From *i** to an Integrated Requirements Knowledge Representation, to Requirements for Services

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Abstract. This paper aims to review the research results from the past three years from the RE group at the school of software, Tsinghua University. Major threads of work include: (1) study the common body of knowledge on requirements modelling, and integrate *i** with other requirements languages, such as problem frames, UCM and UML; (2) work on a service capability and requirements modelling ontology – SRMO, based on goal and agent-oriented concepts from *i**; (3) build a double feedback loop control framework (*ASREF*) to achieve optimal service demand - supply relationship based on service models. (4) Tool development attempts related to *i** framework within the Tsinghua group.

Keywords Service capability, requirements model, feedback loop, requirements tools

1. Introduction

In retrospect, the *i** framework has gained growing attention in software requirements engineering research and industry in the past decade. It is recognized as a very different way of thinking that can be adopted by requirements engineers to understand the origin and focal point of a software problem within the organizational and social setting. It helps tackle problems at a different level of abstraction and depth. First, it provides us a set of graphical modelling constructs, so that the different kinds of elements identified from the original problem descriptions can be categorized and structured. Then, it provides us the reasoning mechanisms, such as task decomposition, means-ends analysis, softgoal satisficing level evaluation and dependency network exploration, based on which one can derive what questions to ask, identify where the missing bits and pieces of information are, and balance out the inequalities and conflicts among agents. Finally, it sets up a basic weltanschauung to look at the world, which is distributed, networked, social, strategic and intentional. Bearing such a viewpoint in mind, one can map the real world problem context to an analysis model based on *i** with minimum effort and difficulty. At all three levels, one can benefit from the *i** framework.

2. Research objectives

We have extended our research towards the following directions.

(1) Requirements Engineering Body of Knowledge (REBOK), and an integrated requirements modelling language based on i.*

Based on the above understanding to the *i** framework, it is natural to adopt *i** as a basic requirements knowledge representation language, and try to find how other existing requirements modelling languages relate and complement to it. The ultimate objective is to build a requirement ontology that incorporates as many perspectives as possible. So following the first attempt in integrating *i**(GRL) with UCM, we move to integrate *i** with the Problem Frames[1, 3]. It seems that there is considerable overlapping between the two languages. E.g. they both look into entities external to the system under development (actor vs. domains), and both focus on relationships between external entities and the system (dependency vs. interaction phenomena). The two also differs from each other obviously in that they emphasis on different aspects of the problems, one is at high-level, subjective, design-time decision making, and the other is at implementation-level, objective, run-time behaviors of the future system.

(2) Service capability and requirements modelling ontology – SRMO, based on goal and agent-oriented concepts from i.*

Since service orientation is becoming a dominant paradigm of the web-based software applications, a common feature of service orientation is the need to understand and characterize what the customer wants and to design services that can meet those requirements effectively. At present, user's requirements are often represented in certain existing standard interoperable service description languages such as WSDL/OWL-S. General service requestors may find such languages hard to use directly due to the reason that service requirements are often partially elicited and fragmented. The objective of this line of research is to develop a service requirements ontology SRMO, which extends the agent-oriented requirements modeling framework i* for early-phase requirements analysis with necessary language constructs for services requirements and capability modelling. [2,9,10].

(3) A double feedback control framework (ASREF) to achieve optimal service demand - supply relationship based on service capability and requirements models derived from i.*

This line of research aims to formulates the service-oriented requirements analysis process as a feedback control system, in which a classical "once for all" philosophy is replaced with a continuous negotiation and adaptation process based on existing requirements model and new service request.

3. Scientific contributions.

(1) An integrated requirements analysis approach based on i and problem frames.*

One of the difficulties that goal-oriented requirements analyses encounters is that the efficiency of the goal refinement is based on the analysts' subjective knowledge and experience. To improve the efficiency of the requirements elicitation process, engineers need approaches with more systemized analysis techniques. This work integrates the goal-oriented requirements language *i** with concepts from a structured problem analysis notation, Problem Frames (PF). The PF approach analyzes software design as a contextualized problem which has to respond to constraints imposed by the environment. The proposed approach is illustrated using the meeting scheduler exemplar. Results show that integration of the goal and the problem analysis enables simultaneous consideration of the designer's subjective intentions and the physical environmental constraints.

(2) Service capability and requirements modelling ontology – SRMO, based on goal and agent-oriented concepts from i [8].*

Along this line of work, formalism for service requirements and capability modeling is proposed. It adopts concepts from the agent-oriented requirements modeling framework *i**, which can be used as a means of studying the requirements and architecture for distributed agent systems. A social modeling framework such as *i**, extended with necessary service-related concepts and formal reasoning mechanisms, offers a better understanding of the social/organizational relationship in an open services world. By representing explicitly the underlying assumptions and the essential factors of services, a semi-formal requirements model in *i** can automatically evolve and be refined into a service requirements and capability reasoning framework. Eventually, it will assist intelligent agents with certain knowledge and intentions to make intelligent, rational decisions during service discovery, publication, selection, and binding within an open services community.

(3) A Service Requirements Elicitation Mechanism SREM based on SRMO and a double feedback control framework (ASREF) to achieve optimal service demand - supply relationship based on service capability and requirements models derived from i.*

An automated Service Requirements Elicitation Mechanism (SREM) is also proposed to help extract and accumulate relevant knowledge on service requirements. First, the SREM elicitation approach proposes to use a list of questions to narrow generic service requirements down to specific expressions of user preferences. Then, a service requirements and capability ontology is adopted to capture services requirements in breadth and precision. By integrating service requirements issued by different requestors, SREM provides non-trivial requirements guidelines and heuristic rules on service publication and discovery, also provided is a service requirements analysis mechanism that improves the accuracy of service discovery and efficiency of service composition continuously.

*(4) Tools under Development related to i**

A web-based modelling tool for i* is under development, which adopts a similar user interface as OME, but is operable with the web browser. We are also building tool prototypes to support the research works introduced above [10].

4. Conclusions

In summary, Ongoing work of the Tsinghua group include the investigation to a common requirements engineering body of knowledge, requirements engineering for services[5,7,8], and requirements engineering for trustworthy software [4, 6, 11]. The *i** framework provides a foundation of requirements knowledge representation and reasoning mechanism.

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