Towards a Pattern-Based Core Model of Events in the Legal Domain

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Abstract. Representing events in conceptual models is increasingly gaining widespread attention. In this paper, a core model of events in the legal domain is proposed. For building the model, a pattern-based approach is applied by deriving and combining ontology patterns from the foundational ontology of events UFO-B and the legal core ontology UFO-L. We relied as well in this model on the novel understanding of events as emergent from "scenes". The aim of the core model of events is to provide a comprehensive support to represent a variety of complex aspects of events in the legal domain. The targeted model, that is composed of different modules (ontologies), can be extended by domain ontologies. The use of this model is demonstrated in the domain of carriage of goods by sea aiming to build a well-founded legal domain ontology for the traceability of goods.

Keywords. Ontology of legal events, UFO-B, UFO-L, pattern-based model, conceptual ontology patterns

1. Introduction

Events are considered as central aspects for many domains such as law, medicine, logistics, etc. In research, an explicit modeling of events is increasingly gaining widespread attention [1] and a mandatory modeling requirement is to represent events in (structural) conceptual models [2]. In the ontology engineering domain, representing events using conceptual modeling process is an interesting and challenging task specially that conceptual models should provide conceptual clarification and explicit characterization for them [3]. Actually, events, as behavioral elements, are notions comprising complex worldviews involving a variety of aspects among others the participation of agents and objects in events, as well as the mereological, causal and temporal relations between events. Therefore, in order to represent them in conceptual models, there is a need to investigate the ontological notion of events and their relations with endurants (objects) [4].

The concept *event*, in its general sense, is considered as synonym of *perdurant* or *occurent*. Meanwhile, a novel understanding of this concept, as *emergent from scene*, has raised recently [5, 6]. In the literature, different foundational and upper-level ontologies have presented the notion of event as *perdurant* such as BWW [7], Kaneiwa et al. [8] and UFO-B [4]. Foundational ontologies define a range of top-level domain-independent ontological categories which form a general foundation for more elaborated domain-

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specific ontologies [9, 10]. For representing events in the legal domain, there is a need for a legal core ontology, such as UFO-L [23] and LKIF-Core [24], that provide a precise definition of the structural knowledge in this field that spans across different domain applications (e.g. penal law, maritime law, etc.). In this context, reusing foundational and core ontologies to support the development of lower level ontologies is recognized as a promising approach in the ontology engineering domain since it enables a speeding up of the ontology development process [11]. Meanwhile, it is considered as a hard research issue and one of the most challenging and neglected areas of ontology engineering [12]. The problems of selecting the right ontologies to reuse, extending them and composing several fragments have not been properly addressed yet [13].

Ontology patterns (OPs) are recognized as a promising approach to solve recurrent ontology development problems. OPs are modeling solutions that favor reuse of encoded experiences and good practices [14]. In the ontology engineering community, OPs have been addressed mainly in the works of [12,13,14, 15]. Recently, this approach has gained more attention specially in [11,16,17] where its main goal is to support the building of more consistent ontologies in a reuse-centered process. There are many different types of OPs that can be used in different phases of the ontology engineering process [11]. In this work, we are interested in Conceptual Ontology Patterns (COPs), since the focus is on building a conceptual model of legal events.

The main goal of this paper is to build a core model of events in the legal domain modularized in different ontology modules and can be extended by domain ontologies. This model is developed by applying a pattern-oriented approach that derives ontology patterns from the foundational ontology of events UFO-B [4] and the legal core ontology UFO-L [23]. In addition, in this model, the strict sense of events as *emergent from scenes* is adapted [6]. The core model of events is demonstrated in the domain of carriage of goods aiming to develop a well-founded legal domain ontology for the traceability of goods. The remainder of this paper is organized as follows: section 2 discusses the ontological notion of events. In section 3, the main requirements for events modeling in the legal domain are addressed. Section 4 describes the derivation of ontology patterns from the foundational ontology UFO-B and the legal core ontology UFO-L. In section 5, an application of the model of events in the domain of carriage of goods is demonstrated. Section 6 outlines the related works. Finally, the paper is concluded in section 7.

2. The Ontological Notion of Events

Generally, events are known as perdurants that unfold over time. Several foundational and upper-level ontologies present them as perduring entities. Meanwhile, a novel understanding of events is proposed recently to consider two broad categories in perdurants: *events* and *scenes*. Therefore, events are considered as emergent of scenes. In the following, these notions and the main theories of events will be discussed.

2.1. Events as Perdurants

In the philosophic literature, the term 'event' is considered, in its most general sense, as synonym of *perdurant* or *occurent* [6]. Events are defined as "perduring entities that unfold over time i.e. they take up time" [1]. This aspect is largely adapted in the ontology engineering domain where a variety of foundational and upper-level ontologies have

presented the notion of events as perdurants such as UFO [4], BWW [7], and Kaneiwa et al. [8].

UFO is a philosophically and cognitively well-founded foundational ontology [18]. It makes a fundamental distinction between three kinds of individuals: substance (*endurants*), tropes and events (*perdurants*) [19]. Endurants are entities that are wholly present whenever they are present i.e. they don't have temporal parts [3]. Meanwhile, events are individuals composed of temporal parts and are existentially dependent on endurants. They *happen in time* in the sense that they extend in time accumulating temporal parts [4]. Trope individuals can only exist in other individuals, i.e., they are existentially dependent on other individuals [19]. Examples of endurants are a house, a person or the moon. Examples of perdurants are a football game, a birthday party or a business process. Examples of trope individuals are the enrollment of students, the redness of a T-shirt, or the belief in God. Therefore, two main layers of UFO are distinguished: the layer A that consists of the ontology of substance and tropes individuals (UFO-A), the layer B that consists of the ontology of events (UFO-B). This study is concerned mainly in the ontology of events UFO-B that supports a variety of aspects of events.

- *Event mereology (part-whole relationship)*: events are analyzed as entities with certain mereological structures. They can be atomic or complex. Atomic events have no proper parts. Complex events are aggregations of at least two disjoint events.

- *Temporal relationship between events*: different models for specifying the temporal properties of events are proposed such as: (1) a quality structure "composed of" time intervals and time intervals themselves to be "composed of" time points and (2) a model of time that admit intervals that are delimited by begin and end points.

- *Participation of objects in events*: represents the portion of an event that depends exclusively on a single object. Special cases of object participation in events are *object creation*, *object change* and *object destruction* events [19].

- *Changes promoted by events*: events are defined as mappings from and to situations in the world, in which endurants are characterized by bearing certain properties [3].

- *Causation*: UFO-B contemplates a theory of causation connecting situations brought about by events which in turn trigger the occurrence of other events.

- *Manifestations of object dispositions*: dispositions are considered as properties that are manifested in *particular* situations through the occurrence of events. They are existentially dependent and therefore *inhere* in particular objects. A situation triggers an event when this actuation *activates* the disposition that is manifested by that event.

Most of these theories are neglected in BWW [7] and the upper-level ontology [8]. BWW defined events as a formal relation between two points in the state space of an entity. It doesn't support different aspects of events such as event mereology, participation of endurants, temporal relations between events and object dispositions [4]. Kaneiwa et al. [8] proposed the Upper-Level Ontology of Events that classified the events according to the nature of their participants between natural and artificial events.

In this ontology, objects as events can cause events which is rejected in UFO-B. UFO-B has been extensively tested in practice and successfully employed as a reference model for addressing problems from complex media management, enterprise architecture, software engineering, and the modeling of events in petroleum exploration [6].

Concerning the legal domain, UFO-L [23] is a recent legal core ontology that uses domain-independent concepts provided by UFO to represent essential concepts of law based on Alexy's theory of fundamental rights ontology. In UFO-L, legal events are defined in the frame of endurants as specialization of events. They are considered as *grounding* for legal relationships such as legal contracts. UFO-L defines variety of legal concepts such as *Legal Agent*, *Legal Object*, *Legal Relator*, *Legal Moment*, etc.

2.2. Events as Emergent from Scenes

As aforementioned, events are considered as synonyms of perdurants in their most general sense. Meanwhile, a novel understanding of events has been proposed recently in [5, 6] where authors suggested to stop considering "event" as a synonym of "perdurant" and to distinguish two broad categories within perdurants: events and scenes. According to [6], a scene is a maximal perdurant located in a convex region of space-time containing all perdurants occurring there as parts. Therefore, e*vents* emerge from *scenes through a focusing process*. The authors claim that all ordinary events have focus where their participants are not involved in a homogeneous way, but rather at different levels of involvement with their parts and qualities. More precisely, the focus consists of a collection of object qualities that are involved in the event. Therefore, in one scene many events emerge each one with different focus. Thus, events are *manifestations* of individual qualities. This novel understanding of events will help to clarify the whole picture and make possible the modeling of complex scenes involving multiple emerging events [6].

3. Requirements on Events Modeling in the Legal Domain

Inspired by Scherp [21], we propose in this section two main categories of requirements that need to be fulfilled by the intended core model of events in the legal domain: functional and non-functional. The functional requirements define *what* needs to be expressed by a common model of events and the non-functional requirements specify *how* a model of events needs to be designed in order to be applicable. In the following, a list of functional requirements is presented:

- **R1-mereological structure of events**: the mereological relationship between events in the legal domain should be supported in the core model since legal events, as any other type of events, may be composed of other events.

- **R2-participation of objects in events**: representing participation of objects and the roles they play in legal events.

- **R3-changes promoted by events**: events are considered as transformations from a portion of reality to another [4]. The intended core model of events should support the representation of this transformation in the legal domain.

- **R4-temporal relationships between events**: legal events, as any other type of events, are characterized by the unfolding over time. In the targeted core model, there is a need to model their temporal duration [21].

- **R5-manifestation of object dispositions**: dispositions are particularized properties of objects which are manifested in particular situations through the occurrence of events. In the targeted model, the occurrence of legal events by the manifestation of (legal) object dispositions should be analyzed.

- **R6-causation**: in the intended model, the causal relationship between legal events must be represented since legal events may cause other legal events.

- **R7- events as emergent from scenes**: according to [6], events are distinguished as proper parts of scenes. Therefore, a legal scene can be composed of legal events or events that are not legally defined as well.

- **R8-manifesttaion of object qualities**: as aforementioned, events are considered, in their new strict sense, as *emergent from scenes* through a *focusing process* [6]. In the targeted model, the focus legal relationship, that concerns the involvement of legal objects and their qualities in legal events, must be represented.

In the other hand, the non-functional requirements comprise the extensibility of the model to include future aspects for describing events. Moreover, the modularity is essential to decrease the complexity of the intended model and to simplify its reusability. The core model of legal events should be able to incorporate existing domain ontologies and make use of it. Finally, the model needs to provide a clear separation of the structural knowledge about legal events and legal objects from the domain knowledge.

4. A Pattern-Based Core Model of Events in the Legal Domain

This section represents the main contribution of this paper which is the derivation of conceptual ontology patterns (COPs) from UFO-B and UFO-L and their combination with the novel understanding of events for building a pattern-based core model of events in the legal domain. COPs are small fragments of ontology conceptual models that address a specific modeling issue and can be directly reused by importing them in ontology under development [12]. They are intended to be used during the conceptual modeling phase of an ontology development process [11]. A COP extracted from a higher-level ontology can be used to support the development of lower-level ontologies [17]. COPs should be encoded in a higher-order representation language [12]. OntoUML [18] is an example of an ontology representation language that is suitable for this purpose. This language has been designed to reflect the ontological distinctions and axiomatization put forth by the Unified Foundational Ontology (UFO) [2,18].

For the derivation of COPs from UFO-B and UFO-L, the approach presented in [17] is applied. This approach is based mainly on a fragmentation process that tends to extract sub-ontologies from UFO-B and UFO-L and splitting them into smaller pieces still meaningful to the domain. These pieces are called Domain-Related Ontology Patterns (DROPs). The DROPs that are extracted from UFO-B will be applied by extension in the legal domain. This process is guided by a list of Competency Questions (CQs) that can reveal modeling needs in small pieces. Furthermore, these modules will be reused

for building the core model of events in the legal domain taking into consideration their combination with the modeling of the novel understanding of events as emergent from scenes. In the following, the conceptual ontology patterns of the event model are introduced and illustrated in diagrams encoded in OntoUML [18].

4.1. Mereology Pattern

The mereology pattern (Figure 1) implements three main requirements: R1, R4 and R7. Two main CQs are addressed for this pattern: CQ1: How are legal events structured? CQ2: How are legal events and scenes organized?

The mereology pattern tends to represent how legal events relate to their parts and to scenes. In UFO-B, events can be atomic or complex depending on their mereological structure. While an atomic event has no parts, a complex event is an aggregation of at least two events (that can themselves be atomic or complex) [4]. In this pattern, a similar perspective is applied for Legal Events (or *Legally Defined Event* as defined in UFO-L).

In addition, the new strict sense of events as *emergent from scenes* is taking into consideration where *Legal Events* are distinguished as proper parts of *Scenes* [6]. Moreover, the mereology pattern allows for modeling temporal properties. The temporal attributes of *Legal Events*, or *Scenes*, have values from special temporal datatypes that support the concept of *Time Intervals*, which are composed of *Time Points* (*begin* and *end* points) [19]. In this pattern, a simple temporal structure will be applied. This structure is defined as a linear order of time points where each event, or a *Scene*, is framed by a *Time Interval* which is associated with two values: *begin* and *end*. Finally, as *Scenes* happen in a suitably restricted spatio-temporal region, the mereology pattern allows to relate a *Scene* to a *Spatial Region* where it occurs.
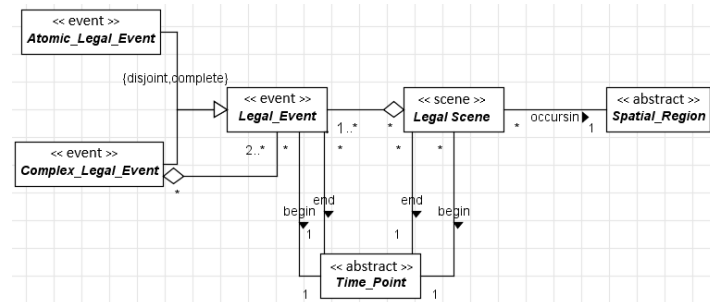

Figure 1. Mereology pattern.

4.2. Participation Pattern

The goal of this pattern (Figure 2) is to fulfill the requirement R2 for the representation of the participation of objects in legal events. Three main competency questions guided the modeling of this pattern, CQ1: What is a legal object participation? CQ2: What are the types of legal object participation? CQ3: Who is involved in a legal object participation?

UFO-B defines participation of objects as the portion of an event that depends exclusively on a single object. In addition, it contemplates the differentiation of roles played by objects inside an event (the so-called *processual roles*). In this context, the

spatial properties of events are defined in terms of the spatial properties of their participants [19]. Therefore, by the extension of this structure in the legal domain, a *Legal Object Participation* is defined as a type of a *Legal Event* which depends exclusively on a single *Legal Object*. In the participation pattern, special cases of *Legal Object Participation* event are defined: *Legal Object Creation*, *Legal Object Change* and *Legal Object Destruction*. In addition, the pattern implements the spatial properties of legal objects that participate in legal events. The spatial properties of a legal event are defined in the term of the *Spatial Location* of the Legal Participants.
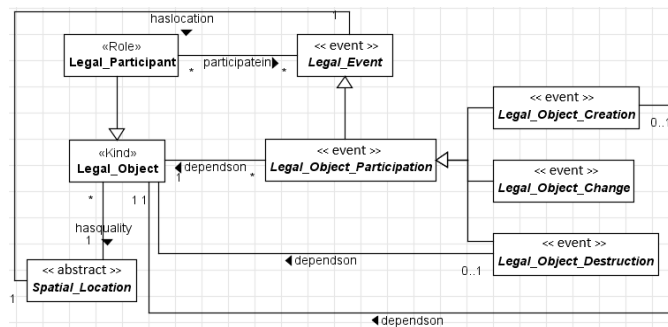

Figure 2. Participation pattern.

4.3. Manifestation of Qualities (Focus) Pattern

The main competency questions that guide the focus pattern are: CQ1: What is a focal legal relationship? CQ2: Which are the legal moments that compose a focal legal relationship? CQ3: Who is involved in a focal legal relationship? CQ4: Is there any legal event that grounds the focal legal relationship?

The manifestation of qualities, or Focus, pattern implements the requirement R8 which is derived from the novel understanding of *events as emergent from scenes* through a *focusing process* [6]. The *focus* is manifested by the *individual qualities and relationships* of the objects involved in events. Therefore, events are considered as *manifestations of object qualities*. This pattern is based mainly on three individuals: *Legal Objects* (*Participants*), *Legal Events* and *Tropes*. Two main kinds of *Trope* individuals are identified: *Intrinsic* trope individuals or *Qualities* and *Relational* trope individuals or *Relators*. Examples of *Qualities* are temperature, weight, intention or skill. Examples of Relators are enrollment, marriage or medical treatment. The special type of existential dependence relation that holds between a *Trope* individual x and the individual y on which x depends is the relation of *inherence*. Existential dependence can also be used to differentiate *intrinsic* and *relational* trope individuals: *Qualities* are dependent on one single individual; *Relators* depend on two or more individuals (their bearers), which they mediate [19]. In the Focus pattern (Figure 3), the *Legal Relator* pattern is reused from UFO-L [23] for modeling the focus of legal events represented by the *Focal Legal Relationship*. Two main *Legal Participants* are involved in the event and the object qualities (e.g. *Commitment* and *Claim*) which are *inherent* in them.
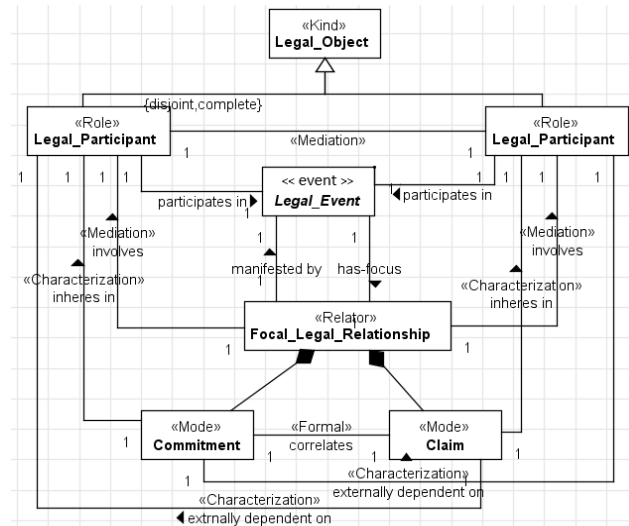
Figure 3. Focus pattern.

4.4. Manifestation of Disposition Pattern

Two main CQs are addressed in this pattern: CQ1: How dispositions are manifested by atomic legal events? CQ2: How situations can trigger legal events indirectly?

In UFO, besides the *Qualities*, the notion of particularized tropes includes also the *Dispositions*. Examples of dispositions are the fragility of glass, the disposition of a magnet to attract metallic material [4]. *Dispositions* are particularized properties that are only manifested in particular situations and that can also fail to be manifested. The manifestation will be through the occurrence of events [4]. As qualities, dispositions are existentially dependent and therefore *inhere in* particular objects. In Figure 4, the manifestation of disposition pattern is represented. This pattern implements the requirement R5 where a given *Situation* activates *Disposition* that *inheres in Legal Objects* which is *manifested by* an *Atomic Legal Event.*
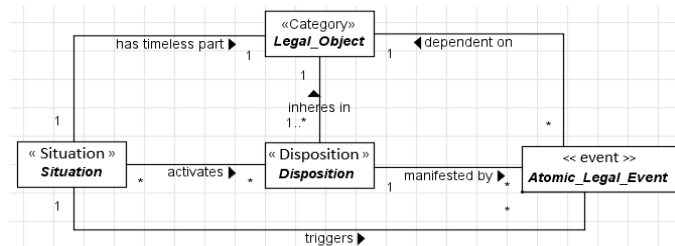

Figure 4. Manifestation of dispositions pattern.

4.5. Changes and Causation Pattern

In this pattern (Figure 5), two main requirements R3 and R6 are fulfilled. The competency questions addressed for this pattern are: CQ1: Can legal events cause the occurrence of other legal events? CQ2: How legal events bring about situations? In UFO-

B, changes are fundamental aspects of events where events are considered as mappings from and to situations in the world, in which endurants are characterized by bearing certain properties [4]. Situations that are brought about by the manifestation of dispositions and can activate other dispositions. The unfolding of the relations between situations, dispositions and events with further activation and manifestation of other dispositions can be used to characterize a useful form of (direct and indirect) causation between events [3]. Two possible relations between situations and events are proposed in UFO-B [20]: (i) a situation s *triggers* an event *e*, in the case that *e* occurs because of the obtaining of s, and; (ii) an event *brings about* a situation s, in which case the occurrence of an event *e* results in the situation *s* obtaining in the world at the time point *end-point(e)*. This structure is reused and extended for legal events (Figure 5).
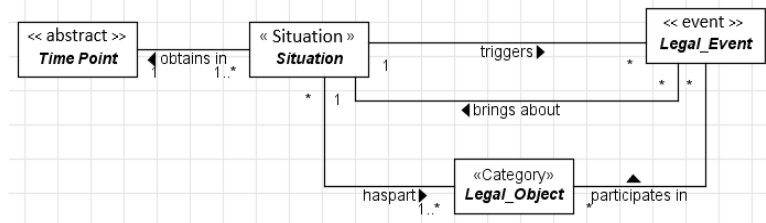

Figure 5. Changes and causation pattern.

5. Application of the Event Model in the Domain of Carriage of Goods by Sea

In this section, the use of the core model of events is demonstrated by the application of the ontology patterns (Section 3) in the domain of carriage of goods by sea. In fact, we aim to develop a well-founded legal domain ontology for the traceability of goods. In this ontology, events constitute a fundamental aspect such as, among others, loading, discharging and delivering of goods. In addition, events that may occur during transportation such as act or omission of the shipper, route deviation, loss, damage or delay in delivery of goods, fire, piracy incidents, etc. For describing such events, the different patterns that are defined in the core model of events will be combined, each providing a specific part of the event description [21].

A simple scenario about carriage of goods between two ports is proposed: A vessel, operated by company X, the *carrier*, loads containers in Mombasa, Kenya, for carriage to France, Le Havre port where they will be discharged. The company X issues bills of lading to company Y, the *shipper*, for containers for which it enters into a contract directly with them for carriage of the goods on the vessel. During the transportation of goods, the vessel has deviated from its agreed route of voyage to another port (The Légué, France). Therefore, the deviation of the route has resulted in a delay of 72 hours for delivery of goods as well as a portion of the goods are unlawfully taken. In addition, a problem occurred on the vessel concerning the ventilation that caused the maturation of fruits in the containers. In Figure 6, a conceptual model of the proposed scenario is illustrated. In this model, a Scene is observed which is composed of three main legal events: *Carriage of Goods*, *Route Deviation* and *Damage of Fruits*. The *Carriage of Goods* event is considered as a complex event composed of two sub-events: *Loading Containers* and *Discharging Containers*. Two main legal objects (agents) participate in

the *Carriage of Goods* event: *Carrier* and *Shipper*. In addition, this event depends on objects such as *Containers* and *Vessel*. Moreover, the *Carriage of Goods* event is considered as a manifestation of a focal legal relationship "*Carriage of Goods Contract*" that involves two legal participants: *Carrier* and *Shipper*. The focal legal relationship is composed of qualities, *Commitment* and *Claim*, that inhere in the *Carrier* and the *Shipper* respectively. The situation of *Ventilation Problem*, such as high temperature, activates a disposition inhered in Fruits which is the *Maturation*. Therefore, this disposition is manifested by an event: *Damage of Fruits*. Finally, the causation is represented in the *Route Deviation* event that caused two resulted events: *Delivery Delay* and *Theft of Goods*.
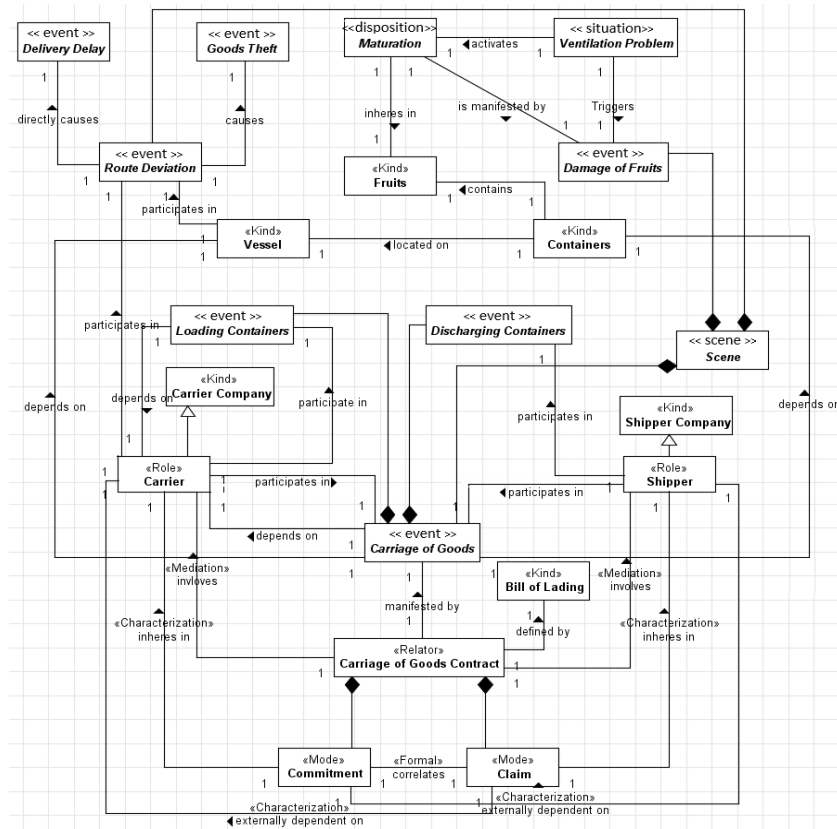

Figure 6. Application of the core model of events in the domain of carriage of goods.

6. Related Works

Representing events in conceptual models is increasingly gaining widespread attention specifically by the application of pattern-oriented approaches. In the literature, a pattern-based core model of events (Event-Model-F) [21, 22] based on the foundational ontology DOLCE is proposed to represent the occurrences in the real world and formally model different relations and interpretations of events. The Event-Model-F provides a formal

representation of the different aspects of events in which humans participate such as time and space, composition, correlation, and documentation. In our work, we have selected the foundational ontology of events UFO-B for grounding the core model of events and UFO-L for the legal background. In this context, different ontology patterns are derived, extended and combined from UFO-B and UFO-L as well as we relied on the novel understanding of events as *emergent from scenes* [6]. This combination has enriched our model with different complex theories and aspects of events. In fact, one of the key contributions of UFO-B is to extend a combination of existing results from formal ontology in a fuller theory for supporting the foundations of events in conceptual modeling [4]. In addition, the new strict sense of events allowed for modeling complex scenes where multiple events can emerge. For the representation of the conceptual models of the different ontology patterns, the ontologically well-founded modeling language OntoUML has been used. In fact, OntoUML gives a clear methodological support for deciding for which types in a model of endurants a behavioral model of changes can be specified [3]. Moreover, the possibility of change can explicitly be represented in OntoUML in terms of contingent types such as roles, phases and their relations [3]. Therefore, the proposed core model of events in the legal domain has fulfilled the main requirements and covered different complex aspects of events such as the manifestation of object properties: dispositions and qualities that are not considered in the Event-Model-F. Concerning the mereology and causation relationships, they are enriched by adding concepts such as *Scene* and *Situation*. In the mereology pattern, events are considered as proper parts of scenes. In the causation pattern, the situations may cause the occurrence of events through the activation of dispositions.

7. Conclusion

In this paper, a pattern-based core model of legal events grounded on the foundational ontology of events UFO-B and the legal core ontology UFO-L is presented. This model is designed by applying a pattern-based approach aimed to derive, extend and combine conceptual ontology patterns from UFO-B and UFO-L. In addition, we relied on the novel understanding of events as *emergent from scenes*. Therefore, the model allows for a formal representation of different complex aspects of events in the legal domain such as: participation of legal objects in events, legal objects dispositions, legal objects qualities and focal legal relationships as well as the causation and mereology relationships. Moreover, the modular aspect of the model which is composed of different ontology patterns encourages its reusability. Actually, separating the model into smaller patterns allows for better managing the complexity of evens [21] and for better reusability of these patterns. In future works, additional notions of events will be considered such as intentional and non-intentional events. This model will be used for building a well-founded ontology for the domain of carriage of goods by sea for reasoning and traceability purposes.

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References

[1] A. Scherp, T. Franz, C. Saathoff, S. Staab, F-A model of Events based on the Foundational Ontology DOLCE+DnS Ultralite. In: K-CAP 2009, ACM, USA, pp. 137-144, 2009.

[2] G. Guizzardi, G. Wagner, R. Guizzardi, Towards Ontological Foundations for Conceptual Modeling: The Unified Foundational Ontology (UFO) Story, *Applied Ontology* **10** (2015), 259–271.

[3] G. Guizzardi, N. Guarino, J. Almeida, Ontological Considerations about the Representation of Events and Endurants in Business Models. In: La Rosa, M., Loos, P., Pastor, O. (eds.) BPM 2016, LNCS, vol. 9850, pp. 20-36, Springer, Cham, 2016.

[4] G. Guizzardi, Towards Ontological Foundations for the Conceptual Modeling of Events. In: Ng, W., Storey, V.C., Trujillo, J.C. (eds.). ER 2013, LNCS, vol. 8217, pp. 327-341, Springer, Heidelberg, 2013.

[5] J. Almeida, P. Costa, G. Guizzardi, Towards an Ontology of Scenes and Situations, IEEE Conference on Cognitive and Computational Aspects of Situation Management, pp. 29-35, 2018.

[6] G. Guizzardi, N. Guarino: Relationships and Events, Towards a General Theory of Reification and Truthmaking. In: Adorni, G., Cagnoni, S., Gori, M., Maratea, M. (eds.) AI*IA 2016, LNCS, 10037, pp. 237-249, Springer, Cham, 2016.

[7] R. Weber, *Ontological Foundations of Information Systems. Coopers & Lybrand*, 1997.

[8] K. Kaneiwa, An Upper Ontology for Event Classifications and Relations. In: Orgun, M.A., Thornton, J. (eds.) AI 2007, LNCS, 4830, pp. 394-403, Springer, Heidelberg, 2007.

[9] S. Borgo, P. Leitao, The role of foundational ontologies in manufacturing domain applications. In: Meersman, R., Tari, Z. (eds.) OTM2004, LNCS, 3290, pp. 670-688, springer, Heidelberg, 2004.

[10] G. Guizzardi, G. Wagner, Towards ontological foundations for agent modelling concepts using the unified foundational ontology (UFO), *Agent-Oriented Inf. Syst.* **2** (2004), 110–124.

[11] F. Ruy, C. Reginato, V. Santos, R. Falbo, G. Guizzardi, Ontology Engineering by Combining Ontology Patterns. In: Johannesson, P., Lee, M., Liddle, S., Opdahl, A., Pastor López, Ó. (eds.) ER 2015, LNCS, 9381, pp. 173-186, Springer, Cham, 2015.

[12] A. Gangemi, V. Presutti, Ontology Design Patterns. In: Staab, S., Studer, R. (eds.) Handbook on Ontologies, Springer, Heidelberg, 2009.

[13] E. Blomqvist, A. Ganemi, V. Presutti, Experiments on Pattern-based Ontology Design. In: K-CAP 2009, pp. 41-48, ACM, USA, 2009.

[14] V. Presutti, E. Daga, A. Gangemi, E. Blomqvist, eXtreme Design with Content Ontology Design Patterns. In: WOP 2009, pp. 83-97, ACM, USA, 2009.

[15] A. Gangemi, Ontology Design Patterns for Semantic Web Content. In: Gil, Y., Motta, E., Benjamins, V.R., Musen, M.A (eds.) International Semantic Web Conference, LNCS, 3729, pp. 262-276, Springer, Heidelberg, 2005.

[16] R. Falbo, G. Guizzardi, A. Gangemi, V. Presutti, Ontology Patterns: Clarifying Concepts and Terminology. In: WOP 2013, vol. 1188, pp. 14-26, CEUR-WS, Germany, 2013.

[17] F. Ruy, G. Guizzardi, R. Falbo, C. Reginato, V. Santos, From Reference Ontologies to Ontology Patterns and Back, *Data and Knowledge Engineering* **109** (2017), 41–69.

[18] G. Guizzardi, Ontological Foundations for Structural Conceptual Models, PhD Thesis, University of Twente, 2005.

[19] G. Guizzardi, G. Wagner, Towards an ontological foundation of discrete event simulation. In: Winter Simulation Conference, pp. 652-664, 2010.

[20] A. Benevides, J. Bourguet, G. Guizzardi, Representing the UFO-B the ontology of events in sroiq. In: JOWO, 2017.

[21] A. Scherp, T. Franz, C. Saathoff, S. Staab, A Core Ontology on Events for Representing Occurrences in the Real World, *Multimedia Tools and Applications* **58** (2010), 293–331.

[22] A. Scherp, C. Saathoff, T. Franz, S. Staab, Designing core ontologies. Applied Ontology 6 (2011), 177–221.

[23] C. Griffo, UFO-L, A Core Ontology of Legal Aspects Building Under the Perspective of Legal Relations, PhD Thesis, Federal University of Espirito Santo, 2018.

[24] R. Hoekstra, J. Breuker, M. Di Bello, A. Boer, The LKIF Core ontology of basic legal concepts, Proceedings of the Workshop on Legal Ontologies and Artificial Intelligence Techniques (2007).