

Towards an Ontology of Document Acts: Introducing a Document Act Template for Healthcare

Mauricio B. Almeida¹, Laura Slaughter^{2,3}, and Mathias Brochhausen⁴

¹ Department of Information Theory and Management,
Federal University of Minas Gerais, Brazil
mba@eci.ufmg.br

² Department of Computer and Information Science, NTNU, Trondheim, Norway

³ The Interventional Centre, Oslo University Hospital, Oslo, Norway
laura.slaughter@gmail.com

⁴ Division of Biomedical Informatics, University of Arkansas for Medical Sciences,
Little Rock, AR, USA
MBrochhausen@uams.edu

Abstract. Background: In current information systems the pervasive role of documents and their ability of creating new entities are often overlooked. Regularly, documents are stored as mere files without analysis of their deontic powers. In order to make intelligent management of documents a real possibility, we propose an ontological representation of document acts. Objectives: This article summarizes first steps towards a sound ontological representation of documents in healthcare organizations by providing a template structure for documents acts. Methods: We rely on the theory of document acts to develop such a template for defining pragmatic aspects of documents and to provide examples of the application in healthcare procedures. Furthermore, we show how this research contributes for the development of an OWL representation of document acts. Results: We provide a template for document acts and show its usage in clinical guidelines. Conclusion: While the definition of pragmatic aspects contributes to a clearer representation of documents acts in the healthcare domain, further development needs to be carried out regarding representation of document acts in ontologies.

Keywords: ontologies, documents, document acts.

1 Introduction

Documents are valuable entities for different sorts of organizations, working as end-points of information flows. A wide variety of documents are used in a multitude of fields of human activity, which adds to the complexity of the task and makes systematic approaches necessary. Looking at examples from medical standards, e.g. HL 7, one can see the multiplicity of documents required to carry out an ordinary activity in healthcare organizations. In the case of blood donation looking at HL7 Version 3 we find documents primarily serving the function of recording data, for instance donor

questionnaires, lab results and donation event information [3]. Some documents, though, are bearers of additional properties. They give rise to new sorts of claims and obligations. For instance, in case of a blood donation order or a blood donation consent form [3].

We argue that information systems employed in healthcare organizations can take advantage of an appropriate characterization and formalization of documents, as well as both the actions they trigger and the states of affair they bring about. To achieve this aim, we present a template grounded on well-founded theories, which can be used as a guide for distinguishing types of documents in formal ontologies. In doing so, we rely on speech act[1] and document act theory [13] to explain the social consequences of documents. In addition, we adapt a framework for formalization [11] to determine the purpose of documents in a certain context. We look at a use case that stems from an ongoing project being conducted in healthcare organizations, dealing with medical guidelines to check generalizability. We explain how this research contributes to the development of an OWL representation of documents and document acts.

In this paper, we first describe theories to manage the complex phenomena arising from the usage of documents in everyday life focusing on healthcare organization environments. Then, we present a case study on which we develop a template for pragmatic characterization of documents present in medical institutions. We validate that step by proofing the applicability of the template for another aspect of healthcare. Finally, we discuss our findings and present the basis for the future development of an ontological representation of document acts in OWL.

2 Deontic Powers of Documents

The basis of document act theory is the recognition, which arose in 20th century philosophy of language, that we can use language to do other things beyond merely describing reality. This recognition led to the development of speech act theory [1, 10]. Austin states that some sentences, instead of describing something in the world, are enabling something to get done. They are performances of acts of certain kinds. These sentences are named performatives, by contrast with sentences in which something true or false is being stated, which are called constantives. Furthermore, speech acts theory establishes that, in any ordinary language, a speaker performs acts of three different kinds: locutionary acts, in which, more than merely uttering sounds, one is speaking the words with the meaning they really have; illocutionary acts, in which one is using the words in order to ask a question, give an order, make a promise, and so forth; and perlocutionary acts, used to convince someone to do something [1].

Important language features depend on the illocutionary acts being performed, rather than on the meaning of words and sentences [5]. Examples of ability of speech acts to bring about new entities are obligations and claims to which promises and orders give rise. The general speech acts theory was consolidated into a theoretical framework [9], in which the dimensions of utterance, meaning and action could be seen as being unified together.

Just as speech enables speech acts, documents can be more than just reports. They can spawn new entities in reality [13]. Searle [10] refers to the ability of documents to add something to reality as their *deontic power*. Smith [13] points out that according shifting from speech acts to document acts extends the purposes achievable by social action. Speech acts are events existing only in their execution and have a limited temporal and spatial reach, while document acts involve documents which endure through time. It is through documents that document acts do not underlie the temporal and spatial restrictions as speech acts.

3 Creating a Document Template

Within the healthcare segment, documents carry extensive economic, legal and medical entailments. Medical documents are complex instances employed for several purposes in healthcare processes and used to: to support patient care, to fulfill external obligations, to support administration, to support quality management, to support scientific research and to support clinical education.

Nevertheless, means to characterize documents regarding their *deontic powers* in medical organizations have not yet been implemented. In order to overcome this, we propose a template that is the result of an analysis of documents and document act in the process of using medical guidelines.

3.1 The Template

The first step in developing a template consists in selecting documents and characterize them according to three components based on Searle's theory of social action: the context, the content and the force [10]. The following paragraphs elucidates each of these components, according [11]:

Context concerns conditions of the world in which a document act is manifested. In order to characterize the context of a document, at a minimum the following questions should be considered: Who issues the document? Who receives the document? What is pertinent concerning the temporal and geographical aspects? Other contextual features that contribute to the success of the document act are gathered under the label contributory features.

Content consists of the proposition underlying the document act, that is, the common element that characterizes the effect of that document, independently of the form in which this element is presented.

Force aims to determine the commitments, that is, the organizational relationships established and the way in which the content is related to the institutions' environment. Searle and Vanderveken [11] give the following sub-components to specify the force of document acts:

- **Point** represents the purpose of a document act, namely, whether it is an assertive, a commissive, a directive, a declarative, or an expressive. An assertive point tells how the world is, for example, in predicting. A commissive point commits one to doing something, for example, promising. A directive point tries to get the receiver

- to do things, for example, ordering. A declarative point changes the world, for example, declaring. An expressive point expresses attitudes, for example, apologizing.
- **Degree** corresponds to the strength of a point, which is defined according to a taxonomy[11]. For example, assertives can be identified by the sequence of verbs: assert, claim, state, deny, argue, inform, suggest, to mention but a few. The verb “assert” produces an assertive stronger than the verb “suggest”. Other sequences of verbs are organized in a similar fashion for commissives (e.g., commit, consent, etc.), directives (direct, recommend, etc.), declaratives (declare, endorse, etc.) and expressives (complain, protest, etc.).
 - **Content conditions** are conditions required by the propositional content so a document act can be achieved. For example, invoicing can only refer to payments and not to salaries.
 - **Preparatory conditions** are states of affairs that an entity must address for the success of the document act. For example, in placing an order the buyer presupposes that the supplier still sells those products.

Once presented the basic issues, we summarize the elements for the characterization into a template where some additional details and examples are added (Table 1):

Table 1. Template for the characterization of documents

Step	How to execute
Selecting document bearers of document-acts	Identify actions triggered by the document in its official usages Identify economic entities
Describing the context	Identify who issues and who receives the document Identify what are the related temporal and geographical aspects
Defining the content	Identify the underlying proposition of the document
Assigning the point	Identify the point according to the content defined. The point can be: an assertive, a commissive, a directive, a declarative, an expressive.
Assigning the degree	Identify the degree according to the point defined (ascending order): <ul style="list-style-type: none"> ▪ Assertives: assert > claim > state > assure > argue > inform > ... ▪ Commissives: commit > promise > threaten > refuse > offer ... ▪ Directives: direct > request > demand > advice > recommend ... ▪ Declaratives: declare > resign > appoint > approve > endorse > ... ▪ Expressives: apologize > thank > complain > protest > greet ...
Assessing content conditions	Identify premises that assure the point and degree feasibility.
Assessing preparatory conditions	Identify premises that assure the success of the point and degree.

3.2 Applying the Template

A template based on the aforementioned guidelines was applied to instances of documents pertaining to the scope of healthcare institutions. From the Evicare Project¹, a medical guideline was used to test the template. The results are depicted in Table 2. With these documents a receiver chooses to act (give a specific treatment) or not to act (does not act according to the original plan) after reading the contents stated as part of guideline recommendations. The force “degree” of these documents can be either “advice” or “recommendation”.

¹ <http://www.evicare.no/>

Table 2. Template applied to a medical guideline

Context	Who issues	Guideline authoring panel
	Who receives	Physician
	Temporal aspect	Occasional, intermittent use during patient encounter
	Local aspect	In hospital, clinic or private practice within the area of application of the guideline authoring panel
	Contributory features	-Purpose: inform physicians of what a panel recommends they do based on evidence -Institutional system involved: healthcare -Possible actions: read, follow recommendations -Role of the agents: physician role
Content	x provides medical services in accordance with the guidelines to patient y	
Force	Point	Directive
	Degree	Advice, Recommend
	Content conditions	The healthcare institution agrees that the guidelines are authoritative, up to date, and can be used by physicians that work
	Preparatory conditions	The physician can understand and carry out the recommendations in the guidelines.

4 Discussion and Future work

Above we demonstrated an application of Searle's work to create a comprehensive and consistent representation of document acts in the healthcare domain. However, the steps presented are merely preparatory to the final goal of providing an ontology of document acts in Web Ontology Language Version 2 (OWL 2) [8]. We argue that in order to achieve that goal, beyond the initial steps based on Searle's work, we really need to engage in in-depth ontological analysis of social action. Smith [14] argues that Searle's position, which restricts social ontology to elements reducible to physical entities, is lacking an analysis for the most central features of the social world: quasi-abstract entities that lie outside the world of physics, but are indeed fully part of the historical world [14].

Therefore, in creating the OWL representation of document acts we will base our efforts on Smith's proposal [14] to use Adolf Reinach's social ontology [9] as the foundation. This bases the existence of social entities on declarations which can be made portable and pertinent through time and space in documents. We hold that the key entities in a formal ontology of document acts based on Reinach are claims and obligations. Thus, the ontological status of these is a key issue that needs to be resolved.

The OWL implementation of our document act ontology which is still under development follows the OBO Foundry criteria [7]². The ontology is based on Basic Formal Ontology (BFO) [2] and re-uses existing ontologies in the domain. Foremost, we imported classes from Information Artifact Ontology (IAO) [5], for instance *document* (http://purl.obolibrary.org/obo/IAO_0000310). With regard to the ontological status of claims and obligations, which are of crucial importance to document act

² For now the criterion of the ontology being publicly available is not fulfilled due to the fact that the size and stability of the OWL file is below initial release.

ontology, we agree with Smith [13] that both are instances of generically dependent continuants. However, the axiomatization of *document act* in OWL 2 based on these elements has proven to be the hard nut.

We expect to make continuing progress regarding the OWL implementation. Once this is achieved we aim for a complete coverage of the elements of the template, thus binding Searle's naturalist social ontology to a theory that allows for quasi-abstract entities.

An OWL implementation will allow not only capturing the subtleties of document act theory, but enable reasoning data annotated with terms from the template or the ontology. This will create the opportunity to reason over claims and obligations created and acted upon in healthcare, for instance in the case of checking the impact of clinical guidelines or ensuring the legality of blood specimens.

Acknowledgements. This work is partially supported by the Arkansas Biosciences Institute, the major research component of the Arkansas Tobacco Settlement Proceeds Act of 2000 and by award number 1UL1RR029884 from the National Center for Research Resources. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Center for Research Resources or the National Institutes of Health. Thanks are due to the Ontology Research Group team from the New York State University at Buffalo, US and to William R. Hogan, Division of Biomedical Informatics, UAMS, Little Rock, US.

References

1. Austin, J.L.: How to do things with words. Oxford University Press, Oxford (1962)
2. Basic Formal Ontology, <http://www.ifomis.org/bfo> (retrieved May 24, 2012)
3. HL7 Version 3 Standard: Blood, Tissue, Organ; Donation, Release 1, Committee Ballot 2 (January 2008), <http://www.hl7.org> (retrieved September 04, 2010)
4. Information Artifact Ontology, <http://purl.obolibrary.org/obo/iao.owl> (retrieved May 24, 2012)
5. Morris, M.: An Introduction to the Philosophy of Language. Cambridge Press, Cambridge (2005)
6. OBO Foundry Principles, <http://obofoundry.org/crit.shtml> (retrieved May 24, 2012)
7. OWL 2 Web Ontology Language. Overview, <http://www.w3.org/TR/owl2-overview> (retrieved May 24, 2012)
8. Reinach, A.: Sämtliche Werke. Textkritische Ausgabe in 2 Bänden, Smith, S.K. (ed.) Philosophia Verlag, München (1989)
9. Searle, J.: Expression and Meaning: Studies in the Theory of Speech Acts. Cambridge Press, Cambridge (1985)
10. Searle, J.: The Construction of Social Reality. Free Press, New York (1995)
11. Searle, J., Vanderveken, D.: Foundations of Illocutionary Logic. Cambridge Press, Cambridge (1985)
12. Smith, B.: An Essay on Material Necessity. In: Hanson, P., Hunter, B. (eds.) Return of the A Priori (Canadian Journal of Philosophy, Supplementary Volume 18), pp. 301–322 (1993)
13. Smith, B.: Document Acts, <http://ontology.buffalo.edu/smith/articles/DocumentActs.pdf> (retrieved July 02, 2010)