Exposé for a Master Thesis

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Working title: A Generalisation of Uniform Revision by Deterministic Switching Between Total Preorders

1 Introduction

A fundamental skill for an intelligent agent is updating their internal beliefs about the world with new, potential conflicting, information. A logic based approach is discussed in the field of iterated belief change. The dominant framework considers an agent to posses an epistemic state, an abstract entity containing both it's current belief set as well as a strategy for future belief revision when encountering new evidence. Based on the paradigm of AGM revision [AGM85], Darwiche and Pearl [DP97] have shown that their implementation of iterated belief change can be modelled as a plausibility ordering over possible worlds.

2 Problem statement

Due to the loose restrictions on AGM revision of epistemic states, iterated belief change operators can be very complex. In particular, as discussed by Areces and Becher [AB01], belief change operators are relative to the original belief set of an agent. Completely defining an operator with plausibility orderings over worlds therefore requires a total preorder for every possible belief set (2^{2^n} in a propositional language). This is a prohibitively high representational cost for real world applications. Many suggested operators therefor rely on constructing new change strategies with every input.

A different approach is taken in uniform revision [AB01] [Ara20] that encodes the change strategy of an agent in one fixed total preorder over all worlds. Uniform revision defines an operator as a binary function over the belief set of an agent and the input that returns a new belief set. Restricting the representation to only one total preorder has considerable benefits (the operator is simple and intuitive, representational costs are lower and iterated revision is included [Ara20]) but also does not satisfy all postulates for iterated belief change (e.g. it only satisfies three of four of the postulates by Darwiche and Pearl [AB01]).

3 State of research

4 Research question

By deterministically switching between a finite set of total preorders, the class of uniform revision operators can be extended to all AGM revision operators [SB]. As every preorder encodes a revision strategy, and the change between them is encoded in the associated deterministic multiform system, this approach allows for an exploration of both.

The goal of this work is to introduce the theoretical foundation of DMF operators and provide an implementation to support empirical research into DMF operators and their properties.

5 Approach

The thesis will initially introduce uniform revision in the framework of plausibility orderings over worlds by Darwiche and Pearl. Based on uniform revision, deterministic multiform systems and DMF revision operators will be defined. In addition to the thesis the theoretical foundations for DMF revision will be presented in a joint paper with Kai Sauerwald and Christoph Beierle.

To support empirical research on DMF operators, a tool will be implemented that allows users to define DMF revision operators by describing deterministic multiform systems. The tool should support easy exporting and importing of DMF revision operators so they can be shared in future research. The tool will be implemented using modern web browser technologies and be open sourced.

A limited set of common belief revision postulates will be automatically checked for a DMF revision operator by the tool using an extended WHIWAP implementation [SH19].

5.1 Provisional table of contents

- Introduction
- Formal background

- Uniform Revision
  - In the Darwiche and Pearl Framework
- Multiform Revision
  - Multiform System
  - Multiform Revision
  - Deterministic Multiform Revision
- TOOLNAME: Empirical Deterministic Multiform Revision Research
  - Implementation details
  - User interface
  - Importing and Exporting
  - Implementation of a concrete DMF revision operator
- Discussion

6 Provisional timeline

The thesis lasts for six months or 24 weeks.

- Week 1-2: Literature Research
- Week 3-12: Definition DMF operators
- Week 12-18: Implementation Webtool
- Week 18-20: Implementation Postulate Checking
- Week 20-24: Buffer

References

[AB01] Carlos Areces and Verónica Becher. Iterable AGM functions. In *Applied Logic Series*, pages 261–277. Springer Netherlands, 2001.

[AGM85] Carlos E. Alchourrón, Peter Gärdenfors, and David Makinson. On the logic of theory change: Partial meet contraction and revision functions. *Journal of Symbolic Logic*, 50(2):510–530, jun 1985.

[Ara20] Theofanis Aravanis. On uniform belief revision. *Journal of Logic and Computation*, 30(7):1357–1376, sep 2020.

[DP97] Adnan Darwiche and Judea Pearl. On the logic of iterated belief revision. *Artificial Intelligence*, 89(1-2):1–29, jan 1997.

[SB] Kai Sauerwald and Christoph Beierle. Multiform revision (draft paper).

[SH19] Kai Sauerwald and Jonas Haldimann. Whiwap: Checking iterative belief changes. In *DKB/KIK@ KI*, pages 14–23, 2019.