The Philosophy Behind IRES,
an Intentional Requirements Engineering Strategy

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Abstract. Intentionality is considered particularly important in several facets of social context. For example, police investigation usually starts based on "the why", which is searching for a motive. The search for a motive is also frequent in the anamnesis process in medicine, as well as in investigative journalism. In a criminal investigation, early discovery of motive usually provides a track to identify a crime's perpetrators. When in the doctor's office, the usual first question a patient has to answer is why he/she is there. In the same way, no one disagrees that software utility is the backbone of construction success. Since the task of discovering "the why" (goals) is abstract, subjective, and complicated, we delineate a thinking process frame, a philosophy, for guiding Requirements Engineers into focusing on intentions for the elicitation of goals. The philosophy, at the beginning of the IRES (Intentional Requirements Engineering Strategy), provides a backbone to the requirements process. It is composed of four topics (Necessity, Motivation, Goal, Action), and is linked by the intentionality and their interconnections in a given State of Affairs. The goal of this paper is to explain how this frame helps the construction of well-anchored models.

Keywords: Goals Elicitation, GORE, Goal-Oriented Requirements Engineering, Intentionality, iStar Framework, Model-driven Requirements.

1 Introduction

Goal Oriented Requirements Engineering (GORE) approaches aim to bring to Requirements Engineering a higher level of abstraction: goals. In this context, the IRES (Intentional Requirements Engineering Strategy), an evolution of ERi*C [7], focuses on answering the following questions:

a) *How to improve contextual information to mitigate vulnerabilities in requirements artifacts?*
b) *Is it possible to devise new alternatives by evaluating an organizational model?*
c) *How to get information to build an organizational model?*
d) *What is the role of actors in organizational models?*

Answering those questions is far from trivial, but we are working on some truisms, which can be stated as follows:

- Organizational business models must consider strategic dependencies to face adversities, competition, or new technologies that may bring vulnerabilities.
- Information systems must be aligned with Organizations' models to react to change, minimizing vulnerabilities.
- The iStar Framework [8] emphasizes strategic dependencies, providing ways to evaluate models for vulnerabilities.
- Using the concept of a goal, as an abstraction, it is possible to focus on *Intentionality*, which is the *end.* If the concept of goal may be reified in diverse ways, it is possible to uncover new *means* to achieve an *end*.
- The iStar Framework helps the organization discover new ways of doing things, challenging the system "as-it-is" by looking for alternatives (means) of achieving a goal (end). In iStar the way of doing things is bounded by goals and softgoals, which are reified by the means-end construct.
- IRES provides a way to approach the Organization and its Information Systems to uncover *Intentionality* by means of goals and softgoals to define and evolve requirements.
- When modeling we must consider the concepts of Viewpoint and Perspective [3].
- We are dealing with E-type Systems, and as such the 8th Lehman law holds: "E-type Programming Processes constitute Multi-loop, Multi-level Feedback systems and must be treated as such to be successfully modified or improved." [2].

2 Objectives of the research

Goal-Oriented Requirements Engineering (GORE) shifts the modeling focus from function/data towards intention. The iStar Modeling Framework converges the idea of intentionality towards actors' dependencies. From our experience in working with GORE research as well as teaching it, this paradigm shift is a challenge.

As in the transition from procedural programming towards object orientation [9], it is easier to explain iStar to students than to practitioners and to researchers unfamiliar with GORE. Teaching students, by presenting iStar exemplars, is not a big problem; they accept the approach as a clever idea. However, even with students, there is a solid heritage from earlier courses, which are very much function/data-oriented, so the intentional paradigm is not clear cut.

Explaining to students the goal concept, we use the dialogue1 among Alice and the Cheshire Cat in Lewis Carroll's novel "Alice's Adventures in Wonderland":

Alice asked the Cheshire Cat, who was sitting in a tree:
- "What road do I take?" The cat asked,
- "Where do you want to go?"
- "I don't know," Alice answered.
- "Then," said the cat, "it really doesn't matter, does it?"

[1] https://www.goodreads.com/quotes/tag/cheshire-cat

Using this, we reached one target and a usual student's misconception: clarifying that the goal is the end, not the halfway. Notwithstanding the fact of understanding the goal concept, we found out that the question of finding goals was persistent, and the why question is not sufficient to clearly express intentionality. We also found this problem in referees' feedback on submission to grants as well as to conferences and journals. Reviewers have difficulties in understanding the concept of means-end and the satisficing nature of softgoals (Non-Functional Requirements).

Pursuing a better explanation, we started to investigate Philosophers and found out that some of their well-known quotes could be of help. As such, we started an inquiry standpoint about intentionality. First, we focused on two elements action and goal. The Greek philosopher Socrates' phrase was employed to improve the meaning of goal: "When one navigator does not know his terminal port, no wind can help him." As for questions about goal refinement, we use the French philosopher Émile-Auguste Chartier phrase: "Steps did not only achieve a goal; each step is itself a goal.". This quote is very much related to iStar goal refinement, which uses a combination of means-end and task decomposition.

During the process, we noted that the "Why?" question remained without a satisfactory explanation. One of us, Padua, came with the insight of considering: motivation and necessity. Again, a Greek Philosopher was of help; in this case, Plato: "Necessity is the mother of the invention", and "Men do not want what they do but the goals which conduct them to do what they do". These two citations explain where a goal comes from.

Yet another citation, from Yu, the iStar inventor, "A goal is a condition or state of affairs in the world that an actor would like to achieve" [8] was proper as to ground the four previous concepts in the real world (State of Affairs).

The Intentionality Model

For us Intentionality is formed by four elements (Figure 1) that interact mutually: necessity, motivation, goal, and action and are grounded on reality (state of affairs).

Rationally, clockwise in Figure 1, intentionality is triggered by necessity. Necessity is bounded by subsistence and may be a pressure of circumstances. Necessity is something that someone (or some "organization") needs. When one necessity "appears or is identified" usually it is not easy to recognize how to supply it. The necessity makes motivation. Motivation may be understood as a chance of change. The motivation creates one idealized goal, and one goal conducts to one or more actions. An action attends a necessity, as well as evolves a state of affairs. A state of affairs shapes necessity.

An example: When in need for paying debts (necessity), an organization has a drive to cash out (motivation). That a property be sold (goal) is created by this motivation and requires the organization to sell an asset (action). This action attends the need for paying debts.

The model, Figure 1, may also be navigated counterclockwise: the identification of a "new" necessity may perform or change actions to achieve or fulfill the set of related goals. An action achieves a goal. The goal depends on the motivation, and the motivation comes from the necessity.

As an example: To know the fair value of an asset (necessity) someone should investigate (action) for how much this item is worth, before having it be sold (goal). The selling depends on an offer considered proper for the seller's needs (motivation).

Note that state of affairs is the place holder for the "Multi-loop, Multi-level Feedback" [2] of the model.

We use the examples above, to show that either thinking clockwise or counterclockwise is a way to better achieve the comprehension of what is the goal to be achieved. The first example uses an organization, and the second uses a person.

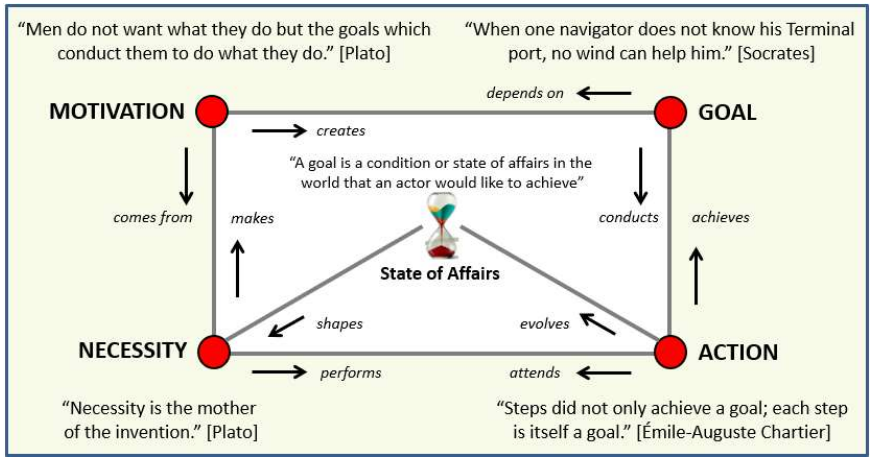

Figure 1 – The IRES Philosophy Model

Within this Intentionality Model, we point out that the actions are the way goals are operationalized or taken into effect by operations that evolve previous states. The Model serves us as a way of making clear how the usage of IRES helps to address the questions in the Introduction.

The sole purpose of producing Intention Oriented Models is to enhance the separation of concerns, focusing on abstract representations, before committing towards a specific action, or operationalization. In our understanding of *Intentionality*, we stress the duality of creation and inspiration. Creation is represented by **Goal** and **Action**, while inspiration is represented by **Necessity** and **Motivation**. We have to keep in mind that, by being abstract, intentionality is difficult to materialize. As such, it is seldom said/written in an explicit manner. Uncovering intentionality is hard and the frame proposed is in the direction of making intentionality transparent.

At this point, one may ask: "Where is the beginning?" This a common question that students ask. There is no specific spot for beginning, if you know one goal candidate you may work counterclockwise, that is asking for the motivation and continuing in the counterclockwise until you are back to the goal candidate. However, you could also have proceeded clockwise and think of possible actions and continuing until you are back to the goal. This process may start at any of the four vertices, either clockwise or not. More important is that the traces, given by the verbs (arrows), among vertices have to be consistent. Questioning for the consistency of the traces among vertices is a powerful way of driving the elicitation process in a constructive manner.

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As such, our Model of Intentionality addresses the interaction of creation and inspiration both in a forward as in a backward (feedback) manner. Goals are created (forward), but Action evolves the State of Affairs, which in turn, shapes (feedback) Necessity. As such, the Model presents itself as a perpetual motion model, as new necessities are brought by the evolution of the State of Affairs.

3 Ongoing work

Using IRES Intentionality Model (Figure 1), we perceived that one concept (**action**), because it is not abstract, may help the requirements engineer (the elicitor) to identify, with less subjectivity, the other elements of intentionality in a given **state of affairs** (UofD – Universe of Discourse, when the reality is instantiated for the case at hand). This means that actions can be identified in the UofD more easily, and each action identified may give directions (or paths) to requirements engineers for identifying its correspondent goal.

Illustrating the model application: for each **action** identified, the requirements engineer (the elicitor) should find which **necessity** the **action** attends and which **motivation** comes from **necessity** and next to the **goal** that is behind this **action**. These examples use the Expert Committee Exemplar [10]. This exemplar models the organization of a conference focusing on the goals of selecting papers, and as such has different actors (Authors, Reviewers, Chair) performing actions to achieve goals and softgoals.

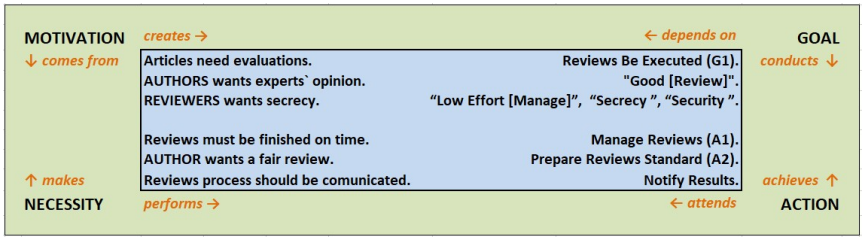

Fig. 2a – Example of intentionality investigation using “EC – Expert Committee”.

In the context of the exemplar “EC – Expert Committee”, see Figure 2a above, the chair’ action “Manage Reviews (A1)” should attend (←) the necessity of “Reviews must be finished on time”, which makes the motivation “Articles need evaluations”. One the other hand the action “Manage Reviews (A1)” achieves the goal “Reviews Be Executed (G1)”, which depends on (←) the motivation of “Articles need evaluations”.

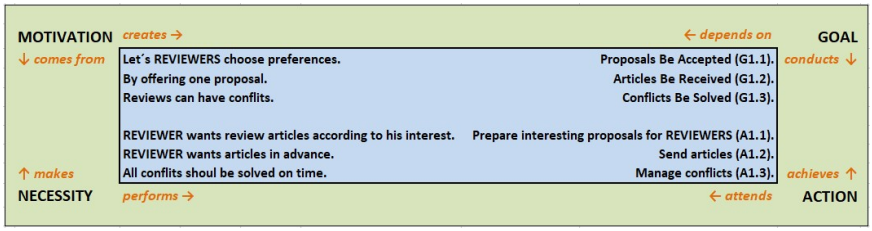

Fig. 2b – Example of intentionality investigation using "EC – Expert Committee".

Figure 2b shows refinements of **goal** "Reviews Be Executed (G1)" (from Figure 2a). In this case the chair's **action** "Prepare interesting proposals for REVIEWERS" attends the **necessity** of "REVIEWER wants review articles according to his/her interest" since there is a **motivation** of "Let's REVIEWERS choose preferences". The **action** "Prepare interesting proposals for REVIEWERS" achieves the **goal** "Proposal BE accepted".

In the case of the COVID -19 Pandemic, see example in Figure 3, three nonexclusive **actions** ("Provide ICU beds and medical provisions" (A1), "Adopt preventive measures" (A2), and Vaccinate people (A3)) were sometimes confused with being exclusive. Although, if the exclusion path was taken, both of A1 and A2 may attend the **necessity** "Sufficient ICU beds to be used by the all-infected people", which makes **motivation**: "By reducing the demand of ICU - Intensive Care Unit", which creates the **goal** "ICU beds and provisions BE created" (G1). However, this line of thought might miss the proper **motivation** "Lives are important".

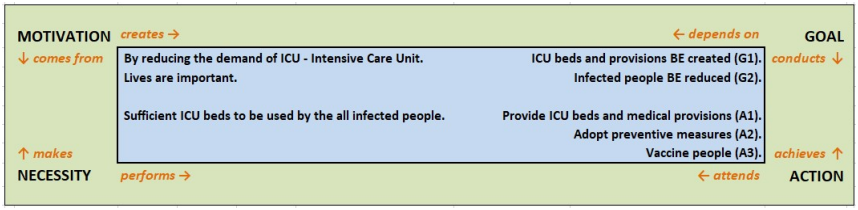

Fig. 3 – Example of intentionality investigation using "COVID -19 Pandemic".

We believe the presentation of IRES fundamentals may be understood as of the same type as described by Parnas and Clements [1] in "A rational design process: how and why to fake it". That is, we did not have the fundamentals laid down as we started working on IRES, which was previously named ERi*c. We rationalized the fundamentals as an after the fact, based on our experience and on trying to rationalize our modeling process.

IRES provides a way to help the identification of goals and softgoals in a bottom-up elicitation strategy. Elicited information is represented in the iStar language. We straightforwardly introduce the iStar language, adopting the convention of patterns and heuristics. Besides modeling heuristics, IRES also includes a diagnoses approach to improve the quality of iStar models. Examples are given of both proper modeling and modeling that should be avoided. Emphasis is given to the construction of more concise and communicative iStar models. Figure 4 summarizes the IRES proposal.

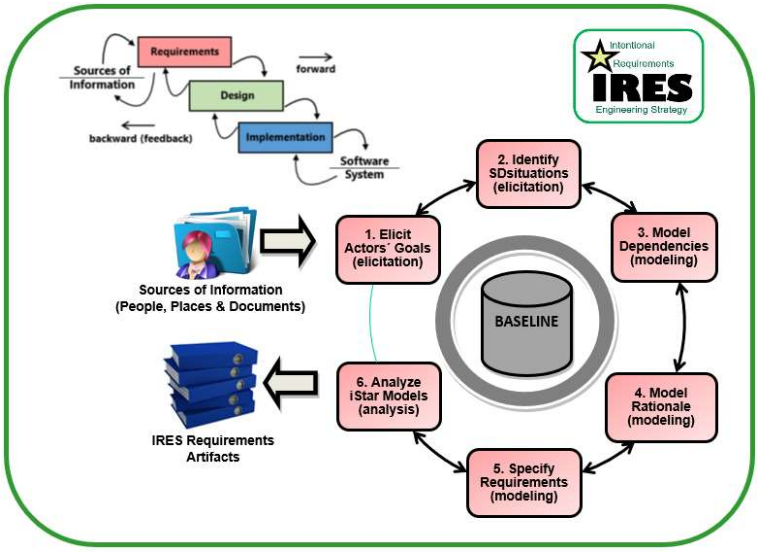

Fig 4. Intentional RE Strategy (IRES) overview.

IRES is grounded on the Philosophy Model but focuses its operationalization on the concepts of goals and actions. As such, IRES does not model necessity and motivation. As per Figure 4 the IRES method has six steps. Step 1. "Elicit Actors' Goals" [2], partially supported by the C&L tool software [5], is composed of three tasks: 1.1) Build LEL - Lexicon Extended Language [4], 1.2) Extract goals, and 1.3) Refine goals. It is relevant to mention that Task 1.2) Extract goals and Task 1.3) Refine goals uses one peculiar strategy named AGFL - Actors' Goals from Lexicon [6] for goals elicitation.

Goal's elicitation and the identification of actions are achieved by one systematic approach named AGFL [6] (Actor Goal From Lexicon) heuristics, which uses the problem domain language for identifying both goals and softgoals.

AGFL is an indirect elicitation strategy based on the existence of a LEL (Language Extended Lexicon) for a given UofD. In the LEL, actors are described as subject symbols. Actors appear in both notion and behavioral response definitions. Behavioral responses mention actions that happen in the UofD, and two kinds of actions can be observed: concrete actions and flexible actions. A concrete action changes one state, it changes one state to another one, and a flexible action adds a quality attribute to one or more goals. Because actions change states, identifying the motivation (why?) and the necessity behind each action is the key point to AGFL. The IRES Philosophy Model (Figure 1) is the backbone of *elicitation* (step 1 and step 2) and provides guidance as instructions, heuristics, and recommendations for *modeling* (step 3, step 4, and step 5) as well as for *analysis* (step 6) of IRES (Figure 4).

[2] It should be noted that the case of finding goals in the lexicon is based on the identification of lexicon symbols classified as states, and as such is bounded by which states were found in the language of the UofD. Having a broader view of intentionality elicitation, given by the proposed frame is a plus in refining goals.

Conclusions and Future work

We understand that this vision paper reflects our understanding of IRES, an intentional approach towards requirements building, anchored on the iStar language. We believe that its contribution is to bring a discussion upon the fundamentals of an intentional oriented way for building requirements. The IRES philosophy frame is one idea for helping goals' elicitation, making transparent the justification for their elicitation. IRES philosophy helps both elicitation and the explanation/justification of the goals' elicitation process. "Since goals change, the philosophy frame is said alive because it follows the process of goals elicitation."

This paper shows how the frame concepts were designed and what was included to make intentionality elicitation clearer to UERJ's undergraduate students. We are just finishing the redesign of templates connections (Figures 2a, 2b and 3). After that, we are planning an experiment with UERJ undergraduate students using a software tool supporting the intentionality elicitation integrated with the IRES baseline.

As said, "Multi-loop, Multi-level Feedback" [2] is upon us. Hence the more we learn, the better we can explain our understanding of what it means to use an intentional perspective in Requirements Engineering.

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