Evolution of Keyword parameters

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Rubyconf Portugal'15

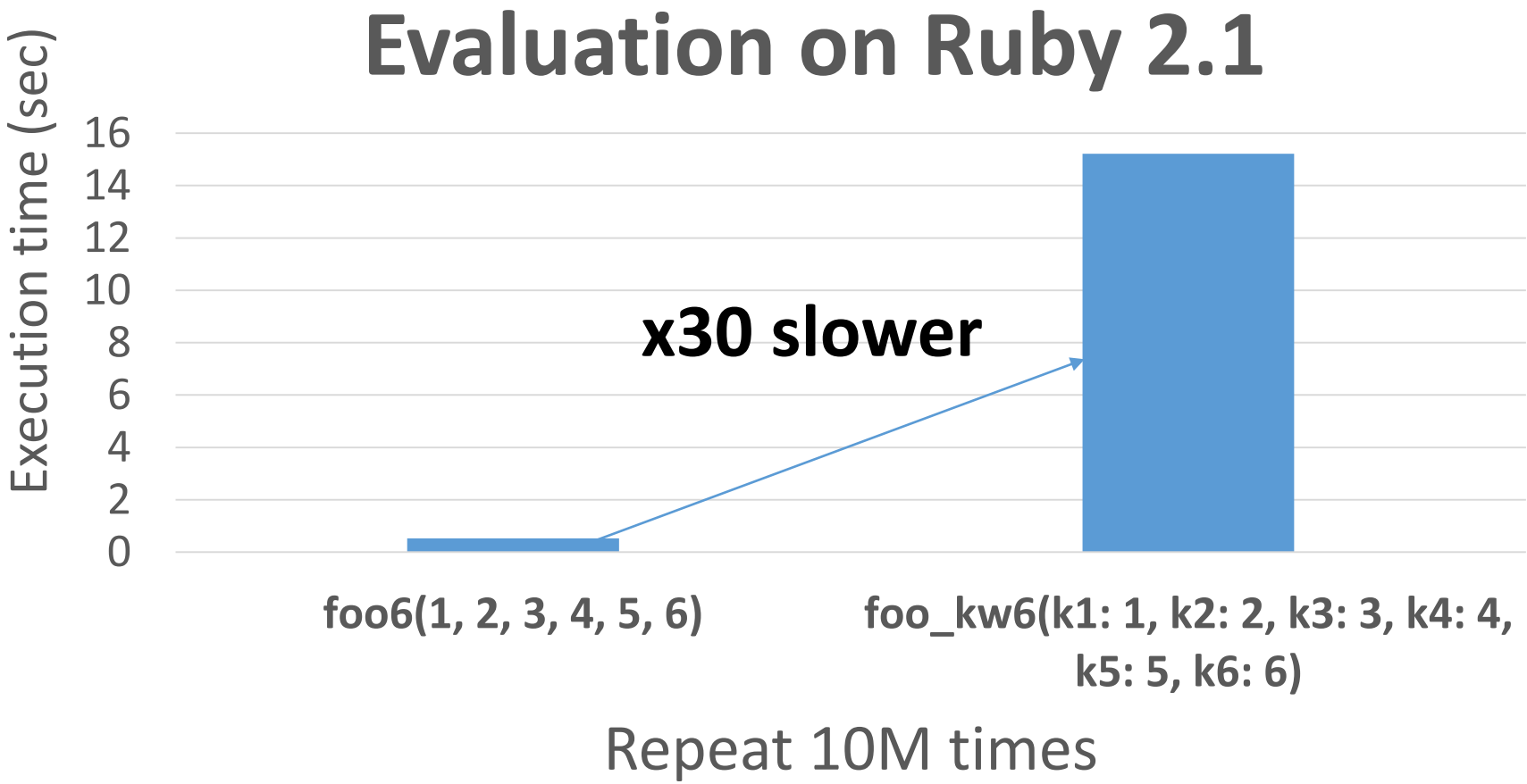
Background

"Keyword parameters" from Ruby 2.0

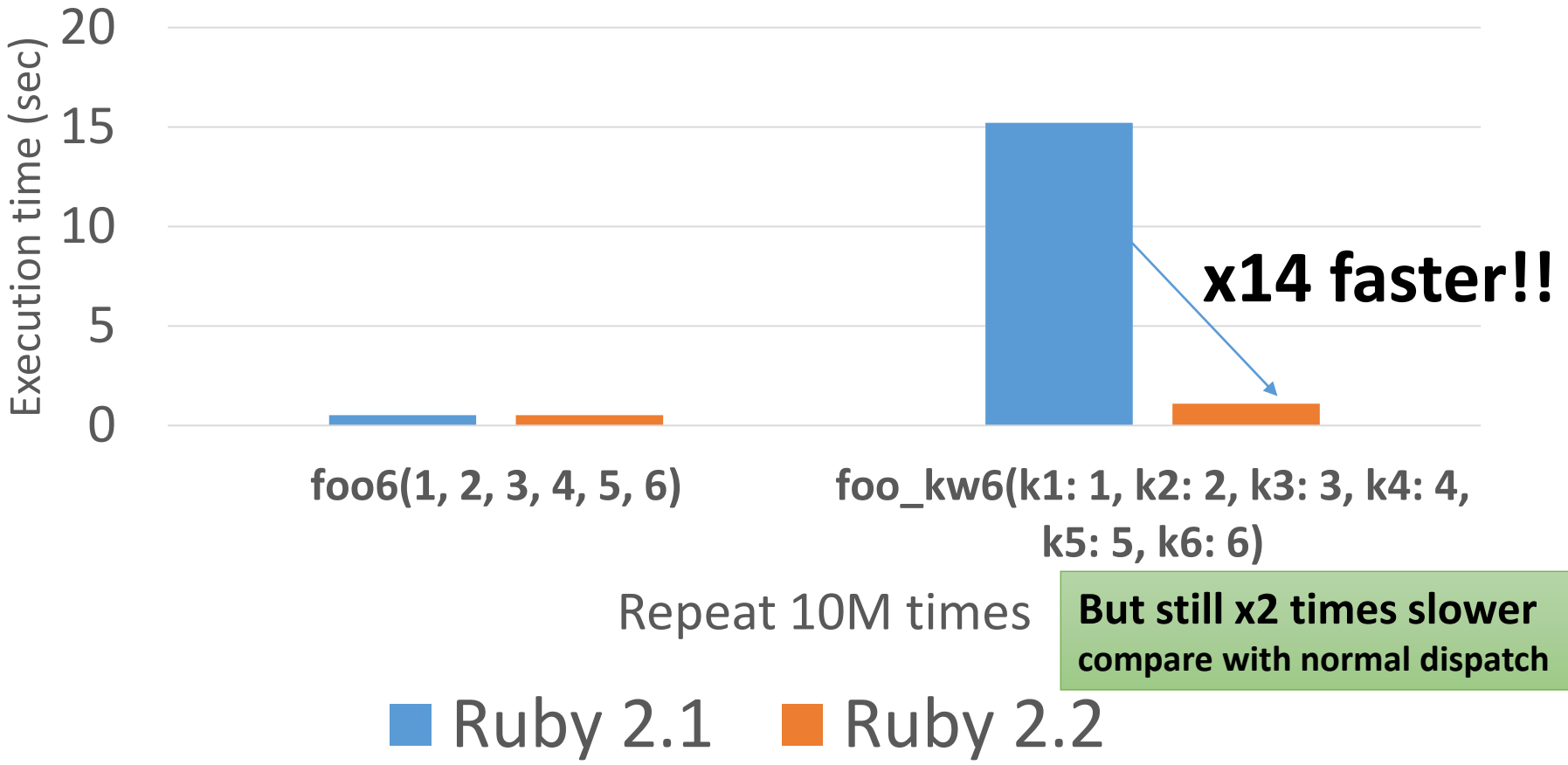
```
# From Ruby 2.0 feature
def foo(k1: 1, k2: 2)
  p [k1, k2] #=> [345, 2]
end

foo(k1: 345)
```

Background

"Keyword parameters" was slow!!



Summary
Ruby 2.2 optimized “keyword parameters”



Why was slow?

How to solve it?

Koichi Sasada is a Programmer

- MRI committer since 2007/01
  - Original YARV developer since 2004/01
    - YARV: Yet Another RubyVM
    - Introduced into Ruby (MRI) 1.9.0 and later
  - Generational/incremental GC for 2.x

Koichi Sasada from Japan

Japanese lesson

English	Thank you
Portuguese	Obrigado
Japanese	Arigato ありがとう

Koichi is an Employee

Koichi is a member of Heroku Matz team

Mission

Design Ruby language and improve quality of MRI

Heroku employs three full time Ruby core developers in Japan named “Matz team”

Heroku Matz team

Matz  **Designer/director of Ruby**

Nobu  **Quite active committer**

Ko1  **Internal Hacker**

Matz
Title collector

- He has so many (job) title
  - Chairman - Ruby Association
  - Fellow - NaCl
  - Chief architect, Ruby - Heroku
  - Research institute fellow – Rakuten
  - Chairman – NPO mruby Forum
  - Senior researcher – Kadokawa Ascii Research Lab
  - Visiting professor – Shimane University
  - Honorable citizen (living) – Matsue city
  - Honorable member – Nihon Ruby no Kai
  - …
- This margin is too narrow to contain

Nobu
Great Patch monster

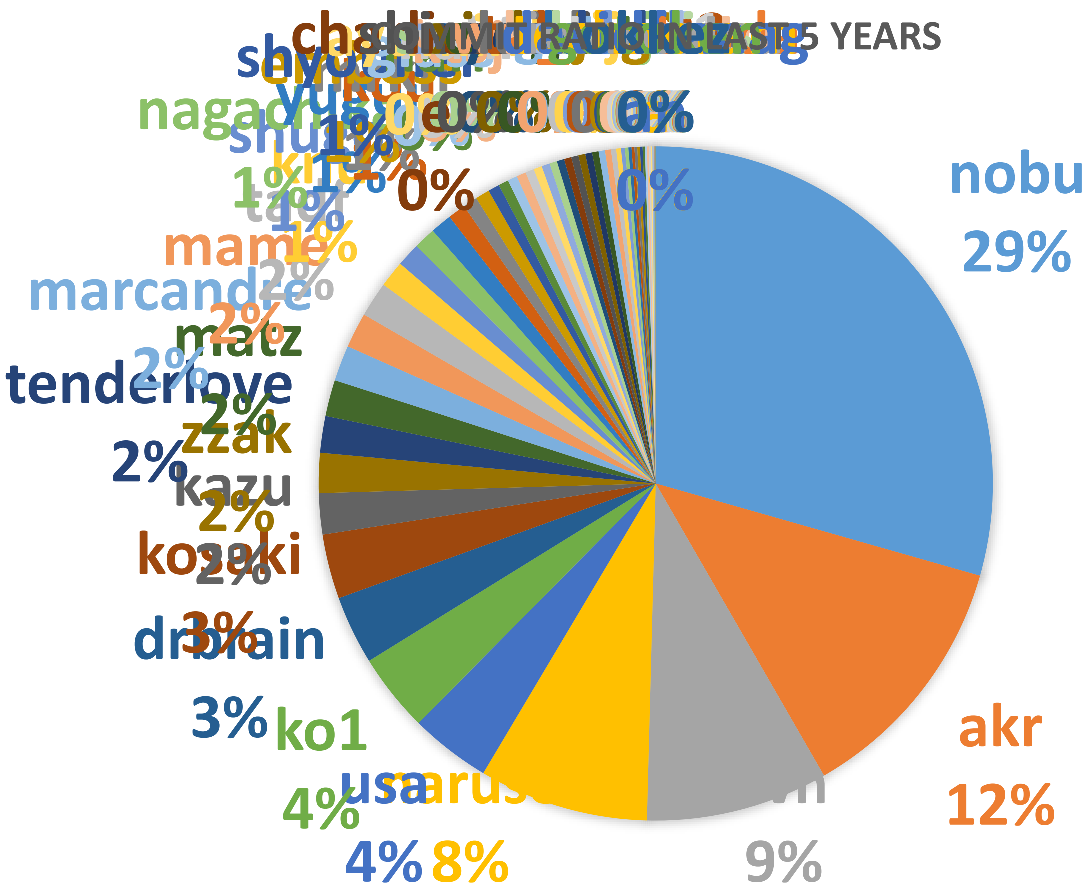
Ruby's bug

|> Fix Ruby

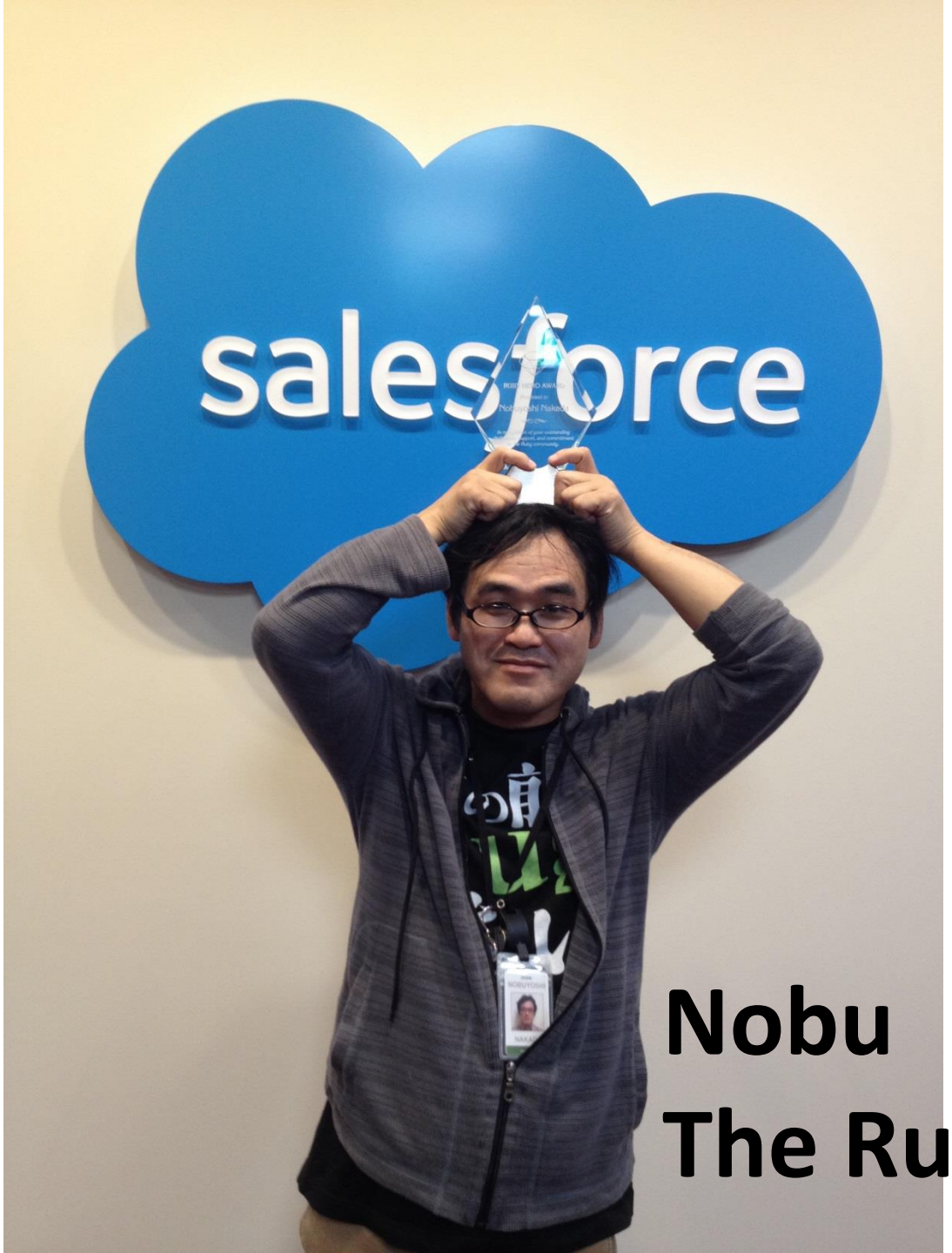
|> Break Ruby

|> And Fix Ruby

Nobu
Patch monster



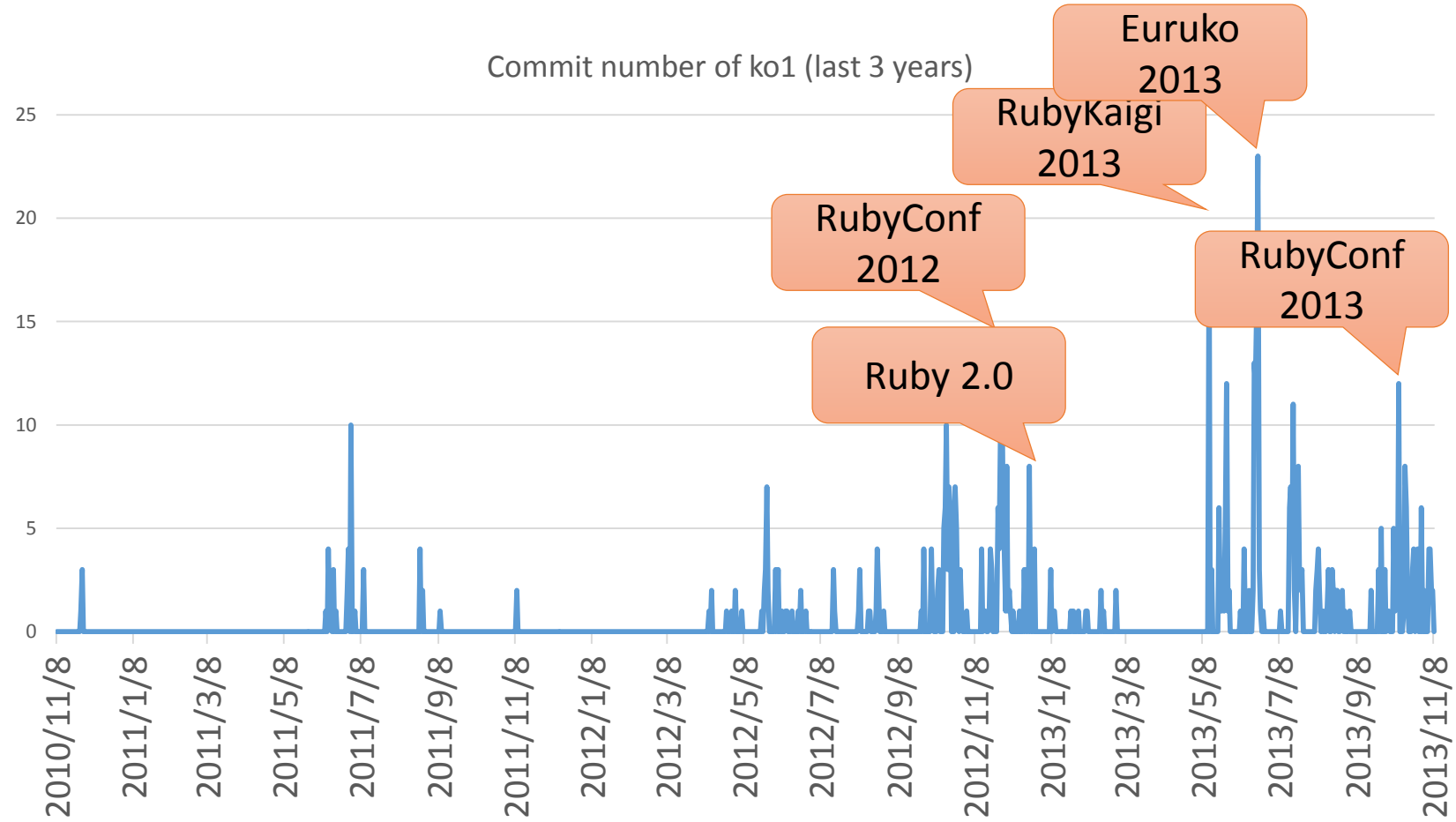
Commit count of MRI



Nobu

The Ruby Hero

Ko1
EDD developer



EDD: Event Driven Development

Heroku Matz team and Ruby core team
Recent achievement

Ruby 2.2

Current stable

Ruby 2.2 Syntax

- Symbol key of Hash literal can be quoted

```
{“foo-bar”: baz}
  #=> {:“foo-bar” => baz}
  #=> not {“foo-bar” => baz} like JSON
```

TRAP!!

Easy to misunderstand

(I wrote a wrong code, already…)

Ruby 2.2
Classes and Methods

- Some methods are introduced
  - Kernel#itself
  - String#unicode_normalize
  - Method#curry
  - Binding#receiver
  - Enumerable#slice_after, slice_before
  - File.birthtime
  - Etc.nprocessors
  - …

Ruby 2.2 Improvements

- Improve GC
  - Symbol GC
  - Incremental GC
  - Improved promotion algorithm
    - Young objects promote after 4 GCs
- Fast keyword parameters
- Use frozen string literals if possible

Ruby 2.2
Symbol GC

```
before = Symbol.all_symbols.size
1_000_000.times{|i| i.to_s.to_sym} # Make 1M symbols
after = Symbol.all_symbols.size; p [before, after]

# Ruby 2.1
#=> [2_378, 1_002_378] # not GCed ☹

# Ruby 2.2
#=> [2_456, 2_456] # GCed! ☺
```

Ruby 2.2
Symbol GC Issues history

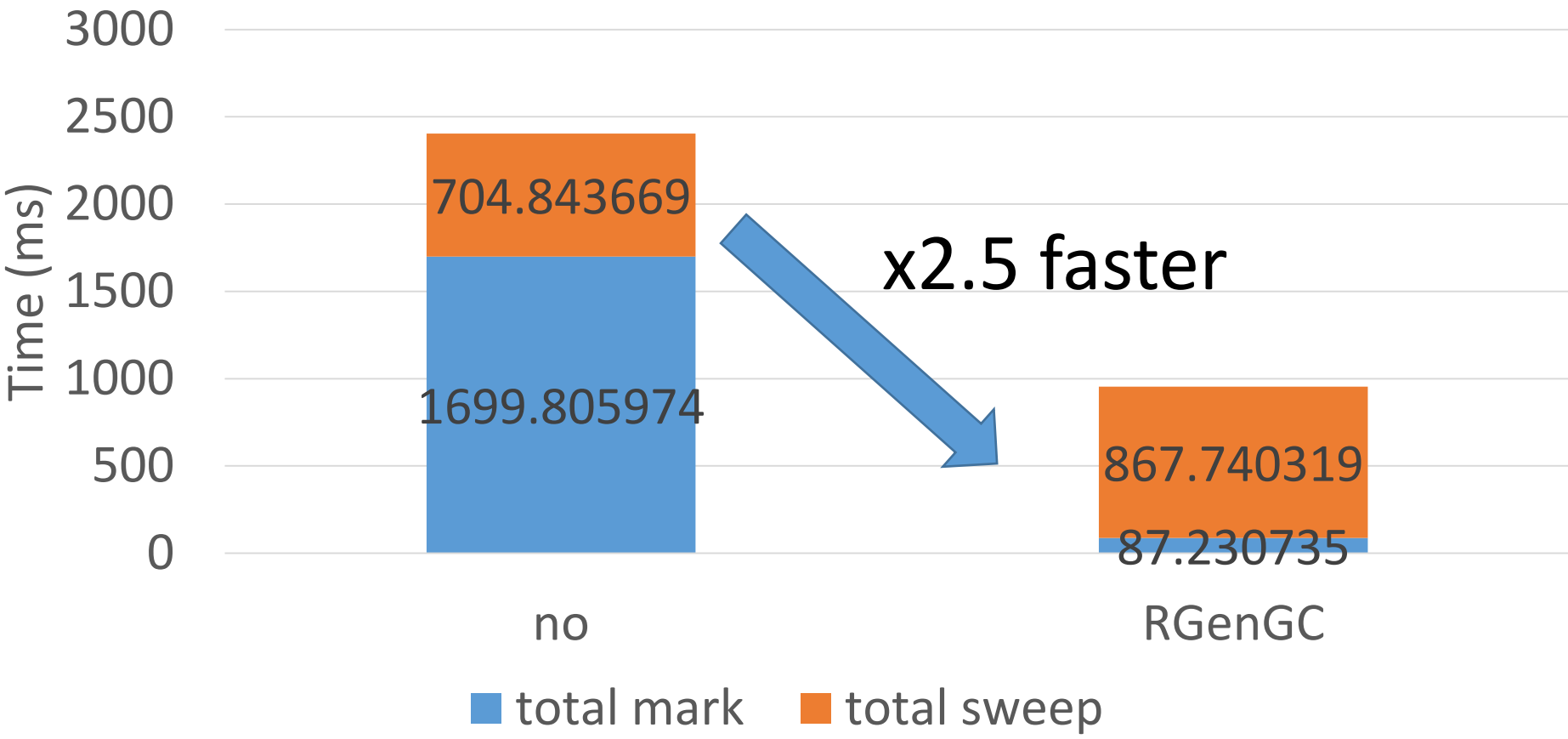
- **Ruby 2.2.0** has memory (object) leak problem
  - Symbols has corresponding String objects
  - Symbols are collected, but Strings are not collected! (leak)
- **Ruby 2.2.1** solved this problem!!
  - However, 2.2.1 also has problem (rarely you encounter BUG at **the end of process** **[Bug #10933]** ← not big issue, I want to believe)
- **Ruby 2.2.2** had solved [Bug #10933]!!
  - However, patch was forgot to introduce!!
- **Finally, Ruby 2.2.3 solved it!!**
  - **Please use newest version!!**

Ruby 2.2
Incremental GC

Goal

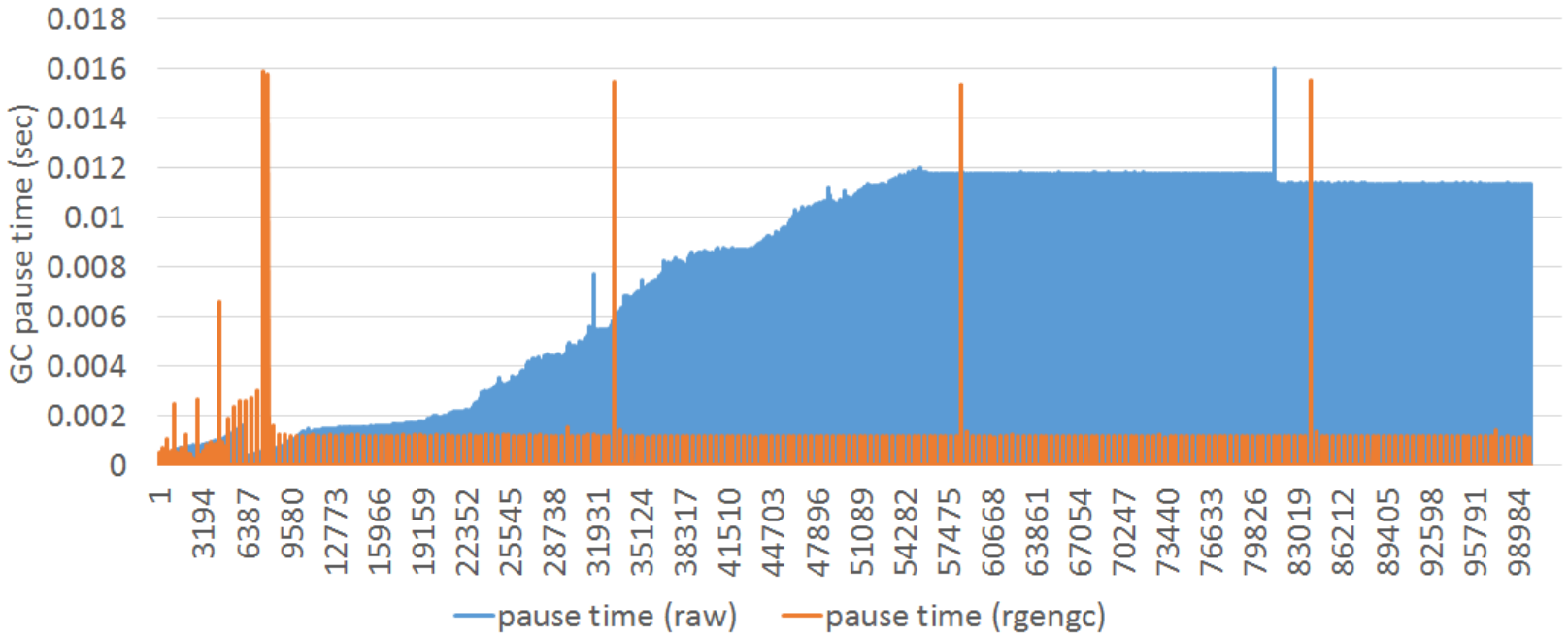
	Before Ruby 2.1	Ruby 2.1 RGenGC	Incremental GC	Ruby 2.2 Gen+IncGC
Throughput	Low	High	Low	High
Pause time	Long	Long	Short	Short

RGenGC from Ruby 2.1: Micro-benchmark



RGenGC from Ruby 2.1: Pause time

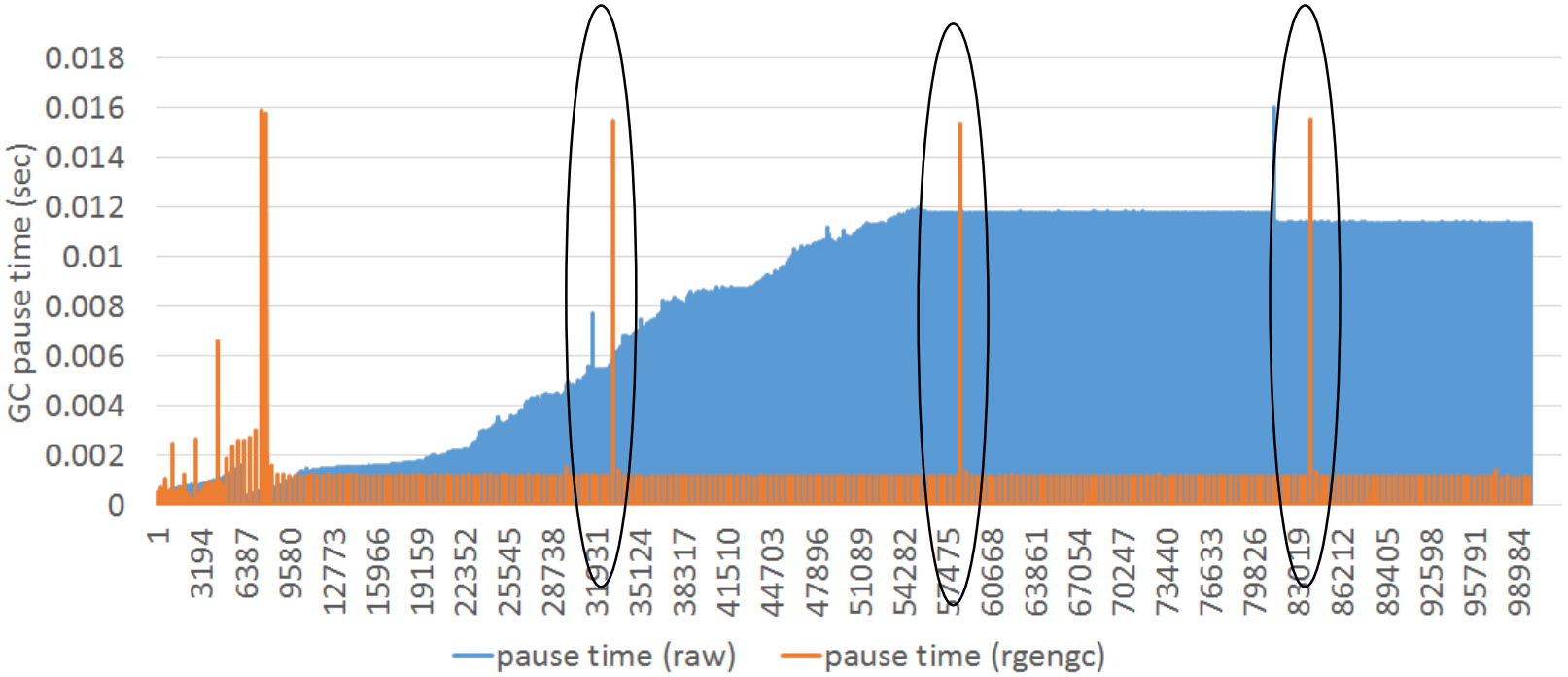
Most of cases, FASTER ☺



(w/o rgengc)

RGenGC from Ruby 2.1: Pause time

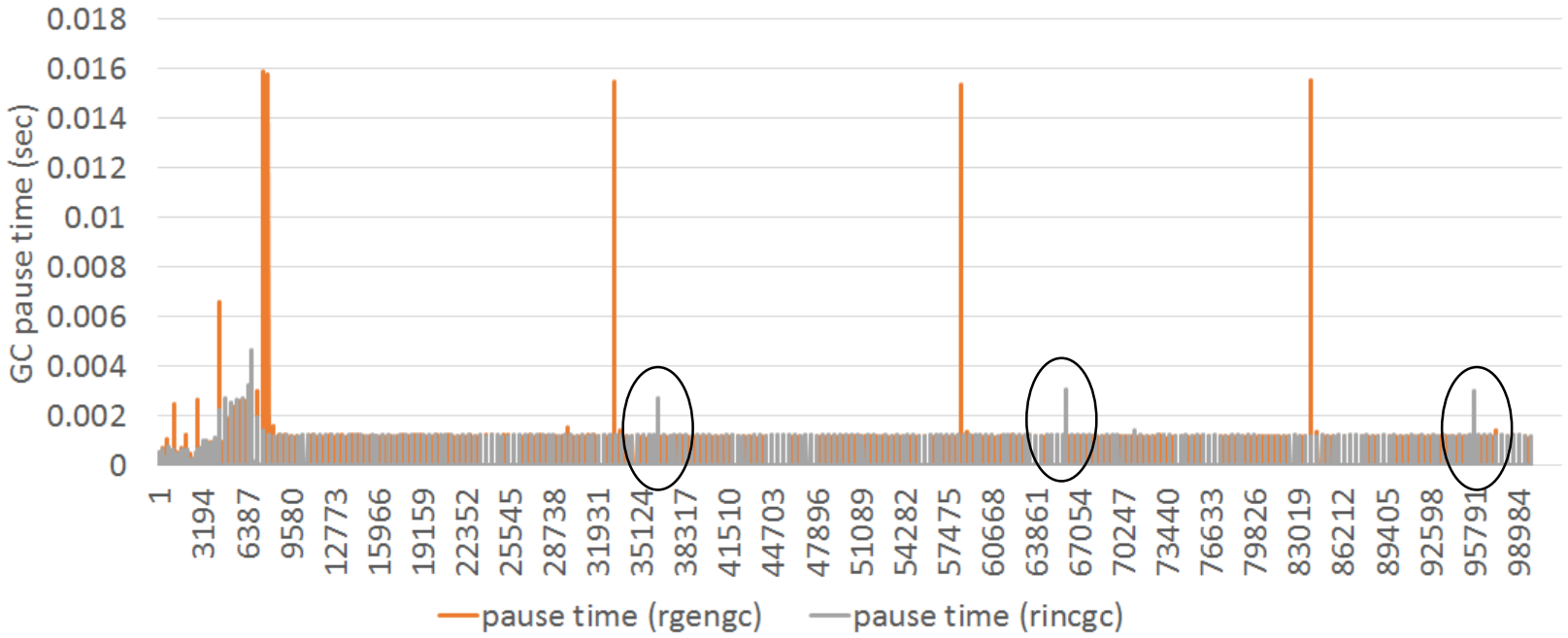
Several peaks ☹



(w/o rgengc)

Ruby 2.2 Incremental GC

Short pause time ☺



Heroku Matz team and Ruby core team
Next target is

Ruby 2.3

Heroku Matz team and Ruby core team
Next target is

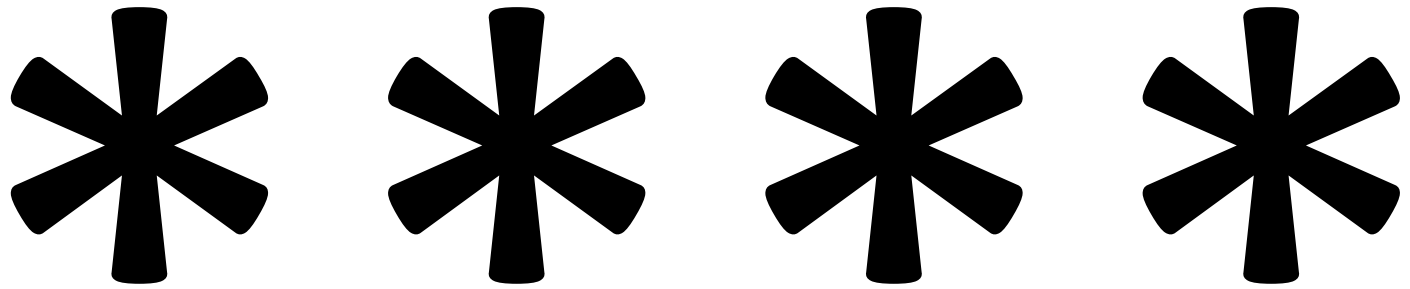
Ruby 2.3

No time to talk about it.

Please ask me later ☺

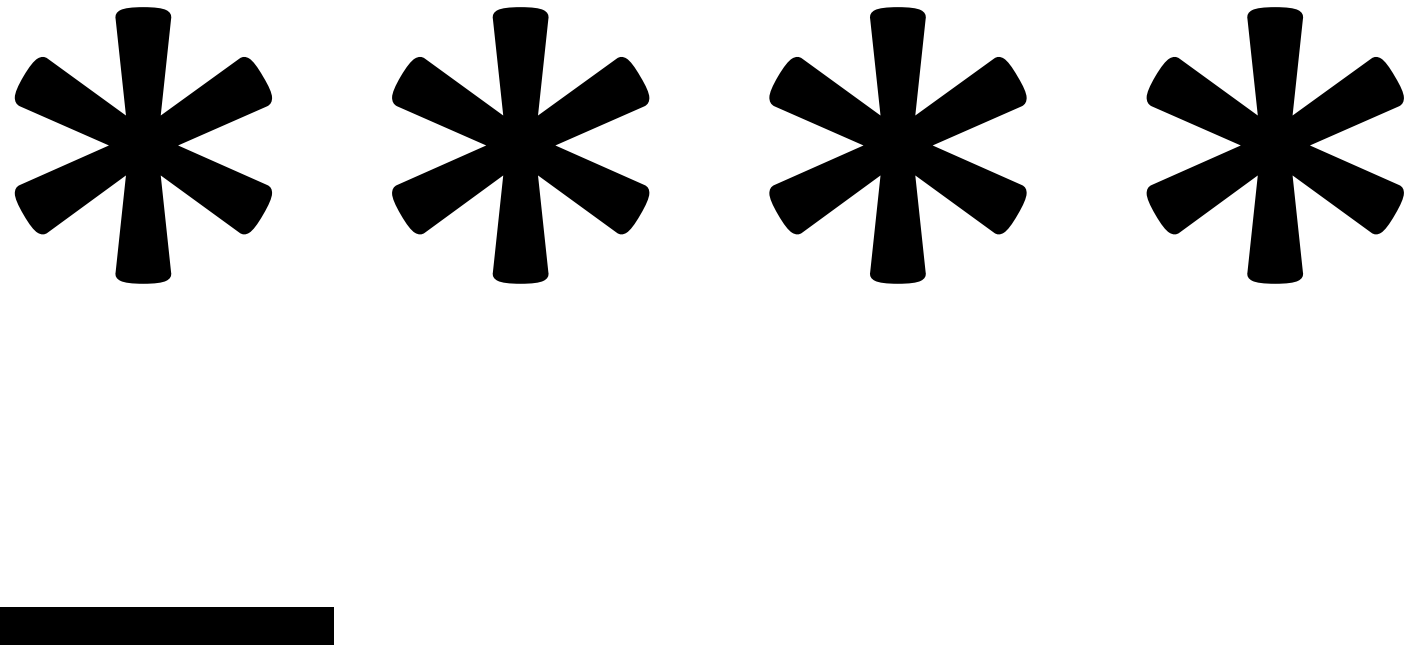
Back to the main topic

Ruby has many

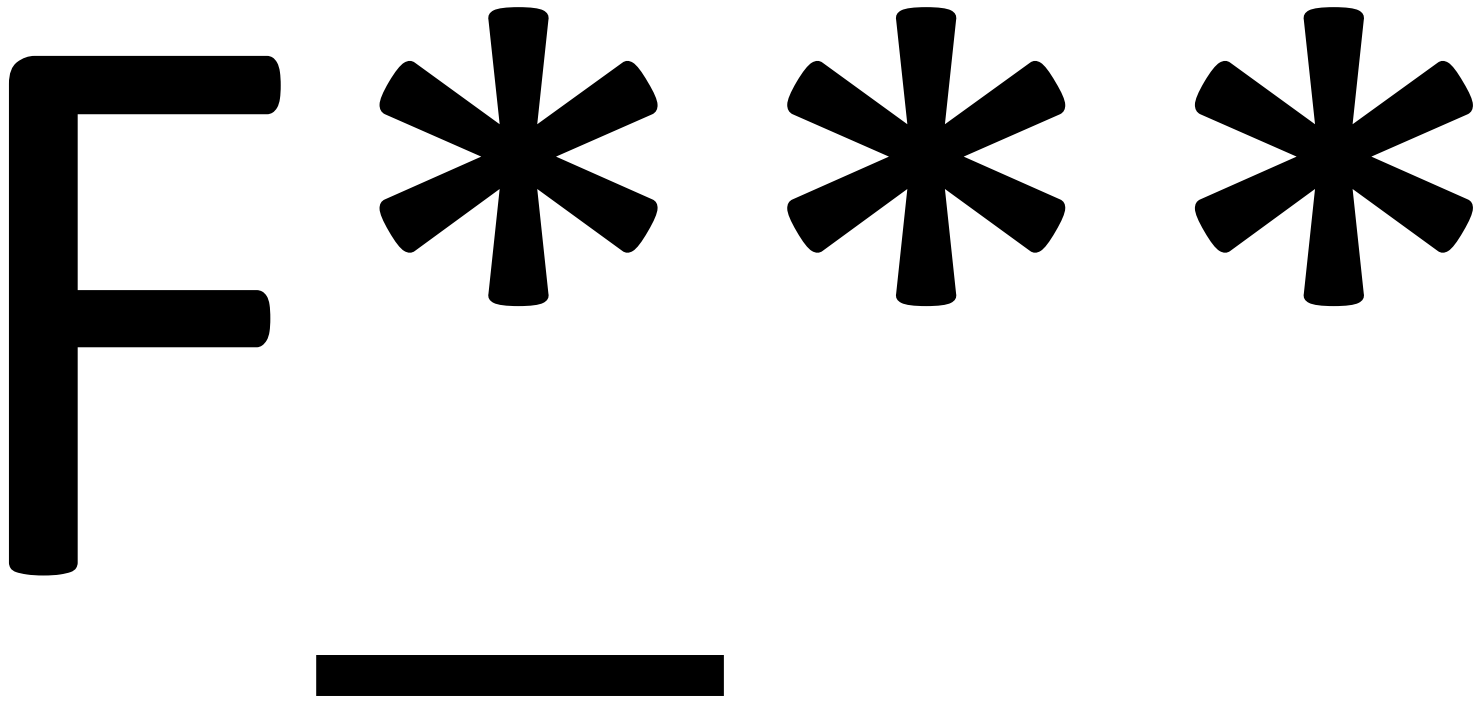


Let’s play hangman game

Ruby has many



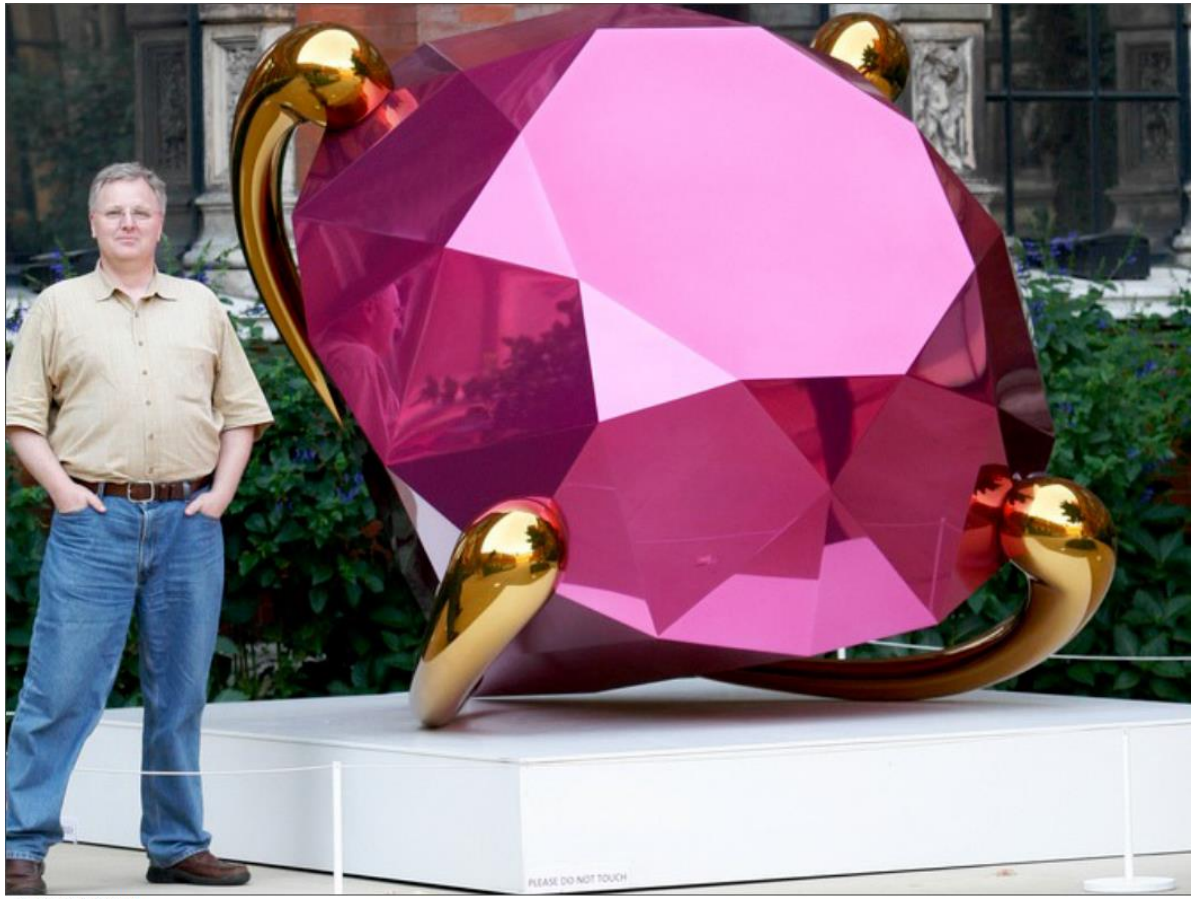
Ruby has many



Ruby has many

FU**

RubyConf 2008 Keynote
by Dave Thomas (Pragmatic programmer)



Friday, April 8, 2011

Quoted from Dave Thomas Keynote

RubyConf 2008
Keynote by Dave Thomas

Quoted from Dave Thomas Keynote

RubyConf 2008
Keynote by Dave Thomas

Quoted from Dave Thomas Keynote

Ruby has many

FU**

RubyConf Portgual 2015

Koichi Sasada

Ruby has many

FUNC

Or Methods

Optimizing Func(tion)s or Methods is important for Ruby

- Syntax optimization (readable/writable)
  - Call without **parenthesis**
  - Passing blocks with **braces** or **do/end**
  - Splat/block arguments (*args, &block)
  - Optional/rest/post/block parameters by def
    - **def foo(m1, m2, o1=1, o2=2, *rest, p1, p2, &block)**
  - **Keyword arguments/parameters**
- Performance optimization
  - By virtual machine implementation. My task ☺

Tough work to pass many arguments

```
# Quoted from my Ruby code
 scinsn = Instruction.new(
        name, opes, pops, rets, comm,
        orig_insn.body, orig_insn.tvars, orig_insn.sp_inc,
        orig_insn, orig_insn.defopes, :sc, nextsc, pushs)
```

12 arguments.

Can’t understand what parameter mean.

Tough work to pass many arguments

```
# Difficult to understand what we specify
GC::Tracer.start_logging(filename, false, false, false)
```

Only 4 arugments,
but also it's difficult to read

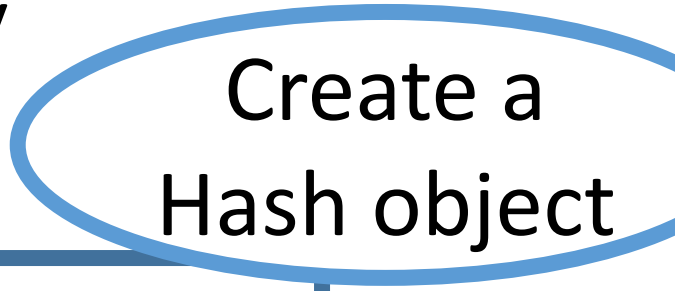
Keyword parameter helps you

```
# quoted from my Ruby code
GC::Tracer.start_logging(
    filename,
    gc_stat: false,
    gc_latest_gc_info: false,
    rusage: false
)
```

Easy to understand!

The History of Keyword parameter

Hash notation at the last argument from beginning of Ruby




```
foo(1, 2, :key1 => v1, :key2 => v2 )
```

3 arguments

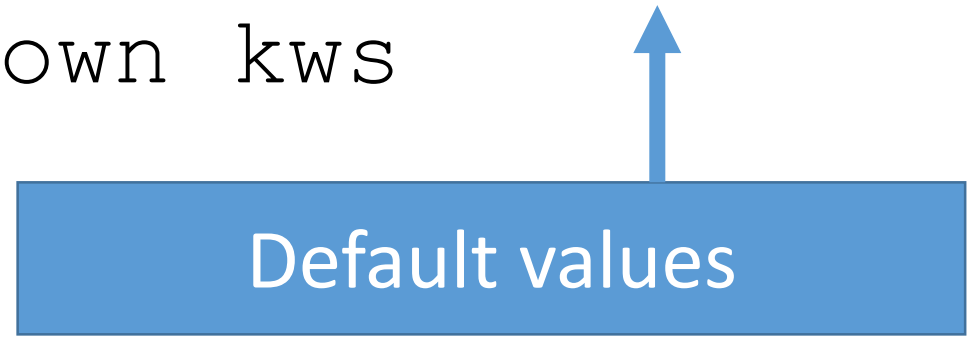
```
# Same as
# foo(1, 2, {:key1 => v1, :key2 => v2})
```

Symbol hash notation from Ruby 1.9.3

```
foo(1, 2, key1: v1, key2: v2)

# Same as
# foo(1, 2, :key1 => v1, :key2 => v2)
# foo(1, 2, {:key1 => v1, :key2 => v2})
```

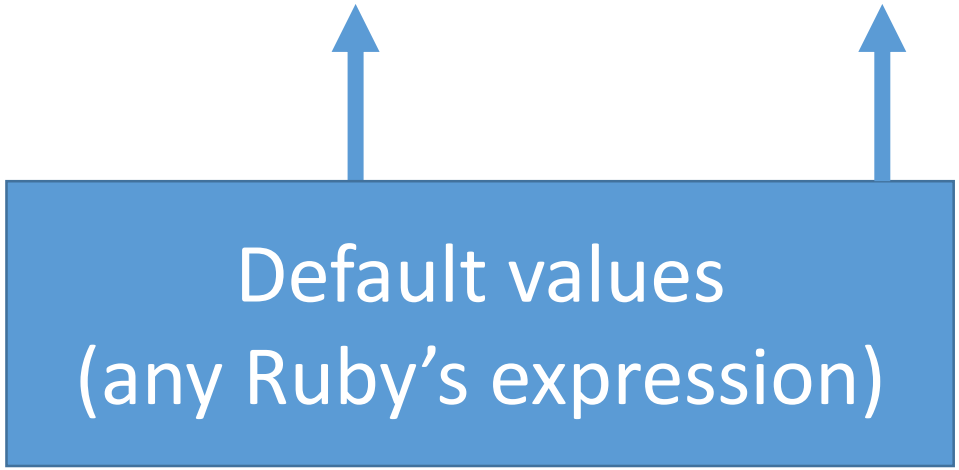
Keyword parameters processing before Ruby 2.0

```
def foo(a, b, kw={}) # kw is Hash
  key1 = kw.fetch(:key1, 1)
  key2 = kw.fetch(:key2, 2)
  # check unknown kws
  …
end
```



Keyword parameters from Ruby 2.0 (1)

```
def foo(a, b, key1: 1, key2: 2)
  …
end
```



We don't need to write Hash access any more!

Keyword parameters from Ruby 2.0 (2)

- Raise an exception when unknown keywords are passed
- Rest keyword parameter (**kw) can receive non-specified keyword parameters

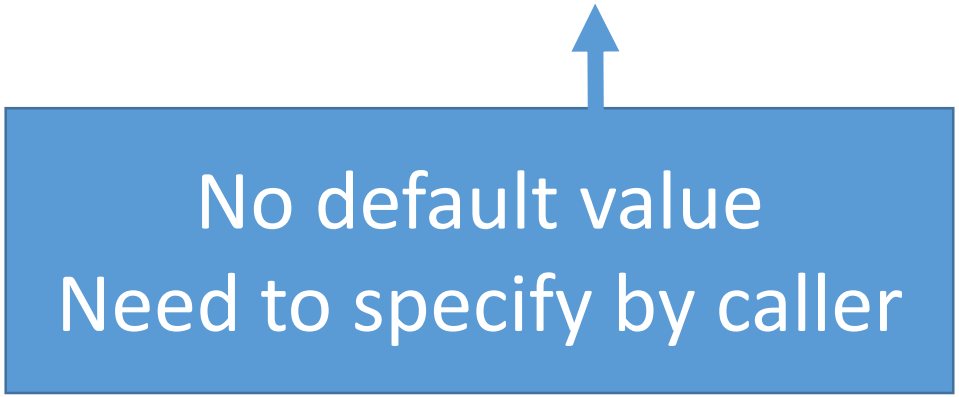
```
def foo(k1: v1, **kw)
  p kw #=> {k2: 2, k3: 3}
end
foo(k1: 1, k2: 2, k3: 3)
```

- Blocks also can accept keyword parameters

```
foo{|k1: 1, k2: 2| …}
```

Required keyword parameter from Ruby 2.1

```
def foo(a, b, key1: 1, key2:)
  …
end
```




```
# Similar to
def foo(a, b, key1: 1, key2: raise("err"))
  …
end
```

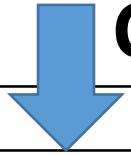
The Implementation of Keyword parameter

Implementation of keyword parameter Ruby 2.0 and Ruby 2.1

- Caller: make a Hash object and pass it normally
  - Same as Ruby 2.0 and before
- Callee: decompose a Hash object and assign to local variables correctly
  - Mostly same code of decomposing code in Ruby
  - Need some more error checking

Implementation of keyword parameter Ruby 2.0 and Ruby 2.1

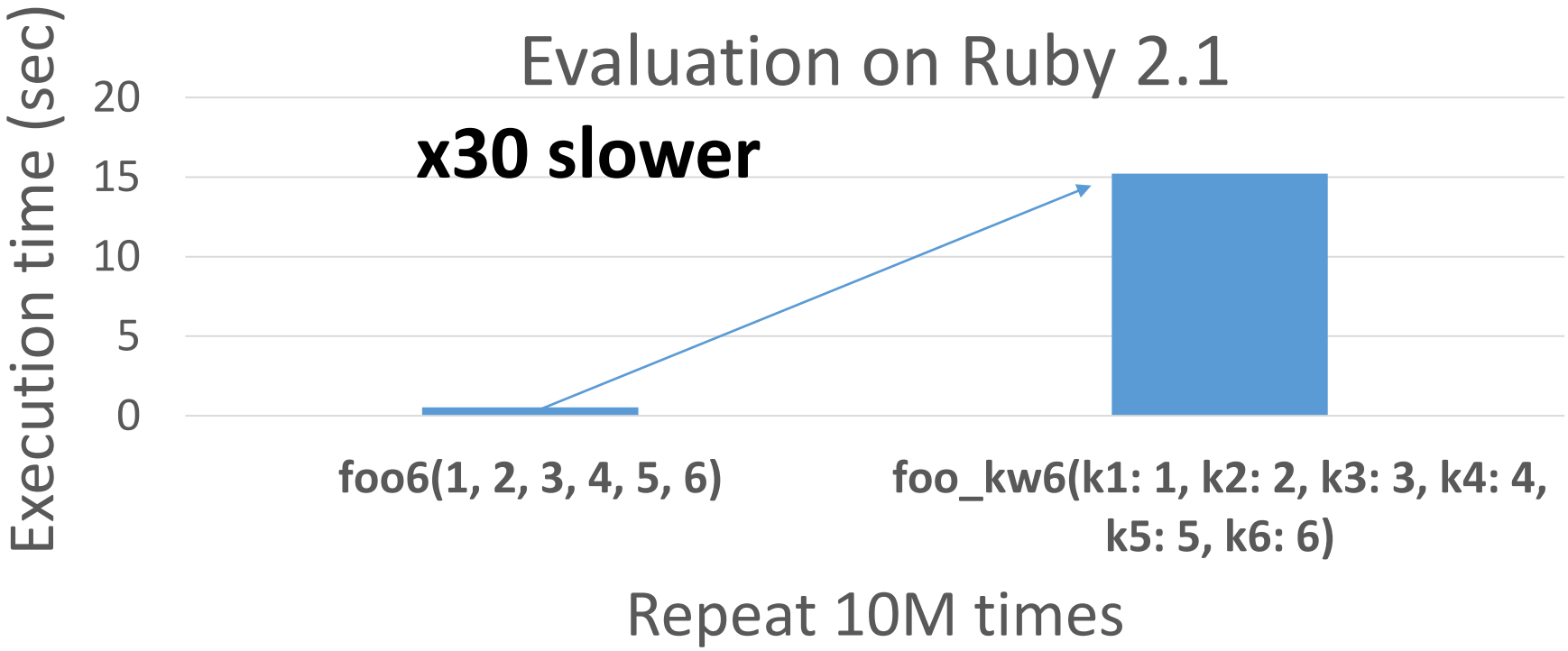
```
def foo(k1: v1, k2: v2)
  …
end
```



Compiler translate to

```
def foo(h={})
  k1 = h.fetch(:k1, v1)
  k2 = h.fetch(:k2, v2)
  #(and error check code)
  …
end
```

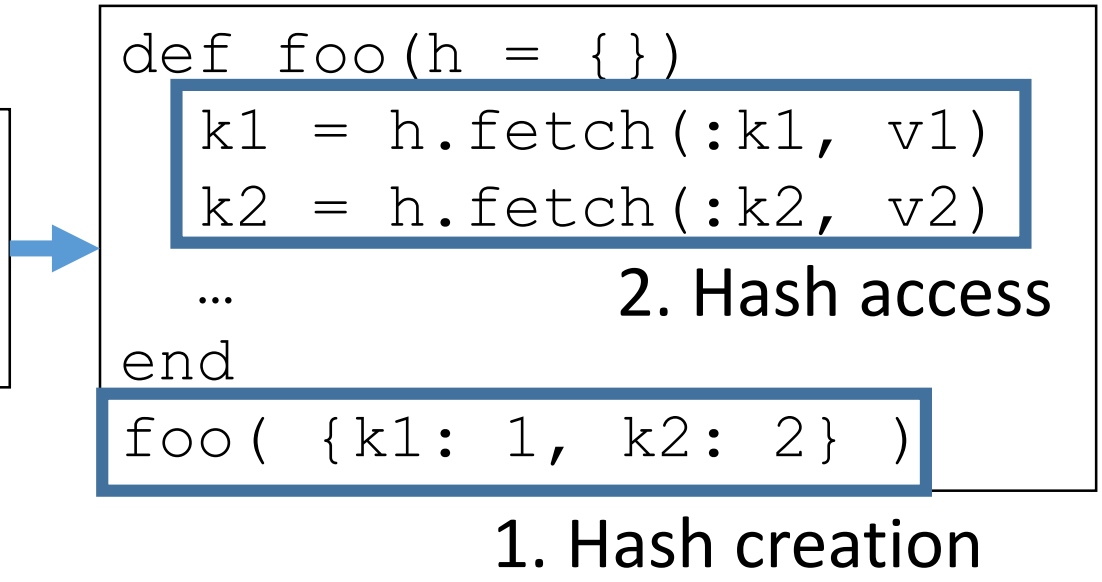
Bad NEWS
Slow keyword parameters



Why slow, compare with normal parameters?

1. **Hash creation**
2. **Hash access**

```
def foo(k1: v1, k2: v2)
  …
end
foo(k1: 1, k2: 2)
```



Optimization technique of keyword parameters from Ruby 2.2

- Key technique

  → Pass “a keyword list” instead of a Hash object

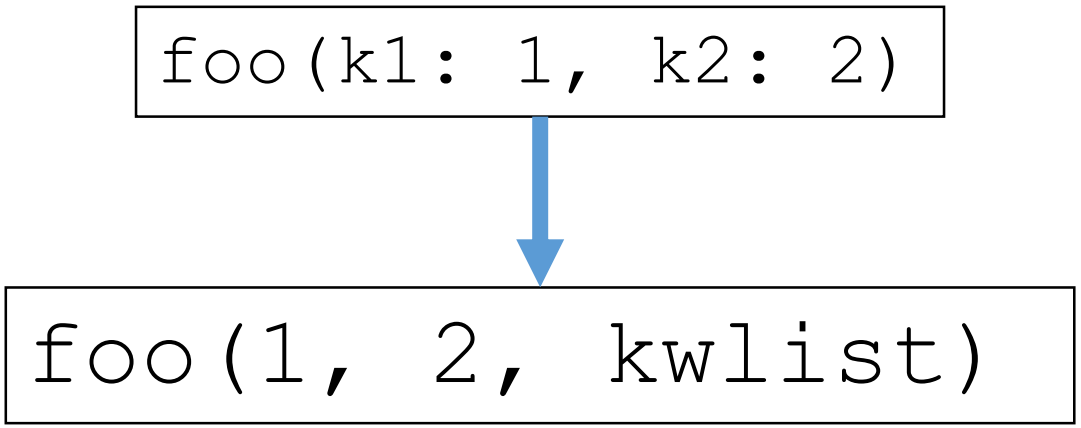
Preparation: Make “keyword list” and “default value list” at compile time

- We can see all source code at compile time
- Collect keywords in a list for each method call
  - ex: “foo(k1: x, k2: y)” #=> kwlist is [:k1, :k2]
- Collect “Receive keyword list (Rkwlist)” and “Default values list (dvlist)” in each method definition
  - ex: “def foo(k1: 1, k2: 2)” #=> Rkwlist is [:k1, :k2], dvlist is [1, 2]
  - ex: “def foo(k1: 1, k2: f2()) #=> dvlist is [1, Qundef]

NOTE: Qundef is internal special value which should not expose Ruby world

Call with keyword parameter [Sender] Pass “kwlist” instead of making a Hash

- Pass values as a “keyword list”



NOTE: This is pseudo code.
kwlist is not passed as an argument,
but passed as calling information.

Call with keyword parameter [Receiver] Manipulate passed kwlist

- Assign local variables with passed keyword list

```
def foo(k1: 1, k2: 2, k3: 3)
```

kvs = [1, 2]; kwlist=[:k1, :k2]
Rkwlist = [:k1, :k2, :k3]
dvlist = [1, 2, 3]

Pseudo code

```
def foo(*kvs, kwlist)
  Rkwlist.each.with_index{|k, i|
    ki = kwlist.index(k)
    assign(k, ki ? kvs[ki] : dvlist[i])
  }
```

Call with keyword parameter [Receiver]
Treat with default values with expressions

```
def foo(k1: 1, k2: f2(), k3: f3())
```

Rkwlist = [:k1, :k2, :k3]
dvlist = [1, Qundef, Qundef]

Pseudo code

```
def foo(*kvs, kwlist)
  unset_bits = 0
  Rkwlist.each.with_index{|k, i|
    if ki = kwlist.index(k)
      v = kvs[ki]
    else if (v = dvlist[i]) == Qundef
      v = nil
      unset_bits[i] = 1
    end
    assign(k, v)
  } # cont to right
```

```
  # k1 is already initialized
  k2 = f2() unless unset_bits[1]
  k3 = f3() unless unset_bits[2]

  … # start of method body
end
```

Using BITMAP to remember unspecified keywords

NOTE: Qundef is internal special value which should not expose Ruby world

ADVANCED

Q. Why not assign Qundef directly? (instead of using bitmap)

```
def foo(k1: 1, k2: f2(), k3: f3())
```

Rkwlist = [:k1, :k2, :k3]
dvlist = [1, Qundef, Qundef]

Pseudo code

```
def foo(*kvs, kwlist)
  unset_bits = 0
  Rkwlist.each.with_index{|k, i|
    ki = kwlist.index(k)
    v = ki ? kvs[i] : dvlist[i]
    assign(k, v)
  }
  k2 = f2() unless k2 == Qundef
  k3 = f3() unless k3 == Qundef
  … # start of method body
end
```

ADVANCED

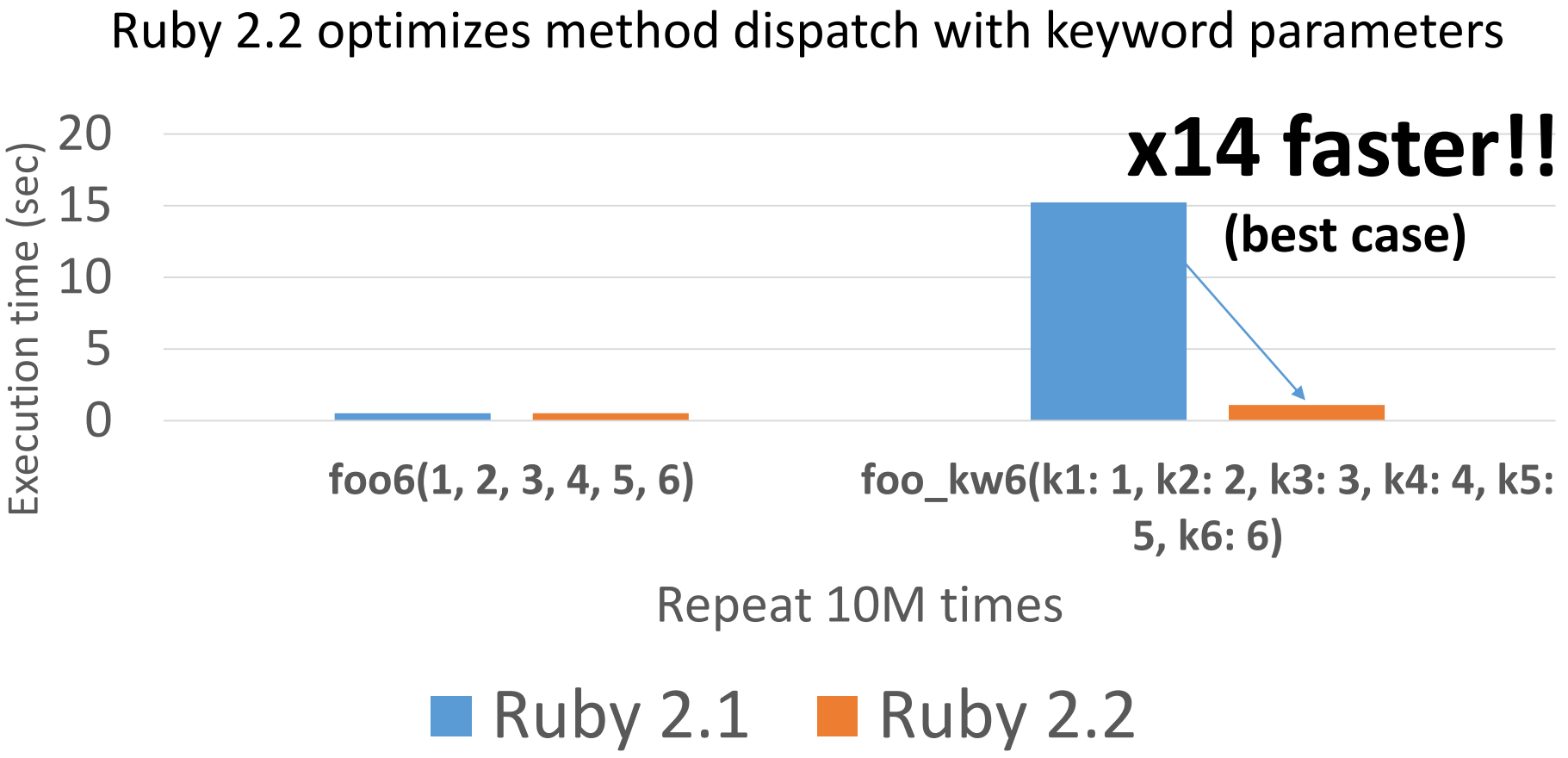
A. We can access initializing keyword variables with eval()

```
def foo(k1: 1,
        k2: eval("k3"), # should be nil
        k3: f3())
```

Evaluation result
Compare 3 types methods

1. def foo6(a, b, c, d, e, f); end
   - Normal method dispatch with 6 parameters
2. def foo_kw6(k1: 1, k2: 2, k3: 3, k4: 4, k5: 5, k6: 6); end
   - Default values are immediate values
3. def foo_complex_kw6(k1: 1+1, k2: 2+1, k3: 3+1, k4: 4+1, k5: 5+1, k6: 6+1); end
   - Default values are expressions (not immediate values)

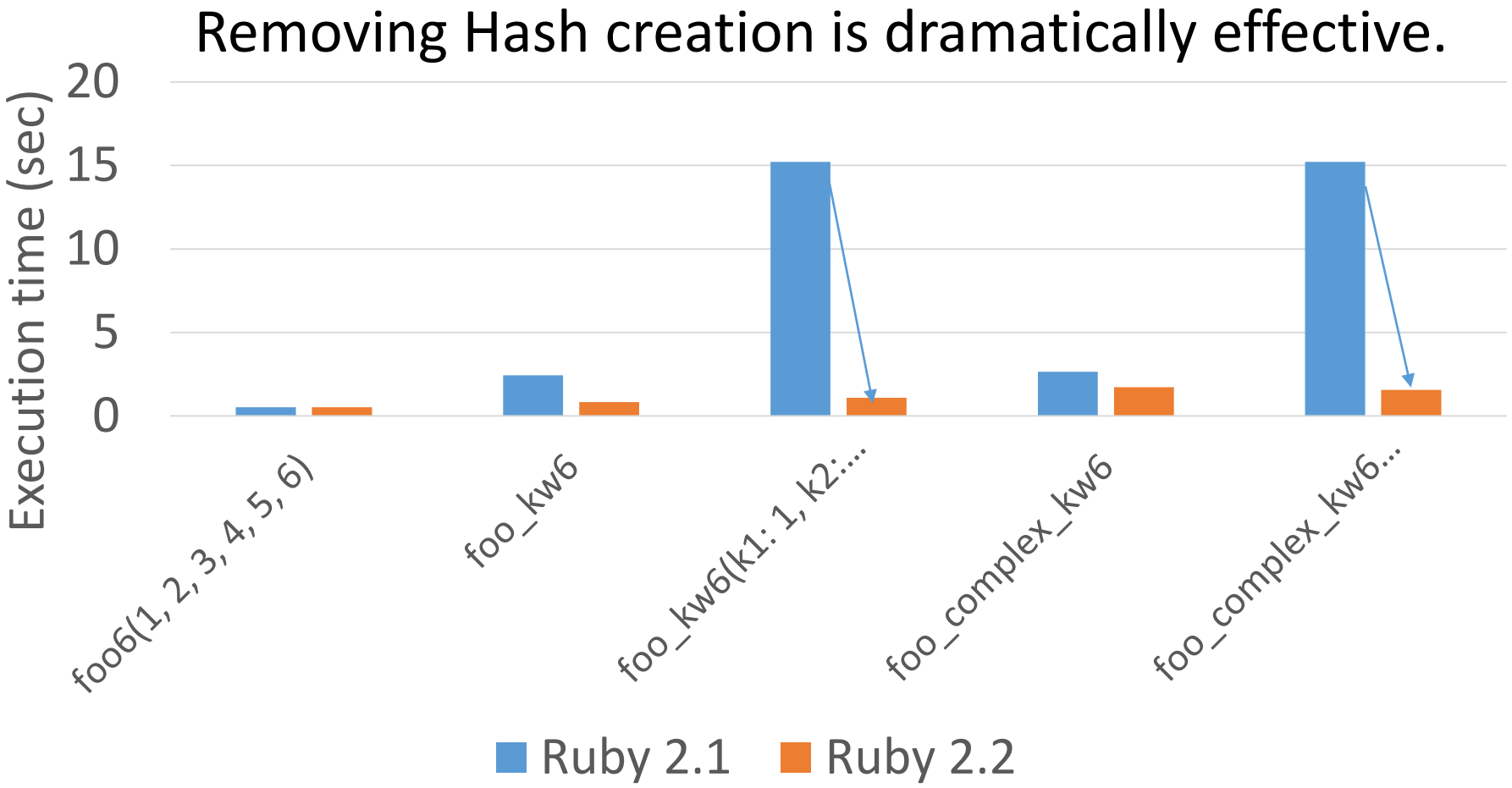
Result: Fast keyword parameters



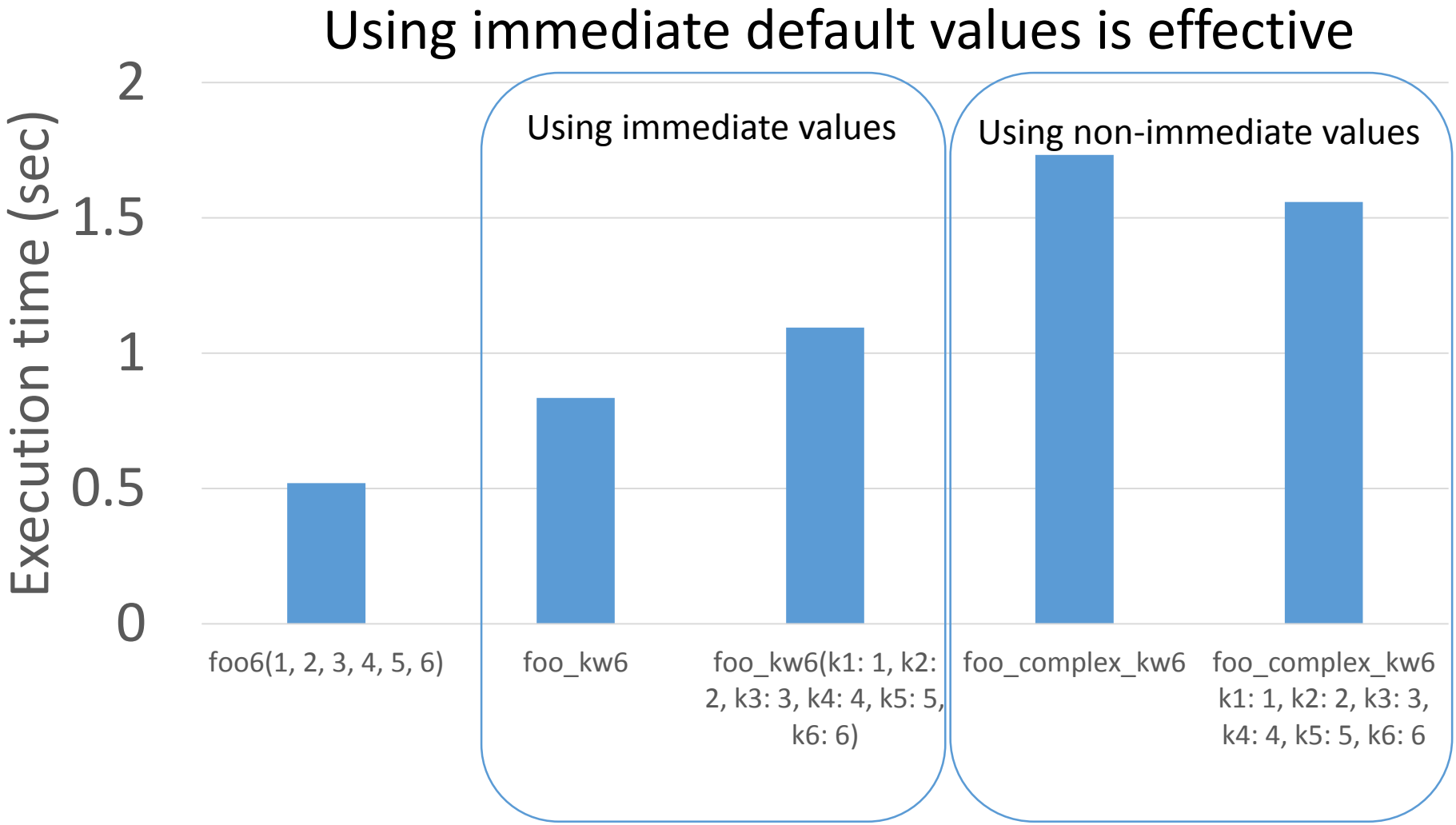
But still x2 times slower

compare with normal dispatch

Result: Ruby 2.1 vs. Ruby 2.2



Result: Ruby 2.2



Challenge: Improve computational complexity

- Computational complexity of current impl. is **O(mn)**
  - Now, m and n is enough small (only a few keywords), but…

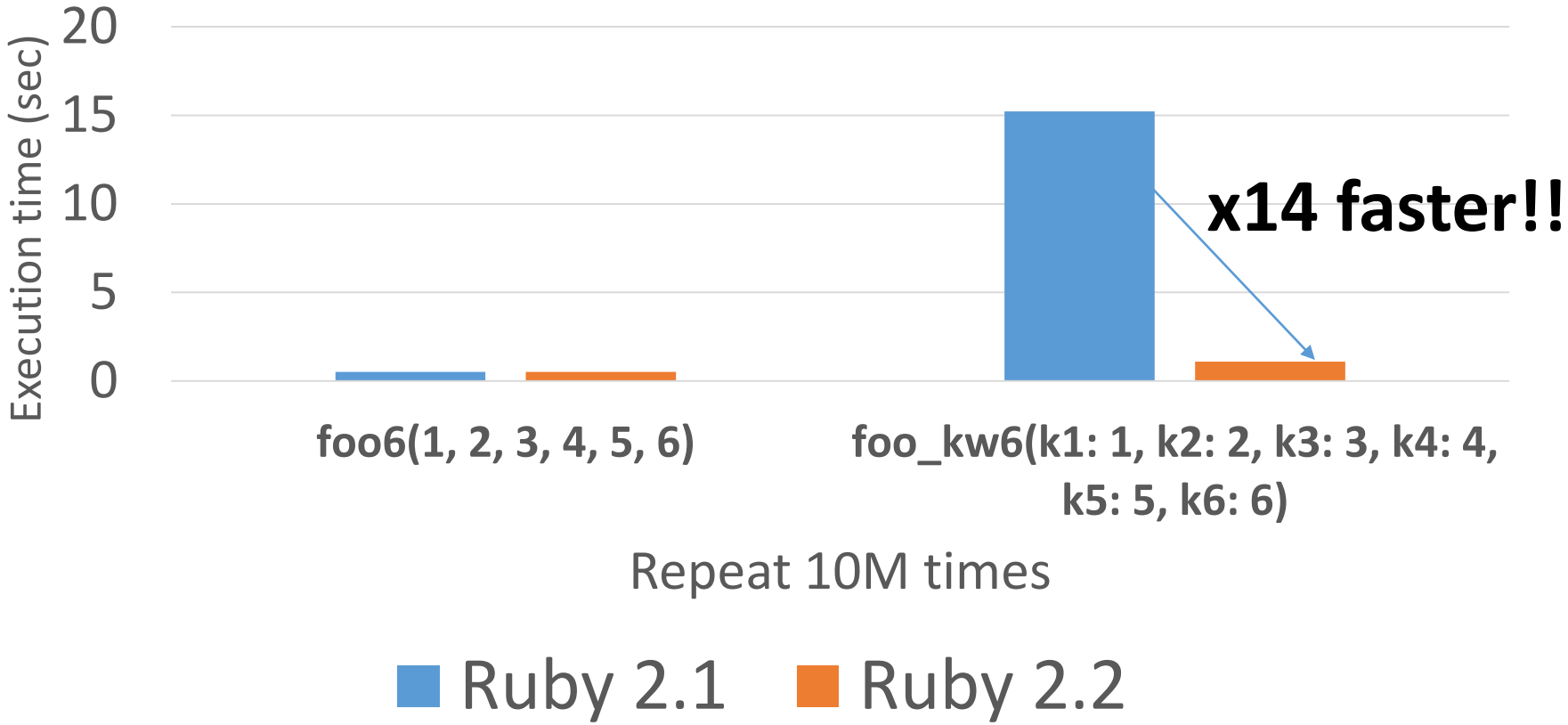
n = kwlist.length
m = Rkwlist.length
Total computationan complexity: **O(mn)**

Pseudo code

```
def foo(*kvs, kwlist)
  Rkwlist.each.with_index{|k, i| # m times
    ki = kwlist.index(k)                → O(m)
    …                          O(n)
```

Summary

Ruby 2.2 optimized “keyword parameters”



But still x2 times slower
compare with normal dispatch

Thank you for your attention
Arigato!

Koichi Sasada

<ko1@heroku.com>

heroku