Argumentation-based Methodology for Goal-oriented Requirements Language (GRL)

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Abstract. Goal-oriented Requirements Language (GRL) aims to capture goals and non-functional requirements of stakeholders and analyzing alternative solutions for realizing these goals. GRL also documents the rationale behind selecting certain goals or alternatives. However, it does not have any means to document and trace back all of the arguments that occur during the stakeholder's discussion process. To address this, we have developed the RationalGRL framework. RationalGRL combines techniques for formal argumentation from artificial intelligence with goal modeling in GRL. However, we did not specify how practitioners can actually *use* this framework. In this paper we discuss the methodology for RationalGRL, which consists of two processes, goal modeling and argumentation, that can be done interchangeably. We motivate our approach with an example.
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1 Introduction

Goal-oriented Requirements Language (GRL) [1] is part of User Requirements Notation (URN), an ITU-T standard [4]. GRL models high-level goals and objectives in terms of *softgoal* or *goal* which are refined into operationalized solutions called *tasks*. GRL includes *beliefs* which aims at capturing reasons behind selecting certain goals or tasks. GRL beliefs are very limited and static. It is also not possible to reason about them.

In recent years much work has been done to integrate argumentation-based techniques with goal modeling approaches. Goal Argumentation Method (GAM) [5] proposed by Jureta *et al.* applies argumentation and reasoning to decide between alternatives and goals for developing goal models. GAM includes a mechanism to translate formal argument models to goal models. Haley *et al.* [3] introduce a framework which exploits a set of structured arguments to capture the rationales behind choosing a set of security requirements. Their work does not include formal semantics for analyzing and evaluating whether the arguments are acceptable or not. Murukannaiah *et al.* [6] also propose Arg-ACH which includes argumentation techniques to identify and resolve the inconsistencies and mismatches between the stakeholders' goals and beliefs.

In recent work, we have proposed a preliminary framework called RationalGRL [11, 10, 13] with tool-support [12], which maps argument diagrams with GRL and helps developing GRL models by allowing for better representation of the stakeholders' arguments and discussions. The RationalGRL framework is similar to GAM in that it also provides a translation between formal arguments and GRL models. However, the main difference between GAM and our RationalGRL framework is that in RationalGRL, the arguments are integrated with goal models through argument schemes which are used in artificial intelligence research and philosophy to model discussion about arguments.

While the RationalGRL framework contained various algorithms for computing GRL models from arguments, we did not clarify how practitioners can actually *use* this framework. Therefore, in this paper, we discuss the methodology for developing GRL models based on underlying discussions and arguments using the RationalGRL framework.

The rest of the paper is as followed: In Section 2, we discuss practical reasoning and GRL. We provide an overview of the RationalGRL methodology in Section 3. We give a brief example in Section 4 and finally, we conclude and discuss the future work in Section 5.

2 Practical Argumentation and GRL

Practical reasoning which has been studied extensively in both philosophy [14] and AI [2], aims at analyzing and reasoning about goals and actions. Walton *et al.* [14] introduce an approach to practical reasoning based on arguments schemes (AS) and critical questions (CQs). In this approach, an instantiation of an AS can result positively or negatively in taking an action. CQs can be used to test the AS (for example, to verify whether the action is possible given the current situation). If the answer to the CQ is negative, a counterargument to the original argument is instantiated. Atkinson et al. [2] developed the *practical reasoning argument scheme* (PRAS) for reasoning about goals and actions. PRAS follows the basic argument structure as:

> We have goal G; Doing action A realize goal G; Which promote value V;
> *Therefore,* We should perform action A.

PRAS also includes a set of CQs which criticize practical arguments for acceptance or rejection. Some examples of CQs are: *Will the action satisfies the desired goal?* or *Are there alternative ways of realizing the same goal?*

We apply PRAS to goal modeling to document the stakeholders' discussions as formal argumentation. This allows us to compute whether GRL intentional elements (IEs) and their relationships are shown in the resulting goal model, or whether they are disabled. This framework includes both AS and CQs. The framework provides a rationalization to GRL IE in terms of underlying arguments, and it allows one to understand why certain elements have been rejected.

In the next section, we will discuss the integration of the argumentation framework with GRL which leads to RationalGRL framework as well as the methodology for developing models in this framework.

3 RationalGRL Framework and Methodology

As mentioned earlier, the RationalGRL framework aims at integrating GRL models with the underlying discussions and arguments of the stakeholders during the analysis phase by combining PRAS with GRL. Our argumentation framework is developed based on the analysis of the CQs, practical reasoning and discussions of the stakeholders of the system. Initial GRL models are first created based on the analysis of non-functional requirements in the requirements specification documents, discussions with stakeholders and by refining the high-level goals into operationalized tasks.

In RationalGRL, both GRL and argumentation models are done iteratively. Argumentation models impact GRL models and result in refinement and changes in GRL. For example, an answer to the CQ *Is the task possible?* can lead to rejection or acceptance of the task in GRL. The analysis of GRL models may result in changes in the underlying argumentation framework as well. For example, adding a new IE to the GRL model can result in posing new CQs with respect to the IE and its relationships. Figure 1 shows RationalGRL and the relationships between the different parts. On the right-hand side of the framework, we have GRL models and on the left-hand side we have argumentation framework. The links between the two sides illustrates the impacts each side has on the other side and the changes that occur due to the impacts and the refinements.

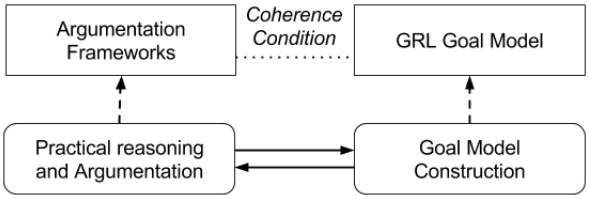

Fig. 1: The RationalGRL Framework

To develop RationalGRL, we follow the methodology shown in Figure 2. We already have an initial GRL model. The steps of the methodology are as follows:

Instantiate Argument Schemes (AS) – In this step, we instantiate one of the AS from the argumentation framework. PRAS identifies 8 arguments schemes which we use in our analysis. An example of an argument scheme is "Goal G contributes to softgoal S". An instantiation of an argument scheme thus corresponds to an argument for or against part of a goal model.

Answer Critical Questions (CQs) – Instantiated arguments can be attacked by counter-arguments. CQs are ways in which AS can be attacked. Each argument scheme in PRAS includes one or more CQs. For example, for the argument scheme mentioned above, we have two CQs as: *Does the goal contributes to the softgoal?* and *Does the goal contributes to some other softgoals?*. Note that, the answer to CQ can also result into "conflict" situation which we do not

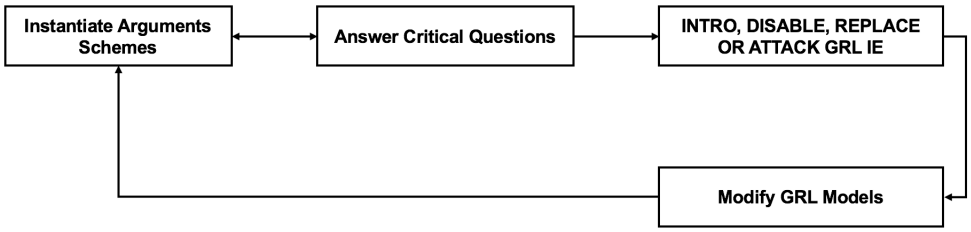

Fig. 2: The RationalGRL Methodology

consider here. Answering a CQ may result in an instantiation of a new AS. Thus, it is possible to go back and forth between this step and the previous one.

Decide on IE and the Relationships – The answers to the CQs can result in one of the four cases which impact the arguments and corresponding GRL IE: INTRO, DISABLE, REPLACE or ATTACK. INTRO means that the argument scheme of the CQ does not get attacked and instead it creates a new argument. DISABLE means that the IE or the relationship related to the AS needs to be disabled or removed from the models. REPLACE introduces a new argument and attack the original argument at the same time. It basically replace the original element of the AS with a new one. ATTACK is a generic counterargument which attacks any argument with another argument when a new evidence occur.

Modify GRL Models – Based on the result of step three, the GRL models can be modified. In this case, either a new IE or a new relationships is introduced, an existing IE or relationship gets disabled (removed) from the model or finally an existing IE or relationships is replaced by a new one. This results in a new modified GRL. The new GRL model can then impact the argument schemes and instantiate another argument scheme.

In the next section, we provide a short example to illustrate the relationship between argumentation framework and goal models.

4 Example

Our examples comes from a transcript containing discussions about the development of an information system, and they are created as part of two master theses on improving design reasoning [9, 8].

A group of stakeholders is developing a goal model for a traffic simulator example and they are modeling the goal *simulate* of the system using the RationalGRL methodology. This proceeds in the following way:

- First they start at step *Modify GRL models* (Figure 2), and add the IE `Simulate` to GRL model (Figure 3, GRL model, top IE).
- Next, they switch to the argumentation part (step *Instantiate arguments schemes*). They answer CQ *Does Simulate AND-decompose into any tasks?* with *Yes: namely tasks "Dynamic simulation" and "Static simulation.*
- As a result, two argument schemes are created, namely:

  - Actor *System* has task *Dynamic simulation*
  - Actor *System* has task *Static simulation*
- In the GRL model, this corresponds to the addition of two tasks, and an AND-decomposition from the goal *Simulate* to these two tasks.
- Next, the stakeholders test the validity of their goal model by answering more CQ. They answer two CQs:
  - CQ *Is task "Dynamic simulation" relevant* is answered with "No, it is not relevant since the problem specification explicitly states dynamic simulations are not required". Thus, the corresponding GRL IE is disabled.
  - The decomposition is changed from AND to OR, since it turned out not both tasks can be implemented together.

The resulting RationalGRL model is shown in Figure 3.

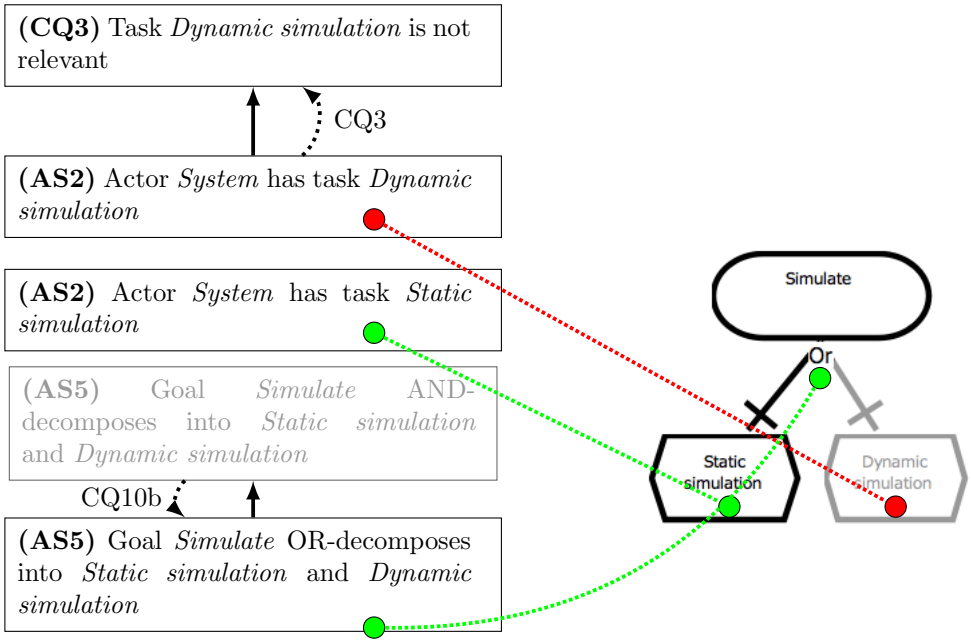

Fig. 3: Argument schemes and critical questions (left), GRL model (right), and traceability link (dotted line) of the example.

5 Conclusions

In this paper, we give an overview of our RationalGRL methodology, which integrates argumentation techniques from AI with goal modeling GRL, in order to incorporate and document the discussions between stakeholders. We also present an example to show how the integration and analysis work.

In future, we aim at extending the argumentation framework by performing an empirical studies so that we can capture more AS that are relevant to GRL. Although PRAS arguments schemes are a good start to analyze and modify GRL models, there are important differences between PRAS and GRL. For example, PRAS does not have the GRL notion of "resource". Thus, not all of the relationships and GRL IE are covered by the current AS. In addition, the current process for integrating argumentation framework with GRL is done manually. In future, we would like to develop a tool-support that can also be integrated with GRL tool-support, jUCMNav [7], to help analyzing the AS and CQs.

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