# Optimising the compilation of Petri net models

Łukasz Fronc and Franck Pommereau
{fronc,pommereau}@ibisc.univ-evry.fr

SUMo (at PETRI NETS), June 21th, 2011


# Outlines

Domain:

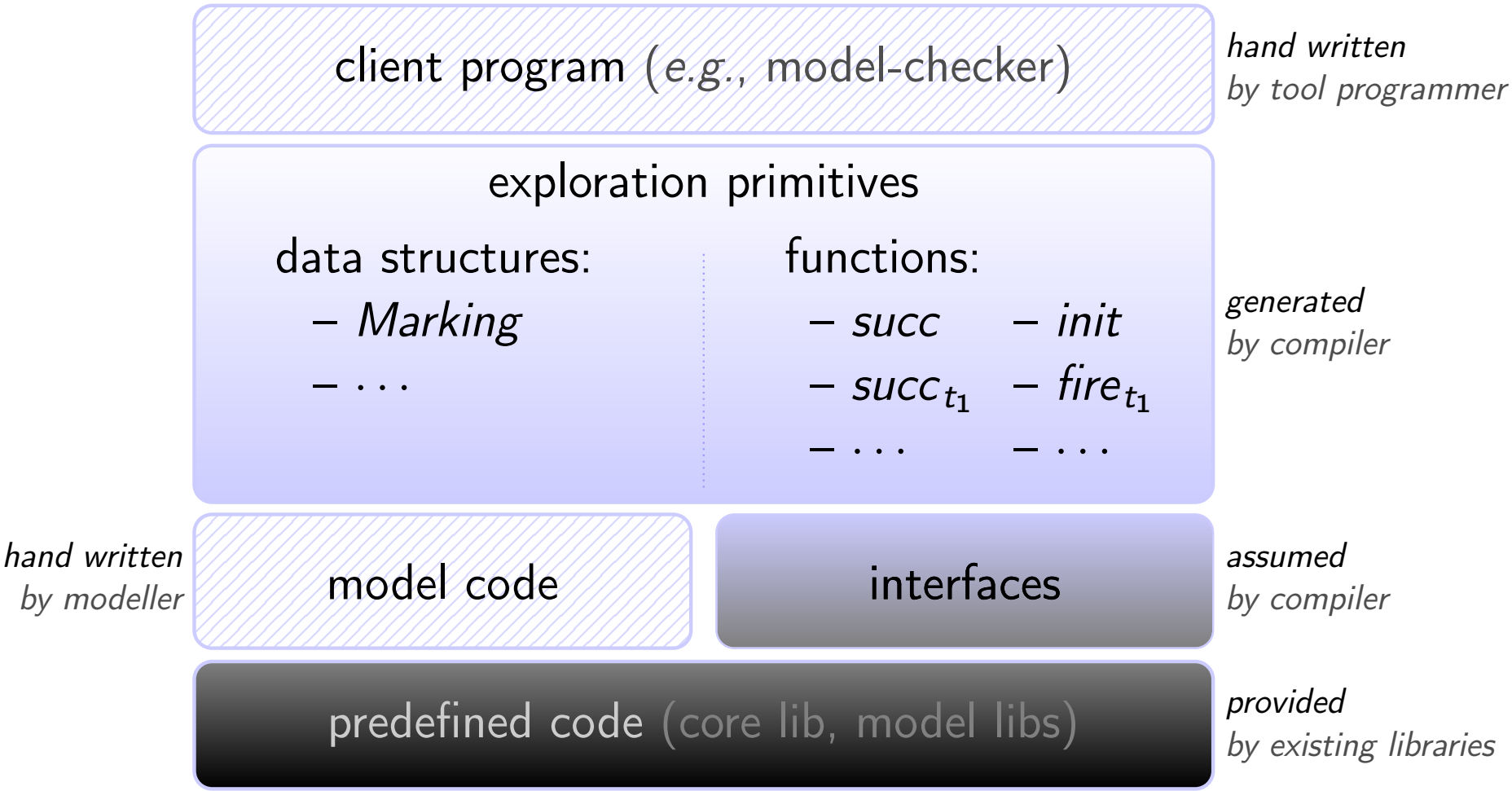
- coloured Petri nets
  - colour domain is Python
  - infinite place types allowed
  - output arcs do computation (arbitrary Python expressions)
  - input arcs bind variables (with pattern matching)
- explicit model-checking (or simulation)

Goal: accelerate transition firing

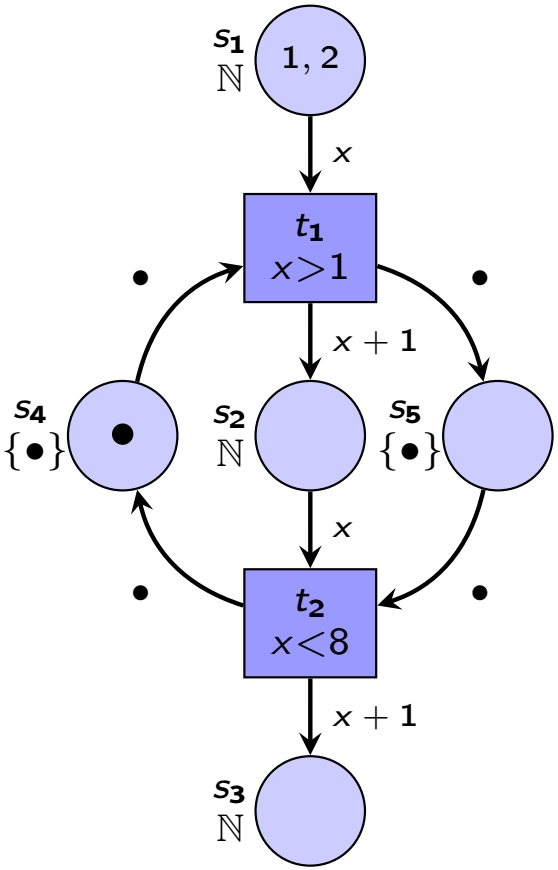
- use model compilation
  - used by Helena, Spin, ...
  - remove many data structures (remain: markings, functions)
  - produce simple and efficient code (model-specific)
- exploit model-dependent optimisations

# Contents

# Produced code



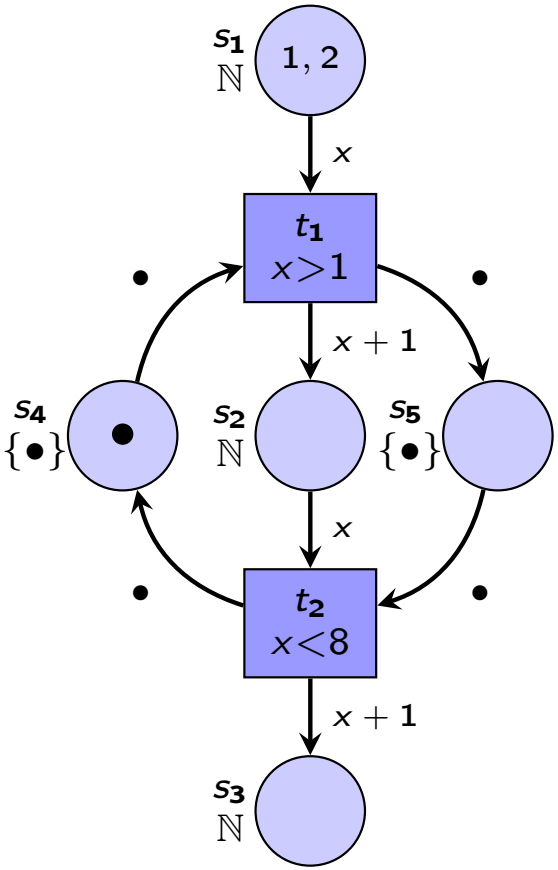
# Interpreting successor algorithm




**succ** : $M$ : *Marking*, $t$ : *Transition* $\rightarrow$ *MarkingSet*

*next* $\leftarrow \emptyset$
**for** $b$ **in** $modes(M, t)$ **do**
  *next* $\leftarrow$ *next* $\cup \{fire(M, t, b)\}$
**endfor**
**return** *next*

# Compiled successor algorithm




**succ$_{t_1}$** : $M$ : *Marking* $\rightarrow$ *MarkingSet*

$next \leftarrow \emptyset$
**for** $x$ **in** $M(s_1)$ **do**
  **for** $token_{s_4}$ **in** $M(s_4)$ **do**
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    **endif**
  **endfor**
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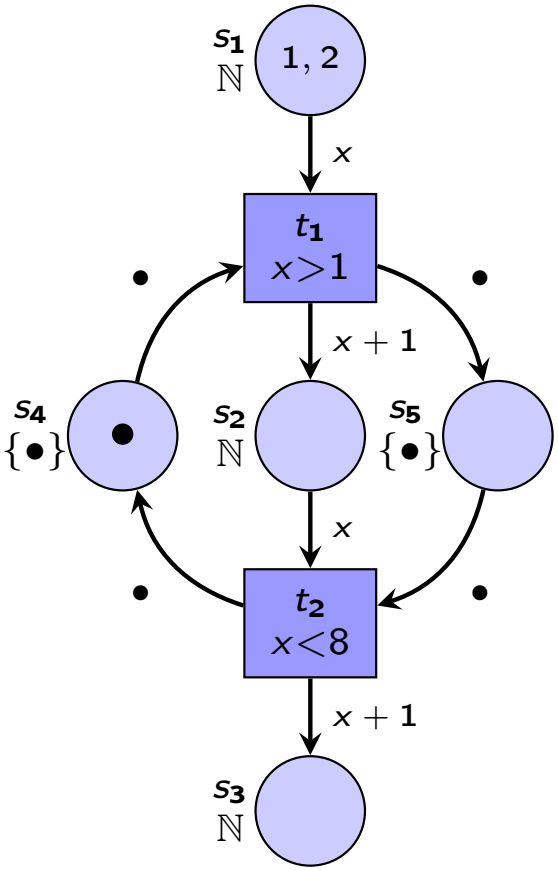
# Example of successor algorithm optimisations

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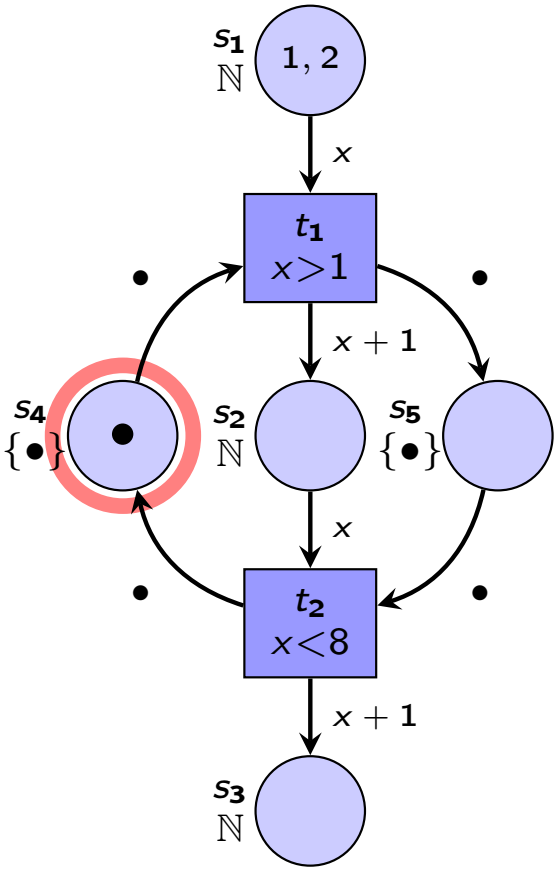


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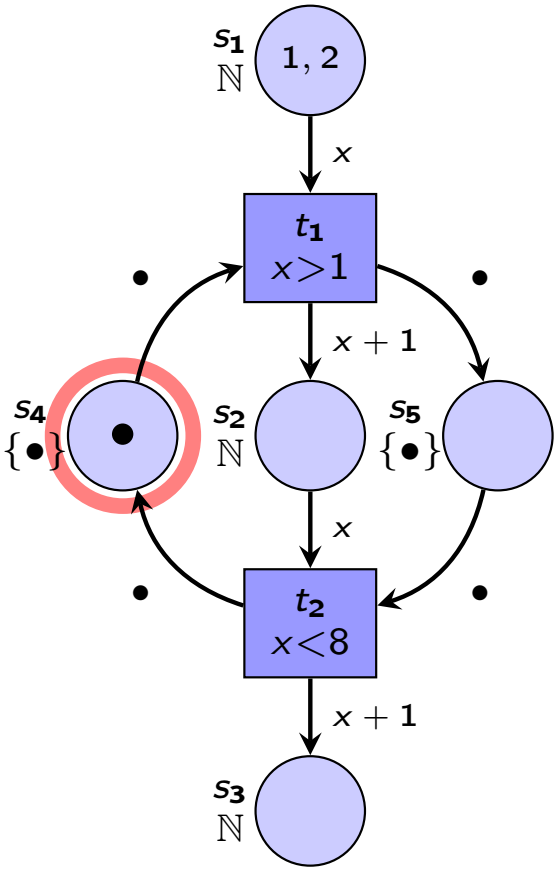


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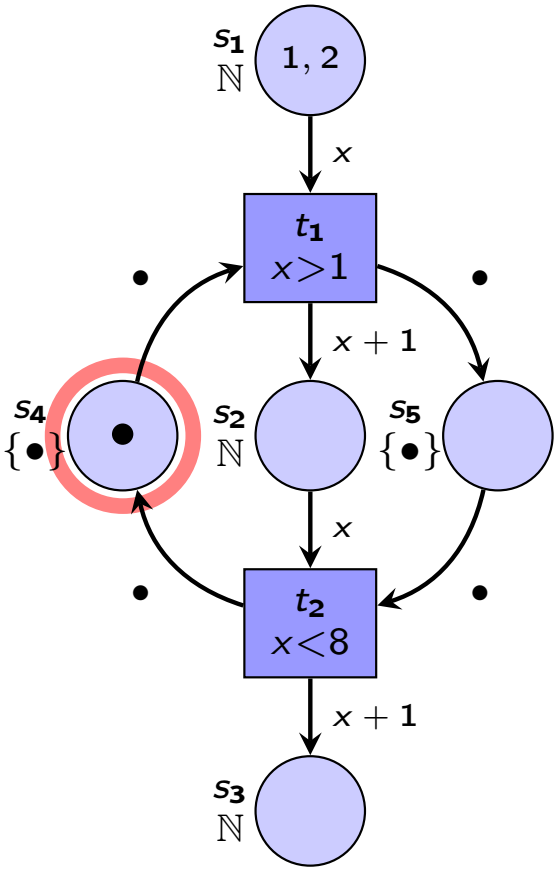


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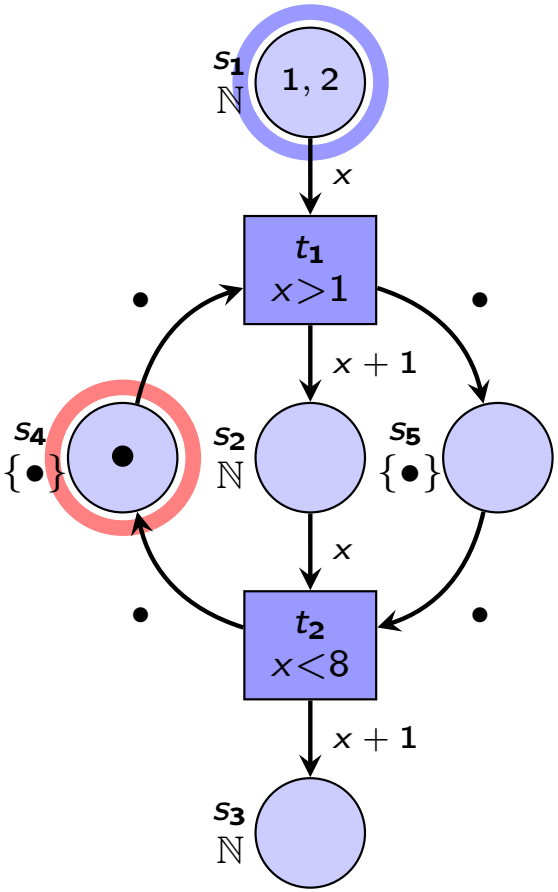


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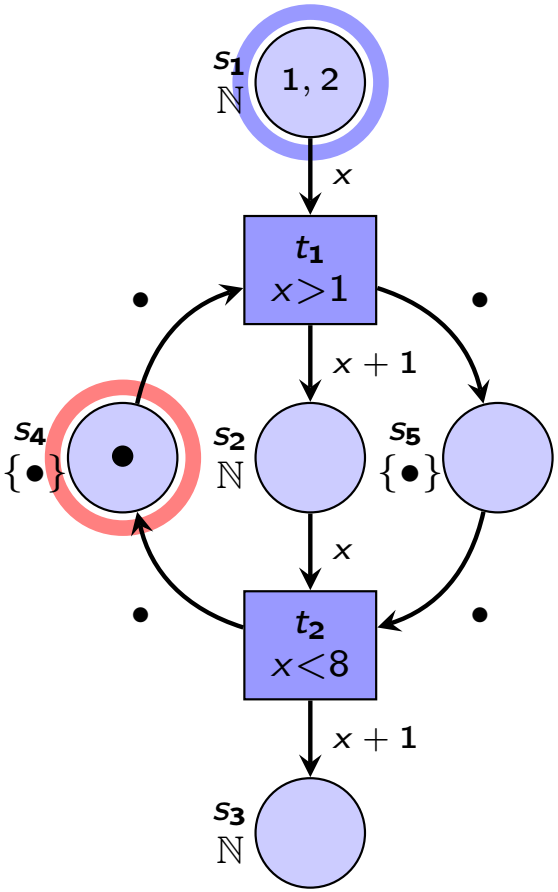


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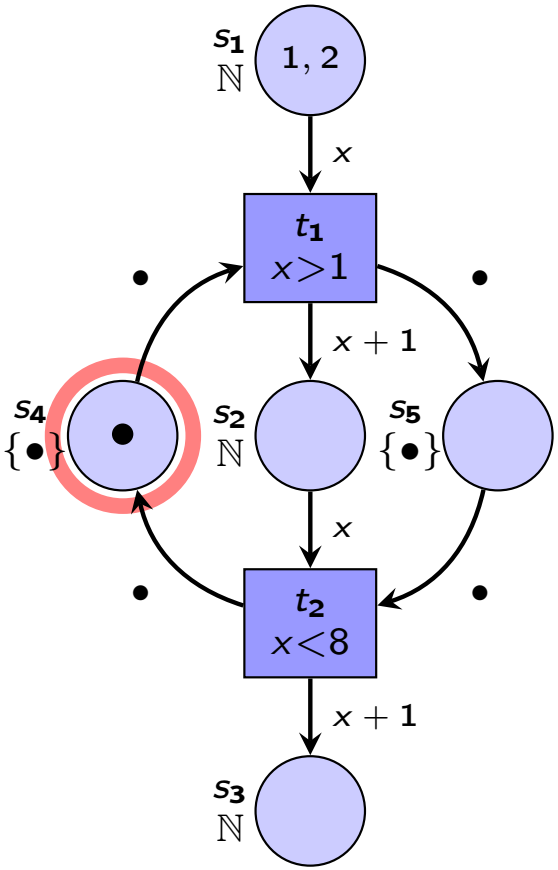


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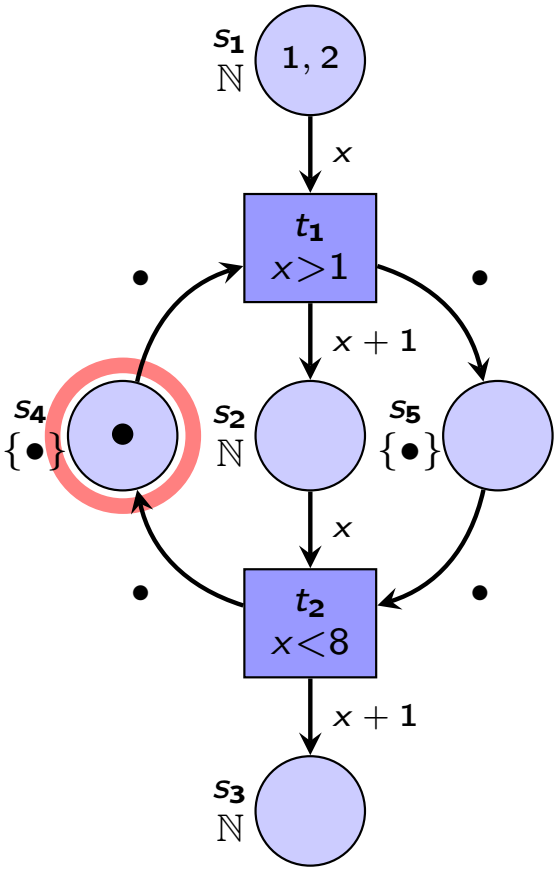


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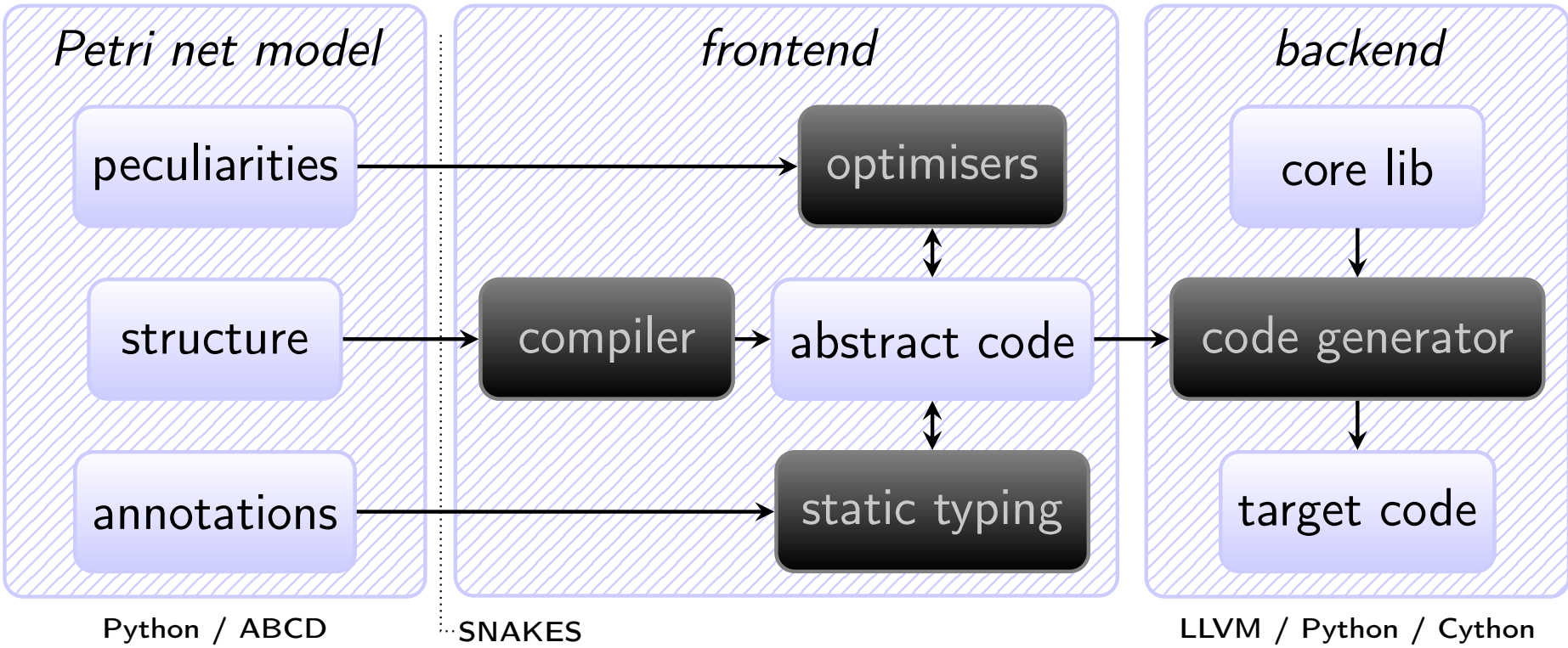
# Compiler architecture




python powered

# Experimental results

We compare:

our prototype using the Cython backend

most efficient, as expressive as Python

with Helena model checker

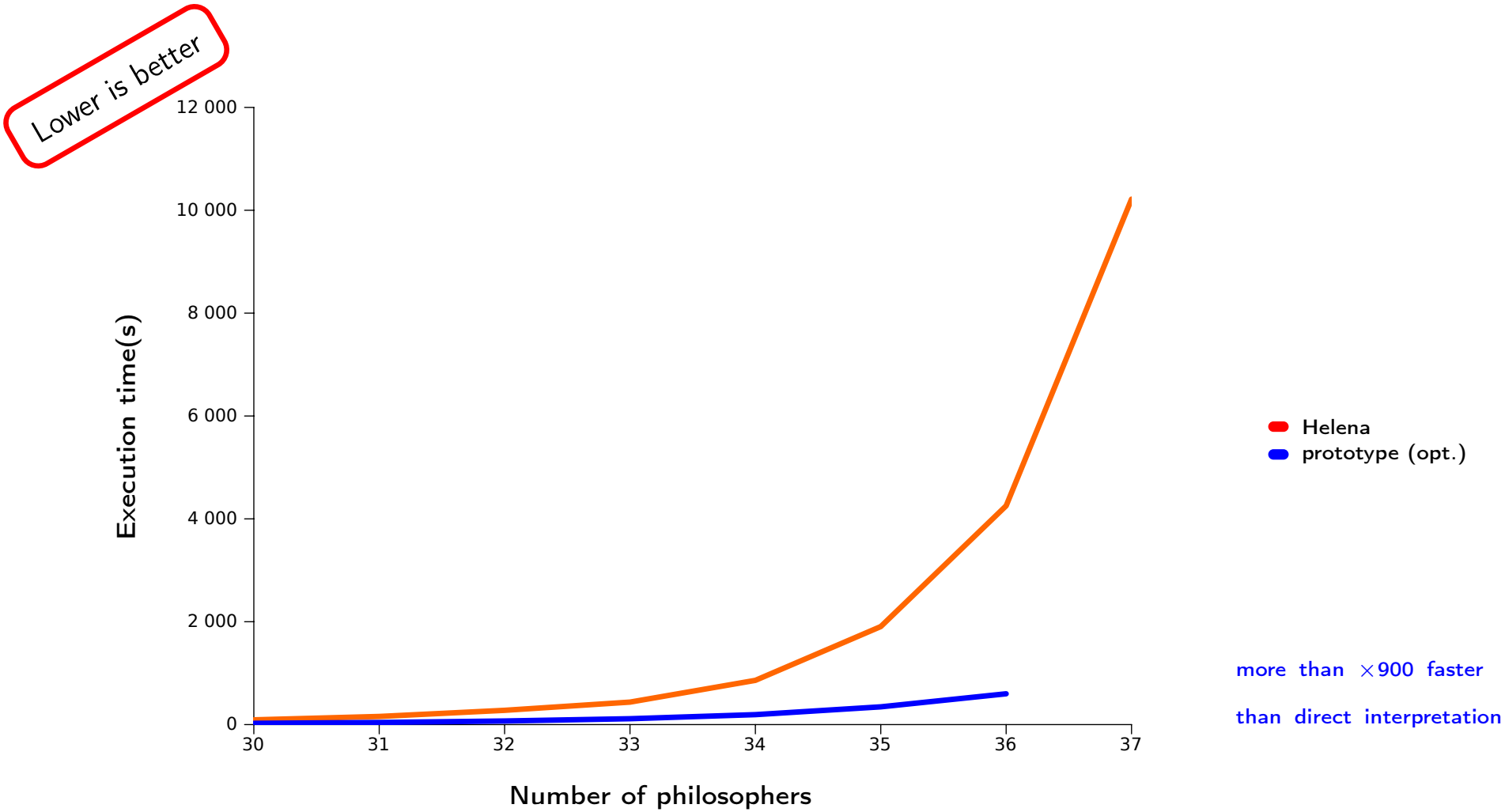
static reductions disabled

Three test cases:

- ◇ dining philosophers — one bounded Petri net
- ◇ a railroad crossing model — colored Petri net
- ◇ a security protocol model — "highly" colored Petri net

# Dining Philosophers model

## *vs* Helena



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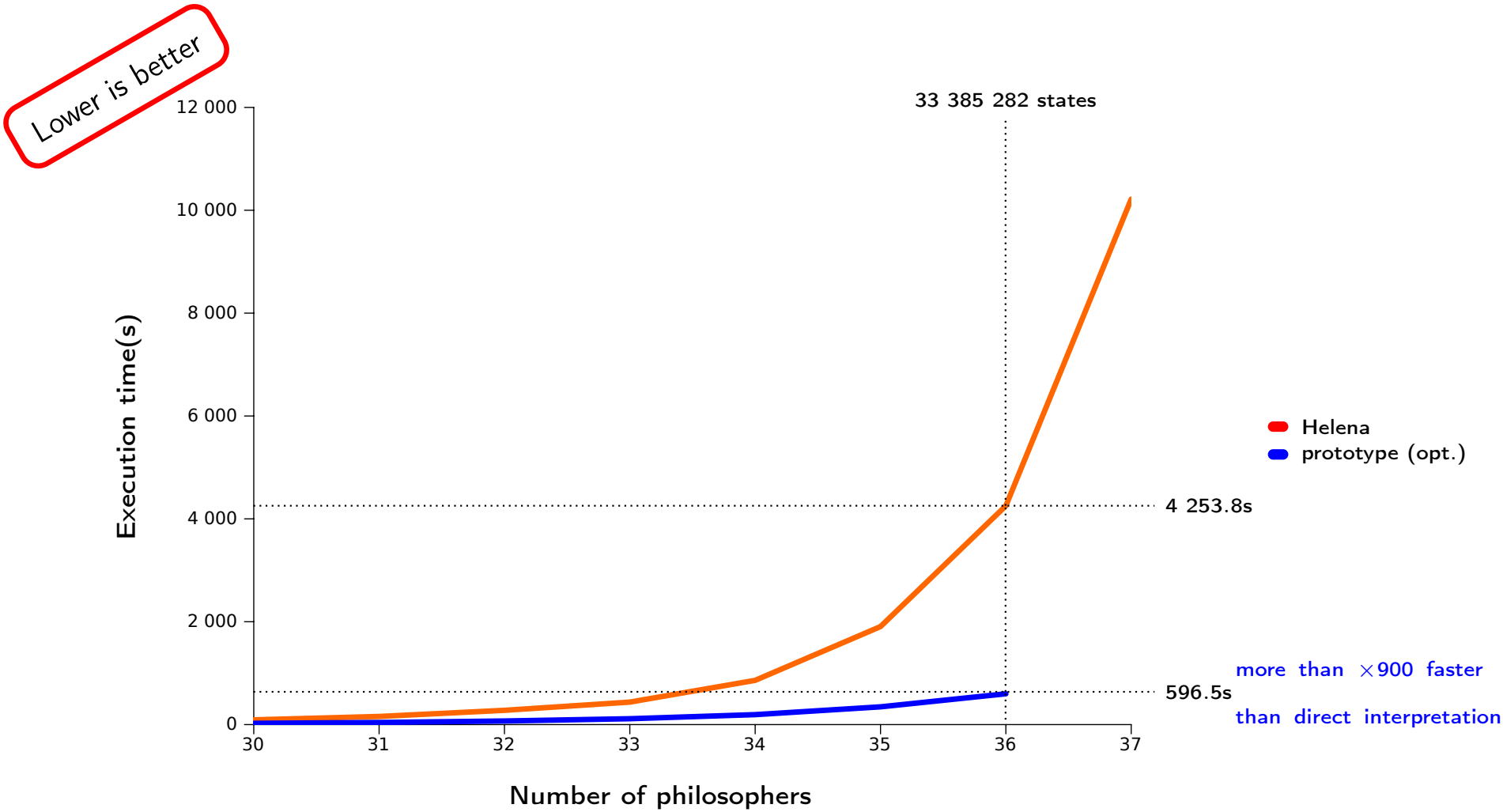

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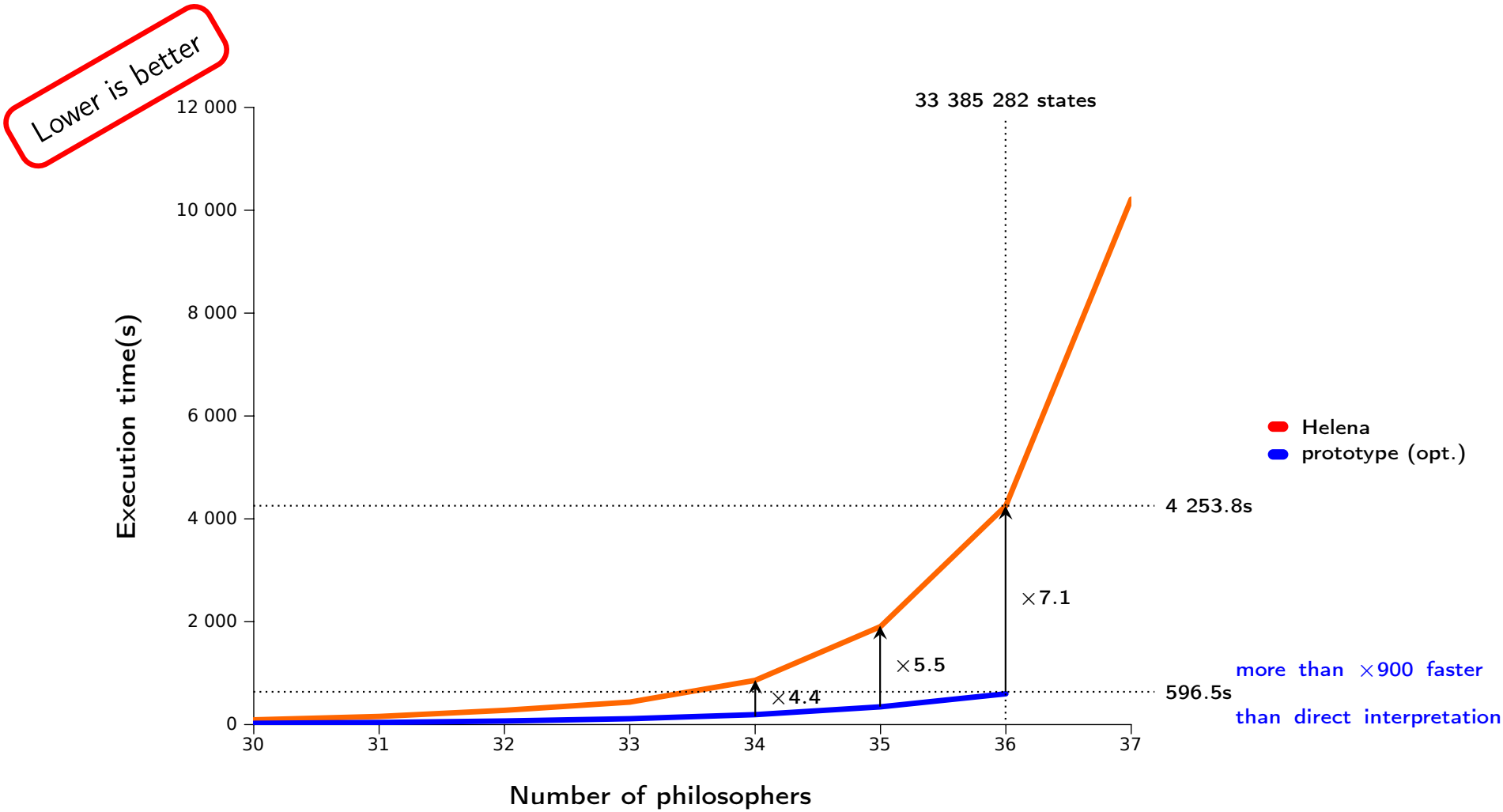

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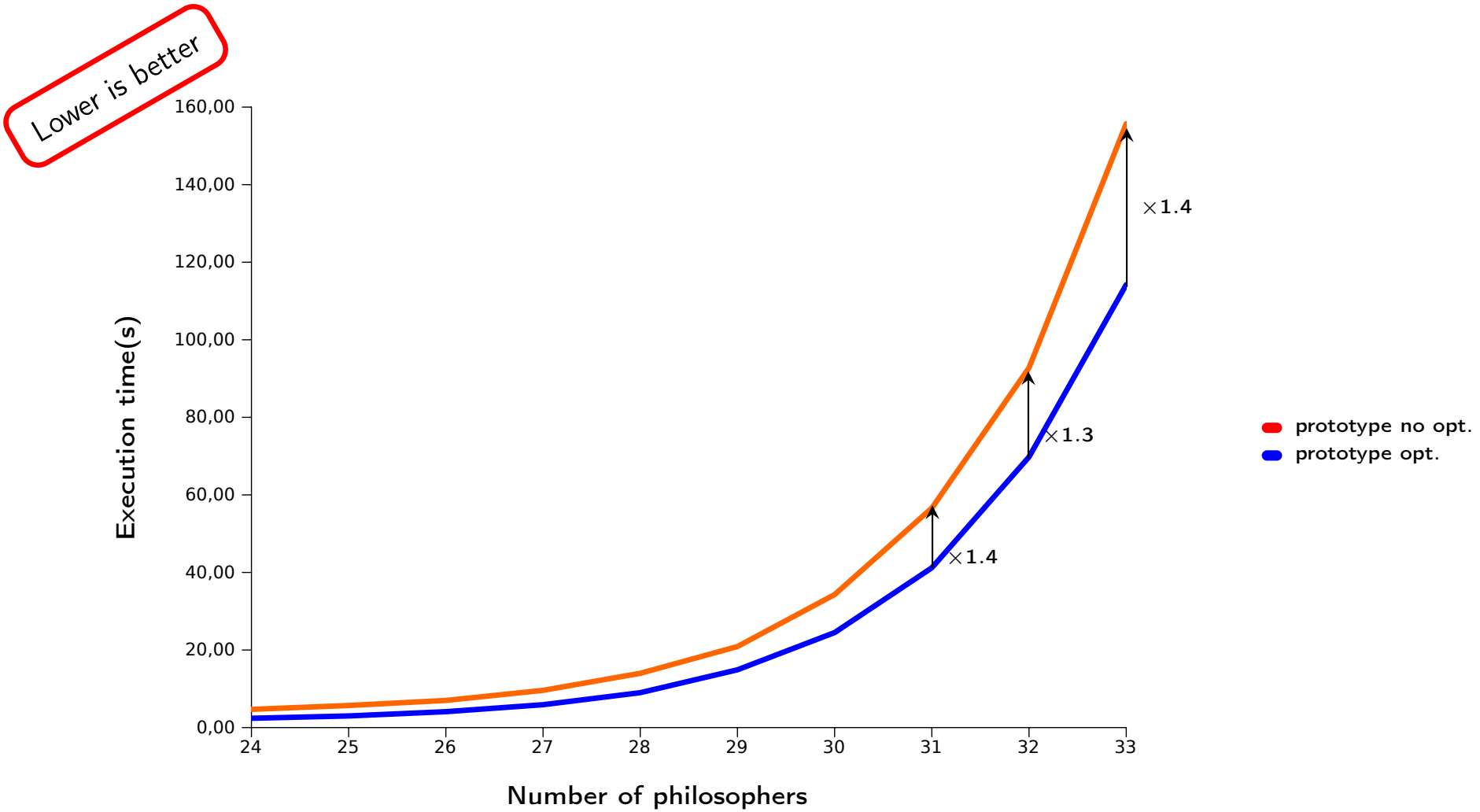

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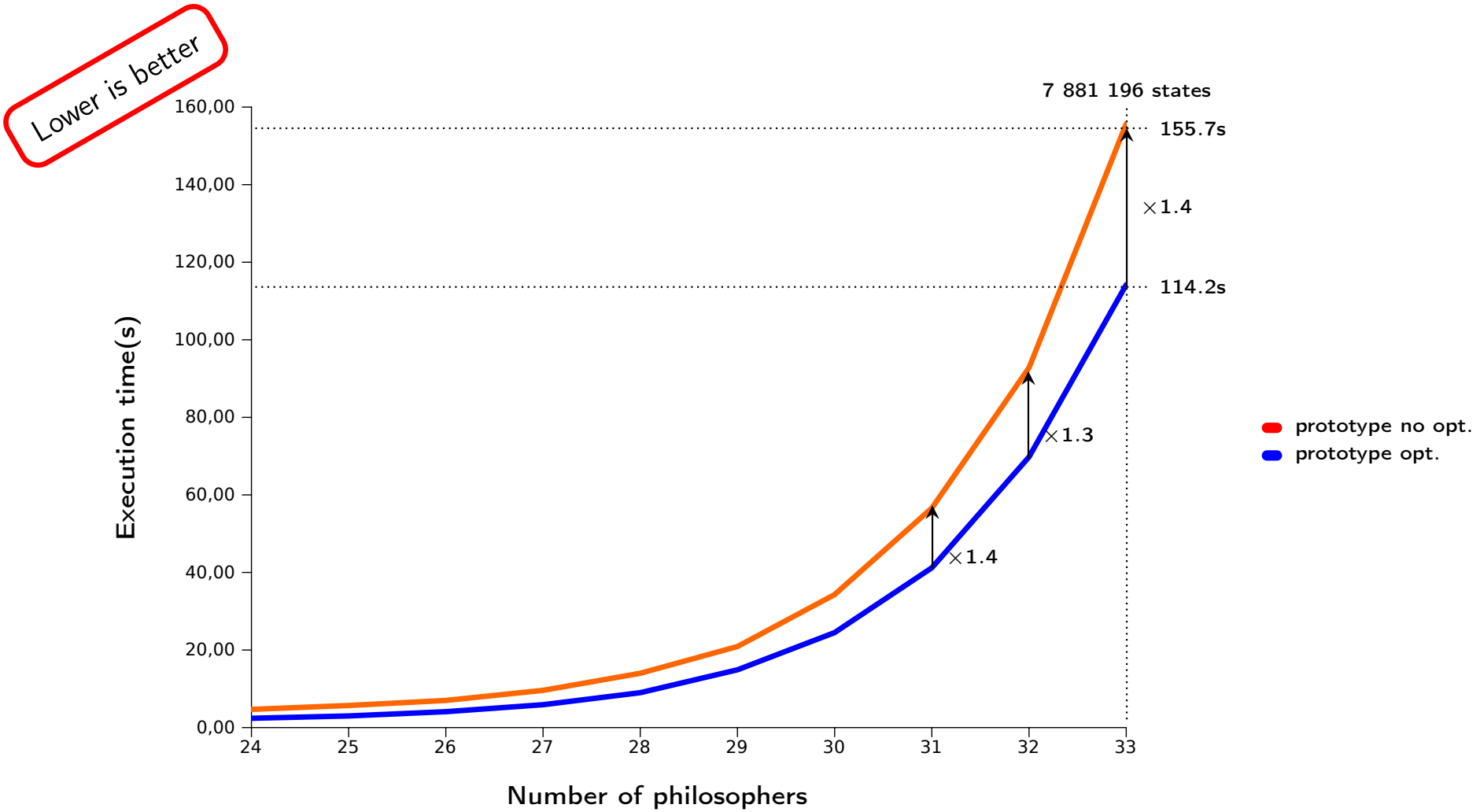

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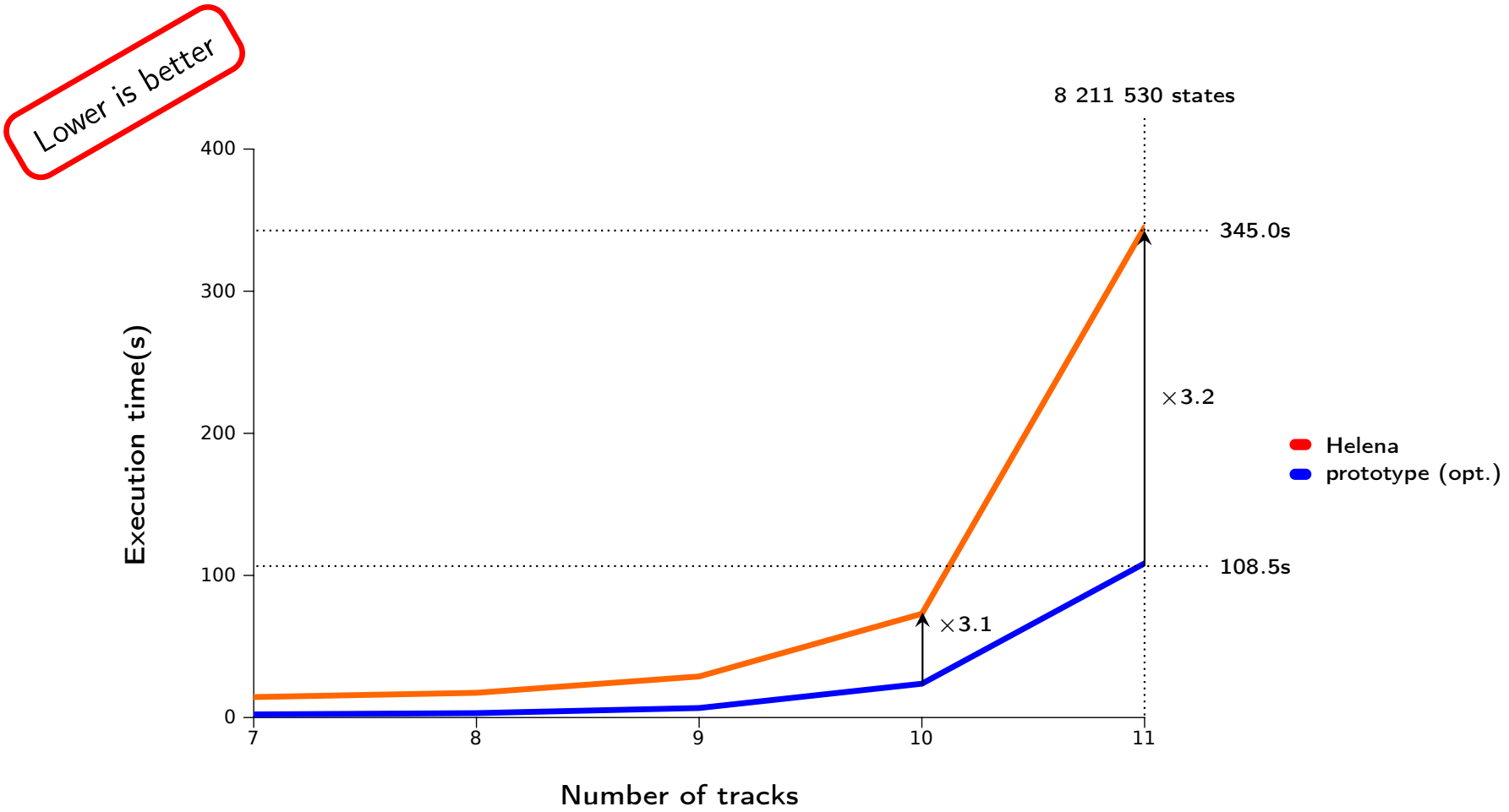

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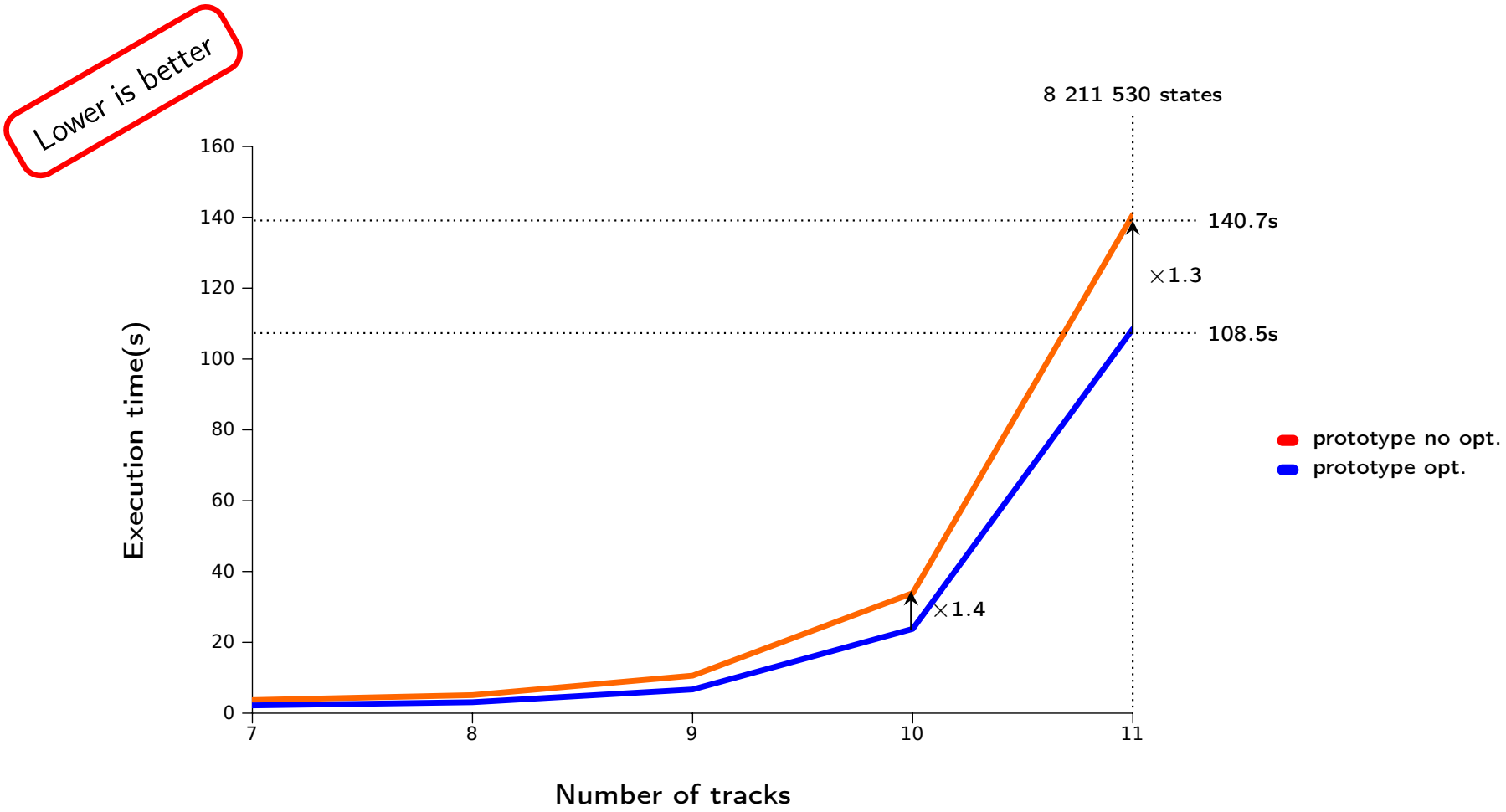

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- Needham-Schroeder public key cryptographic protocol
- embeds about 350 lines of Python code Dolev-Yao attacker
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similar model in Helena [Bouroulet 2006]

- SNAKES and Helena run in comparable times
- Python backend 10 times faster than SNAKES
  - we show now: Python *vs* Cython

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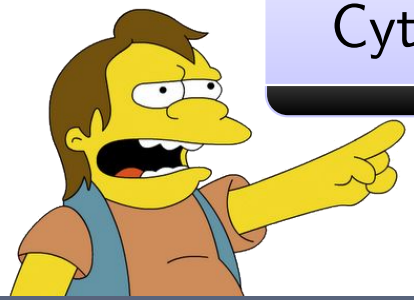
| language | not optimised | optimised | speedup |
|---|---|---|---|
| Python | 0.07s 4.93s 5.00s | 0.07s 4.11s 4.18s | 1.20 |
| Cython | 2.36s 3.14s 5.50s | 2.02s 2.82s 4.84s | 1.14 |



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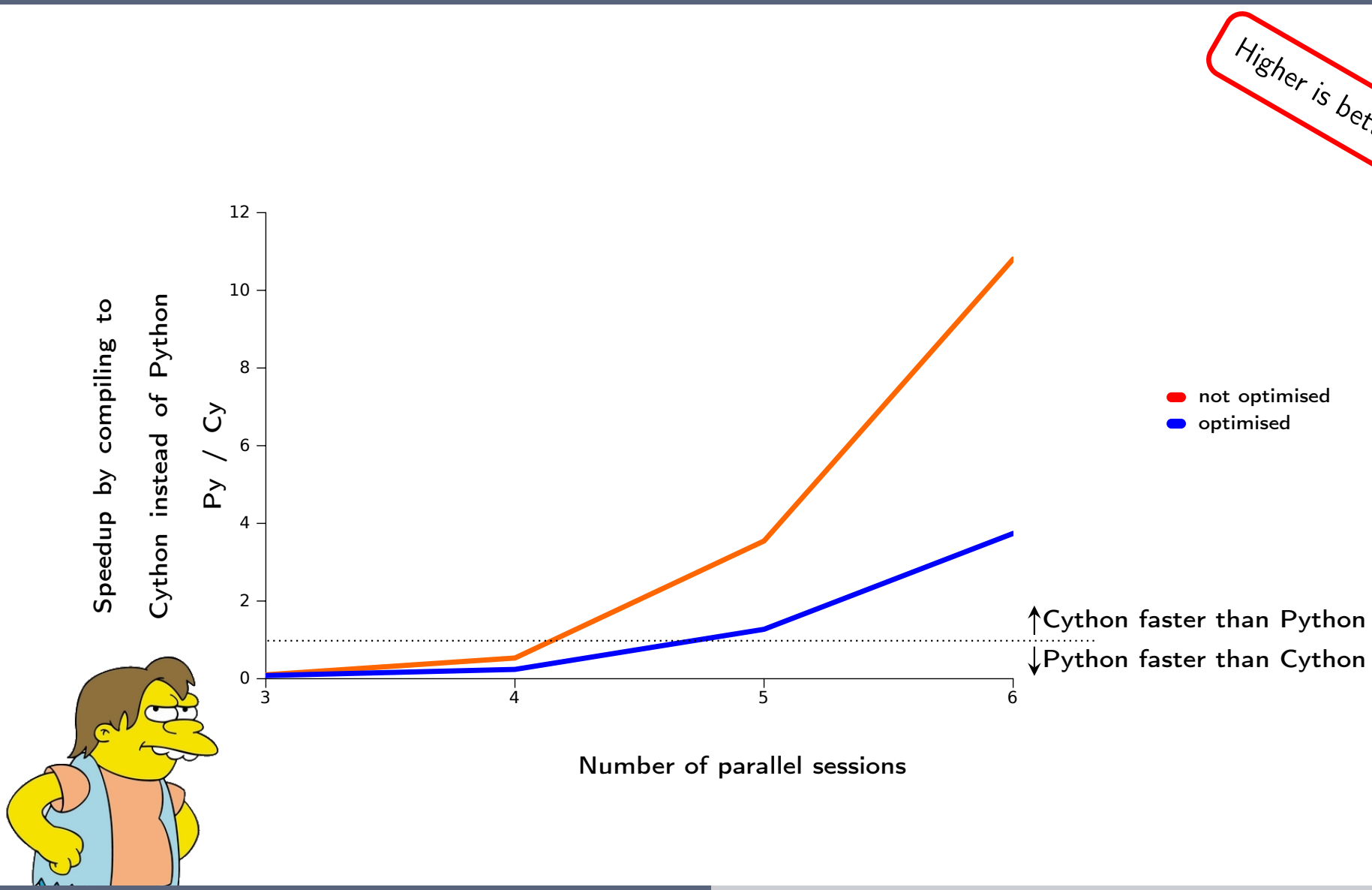

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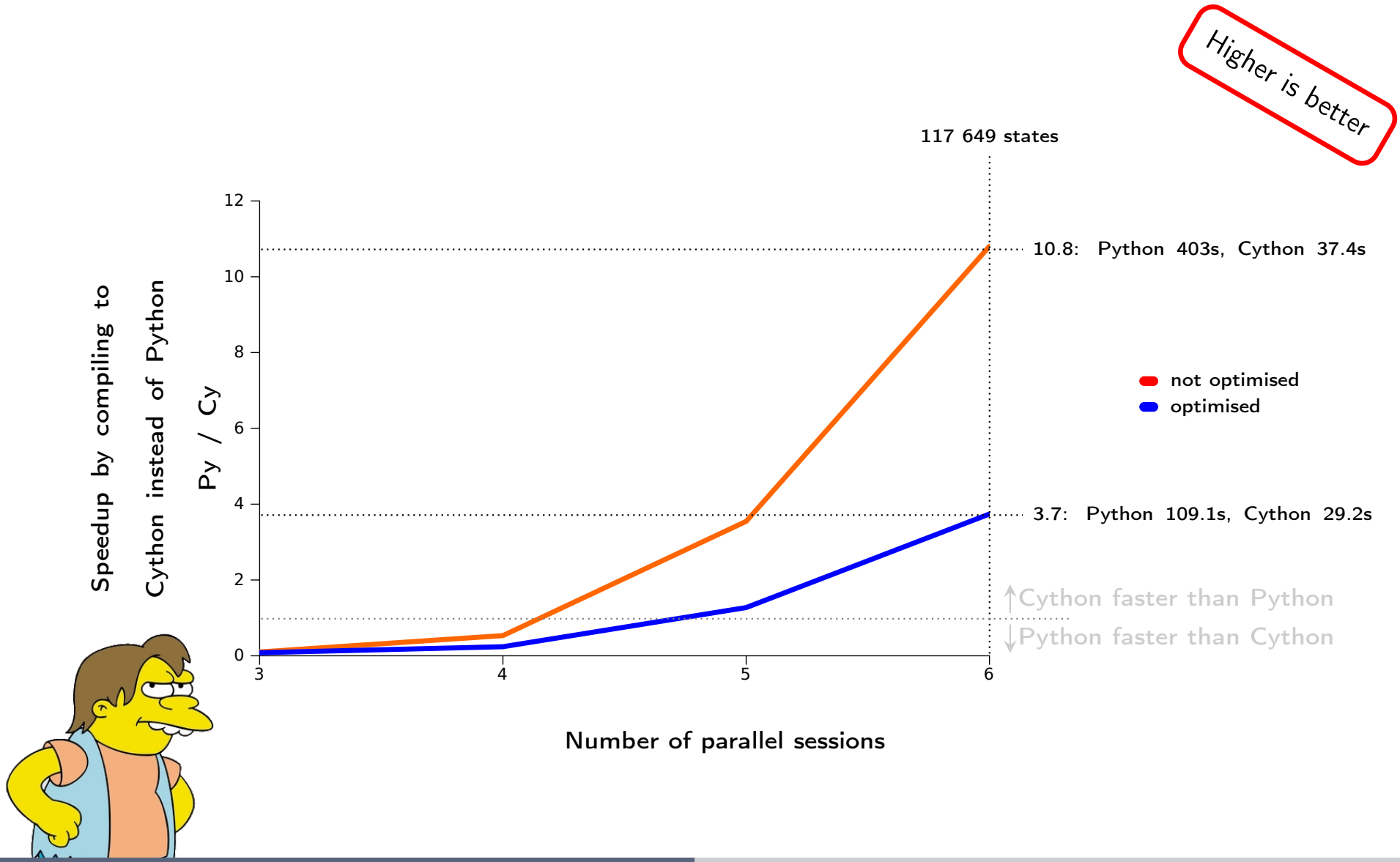

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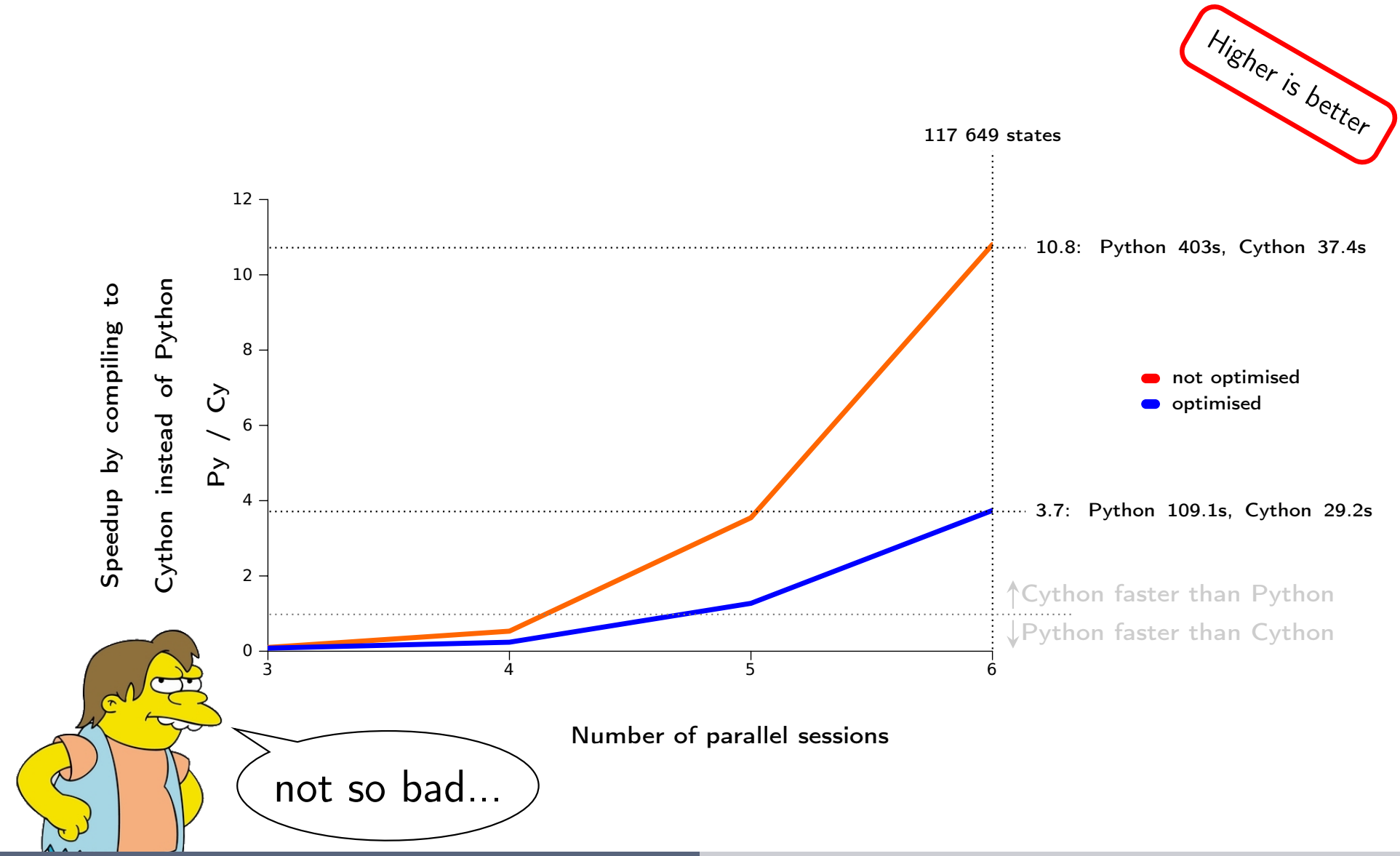

# Conclusion

- simple model peculiarities — boundaries, place types
  - compile/compute faster — than Helena and than ourselves
  - may be known by construction — *i.e.*, for free
- relevance shown by experimental results

  optimisations: speedup up to $\times 2$ faster — avg. $\times 1.4$

  over $\times 900$ faster than direct interpretation — w.r.t. SNAKES

## What's next?

- more case studies
- integrate into Helena, interface with SPOT
  - real model-checking
  - optimisations: stubborn sets, states compression, ...