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Polyglot: From the Very Old to the Very New

Chris Seaton
Research Manager
Oracle Labs
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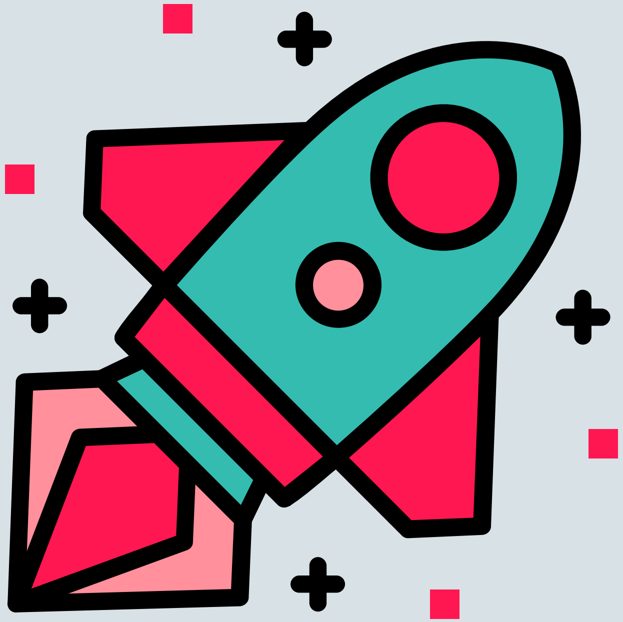

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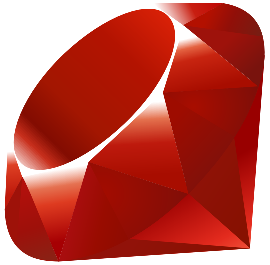
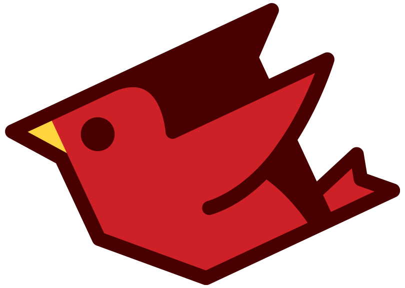
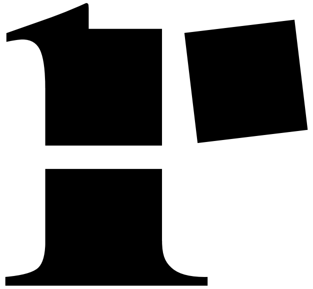
Why people write in Ruby

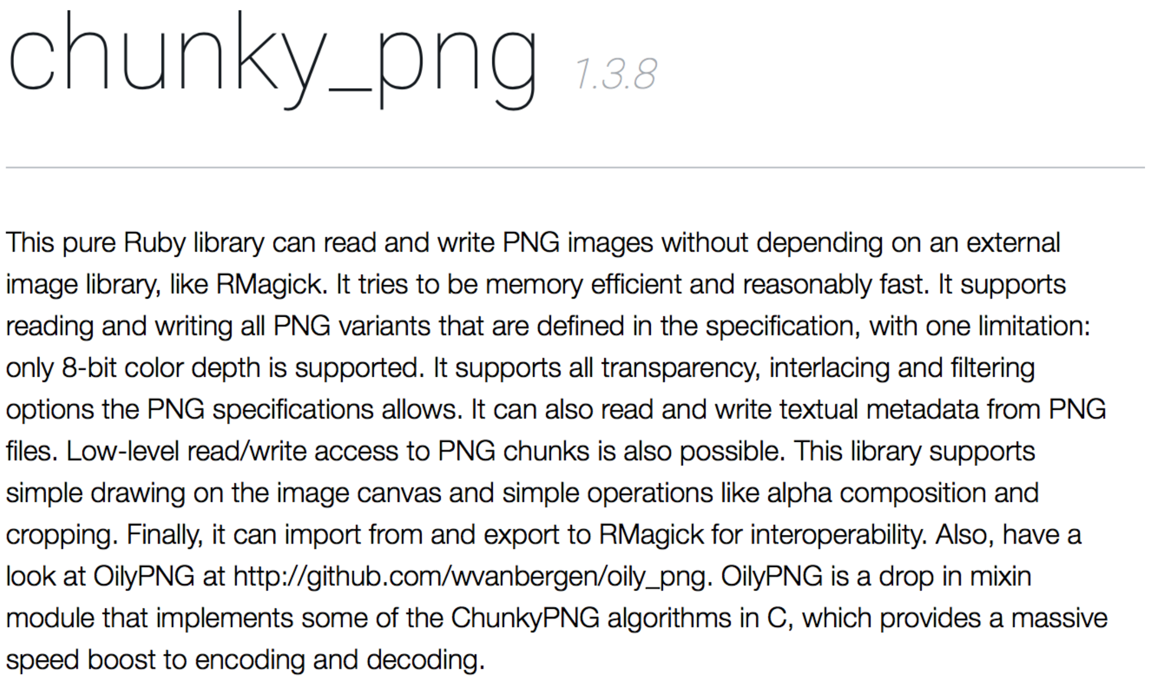
What about when you reach the limits?





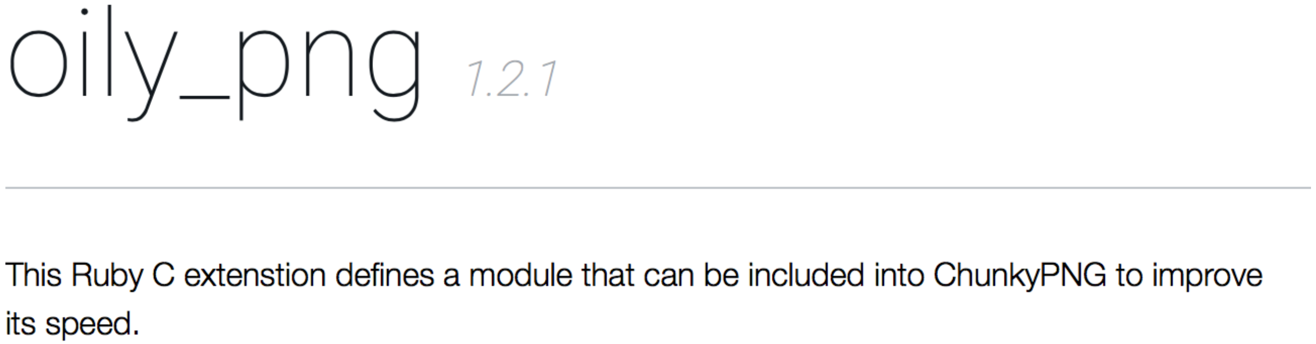


MAGLEV™



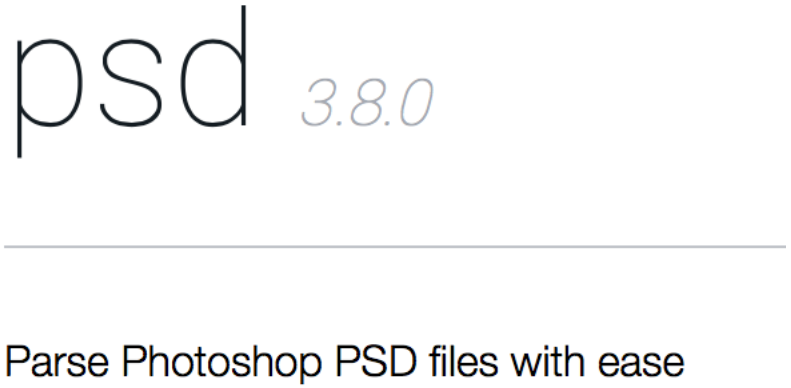
chunky_png 1.3.8

This pure Ruby library can read and write PNG images without depending on an external image library, like RMagick. It tries to be memory efficient and reasonably fast. It supports reading and writing all PNG variants that are defined in the specification, with one limitation: only 8-bit color depth is supported. It supports all transparency, interlacing and filtering options the PNG specifications allows. It can also read and write textual metadata from PNG files. Low-level read/write access to PNG chunks is also possible. This library supports simple drawing on the image canvas and simple operations like alpha composition and cropping. Finally, it can import from and export to RMagick for interoperability. Also, have a look at OilyPNG at http://github.com/wvanbergen/oily_png. OilyPNG is a drop in mixin module that implements some of the ChunkyPNG algorithms in C, which provides a massive speed boost to encoding and decoding.



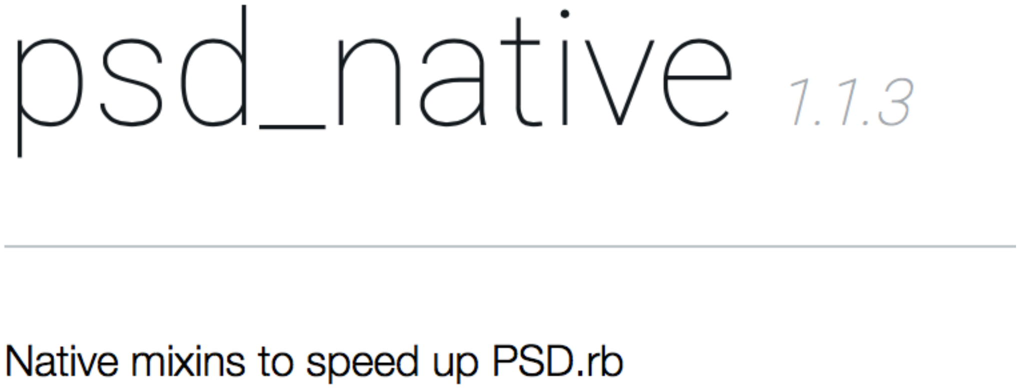
oily_png 1.2.1

This Ruby C extenstion defines a module that can be included into ChunkyPNG to improve its speed.



psd 3.8.0

Parse Photoshop PSD files with ease



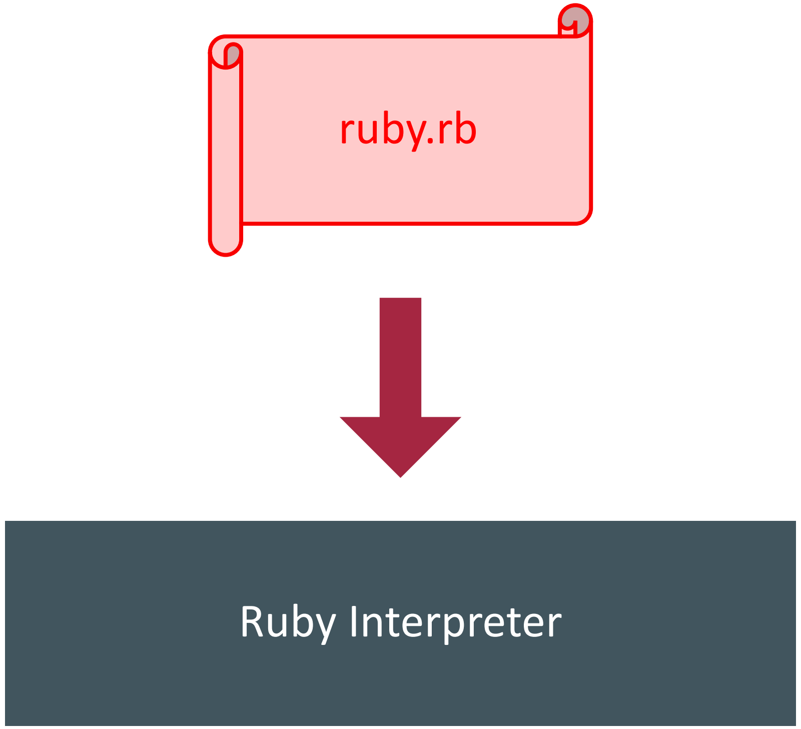
psd_native 1.1.3

Native mixins to speed up PSD.rb

```ruby
def clamp(num, min, max)
  [min, num, max].sort[1]
end
```

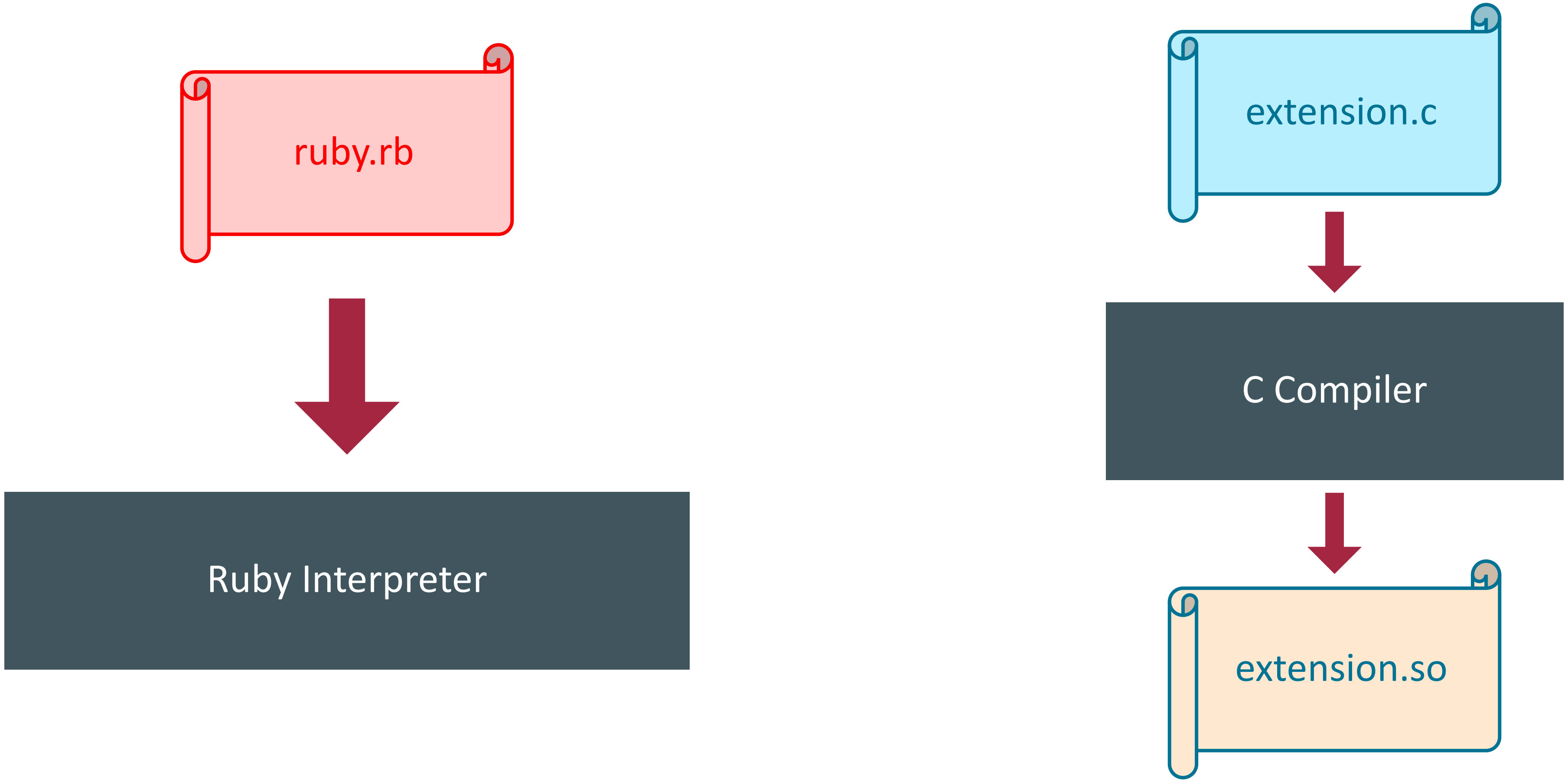
```c
VALUE psd_native_util_clamp(VALUE self,
    VALUE r_num, VALUE r_min, VALUE r_max) {
  int num = FIX2INT(r_num);
  int min = FIX2INT(r_min);
  int max = FIX2INT(r_max);

  return num > max ? r_max : (num < min ? r_min : r_num);
}
```



ruby.rb

Ruby Interpreter



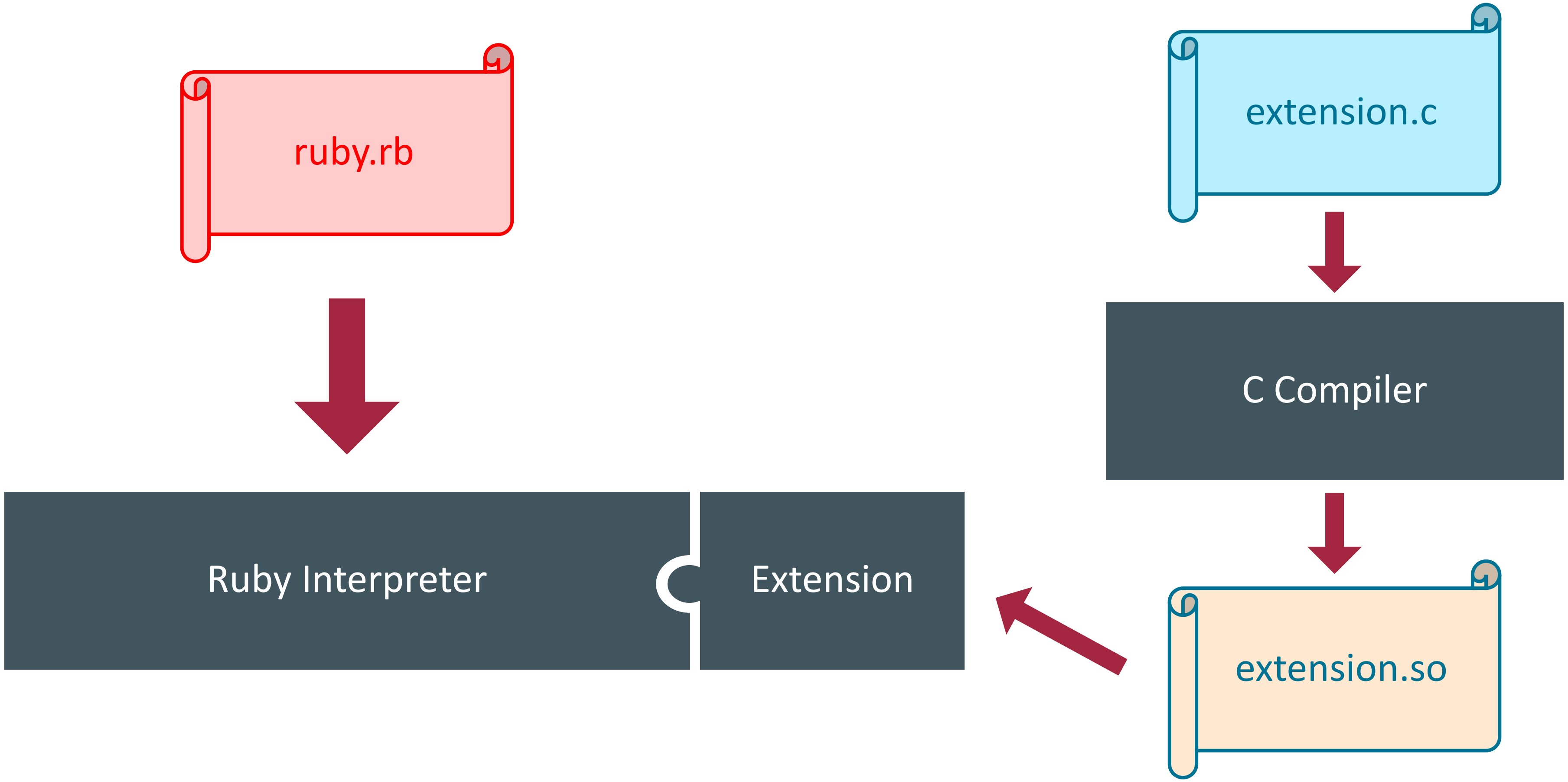
ruby.rb

Ruby Interpreter

extension.c

C Compiler

extension.so


ruby.rb
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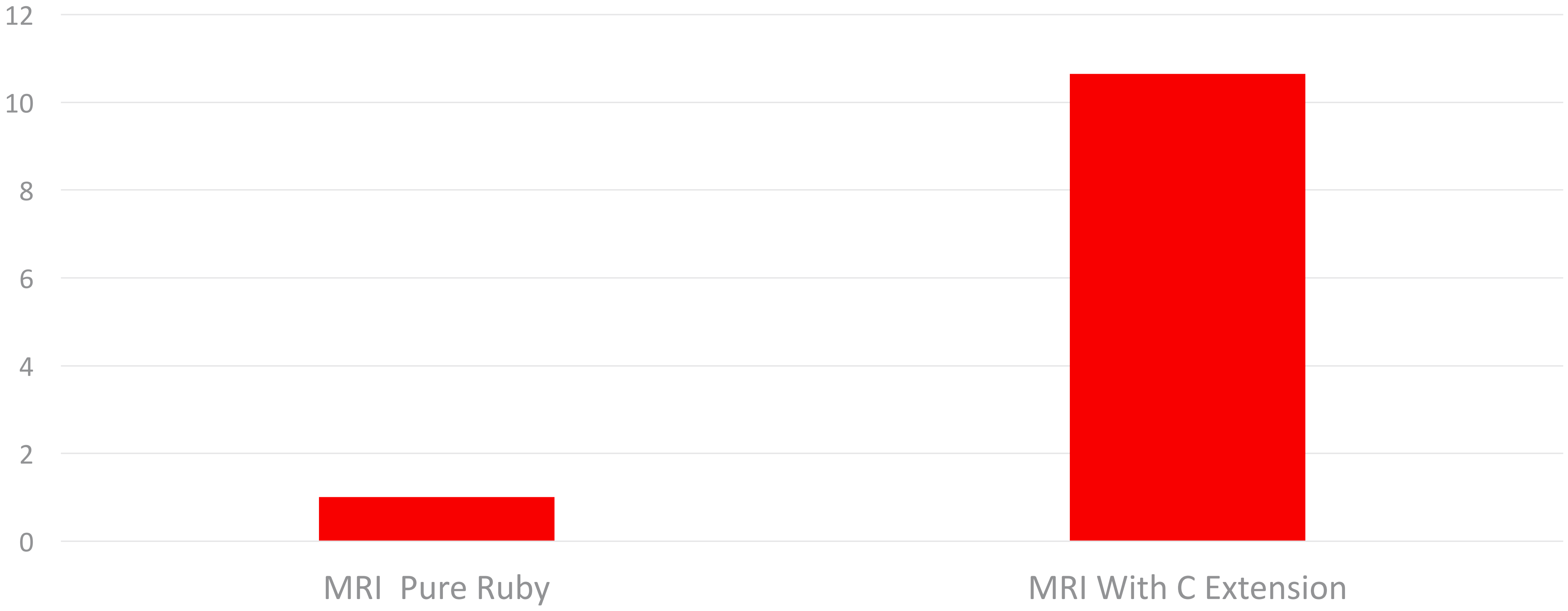
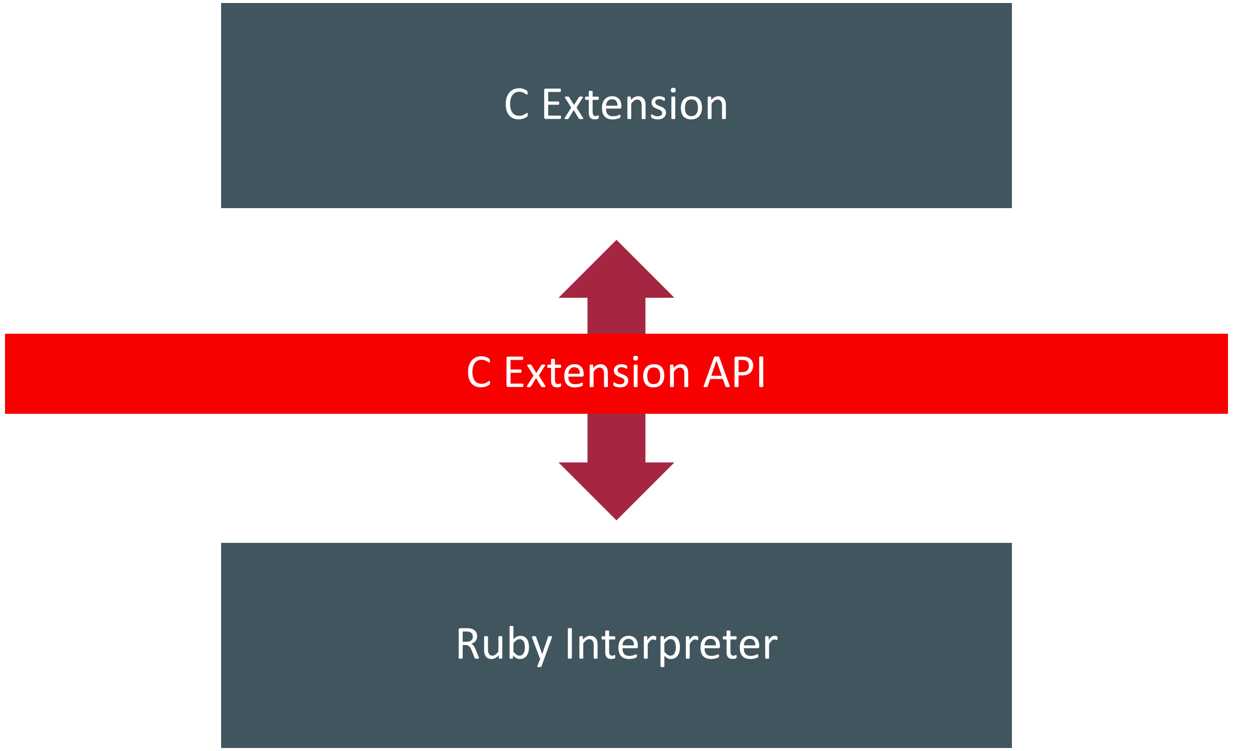
Extension
extension.so

Performance on Ruby C Extensions Oily PNG and PSD Native



M. Grimmer, C. Seaton, T. Würthinger, H. Mössenböck. Dynamically Composing Languages in a Modular Way: Supporting C Extensions for Dynamic Languages. In Proceedings of the 14th International Conference on Modularity, 2015.

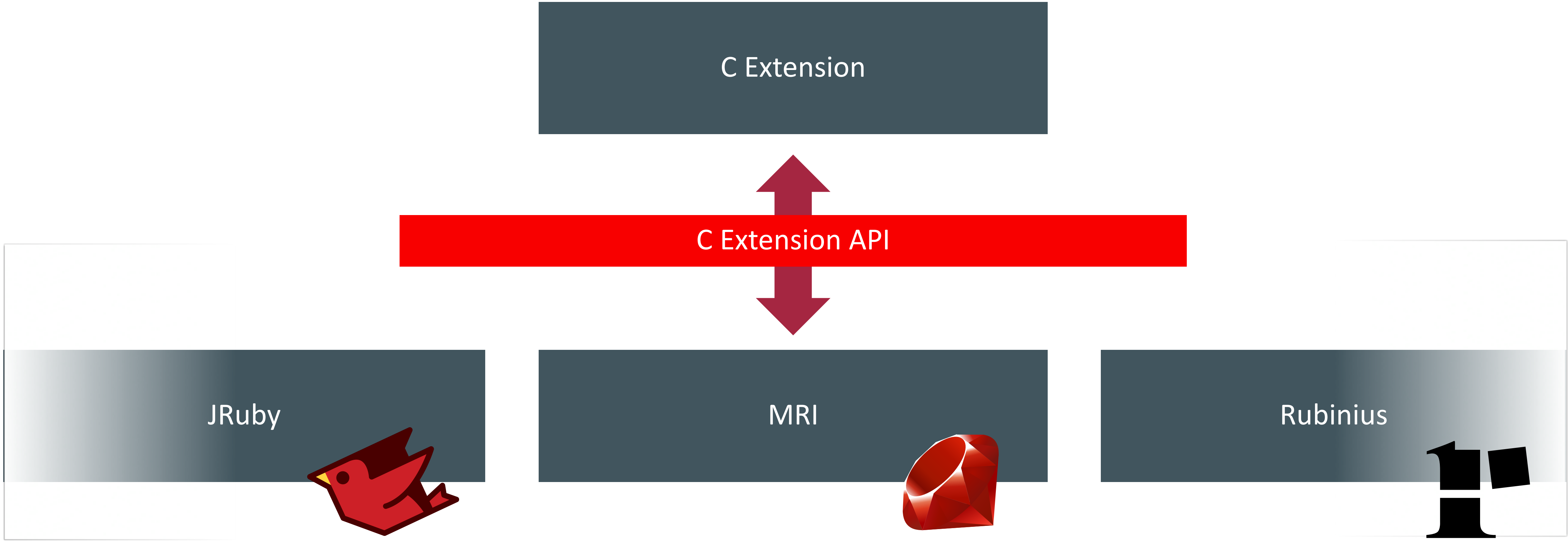
The technical debt of C extensions



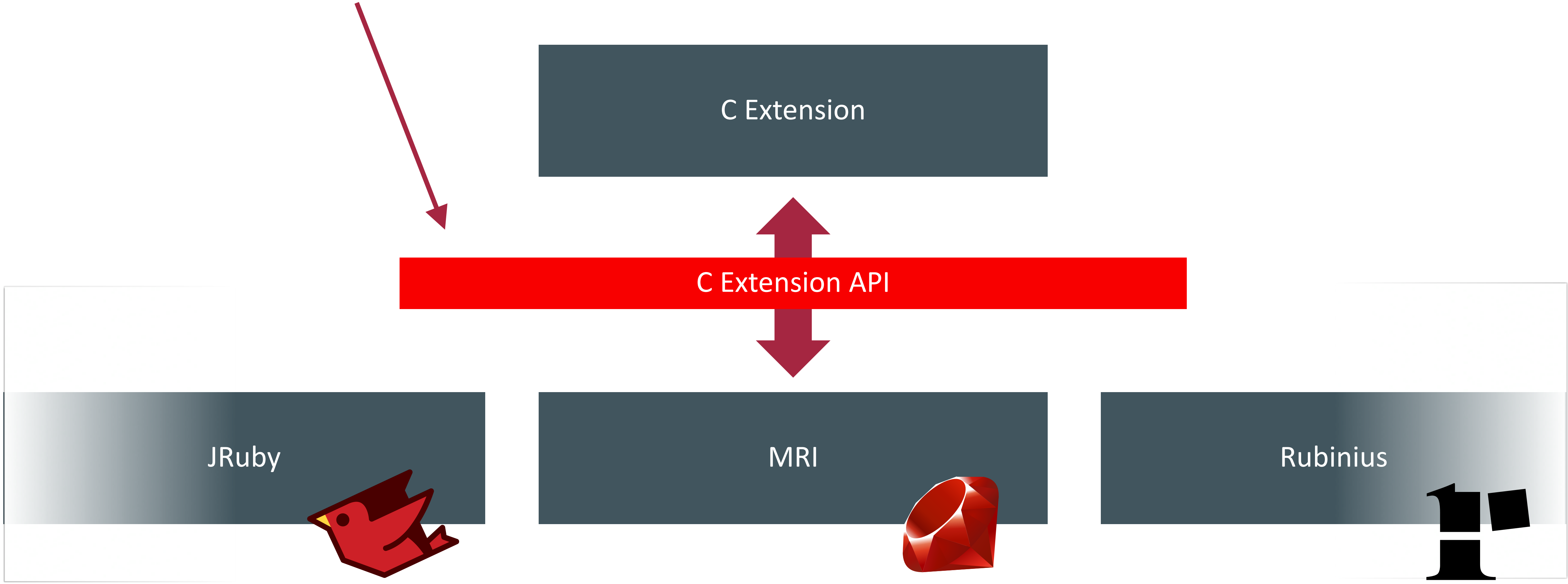
C Extension

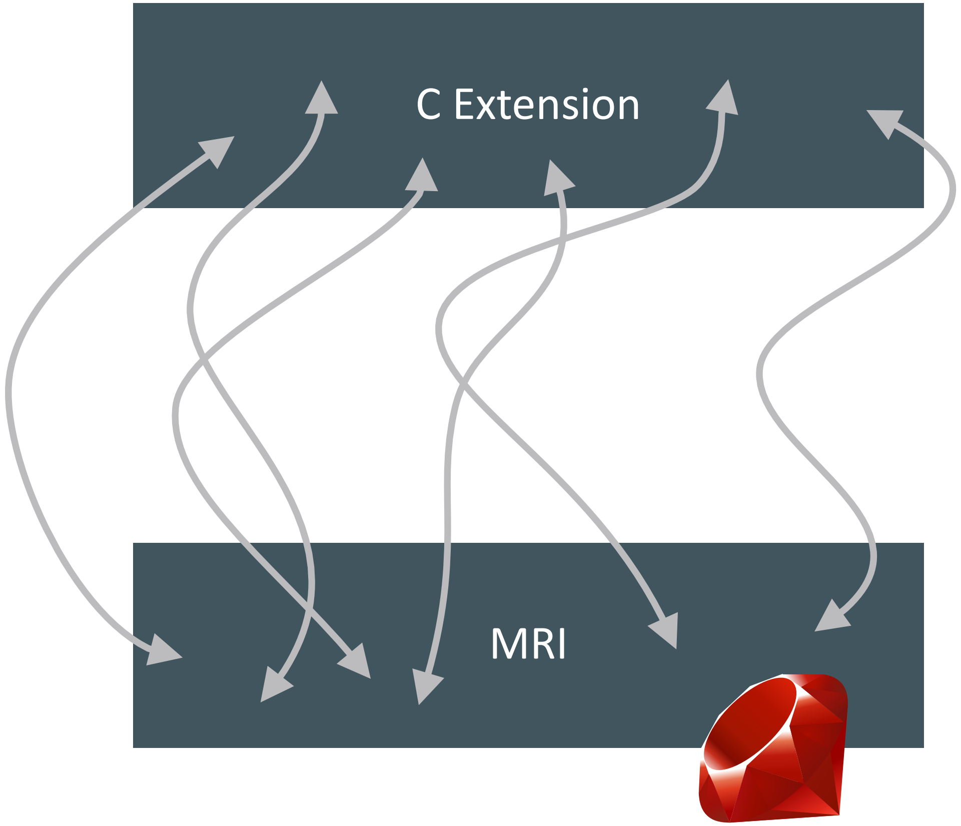
C Extension API

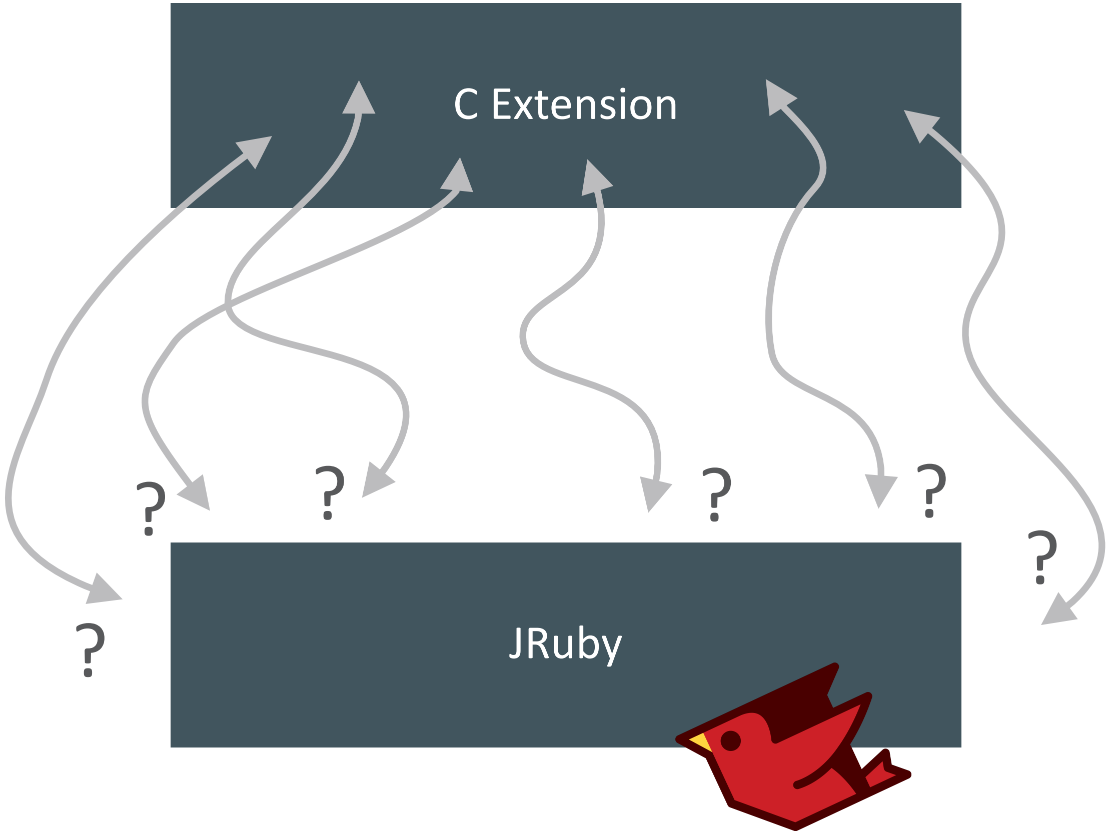
Ruby Interpreter


C Extension
C Extension API
JRuby
MRI
Rubinius

Bad news – this isn't really a thing in practice




C Extension
MRI


C Extension
JRuby
?
?
?
?
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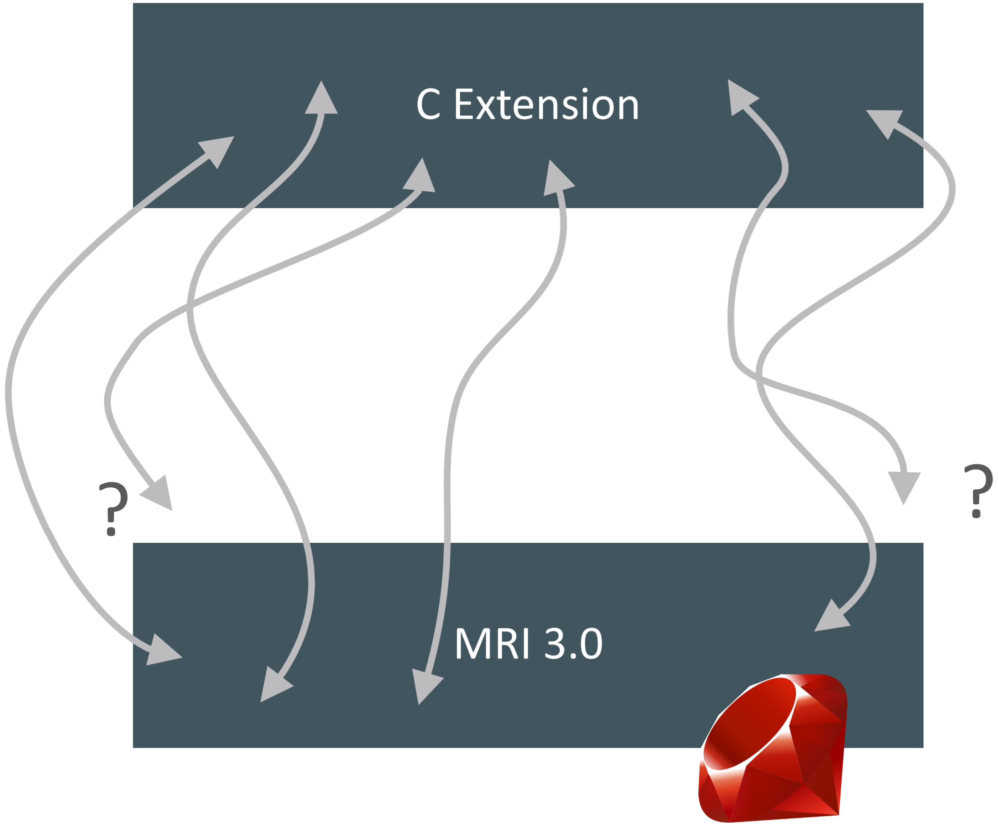
?
?


C Extension
MRI 3.0
?
?

String pointers

```
char *RSTRING_PTR(VALUE string);

static VALUE
ossl_dsa_export(int argc, VALUE *argv, VALUE self)
{
    char *passwd;
    ...
    passwd = RSTRING_PTR(pass);
    ...
    PEM_write_bio_DSAPrivateKey(out, pkey->pkey.dsa, ciph,
            NULL, 0, ossl_pem_passwd_cb, passwd)
    ...
}
```

Array pointers

```
VALUE *RARRAY_PTR(VALUE array);

VALUE psd_native_blender_compose_bang(VALUE self) {
  ...
  VALUE bg_pixels = rb_funcall(bg_canvas, rb_intern("pixels"), 0);
  VALUE *bg_pixels_ptr = RARRAY_PTR(bg_pixels);
  ...
  for (i = 0, len = RARRAY_LEN(bg_pixels); i < len; i++) {
    ... bg_pixels_ptr[i] ...
  }
  ...
}
```

Data fields

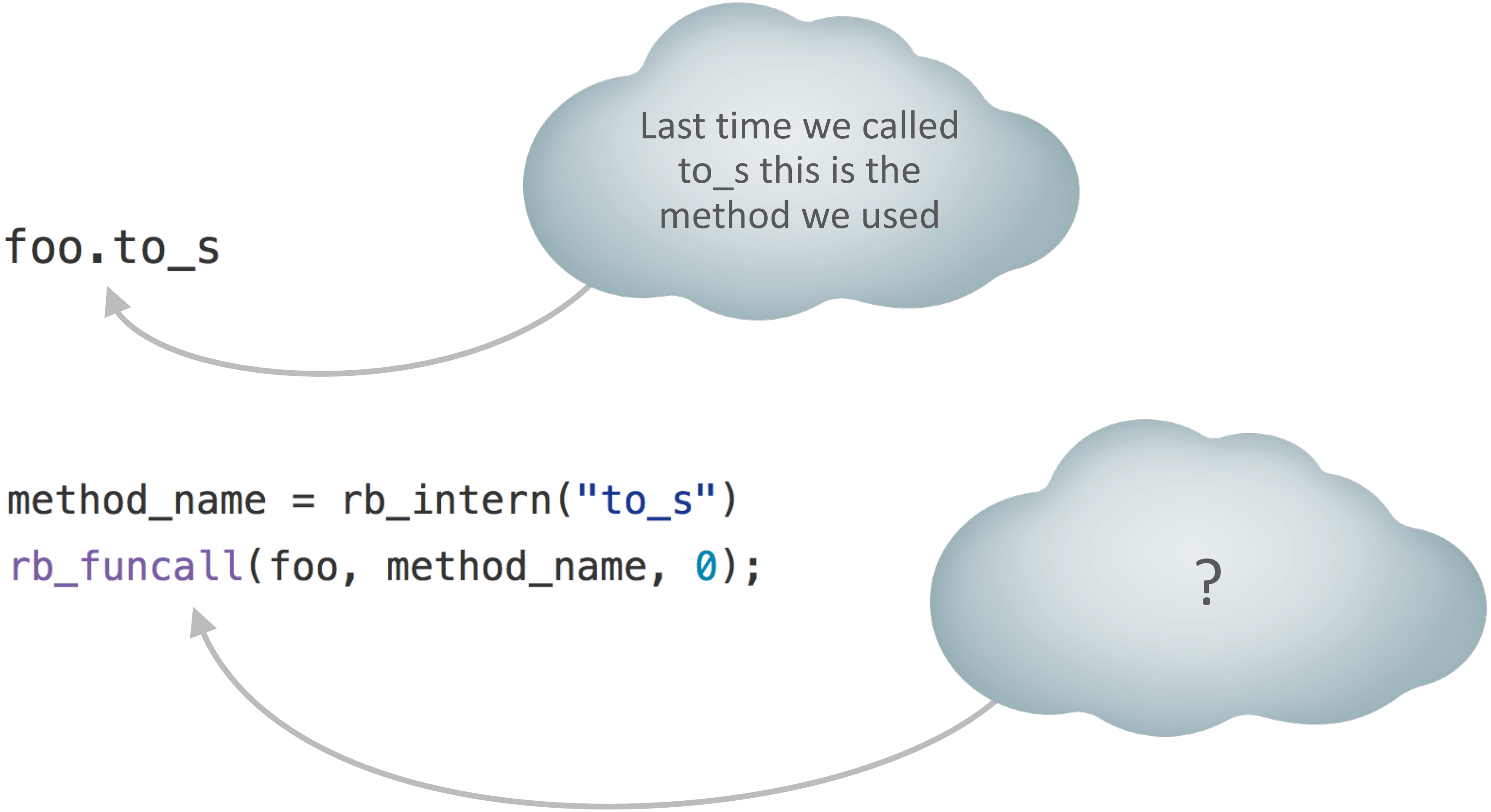
```
struct RData {
  struct RBasic basic;
  void (*dmark)(void *data);
  void (*dfree)(void *data);
  void *data;
};

#define RDATA(value)    ((struct RData *)value)

#define DATA_PTR(value) (RDATA(value)->data)

static VALUE
ossl_x509req_copy(VALUE self, VALUE other)
{
    ...
    DATA_PTR(self) = X509_REQ_dup(b);
    ...
}
```

Lack of caching when you are in C



```
foo.to_s
```

Last time we called to_s this is the method we used

```
method_name = rb_intern("to_s")
rb_funcall(foo, method_name, 0);
```

?

The black box

```ruby
def add(a, b)
  a + b
end

add(14, 2)
```

```c
VALUE add(VALUE self, VALUE a, VALUE b) {
  return INT2FIX(FIX2INT(a) + FIX2INT(b));
}

add(14, 2)
```

The black box

```
def add(a, b)
  a + b
end

add(14, 2)
```

= 16

```
VALUE add(VALUE self, VALUE a, VALUE b) {
  return INT2FIX(FIX2INT(a) + FIX2INT(b));
}

add(14, 2)
```

The black box

```
def add(a, b)
  a + b
end

add(14, 2)
```

= ?

```
VALUE add(VALUE self, VALUE a, VALUE b) {
  return INT2FIX(FIX2INT(a) + FIX2INT(b));
}

add(14, 2)
```

The current workaround to Ruby's performance problem is now preventing fixing the problem properly

How are people trying to solve this?

Denial

- Everyone should use the FFI or Fiddle
  - FFI and Fiddle are two ways to call C functions directly from Ruby
  - 2.1 billion lines of code in RubyGems, 0.5 billion of it is C extension code
  - It might be nice if people used FFI instead of C extensions… but they don’t… so little point in continuing to argue about it

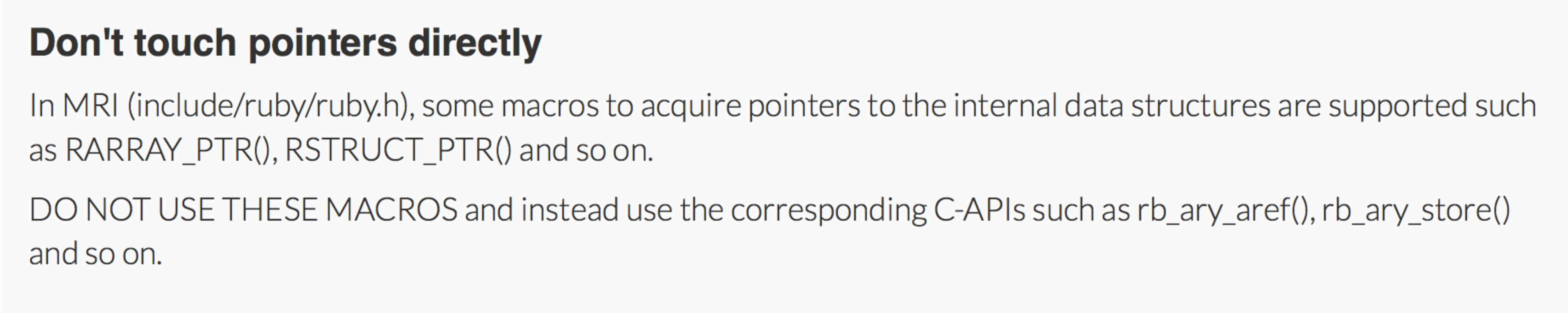
```
module MyLib
  extend FFI::Library
  ffi_lib 'c'
  attach_function :sqrt, [ :double ], :double
end
```

Bargaining

- Attempt to implement the C extension API as best as possible, alongside optimisations
- Generally involves a lot of copying
- JRuby used this approach in the past, Rubinius still uses it
  - JRuby only ran 60% of C extensions I tried
  - Rubinius ran 90%
  - Worse: when they didn’t work they just ground to a halt, no clear failure point

Bargaining

- Try to improve the C extension API over time
  - The JavaScript (V8) and Java C extension APIs don’t have these problems because they have better designed APIs that don’t expose internals
  - Steady progress in this direction, has helped
  - But even OpenSSL doesn’t use these new methods!



> **Don't touch pointers directly**
>
> In MRI (include/ruby/ruby.h), some macros to acquire pointers to the internal data structures are supported such as RARRAY_PTR(), RSTRUCT_PTR() and so on.
>
> DO NOT USE THESE MACROS and instead use the corresponding C-APIs such as rb_ary_aref(), rb_ary_store() and so on.

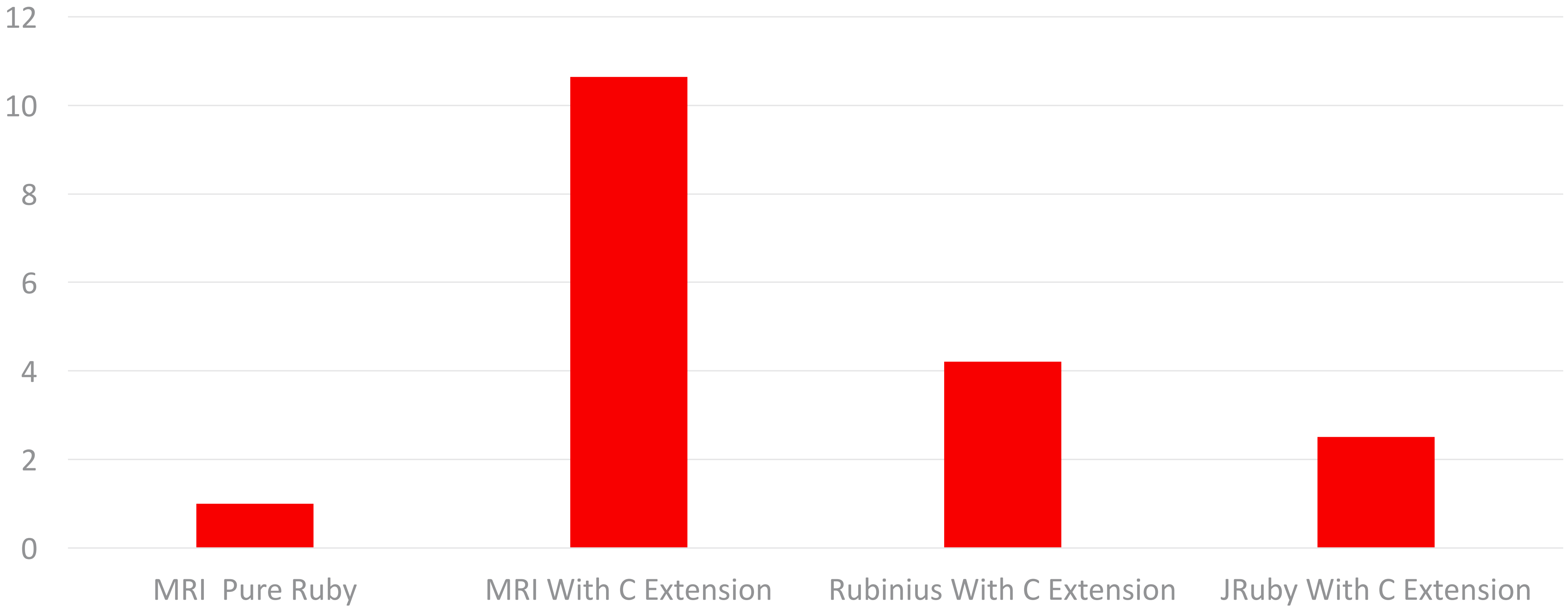
Depression

- JRuby unfortunately had to give up on their C extension work
  - They didn’t have the resources to maintain it after the original developer moved on
  - Limited compatibility and limited performance
  - In the end, in was removed entirely
  - Maybe it’ll return in the future (they could use the same approach as us)

Acceptance

- JRuby encourage Java extensions instead of C extensions
- Try to optimise Ruby while keeping most of the internals the same
  - IBM’s OMR adds a new GC and JIT to Ruby while keeping support for C extensions
  - The techniques they can use are therefore limited
  - And so performance increases expected from OMR are more modest

Performance on Ruby C Extensions Oily PNG and PSD Native



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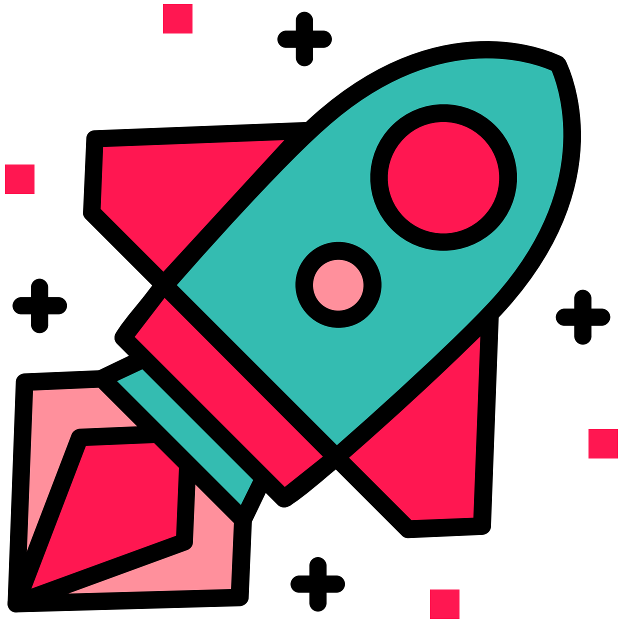
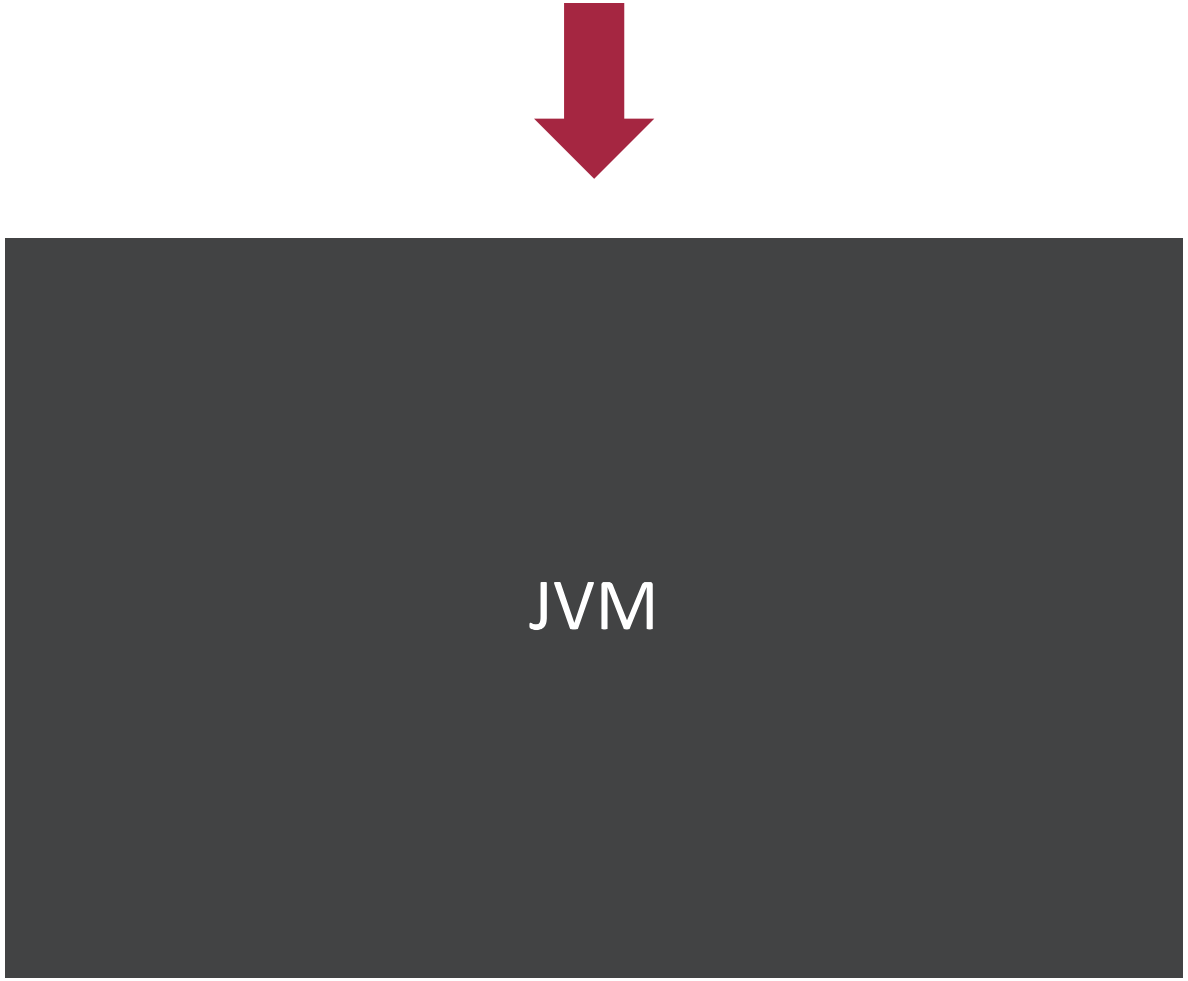
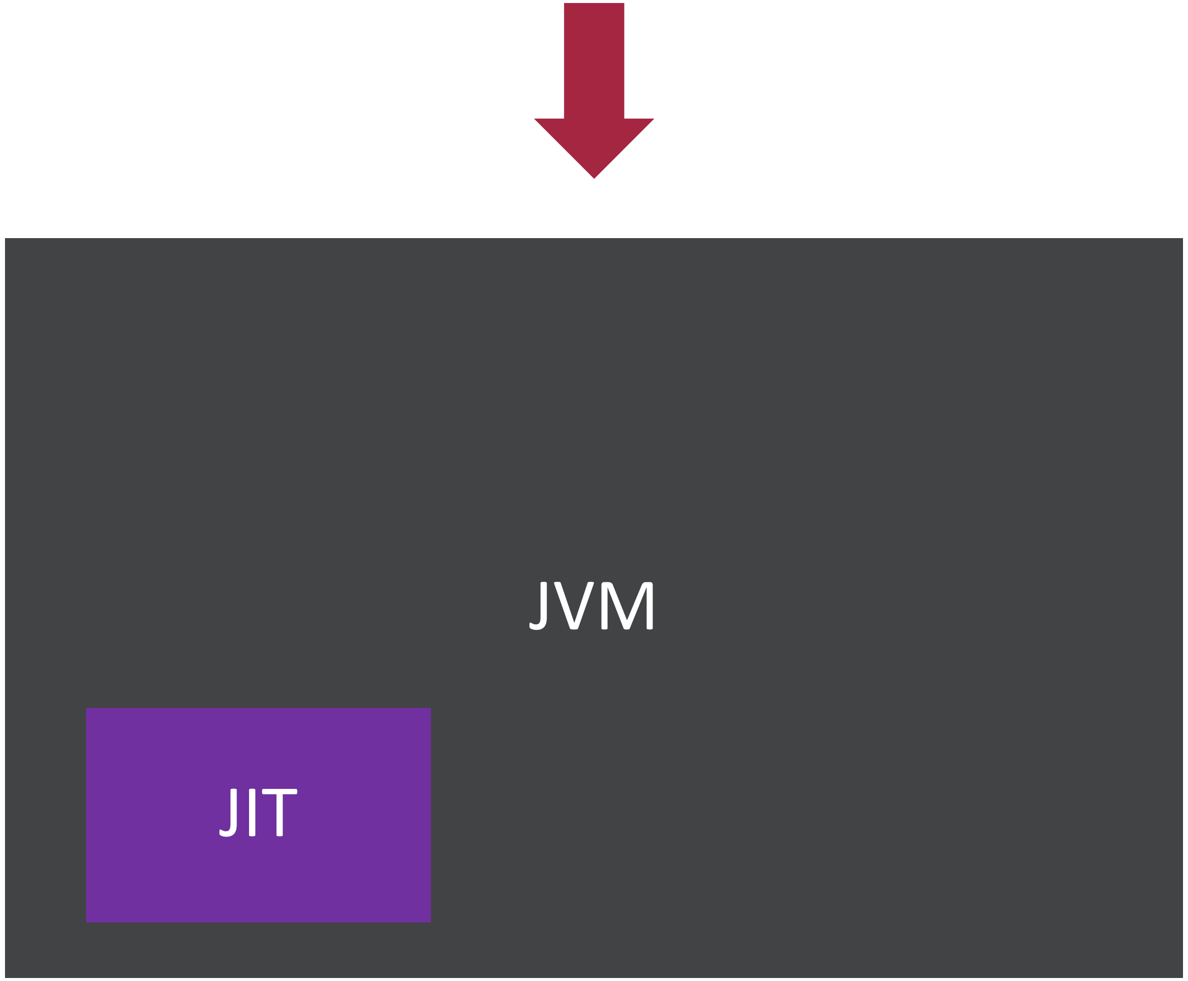
TruffleRuby

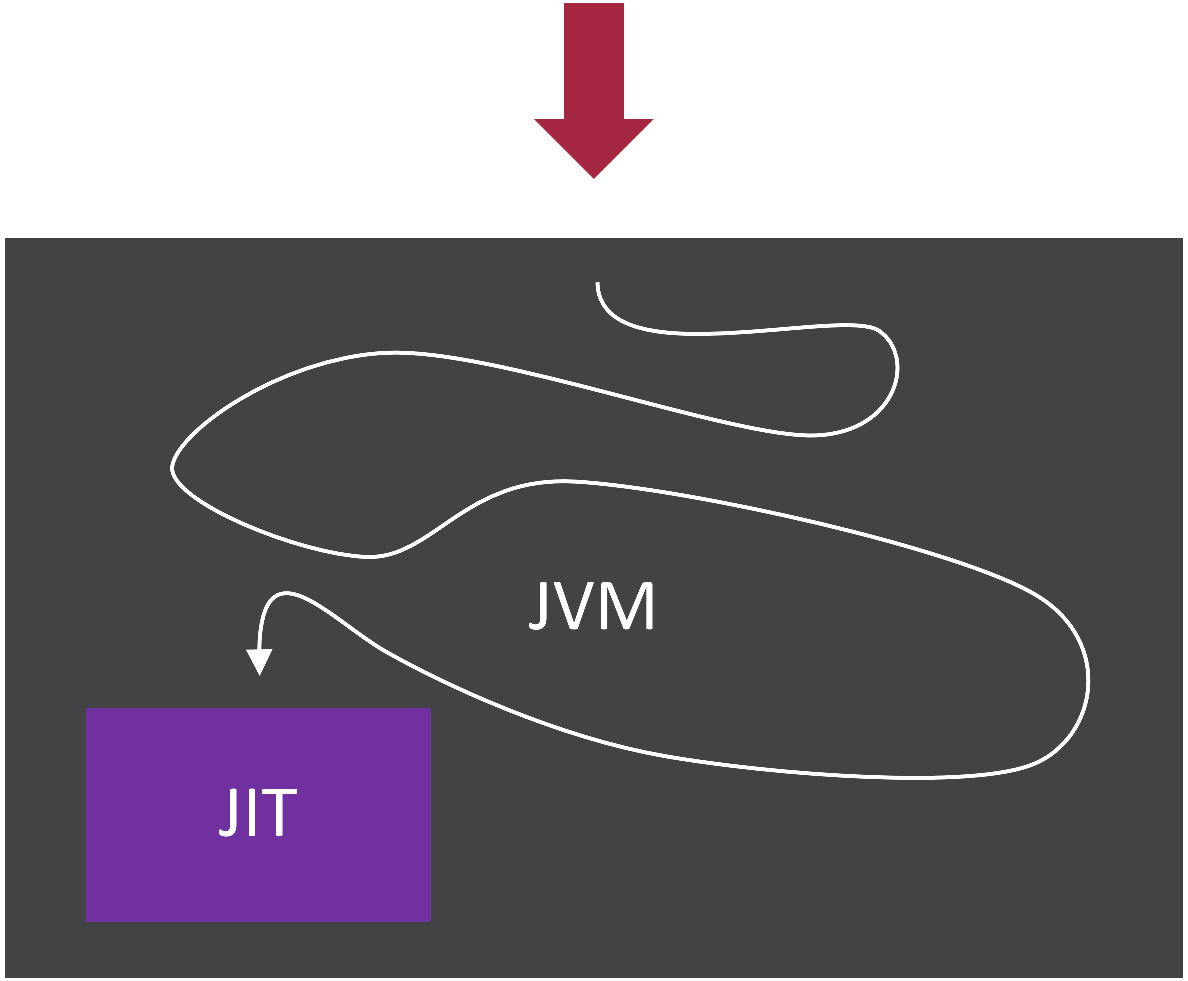


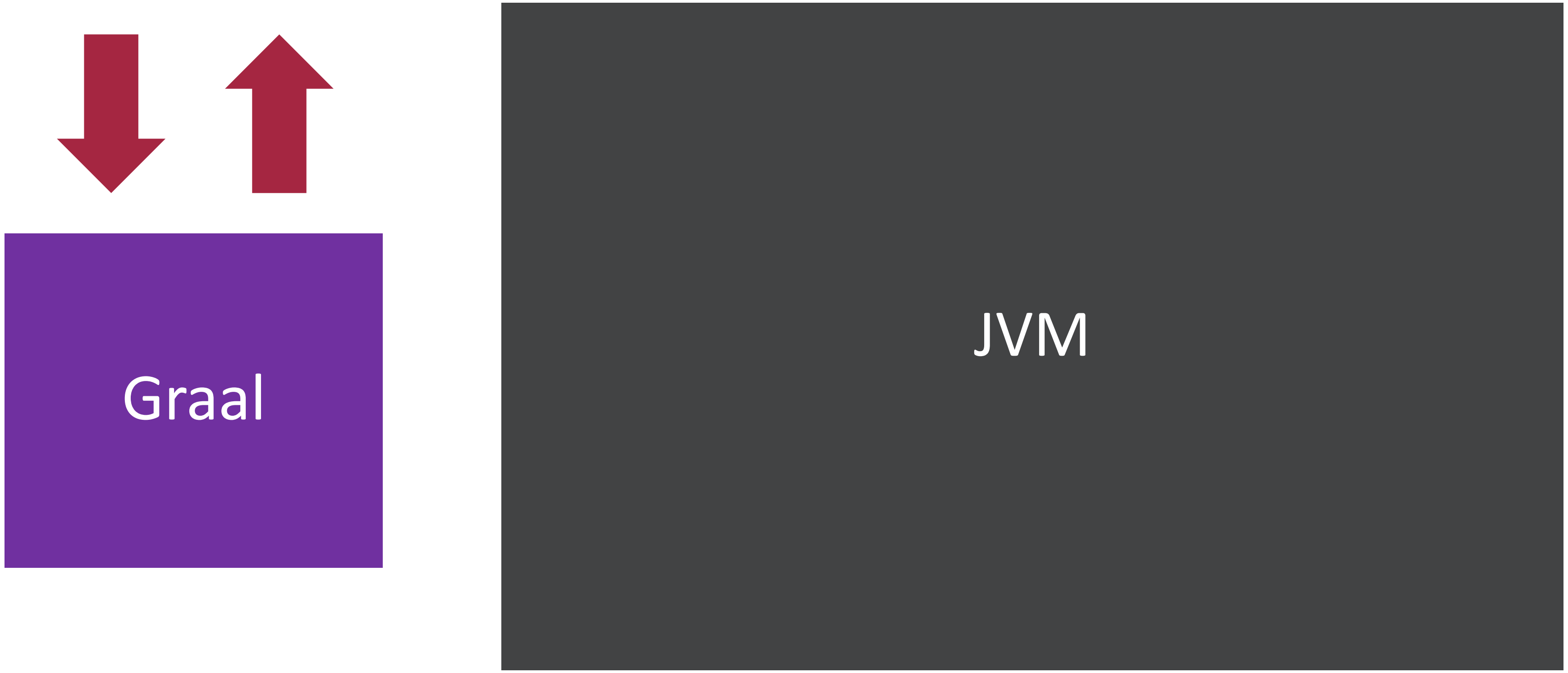
JVM



JVM

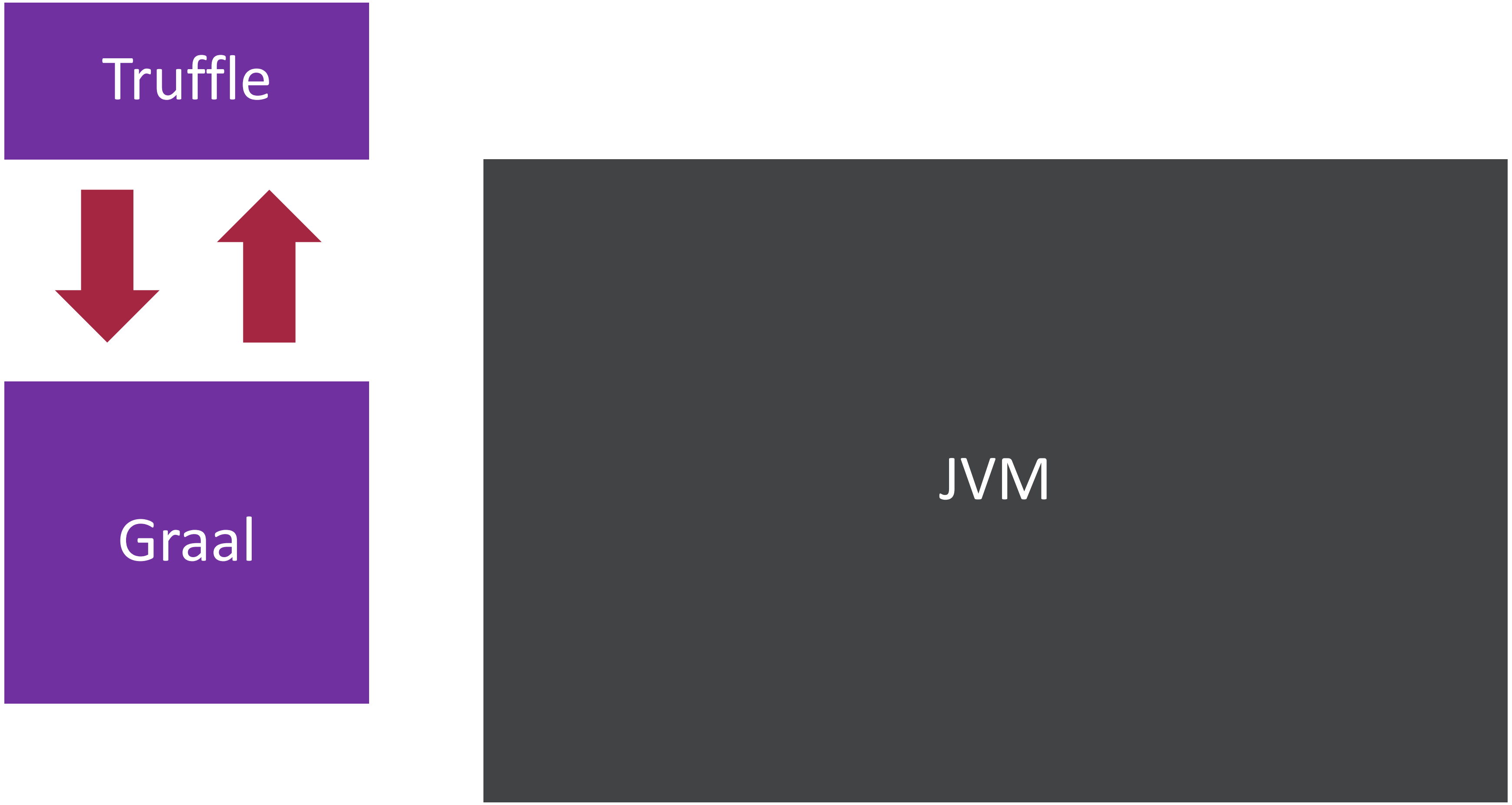

JVM
JIT


JVM
JIT



Graal

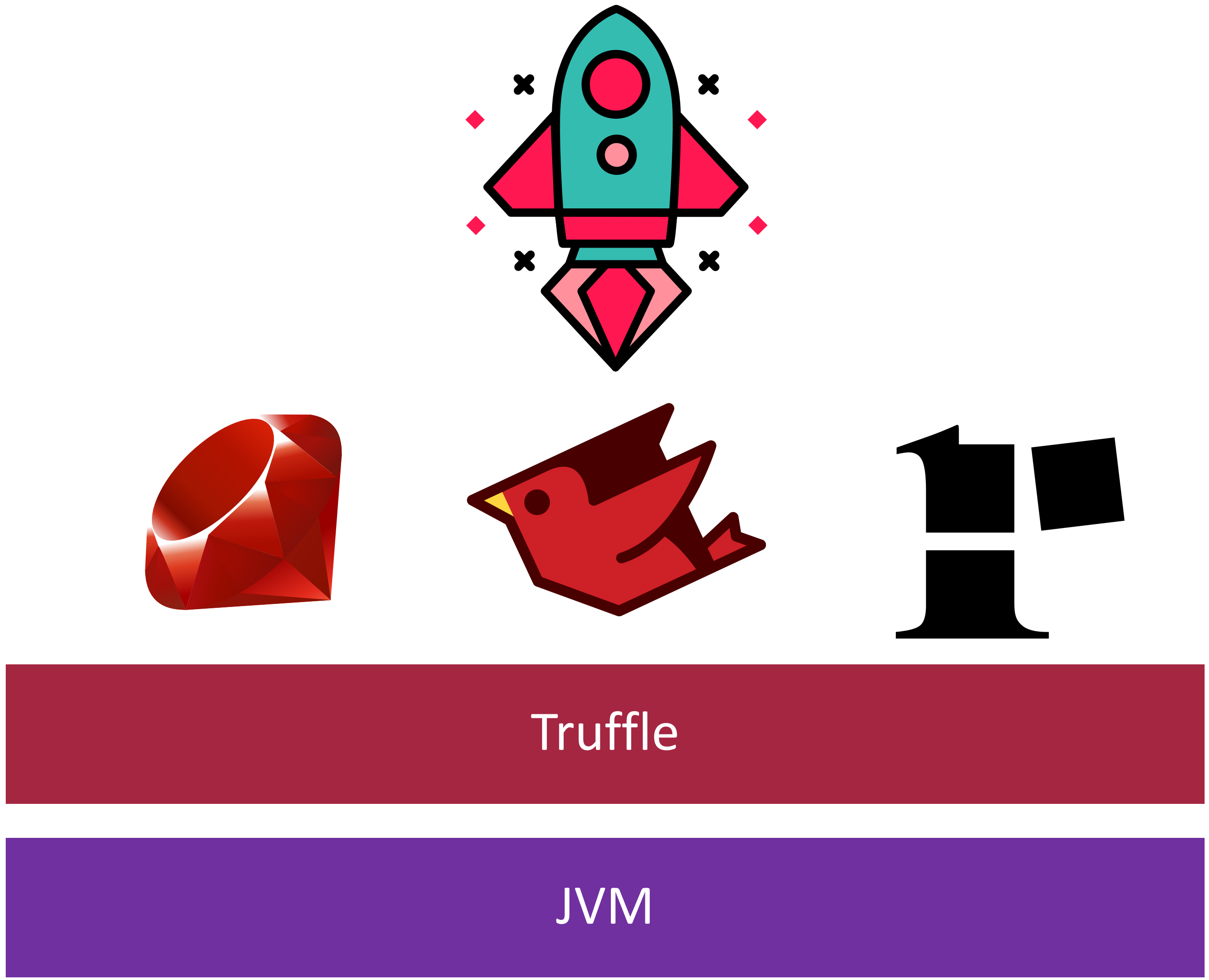
JVM



Truffle

Graal

JVM

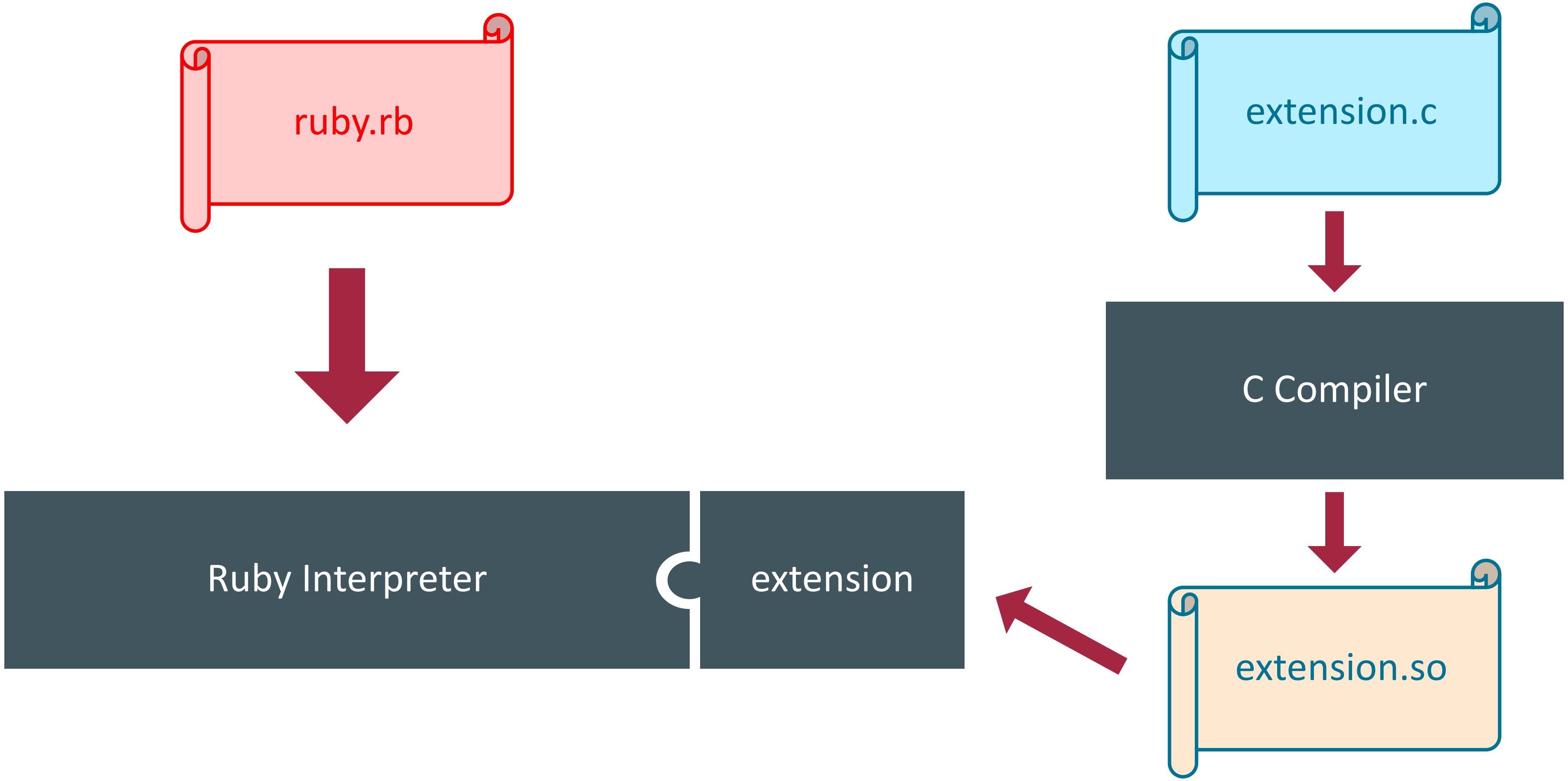


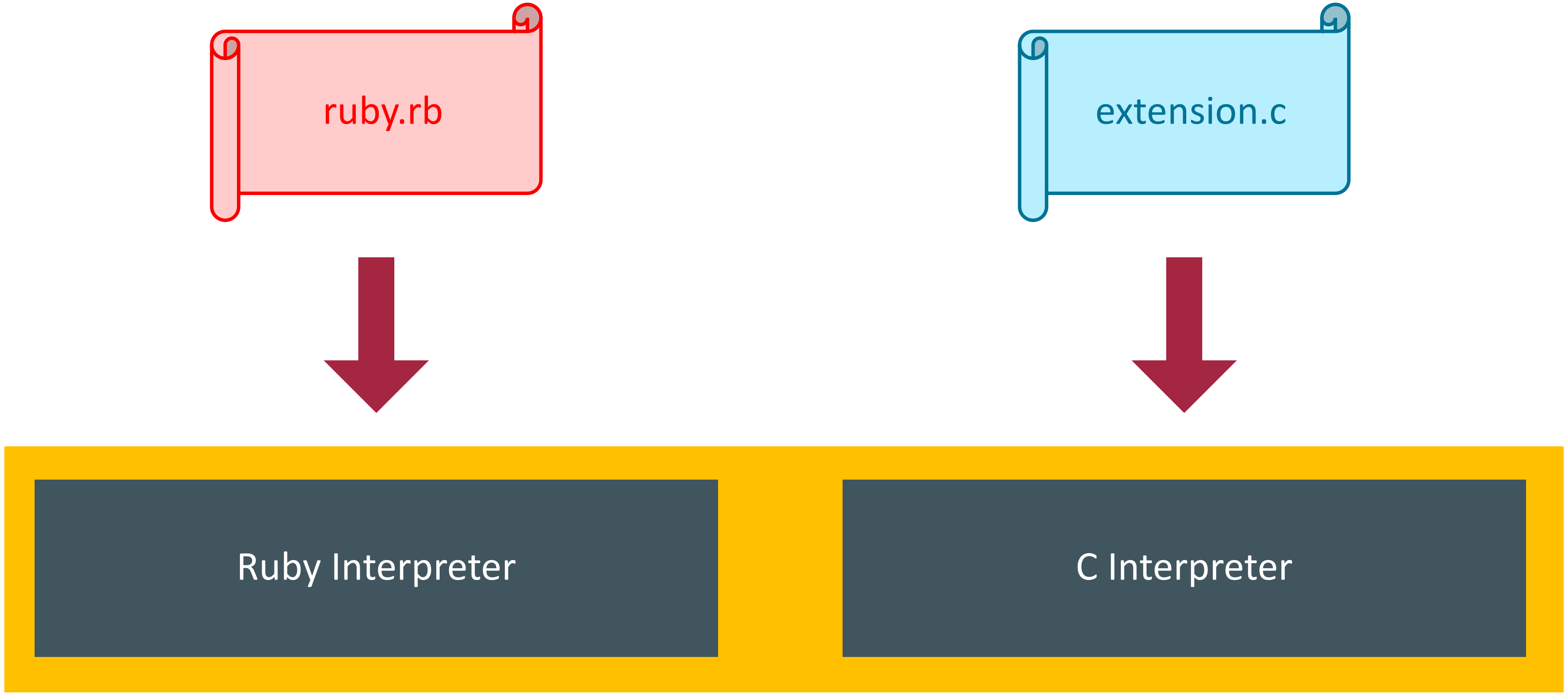
Truffle

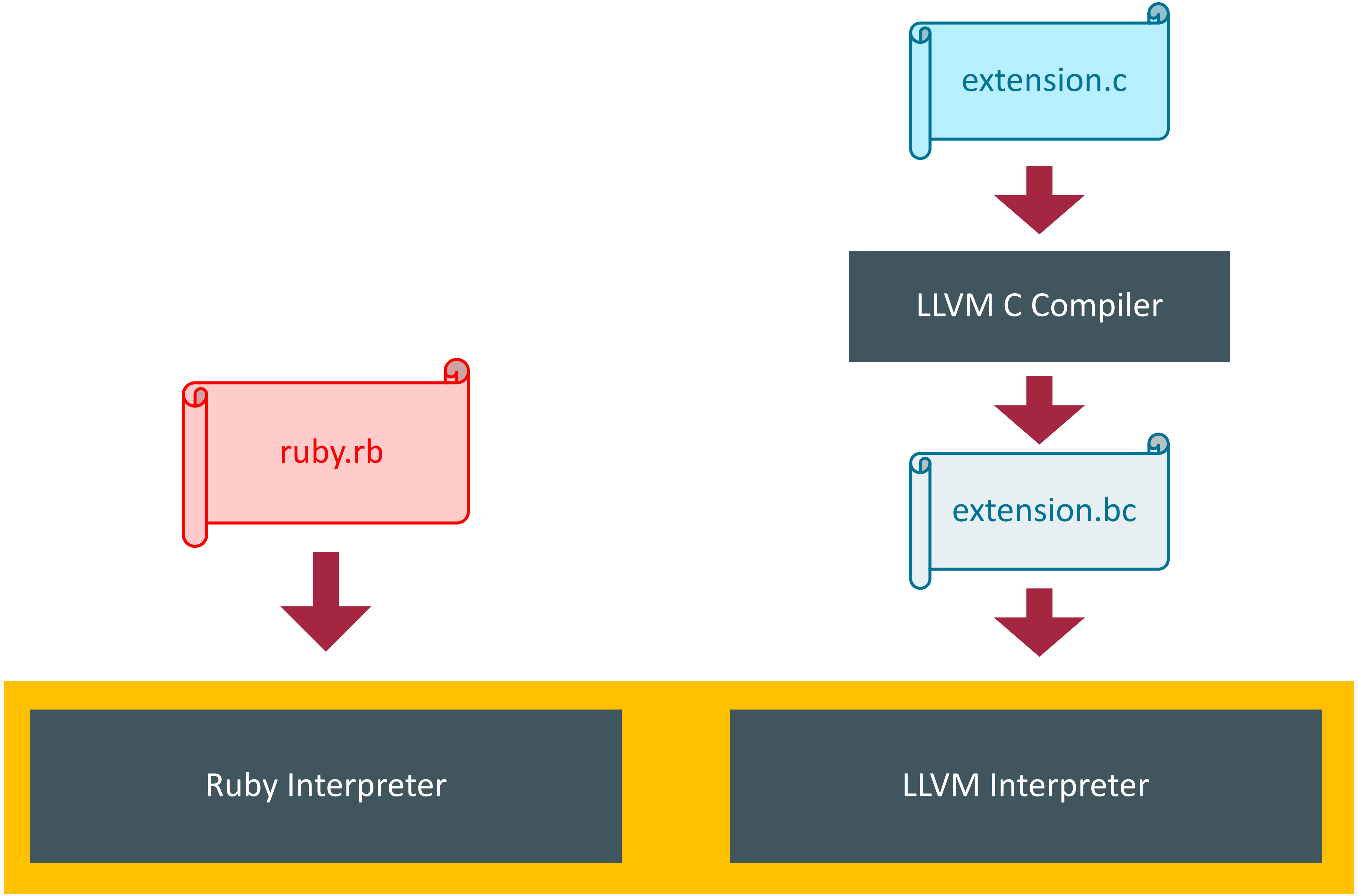
JVM

The Sulong logo was designed by Valentina Caruso

Sulong


ruby.rb
extension.c
C Compiler
Ruby Interpreter
extension
extension.so


ruby.rb
extension.c
Ruby Interpreter
C Interpreter

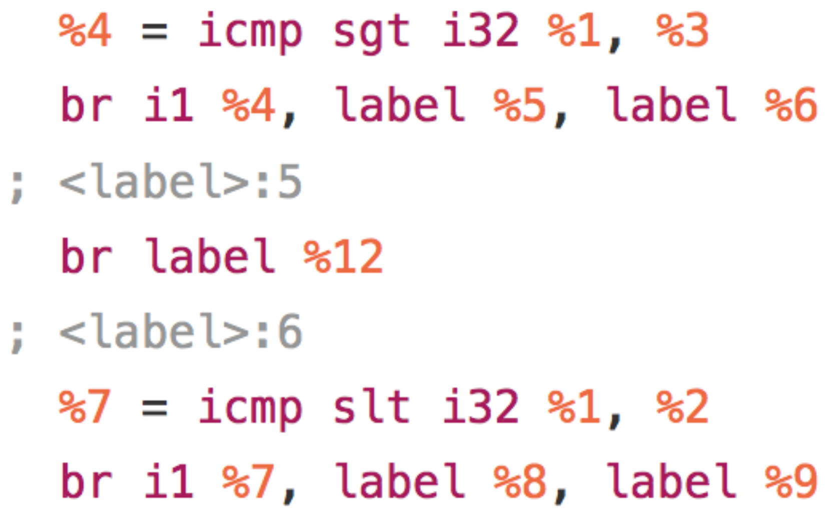

extension.c
LLVM C Compiler
ruby.rb
extension.bc
Ruby Interpreter
LLVM Interpreter

```
VALUE psd_native_util_clamp(VALUE self,
    VALUE r_num, VALUE r_min, VALUE r_max) {
  int num = FIX2INT(r_num);
  int min = FIX2INT(r_min);
  int max = FIX2INT(r_max);

  return num > max ? r_max : (num < min ? r_min : r_num);
}
```

```
define i8* @psd_native_util_clamp(i8* %self,
    i8* %r_num, i8* %r_min, i8* %r_max) nounwind uwtable ssp {
  %1 = call i32 @FIX2INT(i8* %r_num)
  %2 = call i32 @FIX2INT(i8* %r_min)
  %3 = call i32 @FIX2INT(i8* %r_max)
  %4 = icmp sgt i32 %1, %3
  br i1 %4, label %5, label %6
; <label>:5                                        ; preds = %0
  br label %12
; <label>:6                                        ; preds = %0
  %7 = icmp slt i32 %1, %2
  br i1 %7, label %8, label %9
; <label>:8                                        ; preds = %6
  br label %10
; <label>:9                                        ; preds = %6
  br label %10
; <label>:10                                       ; preds = %9, %8
  %11 = phi i8* [ %r_min, %8 ], [ %r_num, %9 ]
  br label %12
; <label>:12                                       ; preds = %10, %5
  %13 = phi i8* [ %r_max, %5 ], [ %11, %10 ]
  ret i8* %13
}
```

```
VALUE psd_native_util_clamp(VALUE self,
    VALUE r_num, VALUE r_min, VALUE r_max) {
  int num = FIX2INT(r_num);
  int min = FIX2INT(r_min);
  int max = FIX2INT(r_max);

  return num > max ? r_max : (num < min ? r_min : r_num);
}
```

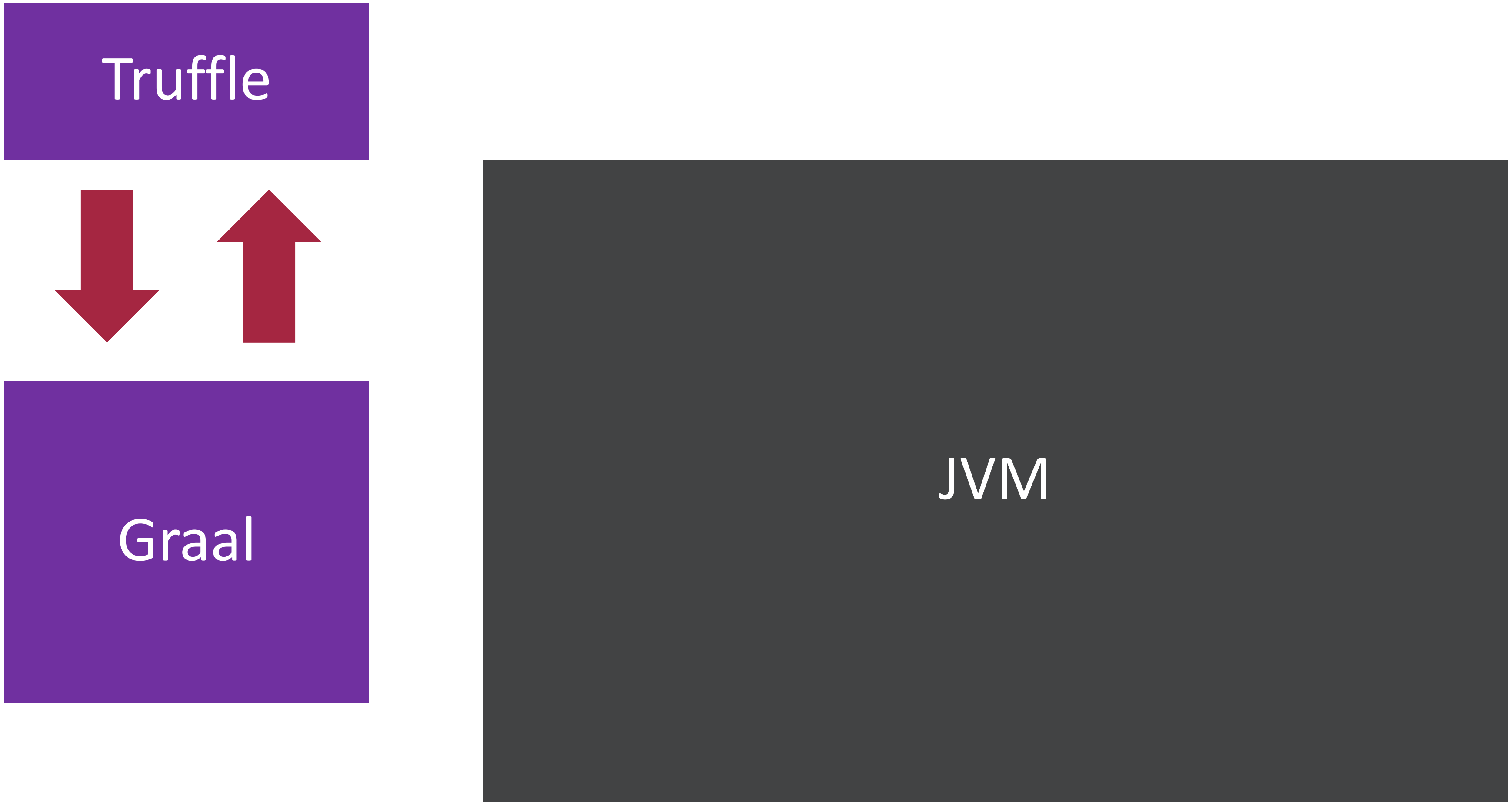
```
define i8* @psd_native_util_clamp(i8* %self,
    i8* %r_num, i8* %r_min, i8* %r_max) nounwind uwtable ssp {
  %1 = call i32 @FIX2INT(i8* %r_num)
  %2 = call i32 @FIX2INT(i8* %r_min)
  %3 = call i32 @FIX2INT(i8* %r_max)
  %4 = icmp sgt i32 %1, %3
  br i1 %4, label %5, label %6
; <label>:5                                       ; preds = %0
  br label %12
; <label>:6                                       ; preds = %0
  %7 = icmp slt i32 %1, %2
  br i1 %7, label %8, label %9
; <label>:8                                       ; preds = %6
  br label %10
; <label>:9                                       ; preds = %6
  br label %10
; <label>:10                                      ; preds = %9, %8
  %11 = phi i8* [ %r_min, %8 ], [ %r_num, %9 ]
  br label %12
; <label>:12                                      ; preds = %10, %5
  %13 = phi i8* [ %r_max, %5 ], [ %11, %10 ]
  ret i8* %13
}
```



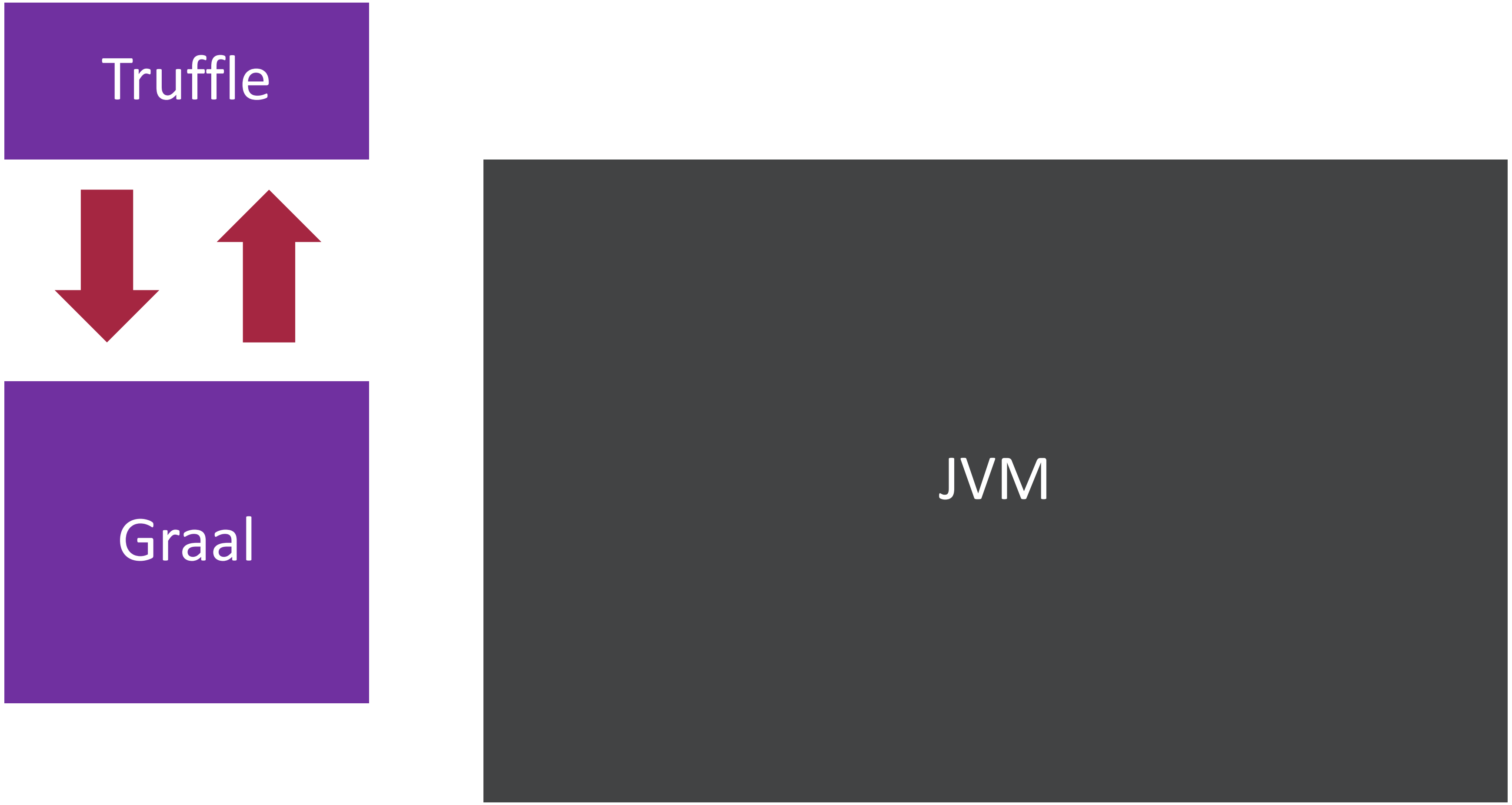
```
  %4 = icmp sgt i32 %1, %3
  br i1 %4, label %5, label %6
; <label>:5
  br label %12
; <label>:6
  %7 = icmp slt i32 %1, %2
  br i1 %7, label %8, label %9
  %4 = icmp sgt i32 %1, %3
  br i1 %4, label %5, label %6
; <label>:5
  br label %12
; <label>:6
  %7 = icmp slt i32 %1, %2
  br i1 %7, label %8, label %9
```

```
    t4 = t1 > t3
    if t4
      goto l5
    else
      goto l6
    end
l5: goto l12
l6: t7 = t1 < t2
    if t7
      goto l8
    else
      goto l9
    end
```

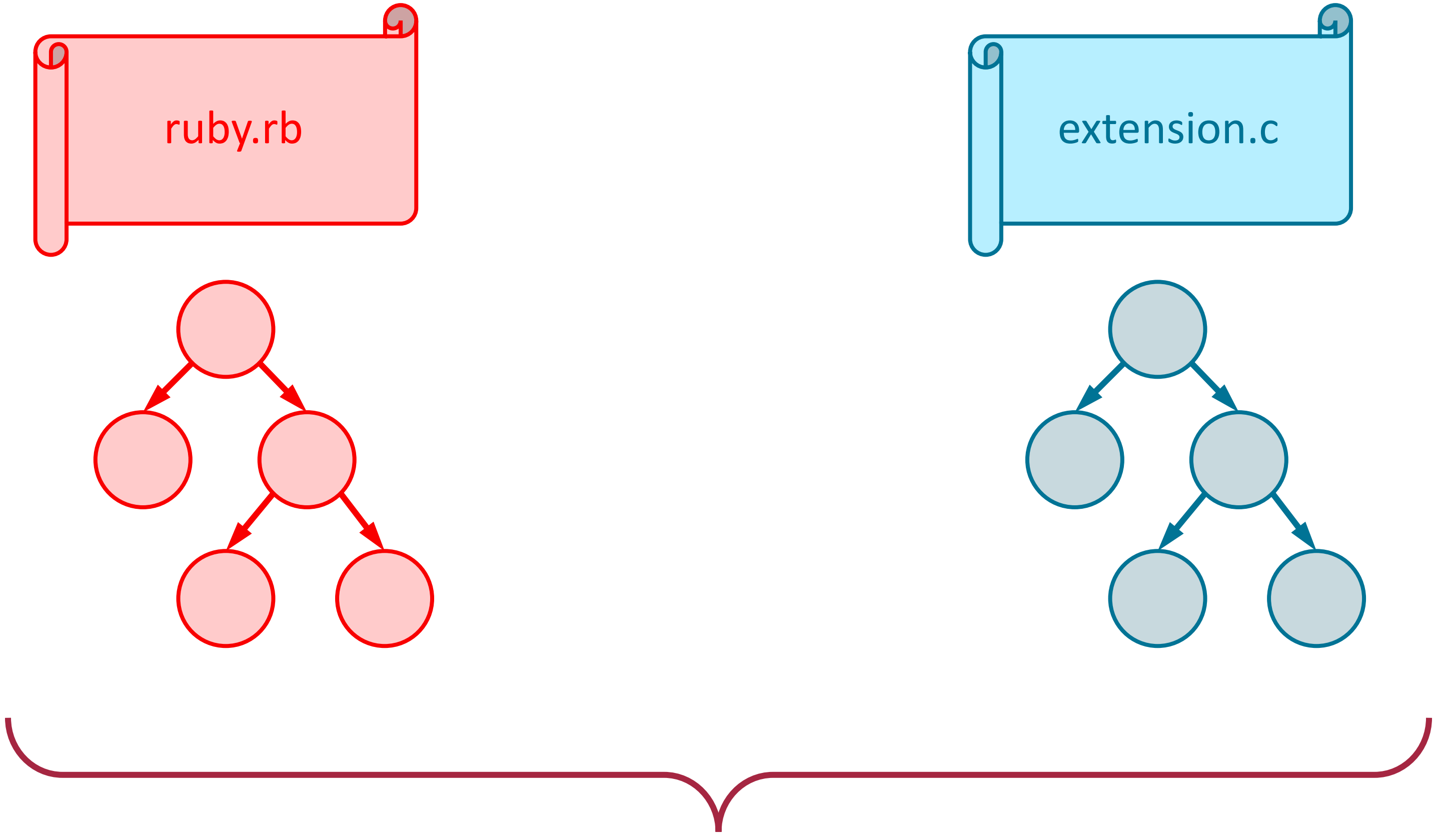
Ruby and C as two equal languages


Truffle
Graal
JVM

Sulong

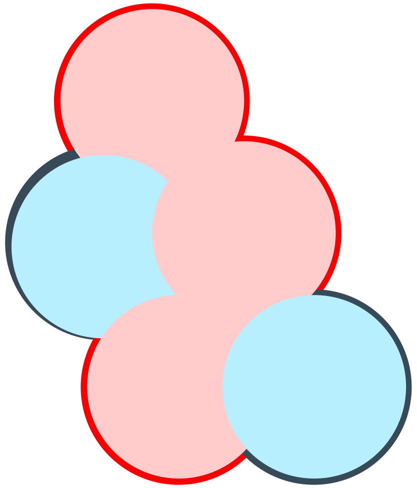


Optimise Ruby and C together



Optimisations

Optimise Ruby and C together



Optimisations

Some interesting problems and their solutions

Defining the C extension API in Ruby

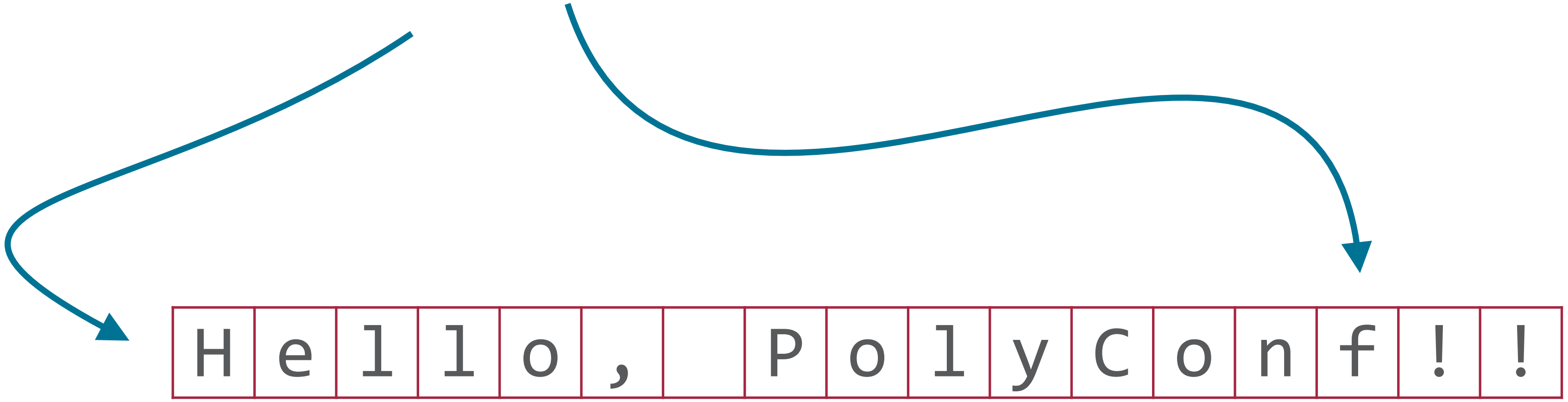
```c
int FIX2INT(VALUE value);
```

```c
int FIX2INT(VALUE value) {
  return truffle_invoke_i(RUBY_CEXT, "FIX2INT", value);
}
```

```ruby
module Truffle::CExt

  def rb_fix2int(value)
    if value.nil?
      raise TypeError
    else
      int = value.to_int
      raise RangeError if int >= 2**32
      int
    end
  end

end
```

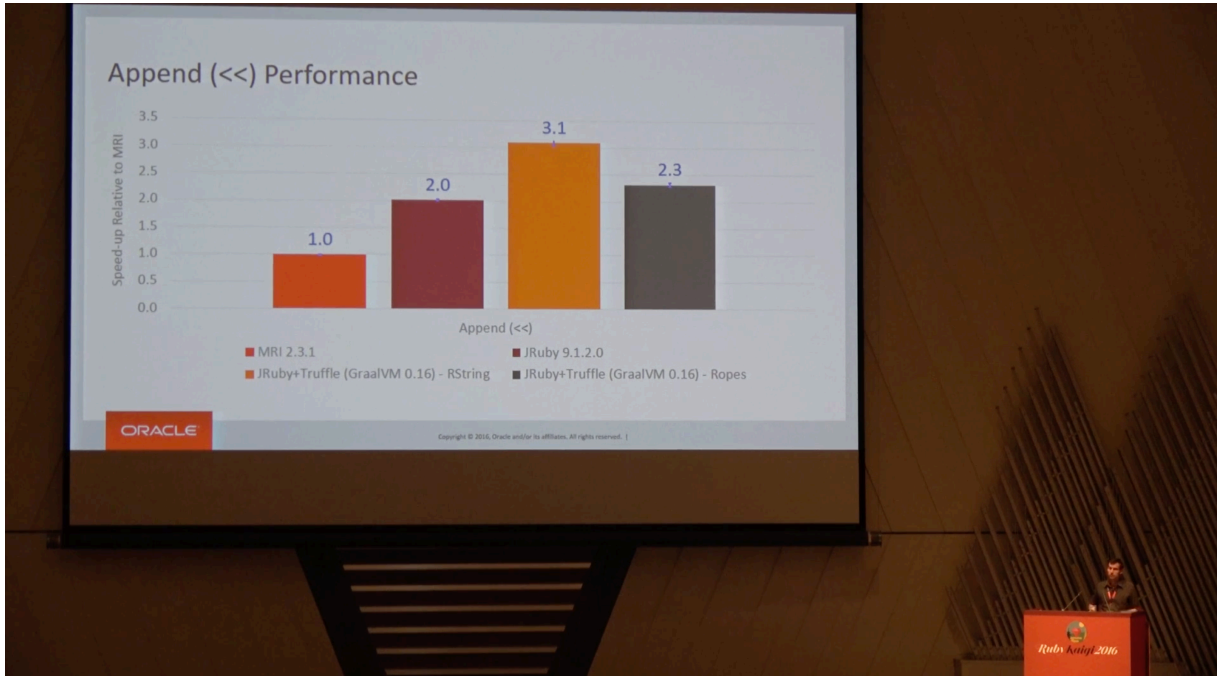
Imaginary strings

```
char *chars = RSTRING_PTR(my_string);
chars[14]
```



H	e	l	l	o	,		P	o	l	y	C	o	n	f	!	!

Imaginary strings



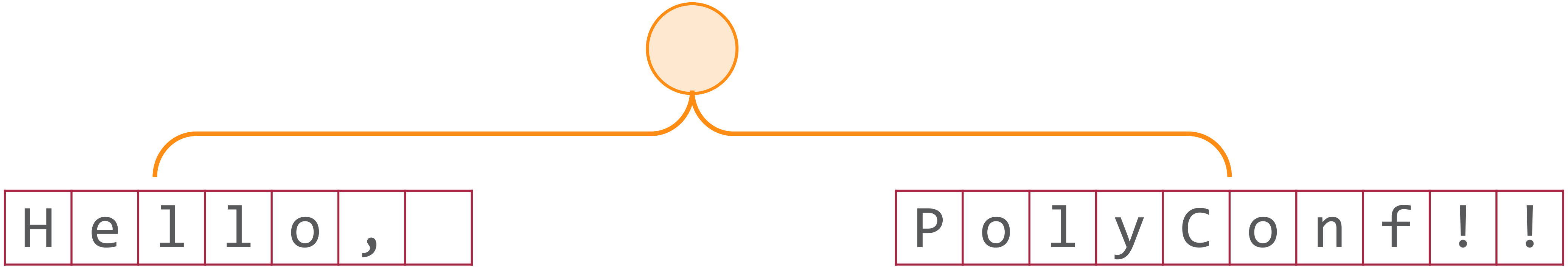
A Tale of Two String Representations

Kevin Menard - RubyKaigi 2016

Imaginary strings

```
%1 = call @RSTRING_PTR(%my_string)
%2 = getelementptr %14, 14
```

```
char *chars = RSTRING_PTR(my_string);
chars[14]
```



H	e	l	l	o	,	

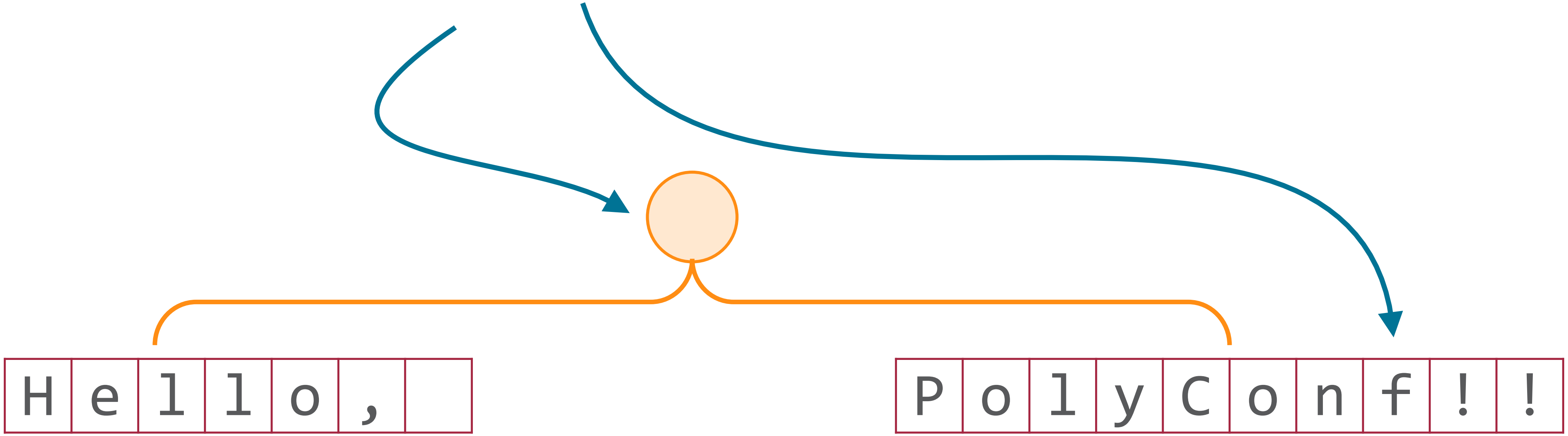
P	o	l	y	C	o	n	f	!	!

Imaginary strings

```
%1 = call @RSTRING_PTR(%my_string)
%2 = getelementptr %14, 14
```

String#[]

```
char *chars = RSTRING_PTR(my_string);
chars[14]
```

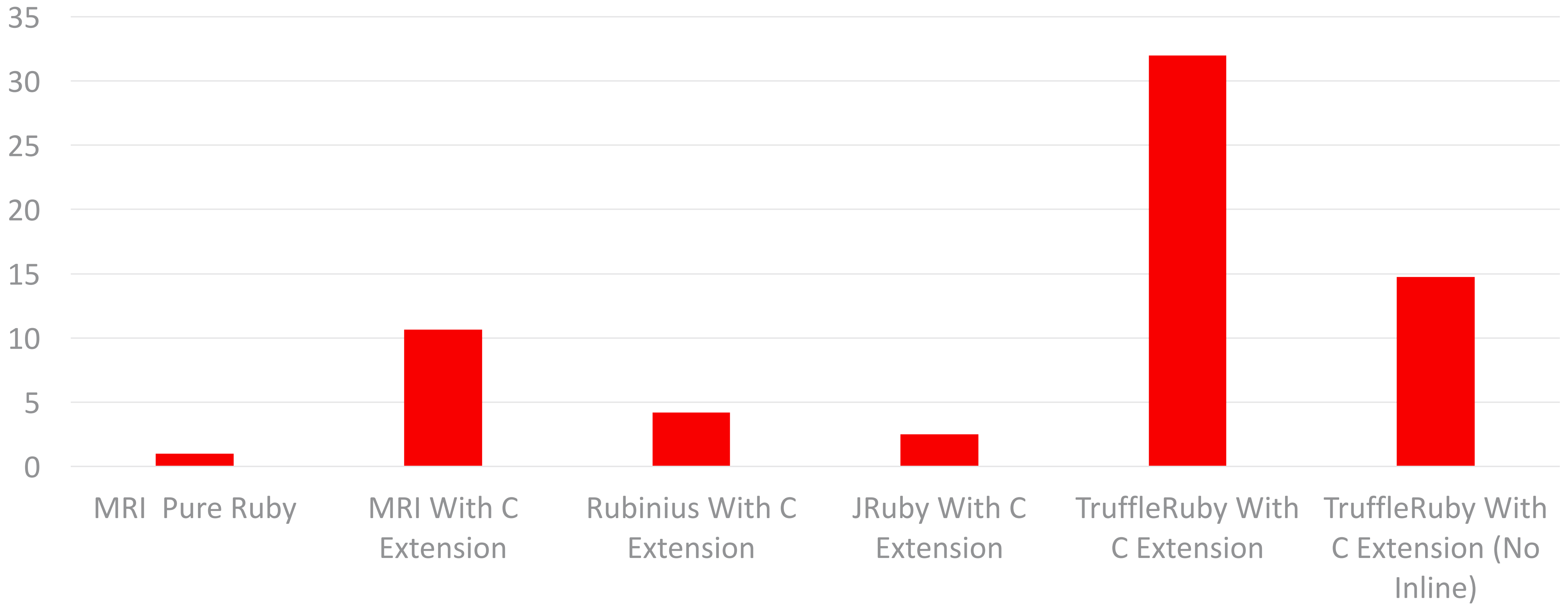


H	e	l	l	o	,	

P	o	l	y	C	o	n	f	!	!

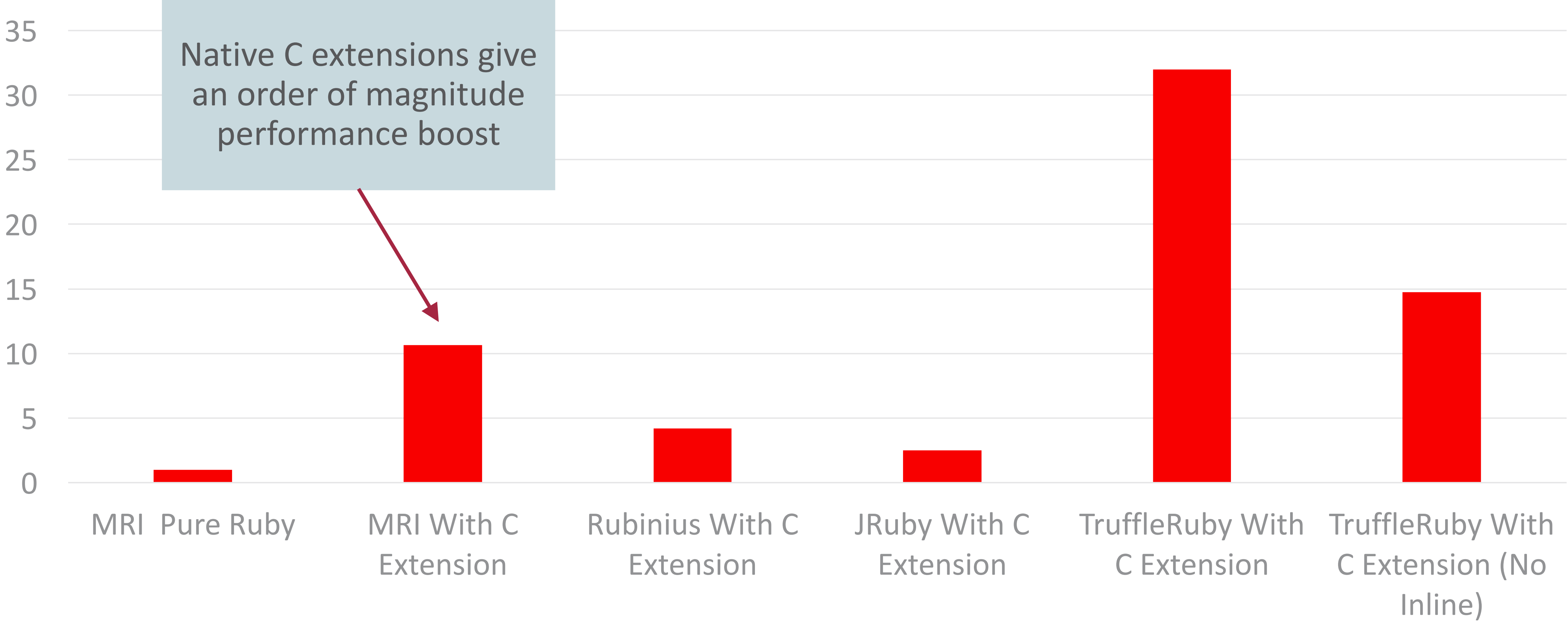
Results

Performance on Ruby C Extensions Oily PNG and PSD Native



M. Grimmer, C. Seaton, T. Würthinger, H. Mössenböck. Dynamically Composing Languages in a Modular Way: Supporting C Extensions for Dynamic Languages. In Proceedings of the 14th International Conference on Modularity, 2015.

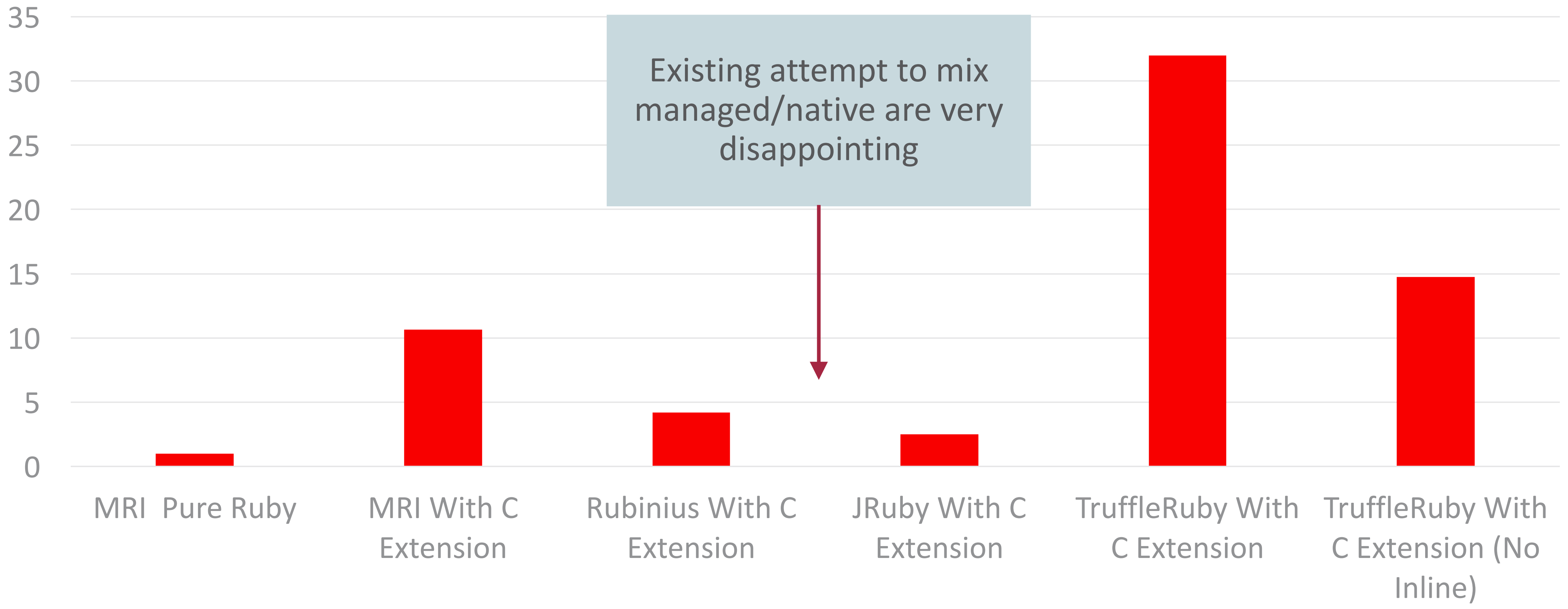
Performance on Ruby C Extensions Oily PNG and PSD Native



Native C extensions give an order of magnitude performance boost

M. Grimmer, C. Seaton, T. Würthinger, H. Mössenböck. Dynamically Composing Languages in a Modular Way: Supporting C Extensions for Dynamic Languages. In Proceedings of the 14th International Conference on Modularity, 2015.

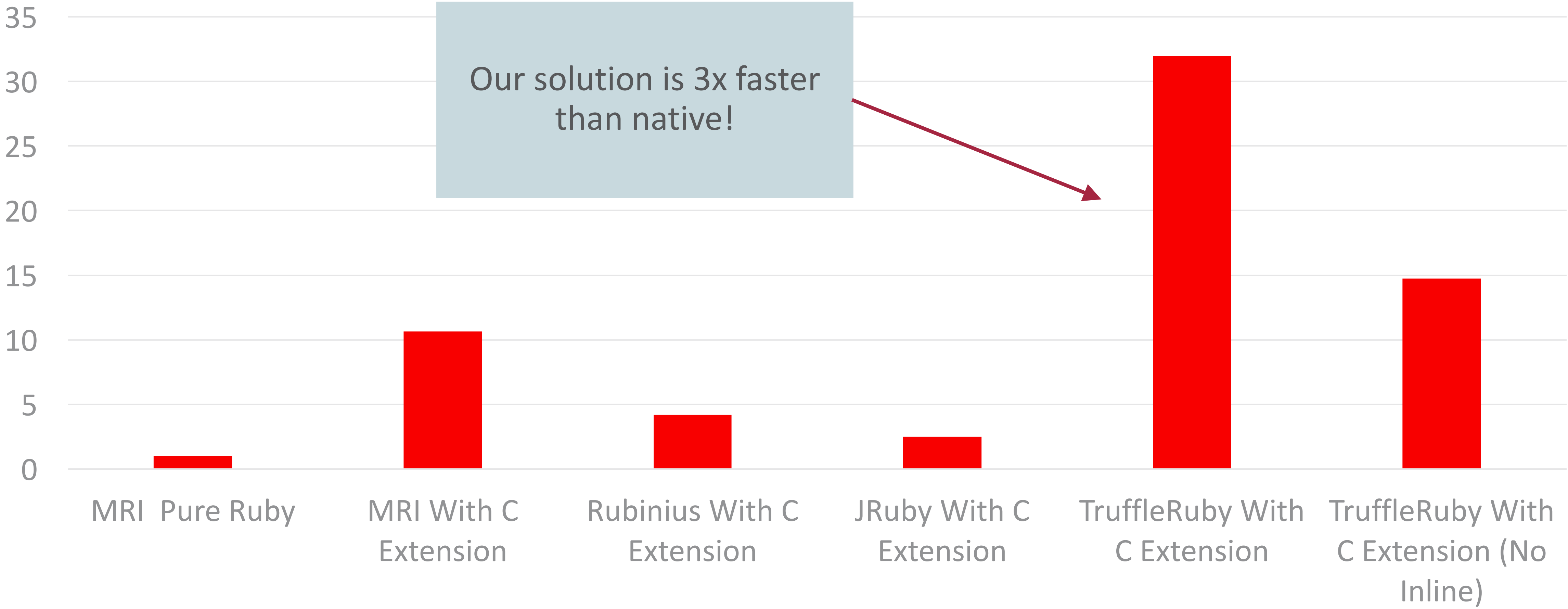
Performance on Ruby C Extensions Oily PNG and PSD Native



Existing attempt to mix managed/native are very disappointing

M. Grimmer, C. Seaton, T. Würthinger, H. Mössenböck. Dynamically Composing Languages in a Modular Way: Supporting C Extensions for Dynamic Languages. In Proceedings of the 14th International Conference on Modularity, 2015.

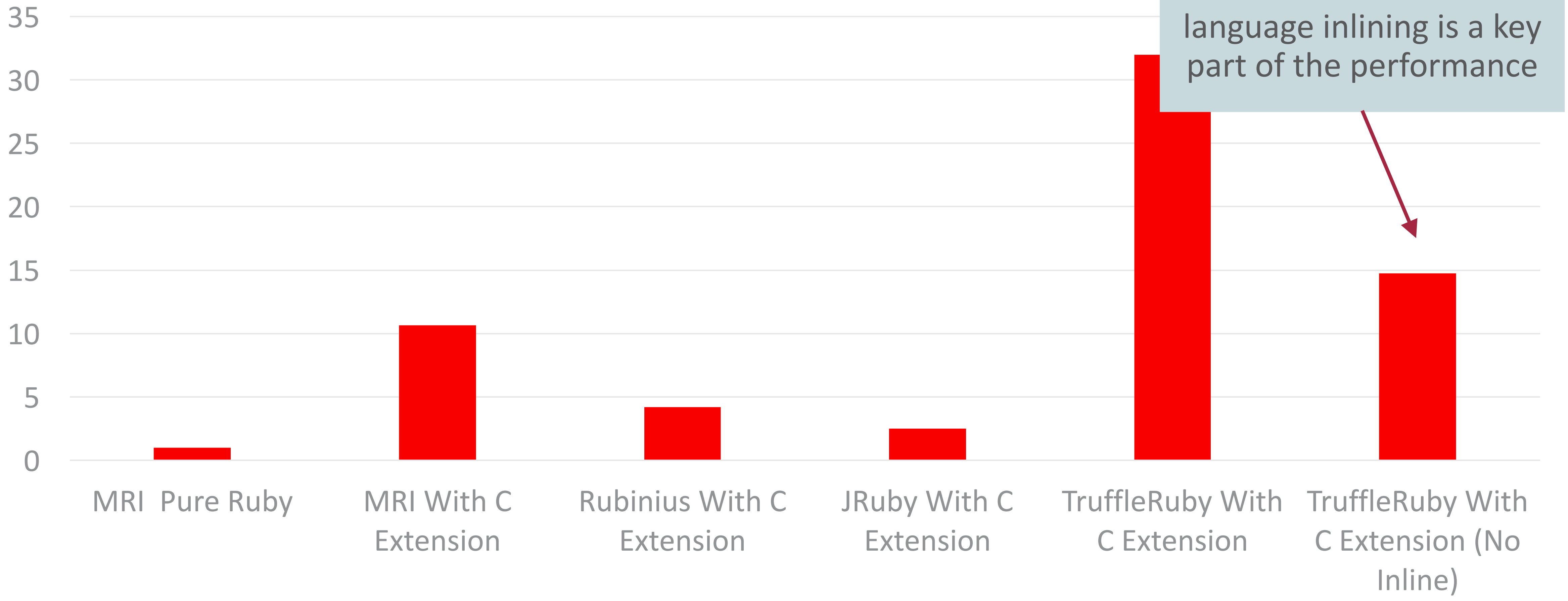
Performance on Ruby C Extensions Oily PNG and PSD Native



Our solution is 3x faster than native!

M. Grimmer, C. Seaton, T. Würthinger, H. Mössenböck. Dynamically Composing Languages in a Modular Way: Supporting C Extensions for Dynamic Languages. In Proceedings of the 14th International Conference on Modularity, 2015.

Performance on Ruby C Extensions Oily PNG and PSD Native



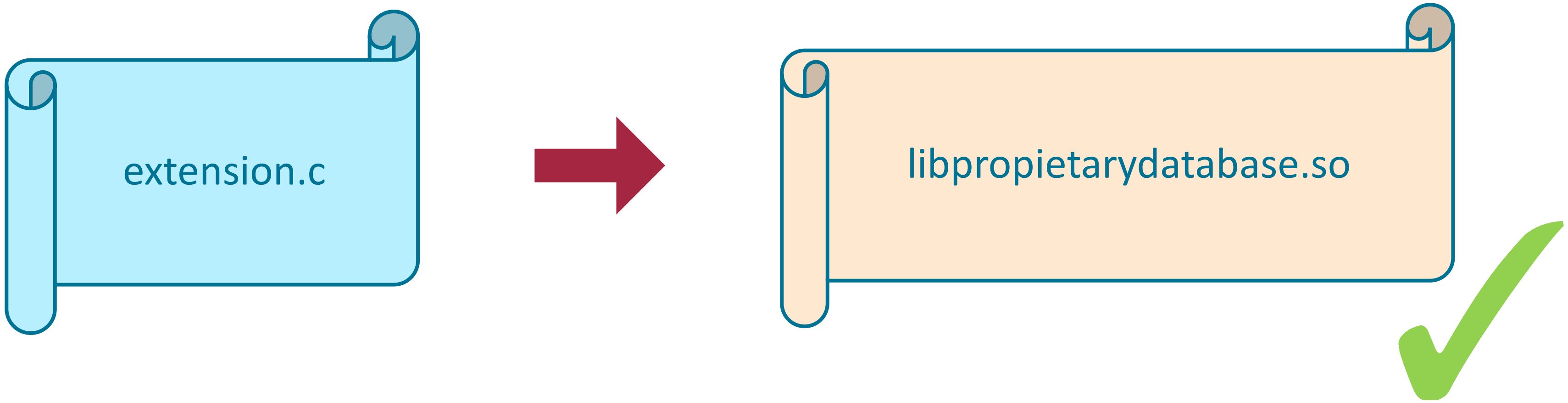
It’s clear that cross-language inlining is a key part of the performance

M. Grimmer, C. Seaton, T. Würthinger, H. Mössenböck. Dynamically Composing Languages in a Modular Way: Supporting C Extensions for Dynamic Languages. In Proceedings of the 14th International Conference on Modularity, 2015.

Limitations

You do need the source code of the C extension

- Means no closed source C extensions
  - Is this a problem in reality for anyone?
  - I’m not aware of any closed source C extensions
  - C extensions in turn using closed source libraries like database drivers is fine



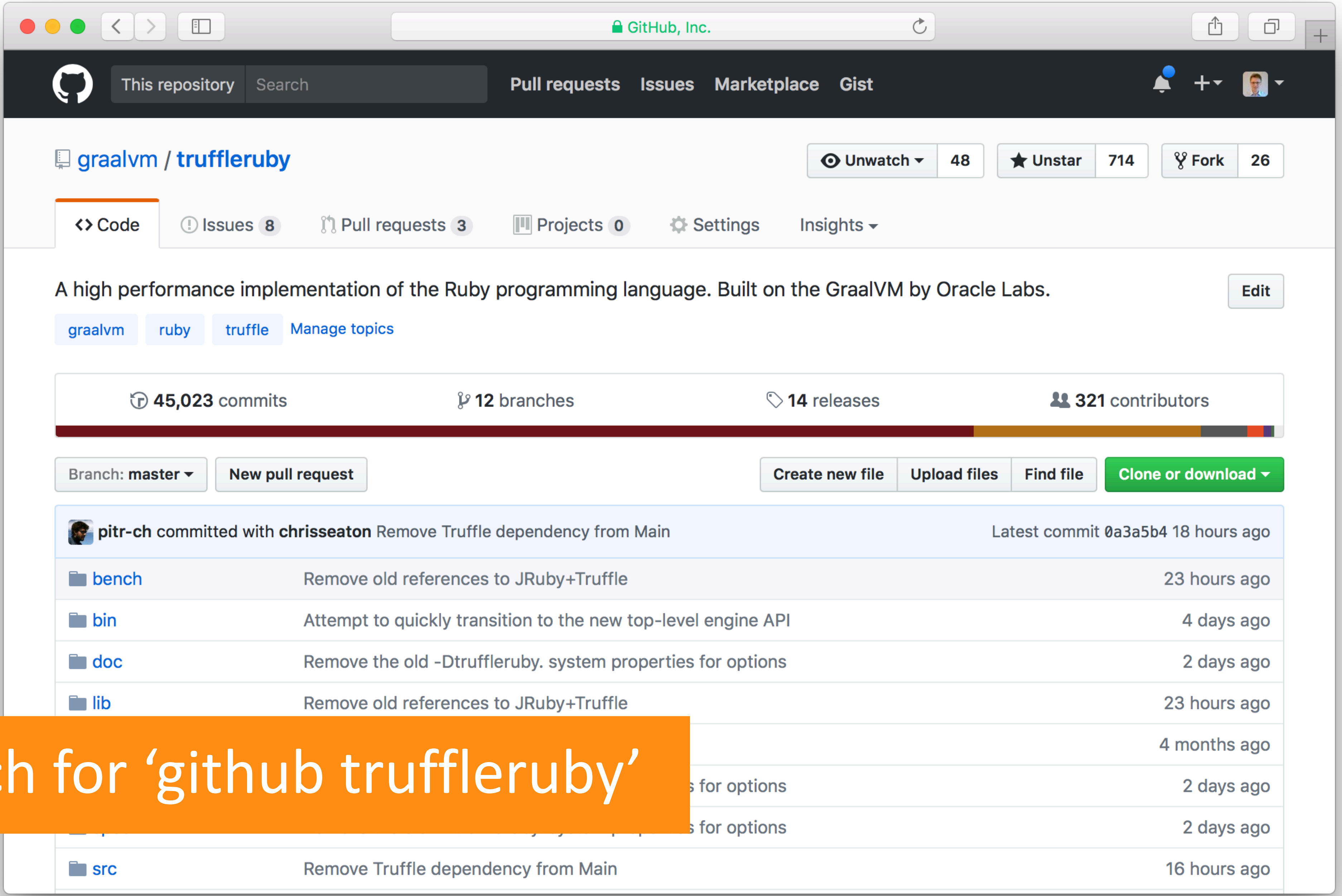
You can’t store pointers to Ruby objects in native code

- If your C extension uses a compiled library, such as libssl.so
  - You can’t give that compiled library a reference to a Ruby object
  - The Ruby object may not really exist
  - The GC may want to move the object

```
void *rb_jt_to_native_handle(VALUE managed);
VALUE rb_jt_from_native_handle(void *native);

SSL_CTX_set_ex_data(ctx, ossl_ssl_ex_ptr_idx, obj);

SSL_CTX_set_ex_data(ctx, ossl_ssl_ex_ptr_idx, rb_jt_to_native_handle(obj));
```

To summarise…

Where to find more info



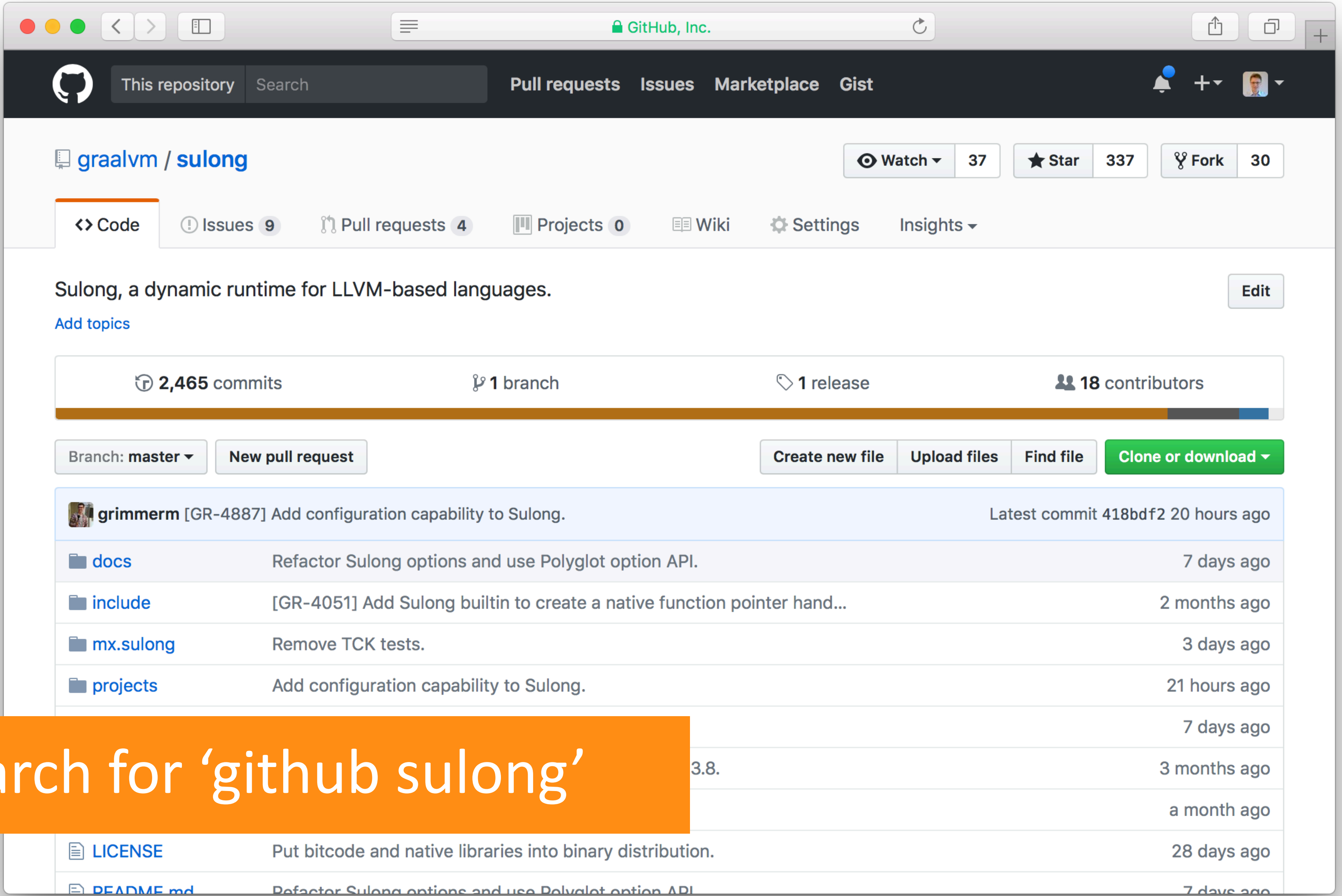
A high performance implementation of the Ruby programming language. Built on the GraalVM by Oracle Labs.

45,023 commits | 12 branches | 14 releases | 321 contributors

pitr-ch committed with chrisseaton Remove Truffle dependency from Main | Latest commit 0a3a5b4 18 hours ago

bench	Remove old references to JRuby+Truffle	23 hours ago
bin	Attempt to quickly transition to the new top-level engine API	4 days ago
doc	Remove the old -Dtruffleruby. system properties for options	2 days ago
lib	Remove old references to JRuby+Truffle	23 hours ago
		4 months ago
	s for options	2 days ago
	s for options	2 days ago
src	Remove Truffle dependency from Main	16 hours ago

Search for ‘github truffleruby’



graalvm / sulong

Sulong, a dynamic runtime for LLVM-based languages.

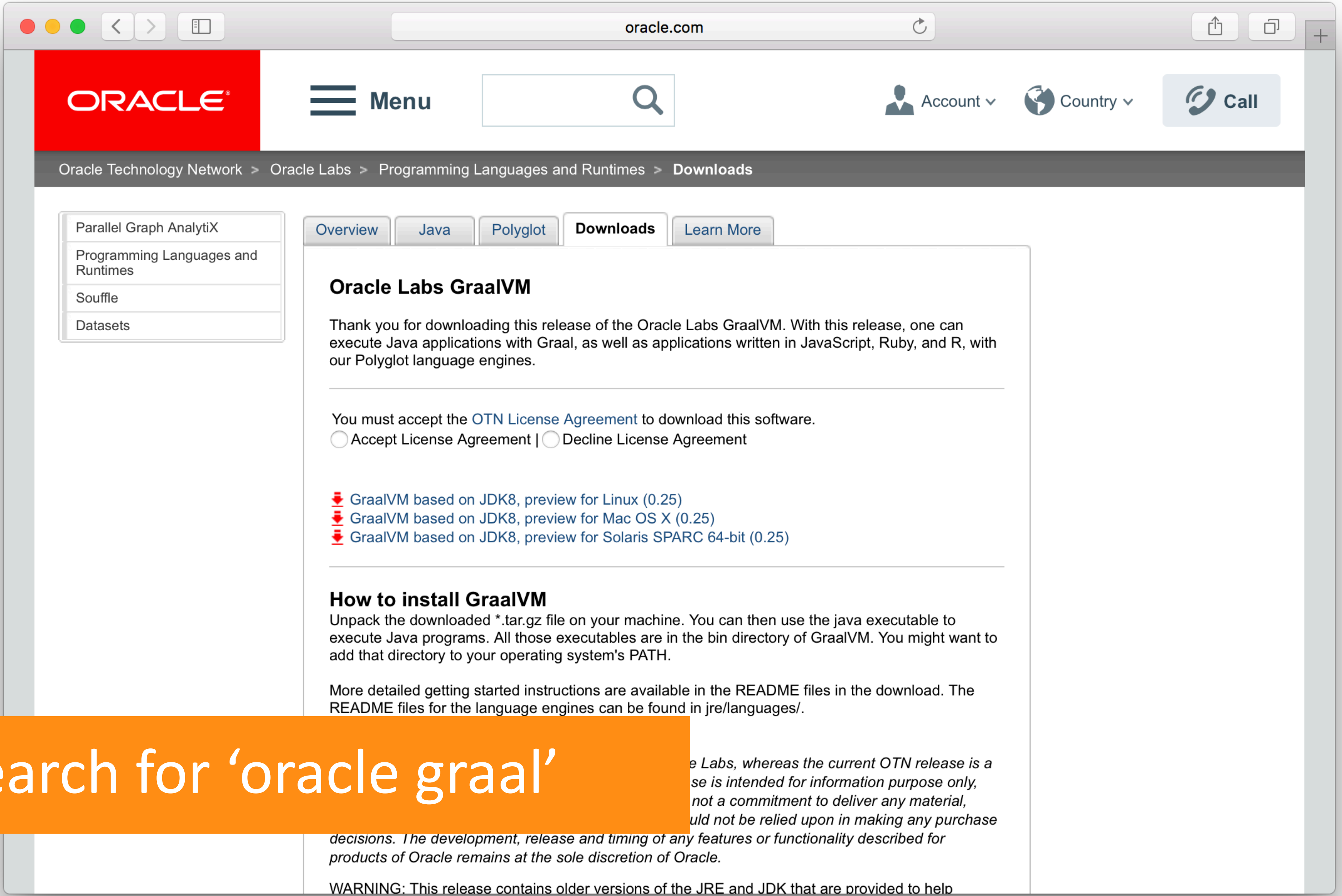
Add topics

2,465 commits | 1 branch | 1 release | 18 contributors

grimmerm [GR-4887] Add configuration capability to Sulong. Latest commit 418bdf2 20 hours ago

docs	Refactor Sulong options and use Polyglot option API.	7 days ago
include	[GR-4051] Add Sulong builtin to create a native function pointer hand…	2 months ago
mx.sulong	Remove TCK tests.	3 days ago
projects	Add configuration capability to Sulong.	21 hours ago
		7 days ago
	3.8.	3 months ago
		a month ago
LICENSE	Put bitcode and native libraries into binary distribution.	28 days ago
README.md	Refactor Sulong options and use Polyglot option API.	7 days ago

Search for ‘github sulong’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Oracle Labs GraalVM

Thank you for downloading this release of the Oracle Labs GraalVM. With this release, one can execute Java applications with Graal, as well as applications written in JavaScript, Ruby, and R, with our Polyglot language engines.

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- GraalVM based on JDK8, preview for Linux (0.25)
- GraalVM based on JDK8, preview for Mac OS X (0.25)
- GraalVM based on JDK8, preview for Solaris SPARC 64-bit (0.25)

How to install GraalVM

Unpack the downloaded *.tar.gz file on your machine. You can then use the java executable to execute Java programs. All those executables are in the bin directory of GraalVM. You might want to add that directory to your operating system's PATH.

More detailed getting started instructions are available in the README files in the download. The README files for the language engines can be found in jre/languages/.

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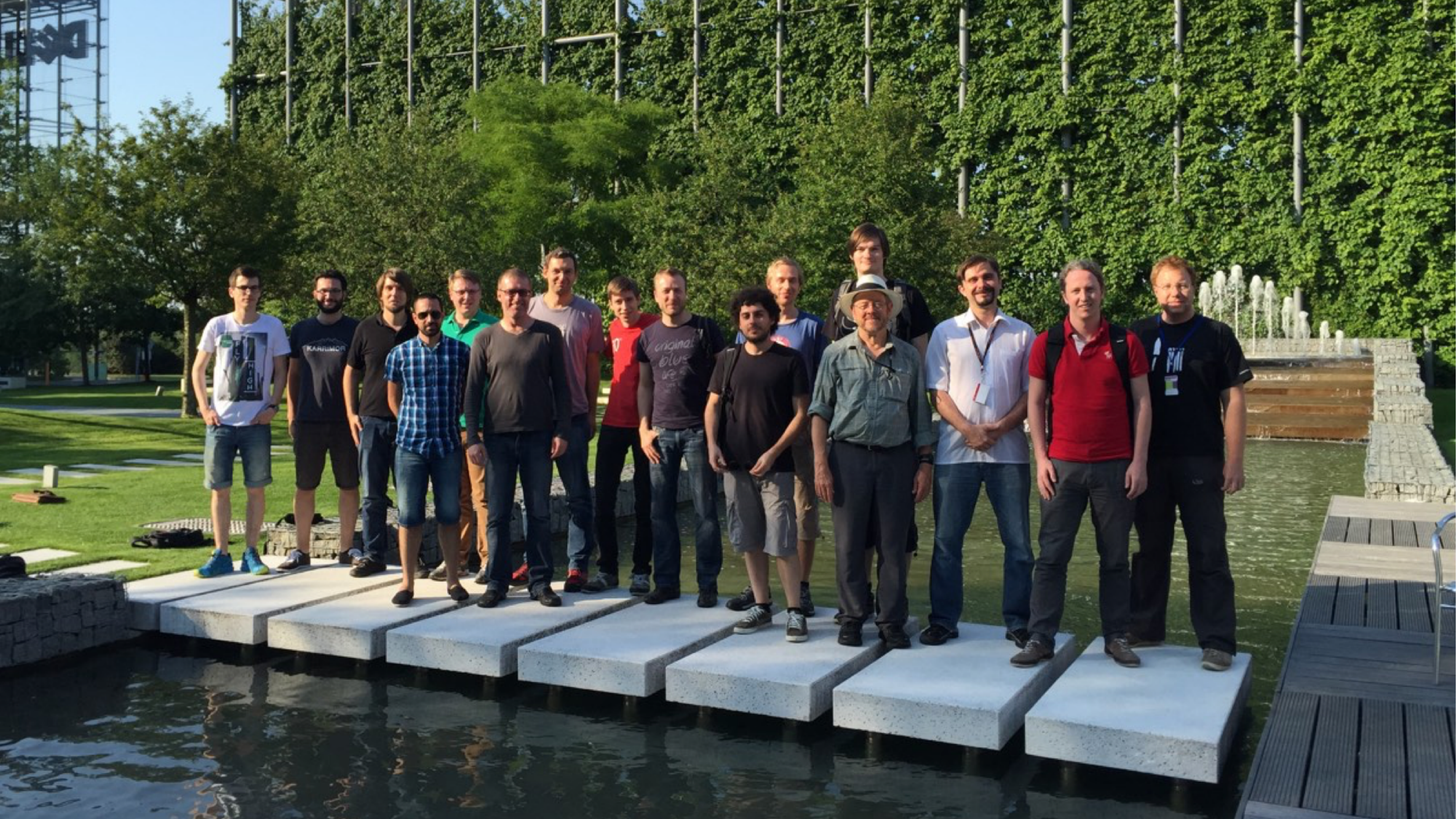
WARNING: This release contains older versions of the JRE and JDK that are provided to help

Search for ‘oracle graal’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Danilo Ansaloni
Stefan Anzinger
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