Goals and Compliance in Nòmos 3

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Abstract. The impact of laws in Requirement Engineering has increasingly drawn attention to new methodologies and techniques that address the problem of aligning a set of requirements with applicable norms. Goal models have long provided a lightweight approach for the representation and analysis of requirements. This paper presents ongoing work for evaluating the compliance of a goal model with applicable laws.

Keywords: Requirements; Goal; Regulations; Compliance

1 Introduction

Software systems have been increasingly gained the attention of governments and enterprises for the risks they pose in case of mishap. This attention often translates into a rapidly growing body of laws (and/or regulations) that these systems must comply with to alleviate — or at least minimize — risk. Given such a setting, new systems must be designed with an eye to applicable laws that the systems must comply with. Moreover, for every new or amended law, every relevant legacy system must be revisited to ensure that it complies, or amended accordingly. A new challenge for software engineers then is to understand the various ways systems can meet user needs while at the same time complying with applicable laws.

In previous work we have introduced Nòmos 2, a conceptual modelling language for laws that supports formal reasoning about alternative ways to comply with them. Nòmos 2 relies on the intuition that laws generally establish norms (i.e., duties and rights), but also the context in which these norms apply, their preconditions, exceptions and logical inter-connections. We are currently working on Nòmos 3, an extension of Nòmos 2 that introduces the concepts of goal (for modelling requirements) and roles for modelling both social roles (e.g., a manager, a professor) and legal ones (e.g., a data processor for a privacy law). The main objective of this progress report is to sketch the main ingredients of Nòmos 3. We show how to link models of the requirements (i*) with model of the law, and offer a glimpse of the types of reasoning it needs to support in order to establish compliance of goals relative to a set of applicable laws.

The rest of the position paper is structured as follows. Section 2 presents the Nòmos 3 language and its concepts. In section 3 and 4 we show the capabilities of Nòmos 3 in evaluating the compliance of goals with some norms.

2 Nòmos 3

Nòmos 3 [2] is a conceptual framework for representing laws and regulations, and for reasoning about compliance of requirements to these legal provisions. Nòmos 3 supports reasoning about a set of requirements represented as goals — the *domain model* — and their compliance with a law represented as norms — the *legal model*. 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 to the norms, and (iii) the *responsibilitys* of roles associated to norms. Variability is modelled by capturing the situations that make a norm apply or be satisfied, as described in [4]; responsibilities are modelled by capturing the situations that make compliant the roles associated to the norm. On the other hand, the domain model represents information about requirements expressed in terms of a) the situations that are brought about, and b) roles responsible for the requirements.

The Nòmos 3 framework consists in a conceptual modelling language and a reasoning technique. The language relies on the concepts of Situation, Legal Role and Norm to represent the legal model; also it has the concepts of Situation, Social Role and Goal to represent the domain model. Relationship among these concepts allow us to give semantics to a Nòmos 3 model and to reason about compliance of requirements.

Situation. A Situation represents a state-of-affairs of the world. In Nòmos 3 this concept is used to represent the conditions that make a norm applicable/satisfied, and the state of the world brought about by satisfied goals. For example, the situation "Personal data are treated" is a situation, which makes applicable the duty for the person treating the data to notify the data-owner about modification to its data. When a Goal like "Annotate students presence at school" is satisfied, the Situation "Students presence is annotated" holds. A Situation is associated to a satisfaction value (ST = Situation is satisfied; SF = Situation is not satisfied; SU = it is unknown if the Situation is satisfied) which depends on the values propagated by relationships in the model or on the scenario evaluated (e.g., a set of satisfied goals in the domain brings about a set of Situations).

Roles. In Nòmos 3 we distinguish 2 types of Roles. *Social Roles* are used to model the roles existing in the domain where the requirements are defined, and are modelled using the same concept of Role as in i* [5]. On the other hand, *Legal Roles* [1] are defined by norms, which describe when these roles should make some Situations happen (e.g., duty to pay taxes for a citizen) or to discretionally make some Situation happen (e.g., the right to request a reimbursement for a client). Role responsibilities are modeled in terms of allocation of Situations to Roles, and when the Situation is satisfied, the responsibility of a role is fulfilled. For example, when the Situation "Consent for data treatment is expressed" is satisfied, the Legal Role of Data Subject in the Privacy Law has correctly fulfilled its responsibility. Similarly in the domain, we can say that the Social Role of "Bus passenger" fulfills its responsibilities when the situation "Ticket is validated" is satisfied. Depending on the situations holding, a Role is associated

to a fulfillment value: a Role is fulfilled (FT) if all its responsibilities are; is not fulfilled (FF) when not all its responsibilities are; or (FU) when it is unknown if it has fulfilled its responsibilities.

Norm. A Norm is defined as a 5 tuple (t, hol, cnt, ant, $cons$). t represents the type of the norm (Duty/Right); the holder (hol) is the Legal Role who is responsible to satisfy the Norm consequent; the counterpart (cnt) is the optional Legal Role whose interests are helped if the Norm is satisfied; the antecedent (ant) are the conditions to make the norm applicable; the consequent ($cons$) are the conditions to comply with the Norm. Holder and counterpart are modeled in terms of Legal Roles, while antecedent and consequent are modeled in terms of Situations. In Nòmos 3 the compliance of a Norm depends on 3 factors: its applicability, its satisfiability and the fulfillment of responsibilities of the Role. The compliance value of a Norm can be as follows:

- Compliant: when a norm is applicable (i.e. the Situations in the antecedent are satisfied), is satisfied (the Situations in the consequent are satisfied), and the holder of the norm has fulfilled its responsibilities.
- Accidentally compliant: when a norm is applicable, satisfied, but the holder has not fulfilled its responsibilities (or it is unknown). The idea of "accidental" compliance is that it allows us to identify cases in which the right situations are brought about, but the Legal Role is not necessarily fulfilled.
- Tolerance: when a norm is not applicable but it is satisfied and the holder is fulfilled; when a right is applicable and not satisfied/unknown satisfaction.
- Non-compliant: when a duty applies but it is not satisfied/unknown satisfaction.
- Inconclusive: when it is unknown whether the norm applies or not.

Goals. Goals are used to represent the requirements expressed by the Social Roles. Nòmos 3 evaluates the compliance of a given goal by taking into account: (i) the Role and its associated goals, and (ii) the Situations that are brought about in the world when the Goal is achieved. The Role to which goals are associated, is the Social Role. A set of Situations, in conjunction or disjunction, represents the consequence of the achievement of the Goal. For example "Evaluate students mid-term tests" represents a Goal desired by the Social Role "Teacher". The Situations "Tests are evaluated" and "Tests are performed at mid-term" are read as the Situations brought about when the Goal is achieved, as well as the Situations that need to be satisfied in order to say that the Goal is achieved. This latter reading allows us to read the responsibility of the "Teacher" as being assigned/allocated the Situations satisfying the Goal.

3 Goals and compliance in Nòmos 3

Relationships in Nòmos 3 allow to propagate values and evaluate compliance to norms and fulfilment of role responsibilities. For example, Figure 1 shows a (part of) goal model that represents the goals of a Teacher; also, the figure contains

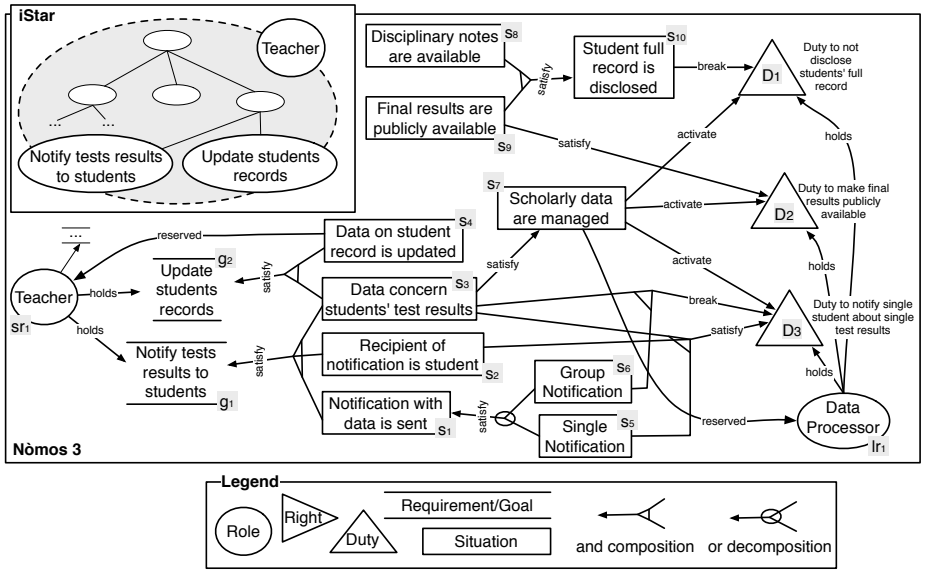

Fig. 1. Example of a Nòmos 3 model.

a Nòmos 3 model representing the duties associated to the Teacher role. The model is used to evaluate the compliance of the Teacher goals with some norms regarding the notification and publication of students results. We present the relationships of our language together with the illustration of the example.

- *hold* is a relation from a Legal Role to a Norm representing the fact that the Role is responsible for the Situations in the consequent of that Norm. This relationship is also from a Social-Role to a Goal and represents the fact that the Social Role is responsible for the Situations that satisfy the Goal. For example in figure 1, the Role having the two Goals is represented by the *hold* relationship between the Social Role "Teacher" and the two Goals g_1, g_2. The intuition is that when the Teacher has fulfilled its responsibility, then the Situations satisfying the Goals are satisfied.
- *satisfy/break* are relationships between Situations: when the source Situation is satisfied, the target Situations is satisfied (resp. not-satisfied for *break*). For example, when "Data concern students' test result" is satisfied, the Situation "Scholarly data are managed" is also satisfied ($s_3 \xrightarrow{\text{satisfy}} s_7$). This relationship is used from Situation to Norm/Goal, to represent that when the source Situations are satisfied, the Norm's consequent/Goal is/is-not satisfied. For example, when "Data on student record is updated" and "Data Concern students' test results" hold, then the Goal g_2 is satisfied (s_4 and $s_3 \xrightarrow{\text{satisfy}} g_2$). When "Student full record is disclosed" holds, the duty to not disclose the full record of a student *is not* satisfied ($s_{10} \xrightarrow{\text{break}} D_1$).

- *activate/block* are relationships between Situations: when the source Situation is satisfied, the Situations antecedent of the Norm are Satisfied (resp. not-satisfied for *block*). For example, when "Scholarly data are managed" holds, the three duties on disclosure of students record and test results are applicable ($s_7 \xrightarrow{\text{activate}} D_1$, $s_7 \xrightarrow{\text{activate}} D_2$, $s_7 \xrightarrow{\text{activate}} D_3$)
- *reserved* is a relationship from a Situation to a Role identifying that the Situation can *only* be brought about by that specific Role (i.e., the specified role is the only responsible for bringing about the situation). The idea behind is that compliance is often strictly related to *who* satisfies a norm, so we need to represent cases in which it is necessary that a specific role. For example, when the consent for data treatment is needed, only the legal role of Data Subject (the Subject whom the data belong) can express a consent for its data. The legal role managing the data (Data Processor) is the only one who can actually manage and process the data ($s_7 \xrightarrow{\text{reserved}} lr_1$). Similarly, in a goal model, we may need to represent that some Situations like "Data on student record is updated" can only be brought about by the Social Role of the "Teacher" ($s_4 \xrightarrow{\text{reserved}} rs_1$)

Nòmos 3 inherits from Nòmos 2 three relationships between Norms (Imply/ Derogate/ Endorse) to model legal variability [4]. An imply relation represents the fact that when the first norm is complied with, the second one is also. A derogate relation represents that when the first norm is applicable, the second one is not applicable. An endorse relation represents that when the first norm is applicable, the second one is also applicable.

4 Compliance of i* models

The concepts in Nòmos 3 allow us to model and reason over a model of the law, while offering concepts for representing and talking about requirements. The link between i* and Nòmos 3 comes therefore from the expression of i* concepts (such as a Role wanting a Goal) in terms of Nòmos 3 concepts and the relationships between them (e.g., the Social Role responsible for some Situations, Situations brought about when a Goal is achieved, ...).

Compliance to norms in Nòmos 3 is evaluated by means of inference reasoning. Initial values are assigned to input nodes of the model and the values are propagated across the model according to the semantics of relations. Input nodes are situations, which are observed or hypothesized to be satisfied (i.e., the state of affair that they represent holds), false (the state of affair that they represent does not hold) or undefined (it is not known whether the state of affairs that they represent holds or not). In the end, norms and roles will also receive values, and from the evaluation of such values a general compliance assessment is formulated. In particular, compliance evaluation involves: (a) the identification of applicable Norms (Situations that satisfy the antecedent of Norms); (b) satisfied Norms (Norms which consequent is satisfied); and (c) Legal Roles, who have fulfilled their responsibilities (Situations assigned to Roles). The general

compliance condition consists in having all the norms complied with, and all the roles fulfilling their responsibilities. A Nòmos 3 model can be queried by means of forward or backward analysis, as described in [4]. In forward analysis, input values are simply propagated across the model, and the resulting knowledge is reported. In backward analysis, an explicit query is requested, and and assignment, which satisfies the query is reported, if found. The positive results of the scalability study of our reasoning [3] suggests that our proposal would scale to real-sized law.

5 Conclusions and Future Work

In this paper we have presented a modeling language, called Nòmos 3, tailored for evaluating compliance of a set of requirements — represented by means of Goals — to a fragment of law — represented by means of Norms and Situations. We have described the main concepts and relations of our language with an example related to the compliance of a set of i* goals with a given law. Currently, our models are generated manually, so part of our current research investigates the possibility to develop a tool-supported methodology for the semi-automatic generation of Nòmos 3 models from natural language regulatory texts. Also, a significant part of our future work concerns the management of responsibilities in an organizational setting: according to what's the role of the actor in charge of complying with a given norm or set of norms, the role must be enabled to delegate its responsibilities to others, while ensuring that the compliance condition is maintained. This will allow us to further integrate Nòmos 3 with i* and goal/task-delegations between Roles. Ongoing work is trying to expand our reasoning support to include questions regarding delegations of responsibilities.

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References

1. Gangemi, A., Sagri, M.T., Tiscornia, D.: A constructive framework for legal ontologies. In: Law and the Semantic Web. pp. 97–124 (2005)
2. Ingolfo, S., Jureta, I., Siena, A., Perini, A., Susi, A., Mylopoulos, J.: Nòmos 3: Legal compliance of roles and requirements. In: Submitted to ER 2014 (2014)
3. Siena, A., Ingolfo, S., Perini, A., Susi, A., Mylopoulos, J.: Automated reasoning for regulatory compliance. ER'13 (2013)
4. Siena, A., Jureta, I., Ingolfo, S., Susi, A., Perini, A., Mylopoulos, J.: Capturing variability of law with Nòmos 2. In: Conceptual Modeling - ER 2012, Lecture Notes in Computer Science, vol. 7532, pp. 383–396 (2012)
5. Yu, E.: Towards modelling and reasoning support for early-phase requirements engineering. In: Proc. IEEE International Symposium on Requirements Engineering - RE97. pp. 226–235 (Jan 1997)