

## Research Internship – M2

**Place :** Laboratoire Spécification et Vérification (LSV) / Laboratoire Méthodes Formelles (LMF)  
Gif-sur-Yvette, France

**Title :** Updates in Description Logics

**Supervisor :** Stéphane Demri (CNRS, LSV/LMF, ENS Paris-Saclay), [demri@lsv.fr](mailto:demri@lsv.fr)

**Description logics.** Description logics (DL) are a prominent family of logical formalisms for reasoning about conceptual knowledge, see e.g. [BHLS17]. Many decision problems have been introduced and the literature is very rich of new logical formalisms or fragments that are tailored to be expressive enough while having a reasonable computational complexity. For example, the DL-Lite family, see e.g. [CDL<sup>+</sup>07], and the  $\mathcal{EL}$  family [BBL05] contain many fragments with interesting computational properties. Typically, several logics in the DL-Lite family have polynomial time computational complexity for usual decision problems such as consistency or subsumption. Description logics are well-known formalisms to represent and reason about ontologies, understood as a specification of concepts in a specific domain. A DL knowledge base (KB) typically consists of the so-called TBox dedicated the general knowledge about the concepts, whereas the so-called ABox contains instances of concepts and roles. In many applications of DLs, an ABox is used to represent the current state of affairs in the application domain.

**Handling updates in DLs.** The question of updating the knowledge base (KB), for instance its ABox, and then reasoning about the new state of affairs is considered as fundamental and very relevant in practice, see e.g. [LLMW06]. Indeed, it is often necessary to update the ABox if the state of affairs has changed and that is why several attempts have been done to incorporate updates in DLs, see e.g. [LLMW06, DLPR06, DLB<sup>+</sup>09]. Most probably, the first formal analysis of ABox updates in several description logics can be found in [LLMW06]. As noted in [DLB<sup>+</sup>09], the update approach from [LLMW06] might become problematic for at least two reasons. First, the update procedures can quickly lead to huge updated ABox that are not anymore manageable by DL reasoners (though many pieces of information could become redundant). Secondly, reasoning about updated ABoxes requires to enrich the DL language and it is not always clear whether DL reasoners can handle such new languages. For specific fragments, this can be partly avoided as shown in [DLPR06]. A recent approach has been also recently developed in [BDM20].

### Objectives of the internship.

- (1) To become familiar with description logics, their main reasoning tasks, and perform a thorough state of the art about updates in description logics.
- (2) To investigate updates in DLs when ABox as well as TBox are involved.
- (3) If time permits, to propose a unifying theory for updates in description logics.

This research internship may be pursued as a PhD thesis, whose subject may vary according to the candidate's research interests.

**Related courses at MPRI** For your information, the following MPRI courses are related to this research internship. Students from other master programmes are welcomed to apply too.

- Course 1.39 *Logical Aspects of Artificial Intelligence*
- Course 1.22 *Basics of Verification*

## References

- [BBL05] F. Baader, S. Brandt, and C. Lutz. Pushing the EL envelope. In *IJCAI'05*, pages 364–369. Professional Book Center, 2005.
- [BDM20] B. Bednarczyk, S. Demri, and A. Mansutti. A framework for reasoning about dynamic axioms in description logics. In *IJCAI'20*, pages 1681–1687, 2020.
- [BHLS17] F. Baader, I. Horrocks, C. Lutz, and U. Sattler. *An Introduction to Description Logic*. Cambridge University Press, 2017.
- [CDL<sup>+</sup>07] D. Calvanese, G. De Giacomo, D. Lembo, M. Lenzerini, and R. Rosati. Tractable reasoning and efficient query answering in description logics: The DL-Lite family. *Journal of Automated Reasoning*, 39(3):385–429, 2007.
- [DLB<sup>+</sup>09] C. Drescher, H. Liu, F. Baader, S. Guhlemann, U. Petersohn, P. Steinke, and M. Thielscher. Putting ABox Updates into Action. In *FroCoS'09*, volume 5749 of *LNCS*, pages 214–229. Springer, 2009.
- [DLPR06] G. De Giacomo, M. Lenzerini, A. Poggi, and R. Rosati. On the update of description logic ontologies at the instance level. In *AAAI'06*, pages 1271–1276. AAAI Press, 2006.
- [LLMW06] H. Liu, C. Lutz, M. Milicic, and F. Wolter. Updating description logic aboxes. In *KR'06*, pages 46–56. AAAI Press, 2006.