Modal logic as a specification tool:
a case study using deontic and action logics

Olga Pacheco
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The specification of a problem is always a subjective exercise. Different persons may have different understandings about the same reality. And if an informal language is used to describe what has been understood about the problem, the degree of ambiguity increases. Thus, formal specification that removes ambiguity and vagueness, is important to avoid misunderstandings.The formalizing effort also helps to clarify the concepts.

Logic can be an useful tool in a formal specification process, fixing in a rigorous way the meaning of the concepts relevant to the problem under consideration, relating them with each other and characterizing its properties. This formal description can then be used to specify the entities involved and reason about them.

When following this approach we first try to use well know logics, to capture the concepts involved. If that is not sufficient, because the logics do not have adequate expressive power, we need to define new logics suited to the problem under consideration. The cost to pay for that increase of expressiveness is the loss of generality and simplicity. Usually, these logics do not fit into standard well known systems. Moreover, to combine different logics, is not just a question of adding axioms and rules of inference. We have to study the inter-relations between them.

We will present here a case study about the normative specification of organizations. In this context there are several concepts that often have an imprecise and divergent meaning, like the concept of role, obligation, permission, representation, among others. So, our first task was to try to define precisely what is the meaning we assume for each of them. The formal characterization of those concepts has been done through the definition of deontic and action modal logics, following the tradition initiated by S. Kanger, I. Pörn and L.Lindahl. It is proposed a first-order, many sorted and multi-modal logic, including a new action operator that captures the notion of *action of an agent in a role*. We will briefly discuss why a new logic is needed and the problems raised by it (e.g. we have non-normal[1] modal logics, which implies that it is not possible to define a Kripke semantic to characterize them; minimal models were adopted to give a semantic model to the logics).

This logic is used in the formal specification of organizations and of normative interactions between agents. With this logic it is possible to analyze, in a rigorous way, the effects of an action of an agent (in the actions of other agents and in the attribution of new obligations or permissions to agents), or in the detection of non-ideal behavior (unfulfillment of obligations).

[1] According to Chellas classification.