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Actions in Health Care Organizations: An Ontological Analysis

Lowell Vizenor

Institute for Formal Ontology and Medical Information Science, University of Leipzig Germany and Department of Philosophy, University at Buffalo, USA

Abstract

In order to ensure that the information and knowledge needed for the management of healthcare is appropriately shared, human behavior within health care organizations (HCOs) needs to be carefully analyzed. Hence, guidelines, protocols, and messaging standards must be combined with models of resources and processes of patient care that are based on a sound ontology of organizations. This requires a general theory of the ontology of social institutions. Among the many groups attempting to develop efficient ways of sharing information across healthcare systems and organizations is Health Level 7 (HL7). Here I address the question whether HL7 reflects a sound analysis of behavior within HCOs on the basis of a sound ontology of organizations. I then apply ontological principles designed to show how the Reference Information Model (RIM) might be modified in such a way as to support efficient communication of medical information within and between healthcare organizations.

Keywords: Ontology, Speech Acts, HL7 RIM, Electronic Health Record

Introduction

There are many efforts underway to develop efficient ways of sharing information across healthcare systems and organizations. One prominent effort is that of the Health Level 7 (HL7). HL7 does not focus exclusively on the requirements of one area of healthcare such as pharmacy, medical devices, imaging or insurance (claims processing) transactions, but extends its remit to the interface requirements of the entire healthcare system. This has inspired the development of a powerful abstract model of healthcare called the Reference Information Model (RIM).

In order to develop guidelines for the management of information and knowledge within HCOs we need a careful analysis of human behavior within HCOs. Hence guidelines, protocols and messaging standards must be combined with representations of resources and processes of patient care that are based on a sound ontology of organizations. This will in turn require a general ontology of social institutions. The present paper outlines the basis of such an organizational ontology, starting with the theory of speech acts. It then applies this ontology to the HL7 RIM, drawing conclusions for the efficient communication and management of medical information and knowledge within and between healthcare organizations, paying special attention to the role that medical documents play in organizational reality.

The Ontology of Health Care Organizations

An HCO is a structure that is created and maintained through the actions of the participants involved and designed to support the over arching goal of patient care. In order to appreciate how human actions can provide the ontological glue that binds organizations together we need to shed light on some features of social reality that often go unnoticed. The neglect of these features, though, is no small matter. Polanyi recognized an important distinction between *explicit* knowledge and *tacit* knowledge [1]. Explicit knowledge typically comes in the form of propositions and as such is relatively easy to translate into a language that a computer can read. Tacit knowledge, on the other hand, involves *knowing how* to do something and is much more difficult to put into a form that a computer can understand without a considerable loss of information. The difficulty of extracting and eliciting tacit knowledge is due in part to what has been called the *knowledge engineering paradox*. The more expertise one has, the more tacit the knowledge and so the harder it is to extract this knowledge for purposes of formalization in a knowledge repository. There exists, then, a definite need to pay closer attention to the ways that agents interact, pick-up and share information and knowledge within an HCO. An ontology of organizations that is maximally representative of organizational reality is an essential tool for those attempting to develop standards and guidelines for interoperability between healthcare information services.

Speech Acts in HCOs: The Case of the Promise

Philosophers have since Aristotle focused primarily on one sort of language use, statements. Austin [2] and Searle [3] saw that what we can do with words goes beyond simply stating facts about the world. We can make requests, ask questions, give orders, make promises, give thanks, offer apologies, and so on, all of which are uses of language that go beyond the statement-making sort and are such that the corresponding utterance

brings about some result in reality. A sound ontological analysis of HCOs should not only identify the sorts of speech acts that are common to HCOs, it should also identify the sorts of entities that are brought into being by speech acts as well as the specific types of *context* in which those speech acts occur. A systematic account of all the sorts of speech acts found in HCOs would be beyond the scope of this paper. Our analysis of speech acts will begin, instead, with a discussion of one central example, namely the promise.

One of the salient features of speech acts in general and of promises in particular is that they are social acts and as such involve at least two people. Speech acts are for this reason opposed to (intentional) solitary acts such as the rehearsal of a difficult medical procedure in ones head. Every promise involves two parties: the *promiser* and the *promisee*. In the simplest cases of promising, one person makes a promise to another. In more complex cases, a group of individuals may play the role of promiser or promisee. For example, a physician might make a promise to a patient's family, or a group of physicians might make a promise to an individual patient or, even, the patient's family. We will restrict our discussion, though, to the simple cases of promising.

In order for a successful issuance of a promise to occur four *core* conditions must be satisfied. First, the promiser must make an outward expression that can be recognized as a promise by others, most of the time this simply involves an utterance to the effect 'I promise to do F'. Second, the promiser must have the appropriate intentional content, i.e., the intention to do F. It is not enough to simply utter the words, the utterance must also indicate a genuine intention on the part of the promiser to do F; otherwise, it is a sham promise. Third, the utterance is in need of what Austin termed uptake [2]. The promisee must register the outward expression, e.g. the utterance, as a promise. Fourth, the promisee must consent to the promiser doing F; otherwise the act might be construed as a threat.

In addition to these four core conditions, there are some additional background conditions that are especially important to an understanding of speech acts within the context of HCOs. In some cases the promiser must have the *authority* to promise to do F. Likewise the promisee must have the authority to accept or decline F. For instance, only some healthcare personnel have the authority to promise a patient a certain medical procedure, likewise only under certain circumstances does the guardian of a patient have the authority to grant permission for a medical procedure or treatment. Another condition is that there should exist no previous commitments on the part of the promiser or the promisee that would *vitiate* the promise. For example, a previous promise to perform a medical procedure can vitiate a subsequent promise to perform some other medical service at that time. And finally, there must be a general background of trust for the promise to hold. Without this the entire social practice of making promises would not work. If all these conditions are met, then the promise gives rise to successor states: an *obligation* on the part of the promiser and to an exactly corresponding *claim* on the part of the promisee. Promises are also associated with a tendency to be realized, which means that a promise is not merely directed to a future action F but that it is bound up with a chain of physical processes ensuing from it.

This brief discussion of promises, based on [4], already makes explicit many of the sorts of entities that are involved in knitting together that complex whole that is an HCO: the participants of speech acts, the speech acts themselves, the relations between participants, the speech acts and their relations of authority, entities such as obligations and claims, and the relation to physical processes and to future states of affairs. This account would still not be complete without an account of the modifications of speech acts such as sham assertions (e.g. forged signatures), speech acts performed in someone else's name (e.g. representation, delegation), speech acts with multiple addresses and even conditional speech acts.

Institutional Facts

Searle distinguishes between brute facts and institutional facts [3, 5]. Brute facts exist independently of any human institutions. It is a brute fact, for example, that a certain patient's temperature is 99.8 degrees. The statement that the patient's temperature is 99.8 degrees requires the institution of language and an institution of measuring temperature in degrees, but the *fact stated*, that the patient has a certain temperature, exists independently of any institution [5, p.27]. Institutional facts, on the other hand, require special human institutions for their very existence. It is an institutional fact, for example, that a given person is a physician, since it is only within the context of certain institutions that a persons counts as a physician.

Searle introduces a distinction between two kinds of rules in order to understand the nature of these institutions [3, 5]. *Regulative* rules, as the name suggests, merely regulate antecedently existing forms of behavior such as rules of polite table behavior regulate the activity of eating. *Constitutive* rules, in contrast, do not merely regulate; they also create or define new forms of behavior. The rules of chess, for instance, create the very possibility of our engaging in the type of activity we call playing chess. Constitutive rules have the basic form:

X counts as Y in context C.

The full significance of the formula as analytic tool for understanding the ontology of HCOs requires further understanding how humans impose functions on phenomena where the function cannot be achieved solely in virtue of physics and chemistry but requires continued human cooperation in specific forms of recognition, acceptance, and acknowledgement of a new status in order for the function to be realized [5]. Searle labels these *status functions*. Consider the difference between a scalpel and a medical prescription. A scalpel can perform its function of making precise incisions simply in virtue of its physical nature (the sharpness of the blade). The same cannot be said of a prescription. A prescription viewed purely physically is just a piece of paper with ink marks on it. Viewed institutionally it is much more. For one, the prescription provides the holder with the *power* to purchase certain medical substances. Clearly this goes beyond the purely physical powers of paper and ink. The reason for this is that humans have the capacity to impose status functions upon entities that they would not otherwise have. In such cases, they have these powers in certain contexts were the appropriate constitutive rules obtain.

The imposition of status functions on physical entities—which is a speech act—is important to understanding how human actions can create, maintain, and alter the structure of an HCO. By acting in accordance with constitutive rules we are able to impose certain rights, duties, obligations on our fellow human beings and on the reality around us. Offices, positions, roles, prescriptions, orders, and so on, are all institutional objects that can only realize their function because humans collectively treat these objects in ways that these objects could not perform exclusively in virtue of their physical properties.

Some Formal Ontological Distinctions

A number of formal ontological distinctions are important for an understanding of the ontology of organizations [6]. First, there exists a distinction between *continuants* and *occurrents*. Continuants are entities which continue to exist through time: they preserve their identity from one moment to the next even while undergoing a variety of different sorts of changes. The principal mark of a continuant is that, if it exists *at* a time, then so also do all of its parts. Examples include healthcare personnel, medical supplies, and contexts, e.g. specific wards in a hospital. Occurrents (also called events, activities, processes) are in contrast never such as to exist in full in any single instant of time; rather, they are such as to unfold themselves in their successive phases, in the way in which, for example, the performance of a medical procedure unfolds itself through time. Occurrents characteristically have a beginning, a middle and an end. In contrast to continuants, occurrents are such that their parts are never present at a single time. Examples include the circulation of blood or the course of a disease, collective actions such as surgery, and institutional acts such as making contracts. The relation between continuants and occurrents is important to the ontology of HCOs, which involve both at a multiplicity of levels. Healthcare personnel (continuants) consume, make contracts and requests that bring about a changes in the states of affairs of an HCO; they are involved with patients (a second group of continuants) in yet further speech acts and also in the physical processes associated therewith.

Second, there exists a distinction between *independent* and *dependent* entities. Independent entities (e.g. humans, surgical equipment, the buildings that house healthcare activities, etc.) have an inherent ability to exist without the support from other entities. Dependent entities, in contrast, require the support of other entities in order to exist. Third, there exists a distinction between institutional entities that coincide with some portion of physical reality and those that do not [7, 8]. The former include such entities as physicians, patients, medical documents and so on. The latter include relations of authority, obligations, claims and so on. To understand this, consider a promise. The physical act of uttering (the X term in the corresponding constitutive rule) counts as a promise (the Y term) in a certain context C. The act of promising coincides with the physical event, the utterance. But once the promise is successful there arises a corresponding obligation and claim. At this point there exists no portion of physical reality with which the successor states can be said to coincide. In virtue of what, then, do these entities exist? The answer is: records. In informal situations, the memories of the participants are often enough, but in formal, legal situations records, whether paper based or electronic, are that which sustain in existence the non-physical relations, claims, obligations, relations of authority, and so forth which glue an HCO together.

Speech acts, which are themselves events, are a major source of organizational change. The ontology of HCOs, then, needs to distinguish between organizational continuants and organizational occurrents. Organizational continuants can be divided further into those that exist independently of human contexts and those that exist in virtue of them. The former entities include humans, buildings and bodily organs. The latter include those entities such as doctors and clinical wards that coincide with physical objects or events and provide the scaffolding which supports those abstract entities that bind together an organization – entities which are do not coincide with any portion of physical reality, but are still tied to contexts of human behavior. This non-physical (institutional) superstructure of the HCO includes all those entities that exist as consequences of speech acts and documents: offices, roles, licenses, prohibitions, rights, laws, and debts as well as the successor states of speech acts that depend on documents for their continued existence, such as obligations and claims. The ontology of continuants in an HCO reflects a similar division between physical processes on the one hand (including processes of speaking and hearing, but also clinical and disease processes) and institutional processes (including the speech acts that are prevalent in HCOs and their institutional consequences).

The HL7 RIM from an Ontological Point of View

The purpose of this discussion is to show how certain important ontological distinctions are blurred in the HL7 RIM and, more specifically, how this failure obscures the important ontological role that documents play in HCOs in sustaining the existence of such abstract entities as obligations and claims—the ontological glue of organizations.

The "Backbone" Classes of the RIM

The RIM consists of six "back-bone" classes: Act, Entity, Role, Participation, ActRelationship, RoleLink [9, A.1.5]. The *Act class* comprehends all intentional actions documented by a healthcare professional in either a clinical or administrative context that has happened, can happen, is happening, is intended to happen, or is requested/demanded to happen. The *Entity class* includes those sorts of physical things or groups of physical things which can participate in an action as perpetrator, target or beneficiary such as people, organizations, medical tools and supplies, etc. (On the surface, these two classes appear to parallel our distinction between occurrents and continuants, but on closer examination this turns out not to be the case.) In the RIM, an entity which participates in an act must do so in a particular *Role*. The Role defines the entity's competency (which actions it can perform) and constraints (which actions it cannot perform).

Whereas a role may be said to delimit the possible actions that an entity may perform, the *Participation class* associates entities-in-a-role with specific acts in which they are involved.

Participation, then, is limited to a particular Act, as opposed to Role, which defines the competency of an entity irrespective of any particular act. The *RoleLink class* defines connections between roles. For example, The RIM links the roles of 'patient' and 'provider' to one another, since there exists a dependency between those roles. And just as roles are related to one another, so too are Acts. An *ActRelationship* is an association between a pair of acts. Sometimes an ActRelationship represents a relationship between two distinct acts such as an order to make some observation and the observation event that occurs in response to this order. In other cases, the ActRelationship represents the relations between within an act. Acts can be decomposed into further sub-acts and the ActRelationship class is designed to capture these relations as well.

The Act-Centered View of Healthcare

In the healthcare field there exists an abundance of acts performed by humans: a clinical observation, an assessment of a health condition, treatment services (such as medication, surgery, and psychological therapy), assisting, monitoring or attending, training and education services to patients and their next of kin, notary services (such as the formation of advanced directives or living wills), editing and maintaining documents, and many others. Some of these such as the formation of advanced directives are what we have referred to as speech acts, others such as treatment services are not.

The concept of *act* plays a central role in the HL7 RIM, since all information and processes in the healthcare domain are represented primarily in terms of the acts performed within an organizational context. The authors of the HL7 RIM defend an act-centered view of healthcare with the argument that any profession or business, including healthcare, primarily consists of a series of *attributable, intentional* actions, performed and recorded by responsible actors. It is easy to see how healthcare may be said to consist largely of intentional or purposeful actions. It is less clear, though, by what is meant by 'attributable'. At one level of representation, we might wish to represent the intentional actions performed by the participants in an HCO. At another level of representation, we might wish to represent not the actual intentional acts but what has been said or reported about them. It is this second level of representation that the authors of the HL7 RIM argue is the proper level of representing HCOs. In effect, then, what the authors of the RIM claim is that the proper level for modeling healthcare is not at the level of what *is* the case, but what is *said* to be the case.

The author's of the HL7 RIM take the act-centered view of healthcare and extend it to medical records. Medical records consists of what clinicians have said about what they have heard, seen, thought and done and do not directly document what actually occurs in a given situation; instead inferences must be made about what was "true" on the basis of these observations. The truth of the real world then is constructed through a combination (and arbitration) of such attributed statements only, and there is no class in the RIM whose objects represent "objective states of affairs" or "real processes" independent of attributed statements [3.1.1]. No direct reference is made to natural events such as a patient's heartbeat, since every act must be an act that can be attributed to someone. Thus a patient's heartbeat may be recorded as observed, but there is no record of the event itself; there is, however, a record of the observation by, say, a physician.

Criticisms

Several criticisms can be offered up against the act-centered view of healthcare forwarded by the authors of the HL7 RIM.

Criticism 1: Speech acts are not attributed acts. The Act-class extends beyond attributed factual statements to embrace the full range of speech acts: "Act as statement or speech-act are the only representation of real world facts or processes in the HL7 RIM" [3.1.1]. The inclusion of speech acts into the HL7 RIM is understandable, since speech acts, unlike factual statements, stand in systematic relations not only to other acts, but also relate in specific ways to the *roles* and *relations of authority* that participants have in HCOs. For example, the simple act of *observing* a resident *attend* to a patient is not linked to any other acts in the same specific way that, say, the act of *ordering* a blood test is linked to the act of *performing* the blood test. In the case of the latter, if the recipient of the blood test order understands the order, the recipient is obligated *ceteris paribus* to perform the test. No such obligation exists in the former case. A speech act, though, is not a representation of a real world event—it *is* a real world event. Speech acts bring about some result in the world. Reports about speech acts, in contrast, do not. So, either the HL7 RIM makes references to real world facts and processes, in which case all the talk about attributed acts is misleading, or it does not make any such reference, in which case the Act class does not embrace speech acts.

Criticism 2: The RIM does not track the distinction between continuants and occurrents. According to the HL7 RIM a 'collection of information' (e.g. a medical record) is not an instance or a subclass of Entity, but is instead considered a collection of attributed Acts [(1.3)]. Elsewhere the RIM lists several characteristics of a clinical document: (1) persistence – a clinical document continues to exist in an unaltered state, for a time period defined by local and regulatory requirements; (2) Stewardship – a clinical document is maintained by a person or organization entrusted with its care [See 3.1.1.1 ActClass]. This is ontologically confused: First, persistence is a characteristic of continuants and not of acts. A clinical document exists *in total* at a given time, it does not unfold through successive stages over time. Second, a person cannot maintain a collection of attributed acts in any way one might be said to maintain a document. This is important, since attributed acts cannot be filled, stored, updated and so on, all of which are things that can be true of documents. Documents, on the other hand, serve as traces or records of past acts. The failure to distinguish between acts (occurrents) on the one hand and documents (continuants) on the other reveals that the RIM does not track the distinction between continuants and occurrents. As a result the information that comes with the tracking this distinction is lost.

Criticism 3: The RIM needs a more principled account of actions. Consider the case of contracts. According to the RIM a contract is an act and is defined as follows: an agreement of obligation between two or more parties that is subject to

contractual law and enforcement. Our previous ontological analysis of speech acts reveals that several important distinctions are overlooked here. First, there is the complex speech act (an occurrent) that brings about the contract. Second, there is the obligation between parties (continuants), and the document (a physical entity) that records the existence of the obligation. These distinctions are important to track, since speech acts, their successor states, and the documents that record their existence all, so to speak, behave differently from one another.

In order to understand the relation between a speech act and the associated future action or state of affairs to which it is directed, it is important to understand the structure of the speech act (this is something that certain instances of the ActRelationship is intended to capture). It is only if the structure of the speech act in question is understood that one will be able to see how modifications to different aspects of that structure will be associated with different future actions and states of affairs respectively. So long as the HL7 RIM does not have an adequate ontology of speech acts and HCOs its attempts to model the relations between speech acts will fall sort of being systematic, since it lacks any principled way of treating this acts.

Conclusion

Researchers in medical informatics recognize the importance of developing health information systems that are sensitive to the way intentional agents interact not only with one another but also with their surroundings [10, 11, 12]. There exists a definite need, then, to pay closer attention to the tacit dimension of knowledge, the way humans interact, pick-up and share information and knowledge in HCOs. In turn, traditional approaches to knowledge management, i.e. knowledge acquisition, representation, and transfer, need to be combined with an ontology of HCOs that is maximally representative of organizational reality. The ontology of HCOs can map out those provinces of the reality of HCOs which are a part of physical reality and those which exist because and to the extent that there are documents to sustain their existence. Likewise, it can provide principled ways for recognizing those entities such as doctors and clinical wards that coincide with physical objects or events and provide the scaffolding which supports those abstract entities that are brought into existence by the appropriate speech and bind together an organization—entities which not do not correspond to any portion of physical reality, but are still tied to contexts of human behavior.

Attempts such the HL7 will be greatly improved if more effort is brought to bear on understanding the ontological nature of healthcare organizations. The neglect of objective states of affairs and real processes, the failure to distinguish properly between acts and documents and more generally the neglect of the *context* within which messages are conveyed places obstacles in the way of an adequate ontology of healthcare organizations of the sort which is needed for effective knowledge management.

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Address for correspondence

Lowell Vizenor <lowell.vizenor@ifomis.uni-leipzig.de>, Institute for Formal Ontology and Medical Information Science (IFOMIS), University of Leipzig, Härtelstr. 16, 04107 Leipzig Germany. URL: http://infomis.de.