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Intentions and systems intelligence: prospects for complexity research

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We study the role of intention-reading in the systems intelligent capabilities of humans. Systems intelligence hypothesizes that human agents possess an innate ability to experience themselves as part of complex wholes and act intelligently from therein. The perspective is both interventionistic and sensitive as it calls stronger attention to micro-level interactions as the fundamental arena of human intelligence. This sensitivity, we argue, arises out of a human in-between, intersubjectivity which is largely nonverbal, and arises out of epistemically implicit intention reading and signalling capabilities. Intention reading and signalling capabilities are key characteristics of systems intelligence. With this perspective we contribute to the theory of human action where it is often argued that complexity hinders decision making, and that taking actions without knowing what unfolds is to be avoided. Contrary to this view, our systems intelligent perspective takes complexity, epistemic non-omniscience and systemicity as given properties of the environment, and as features not to be abstracted away. We conclude that there is need to study human moment-to-moment relational capabilities that are based on implicit knowing and on sensibilities rather than objective or verbalized knowledge. In particular, the study of the way humans are sensitive to the intentions of other agents, in complex settings is a field of study that is highlighted in the light of the findings of this paper.

1 Introduction

Various philosophical and scientific discourses on human behavior have emphasized the importance of human intentions, states of mind that are usually seen to precede thoughtful action, in striving towards sought-after outcomes. Recent findings in neurobiology have provided a theory that intentions do exist in the human mind and

precede thoughtful action. Where human individual micro-level decisions and actions build the macro-level phenomenon of behavior, there also stands the need to understand complexity; as complexity theorists argue (say [Anderson 1999]), macro-level phenomena are not always obvious from micro-level causalities, therefore puzzling the relationship of decision and behavior. The discourses play a central role in theoretizing human behavior[1]. We emphasize the importance of human agents' *intention reading capabilities* in complex systems: our hypothesis is that intentionality as a precedent of decision and as an integral part of interpersonal action is in central role in getting hold of the complexity an agent confronts in her environment.

Our aim in this paper is to argue for this hypothesis with the concept of systems intelligence (Hämäläinen and Saarinen 2006, 2007b). Systems intelligence proposes that humans possess a skill of overcoming difficulties that arise due to complexity and systemicity in their environments, by systems thinking, that is embedded in human behavioral capabilities. Such systems thinking does not arise out of rigorously planned interventions based on explicit modeling of the problem at hand, but out of reconcilement of the subjective experience of the situation with the capacity to solve problems with sound judgement, systems endowment and readiness to cooperate. We focus on the experience of living in systemic environments, and suggest that some recent findings in neurophysiology and developmental psychology can shed light on understanding the intersubjective systemic environment.

In section 2, we cross-disciplinarily discuss the nature of intentions, and how they relate to the human experience of her environment. In section 3, intentions are seen as a part of the behavioral repertoire that systems intelligence research is interested in. Section 4 presents our ideas of confronting complexity with systems intelligence, and Section 5 concludes.

2 What are intentions?

We distinguish a divide between interests towards intentions: on the one hand intention-interested scholars aim to resolve the mysteries of intention production in psychological processes of the human mind, and on the other hand they are interested in the role of intentions in ethical discourse. The former group consists mostly of natural and social scientists who use established theories and methodologies to address the questions of how the mind works and what parts in the brain produce capabilities and determinants by which humans choose and act. The latter group consists mostly of scholars of philosophy and humanities. They address questions such as what is ethically appropriate behavior, and on what grounds can a man's actions be evaluated.

Intentions are seen as precursors to planned action, parts of action plans, and parts of reasoning by many analytic philosophers (such as Bratman (1987), Searle

[1] Grinker (1956) speaks of human behavior as a theoretized discipline. Generally, the « human behavior theory » consists of various seemingly disconnected behavioral theories developed in different fields of academic thought.

(1983, 1990), and Tuomela (1993, 2005) among others). Intentions are important in action theory, the part of analytical philosophy that centers its interest on human willful action. Dennett (1987) has developed the theory about the content of the human mind, which he calls the intentional stance theory. The intentional stance is a level of abstraction from which behavior of an object can be observed, and it is the 'highest' level of abstraction compared to other levels that are physical stance and design stance. From the intentional stance, another intentional being can reason that an intentional agent will behave according to her beliefs and desires as a willful agent. Dennett sees intentionality as a deeply human characteristic that allows the human to anticipate other humans' actions from their intentions.

Gigerenzer et al. (1999) experiment human's abilities to infer and categorize motion cues from computer-simulated trajectories of two moving objects that imitate natural motion (such as pursuit or play). According to their study, naïve human participants have the ability to categorize behavior into 'biologically important classes at far above chance levels' (ibid. p. 274). Such abilities are important e.g. in situations when an agent has to decide whether another agent has an intention to pursue her or an intention to court her. Gigerenzer et al. infer that animals naturally signal their intentions as well as read each other's intentions in basic survival and reproduction situations. Similar findings have also been reported by Barrett et al. (2005) and Scholl and Tremoulet (2000).

A label given to the unique social understanding that humans and other social primates have has been termed the 'theory of mind' (Baron-Cohen 1995, Barresi and Moore 1996). Theory of mind relates to a conceptual system by which agents make sense, predict and manipulate behavior of individuals of their species (Barresi and Moore 1996). The theory of mind aims to explain what 'mindreading' is about; that is, how is it that humans have the capacity to infer others' mental states without knowing the exact states of their minds (Baron-Cohen 1995). This conceptual system, according to Barresi and Moore, consists of two capacities: (i) it represents intentions of agents that are directed at objects, be they real or imaginary, and (ii) it can be used to understand interpersonal activities. An agent can use her conceptual system to understand the actions of oneself as well as of another. Barresi and Moore's argument is analogical to the distinction between theory and simulation theories that are covered later.

Two theories of how humans interpret each others' mental states are classified by Davis and Stone (1995ab): theory theory, which assumes that humans form theories of behavior in a manner similar to scientists forming theories in their disciplines, and simulation theory, which assumes that humans read others' minds by a simulation process. The simulation theory as a heuristic was proposed by Kahneman and Tversky as early as (1982). This divide is similar to the inference mechanism divide in philosophy (Johnson-Laird 2006): deductive inference (that the theory theory resembles), and inductive inference (that the simulation theory resembles). Whereas deductive inference and reasoning abilities demand for complete understanding of the relationship with the act and the result, inductive inference and reasoning allow for learning about the possible outcomes of one's actions by trial and error. The appearance of inductive inference from neurological

evidence is not a surprise for decision theorists, who have argued that reasoning and decision making in humans is inductive rather than deductive (see Arthur 1994, and Gilboa and Schmeidler 2003).

Neuroscientists have localized brain areas that are thought to be important in the intention reading and action simulation capabilitites of humans. Humans do have an inherent capability to infer intentions from other peopls's actions. Blakemore and Decety (2001) account this skill as a component of the theory of mind. These studies can be roughly divided in two research areas: neurophysiology and developmental psychology. In neurophysiology, neural correlates of action mechanisms are of interest, whereas developmental psychology searches reasons for human behavior from human development during adolescent years (ibid.). Blakemore and Decety (2001) present psychophysical and functional neuroimaging evidence to support the idea of a simulation theory. Perception of motion is a central sensory input by which humans predict and interpret others' intentions. Test subjects have been recorded to have the ability not only to infer logical motion (walking forwards, dancing), but also more complex traits such as sex, emotions and personality from light sources against a dark environment that simulate human motion (Dittrich et al. 1996, Brownlow et al. 1997).

Evidence exists that the simulation theory also holds for infants of a very early age, who can discern humanly moving dots from randomly moving ones (Fox and McDaniel 1982). This evidence is a contribution for developmental psychology, and partly a confirmation of the innateness of intention reading abilities of the human species. Stern (2004) combines theories from developmental psychology and neurophysiology to propose that a property termed intersubjectivity is central to humans' understanding of each others' mental states. This intersubjectivity between two or more agents allows us to understand what interaction is about when the one important level of decision making, the mental level, is taken into account. Change processes in psychotherapeutic interaction have recently been of wide interest from the intersubjectivity thematization (we discuss this arena in the latter part of this paper). Lyons-Ruth (1998) stresses the implicit and relational knowing in human relationships. Brothers (1997/2001) argues for a "social brain" that humans develop through socialization, and Goleman (2006) accounts the social brain the abilities to attune to others. This research is all well in line with the idea of an intersubjective human experience of the world.

We can distinguish two defining properties that intentions have in human interaction:

i. Change in the value and norm systems one acts within emerges *as a result of interplay of intentions*. An intention can be viewed as one type of communicative intervention in the systems.
ii. Intentions act as *precursors to non-myopic action*; a human being acting non-myopically, which in our terminology means *intelligently*, forms communicated intentions to actions.

In the next chapter, we use the concept of intention to rationalize action that is context-sensitive and intelligent.

3 Systems intelligence – a behavioral perspective

Hämäläinen and Saarinen promote the idea of a human natural capacity to cope with complex systemic wholes in their research on systems intelligence (2006, 2007a, 2007b). Systems intelligence argues that a human competence exists by which agents can cope with complexity in their environment. The agents are equipped with skills and endowments that the nature and evolution of human race has allowed them. Besides a theory of human behavior, systems intelligence is a perspective by which a bunch of theories can be combined to serve the purpose of understanding what natural action is about, and what composes of and effects on rational decision making. In this section we briefly describe the qualities of a systems intelligent agent.

Systems intelligence argues that a human agent experiences her inter-dependence of the environment in a way that is intelligent by definition, and with this intelligence, the agent is able to act productively. The environment is marked by interconnectedness, feedback intensity and feedback vagueness, and these properties the agent manages to get a hold of, without any explicit conceptualizations and planned interventions. The agent uses her cognitive skills[2], such as intuition, to act and decide.

The philosophical tradition that systems intelligence rests on is systems thinking (Hämäläinen and Saarinen 2007b). Note that, although systems intelligence emphasizes the implicit knowing, the explicit problem structuring and solving skills matter too—Hämäläinen and Saarinen account systems intelligence as an 'engineering discipline' (2004). Matters that are important to systems thinkers (interconnectivity, interventionist management, holistic outlining) are also important aspects in systems intelligence; systems intelligence can be considered to share similar aspects tha the 'critical' school of systems thinking (see e.g. Churchman (1979), Flood (1999)) in that it perceives systems as constructs and thus relative to the point of view. We could thus also speak of systems intelligence *thinking*.

The dimensions in an agent's innate systems intelligence are often not transparent in the way problems conceptualizations are made transparent in active systems intelligence thinking. The level at which systems intelligence takes place in the human mind is for a large part semiconscious, rather than the conscious level that systems thinking based action settles on. Hämäläinen and Saarinen (2006) acknowledge the intuitive, tacit and nonverbal skills of relating with the environment (with artifacts as well as with other agents) as crucial determinants with which social intelligence has developed. This acknowledgement is well in line with research on the evolution of intelligence through a social need (see e.g. Humphrey 1976), and this acknowledgement is an important reason for the term 'intelligence' in systems intelligence.

[2] These cognitive skills are similar to higher-level capabilities such as multiple intelligences described by Gardner (1993).

With the argument that humans possess systems intelligence as a basic skill in their behavioral repertoire, we can enter the system in the human agent in which reasoning and deciding takes place. Biologically, this system locates in the human brain, which is predominantly understood as the prime biological element of decision making. Especially of interest from the complexity point of view are actions that are directed towards other human agents. This is where understanding of intentions and intentionality enters to deepen our understanding of actions under complex social relationships. We propose that the ability of humans to read each other's intentions, arising out of involvement in intersubjective situations, is a key capability in human systems intelligence.

Where then does this kind of systems intelligence manifest itself most appropriately? As argued earlier, a notable practical field where understanding of intersubjective encounters are important is psychotherapeutic interactions between a patient and a psychotherapist (see e.g. Stern 2005). This field is not only important for the appearance of intersubjective understanding—numerous situations in life are such—but it is important for scholars of intersubjective relationships because it is a rather isolated, two-person situation which resembles a consultant-client relationships abundant in corporate and professional life. To us, psychotherapeutic interactions appear as interesting practical areas of everyday problem solving where both systems-interventionist and micro-level interactive approaches would inevitably fail. There is no chance for the therapist to conduct planned interventions, nor there is chance for him to consult the patient to do such interventions himself. There is also no point for the therapist to concentrate only on details of the patients' problem, such as some isolated mind mechanisms, without taking the whole array of the complex phenomenon into account.

4 Confronting complexity with systems intelligence

Humans conduct their lives in many different complex social systems where the rational, deductive reasoning easily fails (as argued, say, by Simon (1996) and Arthur (1994, 1999)) due to bounded rationality, inability to comprehend nonlinear feedback (Sterman 1989), or some other sort of bounded reasoning. Sociality of complex systems means that humans co-create and at the same time act upon the complexity of their environment. In the face of complexity, reductionist view of the world fails, as well as does a holistic view that doesn't account individual freedom to resist others' interventions. To take human individual freedom of choice into account, means taking human intentionality into account, and therefore taking the whole repertoire of behavioral phenomena that arises out of intersubjectivity (in the sense of Stern (2004)) into account. It is therefore worthwhile to consider the processes that go on inside human psychological functions that help us comprehend intentional behavior as well as structures and conventions in human everyday life that assert the hypothesis that humans use intentions in their actions to grasp the complexity in the systems they daily interact in.

But systems intelligence does not only provide a behavioral conceptualization for intelligent and intuitive human behavior; systems intelligence

could be comprehended as a framework through which it is fruitful to contemplate matters of interest for behavior researchers. Hämäläinen and Saarinen (2007a) propose that systems intelligence aims to connect two intellectual paradigms, that we term the *objective control paradigm* and the *subjective action paradigm*. The objective control paradigm drives forward the idea of 'rationality' by control of systems and by interventions in agents' systemic worldview, and the subjective action paradigm highlights that humans act by way of their subjective experience of the world in which they are embedded in. When the environment is understood as complex, one can see what limitations these paradigms used alone confront: a systems thinker could not be able to comprehend the fine-tuned feedback mechanisms, and a subjective actor would not be able to realize the rationalistic aspects of systems interventions. The main argument with systems intelligence is that neither of these paradigms is right or wrong, but together they compelement each other. The terminology presented in this paper serves both these paradigms, as intentions can be understood to explain intersubjectivity as well as systems-interventionist methodology.

Advancements in the field of psychotherapeutic interactions reveal that matters of relationality and intersubjectivity of human interaction are crucial because elements of communication and interaction that are neglected with traditional methods can be accounted as important. Like BCSPG (2002, 2005) and Stern (2004), we could describe the *systemic experience* (instead of the moving along process of the therapeutic interaction) as an "inherently sloppy process", referring to the "indeterminate, untidy, or approximate qualities of the exchange of meaning between" agents of the given systemic situation (quotes from ibid. p. 693–694). According to Stern (2004), sources of sloppiness emerge from incorrect interchange of intentions, unpredictability of immediate consequences of one's interventions, and redundant and improvised nature of the process.

Dennett's (1987) concepts of strategic intentionality seem to be central with the logic that a systems intelligent agent employs in her action. In practical examples of how humans experience complexity, it is often noticed that humans with only a systems thinker's attitude, without the additional ability to communicate and thus exchange information with intentions, fail to complete their task in a complex environment; such problems are reported e.g. by Wu and Katok (2006) in a dynamic inventory management system of the beer game.

The systems intelligence concept of Hämäläinen and Saarinen (2007b) stresses that the human agent has an ability to catalyze change in her acting environment, i.e. in the complex system she is embedded in. The sloppy process of systemic experience and action then is epistemically implicit, not easily conceptualized and trivialized no matter how sophisticated the methodologies were. This sloppiness is due to the inobservability of intentions of the acting agents; as we earlier discussed, observing intentions is mostly implicit and instinctual rather than explicit and formal. Intentions are inferred rather than observed and measured; both Dennett (1987) and BCPSG (2005) agree on this.

5 Conclusions

The process by which humans make their intentions transparent, and by which humans read each others' intentions and infer their likely future actions reliably, has an integral role in how self-enforceable cooperative systems emerge. To us, it seems that intentional actions and intention-reading capabilities are connected to intelligent action in complex systems.

Our future research efforts will include the micro-level mechanims that produce self-enforceable cooperative equilibria based on communication by intentions. Arriving at such equilibria (in which agents are able to maintain their cooperative pursuits) demands different mechanims, axioms, and strategies than traditional methods that are used to study cooperation. In addition, we argue that intentions ought to play part in future mechanism design in games that are used to study cooperation under asymmetric and incomplete information; taking intentions into account in dynamic games yet remains undone. By announcing intentions, players could be able to extend their repertoire of behavior, like the patient and analyst do in psychotherapeutic interaction (what Stern (2004) calls "moving along"). The needed mathematical methodology for the basis of discovery of common ground for cooperation can possibly be related to the ideas of fair improving directions (Ehtamo et al. 1999) of negotiation and contracting.

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