Abstract

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Overall, the research is concerned with the problem of specification and analysis behavioural constraints for abstract discrete systems with output. The proposed theoretical framework which answers the problem is based on the theory of coalgebras. This framework involves three different types of systems corresponding to three endofunctors of the category **Set** namely the system with termination, system with output and detector. The properties of these systems are studied in a comprehensive manner. Particularly, a final coalgebra is pointed out for each of the said system types. All endofunctors encountered in the study are exponent polynomial and consequently preserve pullbacks. The functor **Join** plays a key role in the required specification. It maps a pair consisting of a system with output and detector to a system with termination. In other words the functor **Join** is a bifunctor. It must be emphasized that **Join** is stable with regard to bisimulation. The bifunctor **Join** is precisely a tool that allows us to deal with safeness. Given a detector and stream (infinite sequence) it can determine whether this stream is admissible to the detector under some point of its carrier. This determination is via the anamorphism from the obtained system with termination to a final system with termination introduced in the research. It turns out that the set of all acceptable streams under some point constitute a safety constraint. Moreover, given a safety constraint one can define a detector and specify a point of its carrier such that the set of acceptable streams is exactly this safety constraint. Thus **Join** allows to establish a correspondence between detectors and families of safety constraints. A final detector presented in the study is crucial in the context of such determination. The carrier of the final detector is the set of all prefix-free subsets of the set of nonempty words. The final detector is universal in the sense that it allows to determine any safety constraint.

Further, this general approach is applied to study causality constraints in distributed systems. A practically important class of detectors has been studied namely the class of counter-detectors. This class is used to determine the semantics of Clock Constraint Specification Language (CCSL) constructs. There has been given a characterization of points of the carrier of the final detector corresponding to counter-detectors. This characterization leads us directly to important corollaries. The first one is that the family of clock constraints determined by counter-detectors is a family with universal detector. It means that there exists a detector that determines exactly this family of constraints. The second one is that it turns out that there are clock constraints that cannot be specified by the counter-detector. Therefore the class of counter-detectors is incomplete which means that we cannot confine ourselves to them only. But on condition that a counter-detector is defined by a recursively defined set there is a so-called Diophantine representation of the detector. This representation is to specify a recursively defined counter-detector by a set of Diophantine equations. Moreover, it allows us to provide a universal algorithm for verifying constraints corresponding to a recursively defined counter-detector. In case of all the Diophantine equations corresponding to such a counter-detector being linear there is a more effective and direct verification algorithm. The complexity of this algorithm is exponential in the worst case.