A Comparison of Roles in the General Formal Ontology and the HL7 Reference Information Model

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Introduction Medical information systems involve to a large extent social notions, in particular the various roles people play in health care situations. A good understanding of the notion of roles is required for large information models as well as for the integration of distinct systems. For this reason, a general account of roles [1, 2] has been developed in the context of the General Formal Ontology (GFO) [3]. GFO is a top-level ontology, i.e., its aim is to provide a profound model of the most general, domain-independent notions, among others the notion of "role". Linking to the medical domain, the impact of roles for medical data exchange is obvious from HL7 [4], whose reference information model (RIM) [5] contains "role" as one of its core components.

Our general analysis of roles reveals a number of distinctions which yield different interpretations of terms like "patient". This analysis comprises distinctions which have already become common in certain areas of computer science. One of these distinguishes roles and types, where roles are concepts mutually dependent with others whereas types are independent concepts, best understood by the intrinsic properties of an entity, cf. [6, 7]. However, recent developments uncover even more facets of interpreting role terms [1, 8]. In the light of these results, we study the relationship between our role model and roles in RIM. Accordingly, our aim here is twofold: on the one hand, we introduce top-level ontological distinctions for role terms for general consideration in modeling efforts. On the other hand, we evaluate the ease or severity of binding a health care information standard to a top-level ontology focusing on the role category.

Role Models in GFO and RIM The basic role model of GFO as introduced in [1] can be summarized as follows, depicted in figure 1. In general, each *role* requires a *role player* and a *context*. Considering the term patient, some human would be considered to be the player of that role, whereas the context may be provided by some relationship to an attending physician. All notions introduced so far come in an *individual* as well as a *universal* flavor, i.e., one may consider individual humans, patients, etc., as well as one can view these terms as concepts themselves. Note that the distinction between types and roles refers to concepts only, and the notion of types appears as *natural universal* in figure 1. Moreover, contexts are composed of further roles, *complementing* the role under consideration. Therefore, the understanding of some context and the understanding of its roles are highly interrelated, and top-level categories which apply to contexts can serve the classification of roles.

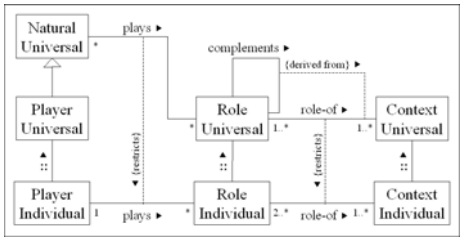

Fig. 0 Basic Role Model of the General Formal Ontology (GFO)

Classifying roles by means of top-level categories for contexts leads to at least *relational* and *processual roles*. For example, the relation "is-patient-of" can provide a context for the role term "patient". In contrast, some treatment (which is a process), is composed of various processual roles like one referring to the entity being treated, another to the treating entity. In the case of relational and processual roles, roles are used as an abstract means for viewing and referring to entities on the basis of some context.

There is yet another dimension which leads to a different notion of roles: this is to make a distinction between different aspects of entities, e.g., distinguishing between material, mental and social ones (cf. [9] which speaks of "ontological levels" in this regard). In particular, the notion of patient determined by features like a patient id, certain rights and by further relations and behavior such as receiving treatment refers to a *social role*. Still a social role fits the general role pattern. Regarding a player, there seems to be some human – seen as entity without social aspects – playing the patient role. With respect to the context, a certain society provides the context for that role. Compared to roles as means of abstraction, however, social roles much more appear like types, i.e., as entities with their own properties and behavior.

In summary, three aspects constitute the role model of GFO. Firstly, there is the general feature of roles to be mediating between entities and contexts. Then there are two major kinds of roles, the first being an abstract way of referring to entities in a context (relational and processual roles), the second being related to distinguishing certain aspects of entities, like the material or the social (social roles).

Next, let us briefly introduce the RIM notion of *Role* and its related classes [5], illustrated in figure 2. Here, *Role* together with *Participation* mediate between *Entity* and *Act*. Entity comprises physical things, organizations or places. The class Act represents records of intentional actions in the healthcare domain. In this connection, Role represents a competency of an Entity as issued by an Entity scoping that Role. Entities in Roles can participate in Acts, still in numerous ways, because of which Participation describes specific ways of how an Entity behaves in an Act. To make the distinction between Role and Participation clear, [5] states that "Participations represent performance while Roles represent competence. Participations specify the actual performance of an Entity in a certain Act […]". Accordingly, there is also a notion of scoping for Participation where the scope is provided by the Act under consideration. Illustrating this in terms of the patient example, patient is a Role which is usually played by a person (an Entity) and scoped by a health care organization (another Entity), the one from which the patient receives services. With respect to some particular Act, a person in the role of the patient participates in a certain form, for instance being the one who is physically examined. A number of Participation types is provided in [5].

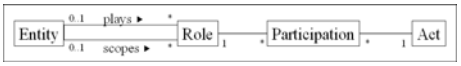

Fig. 1 Roles in the HL7 Reference Information Model (RIM), adapted from [5]

Results Firstly, the distinctions with respect to roles available in the GFO role model shall be demonstrated and clarified using the term "patient". Taking the abstract stance, the first question to be answered is that of what its context is. Patient may appear as a relational role, for instance in a model which represents the mere relation between human beings and hospitals. Similarly, a more process-oriented reading can be applied which is to view a patient as someone who is presently treated by some physician. Under the social perspective, patient is a social role with its own properties and behavior. Note that here, e.g., the weight of some human is not a property of the patient played by that human, because patient in this reading carves out a purely social aspect. This gives rise to two further interpretations besides the social role. Patient may likewise refer to an integrated view of the entity, i.e., to an entity comprising all aspects. On the other hand, it may refer to the player entities (without them being seen in a role). To make this distinction clear, think of some human being which is a patient in some hospital. In the integrated view, one can state that this situation refers to a single entity. However, this single entity comprises several aspects, in particular the role view (omitting all material aspects as well as other roles) and the view as an entity free of its social aspects (here referred to by human).

Secondly, given all these distinctions, the RIM approach to roles can be matched against the GFO role model. We identify the following relationships in this connection. Obviously, RIM introduces a type vs. role distinction by separating Entity and Role. The notion of a scope in RIM reflects the context in the GFO role model. Note that even the distinction is made between a scope in the social sense (due to the "scopes" relation) and the scope for Participations as provided by an Act. This further shows that Participation corresponds to the GFO notion of processual roles. With respect to social roles, i.e., the distinctions based on aspects, it is less clear, however, whether Entity and Role refer to the aspectual or to the integrated view of an entity, although the RIM documentation reveals a tendency towards the aspectual view. On the other hand, there are specializations of Entity, e.g., Person, which would appear as social roles in GFO just like patient, but the relation to patient is then to be explained in a more elaborated framework of inter-role relationships.

Discussion Altogether, roles in RIM seem to fit the role model in GFO fairly well, which has several advantages. From the point of view of reuse and information integration, it is advantageous if information models can be linked with ontologies clearly and without extensive effort. In particular, problems already with the topmost level would complicate further analyses from the beginning. In general, integrating standards like HL7 with top-level ontologies supports information integration and semantics across domain boundaries. Another interesting issue with respect to RIM is that it

already covers a large variety of aspects. This once more supports the view that the medical domain is a very complex one which requires fine-grained distinctions in modeling. Thus, for general ontologies this domain offers a rich application testbed.
Finally, it should be stressed that it is indeed relevant to be aware of all those variations of interpreting role terms (or others), because taking different positions with respect to the available choices results in different information models and different constraints which have to be respected in each model.

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