Applications of Context to Elaboration Tolerance
ABSTRACT

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Elaboration Tolerance

Elaboration Tolerance is concerned with the causes for difficulties in elaborating theories and the ways to avoid them. Attention is given to different kinds of elaborations and the different ways these elaborations are formalized in different logical theories and formalisms. In front of us are the goals of knowledge representational compactness, knowledge reuse, and keeping the effort of elaboration as close as possible to the effort humans give to the same elaborations (e.g., elaboration in English is not difficult, but when coming to a knowledge base, often it is required to completely rewrite it due to unpredicted elaborations).

Theories of Context have some of the same goals. Knowledge reuse is one of these common goals, and one way theories of context suggest dealing with it is using distributed centers of knowledge (contexts) and lifting axioms connecting the knowledge segments. In theories of Elaboration Tolerance there are similar situations, and some elaborations suggest dealing by the same mechanisms.

Three Examples

We explore several ways to elaborate a theory using context, and we demonstrate them using elaboration examples taken from the Missionaries and Cannibals Problem examination in (McCarthy & Amir 1996).

> **Three missionaries and three cannibals come to a river and find a boat that holds two. If the cannibals ever outnumber the missionaries on either bank, the missionaries will be eaten.**
> **How shall they cross?**

The first example is by writing the theory "flat" on one context c_{mcp}. A typical formula detailing the process of crossing the river is

$$c: \quad ist(c_{mcp}, can(go(group, bank), s)) \implies available(Boat, group)) \tag{1}$$

Now we get the following elaboration: *The boat needs oars for its proper functioning.* We create a specialized context $c_{mcp+oars}$ and write

$$c: \quad ist(c_{mcp+oars}, can(go(group, bank), s)) \implies ist(c_{mcp}, can(go(group, bank), s)) \wedge ist(c_{mcp+oars}, accessible(oars, group, s)) \tag{2}$$

Here context allows us to use *lifting* to make the changes more simple to represent. In adding the oars we need to join the ontology of oars and rowing the boat. Let us say that c_{rowing} includes the required theory. It is then fairly easy to import the new theory

$$c: \quad ist(c_{rowing}, \varphi) \wedge \neg ab_1(c_{rowing}, \varphi, c_{mcp+oars}) \implies ist(c_{mcp+oars}, \varphi) \tag{3}$$

The second example uses the same theory in c_{mcp}. Now we get the elaboration that *if a cannibal is left alone with a missionary, they convert him to a missionary.* In the original theory we assume that a person is either a missionary or a cannibal, and that property is independent of the situation. Creating a new context $c_{convert}$ we can solve the problem:

$$c: \quad ist(c_{mcp}, person \in M)) \implies ist(c_{convert}, holds(person \in M, s0)) \tag{4}$$

The last example uses the paradigm of distributed knowledge bases. Instead of writing the MCP theory in a "flat" way, we consider actions to have their own context $context\text{-}of(a)$ for an action a. We then write the theory c_{mcp} as follows:

$$c_{mcp}: \quad ist(context\text{-}of(a), using(oars)) \implies (can(a, s) \implies precond(oars)) \tag{5}$$

Upon getting an elaboration of the action (such as an explanation of how it is carried out) we need to manually change knowledge only for $context\text{-}of(a)$:

$$c_{mcp}: \quad ist(context\text{-}of(a), stages(\langle a_1, ..., a_n \rangle)) \implies (can(a, s) \implies can(a_1, s) \wedge can(a_2, Result(a_1, s)) \wedge ...) \tag{6}$$

References

McCarthy, J., and Amir, E. 1996. Missionaries and Cannibals: Making it Elaboration Tolerant. http://www-formal.stanford.edu/eyal/nmr/m4.ps.

This is /u/eyal/ongo/elaboration/context/et-context-3ex.tex.