferences and actions [21, 643]), social (face-to-face) interactions, encounters

and communication among copresent individuals as well as "social processes that engender relations between persons" [28].

Sociological Meso Level (SMeL): A wide range of social phenomena intermediating between micro and the macro (e.g., social groups, collectivities or networks as well as formal organizations). Note that the characteristics of the meso level depend on the unit of analysis, i.e. the difference of micro, meso, and macro is not based on clear dividing lines separating real social units of different size but rather is motivated by useful *analytical* distinctions.

Sociological Macro Level (SMaL): The society as a whole, groups of societies, societal structures as well as collective social phenomena of a large extent within time and space (e.g., social institutions, culture, markets, etc.).

The most important differences to notice are that the AL itself is not a matter of interest in social science research. Furthermore, even agent interaction per se, i.e. the MASL, does not necessarily constitute what social scientists refer to as SMiL, like for example the purely mechanical interaction between two machines in a flexible manufacturing example is not of interest for social science research. It would be of course nice if socionic research could come-up with precisely defined discriminating properties that would draw clear boundaries between the different layers. However, up to now we can only say that we started to get some understanding of some properties that seem to make the differences for some of the specified levels.

4 Possible Misconceptions of Micro and Macro

The different points of view when referring to concepts like "micro" and "macro" can lead to misunderstandings in discussions as well as in articles of DAI and sociological research. In our work we found the following positions as instances of such misunderstandings [32].

Mechanism design is macro level design: In DAI, mechanism design is usually the coordination of actions of individuals to achieve some invariants of the behaviour of a group of individuals ([33]; etc.). However, unless there is structure or dynamics in the system that goes beyond the single interaction, there will be no manifestation of societal structures or institutions. In social psychology there is a collection of work inspired by game theory on penalty systems and their emergence in games (e.g. [34]). This could be viewed as advancing to the meso (group) level.

Macro level behaviour is emergent behaviour: According to Langton [35] emergence is a result that was not defined statically (i.e. before run-time). Such a not-predefined result is not necessarily a macro level result: see for instance SWARM-like simulations. Although they can produce patterns (of action) they do not lead to the emergence of higher-level institutions that shape and keep a society together. A similar argument holds for the reverse direction: macro level structures can be implemented in a simulation statically without the need to let them emerge.

Value aggregation is an analysis of macro phenomena: One way to distinguish attributes for modelling and reasoning, is to differentiate between dimensional (i.e. numerical attributes) and structural aspects (e.g. relationships on cause-effect, or

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