Slicing Petri nets to reduce their complexity - Abstract

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One of the main problems when transferring Petri net-based technology to the industry is scalability. Many models and analyses that work in theory are simply not applicable to industrial real-time systems due to the complexity of these systems.

In this work, we propose automatic Petri net transformations that allow us to automatically reduce the size and complexity of a Petri net so that the analyses of interest can be applied to it while keeping the part of the behavior of the Petri net that we are interested in.

Our approach is based on *Petri net slicing*, a technique to extract all those places and transitions (the *slice*) that are related to a specified point of interest referred to as *slicing criterion*. This slicing criterion is often a set of places in a given Petri net. The part of the Petri net that is unrelated (e.g., cannot influence) to the slicing criterion is removed; thus, slicing the Petri net can significantly reduce its size and complexity, making it easier and faster to analyze and understand.

We have designed and implemented two different slicing algorithms that have been integrated into an open-source and free tool called `pn_slicer`. The first algorithm (called *maximal contributing slicing algorithm*) extracts from a Petri net all parts (places and transitions) that can contribute tokens to the slicing criterion. This algorithm is useful for Petri net comprehension and debugging because the slice always contains all the causes that produced an error in the slicing criterion (e.g., a place with a token that should not be there or just with more tokens than it should have).

The second algorithm (called *minimal contributing slicing algorithm*) extracts the places and transitions needed to fire the shortest transition sequence that contributes tokens to some place in the slicing criterion. This algorithm is useful for component extraction and reuse (the slice is a subcomponent that can be reused in another net or, e.g., used to understand one specific part of the net). A variant of this algorithm has also been defined to extract the smallest slice of a Petri net.

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