Languages of Higher Dimensional Timed Automata.

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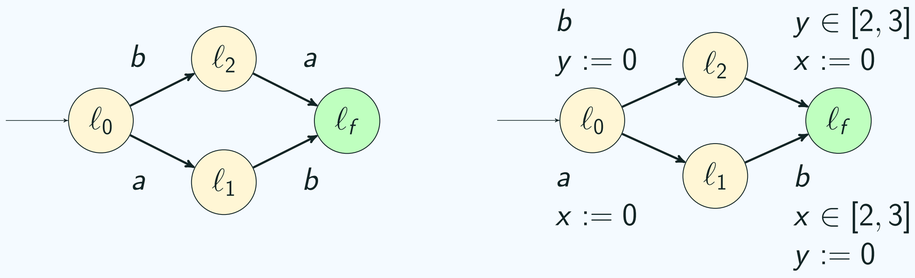
Interleaving concurrency: (Timed) Automata

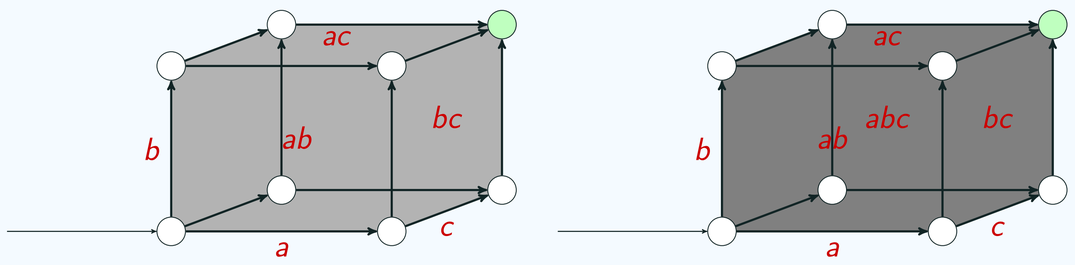
- **Scheduling for Automata (left) and Timed Automata (right):**



- **Issues: how to express both timed constraints, duration and non-interleaving concurrency?**

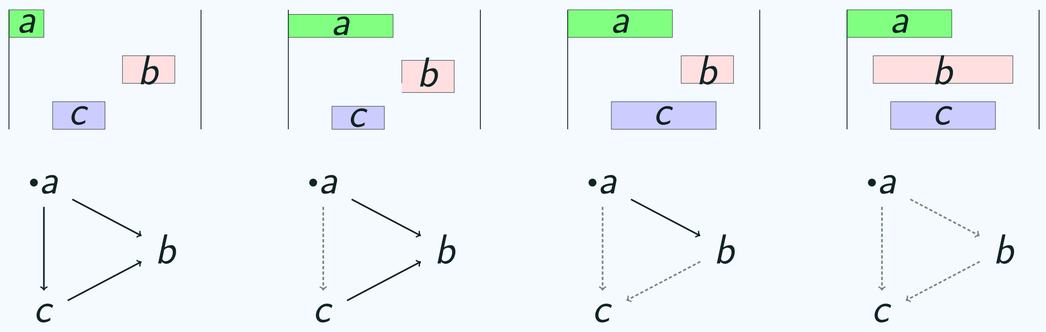
Non-interleaving concurrency: Higher Dimensional Automata

- **Higher Dimensional Automata (HDA): allowing two events simulteneously (left), or three (right)**

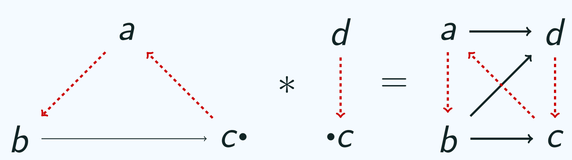


Pomsets with Interfaces

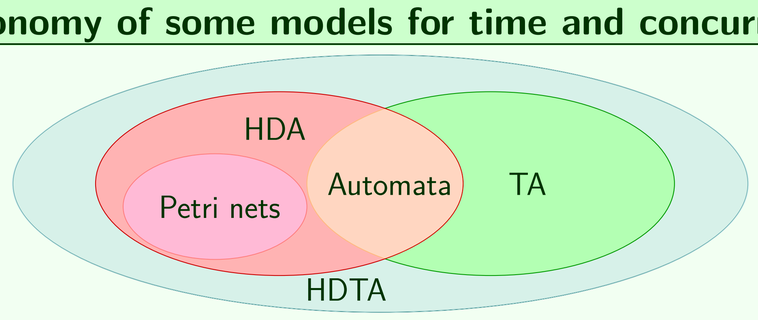
- **Representation of different ipomsets (bottom) as Activity intervals of events (top)**



- **Gluing operation**



Taxonomy of some models for time and concurrency



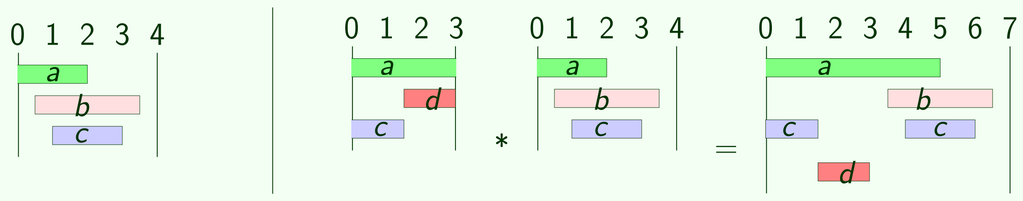
Goals & Contributions

- **Extend results from Timed Automata:**

▷ Undecidability of Language inclusion for Language of HDTA;
▷ Decibablity of Language inclusion for untimed Language of HTDA.

Events representation: Timed Ipomsets

- **Example of Timed ipomsets (left) and a gluing operation (right)**

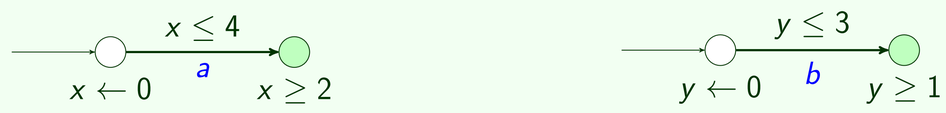


Links

Ipomset Seminar DBLP Webpage

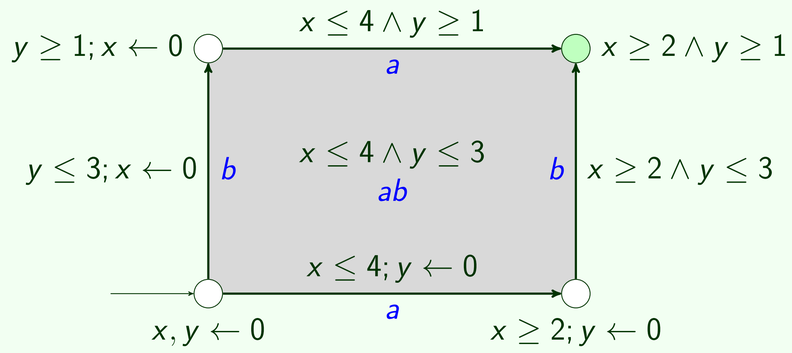
Higher Dimensional Timed Automata (HDTA)

- **Two 1-event examples of HDTA**



- **A 2-events example of a corresponding HDA:**

▷ Cells: Location (0-cell), Arrow (1-cell) and face (2-cell) *ab*.
▷ **Difference with TA**: we **spend** time unit **during** the transitions.
▷ **Example**: here we must spend at **least** a total of 2 time units in cells labelled by *a* (a or ab).
▷ Invariant conditions: $y \leq 3$: apply on **all** cells.
▷ Exit conditions: $y \leftarrow 0$: apply on **all** cells too.
▷ Constraints on duration of events: $a : [2,4], b : [1,3]$



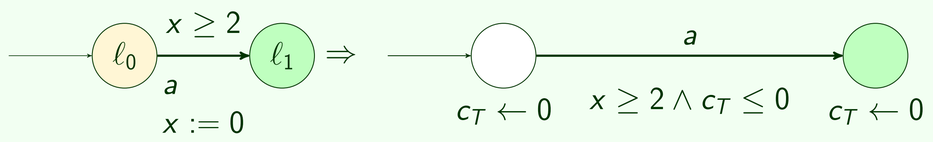
- **Example of execution:**

Taking transition *a* for 1 time unit, then *ab* for 2 time unit, then we can reach the 0-accepting cell (top right green circle).

Language inclusion for HDTA is undecidable

- **Conversion of any TA into an HDTA:**

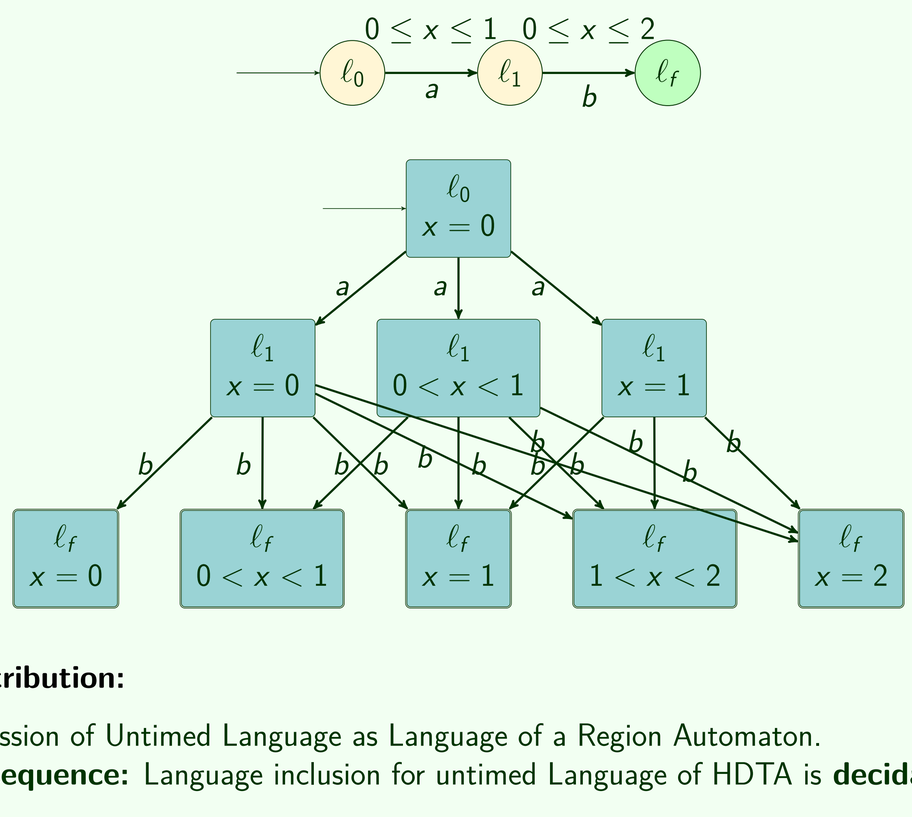
▷ force immediatre transition with an extra clock c_T



- **Language inclusion of HDTA is undecidable.**

Untimed Language for HDTA: inclusion is decidable

- **Example of Region Automata for TA**



- **Contribution:**

▷ Expression of Untimed Language as Language of a Region Automaton.
▷ **Consequence:** Language inclusion for untimed Language of HDTA is **decidable**.

Future work

- **Temporal Logic: Extend Kamp Theorem for Higher Dimensional Automata.**
- **Timed Simulation and Bisimulation: Model-Checking for HDTA.**
- **Robustness:**

▷ Guard enlargment and delay enlargment.
▷ Distance between words.
▷ Topological point of view: tube acceptance.

Organisations