CRYSTAL
The Programming Language

RUBY EASE; C SPEED

CRYSTAL LANGUAGE

RUBY EASE; C SPEED

▸ Crystal is a programming language that has a Ruby like syntax which is easy to read, clean and concise.

▸ Crystal is Statically typed and Compiled so it's very Efficient and provides C like performance (uses LLVM).

▸ Crystal uses Type Inference, Union Types, Macros, Blocks, Proc's and Closures to give you the feel of an interpreted language but the performance of a natively compiled language.

RUBY EASE

```
5.times do |i|
  puts i
end


puts 5.days - 3.hours


[10, 20, 30].map { |x| x.to_s }


x = -1
puts x.abs


x = "hello"
puts x.size
```

RUBY EASE

```
require "http/server"


server = HTTP::Server.new(8080) do |context|

  context.response.content_type = "text/plain"

  context.response.print "Hello world!"

end


puts "Listening on http://127.0.0.1:8080"

server.listen
```

RUBY EASE

▸ Classes, inheritance, modules, include, extend.

▸ Operator overloading.

▸ String, range, regex literals, heredoc, interpolation

▸ Multi-assignment (x, y = y, x)

▸ Blocks, Proc's and Closures

▸ Big standard library: HTTP, OAuth, JSON, YAML, XML,…

RUBY EASE

```crystal
class Person
  getter name
  property age

  def initialize(@name : String, @age : Int32)
  end
end

person = Person.new("Michael", 35)

person.name #=> "Michael" : String

person.age #=> 35 : Int32

person.age += 1 #=> 36 : Int32

person.name = "Other person" # undefined method 'name=' for Person
```

IN SOME CASES BETTER THAN RUBY

```crystal
# arity and type based method overloading

class Dog
  def greet
    "Woof! Woof!"
  end

  def greet(name : String)
    "Woof #{name}!"
  end

  def greet(times : Int32)
    greet * times
  end
end
```

IN SOME CASES BETTER THAN RUBY

```
# catch errors at compile time

x = nil

5.times do |i|
  puts x * i
end

undefined method '*' for Nil
```

BUILT IN

▸ Package Manager - `crystal deps`

▸ Specs - `crystal spec`

▸ Document Generator - `crystal docs`

▸ Playground - `crystal play`

▸ Code Formatter - `crystal tool format`

▸ Debugging Tools - `crystal tool context …`

C SPEED

▸ Compare Crystal to Top Programming languages on Github

▸ JS, Java, Python, Ruby, PHP, C++, CSS, C#, C, Go

▸ Recursive Fibonacci Sequence (45)

▸ Slowest to Fastest

▸ https://github.com/drujensen/fib

#10 PHP – 6 MINUTES 2 SECONDS

```php
<?php
function fib($n)
{
  if ($n <= 1) {
    return 1;
  } else {
    return fib($n - 1) + fib($n - 2);
  }
}

echo fib(45);
?>

$time php fib.php
1836311903
real 6m2.687s
```

#9 PYTHON – 5 MINUTES 44 SECONDS

```python
def fib(n):
    if n <= 1:
        return 1
    else:
        return fib(n - 1) + fib(n - 2)

print fib(45)


$time python fib.py
1836311903
real 5m44.837s
```

#8 RUBY – 2 MINUTES 4 SECONDS

```ruby
def fib(n)
  if n <= 1
    1
  else
    fib(n – 1) + fib(n – 2)
  end
end

puts fib(45)

$time ruby fib.rb
1836311903
real 2m4.082s
```

#7 NODE – 12.76 SECONDS

```javascript
var fib = function(n) {
  if (n <= 1) {
    return 1;
  } else {
    return fib(n - 1) + fib(n - 2);
  }
};

console.log(fib(45));

$time node fib.js
1836311903
real 0m12.760s
```

#6 C# – 7.166 SECONDS

```csharp
using System;

public class Fib
{
  public static uint fib(uint n)
  {
    if (n <= 1)
    {
        return 1;
    }
    else
    {
        return fib(n - 1) + fib(n - 2);
    }
  }

  static void Main(string[] args)
  {
    Console.WriteLine(fib(45));
  }
}

$mcs fib.cs
$time mono fib.exe
1836311903
real 0m7.166s
```

#5 C – 6.999 SECONDS

```c
#include <stdio.h>

unsigned int fib(unsigned int n)
{
  if (n <= 1) {
    return 1;
  } else {
    return fib(n - 1) + fib(n - 2);
  }
}

int main(void) {
  printf("%d", fib(45));
  return 0;
}

$gcc -o fib fib.c
$time ./fib
1836311903
real 0m6.999s
```

#4 C++ – 6.969 SECONDS

```cpp
#include <iostream>

using namespace std;

int fib(int x) {
    if (x <= 1) {
        return 1;
    } else {
        return fib(x - 1) + fib(x - 2);
    }
}


int main()
{
    cout << fib(45);
}

$g++ -o fib fib.cpp
$time ./fib
1836311903
real 0m6.969s
```

#3 GO – 6.703 SECONDS

```go
package main

import "fmt"

func fib(n uint) uint {
    if n <= 1 {
        return 1
    } else {
        return fib(n - 1) + fib(n - 2)
    }
}

func main() {
    fmt.Println(fib(uint(45)))
}

$go build fib.go
$time ./fib
1836311903
real 0m6.703s
```

#2 JAVA – 4.672 SECONDS

```java
import java.util.*;

public class Fib {
  static int fib(int n) {
    if (n <= 1)
      return 1;
    else
      return fib(n - 1) + fib(n - 2);
  }

  public static void main(String[] args) {
    System.out.print(fib(45));
  }
}

$javac Fib.java
$time java Fib
1836311903
real 0m4.672s
```

#1 CRYSTAL – 3.857 SECONDS

```
def fib(n)
  if n <= 1
    1
  else
    fib(n - 1) + fib(n - 2)
  end
end

puts fib(45)

$crystal build fib.cr -release
$time ./fib
1836311903
real 0m3.857s
```

UNION TYPES

▸ Crystal supports union types.

▸ Unions allow a variable to be multiple types at the same time.

▸ Crystal determines the possible types at compile time using type inference.

▸ You need to cast to the specific type if not duck typed.

UNION TYPES EXAMPLE

```crystal
def double(x : (Int32|String))
  x * 2
end

i = double(3)

puts i

s = double("hi")

puts s
```

TYPE INFERENCE

▸ Crystal is compiled and statically typed but leverages type inference to automatically determine the type during compilation.

▸ This allows the Crystal language to look similar to Ruby and avoid specifying the type for each variable.

▸ Once a type is determined, it sticks. Multiple types can be assigned to a single variable (unions).

▸ Empty Arrays and Hashes require types to be defined.

EXAMPLE TYPE INFERENCE

```crystal
x = rand < 0.5 ? 1 : nil

case x
when Number

  puts x + 1

else

  puts "no x"

end
```

MACROS

▸ There are no dynamic meta-programming methods like method_missing found in Ruby.

▸ Crystal supports macros which can handle some situations similar to meta-programming.

▸ Macros are processed at compile-time but give you access to the AST nodes during compilation.

▸ Excellent for defining your own DSL.

EXAMPLE MACROS

```
macro rock(name)
  def {{name.id}}_rocks
    puts "{{name.id}} Rocks!"
  end
end


rock "crystal"
crystal_rocks
```

EXAMPLE MACROS

```crystal
macro getter(name)
  def {{name.id}}
   @{{name.id}}
  end
end


class Dog
  getter :name
end
```

C LIBRARIES

▸ Crystal makes it simple to map to C libraries

▸ Mapping is as simple as specifying a `lib` and `fun`

▸ Linking is automatic in most cases but you can specify the library `-l` if needed

▸ Other `-ldflags` are easily set as well

C FUN EXAMPLE

```
lib LibMath

  fun nearbyint(x: Float64): Float64

  fun pow(x: Float64, y: Float64): Float64

end



LibMath.nearbyint(3.534) #=> 4.0: Float64

LibMath.pow(2, 10) #=> 1024.0: Float64

#man 3 math
```

CONCURRENCY

▸ Crystal supports fibers using `spawn` and `channels` similar to Goroutines in GoLang.

▸ Fibers are light weight processes that have a very small memory footprint.

▸ Millions of fibers can be launched simultaneously.

▸ The main thread can `receive` results similar to `select` in GoLang.

CONCURRENCY EXAMPLE

```crystal
require "http/client"
channel = Channel(String).new
spawn do
  channel.send(HTTP::Client.get("https://crystal-lang.org").body)
end
spawn do
  channel.send(HTTP::Client.get("https://ruby.org").body)
end
2.times do
  puts channel.receive
end
```

HIGHLIGHTS

▸ Powerful Type Inference and Union Types

▸ Blocks, Proc's and Closures are supported

▸ Functional goodness

▸ Object Oriented goodness

▸ Easily integrates with C libraries using lib and fun

▸ Macros make it easy to create a DSL

▸ Concurrency capabilities similar to GoLang

REFERENCES

▸ crystal-lang.org

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▸ https://citizen428.net/a-rubyist-looks-at-crystal-part-1-86a9284c936e#.u6p9t92av

▸ https://github.com/will/crystal_workbook

▸ https://github.com/crystal-lang/crystal-presents/releases/tag/2016.09-rubyconfbr