

## Cultural knowledge evolution and belief revision

### PhD position / Sujet de thèse

**Cultural knowledge evolution considers how agents can evolve their knowledge through communicating and adapting their knowledge. Knowledge adaptation may be modelled as belief revision operators or agents may implement a specific distributed belief revision operation.**

Cultural knowledge evolution deals with the evolution of knowledge representation in a group of agents. For that purpose, cooperating agents interact with their environment and other agents. When these agents find their behaviour inadequate, which can be detected by failing to understand others, they use operators to adapt their beliefs. This framework has been considered in the context of evolving natural languages [Steels, 2012]. We have applied it to ontology alignment repair, i.e. the improvement of incorrect alignments [Euzenat, 2017] and ontology evolution [Bourahla *et al.*, 2021]. We have shown that it converges towards successful communication through improving the intrinsic knowledge quality.

This sounds like agents revising their beliefs when something tells them that they may not be correct. Belief revision operators have been designed for that purpose [Fermé and Hansson, 2018]. This Phd position aims at investigating deeper the relationships between cultural knowledge evolution and belief revision. There are, at least, two possible distinct starting points for that purpose.

Multi-agent dynamic epistemic-doxastic logics (DEL for short) are dedicated to describe agent knowledge and beliefs and modelling agent actions, such as communicating, through dynamic modal operators [van Ditmarsch *et al.*, 2007]. It has been used to model specific cultural knowledge evolution experiments [van den Berg, 2021].

Belief upgrade modalities available in dynamic epistemic logics enable them to revise beliefs in the face of new information and can be thought of as belief revision [Baltag and Smets, 2006; van Benthem, 2007]. It would be useful to understand how far the parallel between belief upgrade and belief revision can be pursued and if this is sufficient to model more elaborate cultural knowledge evolution experiments.

Along a complementary research direction, partial meet revision operators are among the most natural ones [Alchourron *et al.*, 1985]. They process the intersection of selected maximal sub-theories consistent with the formula by which it is revised. The difficulty lies in designing a 'good' selection operation.

Instead of considering that agents use an elaborate belief revision operator for adaptation, it may be considered that each one simply selects one sub-theory (this is called maxichoice revision). Then through cultural evolution mechanisms, the relevant subtheories will be selected and only the viable ones will remain. Such theories may not be the same [Bourahla *et al.*, 2021], but they will be compatible with the agent environment and societies which have selected them. This could be considered as deconstructing partial meet revision.

Finally, this can also be interpreted epistemologically. Indeed, there are agents, initially sharing the same theory, who will face new facts. For accommodating them, there exists several concurrent revision, that can evolve independently when facing new experiments and facts, and that may be so selected. This would provide an operational support for evolutionary epistemology.

More generally, these two research directions may contribute reconnecting the multi-agent DEL and distributed approaches to belief revision.

This work is part of an ambitious program towards what we call cultural knowledge evolution partly funded by the [MIAI Knowledge communication and evolution chair](#).

#### References:

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- [Baltag and Smets, 2006] Alexandru Baltag, Sonja Smets, Dynamic belief revision over multi-agent plausibility models, In: Proc. of 6<sup>th</sup> LOFT, pp11–24. University of Liverpool, 2006
- [Bourahla *et al.*, 2021] Yasser Bourahla, Manuel Atencia, Jérôme Euzenat, Knowledge improvement and diversity under interaction-driven adaptation of learned ontologies, Proc. 20th AAMAS, London (UK), pp242-250, 2021 <https://moex.inria.fr/files/papers/bourahla2021a.pdf>
- [Campbell, 1974] Donald Campbell, Evolutionary epistemology, in: Paul Schipp (ed.), *The philosophy of Karl Popper*, Open court, La Salle (IL US), Book I, pp413-463, 1974
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- [van den Berg, 2021] Line van den Berg, Cultural knowledge evolution in dynamic epistemic logic, Phd thesis, Université

Grenoble Alpes, 2021 <https://moex.inria.fr/files/theses/thesis-vandenberg.pdf>

[van Benthem, 2007] Johan van Benthem, Dynamic logic for belief revision, *Journal of applied non-classical logics* 17(2):129-155, 2007 <https://staff.fnwi.uva.nl/j.vanbenthem/DL-BR-new.pdf>

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#### Links:

- This page: <https://moex.inria.fr/training/2023-Th-ckebr.html>
- MIAI Knowledge communication and evolution: <https://moex.inria.fr/cooperation/miai/>
- mOeX web site: <https://moex.inria.fr>
- *Lazy lavender*: <https://gitlab.inria.fr/moex/lazylav>

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**Qualification:** Master or equivalent in computer science.

#### Researched skills:

- Curiosity and openness.
- Interaction with other researchers.
- Autonomous researcher.
- Solid logic background.
- Knowledge of dynamic epistemic logics and/or belief revision would be a plus.
- Innovative.

**Doctoral school:** MSTII, Université Grenoble Alpes.

**Advisor:** Jérôme Euzenat (Jerome:Euzenat#inria.fr).

**Group:** The work will be carried out in the mOeX team common to INRIA & LIG. mOeX is dedicated to study knowledge evolution through adaptation. It gathers researchers which have taken an active part these past 15 years in the development of the semantic web and more specifically ontology matching and data interlinking.

**Place of work:** The position is located at INRIA Grenoble Rhône-Alpes, Montbonnot a main computer science research lab, in a stimulating research environment.

**Hiring date:** October 2023.

**Duration:** 36 months

**Salary:** 1982€/month (gross, before social contributions and taxes).

**Deadline:** as soon as possible.

**Contact:** For further information, contact us.

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**File:** Provide Vitæ, motivation letter and references. It is very good if you can provide a Master report and we will ask for your marks in Master, so if you have them, you can join them.