Small steps in dynamics of information

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Citation for published version (APA):

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This dissertation presents a logical framework for representing small steps in
dynamics of information.

Classical Epistemic Logic with possible worlds models is one of the most
widely used frameworks for representing and reasoning about agents’ informa-
tion. Its dynamic counterpart, Dynamic Epistemic Logic, allows us to represent
and reason about actions that change this information, like ‘hard’ announce-
ments that make us discard completely the possibilities where the announced
proposition is not true, of ‘soft’ announcements where we simply consider the
announced proposition very likely to be the case, but nevertheless we do not
eliminate the situations in which it does not hold.

However, agents represented in the epistemic logic framework are omni-
scient: their information is closed under logical consequence. This property,
useful in some applications, is a very strong idealization in some others: it
is often argued that, because of it, epistemic logic is not an adequate tool for
reasoning about the information of ‘real’ agents with bounded abilities. More
importantly, omniscience makes irrelevant the small steps that we non-ideal
agents perform every day in our life, like change in awareness, introspection
and, especially, inference.

In this dissertation, we extend the classical epistemic logic framework in
order to represent, besides the omniscient epistemic logic notion of informa-
tion, other finer notions that do not need to have strong closure properties and,
in particular, do not need to be closed under logical consequence. We explore
different definitions for notions like awareness (Chapters 3 and 4), explicit knowl-
edge (Chapters 2, 4 and 5) and explicit beliefs (Chapter 5), discussing some of
their properties.

More importantly, we provide definitions for finer actions that affect these
finer notions of information. We introduce actions representing changes in
awareness (Chapters 3 and 4), knowledge-based (i.e., truth-preserving) inference
(Chapters 2, 4 and 5) and belief-based (non-truth-preserving) inference (Chapter
We also present non-omniscient versions of the already studied acts of ‘hard’ and ‘soft’ announcement (Chapters 2 and 4 for the first, Chapter 5 for the second). In all cases we define the action, present its basic properties, and provide a sound and complete axiom system.

The developed framework has a wide range of connections and applications. In particular, we discuss the relation of the several acts of inference we define with known forms of reasoning, like deduction, default and abductive reasoning (Chapter 6). For applications, we make a few suggestions of how our framework might provide a useful tool that gives new perspective in fields like Linguistics, Cognitive Science and Game Theory (Chapter 7).

We conclude by mentioning further interesting questions and extensions that deserve additional investigation (Chapter 8).