ENS Research Projects
David Ferández-Duque

Master's project

Implementation of logics for dynamical systems

We will study logics for reasoning about dynamical systems that are known to be decidable, implement them in LoTREC, and apply them in verification problems. In particular, we are interested in the logics S4F, S4C and S4H, designed for reasoning about different classes of dynamical systems. To be precise, a dynamical system is a pair (X, f) where X is a spatial structure (say, the plane or the real line) and f a continuous function on X; such structures are used to model movement in many disciplines, most notably physics, biology and computer science. The three logics we consider combine spatial and temporal reasoning and assume f to be arbitrary, continuous, or a homeomorphism, respectively. All three are known to be PSPACE-decidable (as is the case for many standard modal logics). The student will familiarize themselves with these decision procedures, study which are more feasible from a practical perspective, and implement these using software such as LoTREC. This will be use to model and certify properties of various dynamical systems arising from real-world problems, and test the performance of these methods for such applications.

Doctoral project

Complexity of logics for dynamical systems

We will study logics for reasoning about dynamical systems that are known to be decidable, but whose complexity is unknown or very high. In particular we are interested in dynamic topological logic (DTL) and its fragments. Of interest are dynamic topological logics over minimal systems, known to be decidable but in non primitive-recursive time, and the intuitionistic temporal logic of dynamical systems ITLC, whose only known upper bound is superexponential. The student will explore feasible variants, for example fragments with one variable or low modal depth, and implement them on LoTREC for automated theorem proving. In particular, we are interested in deductive calculi and tableau methods for the DTL of minimal systems and for ITLC. Once implemented, these methods will be demonstrated by modeling real-world examples of dynamical systems from physics, biology or computer science.