DESCRIPTION FOR THE GENERAL PUBLIC (IN ENGLISH)

Reasoning about time arouses people's interest since antique researches conducted by Zeno and Aristotle. Since then a philosophical debate about the nature of time, temporal relations occurring between events, and methods for modelling human reasoning about time takes place continuously. Reasoning about time fascinates not only philosophers but also logicians, mathematicians, computer scientists, linguists, and psychologists. Research conducted within these areas has resulted in numerous formal methods for representing temporal events and reasoning about them. Many significant research results in temporal reasoning have come from the field of Artificial Intelligence which aims to devise methods for representing and simulating intelligent behaviour that we observe in humans, in a manner that can be understood by, and 'built into', computers. Proposed approaches for temporal reasoning may be divided into two groups depending on the type of primitive temporal objects, namely, time-based (a timeline consists of time points) and interval-based methods (a timeline consists of time intervals). The research conducted within this project will consider the latter approach for temporal reasoning. It is worth mentioning that, by means of intervals as primitive temporal objects, it is possible to express all properties expressible by means of time points, but not vice versa.

Within the project one of the most influential interval temporal logics, namely Halpern-Shoham logic (HS in short), will be investigated. The language of HS enables one to express complex relations between temporal intervals but the satisfiability problem of its formulas is undecidable, i.e., it is impossible for any computer algorithm to check whether some formulas of HS are true, or not. As a result, one of the main tasks undertaken within the research on HS is to find decidable fragments of this logic which retain the possibility to express complex temporal relations. One of the recently proposed methods to indicate such HS fragments amounts to restricting the syntax of the formulas. This method has been used to identify decidable fragments. Interestingly, one such fragment was implemented as the first, and so far the only, fragment of HS. The implementation was tested experimentally using real-world historical and meteorological data.

However, it seems that after imposing the above described restrictions on HS formulas in the obtained fragments it is impossible to express the so-called *referentiality*, i.e., to express that some property holds in a particular, single interval, for instance, that "it will rain tomorrow between 1'p.m. and 2 p.m.". A standard method of enabling referentiality in modal logics is the *hybridization* of a logic. The method amounts to augmenting the language of a given logic with expressions of two types. An expression of the first type allows us to mark a single interval with a label, whereas an expression of the second type allows us to refer to the interval that has a specific label. As an example, to express that "it will rain tomorrow between 1 p.m. and 2 p.m." it suffices to firstly add a specific label to the interval that starts tomorrow at 1 p.m. and ends at 2 p.m., and secondly, to state that in the interval with this label it will rain. Hybridization of modal logics is a well-established area of research that was exploited, e.g., within research on point-based temporal logics. Unexpectedly, hybridization of interval-based logics, and in particular fragments of HS, has remained largely unanalysed thus far (except single results for the full HS and the preliminary research of the Principal Investigator). Hybridization of HS fragments has been recognized more than a decade ago as a promising direction of research.

The project assumes that, on the one hand, hybridization of HS fragments will allow us to express concepts that are not expressible before the hybridization, e.g., that some property holds in a particular interval in the future (or in the past). On the other hand, the project assumes that decidable HS fragments will remain decidable after hybridization. Consequently, the hybrid HS fragments may turn out to be valuable tools for temporal reasoning. The research conducted within the project will provide a better understanding of properties of HS and its fragments. Moreover, the results obtained within the project may help solve open problems concerning properties of non-hybrid HS fragments.