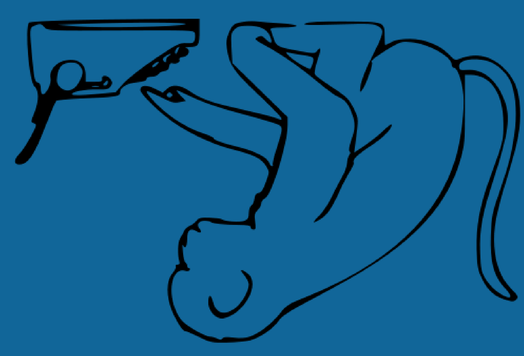
IMITATOR: Parametric verification of real-time systems



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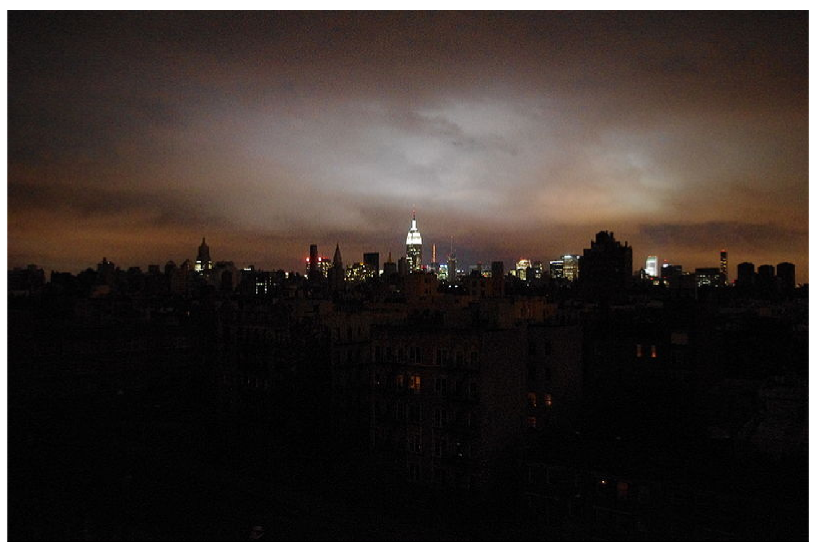
Context: Formal verification of real-time systems

Critical systems involve timing constraints and concurrency

Bugs can be **dramatic** (risk of loss of lives or huge financial loss)



$\Rightarrow$ need for **formal verification**

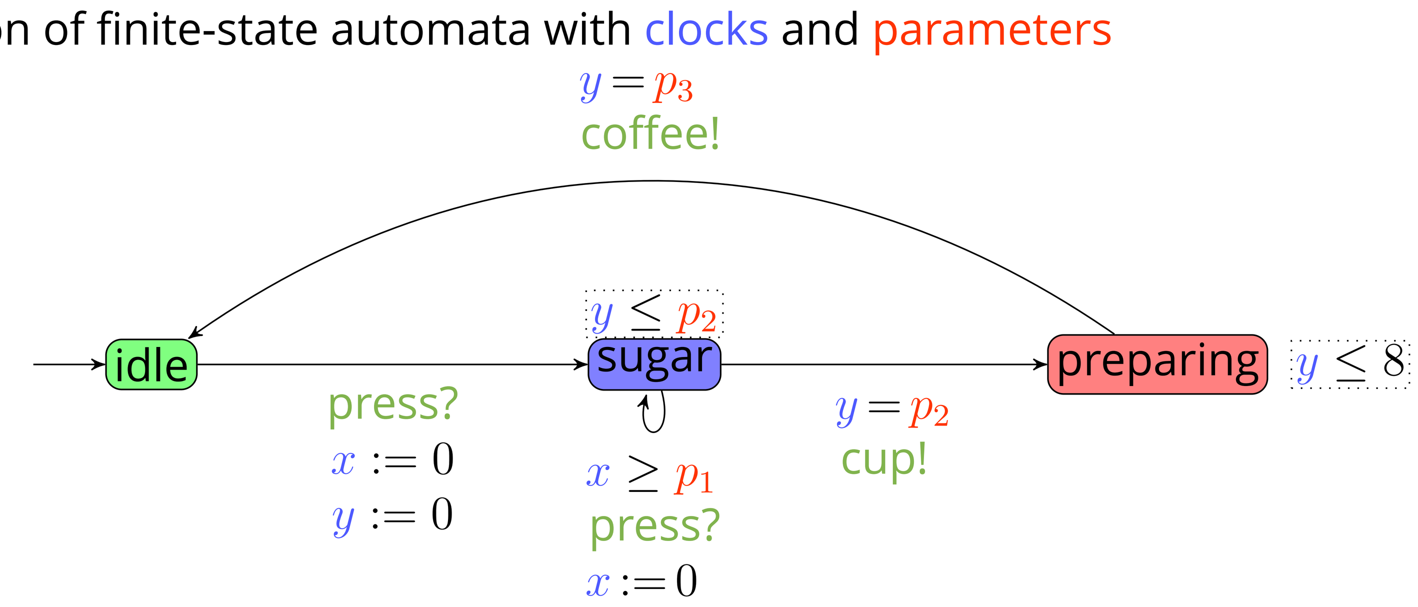
Objective

"Given a model (mathematical representation) of a system and a specification, synthesize timing constraints (parameters) guaranteeing that the system meets its specification"

The formalism: parametric timed automata

[AHV93]

Extension of finite-state automata with clocks and parameters



Exemple: a coffee machine modeled using a parametric timed automaton

IMITATOR in a nutshell

A **parametric timed model checker**

Input

- a **real-time system** modeled using parametric timed automata
- a **specification**

Output

- Conditions on the parameters formally guaranteeing the system correctness

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Constraint for which the system meets its specification:
p1 + p2 > 2 p3 & p3 > 0
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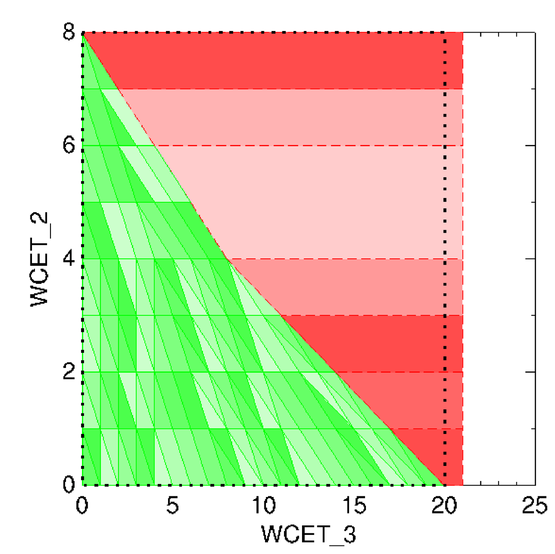
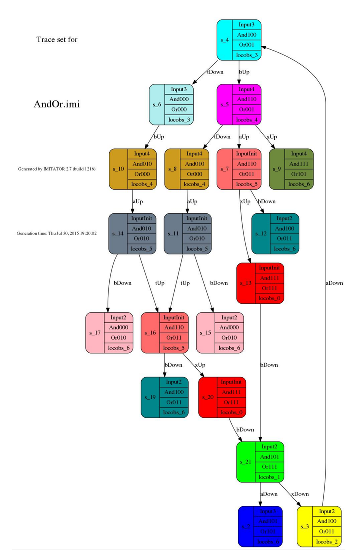
- Graphical visualization





What's inside?

Implemented in **OCaml**

Relying on the **Parma Polyhedra Library** [BHZ08]

Large repository of **benchmarks** [And18]

Distributed under the **GNU-GPL license**

Try it!

`www.imitator.fr`

Notable applications of IMITATOR

- **Hardware verification** [CEFX09]
  - Collaboration with ST-Microelectronics
- **Scheduling for aerospace** [FLMS12]
  - Collaboration with ArianeGroup
- **Scheduling under uncertainty** [SAL15]
  - Solved an industrial challenge by Thales
- **Testing software product lines** [LSBL17]
- Analysis of **music scores** [FJ13]
  - IRCAM, Paris, France
- **Monitoring** real-time systems [AHW18]
  - applications to automotive industry
  - best paper award @ ICECCS 2018

What's next?

- Integration to real-time systems formalisms
  - E.g. Thales' "Time4sys"
- Beyond timed automata
  - Linear hybrid automata
    - Can represent more subtle variations of speed, temperature, energy...
    - Potential: bring (more) formal methods to automotive industry

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Version: December 27, 2018

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