SNAKES: a flexible high-level Petri nets library

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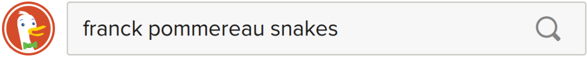
PETRI NETS 2015 — June 25th



franck pommereau snakes

How to implement a fine idea defined in a nice paper?

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- implement Petri nets

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- implement Petri nets
  - places
  - transitions
  - arcs
  - markings
  - implement a bunch of related methods

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        - data model
        - language
        - expressions evaluation
        - interface with Petri net

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  - custom arcs
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  - implement save/load Petri nets and/or state spaces

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How to implement a fine idea defined in a nice paper?

- grab SNAKES
- implement your idea

How to implement a fine idea defined in a nice paper?

- grab SNAKES
- make quick customisation

  (time Petri nets $\leq$ 100 LoC / nets-within-nets $\leq$ 30 LoC)
- implement your idea

Outline

Introducing SNAKES

Efficient model-checking

Interfacing with other languages

Typical use cases

Conclusion

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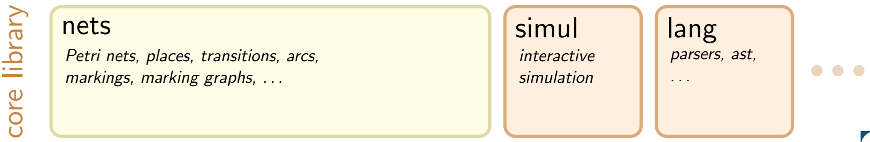
SNAKES in a nutshell

- SNAKES is a Python library
    - free software (GNU LGPL)
    - 82k lines of code
- define and manipulate Petri nets
    - very generic definition
    - various extensions provided by default
      (read arcs, whole-place arcs, inhibitor arcs, . . .)
    - others are easy to add (timed nets, nets-within-nets, . . .)
- annotations are Python expressions
  tokens are Python objects (even SNAKES' net objects)
- every net can be executed (*i.e.*, transitions can be fired)
- limited PNML support
- extensible with plugins

Architecture



core library

nets

Petri nets, places, transitions, arcs, markings, marking graphs, . . .

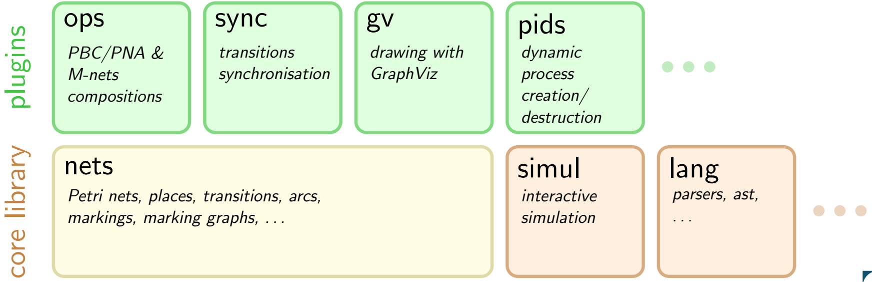
simul

interactive simulation

lang

parsers, ast, . . .

Architecture



plugins

ops

PBC/PNA & M-nets compositions

sync

transitions synchronisation

gv

drawing with GraphViz

pids

dynamic process creation/ destruction

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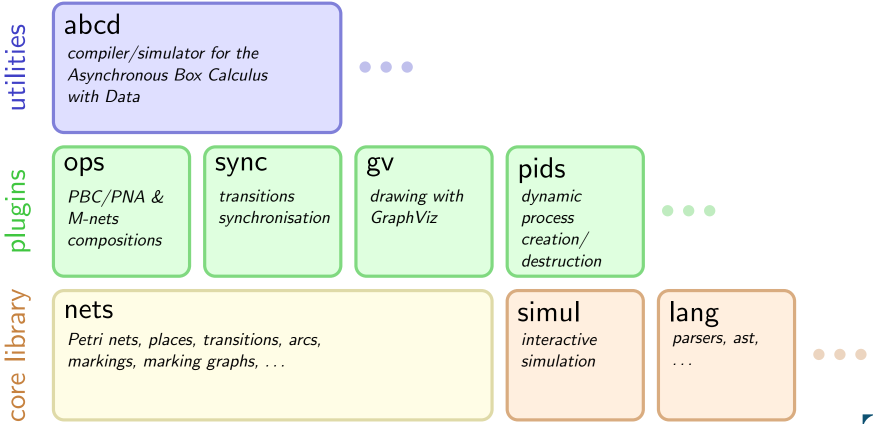

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abcd
compiler/simulator for the Asynchronous Box Calculus with Data

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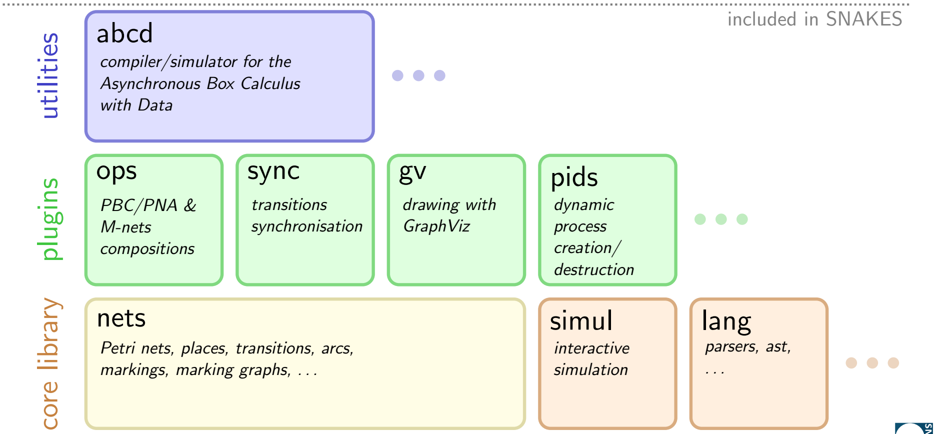

included in SNAKES

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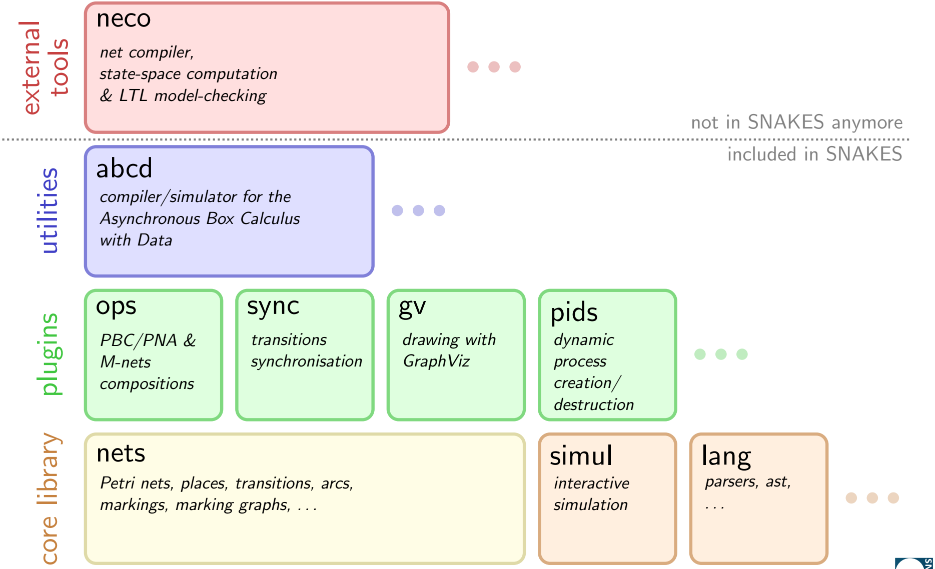

external tools

neco

net compiler,
state-space computation
& LTL model-checking

. . .

not in SNAKES anymore

included in SNAKES

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Hello world

```
from snakes.nets import *
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pn = PetriNet("hello world in SNAKES")
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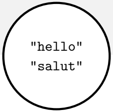

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from snakes.nets import *

pn = PetriNet("hello world in SNAKES")
pn.add_place(Place("hello", ["hello", "salut"]))
```
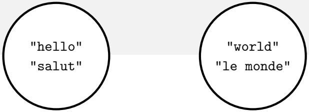

Hello world



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pn.add_place(Place("world", ["world", "le monde"]))
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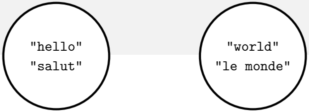

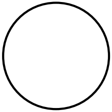

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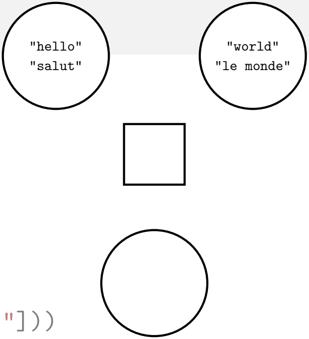

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pn.add_place(Place("hello", ["hello", "salut"]))
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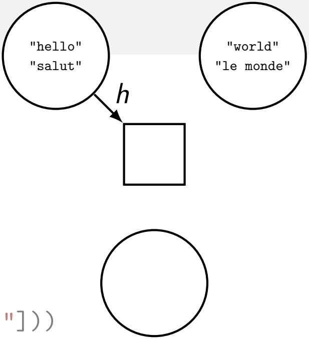
pn.add_place(Place("sentence"))

pn.add_transition(Transition("concat"))
```

Hello world



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pn.add_transition(Transition("concat"))
pn.add_input("hello", "concat", Variable("h"))
```
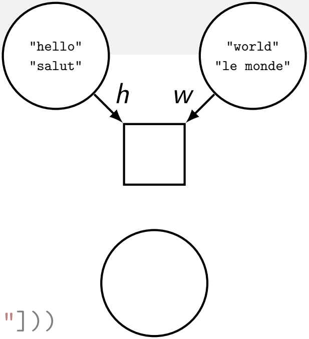

Hello world



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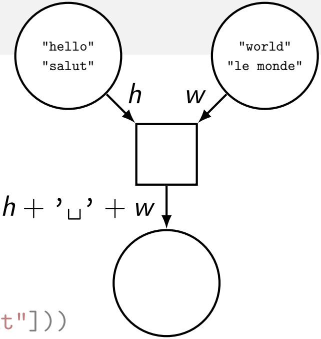

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pn.add_input("hello", "concat", Variable("h"))
pn.add_input("world", "concat", Variable("w"))
pn.add_output("sentence", "concat", Expression("h + ’ ’ + w"))
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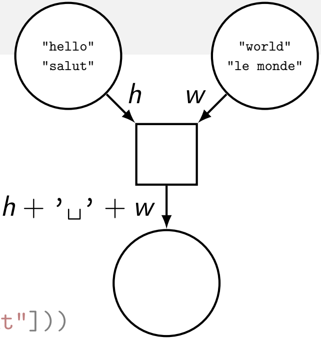

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modes = pn.transition("concat").modes()    # returns 4 modes
```

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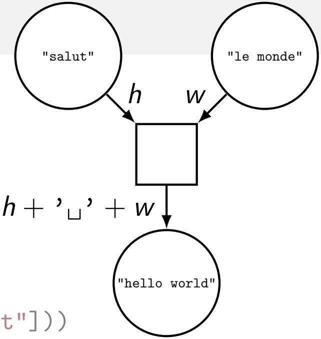

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pn.add_output("sentence", "concat", Expression("h + ' ' + w"))

modes = pn.transition("concat").modes()    # returns 4 modes
pn.transition("concat").fire(modes[2])
```

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Efficient model-checking

Interfacing with other languages

Typical use cases

Conclusion

But… Isn't Python slow as hell?

Python is fast

- for building and manipulating Petri nets (even large ones)
- for firing transitions interactively
- for calling CPU-intensive routines from an external library

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Python is slow

- for computing large state-spaces
- for running complex algorithms
- SNAKES is even slower (not optimised for speed)

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So, can we use SNAKES for model-checking?

Fast analysis with Neco

- Łukasz Fronc's companion tool
  `https://code.google.com/p/neco-net-compiler/`
- Neco compiles SNAKES' Petri nets into fast native code
  - per-net optimised marking structure
  - per-transition optimised firing
  - no magic ⇒ cannot optimise arbitrary Python code
- reads PNML, ABCD, or net objects
- process-symmetries reductions (plugin `pids`)
- state space exploration and LTL model-checking (using SPOT)
- awarded at the *model-checking contest* 2013

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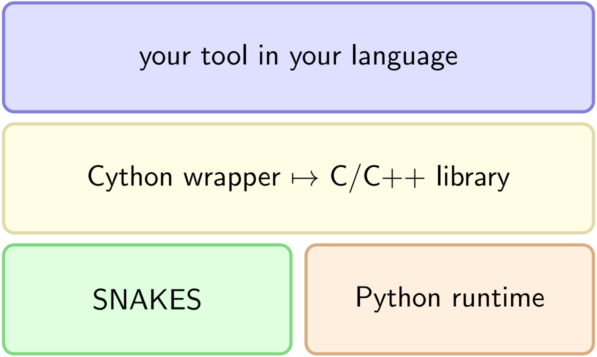
SNAKES out of Python

Cython = Python + type annotations ⇒ generates optimised C/C++



your tool in your language

Cython wrapper ↦ C/C++ library

SNAKES

Python runtime

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- Sam Sanjabi's post-doc (2010) and Samira Chaou's PhD (2013)
  - ABCD modelling of peer-to-peer storage systems
  - security analysis (model-checking, simulation & stats)
- Michaël Guedj's PhD (2012)
  - ABCD modelling of security protocols (Alice-Bob kind)
  - BSP-parallel CTL$\ast$ model-checking (algorithm and scalability study)
- Viet Van Pham's PhD (2014)
  - semantics of π-graphs, analysis of open reconfigurable systems
  - reachability testing, simulation and LTL model-checking (using Neco)
- Mourad Amziani's PhD (2015)
  - modelling of elasticity mechanisms in cloud systems (nets-within-nets)
  - safety analysis (reachability testing)
- support to Petri net research
  - several other PhD around the world (few information available)
  - prototyping, experiments, methods validation, ...
- numerous master students' projects, teaching, tutorials, etc.

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- Sam Sanjabi's post-doc (2010) and Samira Chaou's PhD (2013)
    - ABCD modelling of peer-to-peer storage systems
    - security analysis (model-checking, simulation & stats)
- Michaël Guedj's PhD (2012)
    - ABCD modelling of security protocols (Alice-Bob kind)
    - BSP-parallel CTL$*$ model-checking (algorithm and scalability study)
- Viet Van Pham's PhD (2014)
    - semantics of π-graphs, analysis of open reconfigurable systems
    - reachability testing, simulation and LTL model-checking (using Neco)
- Mourad Amziani's PhD (2015)
    - modelling of elasticity mechanisms in cloud systems (nets-within-nets)
    - safety analysis (reachability testing)
- support to Petri net research
    - several other PhD around the world (few information available)
    - prototyping, experiments, methods validation, . . .
- numerous master students' projects, teaching, tutorials, etc.

Outline

Introducing SNAKES

Efficient model-checking

Interfacing with other languages

Typical use cases

Conclusion

Ongoing and future work

- necessary conditions to reach version 1.0 (current: 0.9.17)
  - replace PNML support with more generic output (GrML, JSON)
  - recover through GrML ↦ PNML (using third-party tool CosyVerif)
  - integrate Neco through a plugin
  - fill a few holes in the documentation
  - minor code cleanup and simplification

Ongoing and future work

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  - integrate Neco through a plugin
  - fill a few holes in the documentation
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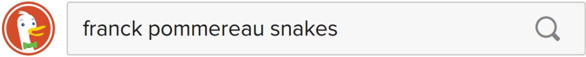
- other needs and ideas
  - better interactive/fast simulation, coupled with statistical analysis
  - genericity w.r.t. annotation language (use compilation approach)
  - major code cleanup and simplification
  - integrate with other tools (GUIs, analysers, etc.)
  - more inputs/outputs (using third-party tools)
  - automate API generation to other languages
  - extend ABCD with a Petri net syntax
  - add processes to ABCD
  - win the lottery and hire engineers

Thank you. Questions?



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