

Nòmos 3: Reasoning about Regulatory Compliance of Requirements

Silvia Ingolfo
UNITN, Trento Italy
ingolfo@disi.unitn.it

Alberto Siena
FBK, Trento Italy
siena@fbk.it

John Mylopoulos
UNITN, Trento Italy
john.mylopoulos@unitn.it

Abstract—The great impact that law has in the RE-process has called for new techniques and procedures to evaluate the alignment of requirements with applicable laws. In this paper we present a modeling language for the evaluation of compliance of requirements with a piece of law: Nòmos3. We introduce our language and show the reasoning capabilities of our proposal.

I. INTRODUCTION

Over the past decades, legislators are increasingly laying down new laws to regulate software systems and their use. Requirements engineers are challenged to elicit requirements that satisfy stakeholder needs and also comply with applicable laws. However, regulatory documents are complex artefacts that contain conditional elements such as derogations, exceptions, and so on. Because of this conditional structure, when making design choices, engineers also choose the conditions that the software system will satisfy, and therefore also the clauses that the system should comply to. This, in turn, causes requirements to need to be changed, generating a cost-increasing cycle. For example, when developing a system for a high-school to electronically manage student careers, an analyst may need to take into account privacy laws. A school may be required by law to make public the student final test results, but it is not allowed to disclose mid-term results, except to the single student. In order to produce system requirements that comply with the law, the analyst needs to identify possible ways to satisfy the duty — e.g., publish final results on the school webpage, or send an email with final results to all students — or identify and exploit exceptions to avoid to comply duty — e.g., private schools may not need to make the results public, provided that they officially send the final results to the Education Ministry.

Different solutions exist in RE to support the problem of regulatory compliance of requirements. Many approaches are based on natural language processing techniques, and focus on direct extraction of legal requirements from legal documents [1], [2]. Our approach takes a different perspective and is aimed at helping the analyst to ensure compliance of requirements to a given law by means of conceptual modelling and lightweight reasoning. Laws are modelled using the Nòmos3 modeling language, and variability points and alternatives are identified through automatic reasoning [3], [4]. The lightweight approach (based on propositional logic) eases the integration with RE practices, and its viability is confirmed by a scalability study [5].

The objective of this paper is to illustrate the reasoning capabilities of Nòmos3 for evaluating compliance of requirements, and help the requirement analyst answer questions like: given a set of requirements, which norms apply? which norms are violated? how do I comply with a given norm? who is responsible for a norm?

II. NÒMOS 3: THE LANGUAGE

Nòmos3 [4] is a modeling language for representing legal provisions, such as laws and regulations, and reasoning about the compliance of requirements — represented in terms of Goals [6]. Nòmos3 models (see figure 1) are built using the following primitive concepts. *Situation*: a proposition describing a state of affairs of the world, e.g., “It is Christmas Season”. *Goal*: a particular Situation desired by (at least) a role in the domain, e.g., “Patients data are updated”. *Domain Assumption*: are particular Situation that hold in the domain, e.g., “The school is private”. *Norm*: a right/duty that somebody has, e.g. “Duty to not to disclose sensitive information”. *Role*: somebody who wants a Goal (Social Role, “Doctor”) or who is addressed by a Norm (Legal Role, “Data Processor”). Relationships allow expressing when:

- Situations make a Norm applicable/not applicable (*activate/block* relation), or make a Norm or Goal or other Situation satisfied/not satisfied (*satisfy/break*)
- Goals bring-about Situations (relation *brings-about*)
- Situations can only be brought about by a specific role (*reserved*)
- Social Roles want Goals (*wants*), and play Legal Roles (*play*)
- Legal Roles are in charge of satisfying Norms (*holds*)
- Norms make other Norms applicable, not applicable or complied (*endorse, derogate, imply*) [3]

Nòmos3 supports reasoning about a set of requirements represented as goals and their compliance with a given law. The *legal model* represents a law in terms of: (i) the norms it provides, (ii) the conditional elements (exceptions, derogations,...) that introduce *variability* in the way to comply with the norms, and (iii) the *responsibility* of roles associated with norms (hold relationship). Variability is modelled by capturing the situations that make a norm apply or be satisfied, as described in [3]. Responsibility is modelled by capturing the situations that make compliant the role associated with the norm. The *domain model* represents information about requirements, expressed in terms of situations brought-about when goals are achieved, and roles responsible for the goals.

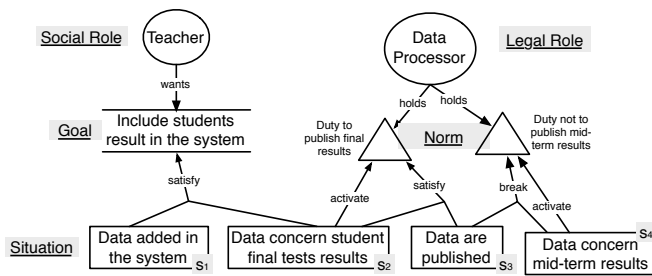


Fig. 1. Example of a Nòmos 3 model

Example. The goal for a Teacher to input the test results in the system (see figure 1), is represented by the Social Role of ‘Teacher’, and the conjunction of two Situations that, when satisfied, make the goal achieved: s_1 “Data are added in the system” and s_2 “Data concern student final-test results”. When the goal is achieved, “Data in the system are updated” is an example of Situation *brought-about* by the Goal. The processing of data concerning students and students results — addressed for example by Title VI of the Italian Privacy laws — addresses the Teacher and the School as “Data Processor”, that who process the data. In the legal model, the Legal Role of ‘Data Processor’ holds the duty to publish the student final-test results, and is responsible to satisfy the norm. The situation s_2 “Data concern student final-test results” identifies what makes this duty applicable; when the situation “Data concern students mid-term results” holds instead of s_2 , then the duty to publish does no longer apply and another duty applies. The duty to publish final results is satisfied when 2 situations hold: s_2 and s_3 “Data are published”. When instead the situations holding are s_3 and “Data concern student mid-term results”, then the duty not to publish mid-term results is not satisfied (it is violated).

III. REASONING WITH NÒMOS 3

Compliance in Nòmos 3 is evaluated by means of inference reasoning. Initial values are assigned to input nodes of the model: Situations which are observed or hypothesized to be satisfied (i.e., the state of affair that they represent holds: ST), false (the state of affair that they represent does not hold: ST) or undefined (it is not known whether the state of affairs that they represent holds or not: SU). Relationship between concepts propagate the values across the legal model in order to perform different types of analysis. A Nòmos 3 model can be queried by means of forward or backward analysis. In forward analysis, input values are simply propagated across the model, and the resulting knowledge is reported (norms complied/violated and roles complying or not). In backward analysis, an explicit query is requested (e.g., specific norms and roles complied), and an assignment satisfying the query is reported, if found. In this analysis, Norms and Roles will receive values through the relations, and from the evaluation of these values a compliance assessment is formulated. In particular, compliance evaluation of norms involves: (a) the identification of applicable Norms (Situations that make a

Norm applicable); (b) satisfied Norms (Situations that make a Norm satisfied); and (c) Legal Roles, who have fulfilled their responsibilities (Situations that should be satisfied by a Role). Compliance evaluation of roles involves the identification of Situations that need to be satisfied by the role: Situations representing the satisfaction of an applicable norm a Legal Role holds, or representing the goal the Social Role wants.

Nòmos 3 models allow the analyst answer questions like:

- *Given a set of requirements, which norm apply?* This question summarizes one of the basic reasoning of Nòmos 3 where a set of Situations are assumed to have a satisfaction value (i.e., goals bring about the sit.), and evaluate which norms these situations make applicable, and the legal roles that should comply with these norms.
- *Given a set of requirements, which norm are complied?* This question summarizes the case where a set of Situations are assumed to have a satisfaction value (i.e., goals bring about the sit.), and evaluate which norms these situations make applicable, satisfied, and make the legal roles comply. Applicable norms not satisfied are violated.
- *Given a set of requirements, which roles in the domain are subject to which norms?* This question summarizes the case where a set of Situations are assumed to have a satisfaction value (i.e., goals bring about the sit.), and evaluate which Social Roles play a Legal Role who is holding an applicable norm.
- *Given a set of requirements, which roles in the domain comply?* This question summarizes the case where a set of Situations are assumed to have a satisfaction value (i.e., goals bring about the sit.), and evaluate the Social Roles that (a) have all their goals satisfied, and (b) the Legal Roles played by the Social Role should have all applicable norms that it holds complied with.

Future work. Currently our model are created manually, so our work-in-progress is working on the semi-automatic generation of Nòmos 3 models from a legal text. Also in future work we plan to implement the primitives of our propositional approach in DLV, to support reasoning over our models.

ACKNOWLEDGMENTS

This work has been supported by the ERC advanced grant 267856 “Lucretius: Foundations for Software Evolution” (April 2011 – March 2016) <http://www.lucretius.eu>.

REFERENCES

- [1] T. Breaux, M. Vail, and A. Anton, “Towards regulatory compliance: Extracting rights and obligations to align requirements with regulations,” in *RE’06*, 2006, pp. 49–58.
- [2] J. Maxwell and A. Anton, “Developing production rule models to aid in acquiring requirements from legal texts,” in *RE’09*, 2009, pp. 101–110.
- [3] A. Siena, I. Jureta, S. Ingolfo, A. Susi, A. Perini, and J. Mylopoulos, “Capturing variability of law with Nòmos 2,” in *ER 2012*, p. 383.
- [4] S. Ingolfo, I. Jureta, A. Siena, A. Perini, A. Susi, and J. Mylopoulos, “Nòmos 3: Legal compliance of roles and requirements,” in *Submitted to ER 2014*, 2014.
- [5] A. Siena, S. Ingolfo, A. Susi, A. Perini, and J. Mylopoulos, “Automated reasoning for regulatory compliance,” in *ER 2013*, 2013.
- [6] E. Yu, “Towards modelling and reasoning support for early-phase requirements engineering,” in *RE’97*, 1997, pp. 226–235.