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The FLINT Ontology: An Actor-Based Model of Legal Relations

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Abstract. Recording and documenting human and AI-driven normative decision-making processes has so far been highly challenging. We focus on the challenge of normative coordination: the process by which stakeholders in a community understand and agree what norms they abide by. Our aim is to develop and formalize the FLINT language, which allows a high-level description of normative systems. FLINT enables legal experts to agree on norms, while also serving as a basis for technical implementation.

Our contribution consists of the development of an ontology for FLINT and its RDF/OWL implementation which we have made openly accessible. We designed the ontology on the basis of competency questions. Additionally, we validated the ontology by modeling example cases and using the ontology's data model in software tooling.

Keywords. Norms, Normative systems, Legal interpretation

1. Introduction

Recording and documenting human and AI-driven normative decision-making processes is highly challenging. We focus on the challenge of normative coordination: the process by which stakeholders in a community understand and agree what norms they abide by. Our aim is to develop and formalize the FLINT language, which allows a high-level description of normative systems [1,2]. FLINT enables legal experts to agree on norms, while also serving as a basis for technical implementation. It does so by focusing on how norms regulate behavior, and therefore takes a dynamic perspective: it represents norms in terms of normative acts and the pre- and postconditions of these acts.

Although this perspective is useful in practice, a formalization of the concepts used in FLINT is lacking. In this paper, we therefore present the FLINT ontology. We start by describing related ontologies for normative representation in Section 2. We will then explain our methodology in Section 3. In Section 4, we showcase the ontology itself, after which we illustrate how to use the ontology in Section 5. We conclude in Section 6.

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2. State of the art

In the legal field, numerous vocabularies and ontologies have been developed to effectively structure and organize data relating to norms [3]. Many solutions address a particular domain or scope, such as norms for assets [4], intellectual property rights [5], or privacy and personal data protection [6,7].

Our interest is in the development of domain-neutral ontologies to represent normative knowledge. Moreover, as we shall motivate in our methodology section, we are interested in representing normative systems [8,9]. Consequently, we focus on representing the full normative action space available to agents across all relevant contexts [10]. In our view, this approach subsumes considerations of normative violations and sanctions. Therefore, our work is at some distance from solutions focusing on obligations and prohibitions or evaluating violations of situations rather than actions, such as LKIF [11], LegalRuleML [12] and recent work by Francesconi & Governatori [13].

Arguably the most relevant comparison for our work is to the UFO-L Legal Core Ontology [14,15].[2] UFO-L provides a formal description of legal relations ([17,18]) in the context of the Unified Foundational Ontology (UFO, [19]). Similar to FLINT, UFO-L has a rich representation for classes of power—liability relations, including ways of identifying what classes of actors can occupy which legal positions within the relation (power holder, liability holder). In adopting the concept of institutional acts, both UFO-L and FLINT can be said to be Searlean [10]. However, we see reason to decouple the concepts of legal relation and institutional act. A second difference between the vocabularies is the representation of institutional facts, which are the parts that together characterize the full state space of a normative system. UFO-L adopts the concept of an event to represent the exercise of legal power. While events can thus encode *that* an action has taken place, they do not offer explicit information about the consequences of that action for the normative state. This further implies that the preconditions under which agents are allowed to take actions cannot be modeled in UFO-L by reference to certain states. Instead, the preconditions would have to be represented by disjunctions of sets of events that need to have taken place in order for the preconditions to hold. We believe an explicit model of normative states enhances normative coordination among stakeholders. That is, FLINT enables stakeholders to understand the influence of acts on the state of the normative system. Vice versa, stakeholders can understand how a state of the normative system determines the deontic status of an act.

3. Methodology

We based the functional requirements for the FLINT ontology on the literature in which the concepts of FLINT are introduced informally [1,2] and described them in terms of competency questions (CQs, see [20]). A fragment of our CQs is displayed in Table 1. The CQs have also been used during the validation process of the level of expressiveness of FLINT. The logical consistency of the ontology has been validated by running HermiT 1.4 on sample data.

[2] Some of the concepts and relations described in UFO-L are implemented as a computational artefact for the Service Contract Ontology (SCO) [16].

Table 1. Examples of competency questions for the FLINT ontology.

Concept	**Competency questions**
Act	Who can perform the action associated with this act? Who can be a recipient of this act? In what situations is it valid to perform this act? What duties does the actor have after performing this act?
Fact	Is this fact atomic? On which facts does this complex fact depend? What can this agent do? What must this agent do?
Duty	Which acts create this duty? What does the duty holder need to do to terminate this duty?

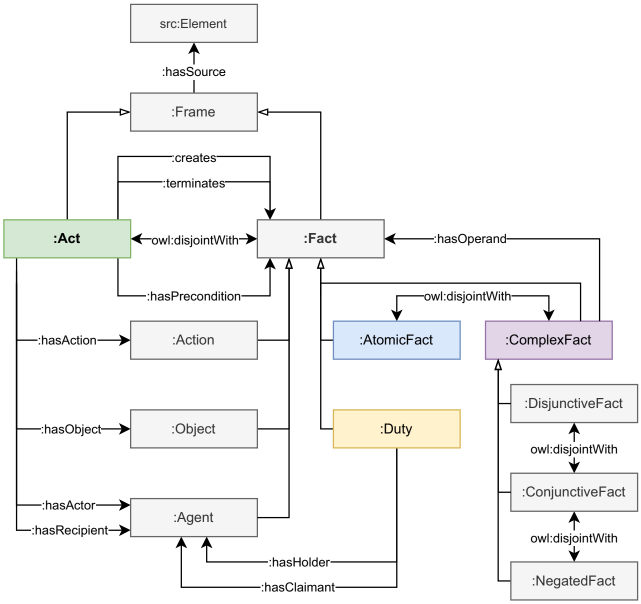

Figure 1. Class diagram of the FLINT ontology. Arrows with white tips represent subclass relations, labelled arrows connect the domain and range of the indicated properties.

4. Ontology overview

The FLINT ontology is a small ontology consisting of only thirteen classes. See Figure 1 for the class diagram. The ontology is implemented in RDF/OWL and is available open source.[3] We describe the main concepts in detail below.

4.1. *Act frames & Fact frames*

The central concept in FLINT is the *frame*: a container that bundles several pieces of information [21]. A FLINT model is made up entirely of these bundles, and the refer-

[3]The repository can be found at https://gitlab.com/normativesystems/knowledge-modeling/flint-ontology. For documentation, see https://normativesystems.gitlab.io/knowledge-modeling/documentation-website/docs/.

ences they make to each other. At the highest level, we make a distinction between two types of frames. *Fact frames* describe matters whose presence or truth value characterizes the state of the normative system. This includes several different kinds of things. First, propositions, which may be complex or atomic and are true or false relative to a state. Second, agents and objects that play a role in the normative system. And third, actions: things an agent can do.

Act frames describe actions that agents might take, which affect the state of the normative system, i.e. the facts. An act frame is connected to fact frames via its properties *hasActor*, *hasRecipient*, *hasObject*, *hasAction*, *hasPrecondition*, *creates* and *terminates*. The first of these three properties describe who can perform the act, who can undergo the act and what objects can be affected by it. In this way, an act frame describes a Hohfeldian power-liability relation between the actor and the recipient. The action related to an act describes what action an agent must take to perform the act. The preconditions of the act describe the circumstances in which the act can be performed legally. Finally, the postconditions of the act are described in terms of the facts that become true and false (using the properties *creates* and *terminates*, respectively) by means of the act.

4.2. Duties

Although a collection of acts with pre- and postconditions can completely describe the valid steps in a process, it is also important to encode what behavior is considered expected according to the norms. This is captured by the *Duty* concept.

We view duties as a special kind of facts, because they are part of the normative state. This means that duties never apply in an absolute manner – like other facts, they are created and terminated by acts. Every duty should have at least one act that creates it (otherwise it never applies) and at least one act that terminates it (otherwise it can never be fulfilled). As a duty represents a Hohfeldian duty-right relation between two parties, it must always have a duty holder and a claimant.

4.3. Classes vs. instances

It is important to note that instances of the classes *Act* and *Fact* are not viewed as concrete acts and facts, but as frames: prototypes of concrete acts and facts as they would be found in a scenario. For example, an act frame can describe applications for a residence permit in general, but not a specific application from an individual. This might raise the question why frames are implemented as individuals rather than as classes like the normative relations in UFO-L. There are three reasons for this.

First, we want to describe intricate relations between act frames and several fact frames without the use of punning. Second, some instantiation is needed not only in a scenario but also in the norms themselves: for example, we want a FLINT model about library regulations to indicate that a borrowed book should be returned. We need a reference to an individual book, not the class of books, to indicate that the borrowed book and the book returned must be one and the same book. Third, while there is a relation between a concrete act in a scenario and an act frame, we believe that conceptually the former is not an instance of the latter.

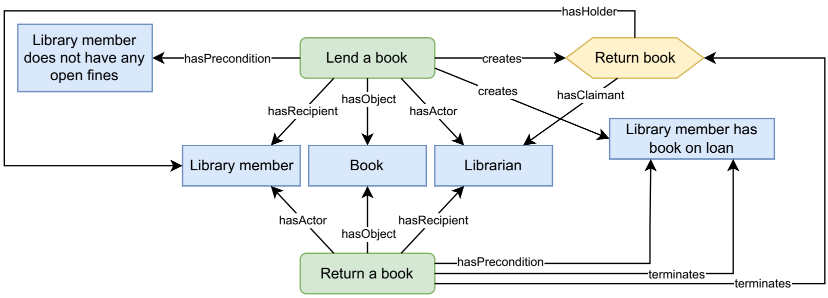

Figure 2. Representation in FLINT of the regulations for lending and returning books. Blue rectangles are instances of *AtomicFact*, green rounded rectangles are instances of *Act*, yellow hexagons are instances of *Duty*. Actions are omitted for readability.

5. Example: library regulations

To illustrate how we intend the FLINT ontology to be used, we describe a toy example of a simple set of library regulations:

1. Books can be loaned to library members if they have no outstanding fines.
2. Library members who borrow books are obligated to return them.
3. Failure to return a book results in a fine.

In our interpretation of these rules, we distinguish three acts: lending a book, returning a book, and giving a fine. The latter act is not found explicitly in the rules, but its existence follows from the assumption that changes to normative states never happen without an act taking place. Therefore, a fine is not viewed as something automatically happening when a book has not been returned, but as the result of an act that has its own pre- and postconditions.[4]

A schematic view of the first two acts and their related facts is shown in Figure 2. This schema shows that a valid performance of the act *Lend a book* creates a duty *Return book*, which can be terminated by a valid performance of the act *Return a book*. That the two operations are related to the same *Book* node as an object, determines that the duty is removed only by returning the same book that was borrowed. Figure 3 shows the act of giving a fine, which has a complex precondition, and terminates the duty to return the book while creating a new duty to pay the fine. Of course, this duty should have a corresponding terminating act in the full picture.

This example illustrates how the FLINT ontology can be used to transform a set of rules into acts and facts, providing insight into what is possible and expected behavior for a particular agent in a given situation. Of course, resolving disputes over what constitutes lawful conduct often requires a much larger graph, in which all parts of laws relevant to the dispute are interpreted as acts and facts.

[4]Note that the rules are not explicit about how much time may elapse before the fine can be given. This could be specified as an additional precondition for the *Give a fine* act.

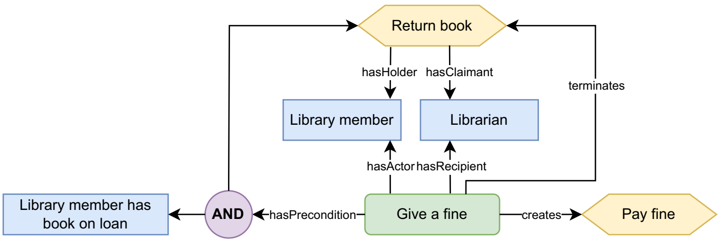

Figure 3. Representation in FLINT of the rules for giving a fine. Purple circles are instances of *ComplexFact*. Nodes related to *Pay fine* are omitted.

6. Conclusion and discussion

We have presented the FLINT ontology and its publicly accessible RDF/OWL implementation. The main aim of the FLINT ontology is to support normative coordination. FLINT does this by describing a normative system using facts to describe a state space, and acts to describe permissible transitions between states. As in [14,15] we thus model legal relations, with a focus on legal powers (in the form of acts) and duties. We found that modeling institutional facts in more detail greatly benefits the clarity of the interpretations of norms. We have also illustrated the intended use of the ontology with a toy example.

There are several research directions connected to FLINT and its ontology in which developments are currently taking place. First, while the FLINT ontology describes interpretations of norms, we are also working towards computational implementations of these interpretations in order to automate normative reasoning. A norm engine based on the FLINT ontology is under development [22], which uses the ontology in combination with SHACL constraints and inference rules to reason about compliance in concrete scenarios.

Second, to support this automated normative reasoning, we are working on a formalization of FLINT as a variant of dynamic logic [23], in order to characterize the decidability and complexity of this logic.

Third, another area of research focuses on the automation of the conversion from legal texts into FLINT frames. This is done by marking some components of FLINT (actions, actors, recipients, and objects) in the legal text through automated semantic role labeling [24,25,26]. The FLINT ontology can be used in this line of work to exchange information between different tools.

Finally, we are working on an extension of the ontology which distinguishes several stages in the transformation from a law in natural language to a FLINT model. This starts with creating annotations in the law text and ends with a full formal model that can be used in conjunction with the norm engine, making all connections between steps explicit so that the formal model is explainable and traceable [27]. With this, we aim to bridge the gap between the theoretical foundations of legal philosophy, and the practical need for normative coordination.

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