Using Goal Models Downstream: A Systematic Roadmap and Literature Review

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ABSTRACT

Goal models have proven useful for capturing, understanding, and communicating requirements during early stages of software development. However, the utility of goal models is greatly enhanced when they can be exploited during downstream stages of the requirements analysis process (e.g., requirements elaboration, validation, planning), and can be used as part of the entire system life cycle (e.g., architectural and behavioral process design, coding, testing, monitoring, adaptation, and evolution). In order to better understand the progress that has been made in integrating goal models with downstream system development, the authors ask: what approaches exist that map/integrate/transform goal models to later stage software artifacts? To answer this question, they conduct a systematic survey, producing a roadmap of work summarizing 243 publications. Results include a categorization of the "why?" and "how?" for each approach. Furthermore, they select the 50 most prominent publications, based on citation numbers, in order to perform an in-depth literature review. Findings show that there is a wide variety of proposals with a variety of proposed goal models and targets, covering multiple paradigms, motivated by a variety of purposes. The authors conclude that although much work has been done in this area, the work is fragmented, following multiple separate strands of goal-orientation, and is often still in early stages of maturity.

Keywords. Evidence-Based Requirements Engineering, Goal Model, Model Transformation, Requirements Engineering, Systematic Literature Map, Systematic Literature Survey

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1. INTRODUCTION

The quality of a software system critically depends on the degree to which it fulfills its requirements. Such requirements are often captured, modeled, and analyzed as (stakeholder) goals. Over the past two decades, goal modeling has received much attention in Requirements Engineering (RE) research, but also in Software Engineering (SE), Information Systems (IS), Conceptual Modeling (CM), and Enterprise Modeling. Goal models have been used as an effective means for capturing the interactions and tradeoffs between requirements.

Although goal models per se have proven their worth during requirements analysis, their utility would be greatly enhanced if these models were also used during other phases of the development process (downstream development), such as architectural and process design, code development, testing, monitoring, adaptation, and system evolution. This integration of goal modeling into downstream activities is challenging due to the qualitative, social nature of goal models. After all, it is difficult to take “fuzzy” concepts such as softgoals, roles, and actor dependencies and map or transform them to concrete functional system elements.

Much existing work has addressed aspects of this integration problem along different dimensions. In this work, we aim to understand the landscape and status of such existing work, evaluating the progress and maturity of efforts in this area, drilling down into the details of prominent publications. In particular, we want to understand the nature of existing proposals for goal model integration, including the type of transformations deployed, the type of goal models used, the motivations for such techniques, the common targets of the transformations, the venues where this work was published, the network of paper authors and citations, and the trends in such approaches.

Our study is shaped in the form of a roadmap of approaches that map, transform or otherwise integrate goal-oriented languages to or with other artifacts or models related to the software or system lifecycle. The study focuses on the top 50 cited papers within our roadmap, providing a deeper analysis and literature review for these papers.

Kitchenham et al. have advocated Evidence-based Software Engineering (2004), inspired by Evidence-based Medicine. In their work, finding and assessing available evidence to address software engineering questions for researchers and practitioners is done in a systematic method-based fashion. In our study, we perform Evidence-based Requirements Engineering (EBRE), systematically finding and summarizing available publications in order to answer goal model-related research questions.

Specifically, we first produce a roadmap summarizing publications falling under the scope of our study without considering their quality (Kitchenham, Budgen, & Brereton, 2011). We then examine more carefully selected publications, in order to better understand the details of and motivations behind proposed mappings/transformations/integrations. We place particular emphasis on publications classified under Software or Requirements Engineering.

This roadmap and literature review can be beneficial for several types of readers. For researchers interested in using goal-orientated system development, the roadmap helps one to build upon existing work, avoiding the proverbial ‘reinvention of the wheel’, helping to understand trends, and guiding efforts towards new directions. For practitioners, this roadmap helps demonstrate the ways in which goal-oriented approaches can be integrated into existing system development paradigms, offering ideas on how goal-orientation can be adopted in practice, including pointers to work containing further details.

This work builds upon work presented by Horkoff et al. (2014). Specifically, we have expanded the coverage of our roadmap, covering an additional 69 papers, including papers appearing from September 2013 to June 2014. As part of our roadmap, we have added an analysis of cross-citations between included papers. Finally, we have selected the...

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