Towards a Formal Representation of Document Acts and the Resulting Legal Entities

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Introduction

Documents are pervasive through the entirety of social life. They are crucial entities for all organizations. We will focus on the use of documents in the medical domain in this chapter. Looking at medical standards, Health Level 7 (HL7) is a good example to illustrate the multiplicity of documents required to carry out an ordinary activity in healthcare organizations such as a blood donation. In this everyday situation, the person's willingness to donate blood triggers a cascade of processes in a blood bank. Throughout the whole process, forms are filled in, reports are filed and labels are created. In this example case, most of the documents primarily serve the function of recording data.

Some documents are bearers of additional properties beyond recording data, as in the example above. They give rise to new sorts of commitments. Through a document, one can create rights or obligations to others, as in the case of a consent form to a blood donation, or induce the adoption of certain technical procedures, as in the case of mandatory procedures demanded by legislation.

Even though our analysis is triggered by the use of documents in medicine, ultimately our aim is to provide a generalizable, formal representation of documents, their use, and the entities resulting thereof. To achieve this aim we rely on document act theory as proposed by Barry Smith (2012: 183) to explain the social impact of documents. We begin by referring to Adolf Reinach's earlier work, which was the basis of Smith's document act theory. A review of Reinach will be presented in order to explain the way in which document acts create socio-legal entities like claims and obligations. In section 1 of this paper, we present the theoretical background of document acts ontology (d-acts). In section two, we provide an overview over the initial implementation of d-acts in Web Ontology Language (OWL). In section 3, we discuss the scope and the usability of our ontology for our use cases. Besides the blood

donation use case already mentioned above, we are working with a use case that stems from an ongoing project on clinical guidelines: the Evicare Project. We demonstrate how data from these two domains can be annotated using terms from d-acts. The latter enables using the formal description of the classes in the ontology to computationally query the data or reason over it.

1. Ontological Analysis of Document Acts

1.1 Introducing Document Acts

Since Aristotle, the study of language has mostly been viewed as pertaining only to uses of language to make statements. The development of speech act theory in the 20th century was triggered by the recognition that we can use language to do other things beyond merely describing reality. In specific contexts, sentences like "*Mr. Harris is allowed to purchase 10 tablets containing 5 mg of lorazepam"* or "*I promise, I will take you to the prom"* do not merely make statements, they create claims and obligation. Austin, the founder of speech act theory, holds that sentences like the ones above do not describe anything in the world at all. They are neither true nor false. Instead, these types of sentences enable something to be done; that is, they are performances of acts of certain kinds. J. L. Austin (1962:6) calls these sentences performatives, in contrast to sentences in which something true or false is being stated, which he calls constantives (Austin 1962:3). Austin was not the first to uncover the role of language in the performance of social action. In 1913, Adolf Reinach undertook the initial efforts in this field (Reinach 2012:181).

Smith added the notion of document acts to Reinach's initial efforts on defining social actions and the resulting socio-legal entities. Speech acts are events existing only in their execution, but documents are objects that endure through time retaining a history of changes. Document acts, just like speech acts, can serve to create new kinds of social and organizational orders, but they transform them into an enduring form (Smith 2012:182).

> (…) I proposed a theory of *document acts* supplementing the traditional Reinach-Austin-Searle theory of speech acts with an account of the ways in which, by *doing things with documents* — whether made of paper and ink or of patterns of blips in computers — we are

> able to *change the world* by bringing into being new types of ownership relations, of legal accountability, of business organizations, and other creatures of modern economies, including mortgages, stocks, shares, insurance protection, and financial derivatives. (Smith 2012: 183)

In order to fully understand the deontic power of document acts, we need to examine Reinach's theory of social acts and declaration. Their ability to create socio-legal entities is inherited by the fact that document acts are based on declarations (Smith 2012: 184).

1.2 Reinach on Social Acts and Declarations

Reinach's approach, unlike speech act theory, is not centered around language as such, but is rooted in a phenomenological inquiry into social activity. Reinach focuses on experiences that involve spontaneous internal activity of the subject (i.e. the originator of the act) and he refers to these specific acts as "spontaneous acts." Examples of these types of experiences are deciding, forgiving, asking, and commanding (Reinach 1989: 189).

Reinach distinguishes two types of spontaneous acts: internal acts and social acts. The former are acts like deciding and forgiving. Unlike social acts, internal acts do not need to be communicated. The example of forgiving makes this obvious: Even though forgiving is directed towards a second person, it is not necessary to communicate that act. It can remain purely internal (Reinach 1989: 190).

What sets apart social acts from internal acts is the necessity of being perceived (*Vernehmungsbedürftigkeit*). A social act can only be completed if a second party perceives it. Reinach clarifies that carrying out the act externally is not essential. We can imagine a society where the members are able to perceive each other's experiences immediately, for instance, without language as a medium. Social acts would still exist in such a society even so there are no external acts going on (Reinach 1989: 192f).

For our present purpose, we focus on a specific type of social acts: declarations (*Bestimmungen*) (Reinach 1989: 302, 315f.). We follow Smith (2012: 184) in assuming that Reinach's *Bestimmungen* are identical with John Searle's *declarations*, and we do not translate *Bestimmungen* as *enactments,* which has been proposed by Crosby (Reinach 2012). However, we think that Reinach uses this term in two different

ways: referring to legally issued norms (Paulson 1987: 148) and referring to declarations. Reinach's point is that legally issued norms are declarations of what ought to be (Reinach 1989: 316). We focus on declarations in general for now. Declarations are neither true nor false since they are not judgments (Reinach 1989: 300). Reinach states that declarations create or demolish reality (Reinach 1989: 333). This is not to be understood in the way that one declaration could create the entirety of reality, but it adds one entity to reality. Every declaration aims for the realization of whatever it posits as the state of affairs that ought to be (Reinach 1989: 306).

Reinach holds that the origin of legal entities lies in declarations (Reinach 1989: 299f). Once the declaration has been made, the resulting claim or obligation is an actual entity; it is not merely an unrealized possibility. Stanley L. Paulson puts Reinach's position in a slightly simplified form:

> Introducing an idiom that will be helpful in underscoring the challenge Reinach puts to the normative reductionists, we might say that legal structures are *products*, and social acts, the corresponding *products*. (Paulson 1987: 145)

Paulson stresses that using the process-product dichotomy would be misleading, since Reinach's thinking is based on the fact that the types of things, for instance the type *claim*, already exists. What is brought about by the social act is one instance of that type (Paulson 1987: 145f). It is sufficiently clear that declarations bring about legal entities.

We have seen that, for Reinach, legally-issued norms are declarations (Reinach 1989: 316); now we want to consider whether declarations bring about claims and obligations, even where the law is not involved.

We hold that this is obvious from Reinach's inquiry into the nature of claim and obligation. He develops his ontological theory of claims and obligations using the example of a person's promise to join another person for a walk. For the person giving the promise, it creates the obligation to join the receiver of the promise for a walk. Simultaneously, it creates a claim for the receiver of the promise to be joined for a walk by the giver of the promise (Reinach 1989: 175f, 180). Reinach makes it very clear that regardless of the fact that this example lies outside of the law, the existence of the obligation brought about by the promise is undeniable (Reinach 1989: 177f). We hold that this shows that the act of

a promise outside the sphere of a law is a declaration of how things ought to be.

According to Reinach, claims and obligations need a sufficient reason (Reinach 1989: 185), namely the declaration. However, social entities, like an obligation, differ greatly from purely natural entities such as in physics (e.g. the movement of a ball). Natural entities can be perceived without the need to go back to the cause of the entity. Reinach stresses that this is not the case for social entities. In order to perceive a social entity, we always need to trace it back to its cause (Reinach 1989: 185f). This is of interest for our inquiry since documentation of the cause for claims and obligations is one of the driving forces in the development of documents and, accordingly, their use in document acts. Documents are the means that allow social relations based on social acts to become enduring entities (Smith 2012: 183).

> The effect is that private memory traces inside human brains are prosthetically augmented by publicly available documents and associated document technologies. (Smith 2012: 182)

In his inquiry into the ontological status of declarations based on Searle, Ingvar Johansson (2008: 84) mentions that documentation of declarations by means of perduring entities can provide grounding of the resulting obligations. The mere speech acts are not able to provide this kind of lasting grounding.

1.3 Formal Ontology of Claims and Obligations

In the previous subsections, we presented material regarding the ontological status and significance of social acts, declarations, and document acts. We have seen how declarations bring about claims and obligations and why document acts are a necessary means towards endurance of the causal history of both. Now we need to look into the ontological status of claims and obligations. Reinach asserts that they are certainly not non-entities (Reinach 1989: 175f), so in social ontology we should not deal with them by providing physical proxies. This is an important point in current debates about social ontology. Smith's critique of Searle's social ontology is based on Reinach's realist approach towards social and legal ontology, which regards social entities as real, bona fide entities. Smith holds that Searle's position that social reality "must in every case be made up by physical parts" (Smith 2008: 41) is wrong. Smith's

theory of document acts is one more contribution towards explaining the ontological status of those entities; an endeavor that started with Reinach's efforts.

Both claims and obligations necessarily presuppose the existence of a person whose claims and obligations they are (Reinach 1989: 179), so claims and obligations are dependent entities. Like the content of *Oliver Twist* or the color of my shirt, they cannot exist independently of the existence of another entity, namely the copy of *Oliver Twist* on my desk and my shirt. Considering the color of my shirt, it is clear that it depends on my shirt. The two entities are individually dependent according to Johansson (1989: 182): this instance of color depends on this instance of a shirt. What makes claims and obligations different from the color of my shirt is that they are transferable, just like the content of *Oliver Twist*. The content of *Oliver Twist* does not depend on my copy of *Oliver Twist*. It is borne by multiple carriers like books, ebooks, PDF files, etc. Once my copy of *Oliver Twist* vanishes, the entity that is its content still exists. In the next section, we will see how both a specific claim and the content of *Oliver Twist* are generically dependent. The latter means they depend on the existence of some bearer of a specific type, but they are not depending on one particular bearer (Mulligan & Smith 1986: 124; Smith 1993: 312).

1.4 Claims and Obligations in Applied Ontology

In order to further pursue the formal ontological analysis, we want to introduce a framework of formal ontology providing the basis for the categorization of entities on which we build. In terms of Applied Ontology, we are going to present an upper ontology.

> An upper ontology is limited to concepts that are meta, generic, abstract and philosophical, and therefore are general enough to address (at a high level) a broad range of domain areas. Concepts specific to given domains will not be included; however, this standard will provide a structure and a set of general concepts upon which domain ontologies (e.g. medical, financial, engineering, etc.) could be constructed. (SUO WG 2003)

Basic Formal Ontology (BFO) is an upper ontology that recognizes a basic distinction between two kinds of entities: substantial entities or continuants, and processual entities or occurrents. Corresponding to

these two kinds of entities are two distinct perspectives that can be applied on the world: these are the SNAP and SPAN perspective. The SNAP perspective of BFO represents continuants: entities that endure through time while maintaining their identity. Examples of such entities include a human individual, the color of a ripe apple, and the Berlin Wall. Furthermore, the SNAP ontology recognizes three major categories of continuants: independent continuants, specifically dependent continuants, and generically dependent continuants. The SPAN perspective of BFO represents occurrents: entities that happen, unfold, or develop in time. Examples of such entities include the process of respiration, a whole human life in the 19th century, and the functioning of a heart. The characteristic feature of occurrents, or processual entities, is that they are extended both in space and also in time. (Spears 2006: 39). In addition to what is argued for in Spear's manual, the current implementation of BFO in Web Ontology Language (OWL), BFO 1.1, represents generically dependent continuants. The following definition is given for these entities:

> A continuant [snap:Continuant] that is dependent on one or other independent continuant [snap:IndependentContinuant] bearers. For every instance of A requires some instance of (an independent continuant [snap:IndependentContinuant] type) B but which instance of B serves can change from time to time.[1]

BFO also represents realizable entities, which are a subtype to dependent continuant (Spear 2006: 52f).

> The exhibition or actualization of a realizable entity is a particular manifestation, functioning or process that occurs under certain circumstances. (examples: the role of being a doctor, the function of the reproductive organs, the disposition of metal to conduct electricity). (Spear 2006: 53)

Notably, generically dependent continuants are not realizable entities.[2] This seems to lead to an inconsistency between BFO and Reinach's social ontology, since Reinach asserts that claims and obligations are realizable (Reinach 1989: 179f). We hold that the contradiction between

[1] Retrieved October 22, 2012, from http://ifomis.org/bfo/1.1
[2] Retrieved October 22, 2012, from http://ifomis.org/bfo/1.1

these positions can be overcome by taking into account the ontological theory of generically dependent continuants and their effects as represented by the Information Artifact Ontology (IAO).

Extending BFO, IAO encompasses several types of entities: 1) information content entities, such as report, journal article content, narrative object, specifications, and serial numbers; 2) processes that consume or produce information content entities, such as writing, documenting, recording, measuring, and encoding; 3) bearers of information materials, such as books, journals, photographic prints, and CDs; 4) relations involved with information content entities including *is_about, denotes, is_measurement_of, encodes, is_topic_of,* and *is_rendering_of*.[1]

IAO extends what we have said about generically dependent continuants (GDCs) by adding that GDCs depend on specifically dependent continuants (SDC), which depend on independent continuants. All individual GDCs need to be *concretized as* individuals of the type SDC.[2] Notably, IAO does not restrict *concretized as* to only hold between GDCs and qualities (for instance, a pattern of ink on paper that concretizes the content of *Oliver Twist*), but allows concretization of GDCs as realizable entities.

As an example, let's assume Punch claims a piece of land that was unclaimed before. This act creates Punch's claim to the specific piece of land. This claim is concretized as Punch's role as claimant of the land. Punch's claimant role can be realized in multiple ways, for example in the process of leasing the land to a third party. Another way that his claimant role can be realized is in the process of selling the land. Once Punch sells the land to Judy, his claimant role goes out of existence and now the claim is concretized in a new role, Judy's claimant role. With respect to what we said in section 1.3, it becomes clear that the claim is not individually or specifically depending on its bearer, or more exactly, on the bearer of its concretization. However, the dependence here is generic: there is no claim without a bearer of its concretization. Claims and obligations are, in the terminology of BFO, *generically dependent continuants*.

We assume that claims and obligations are subtypes of a type we call *socio-legal, generically dependent continuants* (SGDC), which is a

[1] Retrieved October 22, 2012, from http://purl.obolibrary.org/obo/iao.owl
[2] Retrieved October 22, 2012, from http://purl.obolibrary.org/obo/iao.owl

subtype to generically dependent continuants (GDC). Regarding pre-existing ontologies using BFO as upper level, so far the only subtype to GDC has been information content entity (ICE). How are LGDCs different from ICEs? Obviously, the way in which SGDCs migrate from one person to another is quite different from the migration of ICEs. While ICEs often migrate by being concretized as qualities that inhere in material information bearers (which can be copied, thus creating multiple copies of one particular ICE at one time), this is not the case for SGDCs. In our example, we have seen how Punch's claimant role goes out of existence in the process of selling the land to Judy, and it is replaced by Judy's claimant role.

Reinach points out that the transferring of claims and obligations requires another social act; however, the fact that Reinach stresses t one cannot transfer more extensive claims and obligations to someone than one bears oneself, clarifies that there is no creation of new claims and obligations in the act of transferring (Reinach 1989: 264).

1.5 Different Types of Document Acts and their Participant's Roles

The example of Punch transferring his claim to Judy shows that not all declarations create LGDCs. There are three relations between a document act and LGDCs. Besides the already discussed situations — that a document act creates an LGDC and that a document act transfers an LGDC — there are document acts which revoke LGDCs. The first is a case, once a judge or an official signs and stamps the divorce papers previously filled in by a couple. This document does not create a new LGDC, but rather revokes existing ones. The latter is the case in the example of Punch's piece of land, the claim of which is transferred to Judy. In this case, there is a new relation that comes into existence, namely Judy's claimant role, while another one ceases to exist, namely Punch's claimant role. Obviously the claim as such is not altered. It only gets concretized in a new entity.

In order to represent document acts in our medicine-related use case it is not enough to keep track of document acts and the LGDCs created,

revoked, or transferred. It is necessary to be able to track specific roles and their bearers involved in the document act:[1]

1. the creators of the document template,
2. the users of the document,
3. the target bearers of the concretizations of the LGDCs created by document acts.

2. Outlining Document Act Ontology (d-acts)

In order to provide immediate implementability of document act theory, its formalization in a computable format is necessary. Our aim is to provide an implementation of document act theory in Web Ontology Language (OWL) (W3 Consortium 2004) based on the theory of document acts presented above. We will reuse pre-existing ontologies developed on the basis of the Open Biological and Biomedical Ontologies (OBO) Foundry principles (Smith et al. 2007: 1252). The representation is based on IAO, which was imported in its entirety. Besides IAO, we imported selected classes and object properties from Ontology of Biomedical Investigations (OBI),[2] National Center for Biotechnology Information (NCBI) Taxonomy[3] and the Ontology of Medically Related Social Entities (OMRSE)[4] using a plug-in that was developed at the University of Arkansas for Medical Sciences and the University of Arkansas of Little Rock and is based on the "Minimum information to reference an external ontology term" (MIREOT) methodology (Courtot et al. 2009).

The following entities were imported from pre-existing ontologies:

- organization (http://purl.obolibrary.org/obo/OBI_0000245)
- organism (http://purl.obolibrary.org/obo/OBI_0100026)
- realizes (http://purl.obolibrary.org/obo/BFO_0000055)
- Homo sapiens (http://purl.obolibrary.org/obo/NCBITaxon_9606)

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[1] This list is inspired by a presentation by Barry Smith: "Ontology of Documents", http://ontolog.cim3.net/file/resource/presentation/BarrySmith_20051013/Ontology_of_Documents-Ontolog--BarrySmith_20051013.ppt

[2] Retrieved July 4, 2012, from http://www.berkeleybop.org/ontologies/obo-all/obi/obi.owl

[3] Retrieved July 4, 2012, from http://www.berkeleybop.org/ontologies/obo-all/ncbi_taxonomy/ncbi_taxonomy.owl

[4] Retrieved July 4, 2012, from http://www.berkeleybop.org/ontologies/obo-all/omrse/omrse.owl

- aggregate of organizations (http://purl.obolibrary.org/obo/OMRSE_00000033)
- collection of organisms (http://purl.obolibrary.org/obo/OMRSE_00000022)
- collection of humans (http://purl.obolibrary.org/obo/OMRSE_00000023)
- is-aggregate-of (http://purl.obolibrary.org/obo/OMRSE_00000020)

All other classes and object properties we refer to in document act ontology (d-acts) have either been created specifically for d-acts or are represented in IAO.[1]

The following entities are implemented in the initial version of the Document Act Ontology (d-acts), which can be downloaded from http://purl.obolibrary.org/obo/iao/d-acts.owl. (The following notation is being used: **classes** are written in bold, *object properties* are written in italics, and OPERATORS are written in capital letters.)

socio-legal generically dependent continuant
Def.: Socio-legal generically dependent continuants are generically dependent continuants that come into existence through declarations and are concretized as roles. They differ from information content entities in that they are not about something, but exist as quasi-abstract social entities. In addition, their concretizations are not qualities inhering in independent continuants, but roles borne by an organism or an aggregate of organisms. Each socio-legal, generically dependent continuant can only be concretized once at each given time.
Equivalent class: *is_specified_output_of* SOME **declaration**
Superclass: **generically dependent continuant**
Examples: the claim of a piece of land, the obligation to pay rent to the owner of a rental property

[1] Retrieved July 4, 2012, from https://purl.obolibrary.org/obo/iao.owl

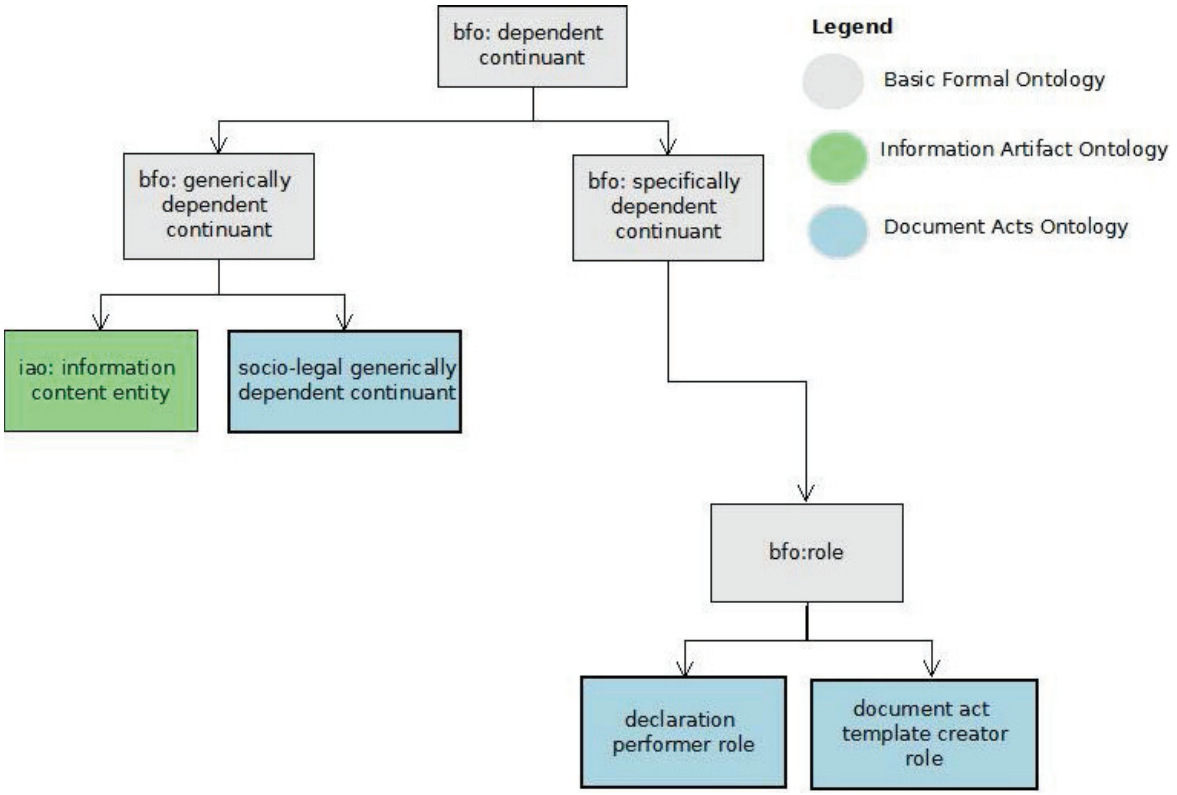

Figure 1. Classes of d-acts ontology and the dependent continuant branch of BFO

social act

Def.: A process that is carried out by a self-conscious being and is spontaneous, directed towards another conscious being, and needs to be perceived.

Equivalent class: -

Superclass: **processual entity**

Example: Colonel Klink giving Sergeant Schultz an order, Jake promising Jill to take her to the junior prom

declaration

Def.: A social act that brings about, transfers, or revokes a socio-legal, generically dependent continuant. Declarations do not depend on words spoken or written, but sometimes are merely actions, for instance the signing of a document.

Equivalent class: (*legally revokes* SOME **socio-legal generically dependent continuant**) OR (*legally transfers* SOME **socio-legal generically dependent continuant**) OR (*has_specified_output* SOME **socio-legal generically dependent continuant**) AND *has_agent* SOME ((**Homo sapiens** OR **organization** OR **collection of humans** OR

aggregate of organizations) AND *bearer_of* SOME **declaration performer role**) AND *realizes* SOME **declaration performer role**
Superclass: **social act**
Examples: my consenting verbally to buy a used TV set for $500, Jane Doe's signing of the divorce papers, John Robie's taking of Mrs. Steven's jewels

legally revokes
Def.: d socio-legally revokes s if s participates in d, and at the end of d, s no longer exists.
It is important to note that this going out of existence of s is complete and unlike the going out of existence for material entities, which basically always are transformed into something else. After the declaration nothing is left of the socio-legal, generically dependent continuant in question.
Domain: **declaration**
Range: **socio-legal generically dependent continuant**
Super property: *has_participant*
Characteristics: Functional, Asymmetric, Irreflexive

legally transfers
Def.: d socio-legally transfers l if l participates in d and d has specified input (concretization of l_1) and specified output (concretization of l_2), where (concretization of l_1) and (concretization of l_2) are not identical.
Domain: **declaration**
Range: **socio-legal, generically dependent continuant**
Super property: *has_participant*
Characteristics: Functional, Asymmetric, Irreflexive

document act
Def.: A declaration that is made using a document to temporally extend the effects of the declaration.
Equivalent class: (*legally revokes* SOME **socio-legal, generically dependent continuant**) OR (*legally transfers* SOME **socio-legal, generically dependent continuant**) OR (*has_specified_output* SOME **socio-legal, generically dependent continuant**) AND *has_agent* SOME (**Homo sapiens** OR **organization** OR **collection of humans** OR

aggregate of organizations) AND *has_specified_input* SOME **document** AND *has_specified_output* SOME **document**)
Superclass: **declaration**
Examples: filling in an immigration form, a judge signing and stamping a court order

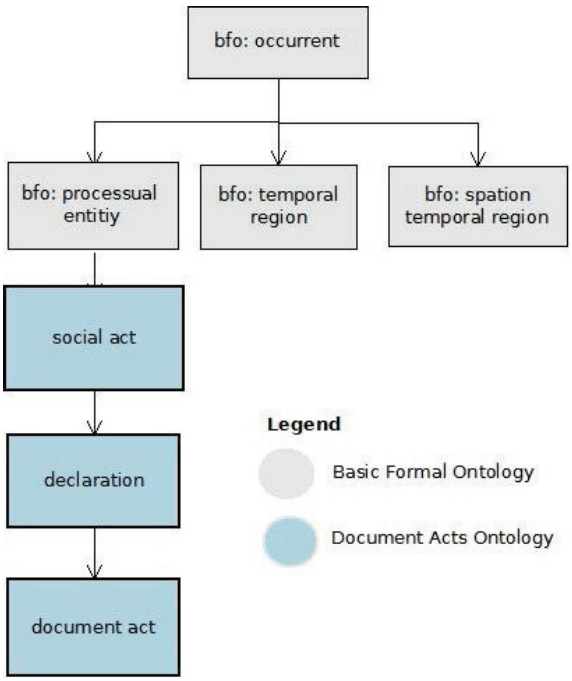

Figure 2. Classes of d-acts ontology and the occurrent branch of BFO

declaration performer role
Def.: A role inhering in a human being or an organization or an aggregate of any of the aforementioned that is realized by the bearer being the agent in a declaration.
Equivalent class: -
Superclass: **role,** *inheres in* SOME (**Homo sapiens** OR **organization** OR **aggregate of organizations** OR **collection of humans**) AND *is_realized_by* ONLY declaration
Examples: a judge's role of signing a court order, a hospital committee's role to sanction conformance to a specific guideline for hospital employees

declaration target
Def.: The human being or organization or aggregate of any of the aforementioned that is the bearer of a concretization of a socio-legal, generic-

ally dependent continuant brought about by or transferred in a specific document act.
Equivalent class: (**Homo sapiens** OR **organization** OR **aggregate of organizations** OR **collection of humans**) AND *bearer_of* SOME ((*is_concretization_of* SOME **socio-legal, generically dependent continuant**) AND *participates_in* SOME **declaration**)
Superclass: **material entity**
Examples: me as bearer of a spouse role who participates in a document act, John Doe as bearer of a debtor role who participates in a document act

document act template creator role
Def.: A role that inheres in a human being or organization or aggregate of any of the aforementioned that prepares a document that is the specified input to a document act and is the input document of a document act.
Equivalent class: -
Superclass: **role,** *inheres in* SOME ((**Homo sapiens** OR **organization** OR **aggregate of organizations** OR **collection of humans**) and *is_realized_by* ONLY (**process** AND *has_specified_output* SOME (**document** AND *participates_in* SOME **document act**)))
Examples: the role of the U.S. Citizenship and Immigration Service realized by the creation of an immigration form being filled in, the role of a national professional association realized by the creation of a clinical guideline to be certified

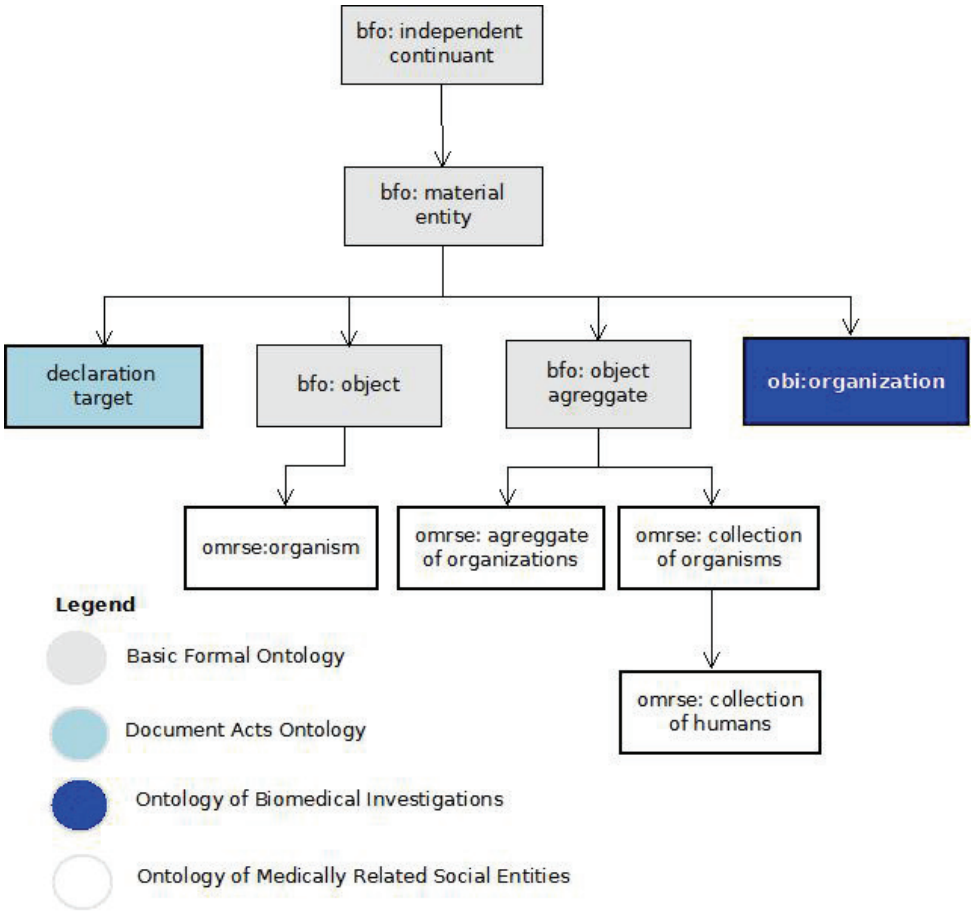

Figure 3. Classes of d-acts ontology and the independent continuant branch of BFO

3. Discussion: Using d-acts

The aim of d-acts is to provide an ontological representation of document acts to be used for data integration in information systems. There are several scenarios in which d-acts can be used. We are presenting examples of annotating data regarding 1) blood transfusion services and 2) clinical guideline management.

In blood transfusion services, we find a multitude of document acts. One example is the consent letter that legally enables the blood donation process. Its effect within a blood transfusion service can be annotated using d-acts. A consent letter is the specified input of the document act of the patient's consenting to the blood donation procedures. The clerk responsible for the blood donation process is the bearer of the document act template creator role. The blood donation candidate is the bearer of the declaration performer role. A nurse is responsible for the medical procedures enabling the patient to donate blood, for instance drawing blood from the patient’s arm. She is the declaration target since she

becomes endowed with the right to perform the aforementioned procedures.

The second use case is the use of d-acts to enable data integration in the Core Clinical Protocol Ontology (C2PO),[1] which deals with clinical guidelines, their authorship, and their distribution. The C2PO is an application ontology built to support various prototypes within the Evicare Project. Evicare concerns promoting the use of clinical guidelines through better searches of these documents and by making them available in connection with records in the electronic health record; therefore, the purpose of C2PO is to provide semantic interoperability between guidelines and other health information systems. This involves the representation of the generic content of guideline documents (for example, the content of the basic part of a guideline, the "recommendation").

The document act ontology has been imported in its entirety into C2PO and extended for the purpose of representing document acts related to guideline authorship, management, and certification. In the following paragraph the entities represented in d-acts are applied in a guideline-related example.

Guidelines in general are instances of *directive information content entities* (http://purl.obolibrary.org/obo/IAO_0000033).[2] This class is imported to C2PO from IAO. A guideline is the specified input to the document act of certifying or sanctioning the use of the aforementioned guideline. The group authoring the guideline is the bearer of the document act template creator role. The entity certifying or sanctioning a specific guideline is the bearer of the declaration performer role. If, for example, the responsible committee in a hospital sanctions the use of a specific guideline, this document act creates an obligation for all medical personnel in the hospital to follow this guideline in the cases covered by it. Thus, the medical professionals are the declaration target since they are the bearers of the concretization of the obligation; however, it is important to note that along with the obligation mentioned above, a claim is created: the claim of a patient with the condition, which is targeted by the guideline. She is to be treated in accordance with said guideline; therefore, this patient is also a declaration target of the docu-

[1] RetrievedFebruary 5, 2012, from http://code.google.com/p/c2po/
[2] Retrieved October 22, 2012, from http://purl.obolibrary.com/obo/iao.owl

ment act in question. Notably, claims and obligations often come into existence simultaneously and are mutually dependent. For example, a physician performing a treatment according to the clinical guidelines under the obligation created by his hospital would thus realize his role as an obligator in that respect. The latter role is the concretization of the obligation mentioned above.

However, there are cases in which a guideline does not only create new obligations, but also creates two alternative relations between a specific guideline and a specific obligation. 1) Sanctioning a guideline can revoke existing obligations based on standard treatment or previously established protocols. 2) Sanctioning a guideline can transfer the obligation to perform a specific procedure from one department of the hospital to another.

In addition, within the scope of C2PO we find examples in which document acts give rise to new document acts, for instance in the case of drug orders being filled in based on guidelines or specific treatment protocols created as a result of guidelines.

Summary and Conclusions

We present document act ontology (d-acts) and demonstrate its possible usage for annotating data in the healthcare domain. The basis of our approach is ontological literature regarding social acts and legal entities. In order to provide a state-of-the-art implementation we choose to follow criteria for developing a formal ontology proposed by the OBO Foundry. By creating an OWL implementation, we allow systems developers to use our ontology as a consistent basis that supports reasoning over data representing document acts, the different roles and participants involved, and the socio-legal entities they bring about.

As mentioned above, we can see from the formal ontology perspective that further development is required regarding the nature of socio-legal entities.

The initial version of d-acts does not take into account the impact of singular statements within a guideline and how these statements affect actions based on the obligation created through sanctioning the guideline. These issues need to be tackled, and we assume that in order to achieve this, IAO needs to represent statements or propositions instead of just representing documents as a whole.

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References

Austin, J. L. (1975). *How to Do Things with Words*, 2nd ed., Cambridge/ Mass.: Harvard University Press (1st ed. Oxford: Clarendon, 1962).

Courtot, M., Gibson, F., Lister, A., Malone, J., Schober, D., Brinkman, R., & Ruttenberg, A. (2009). "MIREOT: the Minimum Information to Reference an External Ontology Term", available from *Nature Precedings* http://hdl.handle.net/10101/npre.2009.3574.1

Johansson, I. (1989) *Ontological Investigations: An Inquiry into the Categories of Nature, Man and Society*, London, New York: Routledge.

Johansson, I. (2008) "How Philosophy and Science May Interact: A Case Study of Works by John Searle and Hernando de Soto", in B. Smith, D. M. Mark & I. Ehrlich (eds.), *The Mystery of Capital and the Construction of Social Reality*, Chicago: Open Court Publishing Company, 79–96.

Mulligan, K., & Smith, B. (1986). "A Relational Theory of the Act", *Topoi*, 5:115–30.

Paulson S. L. (1987). "Demystifying Reinach's Legal Theory", in K. Mulligan (ed.), *Speech Act and Sachverhalt,* Dordrecht: Martinus Nijhoff, 133–154.

Reinach, A. (1989). *Sämtliche Werke. Texkritische Ausgabe*, edited by K. Schuhmann and B. Smith, München: Philosophia Verlag.

Reinach, A. (2012). *The Apriori Foundations of the Civil Law*. edited by J. F. Crosby, Frankfurt: ontos Verlag.

Smith, B. (1993). "An Essay on Material Necessity", *Canadian Journal of Philosophy, Supplementary Volume*, 18: 301–322.

Smith, B. (2008). "Searle and de Soto: The new ontology of the social world", in B. Smith, D. M. Mark & I. Ehrlich (eds.), *The Mystery of Capital and the Construction of Social Reality*, Chicago: Open Court Publishing Company, 35–52.

Smith, B. (2012). "How to Do Things With Documents", *Rivista di estetica*, 50 (2/2012), LII: 179–198.

Smith, B., Ashburner, M., Rosse, C., Bard, J., Bug, W., Ceusters, W., et al. (2007). "The OBO Foundry: Coordinated Evolution of Ontologies to Support Biomedical Data Integration", available from *Nature Biotechnology* http://www.nature.com/nbt/journal/v25/n11/, March.

Spear, A. D. (2006). *Ontology for the Twenty First Century: An Introduction with Recommendations*, available from http://ifomis.org/bfo/manual.pdf

SUO WG (Standard Upper Ontology Working Group) (2003). *IEEE P1600.1, Standard Upper Ontology Working Group (SUO WG) Home Page*. available from http://suo.ieee.org/index.html

W3 Consortium (2004). *Web Ontology Language Recommendation*, available from http://www.w3.org/TR/owl-features/