Weighted Symbolic Automata with Data Storage

> Luisa Herrmann, Heiko Vogler Weighted Symbolic Automata with Data Storage DLT 2016: 203-215

paper

- https://link.springer.com/chapter/10.1007/978-3-662-53132-7_17
- https://dl.acm.org/citation.cfm?id=3081476.3081493
- doi: 10.1007/978-3-662-53132-7_17

slides

- https://wwwtcs.inf.tu-dresden.de/~herrmann/pdf/slides_dlt16.pdf

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see also

> Luisa Herrmann Weighted Automata with Storage PhD thesis. Technische Universität Dresden, 2020, urn:nbn🇩🇪bsz:14-qucosa2-740685

https://tud.qucosa.de/api/qucosa%3A74068/attachment/ATT-0/

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abstract

We introduce weighted symbolic automata with data storage, which combine and generalize the concepts of

- automata with storage types,
- weighted automata, and
- symbolic automata.

By defining two particular data storages, we show that this combination is rich enough to capture

- symbolic visibly pushdown automata and
- weighted timed automata.

We introduce a weighted MSO-logic and prove a Büchi-Elgot-Trakhtenbrot theorem, *i.e.*, the new logic and the new automaton model are expressively equivalent.

Definition

$A = (Q, \Pi, Q_0, Q_f, T, wt, \eta)$ Weighted Symbolic Automata with Data Storage over (S, D, K) where:

- $S = (C, M, P, F, c_0)$ is a data storage type:
  - C set of configurations
  - M set of storage inputs
  - P set of predicates over $C \times M$
  - F set of functions $C \times M \to C$ (instructions)

    - $c_0 \in C$ (initial configuration)
- D infinite set of input labels
- K semiring
- Q finite set of states
- Π set of decidable predicates over D, Boolean-closed
- $Q_0 \subseteq Q$ (initial states)
- $Q_f \subseteq Q$ (final states)
- $T \subseteq Q \times \Pi \times P \times Q \times F$ (transitions)
- $wt : T \times D \to K$ (weight assignement)
- $\eta : D \to M$ (storage encoding)

A-configuration = triple of $Q \times D^* \times C$.

move with transition $\tau = (q, \pi, p, q', f)$:

$$(q, dw, c) \to_\tau (q', w, f(c, \eta(d)))$$

such that

- $q, q' \in Q$
- $d \in D$
- $w \in D^*$
- $c \in C$
- $\pi(d)$ is true
- $p(c, \eta(d))$ is true
- $f(c, \eta(d))$ is defined

computation = sequence of configurations chained with $\to_{\tau_i}$ its weight is the semiring K-product of $wt(\tau_i, d_i)$

Expressiveness

- can express Symbolic Visibly Pushdown Automata with a specific data storage type (nested sets)
- can express Weighted Timed Automata with a specific data storage type (simulating clocks)
- Weighted Symbolic MSO-Logic with Storage Behaviour