

## Chapter 12

# Creating Worlds with Words: Ontology-guided Conceptual Modeling for Institutional Domains

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**Abstract** Conceptual modeling is often viewed as an activity of representing a pre-existing world that should be faithfully mirrored in an information system. This view is adequate for modeling physical domains but needs to be revised and extended for social and institutional domains, as these are continuously produced and reproduced through communicative processes. Thereby, conceptual modeling moves beyond analysis and representation in order to cater also for design and creation. Following such a view on conceptual modeling, this paper proposes an ontology for modeling institutional domains. The ontology emphasizes the role of institutional entities in regulating and governing these domains through rules and rights that define allowed and required interactions. Furthermore, the ontology shows how these institutional entities are dependent on and grounded in material entities. Conceptual modelers can benefit from the ontology when modeling institutional domains, as it highlights fundamental notions and distinctions in these domains, e.g., the role of rights, the role of processes in creating institutional facts, and the difference between documents and institutional information. The ontology is illustrated using a case on public consultation management.

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## 12.1 Introduction

Conceptual modeling has been defined as “the activity that elicits and describes the general knowledge a particular information system needs to know”, [17, p. xi]. Thus, conceptual modeling is about analyzing and representing some piece of reality, a domain that is to be mirrored in an information system. To support this activity, many researchers have proposed that ontology should be used as a foundation for conceptual modeling, building on the assumption that ontology can help to better understand how reality is constituted, [27, 26, 10]. Physical objects are clearly among the constituents of reality, but there are also realities that are built from other kinds of matter. Sometimes language can hint at the foundations of those non-material realities. Consider the phrases “real property” and “real estate”. What is real about them? It is not that they are natural and material objects, because the “real” here is not derived from the Latin “res” meaning “thing”, but from the Spanish “real” meaning “royal”, or “belonging to the king”, [9, p. 86]. They are real because they are recognized and acknowledged by an authority. In other words, they are real because there exists an institution that says they are so.

Developing conceptual models for information systems is very much about investigating social and institutional worlds. These worlds do not exist independently of humans but are created by people that talk them into existence. As pointed out by [17, p. 41], there are not only concepts that can be considered natural, in the sense that their instances are familiar and viewed as natural by everyone, e.g., trees, birds and temperatures. There are also concepts that need to be invented or designed, e.g., leasing contracts, customers and presidents. These concepts are more often than not institutional ones, having the purpose to regulate human interaction by carrying rules and rights that govern how people are allowed and obliged to interact. And the instances of these concepts are not pre-existing but created by people in communicative processes. The need for designed concepts means that conceptual modeling is more than an analysis and representation activity; it also has to include elements of design and creation.

The goal of this paper is to propose an ontology that can support developers in designing conceptual models for institutional domains. The paper extends previous work, [3], [2], primarily by investigating additional kinds of institutional entities, in particular institutional information and institutional rights. The proposed institutional ontology builds on theories for communicative action, as well as existing ontologies for business domains, which are briefly described in Section 2. Institutional entities are created through communicative processes, and Section 2 also offers a brief overview of approaches to business process management. In Section 3, the research method is discussed as well as a case on consultation management, which is used to illustrate and validate the proposed ontology. The ontology itself is presented in Section 4 with examples from the case. Section 5 introduces a conceptual model for the consultation case based on the institutional ontology. Finally, Section 6 summarizes the paper, discusses implications, and suggests directions for future research.

## 12.2 Related Work

### 12.2.1 *The Construction of Social Reality*

Institutions have been defined as “systems of established and prevalent social rules that structure social interactions”, [11]. In order to conceptualize the constituents and relationships of institutions, the paper proposes an institutional ontology. It is primarily founded on the work by John Searle, [24], [22], who has investigated how social and institutional reality is constructed by means of language.

Searle acknowledges that there is a material world existing independently of human beings and their beliefs, and he asks “how can we account for social facts within that ontology?” [23, p. 7]. He answers the question by pointing out that humans have a capacity for collective intentionality, through which they are able to assign functions to things. Some of these functions depend solely on the physical properties of the things to which they are assigned, e.g., the ability of a screwdriver to turn screws depends only on its physical structure. Other functions, however, are more abstract and have little to do with the physical properties of the object that provides them. Such functions are called status functions by Searle. The general logical form of the assignments of status functions is “X counts as Y in C”, where X is often a thing or a human being that is assigned a status function Y in a context C. For example, John (X) counts as a bank customer (Y) in the context of the statutes of a bank (C). This assignment means that John and the bank are related through a number of mutual obligations and claims, e.g., the bank is allowed to use John’s money but is also obliged to pay a certain interest rate, while John can make deposits and claim interest. Thus, the assignment establishes rules and regulations that structure and govern the interactions between John and the bank.

Through the assignment of status functions, people can recursively build ever more complex and advanced institutional phenomena, e.g. moving from dollar bills to stock options, equity futures, and foreign exchange swaps. These institutional objects require collective intentionality for their creation as well as their continued existence. For example, a piece of metal will be able to function as a medium of value exchange only if people together recognize it as money. And it will become money only through a process in which people declare it to be so. Thus, people use words to create and maintain institutional worlds.

### 12.2.2 *The REA Ontology*

The proposed ontology is also informed by work on the REA ontology. REA was originally intended as a basis for accounting information systems, [15], and focused on representing increases and decreases of value in business organizations. In later work, REA has been extended to form a foundation for enterprise information systems architectures, [8], [13], where REA also addresses the policy level in organi-

zations. REA places commitments and contracts into the center of business models, thereby emphasizing their importance for regulating business interactions. While commitments are sufficient for representing most of the rules in business contexts, many institutional settings also require other kinds of rights, such as powers and privileges, see Section 4.1. To address this need, the institutional ontology generalizes REA by allowing for any kinds of rights.

### ***12.2.3 Business Process Management***

Business Process Management (BPM) is a discipline that combines knowledge from both information technology and management sciences and applies it to operational business processes, [1]. BPM studies how work is and should be organized with the purpose to produce value for customers. In its early stages, BPM focused on the automation of workflows, but today it also includes process design, process analysis and work organization. BPM can support organizations in becoming more effective, efficient and customer-oriented, as it focuses on value creation in business processes rather than on functionally oriented ways of management.

Much of the work in the BPM field has investigated the activities of business processes, in particular, their ordering and interdependencies, [6]. Thus, the focus has been on the control-flow perspective of processes. But there are also other perspectives on processes. The resource perspective concerns roles, authorizations and organizational structures, while the data perspective addresses data creation and manipulation, forms, and the use of data for process decisions. The time perspective concerns temporal issues including deadlines and durations, and the function perspective addresses applications related to activities.

Processes can be viewed from a system perspective, in which they are enacted to accomplish a goal of a system. In other words, actors carry out processes in order to produce goods or services that are delivered to the environment of the system. Such processes have been named production processes, which are constituted by production acts, [5]. A production act can be material, such as the manufacturing or transportation of goods, or immaterial, such as granting insurance claims or issuing exam certificates. Actors can also perform coordination acts, by which they enter into and comply with agreements about production acts. For example, an actor can order that some goods be transported (a production act) and another actor can accept this order.

Production acts can also constitute new objects in the sense of making them available in a particular institutional context. For example, production acts in car manufacturing are not only about building physical entities but also about making them into institutional ones. This means to declare that some physical entity is to be counted as an institutional entity, in this case a car. Constituting the car in this way is needed for being able to refer to it and identify it in various institutional contexts, e.g. in the relationship with national authorities as discussed in [7]. Summarizing, a key purpose of business processes is to build an institutional world by creating

agreements and constituting institutional entities. Therefore, being able to represent and analyze institutional phenomena can help to design and implement business processes.

## **12.3 Research Setting and the Consultation Case**

### ***12.3.1 Research Setting***

The ontology presented in the next section has been iteratively developed over a period of five years. Empirically, it is grounded in the study of a number of information systems. The selection of these systems was based on purposeful sampling, [19], where the primary data set consisted of a number of case studies, [2], [3]. Purposeful sampling means that findings are based on the selection of information-rich cases for study in depth, in contrast to probability sampling, which depends on the selection of random and statistically representative samples. In addition to the primary data set, a secondary data set was used, which was also based on purposeful sampling. Design patterns and problems from the mainstream modeling literature, including [26], [14], [7], [25], were selected and used to clarify and investigate modeling problems found in the cases. The primary and secondary data sets were analyzed in several iterations in order to establish and revise the contents of the institutional ontology. This work is on-going and the next sub-section introduces yet another case, which is currently used to validate the ontology.

### ***12.3.2 The Consultation Case***

Public consultation is a regulatory process that is often a part of the larger process of developing proposals for laws, policies, and projects in the public sector, [20], [4]. In a public consultation, a public body seeks the opinions of interested and affected groups, typically through organizations that can represent them. The overall goal of a public consultation is to gather comments and criticisms on a proposal. The comments can help to improve the proposal, thereby improving its quality and effectiveness. Furthermore, consultations can strengthen transparency and public involvement in public decision processes. In the following, based on both literature and our own experience of public consultation cases, a typical consultation process is described. The process consists of four phases: preparation, submission, response collection, and response compilation and publication.

### **12.3.2.1 Preparation**

A proposal is prepared before it is sent on consultation. This means that the public body behind the proposal identifies its various parts and classifies them according to their purpose. Some of the parts are suggestions that propose courses of actions, while other parts are assessments that specify how the authors of the proposal evaluate some state of affairs. Furthermore, there are justifications that provide arguments for the suggestions and assessments. The proposal is given a reference number and is recorded in the registry of the public body. Each part, often called a section, is also numbered so that it can be conveniently referenced.

A key activity in the preparation phase is to identify reviewers that will be invited to comment on the proposal. This is done by an administrator proposing a set of reviewers, which is to be confirmed by a manager. Some of the reviewers can be obliged to answer to the consultation, while others may be allowed to disregard it. Furthermore, a reviewer can be requested to comment on specific sections of the proposal, i.e., the reviewer has to provide feedback on those sections but may leave others without commenting on them. The preparation phase also includes deciding on the deadline for reviewers to submit their responses.

A cover letter to send to the reviewers is prepared. This letter informs the reviewers about the submission deadline, whether it is mandatory to answer, the format in which to submit responses (paper and/or electronic), contact persons at the public body, which sections of the proposal to focus on, as well as other instructions and guidelines.

### **12.3.2.2 Submission**

Submitting a public consultation means that the proposal and its cover letter is sent to the reviewers identified in the preparation phase. This is done using both ordinary mail and email.

### **12.3.2.3 Response Collection**

When the reviewers submit their responses, they are archived in the registry of the public body. Each response is archived under the same reference number as the proposal under consultation. Each response consists of a number of comments, one of which concerns the entire proposal, while each of the other comments concern a single section of it.

### **12.3.2.4 Response Compilation and Publication**

The public body compiles the responses and publishes the resulting compilation on its web site. The compilation shows the number of reviewers that have agreed, or

not agreed, on the entire proposal, as well as on each of its parts. Furthermore, the compilation includes for each section of the proposal a short text based on the most important responses; these texts are written by an administrator at the public body.

## 12.4 The Institutional Ontology

The institutional ontology is structured into three levels, as indicated by color coding in Figure 12.1. The bottom level (white in the figure) is the material level that describes material entities, in particular human beings, physical entities, and physical actions. The middle level (yellow in the figure) is the institutional facts level that describes institutional phenomena and their creation. The entities at this level are used to regulate the entities at the material level. Finally, the top level (blue in the figure) is the rule level that includes rules, as well as groupings of rules, that govern how entities are created at the institutional facts level. The ontology is depicted in the form of a UML class diagram (multiplicities are 0..\* if not otherwise indicated).

### 12.4.1 *Institutional Rights*

The overall purpose of institutions is to regulate, govern and enable human interaction. One way to achieve this structuring of interaction is to create and allocate rights among people, thereby establishing relationships of power and obligations between them. A right is a relational construct that involves at least two agents, e.g., an obligation of one agent to deliver some goods to another agent. In addition, a right can include additional entities that are the objects of the right, such as the goods in the preceding example.

There exist different classifications of rights, but one of the most well-known is the one proposed by [12], who distinguishes between four kinds of rights: claims, privileges, powers and immunities. A *claim* means that one agent is required to act in a certain way for the benefit of another agent, e.g., a person can have a claim on another person to pay an amount of money. An agent has a *privilege* to perform an action if she is free to carry it out without interference from other agents, e.g., privileges of free speech and free movement. A *power* is the ability of an agent to create or modify claims, privileges or powers, e.g., the ability to transfer ownership. Finally, *immunities* are about restricting the power of agents to create formal relationships for other agents. In the institutional ontology, rights are modeled by the classes Right Kind and Institutional Right.

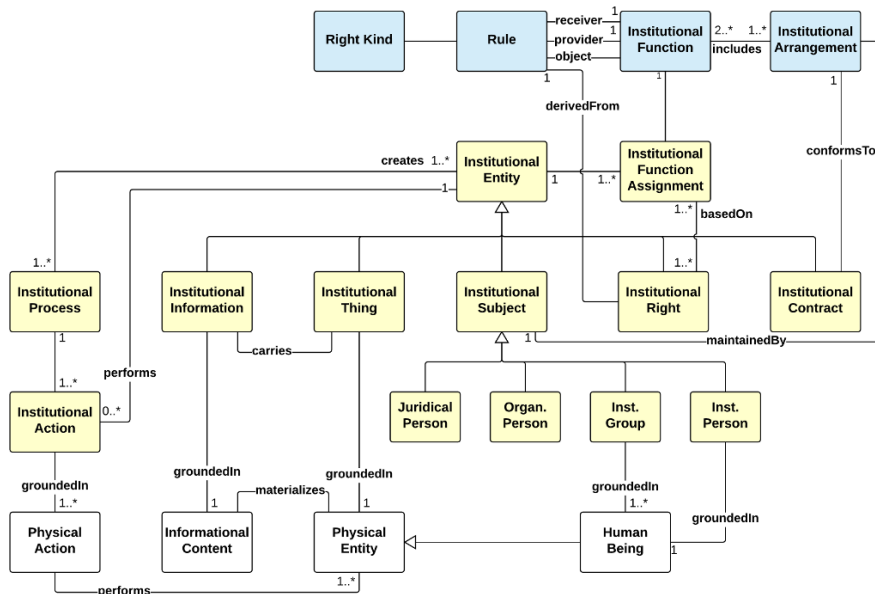


Fig. 12.1 The institutional ontology

### 12.4.2 Institutional Entities

Institutional entities are entities that have the function of regulating interaction by means of rights. An *institutional entity* is either a right, an entity that can have rights, an entity that is the object of a right, or a grouping of rights. Institutional entities are created through language actions, but their creation often requires that there is some other pre-existing entity on which the new institutional entity is dependent. The institutional entity is said to be grounded in that other entity [14], e.g., a citizen (an institutional entity) can be grounded in a human being (a physical entity). By combining the type of grounding and the way of relating to rights, a number of different kinds of institutional entities can be distinguished.

- **Institutional Subject.** An *institutional subject* is an institutional entity that can have claims. The ontology recognizes four kinds of institutional subjects. An *institutional person* is an institutional subject grounded in a human being able to possess both legal rights (i.e., rights acknowledged by a state) and non-legal rights. An *institutional group* is an institutional subject grounded in at least one institutional person but only able to possess non-legal rights. A *juridical person* is an institutional subject that is not grounded in any other entity and able to possess both legal and non-legal rights. Finally, an *organizational person* is an institutional subject that is not grounded in any other entity and able to possess only non-legal rights.
- **Institutional Thing.** An *institutional thing* is an institutional entity that cannot have claims and is grounded in a physical entity or another institutional thing.



- **Institutional Information.** *Institutional information* is an institutional entity that cannot have claims and is grounded in informational content. Examples of informational content are a text, a picture, and a musical score. While informational content is solely information without any formal status, institutional information is officially acknowledged by an institutional subject as an institutional entity. Thus, it has been created through an institutional process and has received its own identifier. For example, a code such as “ABC123” is just informational content, but it can ground a discount code issued by a company; this discount code is institutional information that is related to one or more rights, in particular it can grant a customer the claim to get a discount on goods she has purchased.
- **Institutional Right.** An *institutional right* is an institutional entity that represents a relationship of claim, privilege or power between two or more institutional subjects.
- **Institutional Contract.** An *institutional contract* is an institutional entity that groups together a number of rights, e.g., a purchase contract between two companies.

Informational content can only be materialized through a physical entity, e.g., a musical score can be materialized through a sheet of a paper with musical notation, an electronic document with the same notation, or an audio file. This relationship is captured in the ontology by the association *materializes* between Physical Entity and Informational Content. Analogously, there is an association *carries* between Institutional Thing and Institutional Information. For example, an officially recognized discount coupon can carry a discount code.

### 12.4.3 Rules and Institutional Functions

When people create and use institutional entities, they do so in a framework of rules that define the functions of the entities as well as the processes for creating them. The institutional entities receive their meaning only by being interpreted in the context of these rules.

Rules are formulated through linguistic expressions, e.g., “the *respondent* has to submit its *overall response* to the *initiator* before the deadline”. These expressions include institutional functions that are used for specifying the institutional entities to which the rules should be applied. Institutional functions are similar to roles as they are used for defining bundles of rights that can be bestowed upon institutional entities. Examples of institutional functions are the *respondent* function, the *initiator* function, and the *overall response* function.

Institutional functions never appear in isolation but always in networks, since their meanings are dependent on each other. For example, the meanings of the institutional functions *initiator* and *respondent* depend on each other, in the sense that the one can only be defined by referring to the other. A respondent is someone who is obliged to answer to an invitation from an initiator. A set of interdependent institutional functions is called an *institutional arrangement*. An example is

the consultation arrangement consisting of institutional functions involved in consultations, see Section 5.3 for details. Furthermore, an institutional arrangement is maintained by an institutional subject, who defines and monitors all the rules that apply to the institutional functions that make up the institutional arrangement. For example, some public body maintains the consultation arrangement.

Rules do not directly express rights between institutional entities, but instead they refer to institutional functions. However, if all the institutional functions in a rule are assigned to institutional entities, i.e., each institutional function is replaced by an institutional entity, the rule will result in a right between these. Assigning an institutional function to an institutional entity means that the latter gets related to other institutional entities through a number of rights, as given by the rules of the institutional function. For example, the rule above could result in the right “the company Acme has to submit its overall response to the department of justice before the deadline”. In this example, the result expresses a right involving an organization and a department, which regulates their interactions. This example illustrates how rules are used in general - through assigning institutional functions to institutional entities, the latter become related and regulated by means of rights. In the ontology, institutional function assignments are used to assign institutional functions to institutional entities.

#### ***12.4.4 Institutional Processes***

Institutional entities, as well as institutional function assignments, are created by means of language actions. They are, so to say, talked into existence. This is modeled in the ontology by the class Institutional Process that is associated to both Institutional Entity and Institutional Function Assignment. An *institutional process* consists of a sequence of institutional actions. The latter are always grounded in physical actions, i.e., they are performed through physical actions, such as signing paper documents or pressing keys on a keyboard.

### **12.5 Domain Model for the Consultation Case**

The institutional ontology can be used to guide conceptual modelers when they design domain models, i.e., models for specific institutional domains. The main guideline is that every class introduced in a domain model should correspond to one of the classes on the middle level in the ontology, shown by stereotyping. In contrast, classes on the rule level do not correspond to classes in the domain model, but their instances are represented as classes. Institutional arrangements will be represented by classes stereotyped as Institutional Contract, while rules are represented by classes stereotyped as Institutional Right. An example is shown in Figure 12.2, where the rule *Overall assessment*, i.e., that a respondent shall provide a response

to a submitted proposal sent from an initiator, is represented by means of a class of its own.

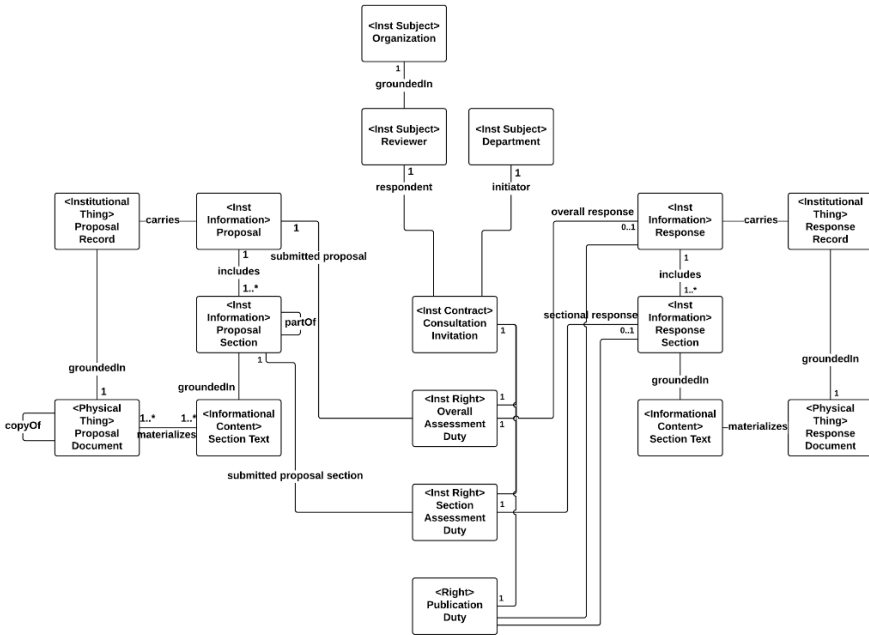


Fig. 12.2 The consultation case

For reasons of simplicity and clarity, not only classes on the rule level are omitted when the institutional ontology is applied, but typically also classes corresponding to institutional function assignments. Instead, they are in most cases represented only as associations between rights, contracts and institutional entities. A domain model of the consultation case is shown in Figure 12.2 in the form of a UML class diagram. The following sub-sections explain how the ontology is applied in the design of the consultation domain model.

### 12.5.1 Institutional Subjects

The consultation case includes two key kinds of institutional subjects, departments that initiate consultations and reviewers that respond to them. A *department* is a part of the public body that is responsible for issuing proposals and performing consultations. For each consultation, there is a department that initiates it. A *reviewer* is

grounded in an *organization*, which is a legal entity, such as a company, an authority, or an NGO.

### ***12.5.2 Institutional Information and Informational Content***

Both proposals and responses to them are made by information, and thus many of the classes in the domain model are stereotyped as Institutional Information or Informational Content.

A *proposal* is institutional information that describes new laws, policies, and plans, e.g., bills and budgets. Proposals are intended to be submitted to reviewers for consideration and feedback. A proposal is divided into a number of *proposal sections*. These sections are the basis for structuring answers to a consultation, as described below. The sections are represented by the class Proposal Section in the domain model. A proposal and its sections are grounded in informational content, the *section texts*. While the section texts only consist of information that does not have any formal status, the proposal and proposal sections are officially acknowledged by a department as institutional entities. Thus, they have been created by the department through an institutional process, and each one of them has received its own identifier.

The section texts of a proposal are materialized in physical documents, the *proposal documents*, which can be in paper as well as electronic form. One of the proposal documents is the original one, from which the other documents are made as copies. The proposal documents ground institutional things, the *proposal records*. While a proposal document is just a physical entity, a proposal record is acknowledged by a department. The proposal record that is grounded in the original proposal document is the original proposal record and is given an identifier, the reference number.

A *response* is institutional information that provides feedback on a proposal. Just as for a proposal, a response includes a number of parts, called *response sections*, which are grounded in section texts. And each response section offers comments on exactly one proposal section. Analogously to the proposal documents, there are *response documents* that provide materializations of the section texts, as well as response records grounded in these response documents.

### ***12.5.3 Rules and Institutional Functions***

The interaction between the reviewers and the departments are regulated by a number of rules, of which the three most important are:

- Overall assessment: A *respondent* is obliged to provide an *overall response* on a *submitted proposal* to an *initiator*

- Sectional assessment: A *respondent* is obliged to provide a *sectional response* on a *submitted proposal section* to an *initiator*
- Publication: An *initiator* is obliged to publish the *overall response* and the *sectional responses* on a *submitted proposal* from a *respondent*

The rules include a number of institutional functions, which are italicized above. These institutional functions can be viewed as roles that can be played by the institutional subjects and institutional information introduced in the previous sections. A *respondent* is played by a reviewer, an *initiator* by a department, a *submitted proposal* by a proposal, a *submitted proposal section* by a proposal section, an *overall response* by a response, and a *sectional response* by a response section. All of the six institutional functions are mutually interdependent on each other, thereby forming one institutional arrangement, the consultation arrangement.

### 12.5.4 Institutional Rights and Institutional Contracts

The rules as well as the institutional functions and the institutional arrangement are reflected in the domain model. To each rule corresponds a class that represents rights: Overall Assessment Duty, Section Assessment Duty and Publication Duty. The single institutional arrangement, consultation arrangement, corresponds to the class Consultation Invitation, which represents institutional contracts. Intuitively, a consultation invitation is an agreement between a department and a reviewer about the former providing feedback on a proposal to the latter, who in turn is obliged to publish the comments.

The institutional functions are reflected by associations to the above classes. As respondent and initiator appear in all the rules, these institutional functions can be represented as associations to the class Consultation Invitation. The remaining institutional functions become associations to the classes representing rights. (It would also have been possible to introduce classes corresponding to the Institutional function assignment in the ontology instead of just using associations. This solution would indeed have been closer to the institutional ontology, but as the extra classes have no attributes, the resulting model would have become more complex without providing additional representational capabilities.)

### 12.5.5 Institutional Processes

The institutional entities represented by the domain model are created by a number of institutional processes, though these for reasons of space are not shown in Figure 12.2. At least five institutional processes are required: one process for creating reviewers; one process for creating departments; one process for creating proposals, their sections, as well as grounding and materializing entities; one process for creating consultation invitations and related rights; and one process for creat-

ing responses, their sections, as well as grounding and materializing entities. This case illustrates a general pattern, where there typically needs to exist a process for each class stereotyped as Institutional Subject, Institutional Information, Institutional Thing, and Institutional Contract. Classes stereotyped as Institutional Right do not need additional processes, since they are closely associated to classes stereotyped as Institutional Contract. The same holds for classes that are related to other classes as parts (such as Proposal Section) or classes on the material level.

## 12.6 Discussion and Conclusions

In this paper, we have proposed an ontology that can support developers in designing conceptual models for institutional domains and have illustrated it through an application on public consultation. In our work with the ontology, we have found that it can support developers in several different ways:

- The ontology helps to distinguish between institutional actions and physical actions, which is particularly useful when different physical actions can be used to ground the same institutional action, e.g., when a contract can be signed both through a paper signature and an electronic signature.
- The ontology helps to distinguish between physical documents and the information they materialize. This distinction is easy to overlook but becomes important when different kinds of documents can materialize the same information, e.g., both a paper document and an electronic one.
- The ontology treats rights as first-class citizens instead of hiding them within other entities. Rights become key entities that are used to regulate the interaction between institutional subjects, and the ontology thereby forces developers to make rights explicit.
- The ontology makes clear that institutional processes do not only relate institutional entities but also create them. The processes bring new entities into existence that together constitute the institutional world.

The institutional ontology can guide conceptual modelers when designing domain models. The paper proposes a set of preliminary guidelines for this task. However, additional guidelines are required in order to utilize the ontology for designing domain models in practice. These include both guidelines for choosing between different modeling constructs if several solutions are possible, as well as guidelines for what processes to include in a domain model to represent the creation of institutional entities.

Another application of the institutional ontology is to use it for analysis of established theoretical and practical problems in conceptual modeling. One example is the disagreements, see for instance [18] and [25], on role modeling where roles are interpreted either as named places in a relationship; a relationship between entities in the form of generalization/specialization; or as separate instances adjoined to the entities playing the roles. The institutional ontology allows for an alternative

explanation based on institutional facts. Another theoretical issue is how to analyze rules in rule modeling. Present rule modeling approaches recognize different kinds of rules, e.g., business rules and definitional rules in SBVR [21], and the institutional ontology can provide a theoretical basis for such classifications.

The institutional ontology should also be compared and related to similar approaches in the literature. As already mentioned, it can be viewed as an extension of parts of the REA ontology, [8]. Another relevant work is the commitment-based reference ontology for services proposed in [16].

## References

1. van der Aalst, W.M.P.: Business process management: A comprehensive survey. *ISRN Software Engineering* 2013, 1–37 (2013)
2. Bergholtz, M., Eriksson, O.: Towards a Socio-Institutional ontology for conceptual modelling of information systems. In: *Advances in Conceptual Modeling*. pp. 225–235. Springer, Cham (19 Oct 2015)
3. Bergholtz, M., Eriksson, O., Johannesson, P.: Towards a sociomaterial ontology. In: *Advanced Information Systems Engineering Workshops*. pp. 341–348. Springer, Berlin, Heidelberg (17 Jun 2013)
4. Catt, H., Murphy, M.: What voice for the people? categorising methods of public consultation. *Aust. J. Polit. Sci.* 38(3), 407–421 (1 Nov 2003)
5. Dietz, J.L.G.: *Enterprise Ontology: Theory and Methodology*. Springer (2006)
6. Dumas, M., La Rosa, M., Mendling, J., Reijers, H.A.: *Fundamentals of Business Process Management*. Springer Berlin Heidelberg (2013)
7. Eriksson, O., Henderson-Sellers, B., Ågerfalk, P.J.: Ontological and linguistic metamodelling revisited: A language use approach. *Information and Software Technology* 55(12), 2099–2124 (Dec 2013)
8. Geerts, G.L., McCarthy, W.E.: Policy-level specifications in REA enterprise information systems. *Journal of Information Systems* 20(2), 37–63 (2006)
9. Graeber, D.: *The utopia of rules: On technology, stupidity, and the secret joys of bureaucracy*. Melville House (2015)
10. Gruber, T.R.: Toward principles for the design of ontologies used for knowledge sharing? *Int. J. Hum. Comput. Stud.* 43(5), 907–928 (1 Nov 1995)
11. Hodgson, G.M.: What are institutions? *J. Econ. Issues* 40(1), 1–24 (2006)
12. Hohfeld, W.N.: Some fundamental legal conceptions as applied in judicial reasoning. *Yale Law J.* 23(1), 16–59 (1913)
13. Hruby, P.: *Model-Driven Design Using Business Patterns*. Springer, Berlin; London, softcover reprint of hardcover 1st ed. 2006 edition edn. (9 Nov 2010)
14. Masolo, C.: Levels for conceptual modeling. In: De Troyer, O., Bauzer Medeiros, C., Billen, R., Hallot, P., Simitsis, A., Van Mingroot, H. (eds.) *Advances in Conceptual Modeling. Recent Developments and New Directions, Lecture Notes in Computer Science*, vol. 6999, pp. 173–182. Springer Berlin / Heidelberg (2011)
15. McCarthy, W.E.: The REA accounting model: A generalized framework for accounting systems in a shared data environment. *The Accounting Review* 57(3), 554–578 (1982)
16. Nardi, J.C., Falbo, R.d.A., Almeida, J.P.A., Guizzardi, G., Pires, L.F., van Sinderen, M.J., Guarino, N., Fonseca, C.M.: A commitment-based reference ontology for services. *Inf. Syst.* 54, 263–288 (Dec 2015)
17. Olivé, A.: *Conceptual Modeling of Information Systems*. Springer Berlin Heidelberg (2007)
18. Parsons, J., Li, X.: An ontological metamodel of classifiers and its application to conceptual modelling and database design. In: *Conceptual Modeling - ER 2007*. pp. 214–228. Springer, Berlin, Heidelberg (5 Nov 2007)

19. Patton, M.Q.: *Qualitative evaluation and research methods*, 2nd ed. Sage Publications, Inc (1990)
20. Rodrigo, D., Amo, P.A.: *Background document on public consultations*. Tech. rep., OECD (2012)
21. SBVR: SBVR 1.4. <http://www.omg.org/spec/SBVR/1.4/index.htm>, accessed: 2017-5-18
22. Searle, J.: *Making the Social World: The Structure of Human Civilization*. Oxford University Press, USA, 1 edn. (12 Jan 2010)
23. Searle, J.R.: *The Construction of Social Reality*. Free Press (1 Jan 1997)
24. Searle, J.R.: *Social ontology: Some basic principles*. *Anthropological Theory* 6(1), 12–29 (1 Mar 2006)
25. Steimann, F.: *On the representation of roles in object-oriented and conceptual modelling*. *Data Knowl. Eng.* 35(1), 83–106 (Oct 2000)
26. Wand, Y., Storey, V.C., Weber, R.: *An ontological analysis of the relationship construct in conceptual modeling*. *ACM Trans. Database Syst.* 24(4), 494–528 (Dec 1999)
27. Wand, Y., Weber, R.: *On ontological foundations of conceptual modeling: A response to Wys-susek*. *Scandinavian Journal of Information Systems* 18(1) (2006)