Deoptimizing Ruby

JRuby+Truffle and the antidote to JITs

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Safe Harbor Statement

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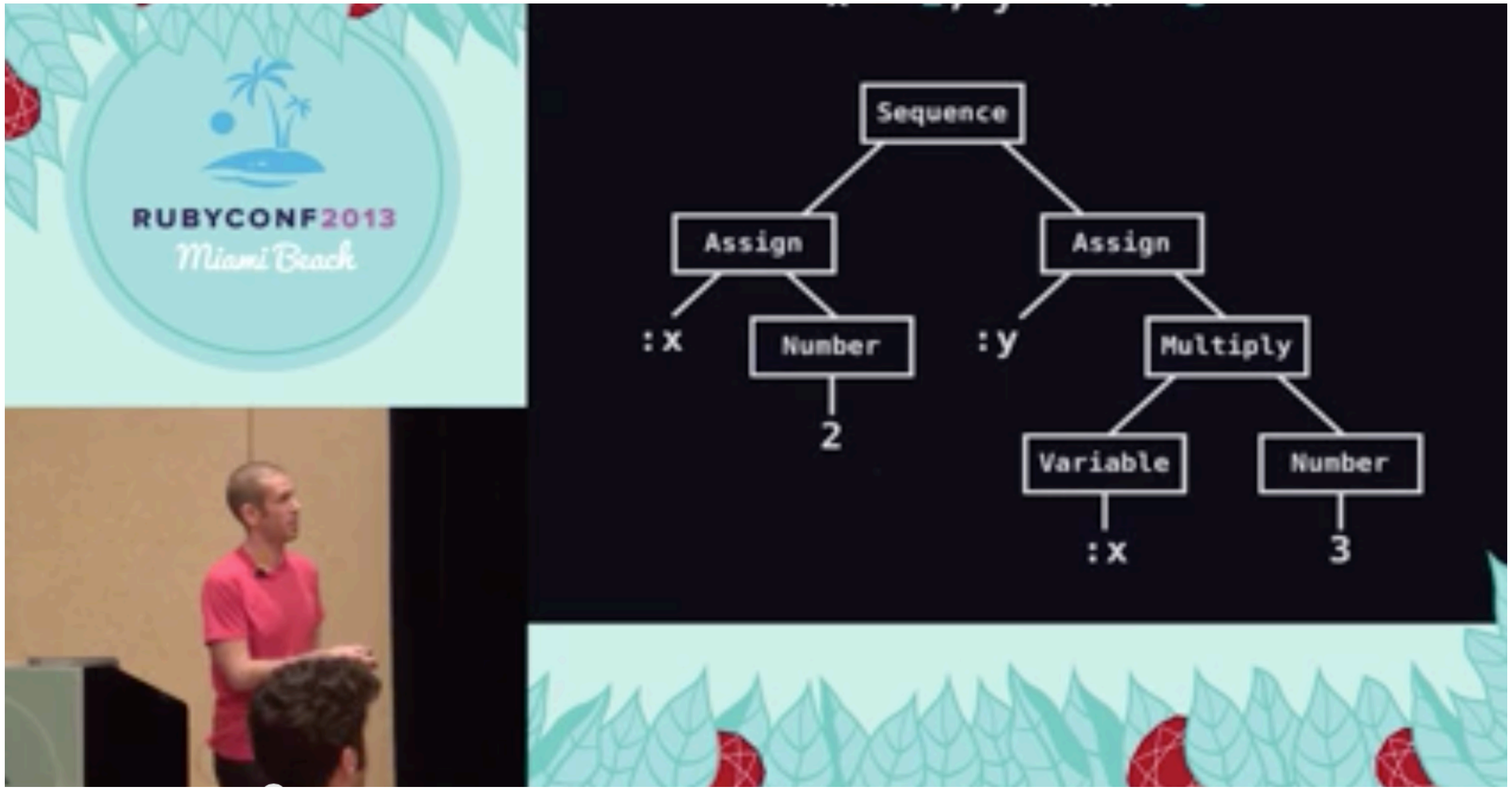
chrisseaton.com/rubytruffle/deoptimizing

JRuby+Truffle

A new open source implementation of Ruby by **Oracle Labs** with a **JIT** using **next-gen JVM** technology and **partial evaluation**, now part of **JRuby**



codon.com/compilers-for-free

Why is Ruby hard to optimize?

Fixnum to Bignum promotion

Monkey patching methods

#binding

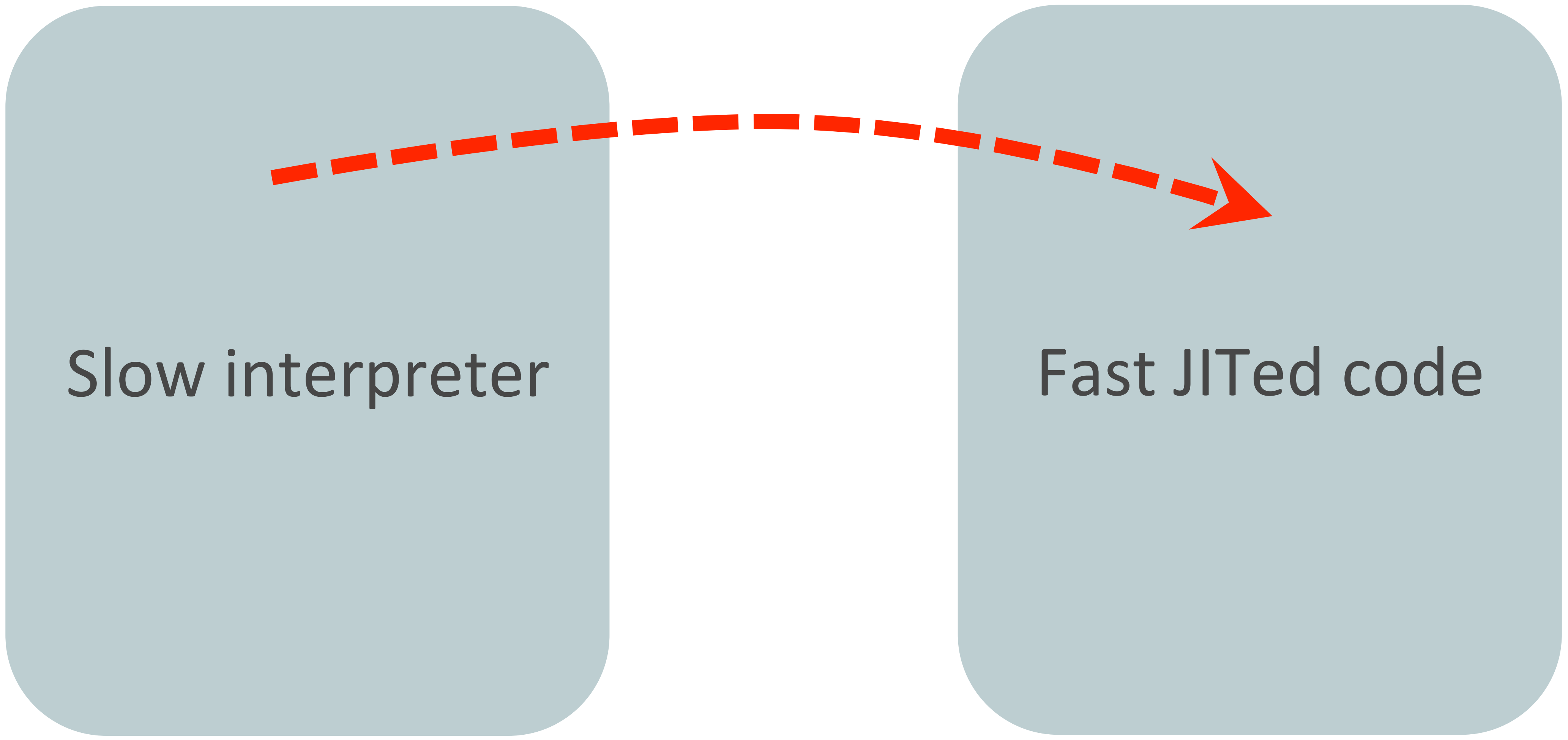
ObjectSpace

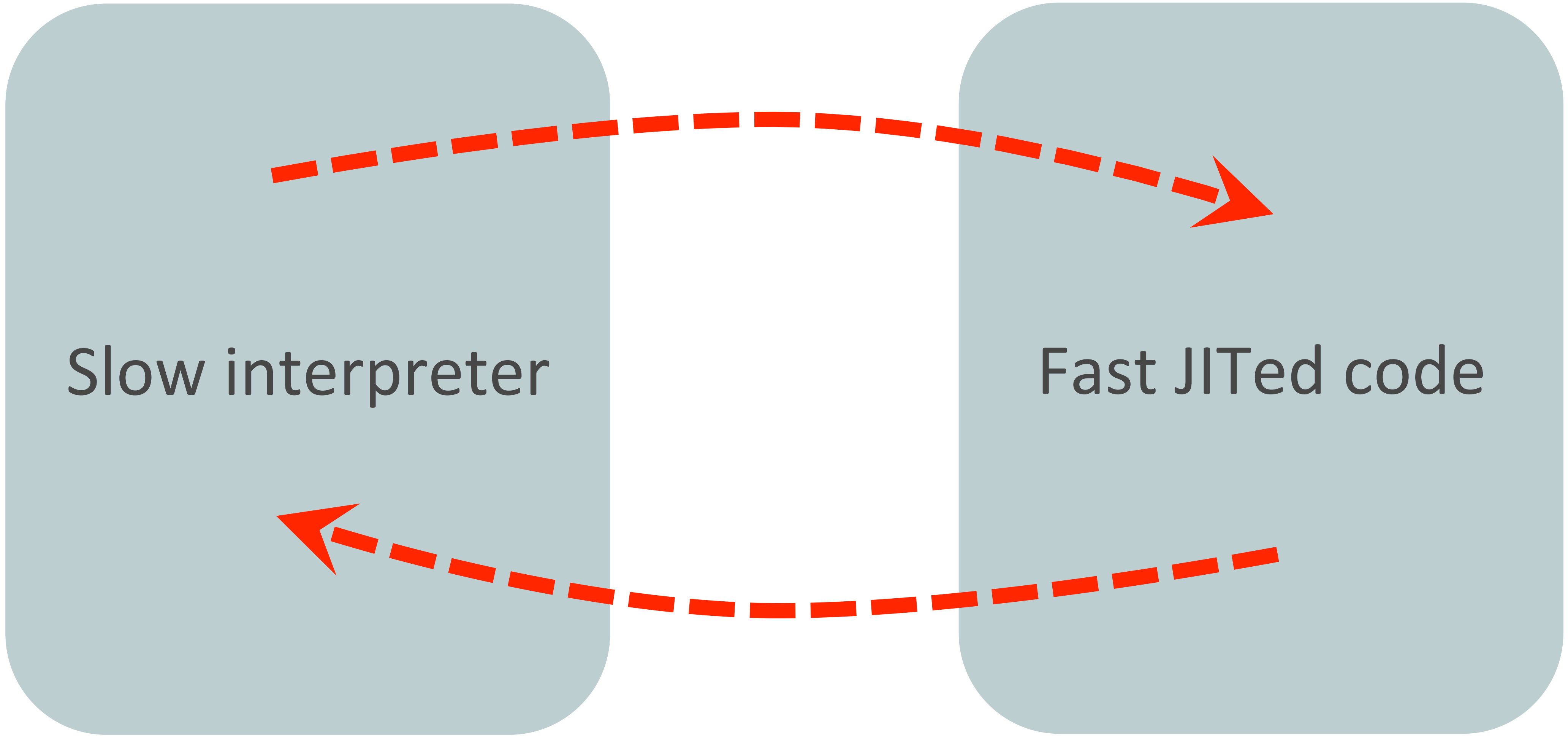
set_trace_func

Thread#raise

Deoptimization

elegantly solves all these problems


Slow interpreter
Fast JITed code


Slow interpreter
Fast JITed code

Illustrating Deoptimization

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Ruby

Door to utopia of high performance

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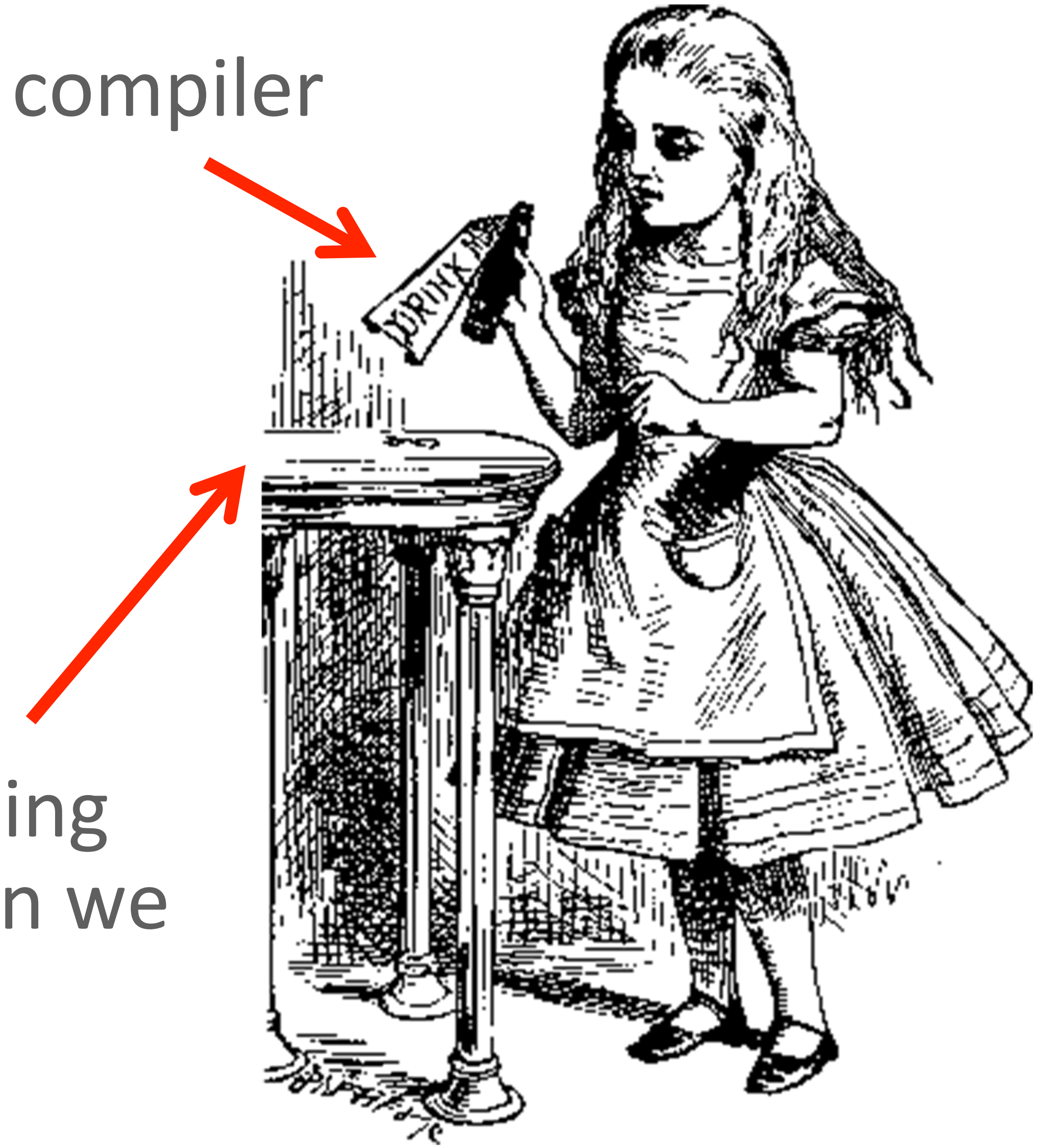
Just-in-time compiler



Left something behind when we compiled

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Deoptimization reverses the effects of the JIT

John Tenniel illustrations public domain in the UK and US

What does deoptimization do for Ruby?

Fixnum to Bignum promotion

```
a + b + c
```

We’ll assume we already know these are Fixnums

```
t1 = Fixnum(a) + Fixnum(b)
if t1.overflowed?
  t1 = Bignum(a) + Bignum(b)
  t2 = Bignum(t1) + Bignum(c)
else
  t2 = Fixnum(t1) + Fixnum(c)
  if t2.overflowed?
    t2 = Bignum(t1) + Bignum(c)
  end
end
```

```
t1 = Fixnum(a) + Fixnum(b)
deoptimize! if t1.overflowed?
t2 = Fixnum(t1) + Fixnum(c)
deoptimize! if t2.overflowed?
```

```
t1 = Fixnum(a) + Fixnum(b)
if t1.overflowed?
  t1 = Bignum(a) + Bignum(b)
  t2 = Bignum(t1) + Bignum(c)
else
  t2 = Fixnum(t1) + Fixnum(c)
  deoptimize! if t2.overflowed?
end
```

Monkey patching methods

```
my_object.my_method(x, y)
```

```
lookup my_method in my_object
call it with (x, y)
```

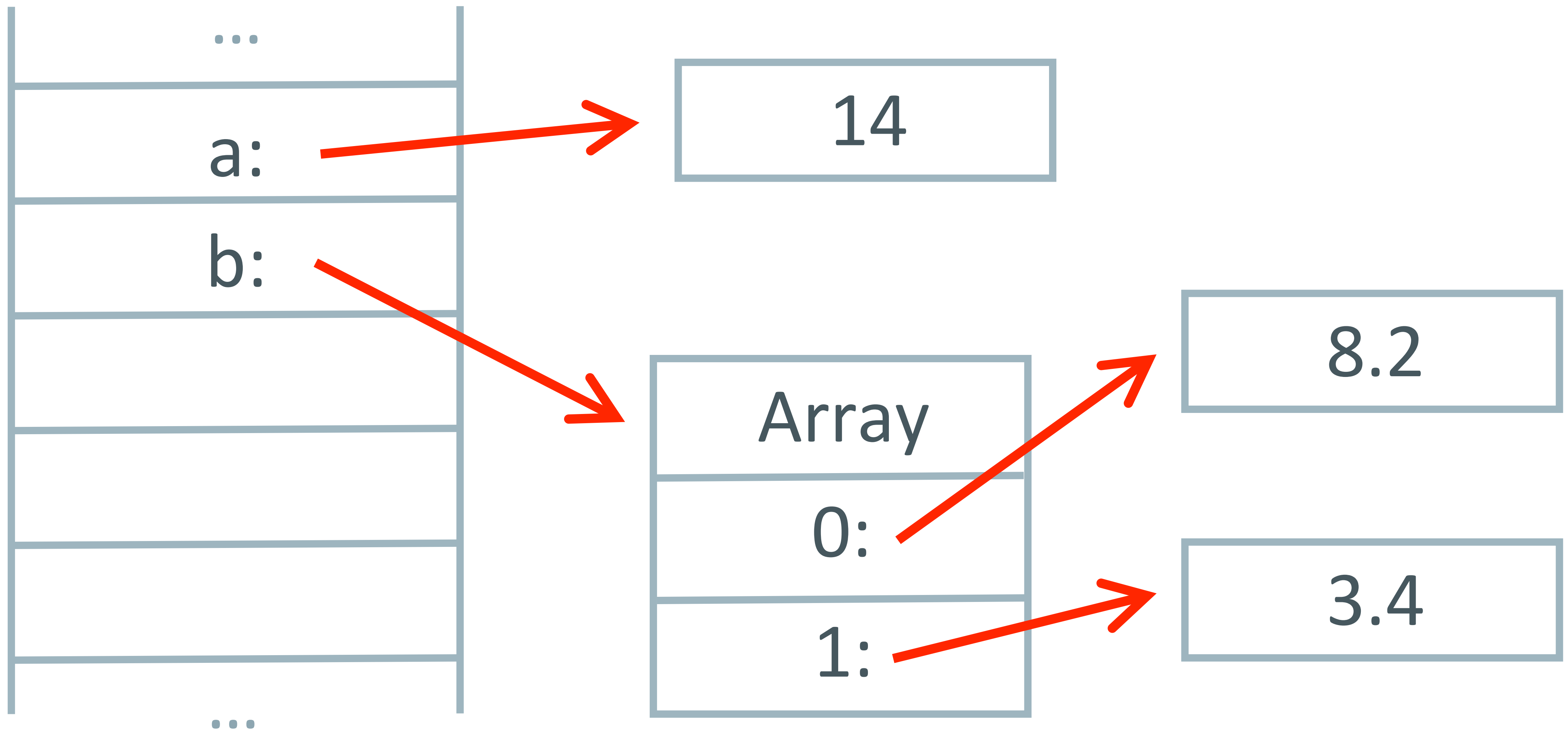
```
if my_object.changed?
  lookup my_method in my_object
  call it with (x, y)
else
  use cached my_method
  call it with (x, y)
end
```

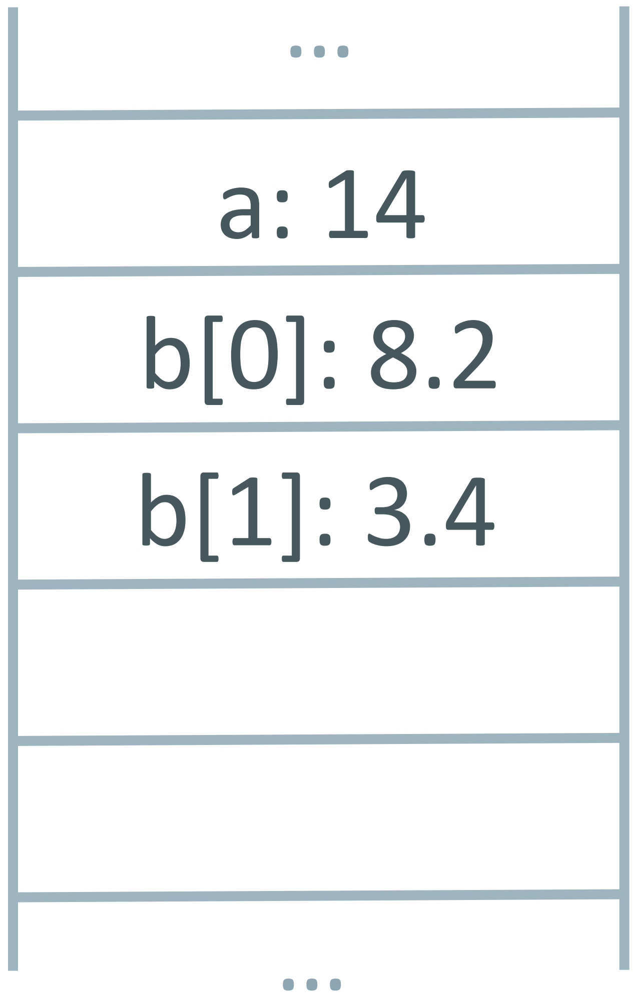
```
if my_object.changed?
  deoptimize!
else
  use cached my_method
  call it with (x, y)
end
```

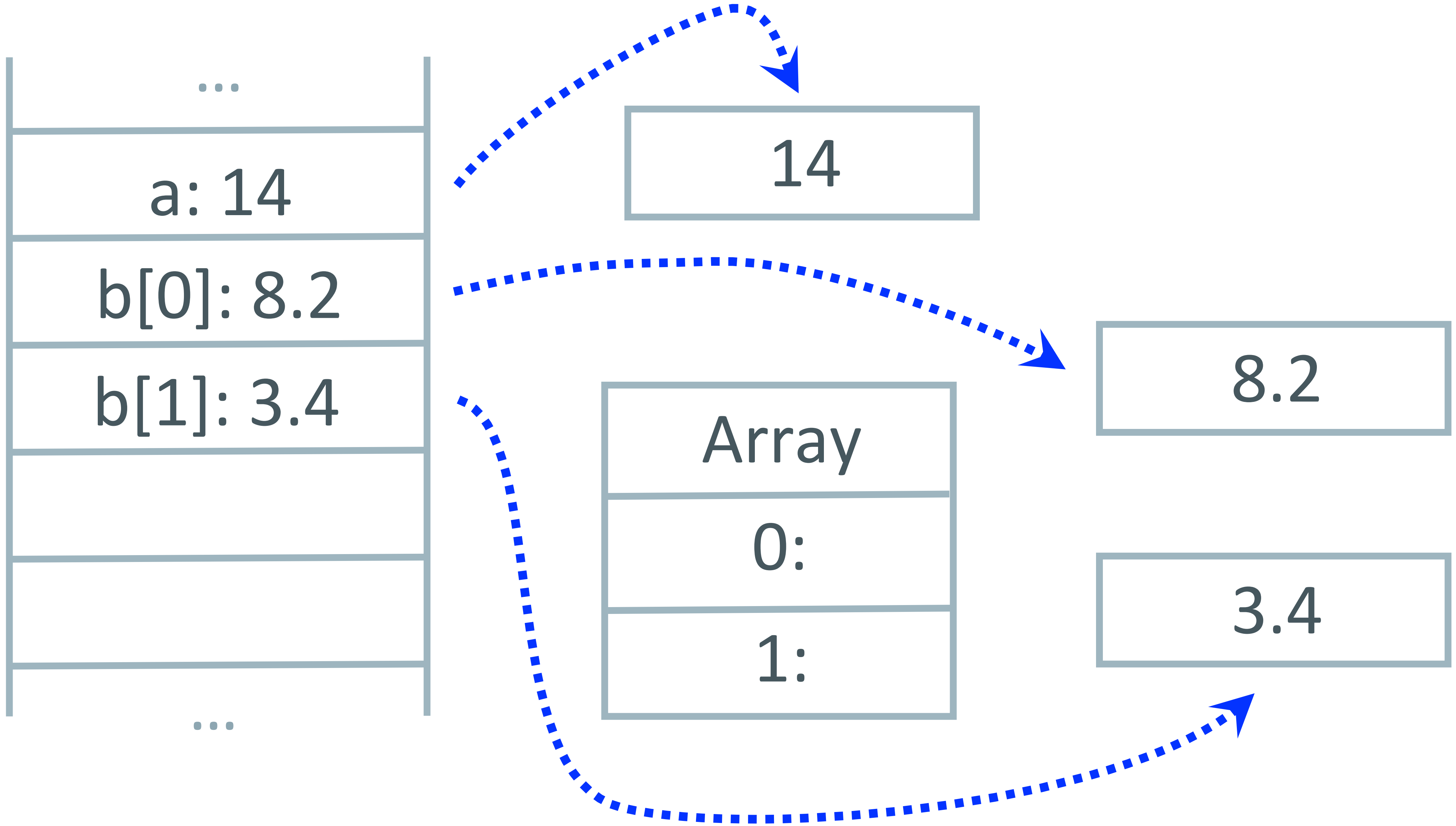
```
use cached my_method
call it with (x, y)
```

#binding

```
a = 14
b = [8.2, 3.4]
```


...
a:
b:
...
14
Array
0:
1:
8.2
3.4


...
a: 14
b[0]: 8.2
b[1]: 3.4
...


...
a: 14
b[0]: 8.2
b[1]: 3.4
...
14
Array
0:
1:
8.2
3.4

ObjectSpace

set_trace_func

How JRuby+Truffle Deoptimizes

1. Recreate the interpreter stack frame
2. Jump from the JITed code into the interpreter
3. Allow us to force threads to do this

```
loop do
  a = 14
  b = 2
  a + b
end
```

```
loop do
  a = 14
  b = 2
  a + b
  deoptimize! if should_deoptimize?
end
```

```
loop do
  a = 14
  b = 2
  a + b
  read the safepoint page
end
```

JRuby+Truffle Performance

86%

RubySpec language specs

rubyspec.org, Brian Shirai et al

#send

#binding

Method invalidation

Float

Threads

Frame-local variables

C extensions

Encodings

ObjectSpace

Regexp

Thread#raise

#eval

Fixnum to Bignum promotion

set_trace_func

Proc#binding

Closures

Concurrency

Constant invalidation

Debugging

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#eval

Fixnum to Bignum promotion

set_trace_func

Proc#binding

Closures

Concurrency

Constant invalidation

Debugging

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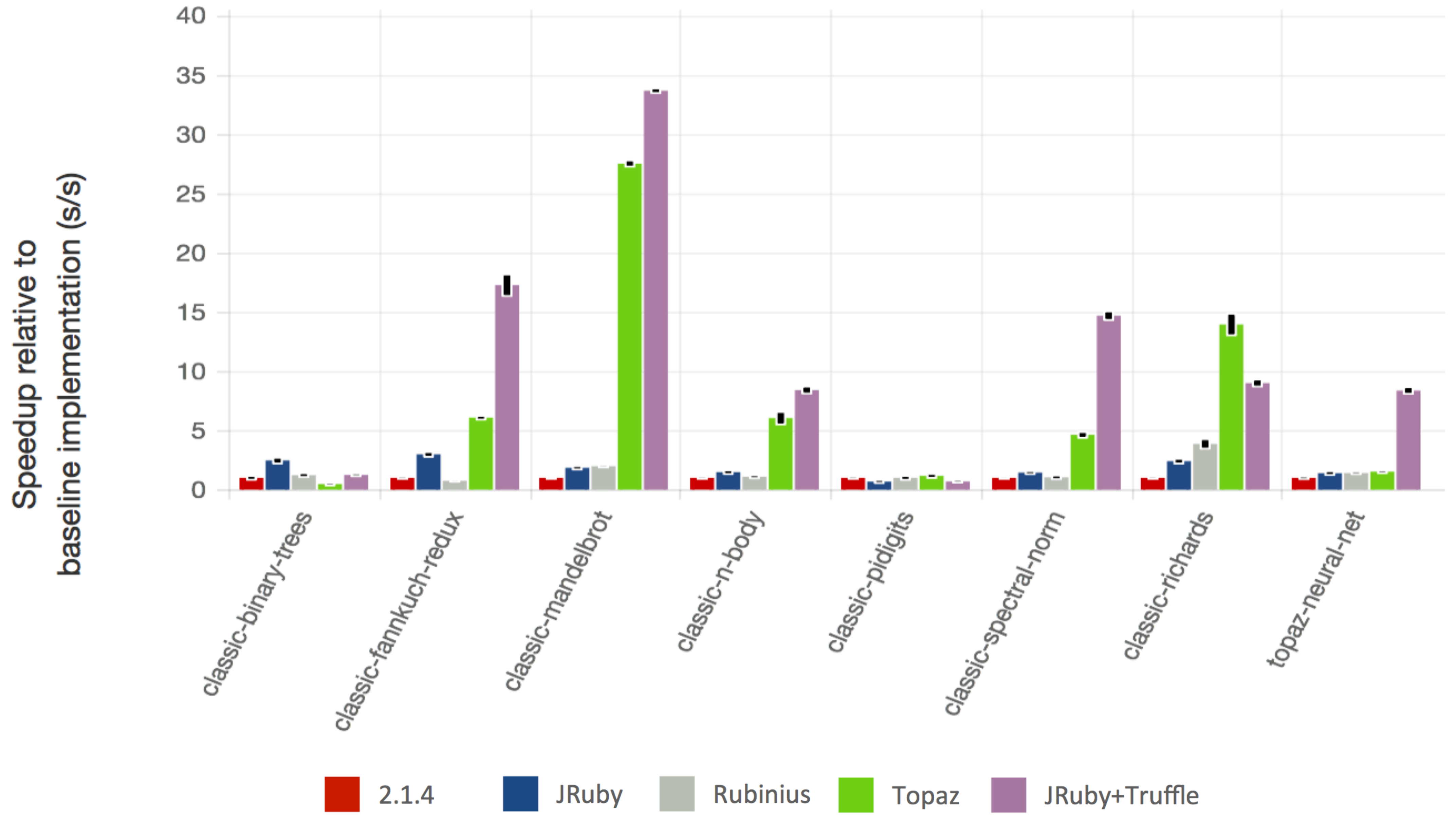
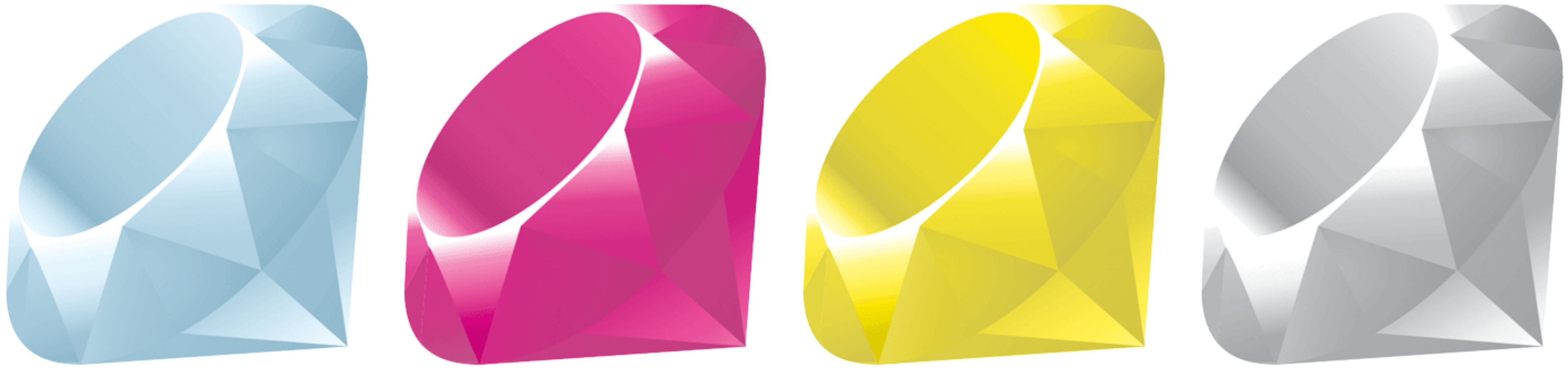
No, we can’t run Rails yet

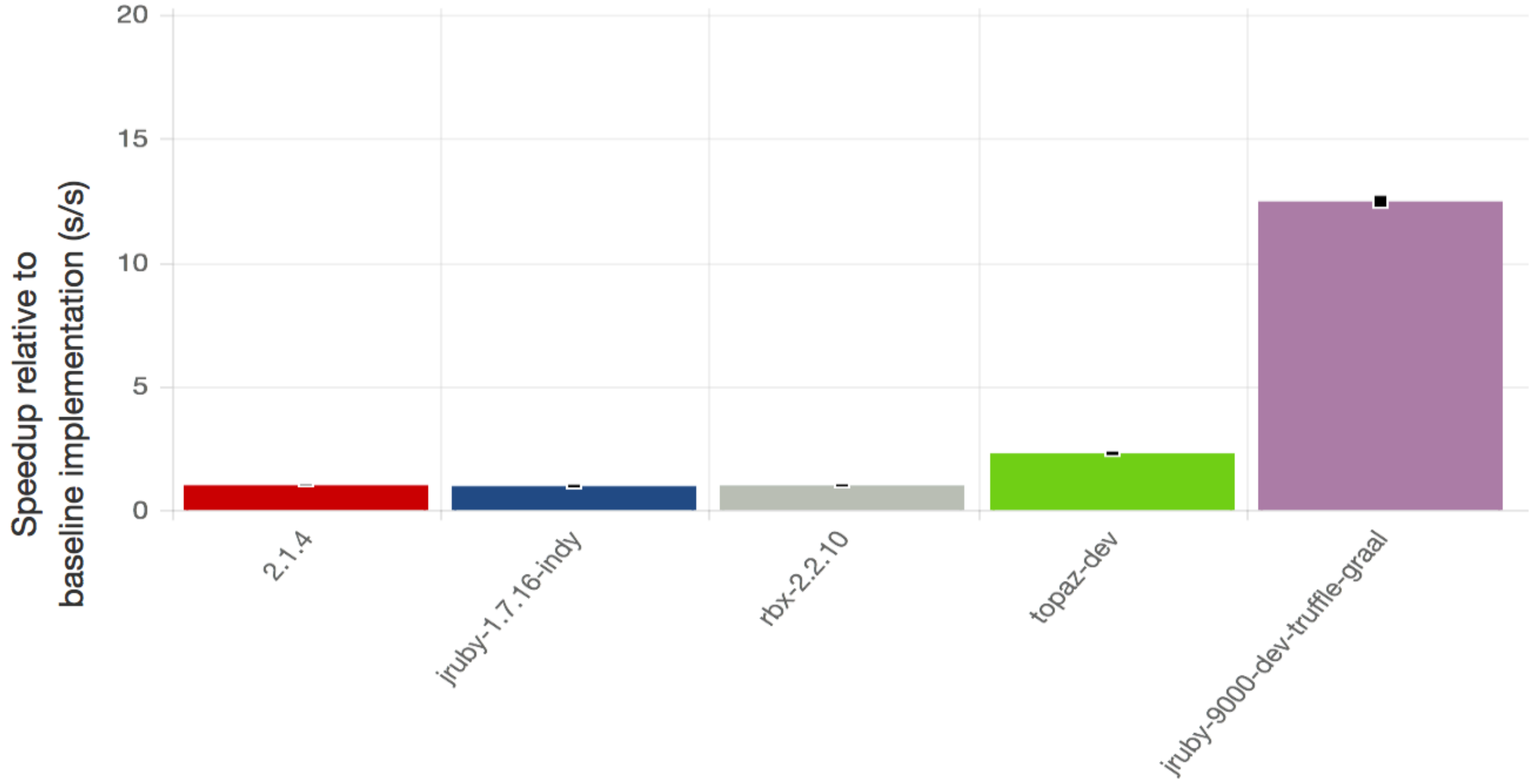
but we’re working towards it

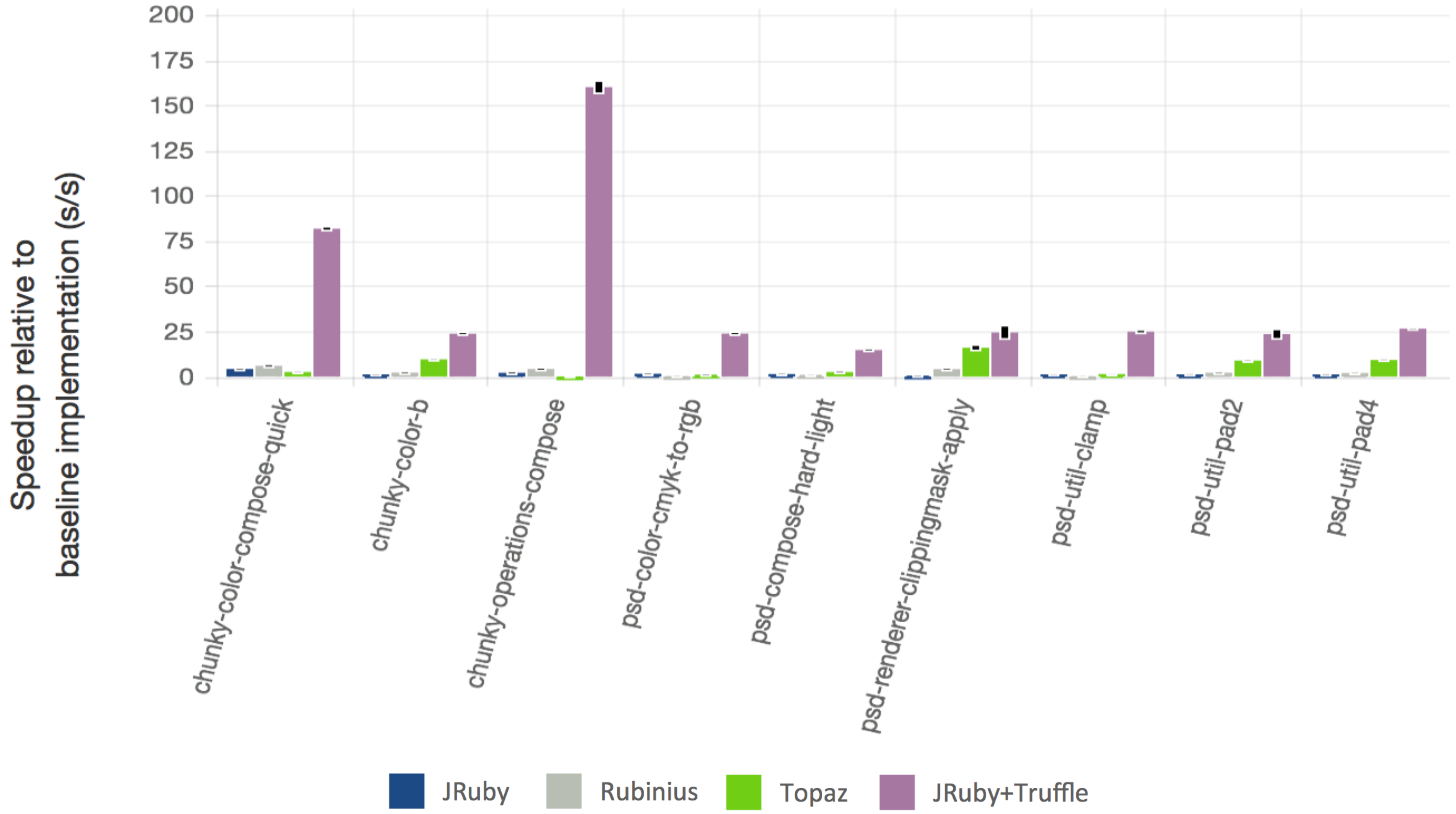

Speedup relative to baseline implementation (s/s)
40
35
30
25
20
15
10
5
0
classic-binary-trees
classic-fannkuch-redux
classic-mandelbrot
classic-n-body
classic-pidigits
classic-spectral-norm
classic-richards
topaz-neural-net
2.1.4
JRuby
Rubinius
Topaz
JRuby+Truffle



chunky_png and psd.rb

Willem van Bergen, Ryan LeFevre, Kelly Sutton, Layer Vault, Floorplanner et al


Speedup relative to baseline implementation (s/s)
20
15
10
5
0
2.1.4
jruby-1.7.16-indy
rbx-2.2.10
topaz-dev
jruby-9000-dev-truffle-graal


Speedup relative to baseline implementation (s/s)
200
175
150
125
100
75
50
25
0
chunky-color-compose-quick
chunky-color-b
chunky-operations-compose
psd-color-cmyk-to-rgb
psd-compose-hard-light
psd-renderer-clippingmask-apply
psd-util-clamp
psd-util-pad2
psd-util-pad4
JRuby
Rubinius
Topaz
JRuby+Truffle

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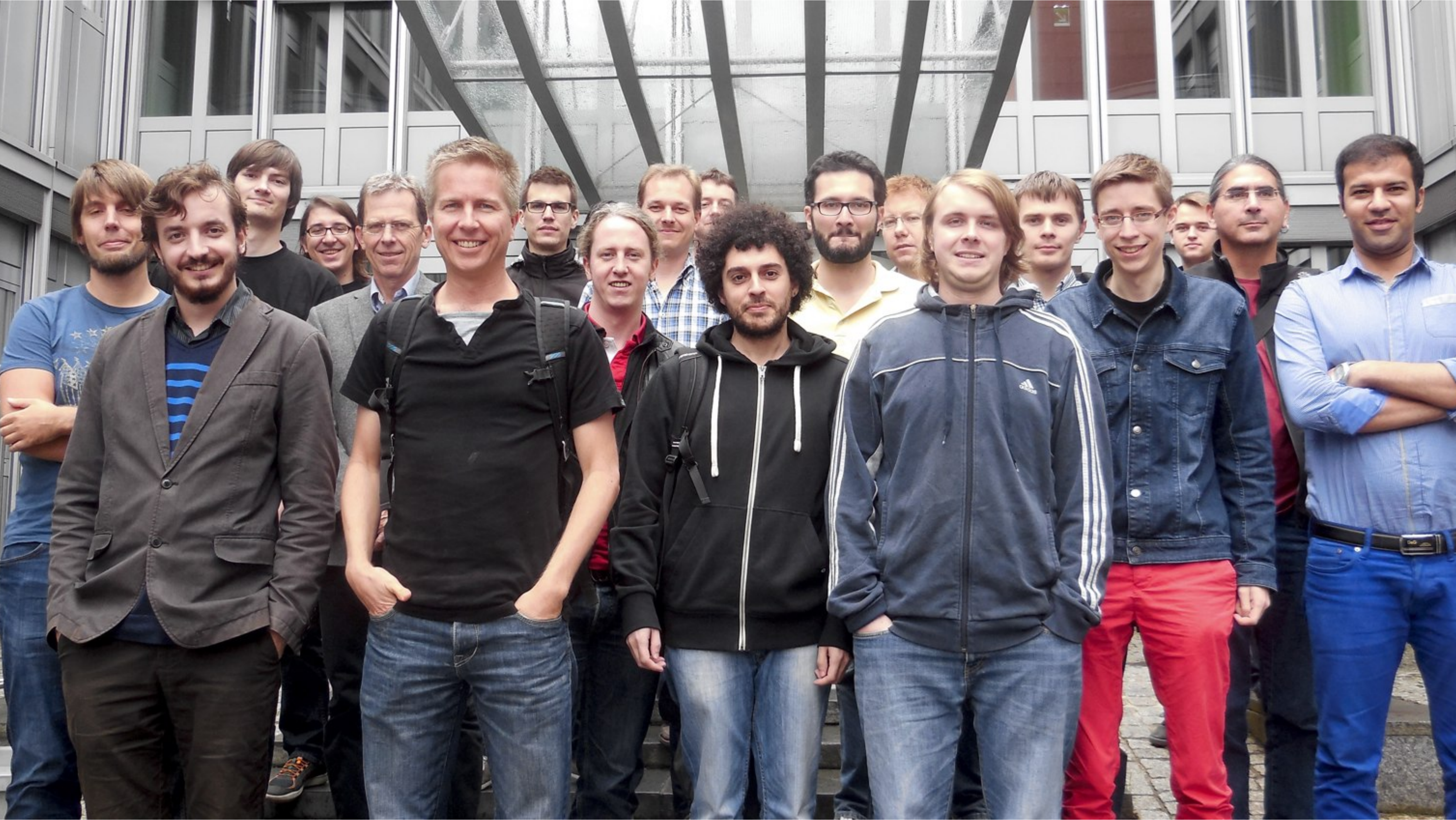
Conclusions

Building on other projects



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