Language integration and migration


Edd Barrett


Carl Friedrich Bolz


Lukas Diekmann


Laurence Tratt


Naveneetha Krishnan Vasudevan

KING'S College LONDON

Software Development Team

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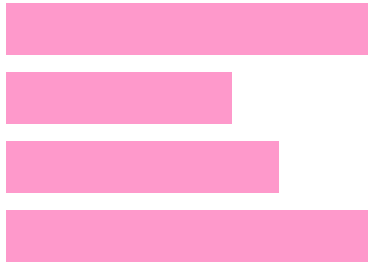
What to expect from this talk

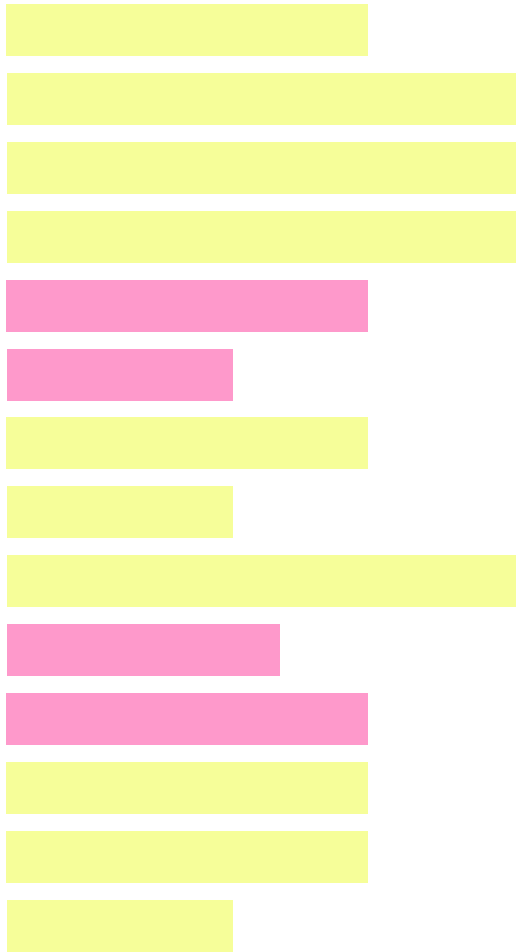
A

B



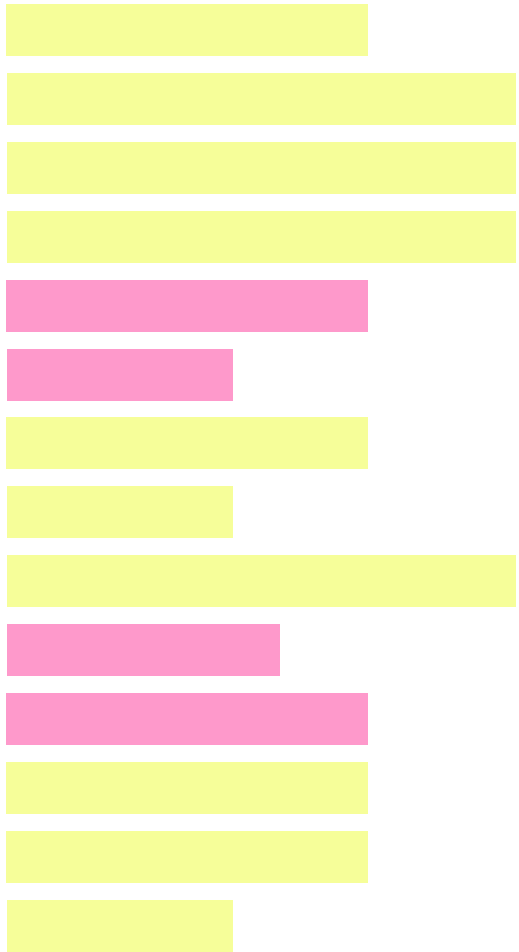
What to expect from this talk

$$A \cup B$$



What to expect from this talk

Python ∪ Prolog



What to expect from this talk

Python ∪ PHP

Our problem

Our problem

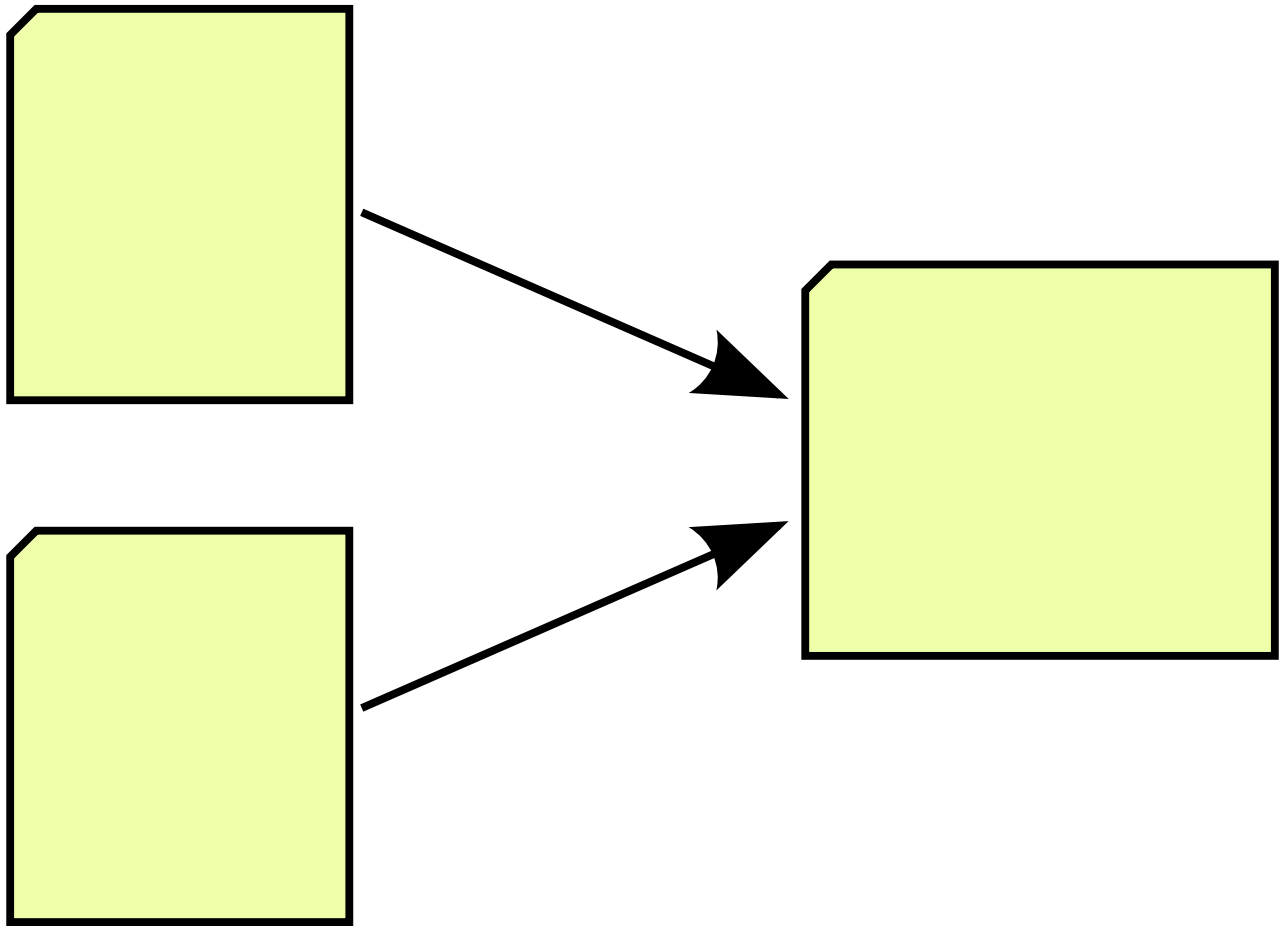
We want **better** programming languages

Our problem

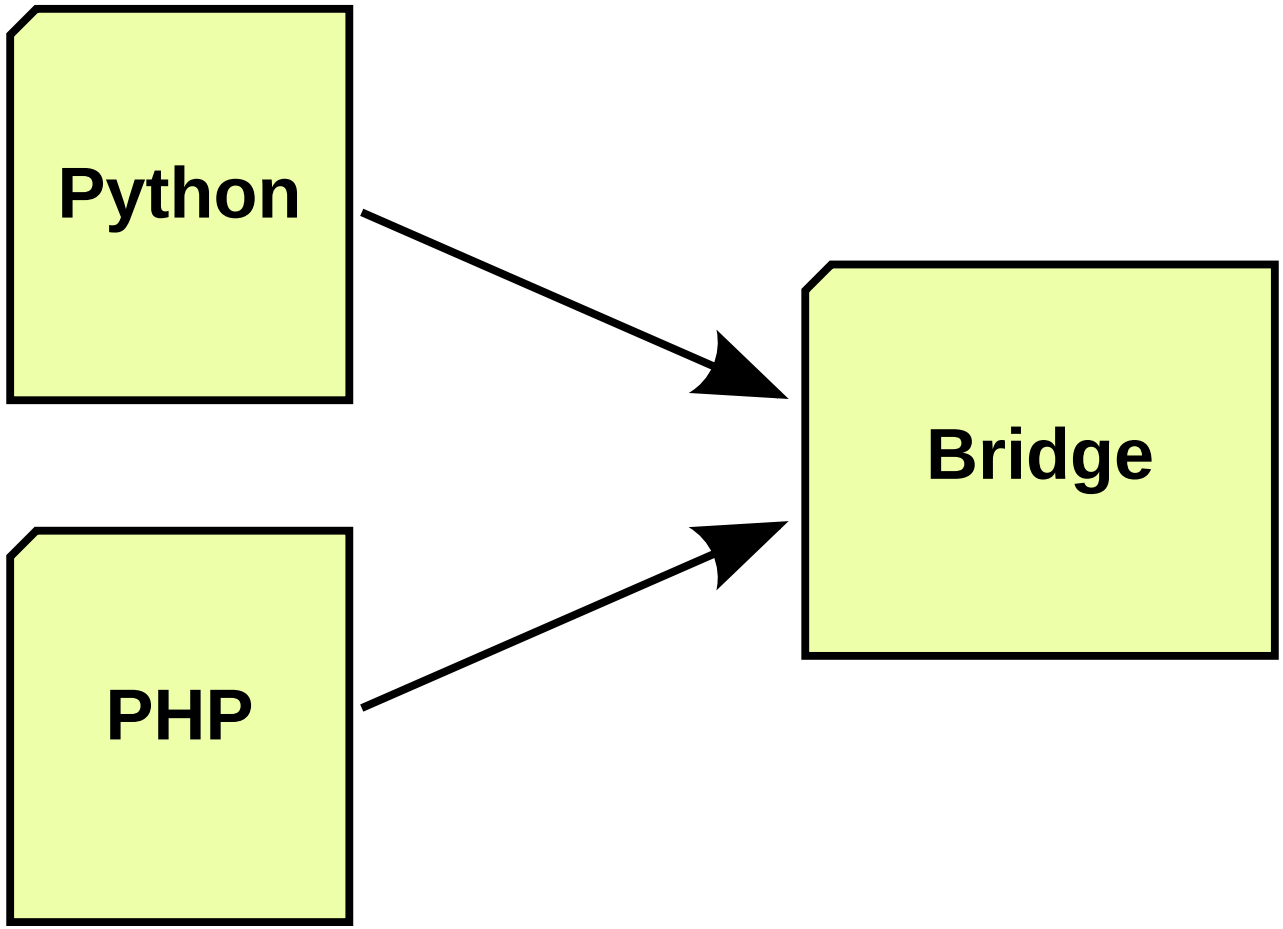
We want **better** programming languages

But better always seems to end up **bigger**

Underlying language composition challenges



Underlying language composition challenges



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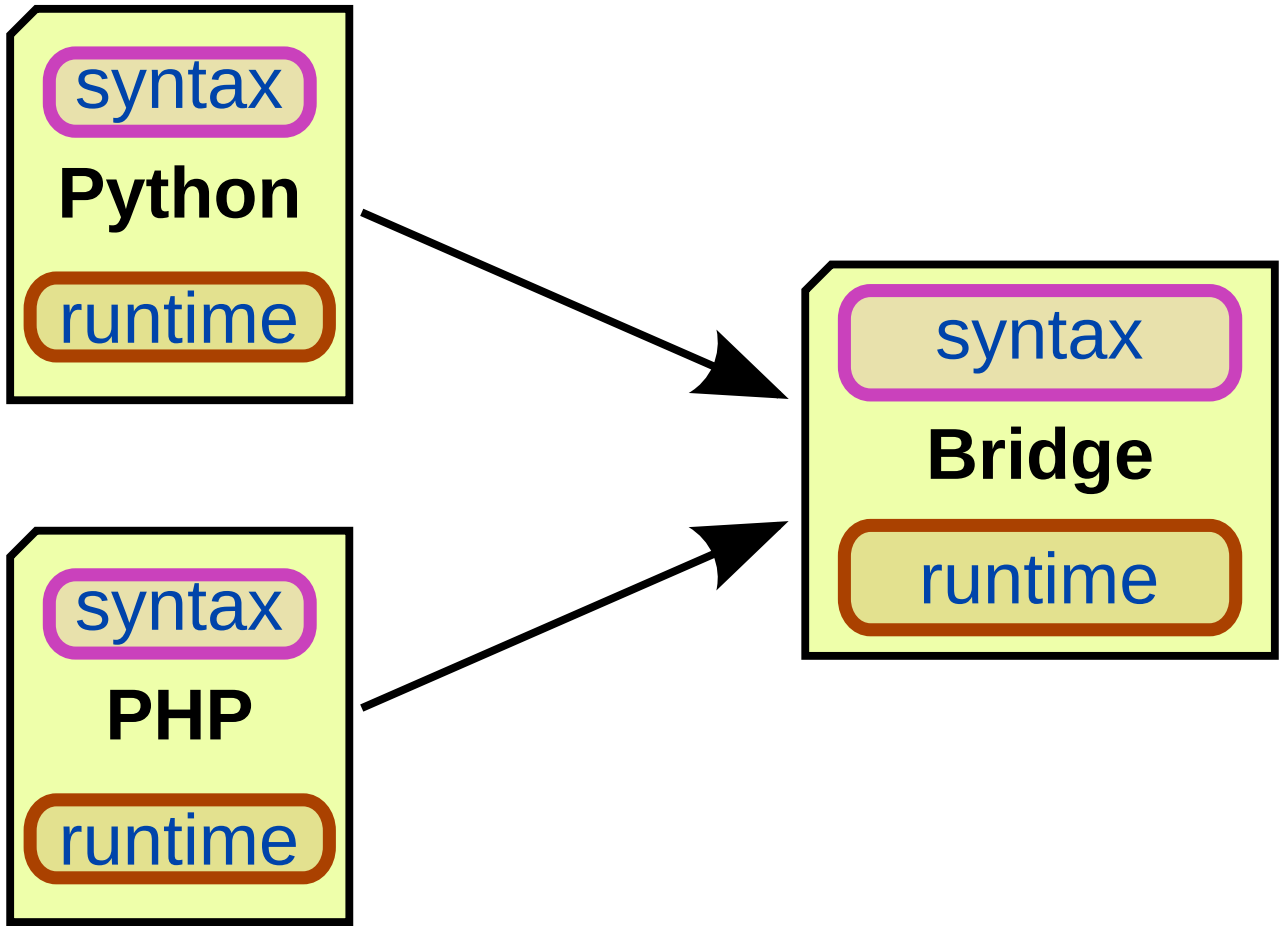
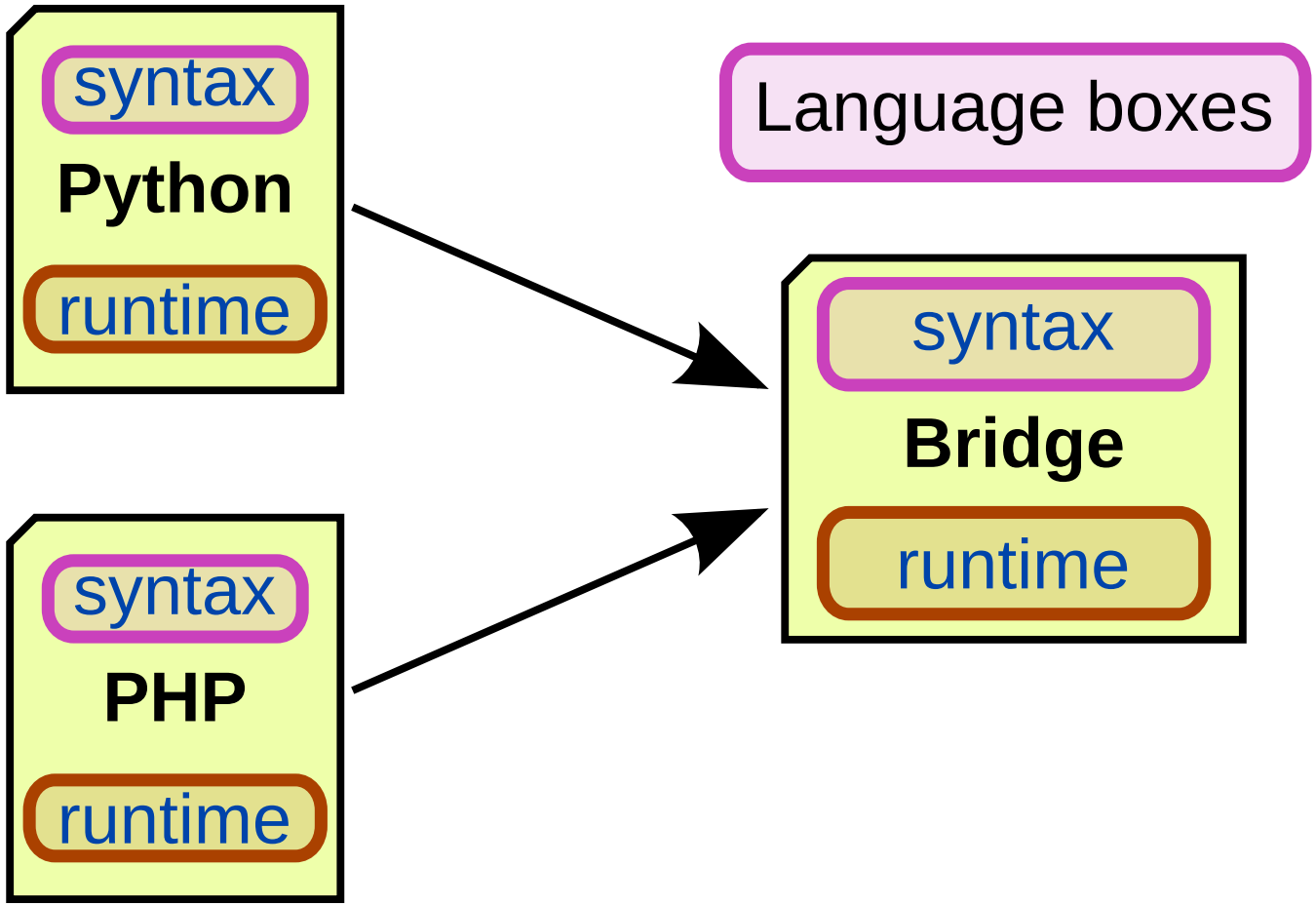
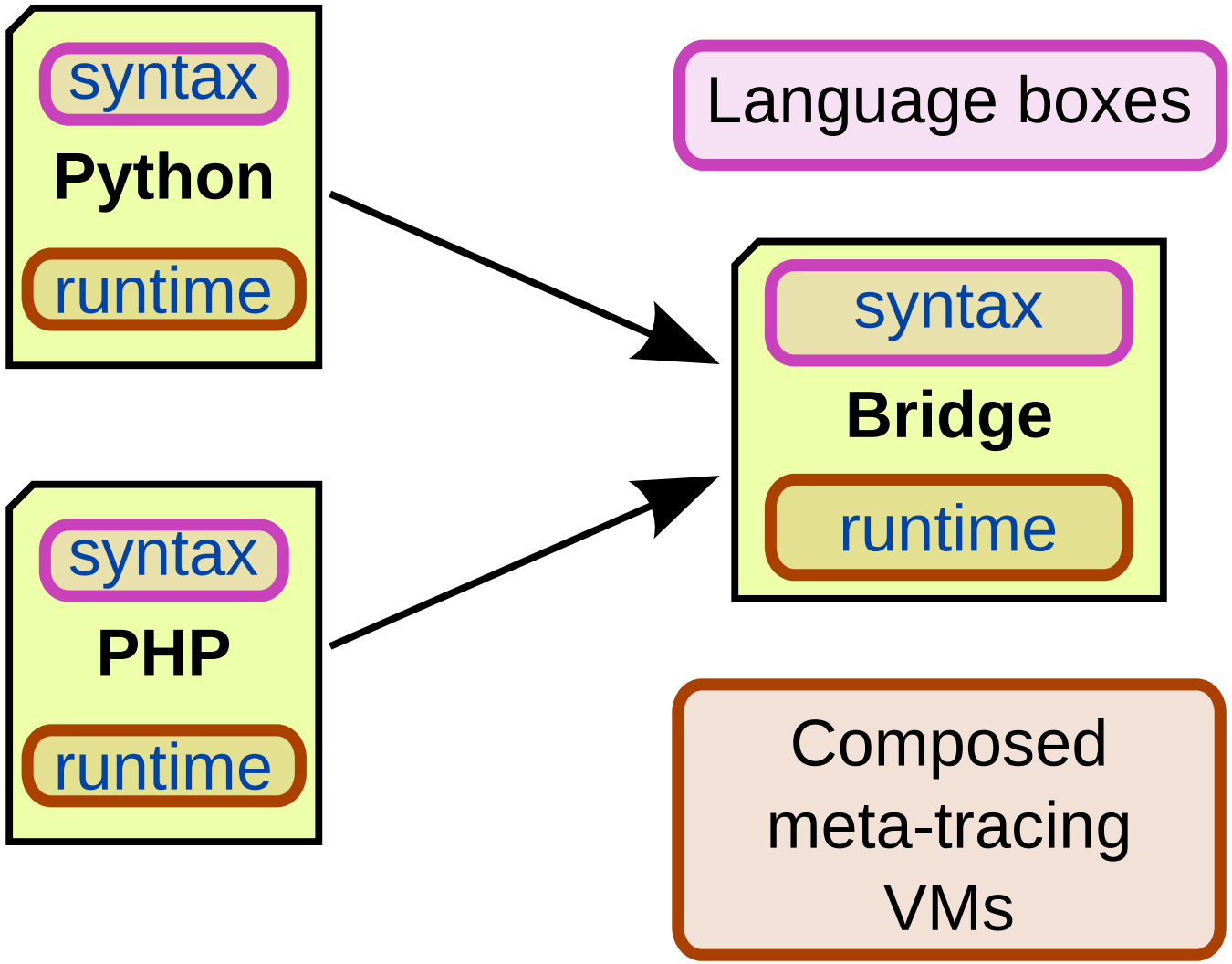


Underlying language composition challenges



Underlying language composition challenges



Syntax composition

PL X

<grammar>

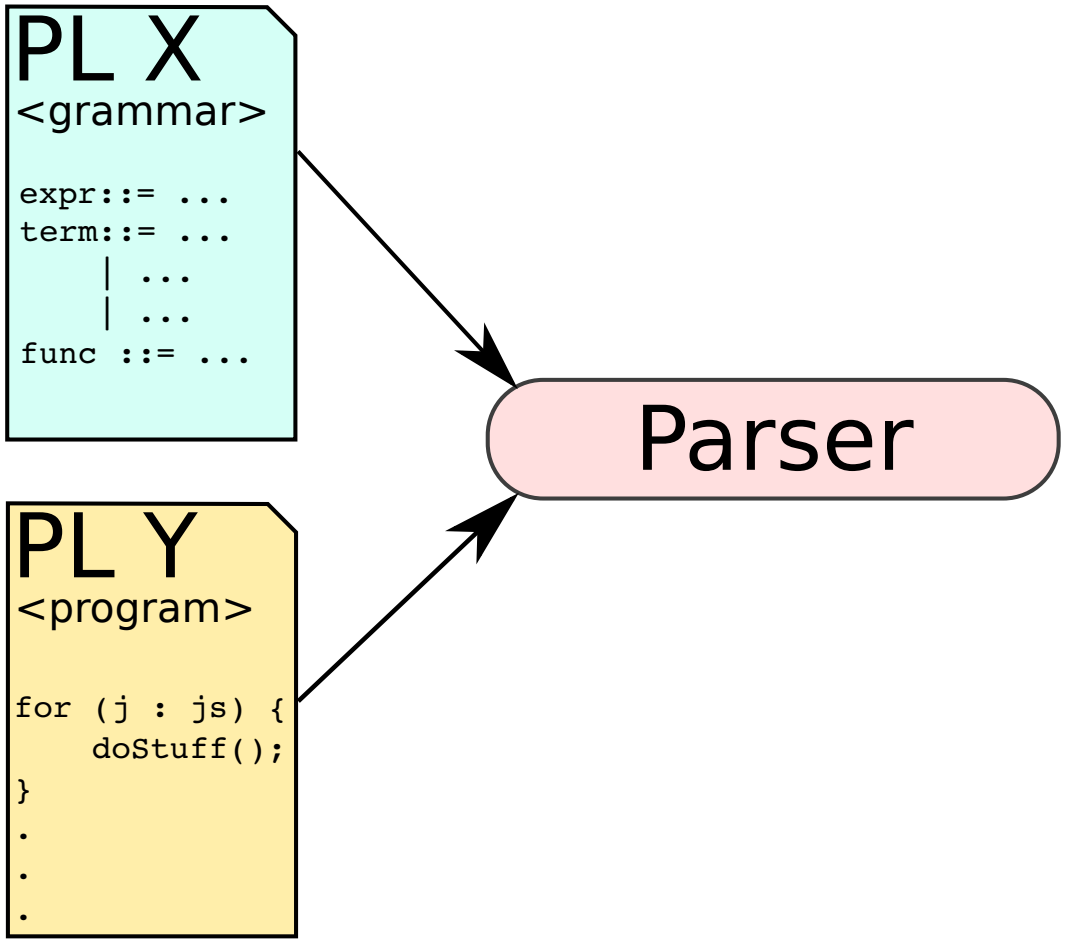
```
expr::= ...
term::= ...
    | ...
    | ...
func ::= ...
```

PL Y

<program>

```
for (j : js) {
    doStuff();
}
.
.
.
```

Syntax composition



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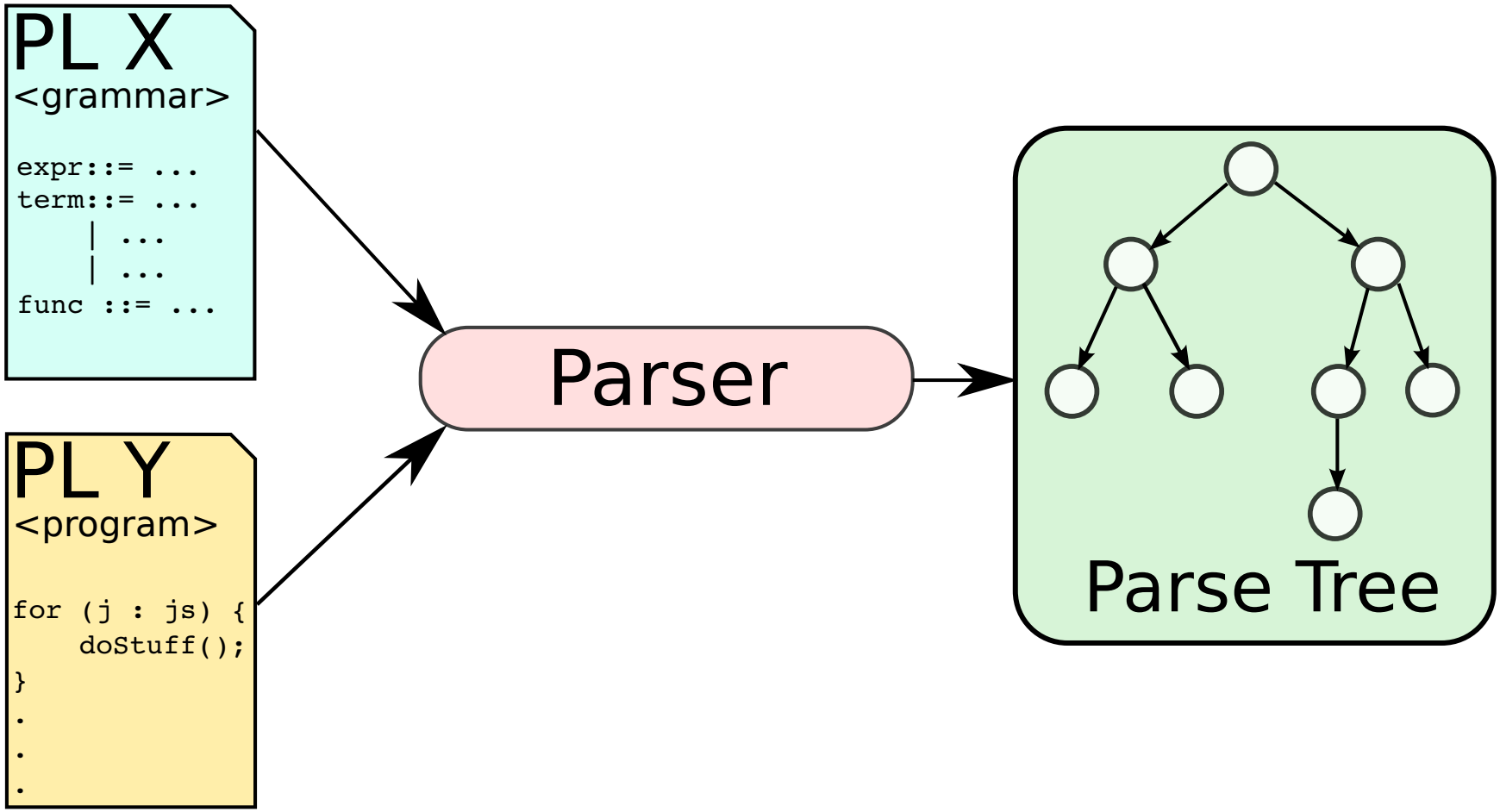

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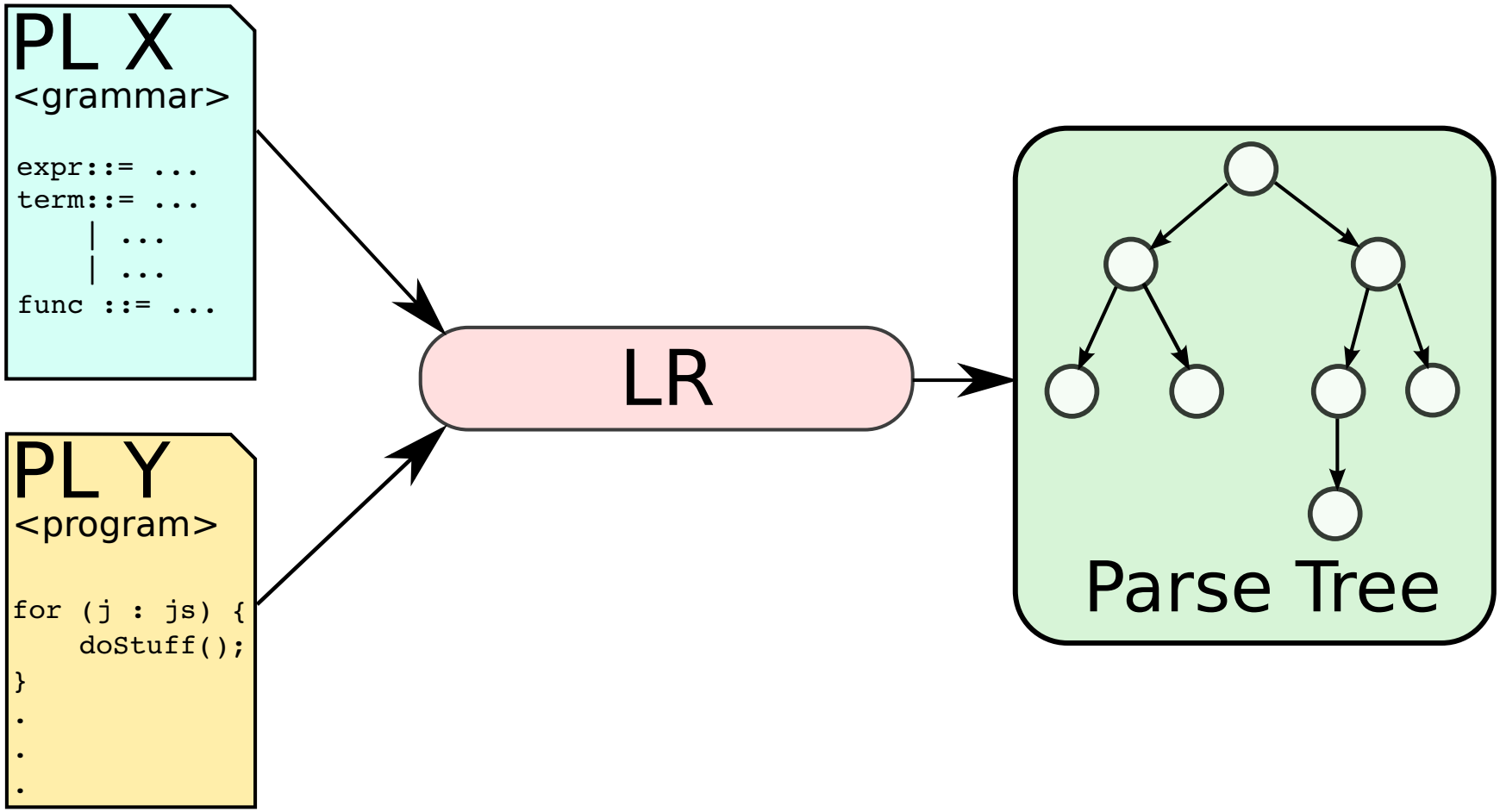

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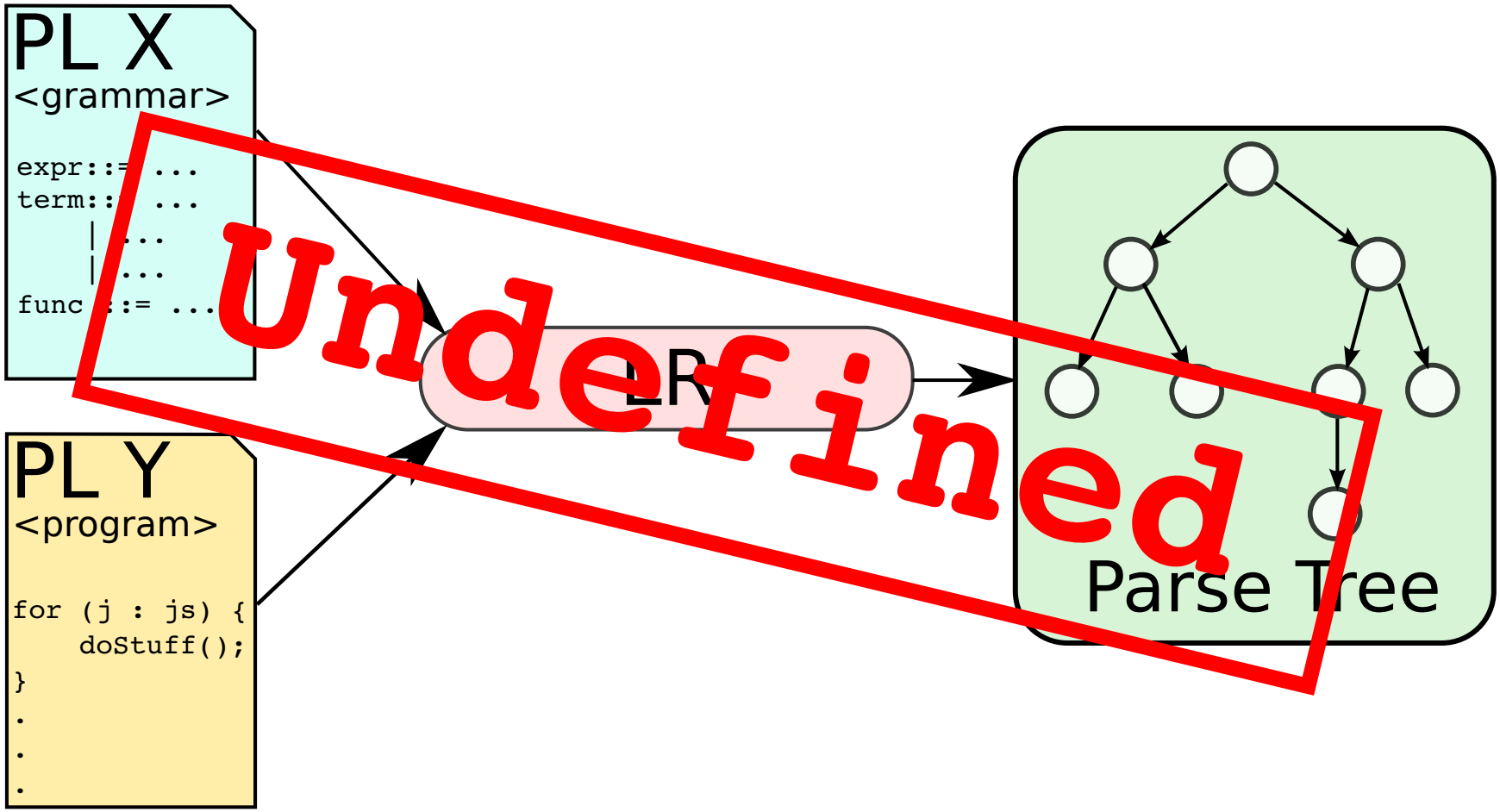

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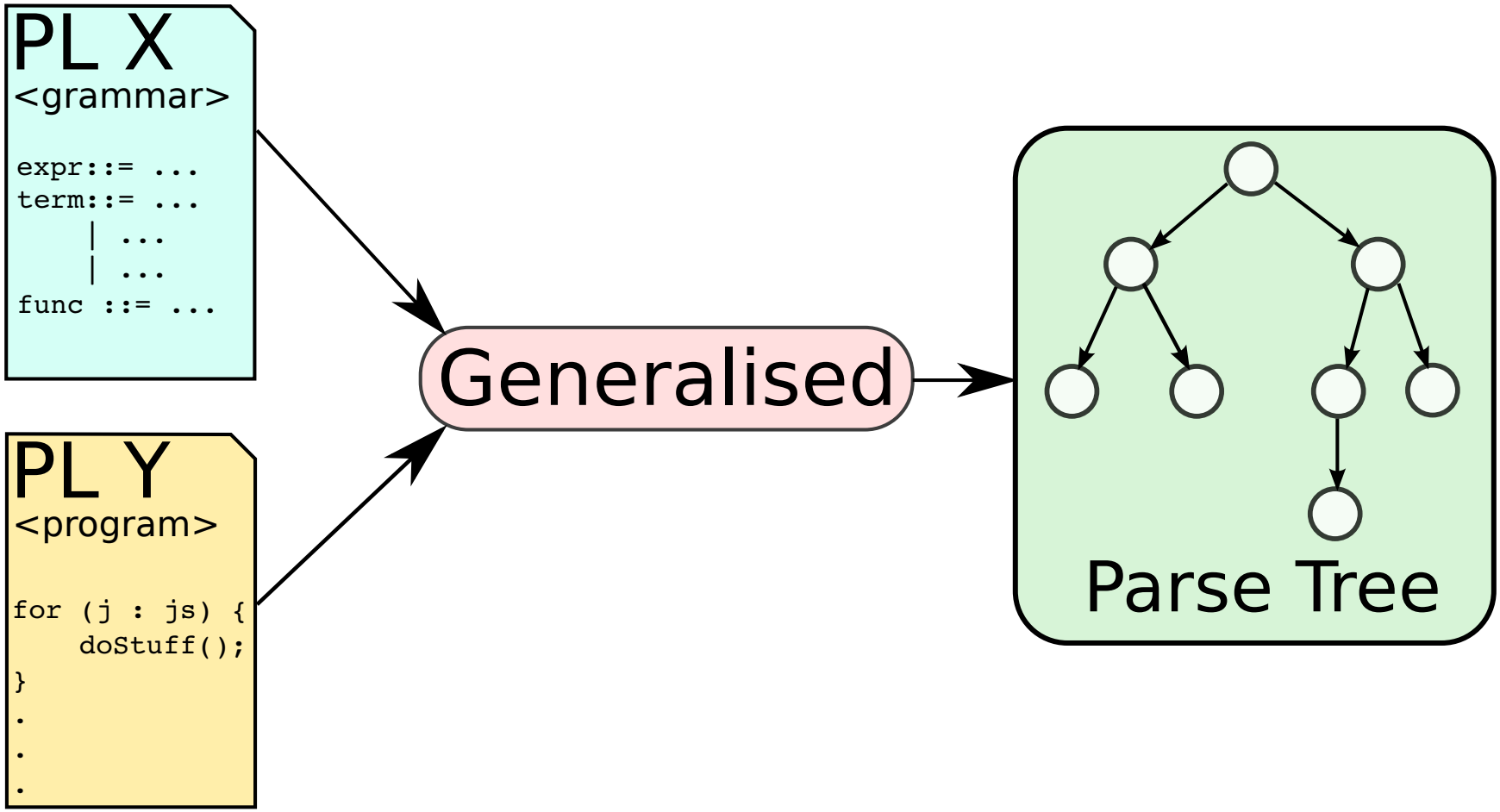

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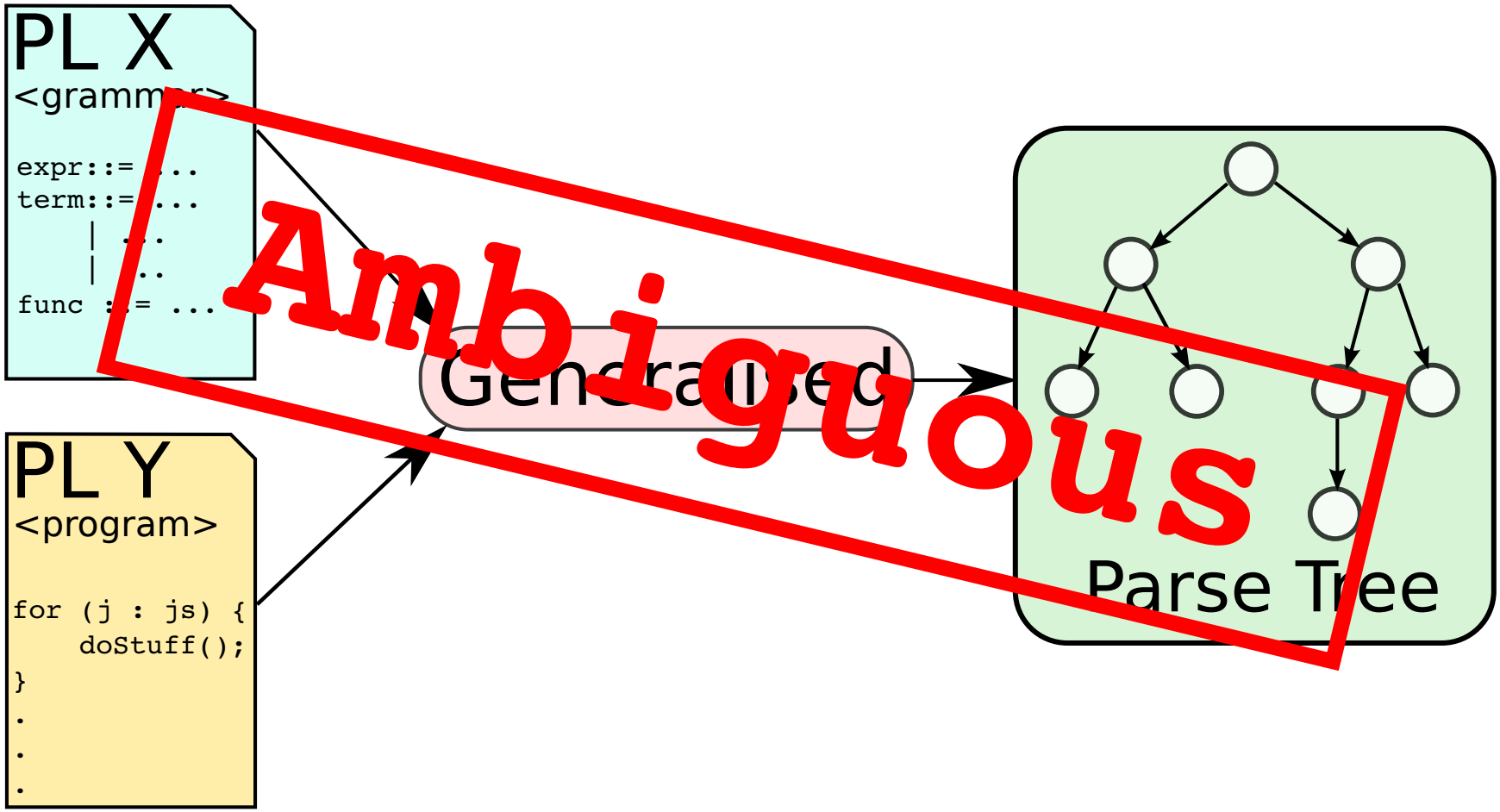

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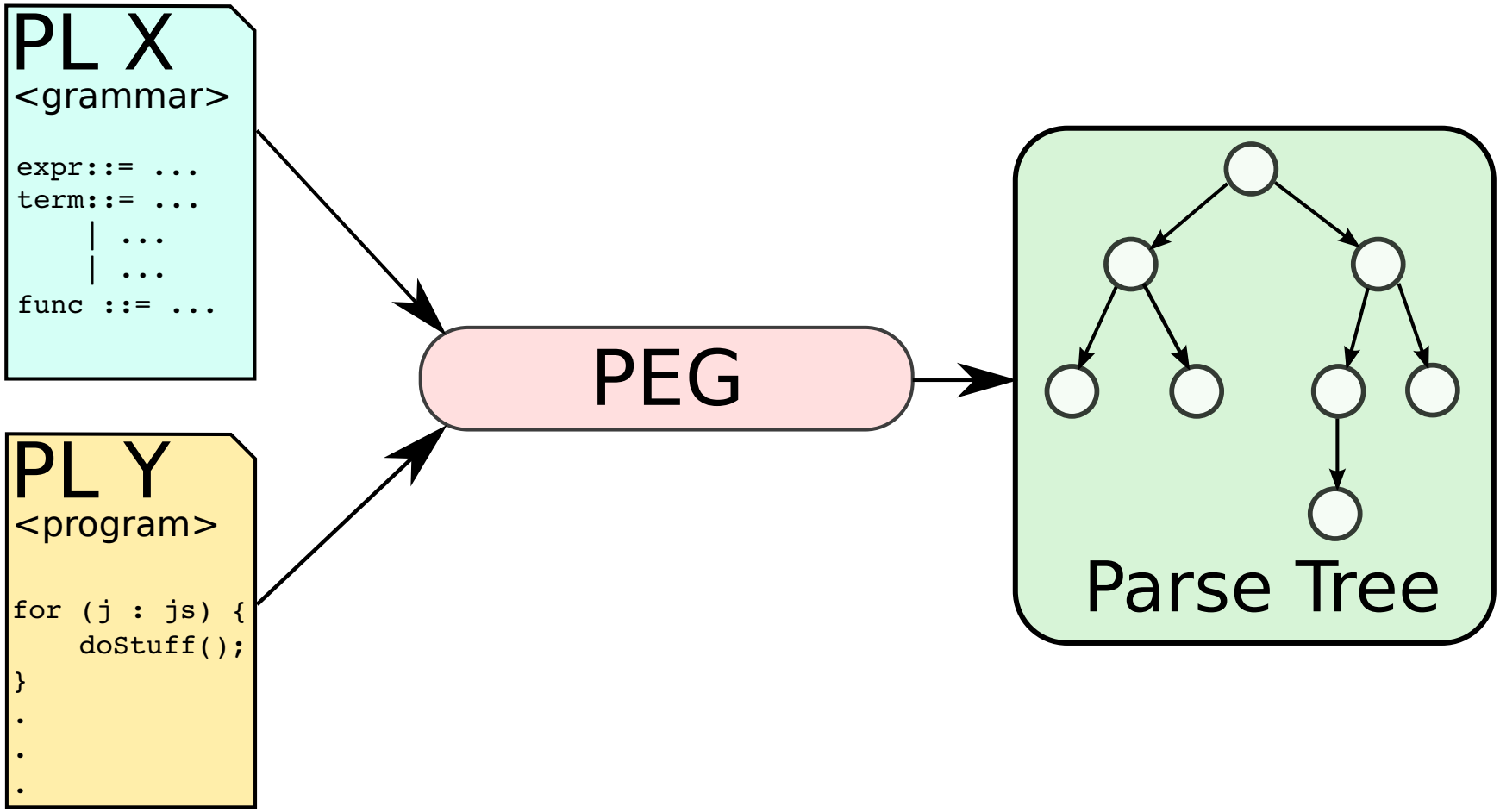

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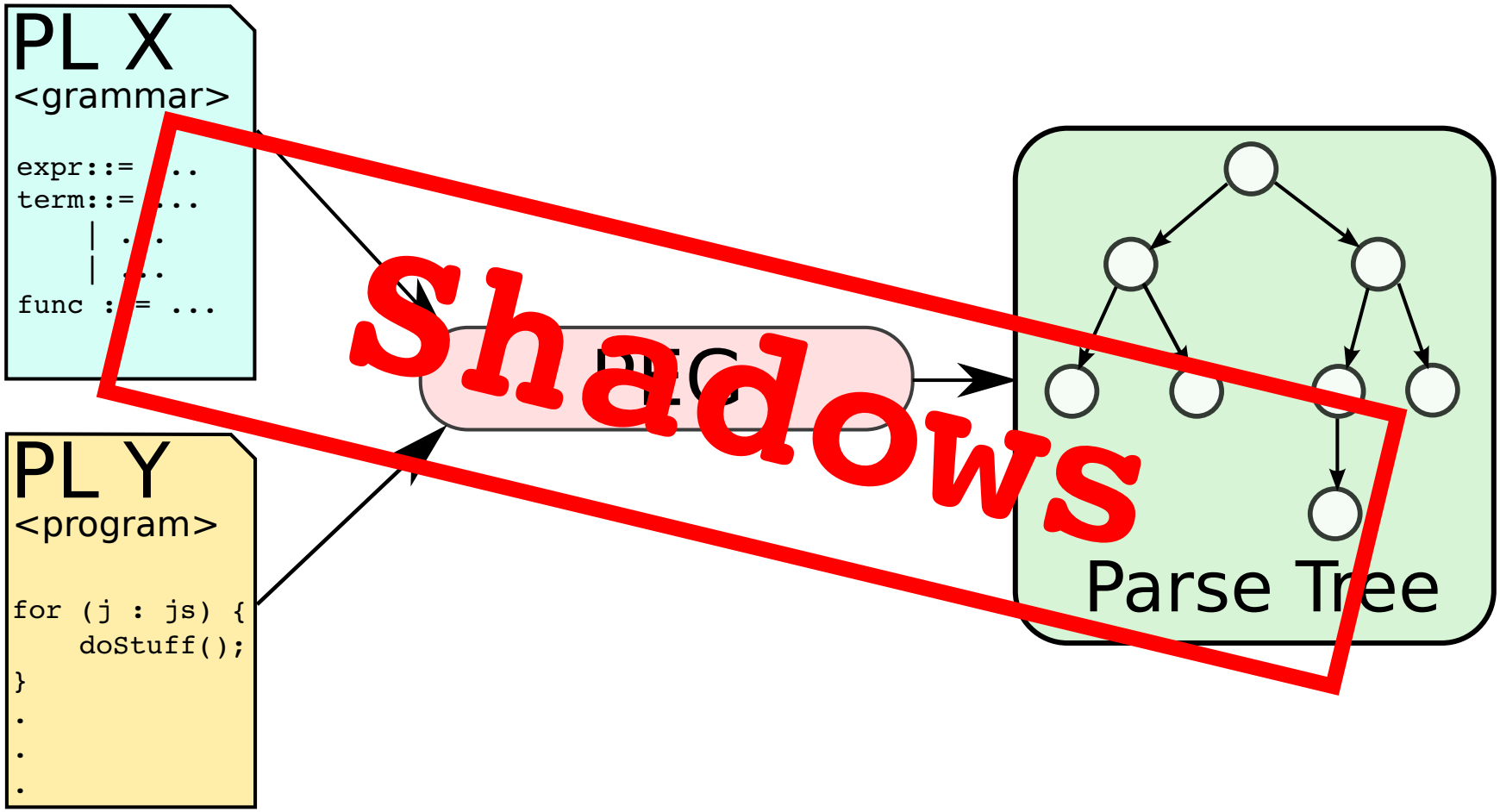


The only choice?

The only choice?

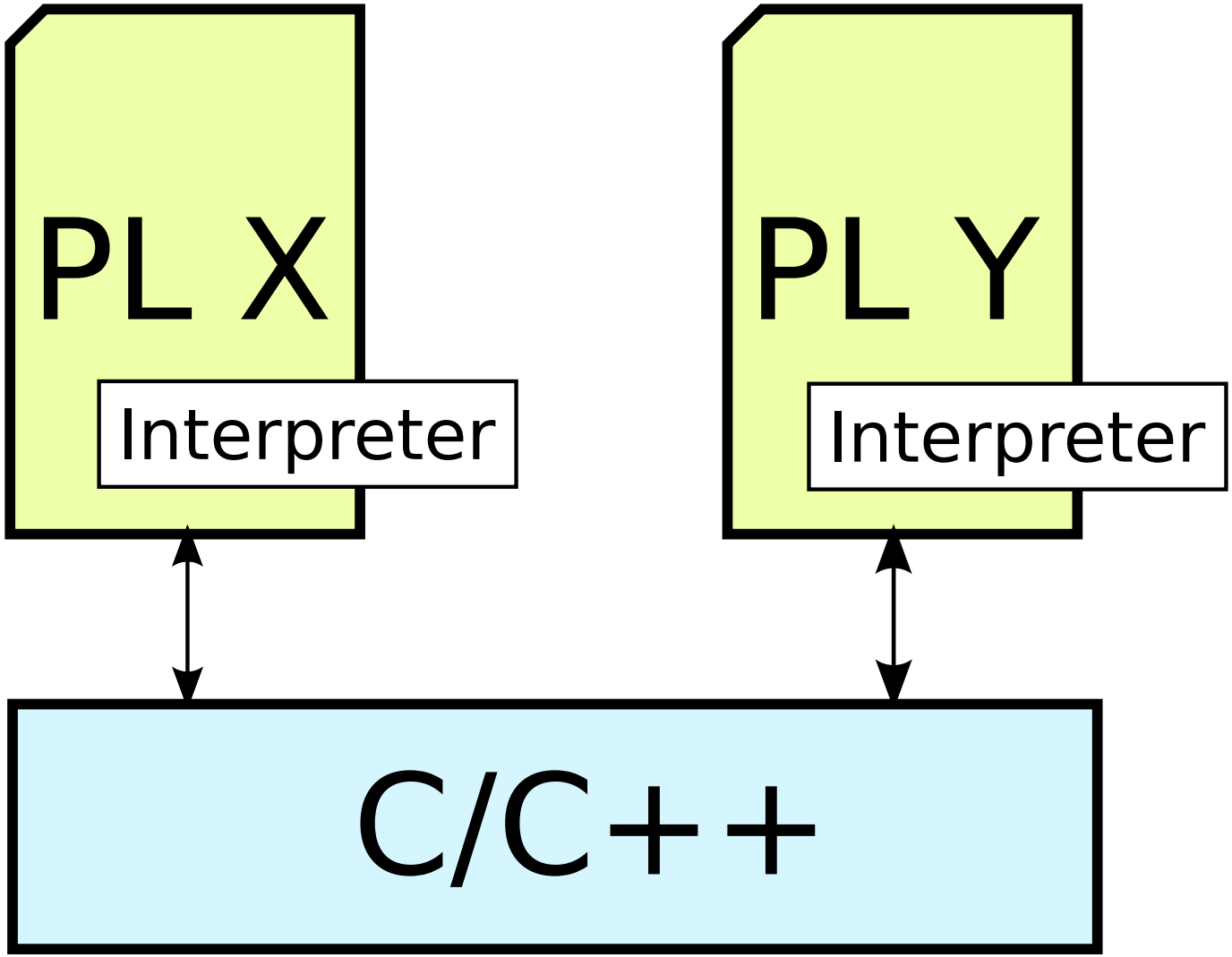
SDE

Challenge:
SDE's power +
a text editor feel?

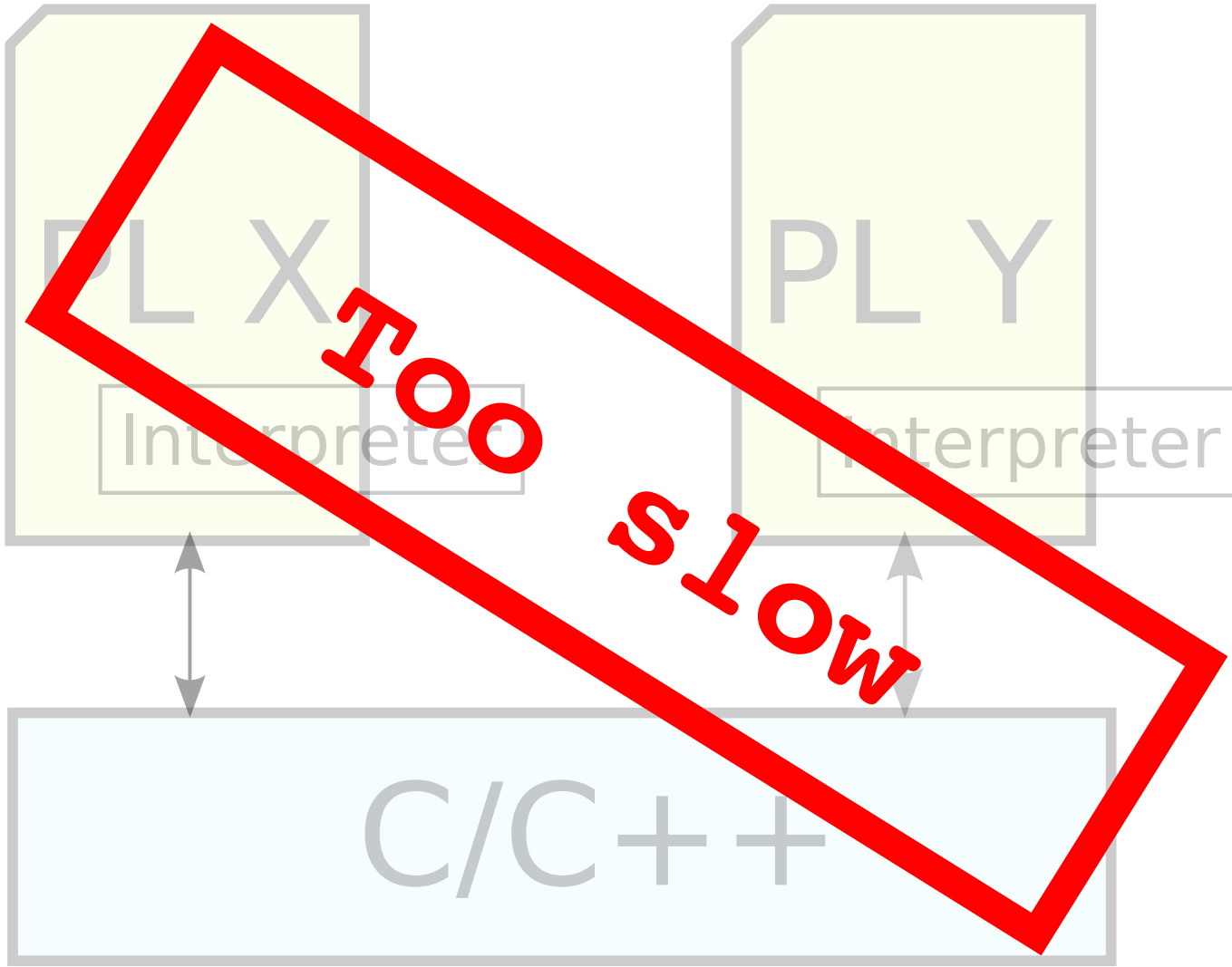
Eco demo

Runtime composition

Runtime composition



Runtime composition



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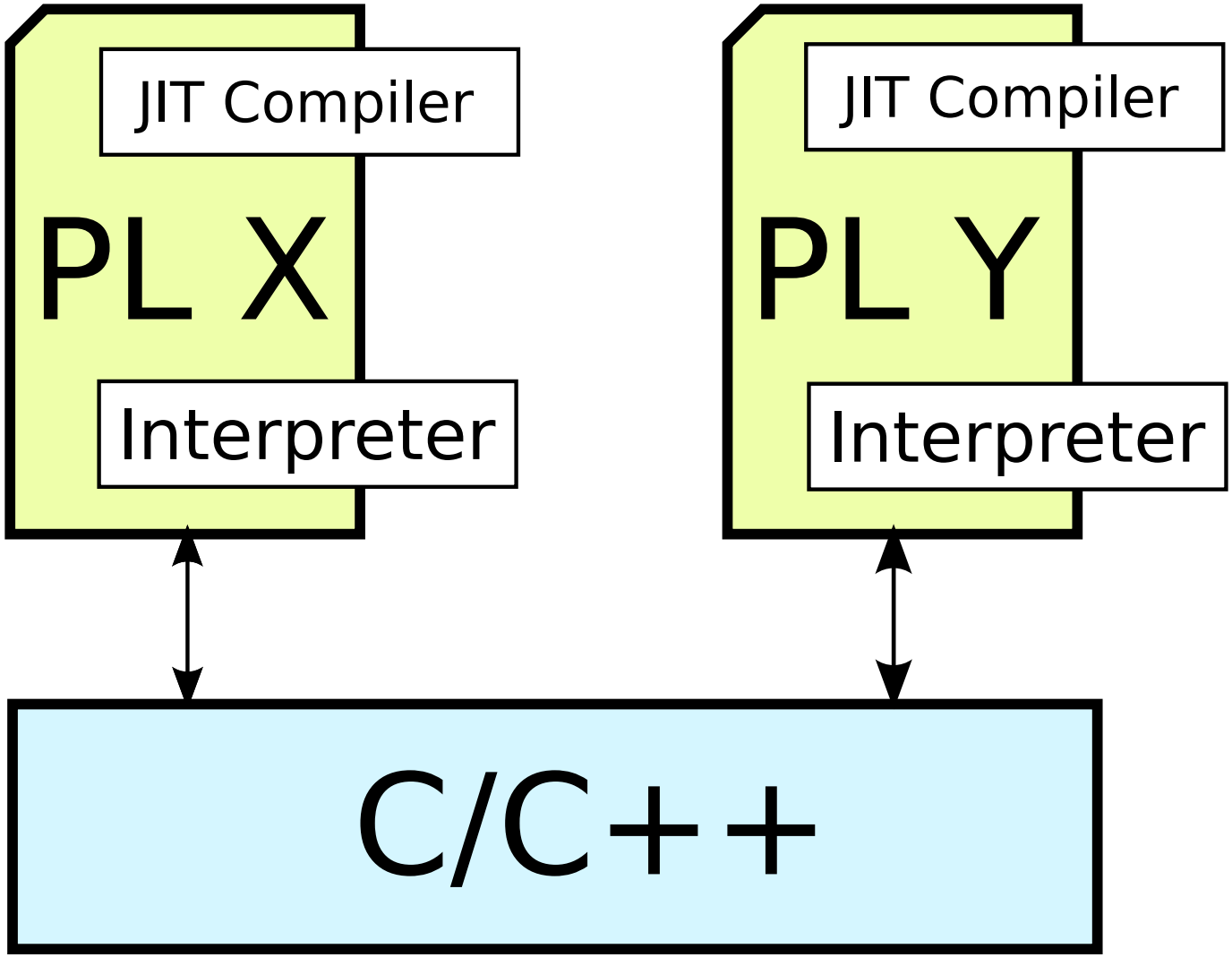

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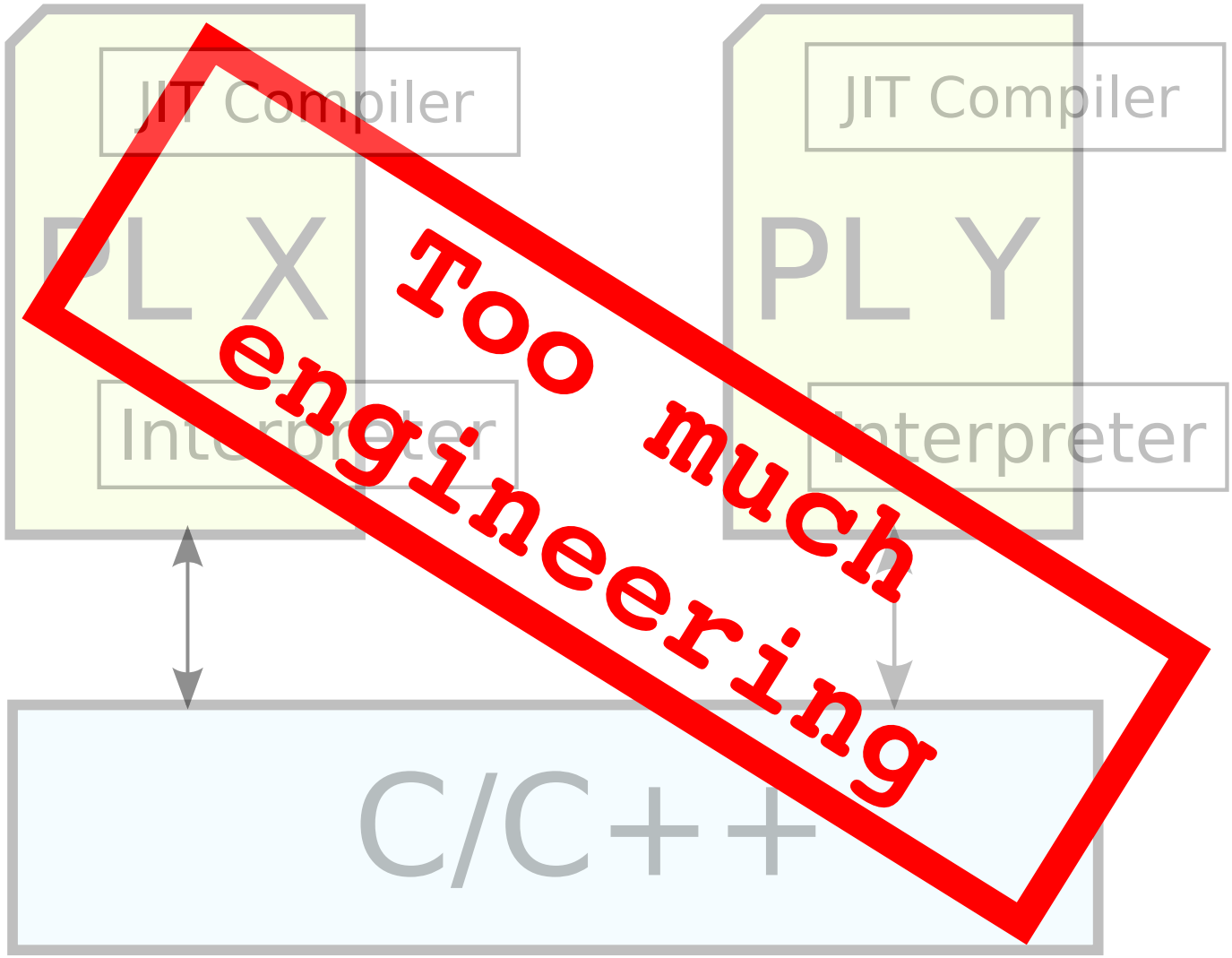

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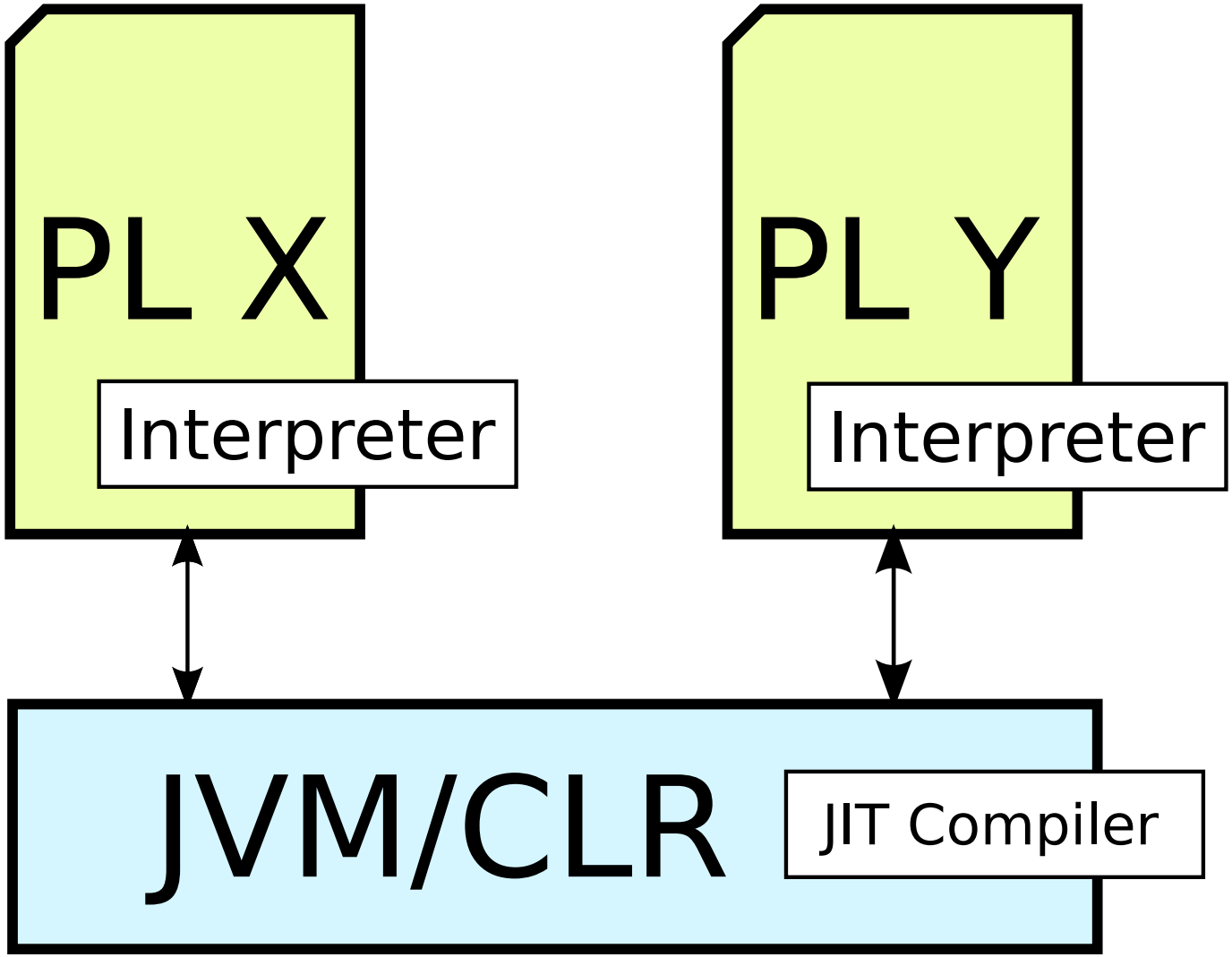

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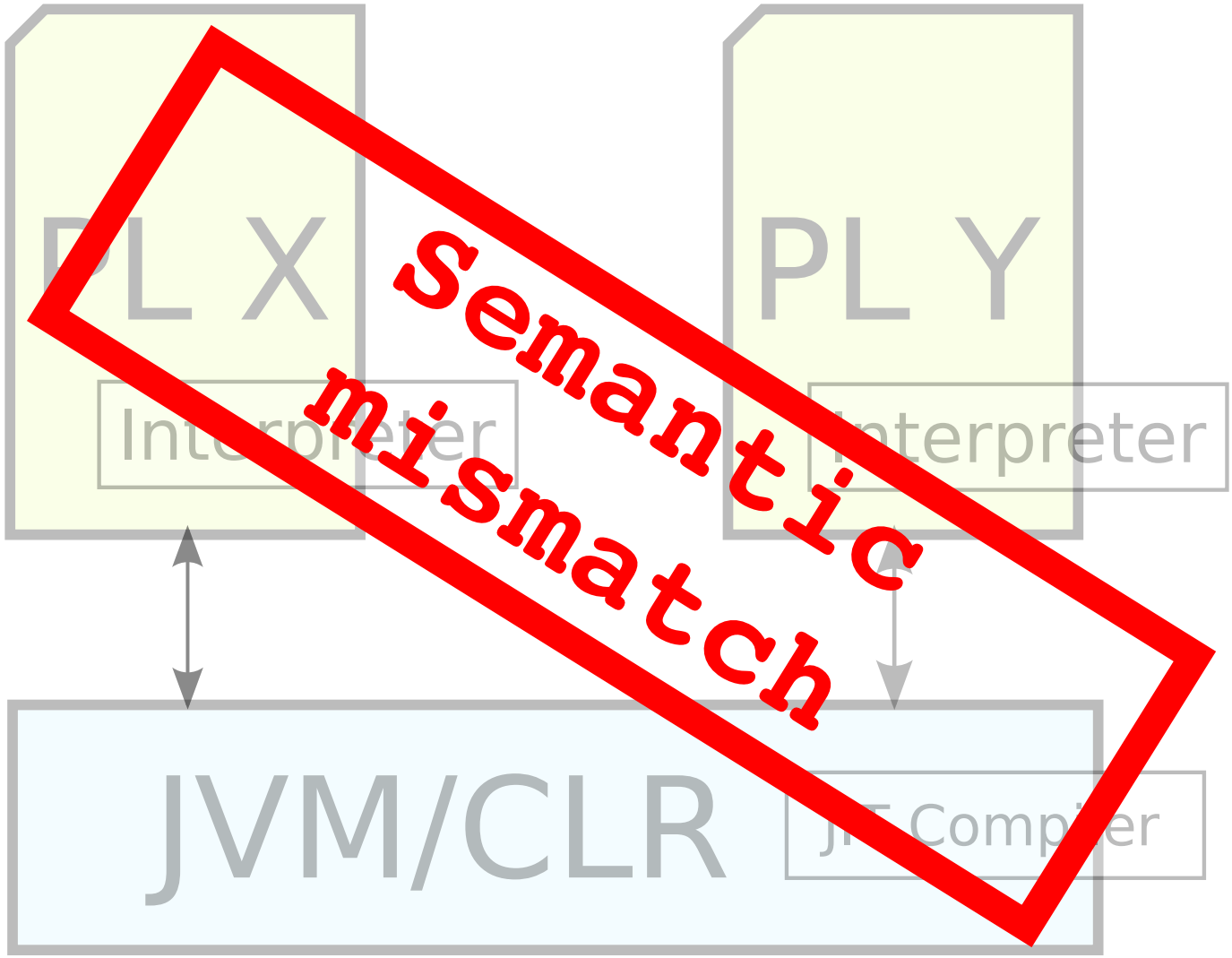

Runtime composition

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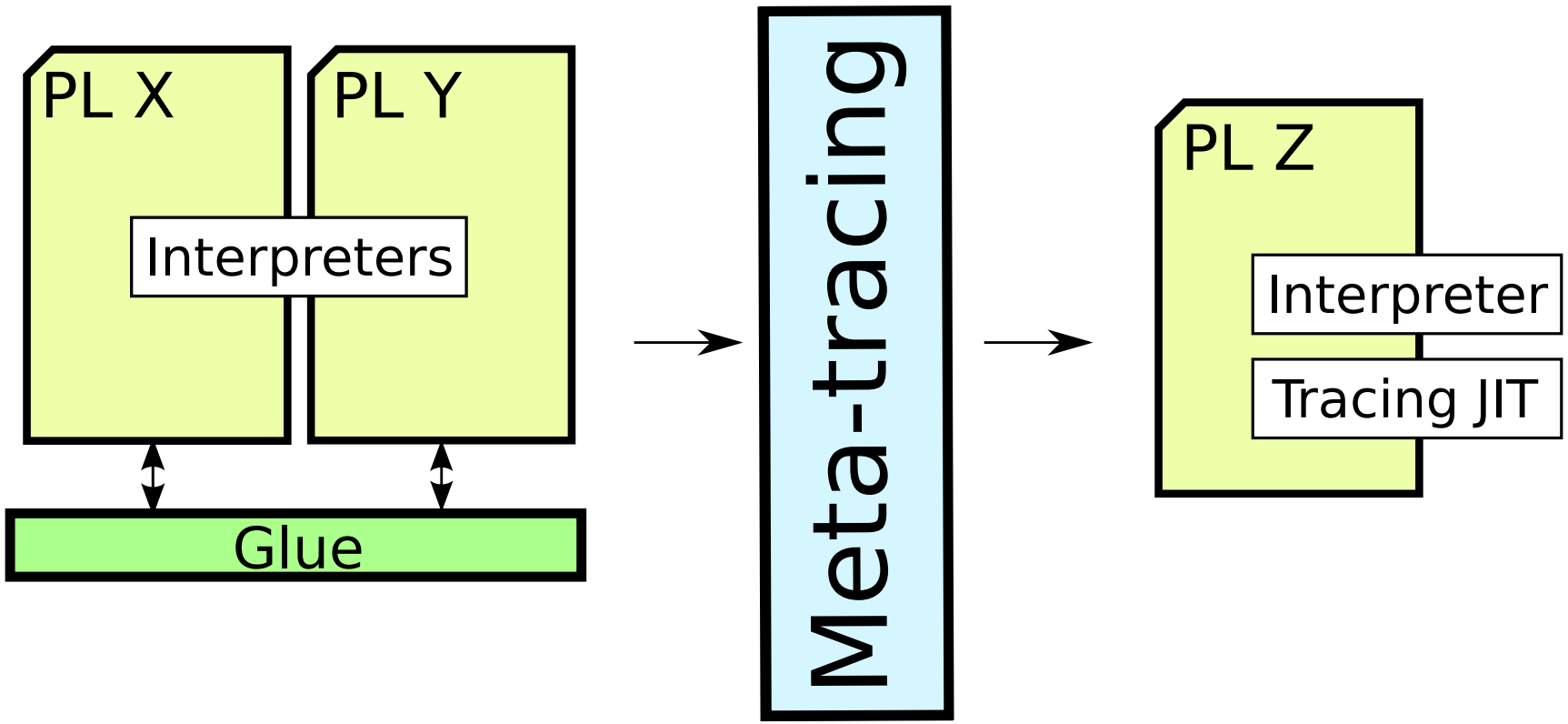
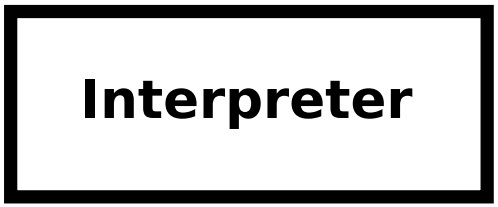
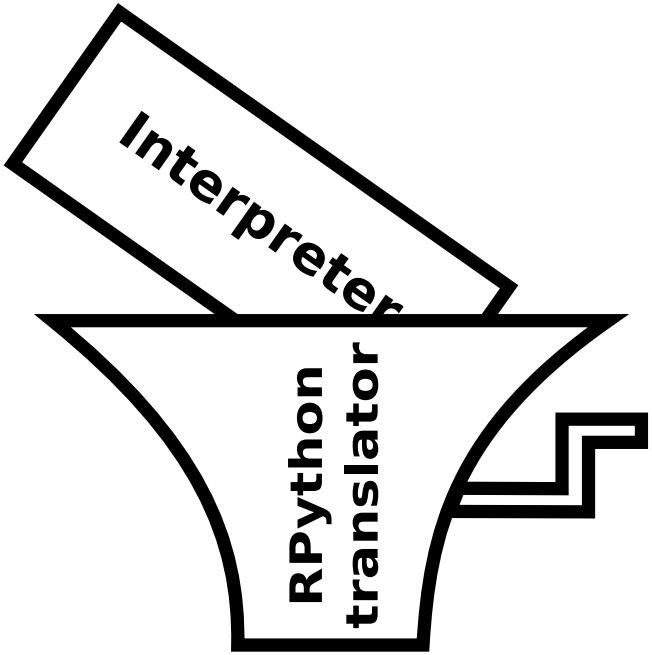



Interpreter

Meta-tracing translation with RPython



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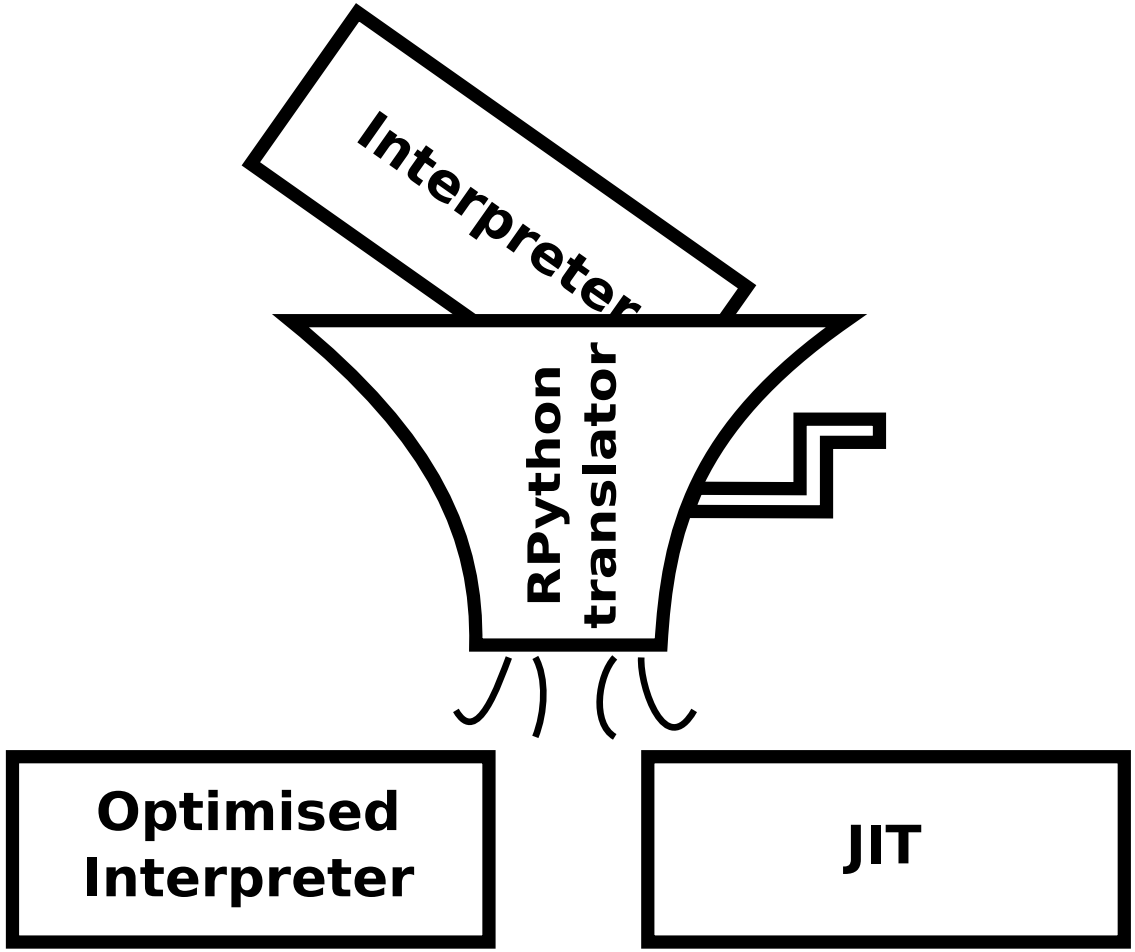

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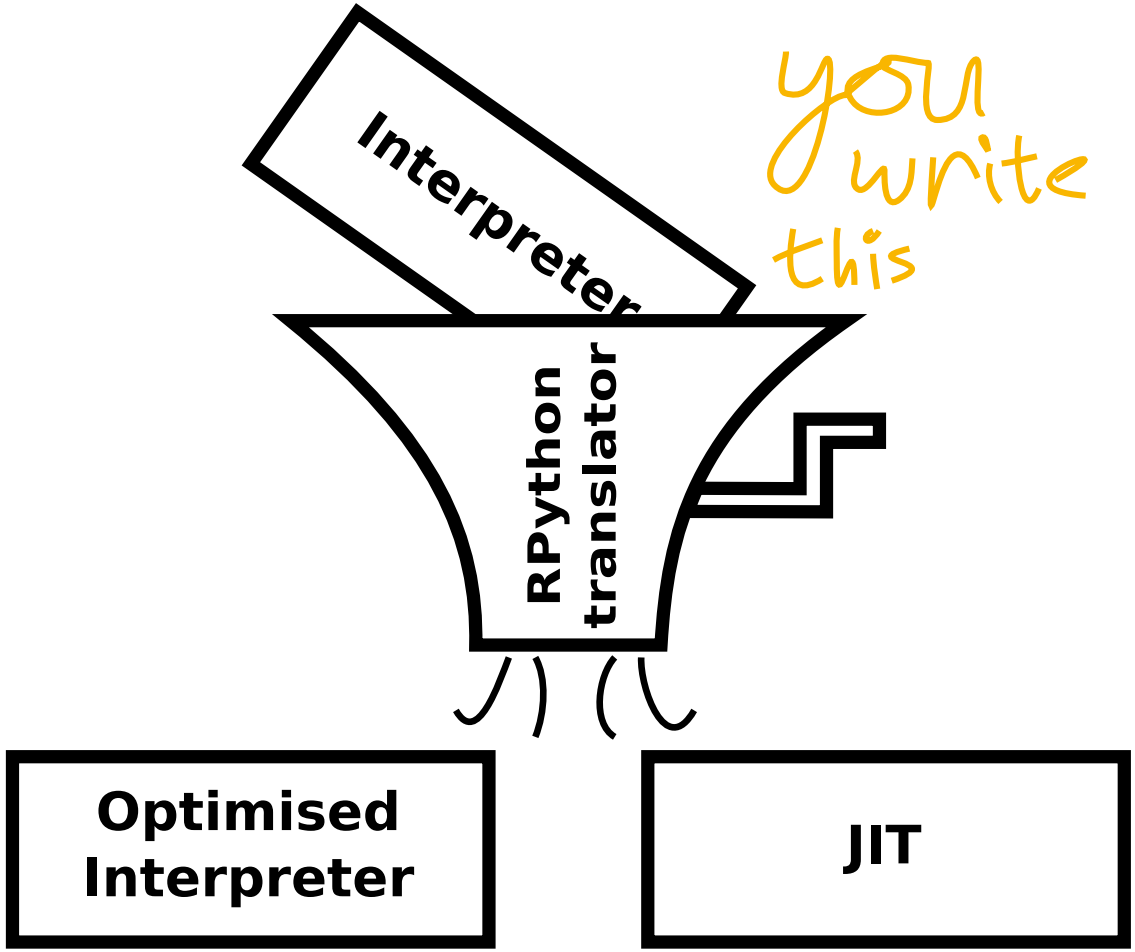

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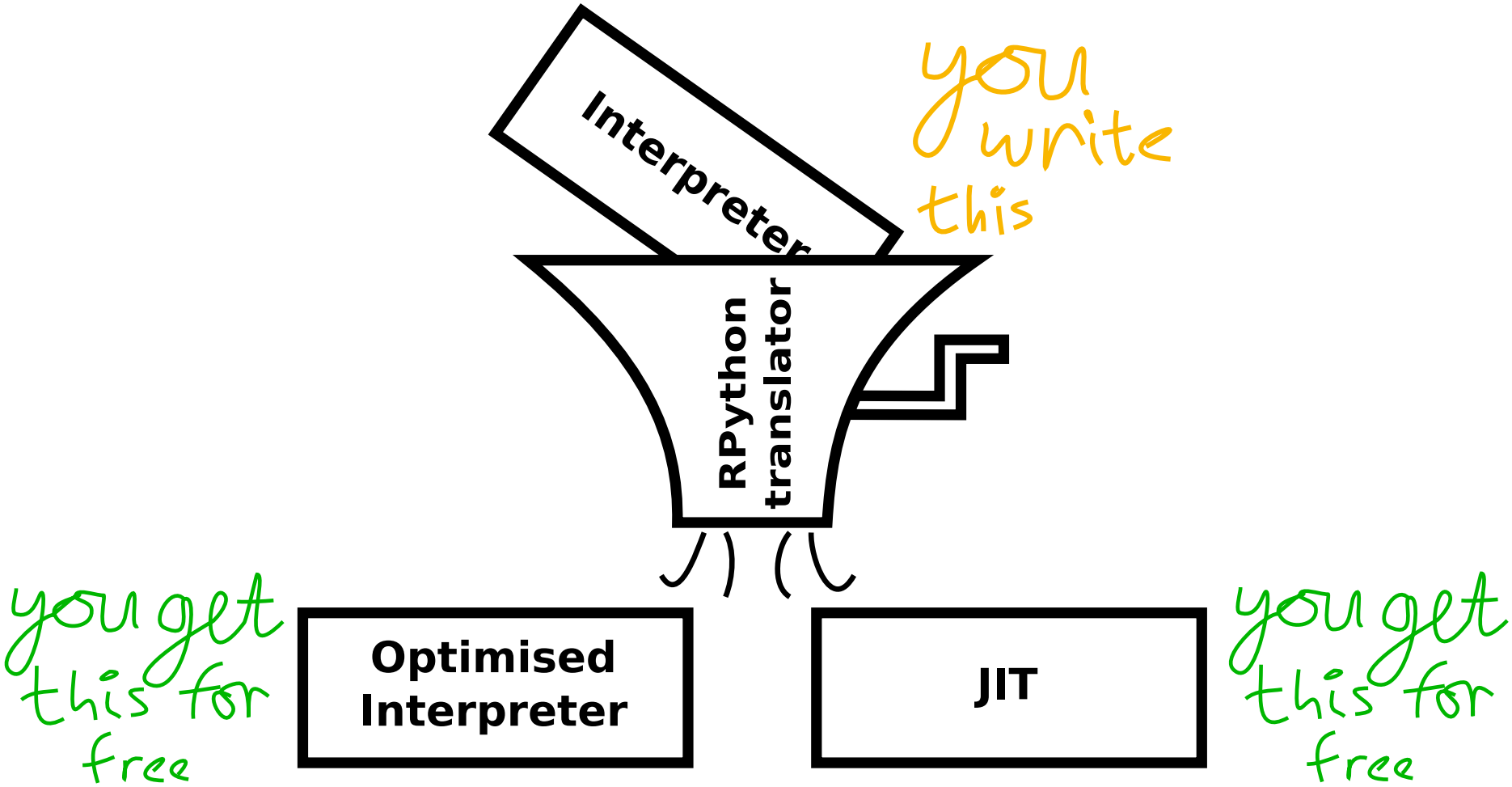


Unipycation demo

Benchmarking VM composition

Warning: draft numbers ahead

Absolute timing comparison

VM	Benchmark	*Python*		*Prolog*		*Python → Prolog*	
CPython-SWI	SmallFunc	0.125s	±0.006	0.257s	±0.001	28.893s	±0.175
	Loop1Arg0Result	2.924s	±0.215	7.352s	±0.037	9.310s	±0.065
	Loop1Arg1Result	4.184s	±0.028	18.890s	±0.082	20.865s	±0.050
	NondetLoop1Arg1Result	7.531s	±0.065	18.643s	±0.159	667.682s	±5.594
	TermConstruction	264.415s	±1.815	48.819s	±0.208	2185.150s	±14.251
	Lists	9.374s	±0.046	25.148s	±0.182	2207.304s	±12.344
Unipycation	SmallFunc	0.001s	±0.000	0.006s	±0.001	0.001s	±0.000
	Loop1Arg0Result	0.085s	±0.000	0.086s	±0.000	0.087s	±0.000
	Loop1Arg1Result	0.112s	±0.000	0.114s	±0.000	0.115s	±0.000
	NondetLoop1Arg1Result	0.500s	±0.002	0.548s	±0.064	2.674s	±0.010
	TermConstruction	6.053s	±0.218	2.444s	±0.002	36.069s	±0.171
	Lists	0.845s	±0.002	1.416s	±0.003	5.056s	±0.026
Jython-tuProlog	SmallFunc	0.088s	±0.002	3.050s	±0.036	52.294s	±0.371
	Loop1Arg0Result	1.078s	±0.007	206.590s	±2.884	199.963s	±1.784
	Loop1Arg1Result	2.145s	±0.175	293.311s	±4.270	294.781s	±4.746
	NondetLoop1Arg1Result	7.939s	±0.341	timeout		timeout	
	TermConstruction	timeout		timeout		timeout	
	Lists	timeout		timeout		timeout	

Relative timing comparison

VM	Benchmark	$\frac{Python \to Prolog}{Python}$		$\frac{Python \to Prolog}{Prolog}$		$\frac{Python \to Prolog}{\text{Unipycation}}$	
CPython-SWI	SmallFunc	231.770×	±10.154	112.567×	±0.934	27821.079×	±1896.725
	Loop1Arg0Result	3.184×	±0.232	1.266×	±0.011	107.591×	±0.779
	Loop1Arg1Result	4.987×	±0.039	1.105×	±0.006	181.899×	±0.444
	NondetLoop1Arg1Result	88.654×	±1.026	35.814×	±0.389	249.737×	±2.244
	TermConstruction	8.264×	±0.081	44.760×	±0.348	60.583×	±0.487
	Lists	235.459×	±1.742	87.772×	±0.789	436.609×	±3.494
Unipycation	SmallFunc	1.295×	±0.086	0.182×	±0.036	1.000×	
	Loop1Arg0Result	1.020×	±0.001	1.012×	±0.002	1.000×	
	Loop1Arg1Result	1.025×	±0.002	1.002×	±0.002	1.000×	
	NondetLoop1Arg1Result	5.349×	±0.035	4.879×	±0.631	1.000×	
	TermConstruction	5.959×	±0.224	14.756×	±0.069	1.000×	
	Lists	5.982×	±0.034	3.569×	±0.019	1.000×	
Jython-tuProlog	SmallFunc	592.904×	±14.602	17.143×	±0.259	50354.204×	±3330.993
	Loop1Arg0Result	185.460×	±2.182	0.968×	±0.017	2310.844×	±21.996
	Loop1Arg1Result	137.427×	±11.805	1.005×	±0.022	2569.873×	±41.331
	NondetLoop1Arg1Result	timeout		timeout		timeout	
	TermConstruction	timeout		timeout		timeout	
	Lists	timeout		timeout		timeout	

PHP / Python bridge demo

Composed Richards vs. other VMs

Warning: even draftier numbers ahead!

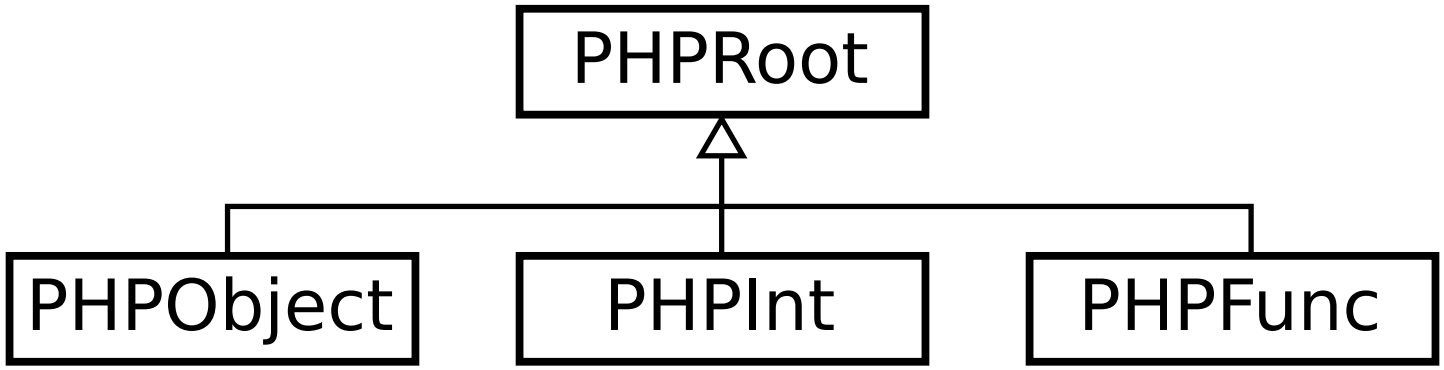
Composed Richards vs. other VMs

Type	VM	
Mono	PyPy 2.4.0	0.370 ± 0.000
	Hippy	0.553 ± 0.008
	Bridge	0.556 ± 0.006
	HHVM 3.2.0	5.353 ± 0.262
	ZEND 5.4.4	10.406 ± 0.106

Composed Richards vs. other VMs

Type	VM	
Mono	PyPy 2.4.0	0.370 ± 0.000
	Hippy	0.553 ± 0.008
	Bridge	0.556 ± 0.006
	HHVM 3.2.0	5.353 ± 0.262
	ZEND 5.4.4	10.406 ± 0.105
Composed	Bridge	0.936 ± 0.038

Datatype conversion



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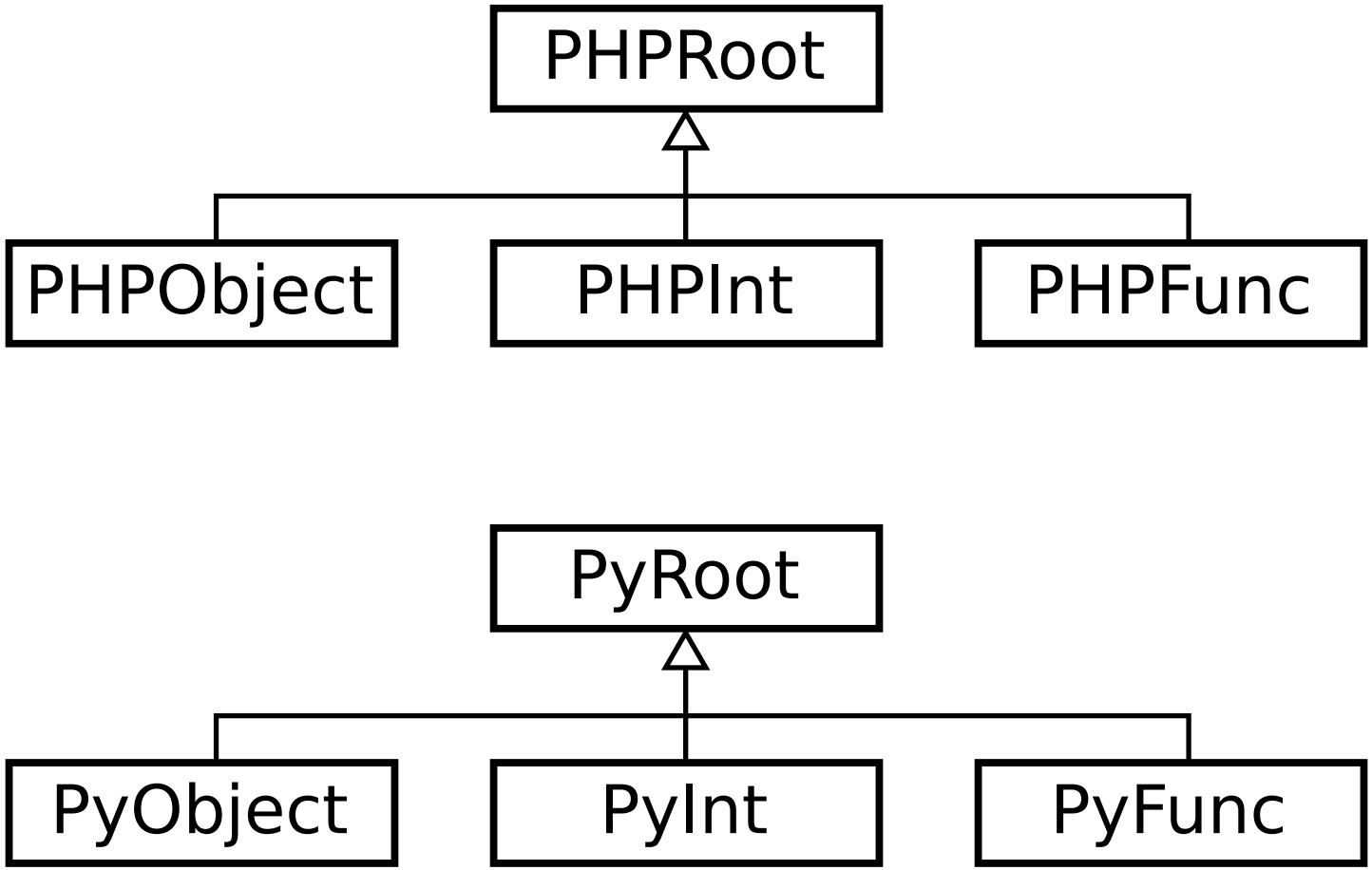


Datatype conversion: primitive types

PHP

Python

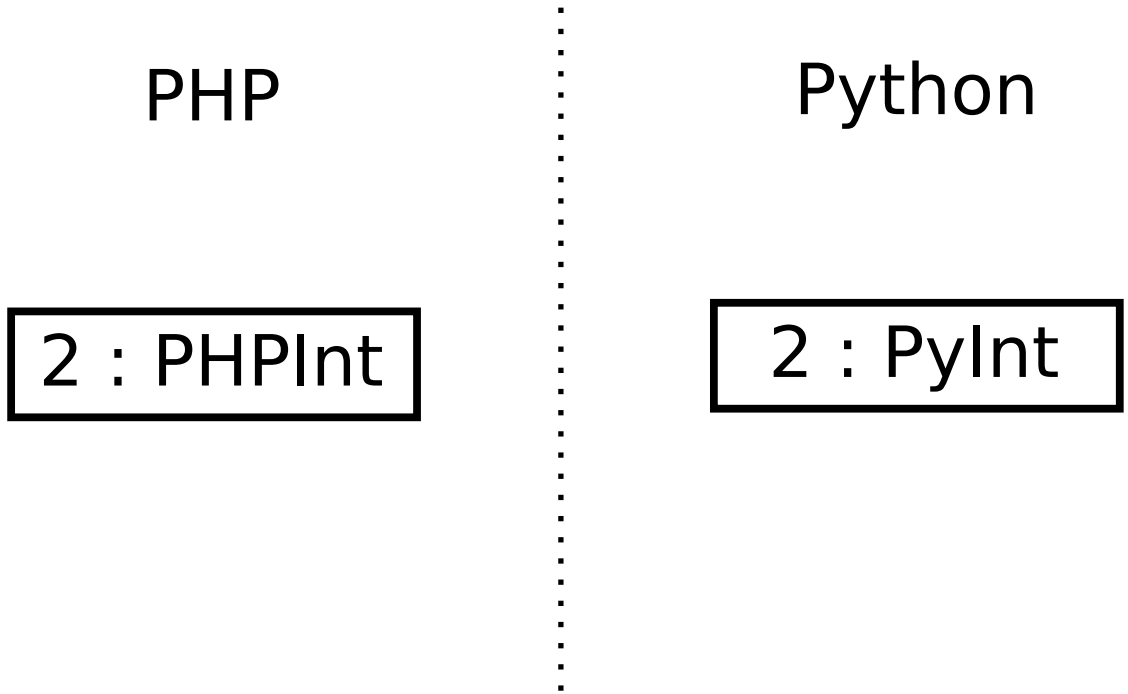
Datatype conversion: primitive types

PHP

Python

2 : PHPInt

Datatype conversion: primitive types



Datatype conversion: user types

PHP

Python

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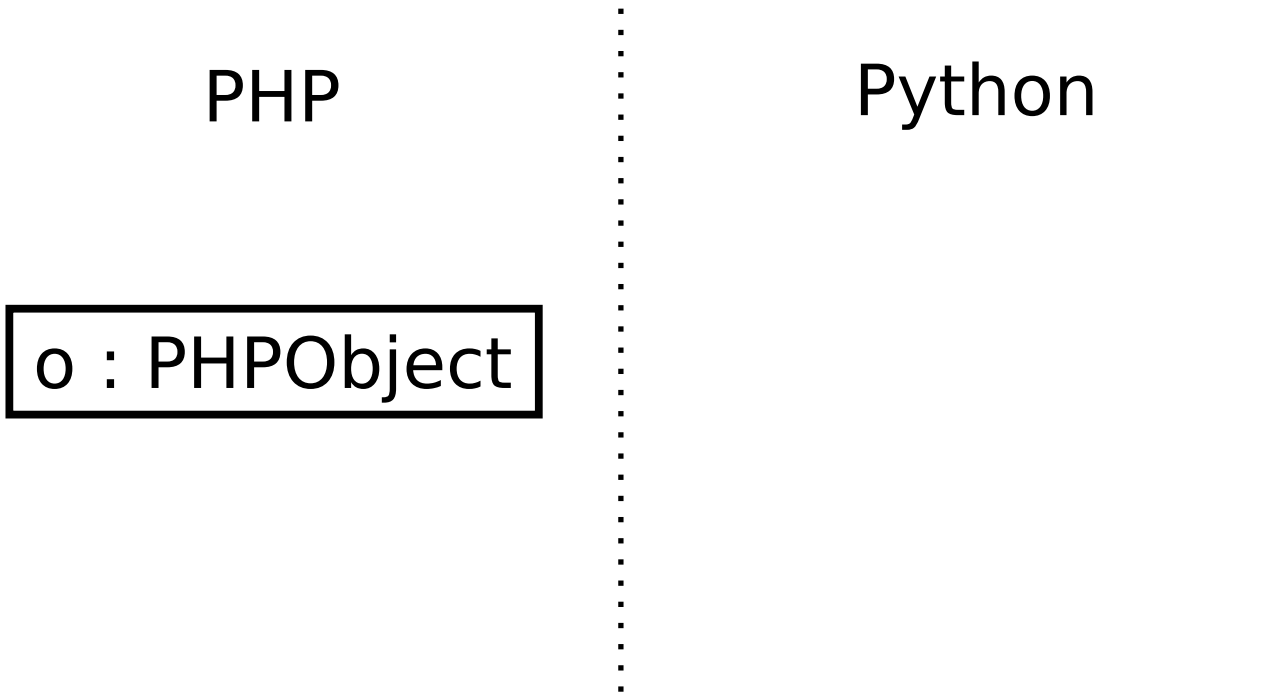

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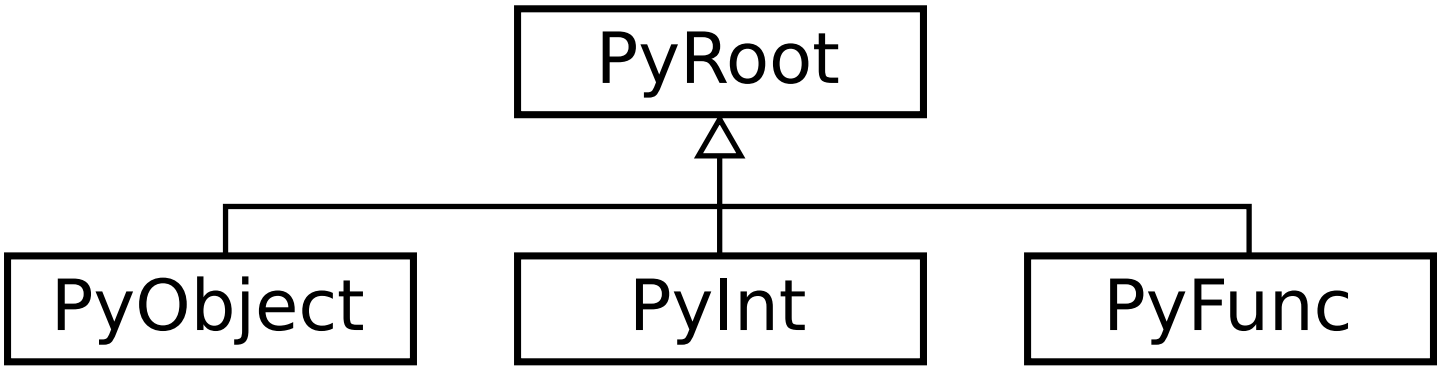

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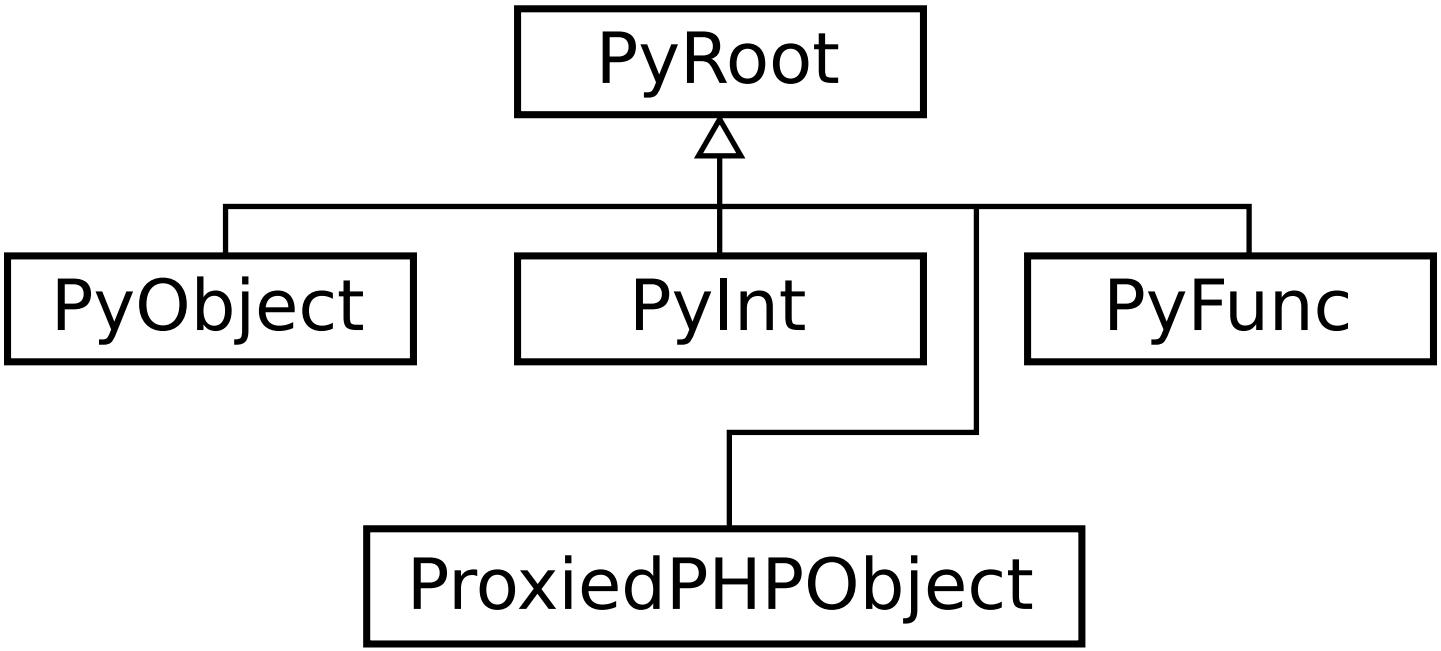

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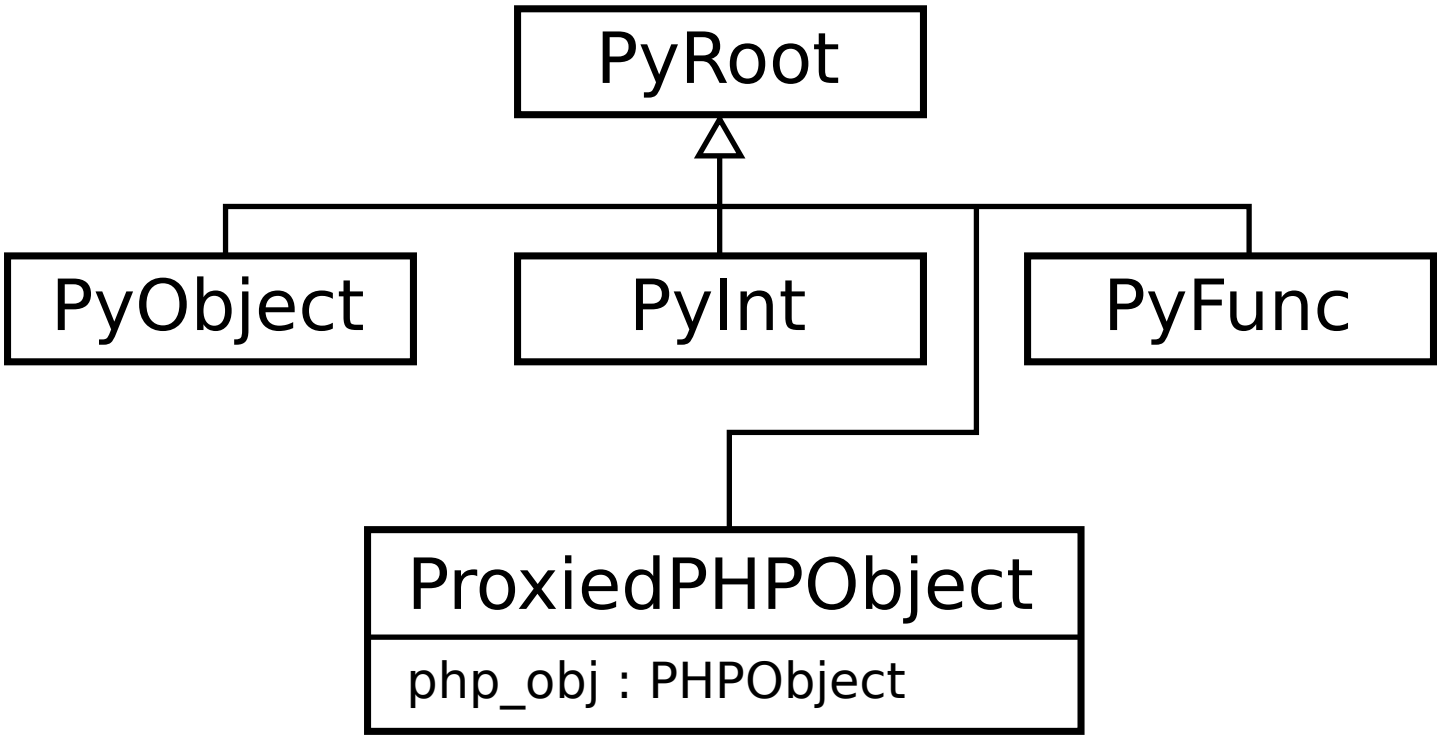

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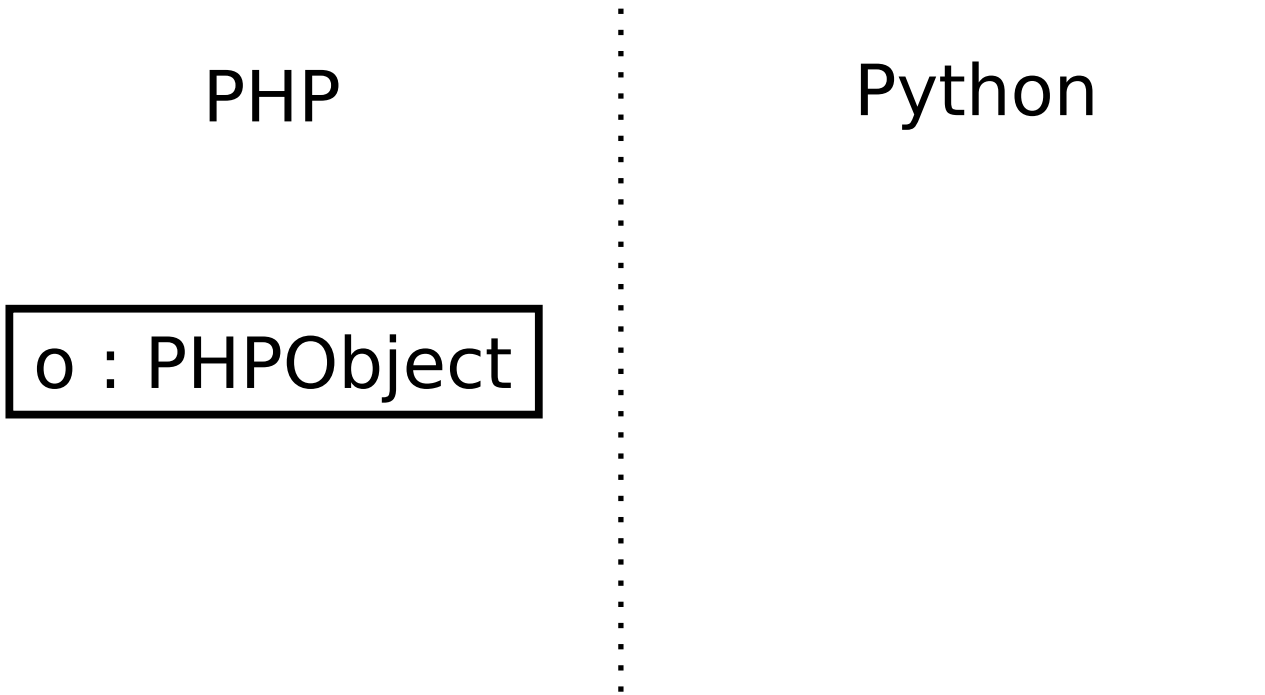

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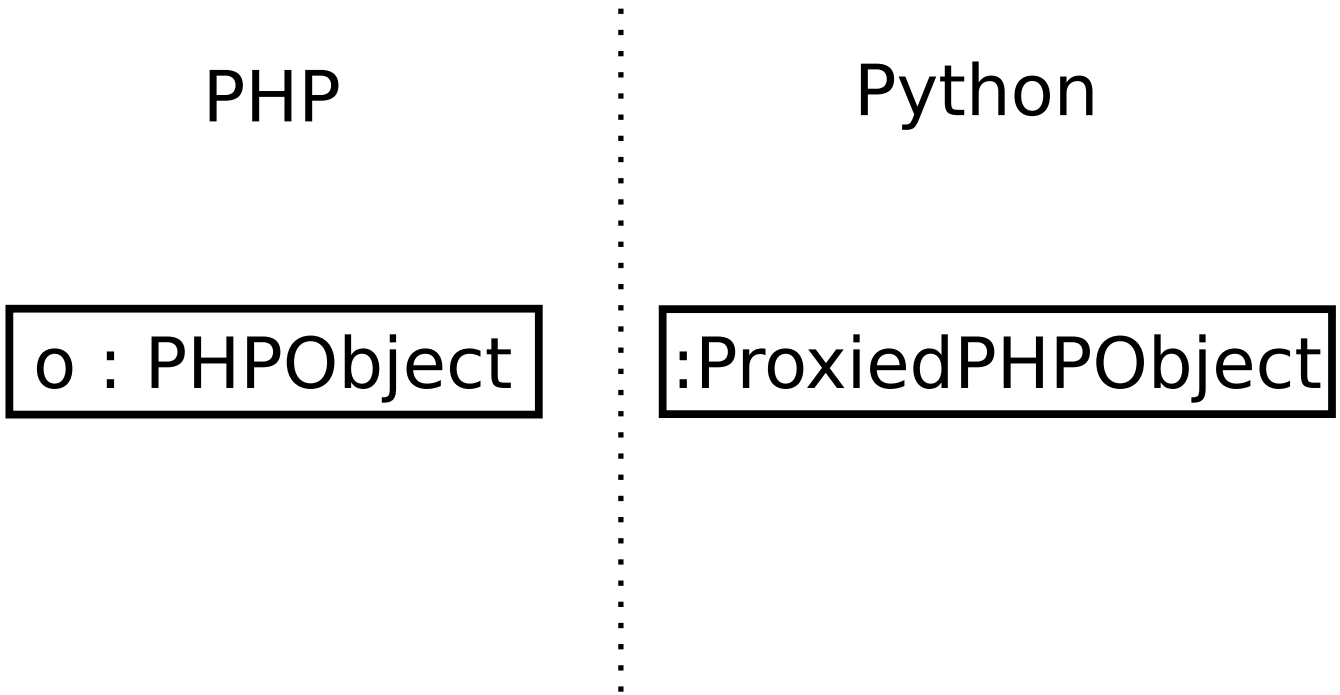

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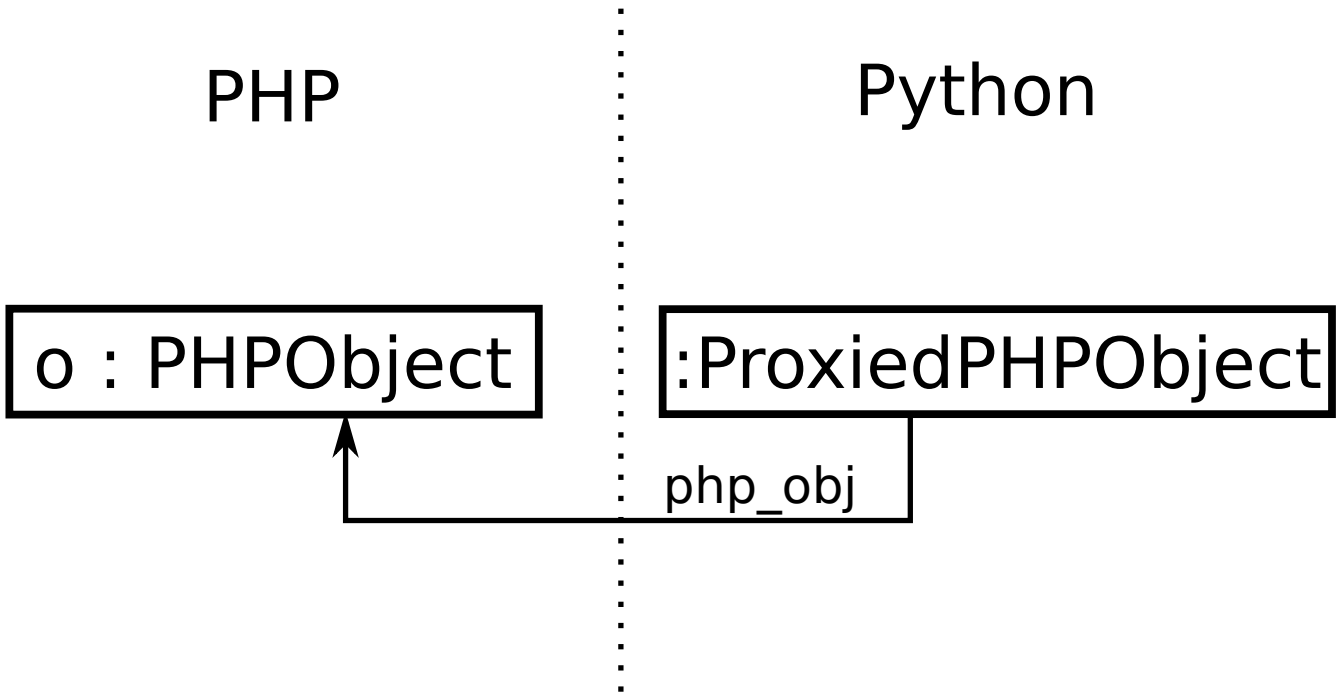

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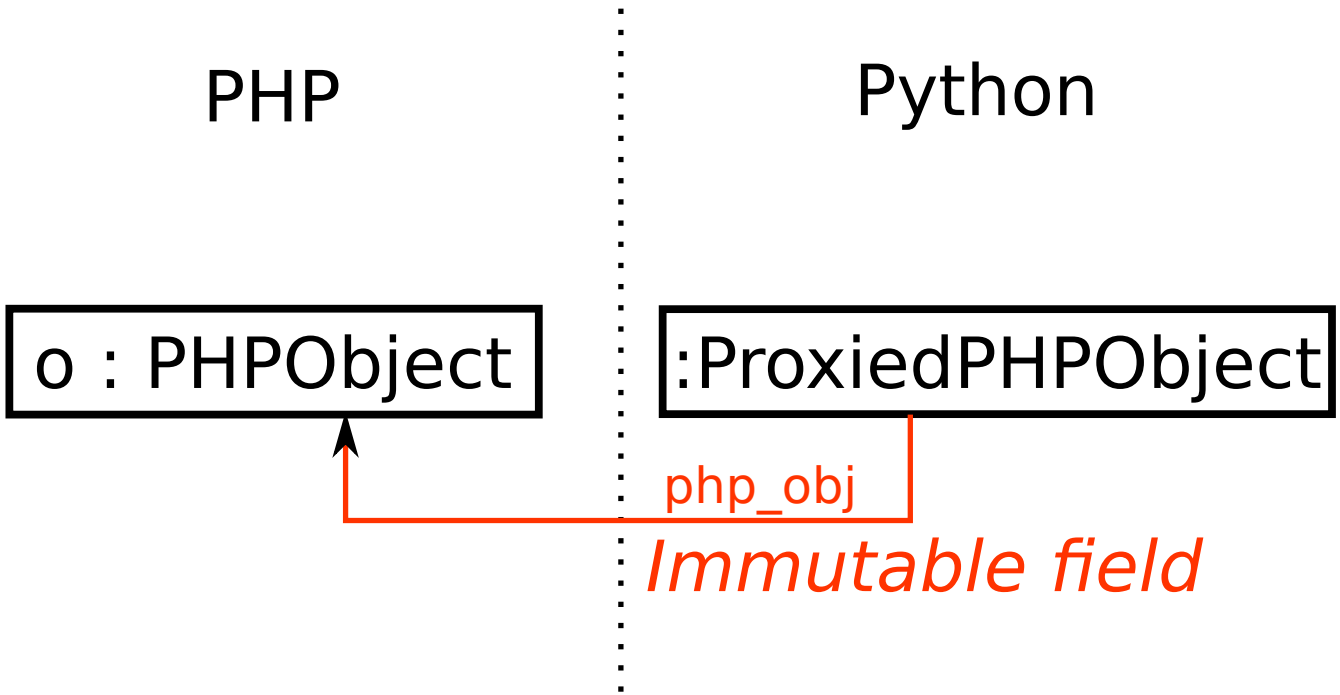

Some thoughts

- Critical: single meta-language (e.g. RPython / Truffle).

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- Simplicity: good performance, yet understandable.

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- Immutable wrappers give near-native performance.

Some thoughts

- Critical: single meta-language (e.g. RPython / Truffle).
- Simplicity: good performance, yet understandable.
- Immutable wrappers give near-native performance.
- **Whole new world of challenges for language designers & formalisers.**

What can we use this for?

What can we use this for?

First-class languages

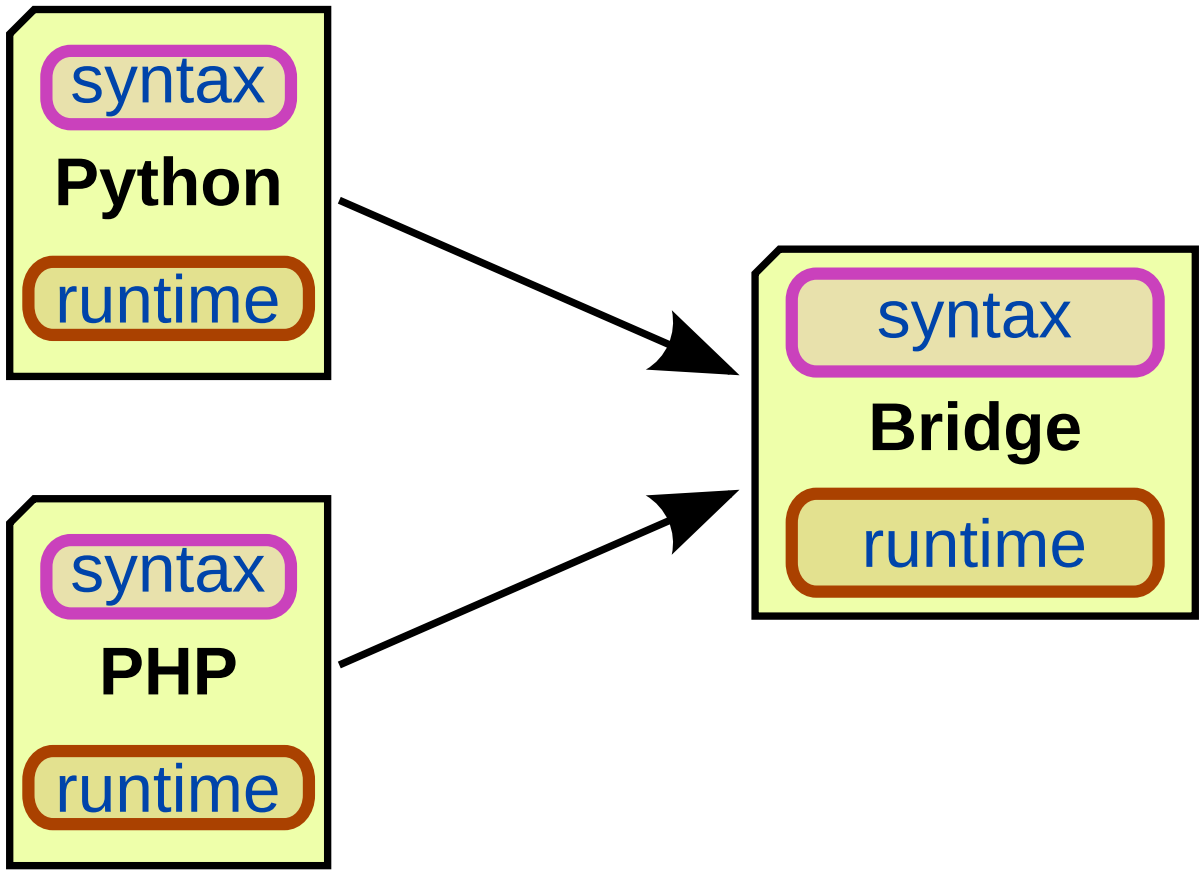
What can we use this for?

First-class languages

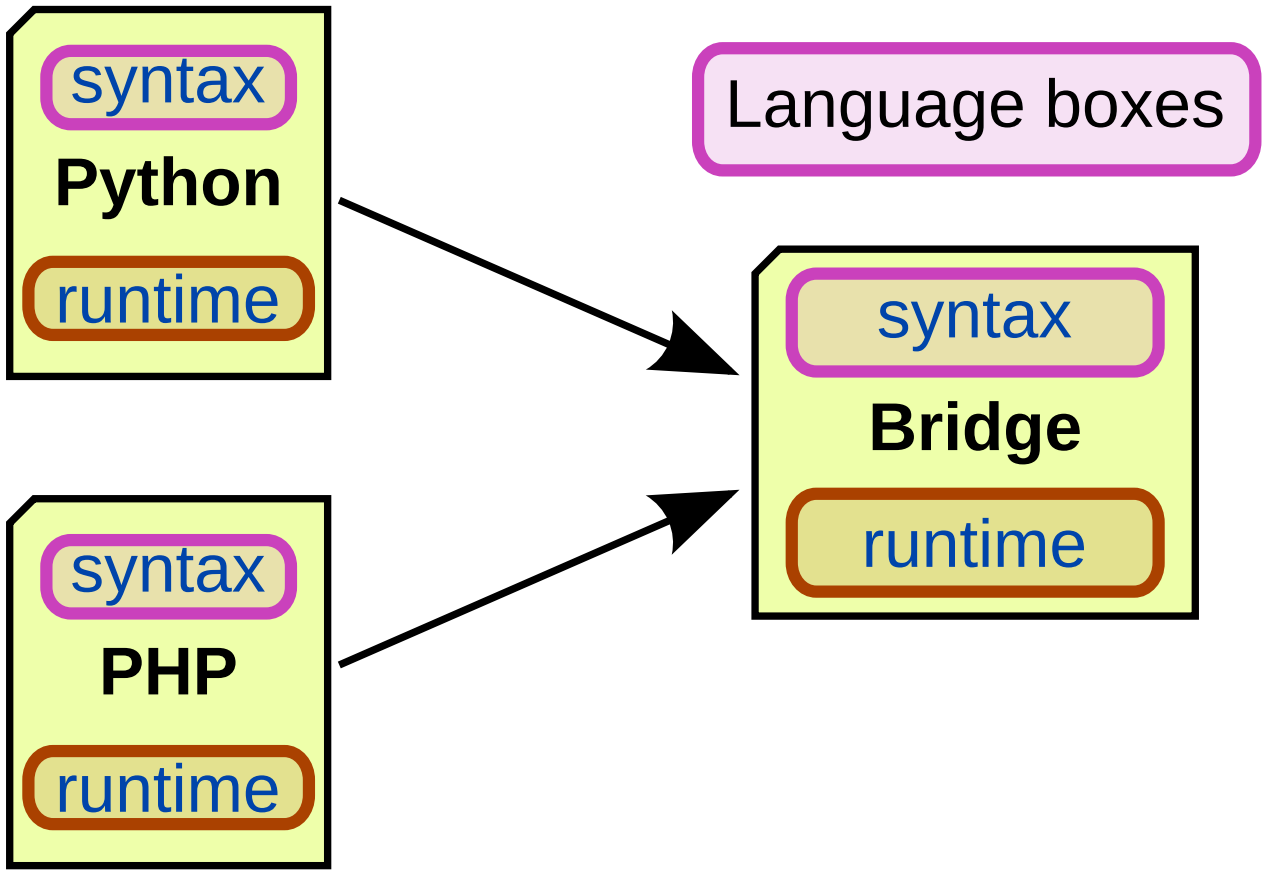
Language migration

Summary

Summary


syntax
Python
runtime
syntax
PHP
runtime
syntax
Bridge
runtime

Summary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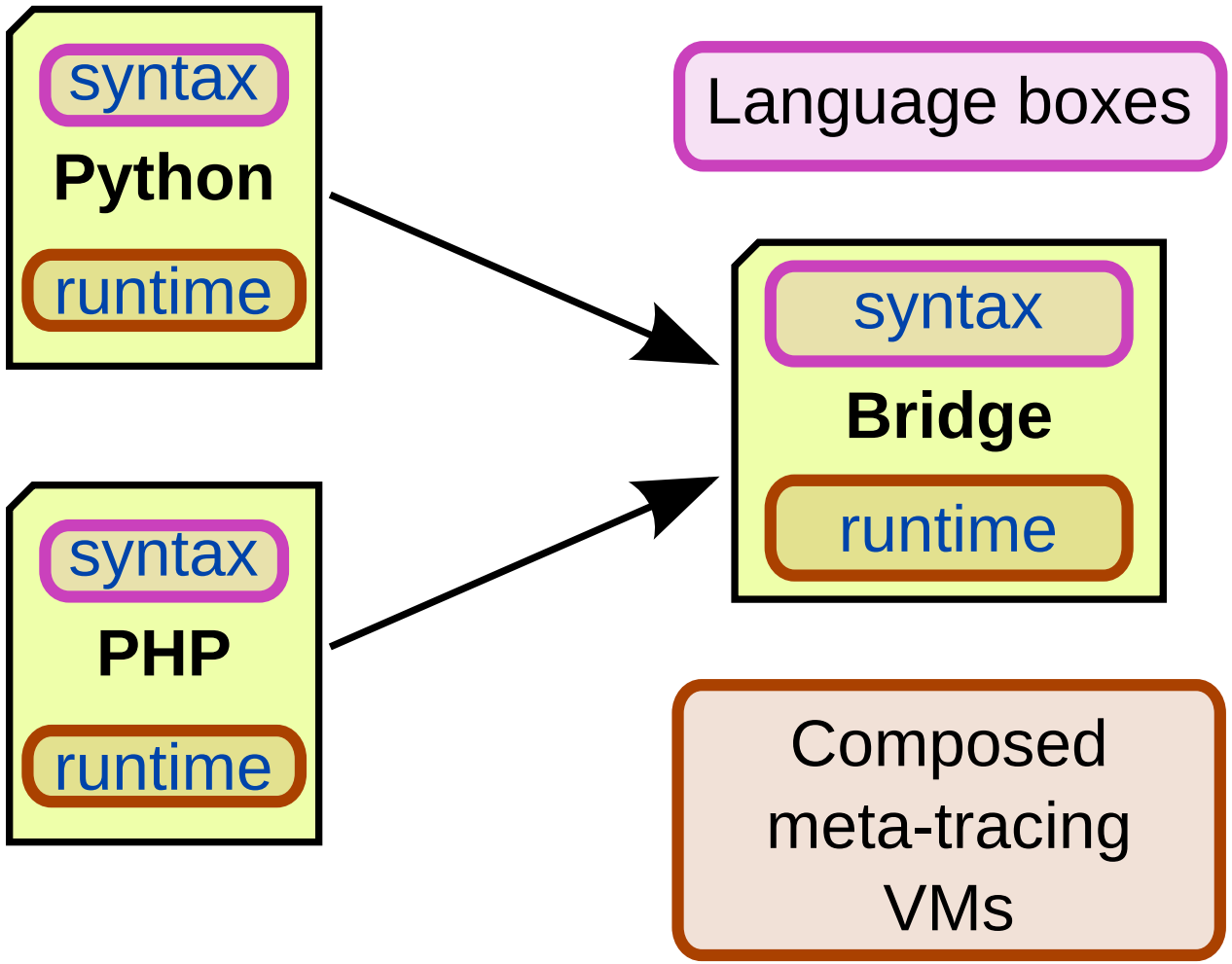
Summary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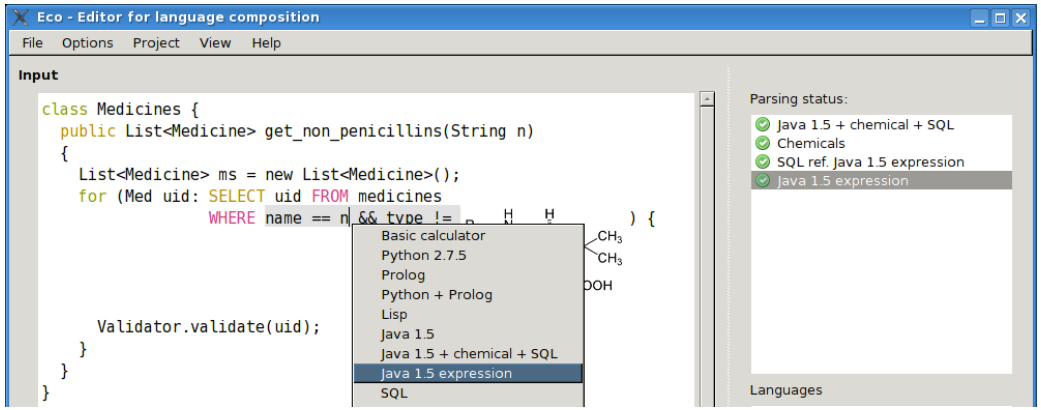
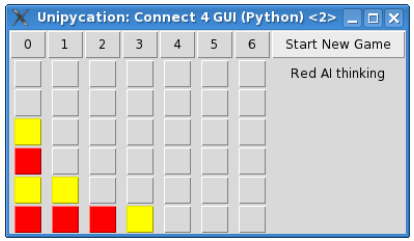
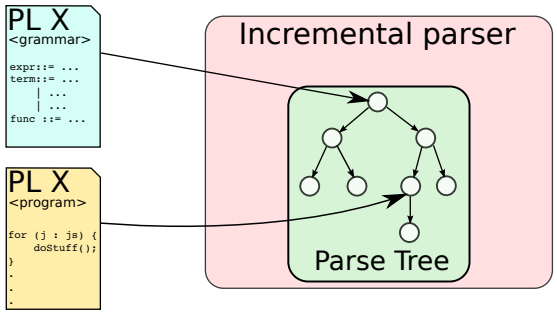
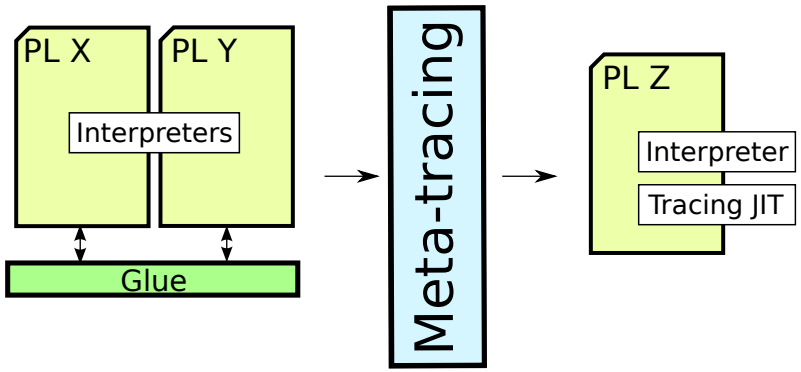
VMs

Thanks for listening









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