Explanation Awareness and Ambient Intelligence as Social Technologies

Jörg Cassens

This work focuses on the socio-technical aspects of artificial intelligence, namely how (specific types of) intelligent systems function in human workplace environments. The goal is first to get a better understanding of human needs and expectations when it comes to interaction with intelligent systems, and then to make use of the understanding gained in the process of designing and implementing such systems.

The work presented focusses on a specific problem in developing intelligent systems, namely how the artefacts to be developed can fit smoothly into existing socio-cultural settings. To achieve this, we make use of theories from the fields of organisational psychology, sociology, and linguistics. This is in line with approaches commonly found in AI. However, most of the existing work deals with individual aspects, like how to mimic the behaviour or emulate methods of reasoning found in humans, whereas our work centers around the social aspect. Therefore, we base our work on theories that have not yet gained much attention in intelligent systems design. To be able to make them fruitful for intelligent systems research and development, we have to adapt them to the specific settings, and we have to transform them to suit the practical problems at hand.

The specific theoretical frameworks we draw on are first and foremost activity theory and to a lesser degree semiotics. Activity theory builds on the works of Leont'ev. It is a descriptive tool to help understand the unity of consciousness and activity. Its focus lies on individual and collective work practise. One of its strengths, and the primary reason for its value in AI development, is the ability to identify the role of material artefacts in the work process. Halliday's systemic functional theory of language (SFL) is a social semiotic theory that sets out from the assumption that humans are social beings that are inclined to interact and that this interaction is inherently multimodal. We interact not just with each other, but with our own constructions and with our natural world. These are all different forms of interaction, but they are all sign processes.

Due to the obvious time and spatial constraints, we cannot address all of the challenges that we face when building intelligent artefacts. In reducing the scope of the thesis, we have focused on the problem of explanation, and here in particular the problem of explanation from a user perspective. By putting social theories to work in the field of artificial intelligence, we show that results from other fields can be beneficial in understanding what explanatory capabilities are needed for a given intelligent system, and to ascertain in which situations an explanation should be delivered. Besides lessons learned in knowledge based system development, the most important input comes from activity theory.

The second focus is the challenge of contextualisation. Here we show that work in other scientific fields can be put to use in the development of context aware or ambient intelligent systems. Again, we draw on results from activity theory and combine this with insights from semiotics.

Explanations are themselves contextual, so the third challenge is to explore the space spanned by the two dimensions *ability to explain* and *contextualisation*. Again, activity theory is beneficial in resolving this issue.

The different theoretical considerations have also led to some practical approaches. Working with activity theory helps to better understand what the relevant contextual aspects of a given application are and helps to develop models of context which are both grounded in the tradition of context aware systems design and are plausible from a cognitive point of view.

Insights from an analysis of research in the knowledge based system area and activity theory have further lead to the amendment of a toolbox for requirements engineering, so called problem frames. New problem frames that target explanation aware ambient intelligent systems are presented. This is supplemented with work looking at the design of an actual system after the requirements have been elicited and specified. Thus, the socio-technical perspective on explanations is coupled with work that addresses knowledge representation issues, namely how to model sufficient knowledge to be able to deliver explanations.

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