

RUST

NON PRENDERE UN GRANCHIO



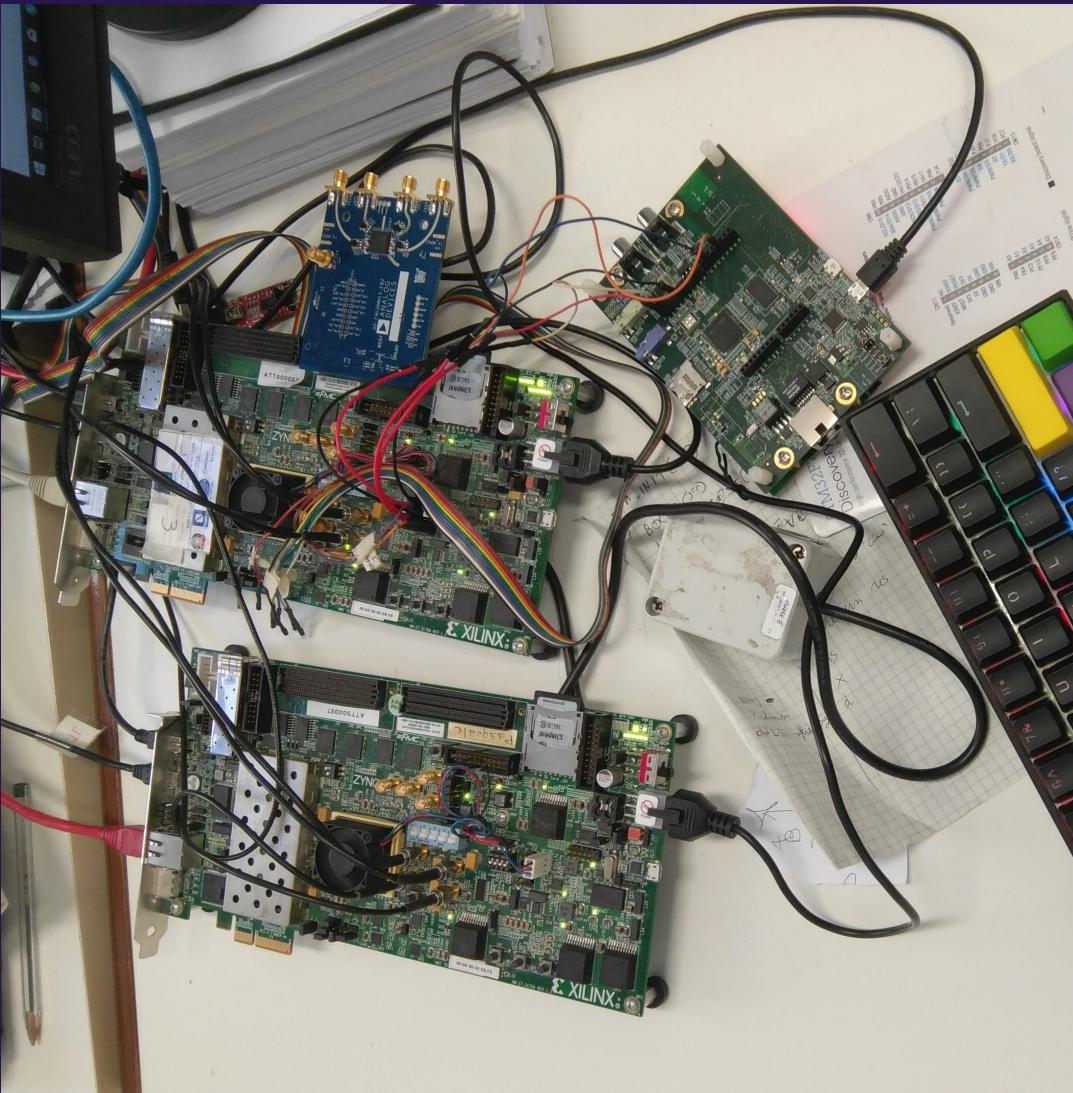
CIAO, SONO MARCO IENI



CHIEDETEMI DI

- Musica 
- Cinema 
- Finanza personale 
- Giochi da tavolo 

SET 2018 - NOV 2020



NOV 2020 - AGO 2022



SET 2022 - IN CORSO



AGENDA

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- Rust non è un toy-language 

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- Rust non è un toy-language 🦀
- Caratteristiche 💪

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- Confronto con altri linguaggi 🤔

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- Svantaggi 🙏

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- Svantaggi 🙅
- Come iniziare 🚀

QUANTO È UTILIZZATO RUST? 🤔

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In May 2022 over 70,000 developers told us how they learn and level up, which tools they're using, and what they want.

STACK OVERFLOW SURVEY



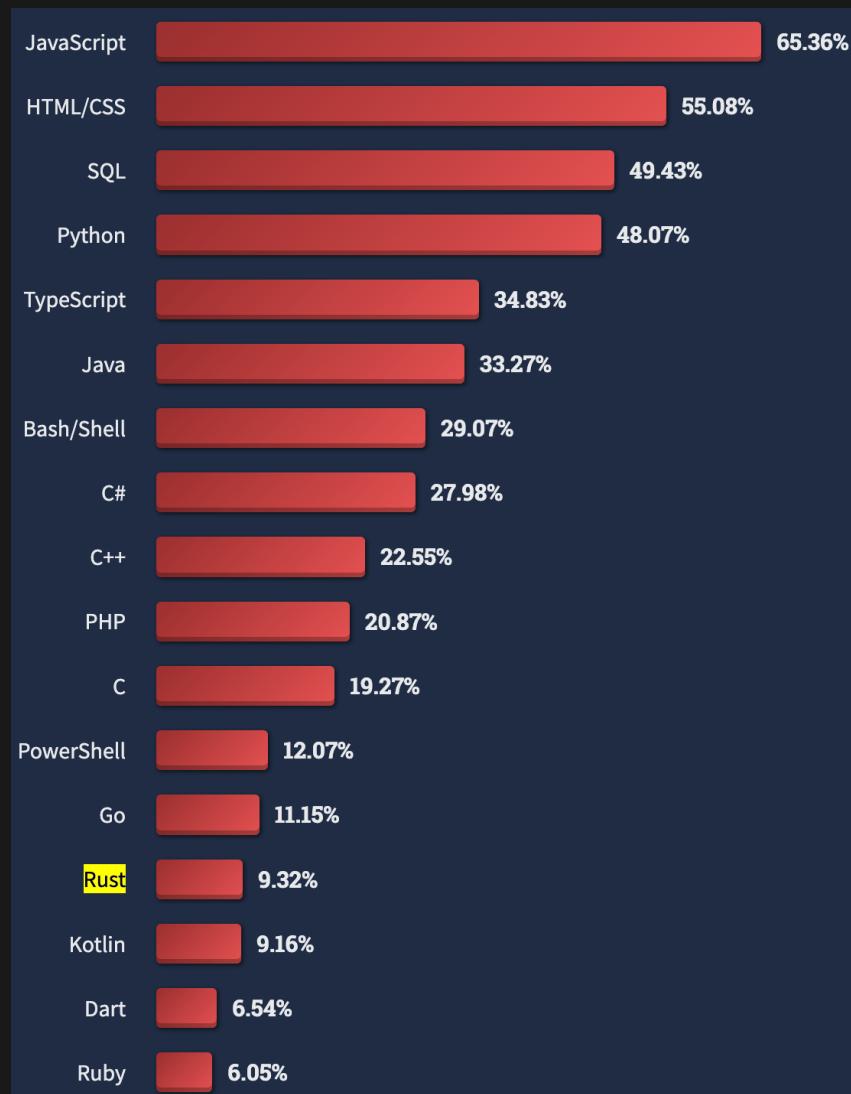
	Worked with in PAST year	Want to work with NEXT year
APL	<input type="checkbox"/>	<input type="checkbox"/>
Assembly	<input type="checkbox"/>	<input type="checkbox"/>
Bash/Shell	<input type="checkbox"/>	<input type="checkbox"/>
C	<input type="checkbox"/>	<input type="checkbox"/>
C#	<input type="checkbox"/>	<input type="checkbox"/>
C++	<input type="checkbox"/>	<input type="checkbox"/>
Clojure	<input type="checkbox"/>	<input type="checkbox"/>

QUANTI HANNO USATO RUST L'ANNO SCORSO? 🤔

Worked with in PAST year



14° LINGUAGGIO PIÙ USATO



QUANTI VOGLIONO USARLO ANCHE L'ANNO PROSSIMO?

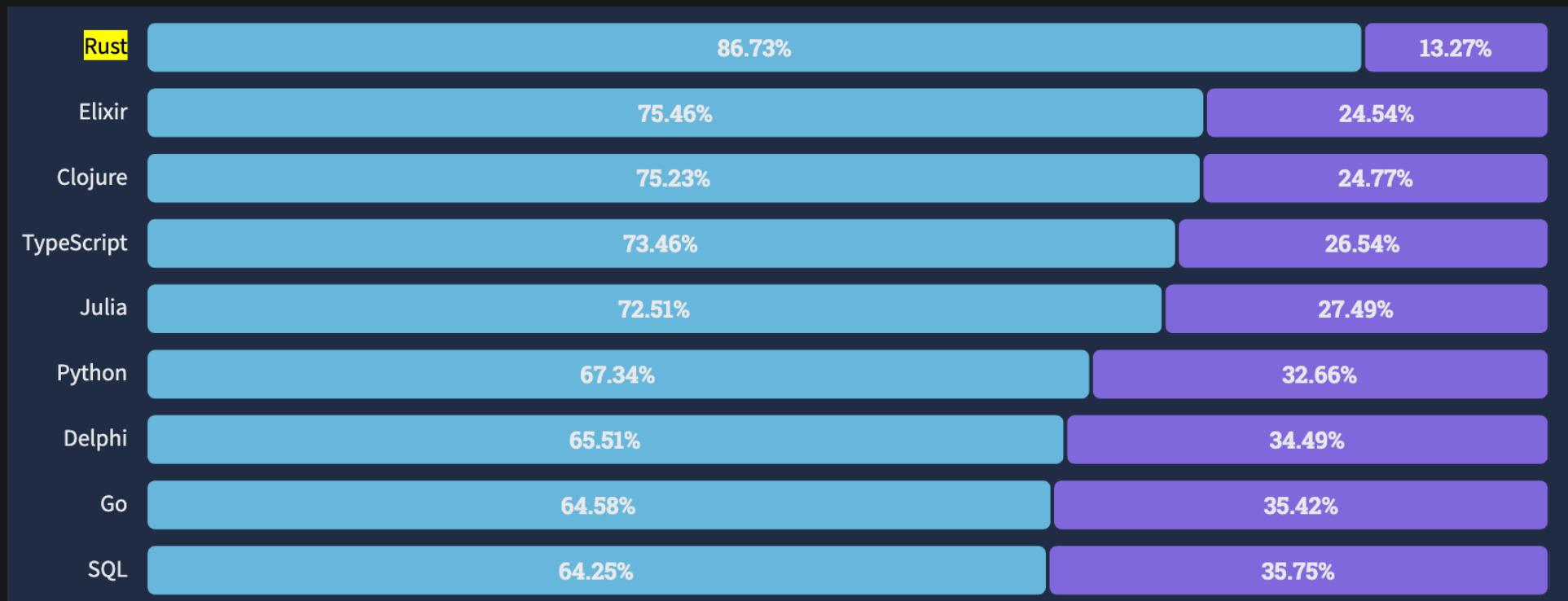
Worked with in PAST year



Want to work with NEXT year



IL PIÙ AMATO DA 7 ANNI ❤



STORIA

- 2006: Progetto personale di Graydon Hoare, impiegato di Mozilla

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- 2009: Mozilla sponsorizza il progetto
- 2015: Prima release stabile (1.0.0)
- 2021: Creazione della Rust Foundation

RUST FUNDATION

- Organizzazione no profit indipendente
- Supporta i maintainers del progetto

RUST FUNDATION: MEMBRI PLATINUM



moz://a

RUST FUNDATION: MEMBRI SILVER



RUST IN PRODUZIONE



- Amazon: Firecracker, S3, EC2
- Dropbox: Storage system
- Google: Fuchsia OS
- Mozilla: Firefox
- Prisma: ORM, microservizi
- Altri su <https://www.rust-lang.org/production/users>

RUST NEL KERNEL LINUX



Torvalds knows that C's subtle type interactions "are not always logical" and "are pitfalls for pretty much anybody".

source: <https://thenewstack.io/linus-torvalds-on-community-rust-and-linuxs-longevity/>

RUST NEL KERNEL LINUX

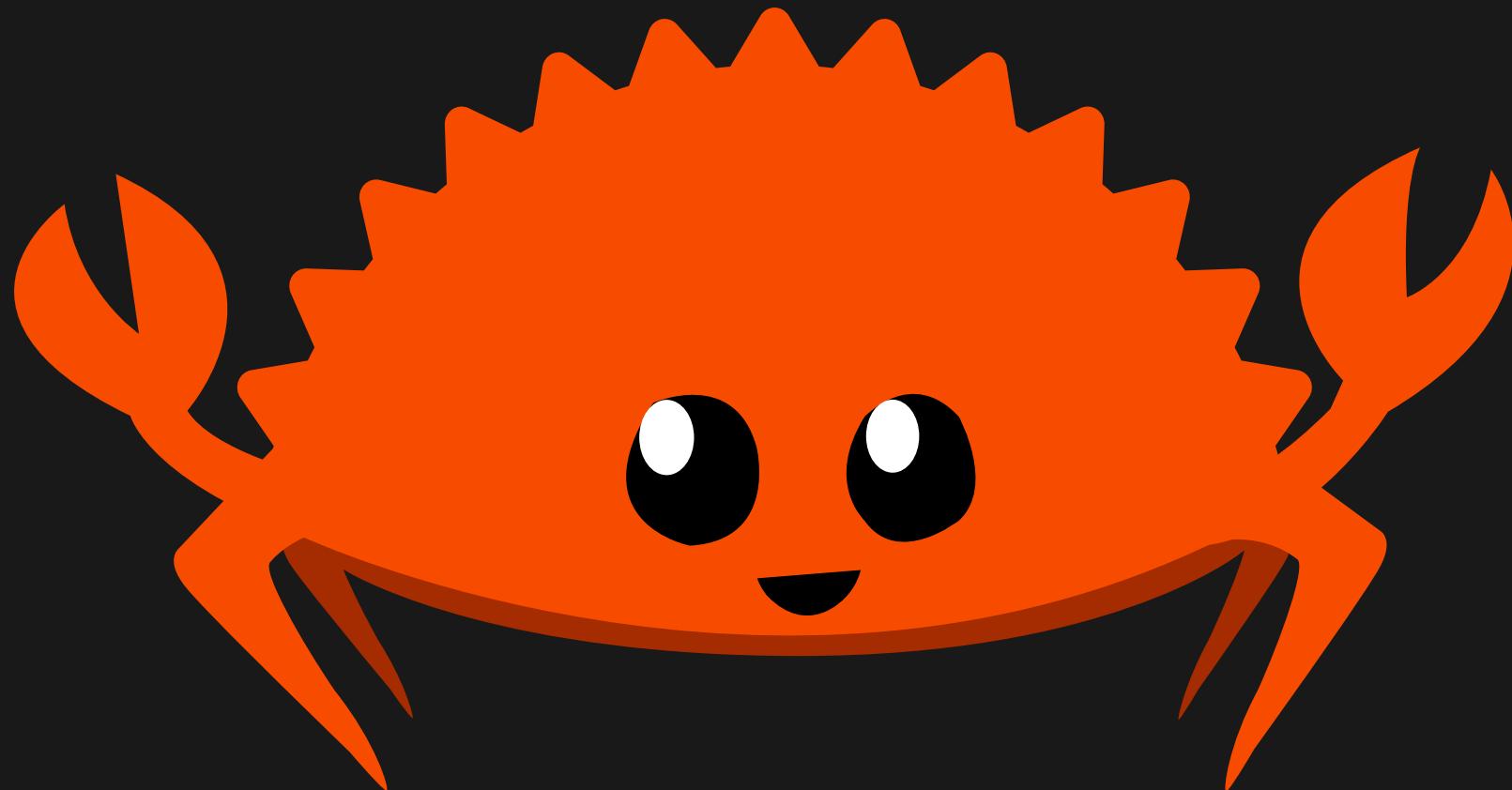


Torvalds knows that C's subtle type interactions "are not always logical" and "are pitfalls for pretty much anybody".

Torvalds called Rust “the first language I saw which looked like this might actually be a solution”

source: <https://thenewstack.io/linus-torvalds-on-community-rust-and-linuxs-longevity/>

RUST È UNA SCELTA VALIDA!



CARATTERISTICHE

- Target di compilazione: assembly

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- Type system statico
 - Usato per rilevare alcuni errori a tempo di compilazione (non a runtime)

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- Target di compilazione: assembly
- Type system statico
 - Usato per rilevare alcuni errori a tempo di compilazione (non a runtime)
- No garbage collector o runtime

CARATTERISTICHE

- Imperativo, ma con caratteristiche funzionali

CARATTERISTICHE

- Imperativo, ma con caratteristiche funzionali



Michele Riva

@MicheleRivaCode

...

Sometimes my JS code is very slow. Then I remove all the map/reduce stuff and convert it to plain imperative code, and the performance gains are incredible

[Traduci il Tweet](#)

11:44 AM · 13 ott 2022 · FeedHive.io

EFFICIENZA ENERGETICA

	Energy
(c) C	1.00
(c) Rust	1.03
(c) C++	1.34
(c) Ada	1.70
(v) Java	1.98
(c) Pascal	2.14
(c) Chapel	2.18
(v) Lisp	2.27
(c) Ocaml	2.40
(c) Fortran	2.52
(c) Swift	2.79
(c) Haskell	3.10
(v) C#	3.14
(c) Go	3.23
(i) Dart	3.83
(v) F#	4.13
(i) JavaScript	4.45
(v) Racket	7.91
(i) TypeScript	21.50
(i) Hack	24.02
(i) PHP	29.30
(v) Erlang	42.23
(i) Lua	45.98
(i) Jruby	46.54
(i) Ruby	69.91
(i) Python	75.88
(i) Perl	79.58

Source: <https://aws.amazon.com/blogsopensource/sustainability-with-rust/>

PRESTAZIONI

- Meno cicli di clock -> termina prima -> meno energia

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- Meno cicli di clock -> termina prima -> meno energia
- Costo del cloud 

RESULTS - LAMBDA 128MB

	Hello World	Palindrome Products 10-99	Palindrome Products 100-999	Palindrome Products 1000-9999
Node 🤖	~200ms			
Node 🔥	2ms	2ms	-500ms	~70s
Rust 🤖	< 20ms			
Rust 🔥	< 1ms	< 1ms	~45ms	~8s

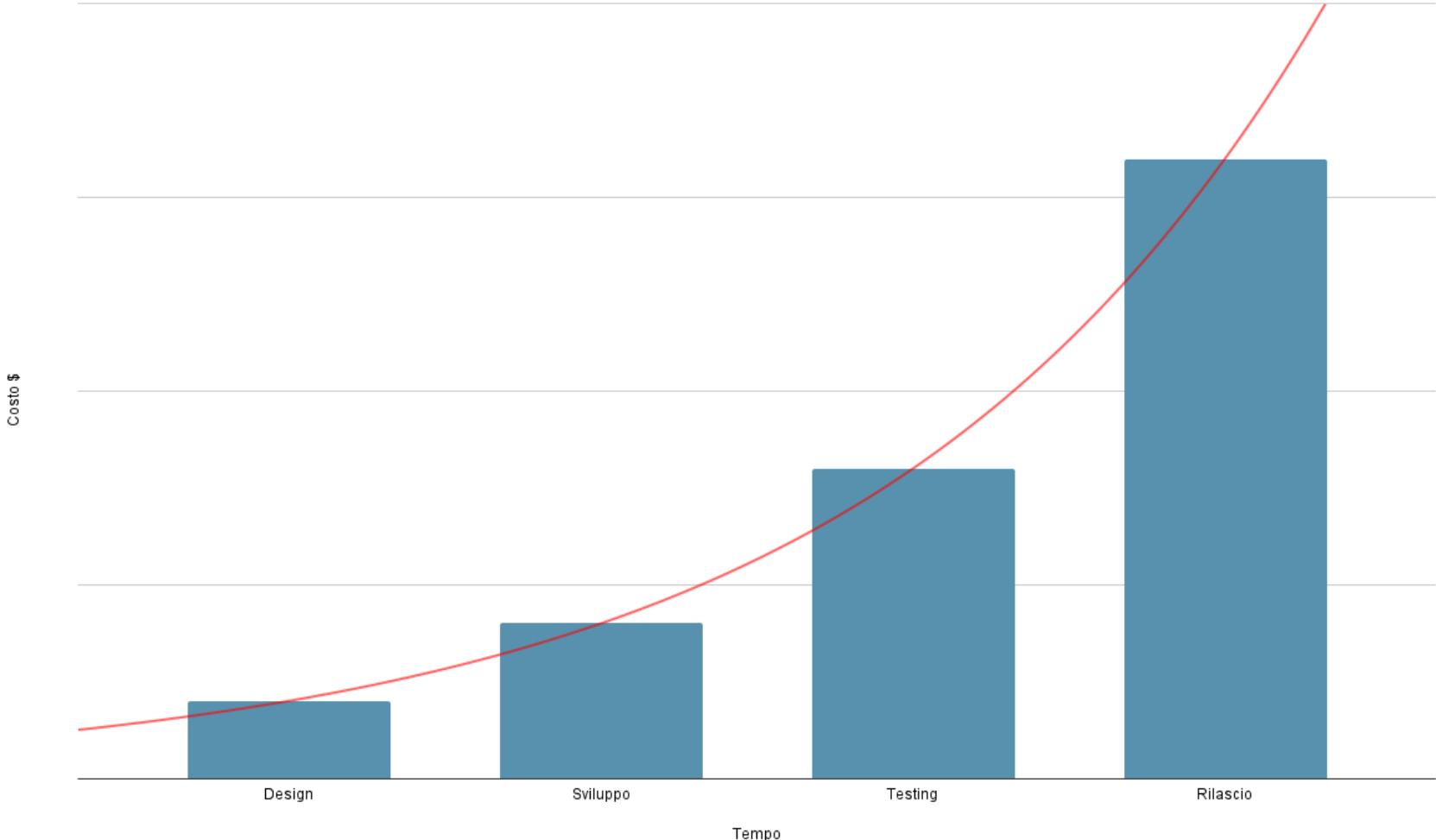
Rust Linz

Rust Linz, July 2021 - Stefan Baumgartner - Serverless Rust

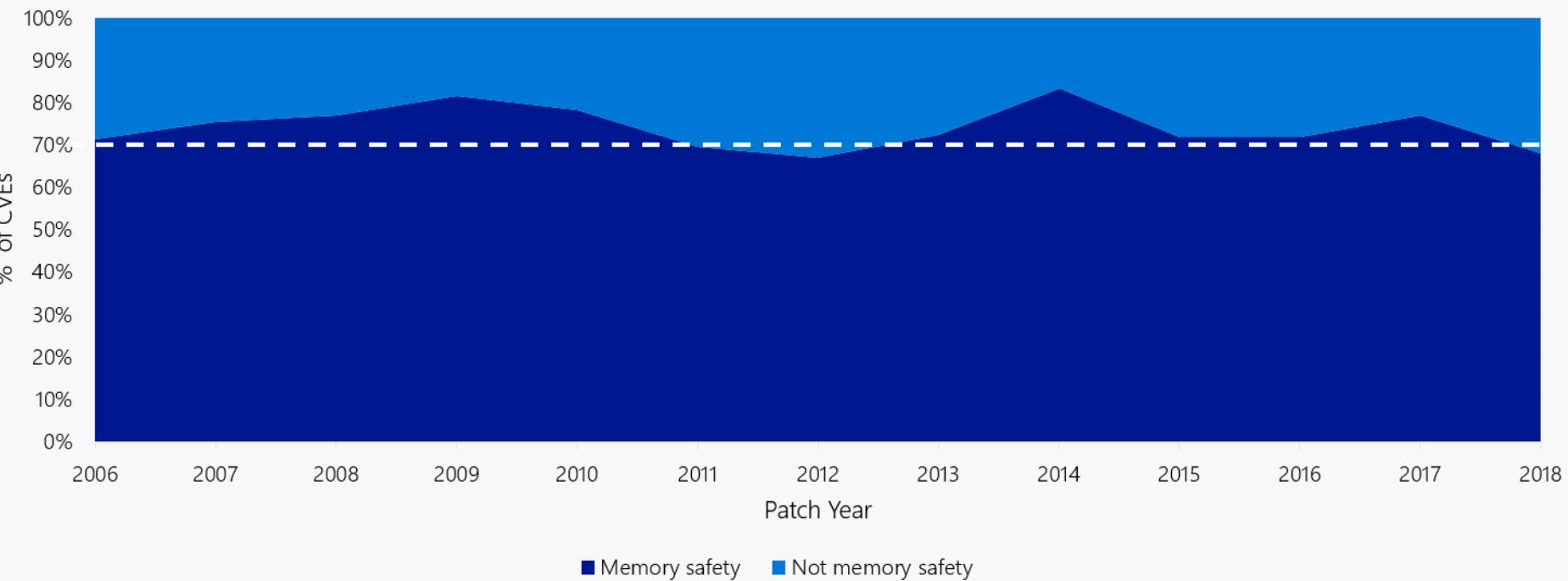
2.523 visualizzazioni • 6 set 2021

like 85 dislike 1 share CONDIVIDI save SALVA ...

COSTO DI UN BUG FIX



VULNERABILITÀ @MICROSOFT



CHI GESTISCE LA MEMORIA?

- C/C++: Lo sviluppatore, manualmente.
- Rust: Il compilatore. (staticamente)
- Altri: Garbage collector. (dinamicamente)

MEMORY SAFETY ERRORS

Access errors (lettura/scrittura invalida di un puntatore):

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- Page fault

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MEMORY SAFETY ERRORS

Access errors (lettura/scrittura invalida di un puntatore):

- Buffer overflow (o over-read)
- Page fault
- Race condition
- Use after free

MEMORY SAFETY ERRORS

Variabili non inizializzate:

Vedi https://en.wikipedia.org/wiki/Memory_safety

MEMORY SAFETY ERRORS

Variabili non inizializzate:

- Null pointer dereference

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Memory leak:

- Double free

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Variabili non inizializzate:

- Null pointer dereference
- Wild pointers

Memory leak:

- Double free
- ...

Vedi https://en.wikipedia.org/wiki/Memory_safety

VEDIAMO UN PO' DI CODICE 😎





BUFFER OVERFLOW



BUFFER OVERFLOW - C/C++

```
1 int main() {
2     int a[2];
3     a[2] = 3;
4     printf("%d", a[2]);
5 }
```

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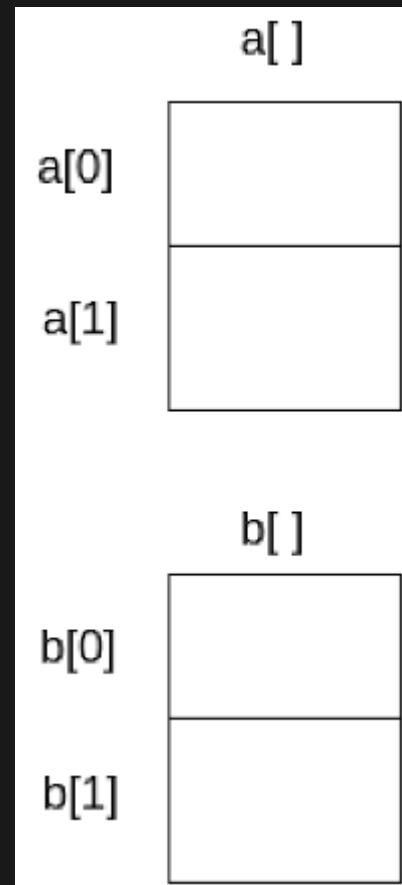
```
*** stack smashing detected ***: terminated
zsh: abort (core dumped) ./a.out
```

BUFFER OVERFLOW - C/C++

```
1 int main() {
2     int a[2];
3     int b[2];
4     a[2] = 3;
5     printf("%d - %d\n", a[2], b[0]);
6 }
```

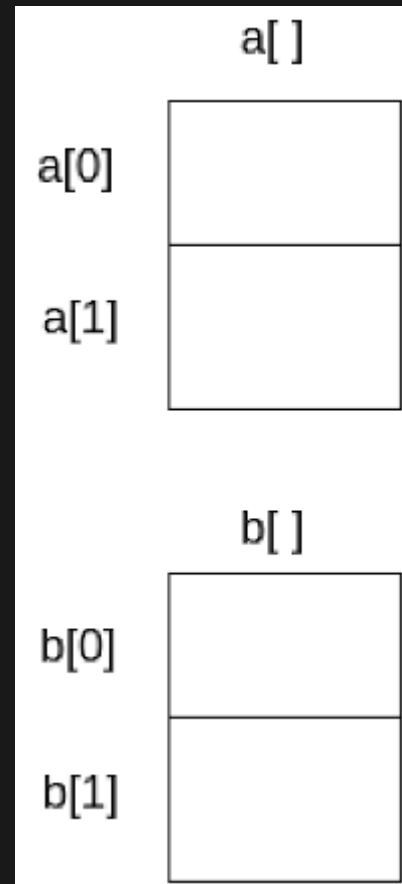
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BUFFER OVERFLOW - C/C++

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5     printf("%d - %d\n", a[2], b[0]);  
6 }
```



3 - 3

BUFFER OVERFLOW - RUST

```
1 fn main() {  
2     let mut arr: [i32; 2] = [0, 0];  
3     arr[2] = 3;  
4 }
```

BUFFER OVERFLOW - RUST

```
1 fn main() {  
2     let mut arr: [i32; 2] = [0, 0];  
3     arr[2] = 3;  
4 }
```

```
error: this operation will panic at runtime  
--> src/main.rs:3:5  
|  
3 |     arr[2] = 3;  
|     ^^^^^^ index out of bounds: the length is 2 but the index is 2  
|= note: `#[deny(unconditional_panic)]` on by default
```

BUFFER OVERFLOW - RUST

```
1 #[allow(unconditional_panic)]
2
3 fn main() {
4     let mut arr: [i32; 2] = [0, 0];
5     arr[2] = 3;
6 }
```

BUFFER OVERFLOW - RUST

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1 #[allow(unconditional_panic)]  
2  
3 fn main() {  
4     let mut arr: [i32; 2] = [0, 0];  
5     arr[2] = 3;  
6 }
```

```
thread 'main' panicked at 'index out of bounds:  
the len is 2 but the index is 2', src/main.rs:5:5
```

BUFFER OVERFLOW



BUFFER OVERFLOW

NULL POINTER



NULL POINTER DEREference - JAVA

```
1 public class MyClass {  
2     static void hello(String name) {  
3         System.out.println("Hello " + name);  
4     }  
5  
6     public static void main(String[ ] args) {  
7         String name = null;  
8         hello(name);  
9     }  
10 }
```

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10 }
```

```
Hello null
```

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9     }  
10 }
```

```
Hello null
```

⌚ MyClass.java ~/me/proj/java-try/src/com/company 1 problem
⚠ Value 'name' is always 'null' :10

NULL POINTER DEREference - JAVA

```
1 public class MyClass {  
2     static void hello(String name) {  
3         System.out.println("Hello " + name);  
4     }  
5  
6     public static void main(String[ ] args) {  
7         Person p = new Person(false);  
8         hello(p.name);  
9     }  
10 }
```

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7         Person p = new Person(false);  
8         hello(p.name);  
9     }  
10 }
```

```
1 public class Person {  
2     public String name;  
3  
4     public Person(boolean isMarco) {  
5         if (isMarco) {  
6             name = "Marco";  
7         }  
8     }  
9 }
```

No problems in MyClass.java

NULL POINTER DEREference - JAVA

```
1 public class MyClass {  
2     static void hello(String name) {  
3         if (name.equals("Marco"))  
4             System.out.println("Hello " + name);  
5     }  
6  
7     public static void main(String[ ] args) {  
8         Person p = new Person(false);  
9         hello(p.name);  
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```

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6  
7     public static void main(String[ ] args) {  
8         Person p = new Person(false);  
9         hello(p.name);  
10    }  
11 }
```

```
Exception in thread "main" java.lang.NullPointerException:  
Cannot invoke "String.equals(Object)" because "name" is null  
at com.company.MyClass.hello(MyClass.java:3)  
at com.company.MyClass.main(MyClass.java:12)
```

NULL POINTER DEREference - RUST

```
1 fn hello(name: &str) {  
2     if name == "Marco" {  
3         println!("Hello {}", name);  
4     }  
5 }  
6  
7 fn main() {  
8     let name = "";  
9     hello(name);  
10 }
```

NULL POINTER DEREference - RUST

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6  
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```

```
enum Option<T> {  
    None,  
    Some(T),  
}
```

NULL POINTER DEREference - RUST

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NULL POINTER DEREference - RUST

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7 fn main() {  
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9     hello(name);  
10 }
```

```
error[E0308]: mismatched types  
--> src/main.rs:9:11  
|  
9 |     hello(name);  
|     ----- ^^^^ expected `&str`, found enum `Option`  
|  
|     arguments to this function are incorrect  
|  
= note: expected reference `&str`  
          found enum `Option<&str>`
```

NULL POINTER DEREference - RUST

```
1 fn hello(name: Option<&str>) {  
2     if name == "Marco" {  
3         println!("Hello {}", name);  
4     }  
5 }  
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NULL POINTER DEREference - RUST

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7 fn main() {  
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9     hello(name);  
10 }
```

```
error[E0308]: mismatched types  
--> src/main.rs:2:16  
|  
2 |     if name == "Marco" {  
|         ^^^^^^^^ expected enum `Option`, found `&str`  
|  
= note:  expected enum `Option<&str>`  
          found reference `&'static str`  
help: try wrapping the expression in `Some`  
|  
2 |     if name == Some("Marco") {  
|         ++++++ +
```

NULL POINTER DEREference - RUST

```
1 fn hello(name: Option<&str>) {  
2     match name {  
3         Some(my_name) => {  
4             if my_name == "Marco" {  
5                 println!("Hello {}", my_name);  
6             }  
7         }  
8         None => {}  
9     }  
10 }  
11  
12 fn main() {  
13     let name: Option<&str> = None;  
14     hello(name);  
15 }
```

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8         None => {}  
9     }  
10 }  
11  
12 fn main() {  
13     let name: Option<&str> = Some("Marco");  
14     hello(name);  
15 }
```

```
$ cargo run
Compiling rust-slides v0.1.0 (/home/marco/tmp/rust-slides)
Finished dev [unoptimized + debuginfo] target(s) in 0.45s
Running `target/debug/rust-slides`
Hello Marco
```

NULL POINTER DEREference - RUST

```
$ cargo clippy
warning: you seem to be trying to use `match` for destructuring a single pattern. Consider using `if let`
--> src/main.rs:2:5
|
2 | /     match name {
3 | |     Some(my_name) => {
4 | |         if my_name == "Marco" {
5 | |             println!("Hello {}", my_name);
...
8 | |     None => {}
9 | |
| |-----^
|
= note: `#[warn(clippy::single_match)]` on by default
= help: for further information visit https://rust-lang.github.io/rust-clippy/master/index.html#single_match
help: try this
|
2 ~     if let Some(my_name) = name {
3 +         if my_name == "Marco" {
4 +             println!("Hello {}", my_name);
5 +         }
6 +     }
|
```

NULL POINTER DEREference - RUST

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9 fn main() {
10    let name: Option<&str> = Some("Marco");
11    hello(name);
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```

BUFFER OVERFLOW

NULL POINTER



BUFFER OVERFLOW

NULL POINTER

RACE CONDITION



RACE CONDITION - PYTHON

```
1 x = 1 # Shared resource
2
3 def increase():
4     global x
5     for n in range(100000):
6         x += 1
7
8 def decrease():
9     global x
10    for n in range(100000):
11        x -= 1
12
13 t1 = Thread(target=increase)
14 t2 = Thread(target=descrease)
15
16 t1.start()
17 t2.start()
18
19 t1.join()
20 t2.join()
21 print(x)
```

RACE CONDITION - PYTHON

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19 t1.join()
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21 print(x)
```

```
$ python3 race.py
83897
```

```
$ python3 race.py
-5491
```

```
$ python3 race.py
92351
```

```
$ python3 race.py
1
```

RACE CONDITION - PYTHON

```
1 x = 1 # Shared resource
2 lock = Lock()
3
4 def increase():
5     global x
6     for n in range(100000):
7         try:
8             lock.acquire()
9             x += 1
10        finally:
11            lock.release()
12
13 def decrease():
14     global x
15     for n in range(100000):
16         try:
17             lock.acquire()
18             x -= 1
19        finally:
20            lock.release()
21 ...
```

RACE CONDITION - PYTHON

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21 ...
```

```
$ python3 race.py
1

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1

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1

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1
```

RACE CONDITION - RUST

```
1 use std::thread;
2
3 fn main() {
4     let mut x: i32 = 1;
5
6     thread::scope(|s| {
7         s.spawn(|| {
8             for _ in 0..100000 {
9                 x += 1;
10            }
11        });
12
13        s.spawn(|| {
14            for _ in 0..100000 {
15                x -= 1;
16            }
17        });
18    });
19    println!("main: {}", x);
20 }
```

```
error[E0499]: cannot borrow `x` as mutable more than once at a time
--> src/main.rs:13:17
|
6 |     thread::scope(|s| {
7 |         - has type `&'1 Scope<'1, '_>`
8 |         s.spawn(|| {
9 |             - first mutable borrow occurs here
10 |             |
11 |             |
12 |             for _ in 0..100000 {
13 |                 x += 1;
14 |                 - first borrow occurs due to use of `x` in closure
15 |             }
16 |         });
17 |         - argument requires that `x` is borrowed for `'1`
18 |
19 |         s.spawn(|| {
20 |             ^^^ second mutable borrow occurs here
21 |             for _ in 0..100000 {
22 |                 x -= 1;
23 |                 - second borrow occurs due to use of `x` in closure
24 |             }
25 |         });
26 |     });
27 | 
```

```
1 use std::thread;
2
3 fn main() {
4     let mut x: i32 = 1;
5
6     thread::scope(| s| {
7         s.spawn(|| {
8             for _ in 0..100000 {
9                 x += 1;
10            }
11        });
12
13        s.spawn(|| {
14            for _ in 0..100000 {
15                x -= 1;
16            }
17        });
18    });
19    println!("main: {}", x);
20 }
```

```
1 use std::sync::Mutex, thread;
2
3 fn main() {
4     let x = Mutex::new(1);
5
6     thread::scope(| s | {
7         s.spawn(|| {
8             for _ in 0..100000 {
9                 let mut num = x.lock().unwrap();
10                *num += 1;
11            }
12        });
13
14        s.spawn(|| {
15            for _ in 0..100000 {
16                let mut num = x.lock().unwrap();
17                *num -= 1;
18            }
19        });
20    });
21    println!("main: {}", x.lock().unwrap());
22 }
```

```
x = 1 # Shared resource
lock = Lock()

def increase():
    global x
    for n in range(100000):
        try:
            lock.acquire()
            x += 1
        finally:
            lock.release()

t1 = Thread(target=increase)
t1.start()
```

```
let x = Mutex::new(1);

thread::scope(|s| {
    s.spawn(|| {
        for _ in 0..100000 {
            let mut num = x.lock().unwrap();
            *num += 1;
        }
    })
})
```


BUFFER OVERFLOW

NULL POINTER

RACE CONDITION



BUFFER OVERFLOW

NULL POINTER

RACE CONDITION

USE AFTER FREE

USE AFTER FREE - C++

```
#include <iostream>
#include <vector>
#include <string>

using namespace std;

int main() {
    cout << "hi there!" << endl;
    vector<string> v;
    v.push_back("Hello");
    string& x = v[0];
    v.push_back("world!");
    cout << x << endl;
}
```

USE AFTER FREE - C++

```
#include <iostream>
#include <vector>
#include <string>

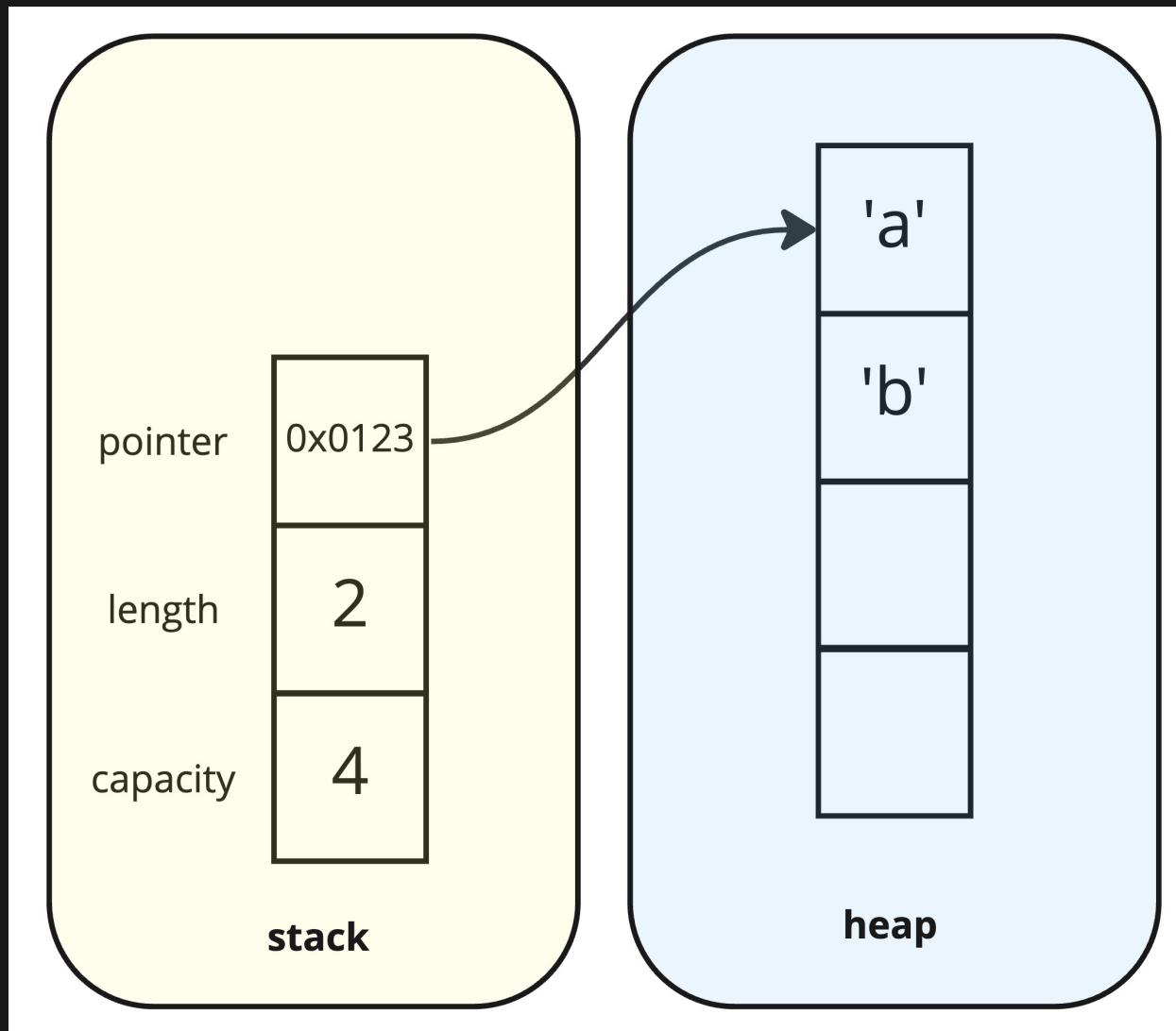
using namespace std;

int main() {
    cout << "hi there!" << endl;
    vector<string> v;
    v.push_back("Hello");
    string& x = v[0];
    v.push_back("world!");
    cout << x << endl;
}
```

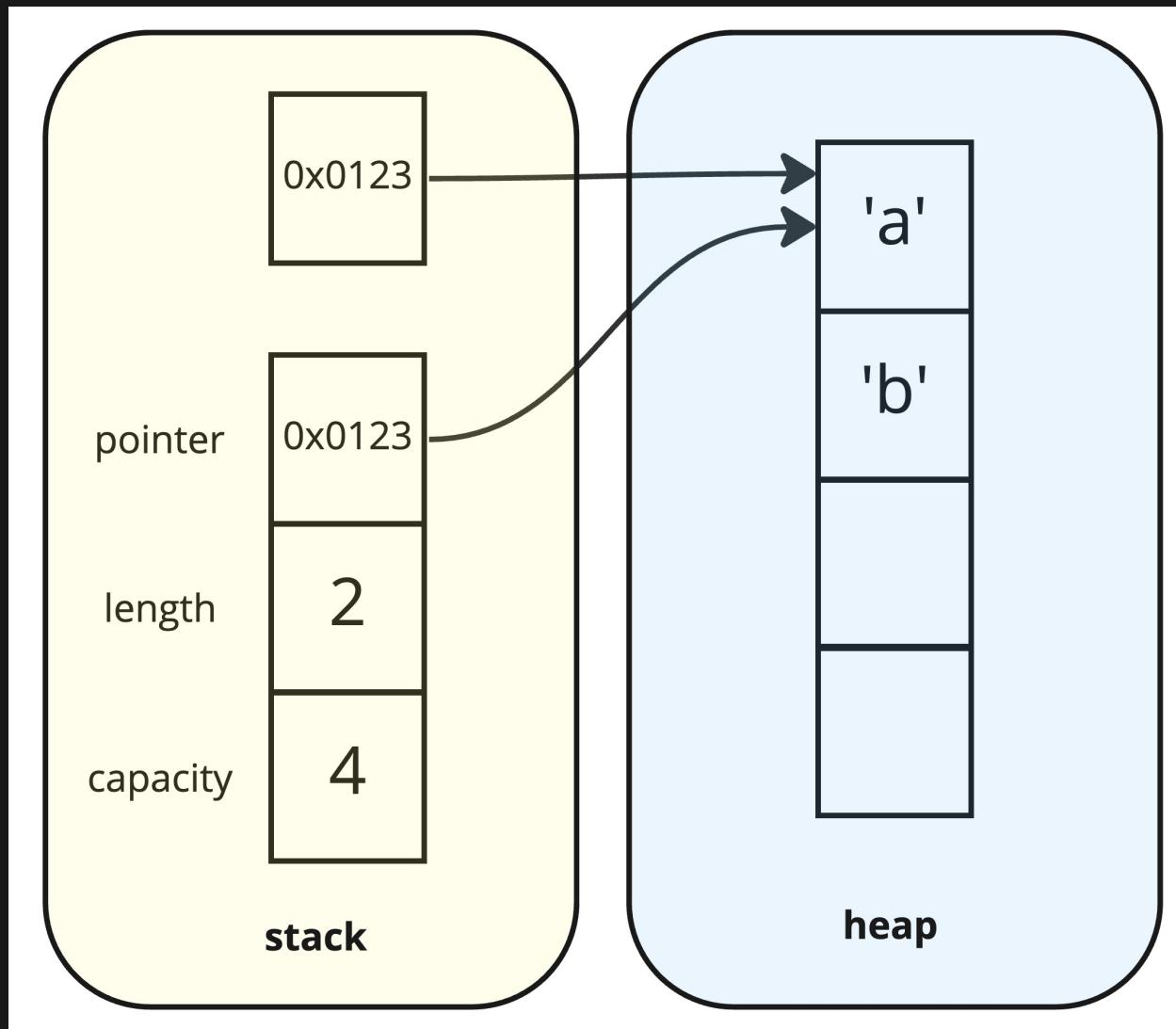
```
$ g++ hello_world.cpp -Wall -Werror
$ ./a.out
hi there!
zsh: segmentation fault (core dumped) ./a.out
```

"If the new size() is greater than capacity() then all iterators and references (including the past-the-end iterator) are invalidated."

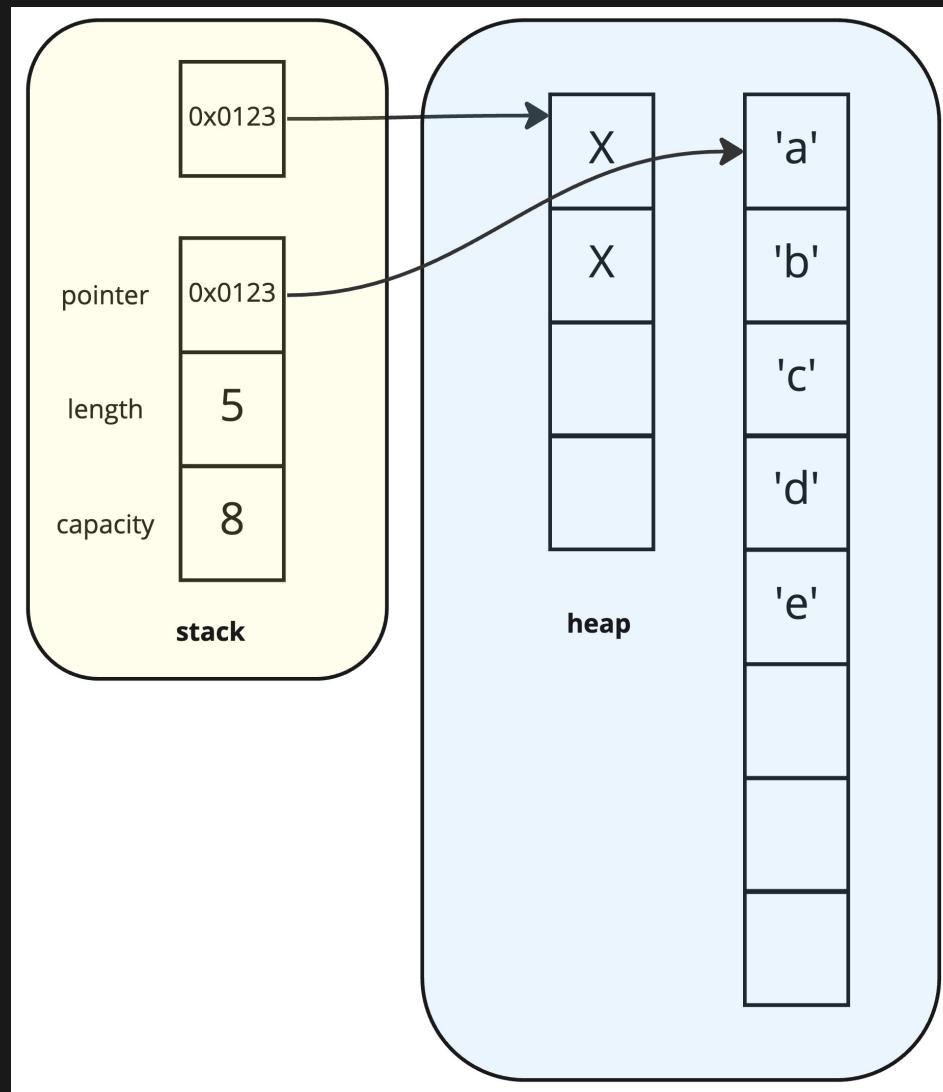
VETTORI IN MEMORIA



VETTORI IN MEMORIA



AGGIUNGIAMO ALTRI ELEMENTI



USE AFTER FREE - RUST

```
fn main() {  
    let mut v = vec![ ];  
    v.push("Hello");  
    let x = &v[0];  
    v.push("world");  
    println!("{}" , x);  
}
```

USE AFTER FREE - RUST

```
fn main() {  
    let mut v = vec![ ];  
    v.push("Hello");  
    let x = &v[0];  
    v.push("world");  
    println!("{}" , x);  
}
```

```
error[E0502]: cannot borrow `v` as mutable because it is also borrowed as immutable  
--> src/main.rs:5:5
```

```
4 |     let x = &v[0];  
   |             - immutable borrow occurs here  
5 |     v.push("world");  
   | ^^^^^^^^^^^^^^^^^^ mutable borrow occurs here  
6 |     println!("{}" , x);  
   |             - immutable borrow later used here
```

BUFFER OVERFLOW

NULL POINTER

RACE CONDITION

USE AFTER FREE

**BUFFER
OVERFLOW**

**NULL
POINTER**

**USE
AFTER FREE**

**RACE
CONDITION**

**UNHANDLED
EXCEPTION**

ERROR HANDLING

- In rust non esistono le eccezioni.
- Esempio: voglio mettere il contenuto di un file in una stringa

ERRORE A RUNTIME - KOTLIN



```
import java.io.File
import java.io.InputStream
import java.nio.charset.Charset

fun main(args: Array<String>) {
    val file = File("content.txt")
    val ins: InputStream = file.inputStream()
    val content: String =
        ins.readBytes().toString(Charset.defaultCharset())
    println(content)
}
```

ERRORE A RUNTIME - KOTLIN

```
import java.io.File
import java.io.InputStream
import java.nio.charset.Charset

fun main(args: Array<String>) {
    val file = File("content.txt")
    val ins: InputStream = file.inputStream()
    val content: String =
        ins.readBytes().toString(Charset.defaultCharset())
    println(content)
}
```

```
Exception in thread "main" java.io.FileNotFoundException: content.txt (No such file or directory)
at java.base/java.io.FileInputStream.open0(Native Method)
at java.base/java.io.FileInputStream.open(FileInputStream.java:211)
at java.base/java.io.FileInputStream.<init>(FileInputStream.java:153)
at MainKt.main(Main.kt:7)
```

ERROR HANDLING - RUST

```
1 enum Result<T, E> {
2     Ok(T),
3     Err(E),
4 }
```

ERROR HANDLING - RUST

```
1 enum Result<T, E> {
2     Ok(T),
3     Err(E),
4 }
```

```
1 use std::fs::read_to_string;
2
3 fn main() {
4     let content_res = read_to_string("content.txt");
5     match content_res {
6         Ok(content) => println!("{}" , content),
7         Err(e) => println!("error occurred: {}" , e),
8     }
9 }
```

ERROR HANDLING - RUST

```
1 use std::fs::read_to_string;
2
3 fn main() {
4     let content_res = read_to_string("content.txt");
5     match content_res {
6         Ok(content) => println!("{}" , content),
7         Err(e) => match e.kind() {
8             std::io::ErrorKind::NotFound =>
9                 println!("file not found"),
10            std::io::ErrorKind::PermissionDenied =>
11                println!("no permission"),
12                _ => println!("error occurred: {}" , e),
13        },
14    }
15 }
```

BAD ERROR HANDLING - RUST

```
1 use std::fs::read_to_string;
2
3 fn main() {
4     let content = read_to_string("content.txt").unwrap();
5     println!("{}", content);
6 }
```

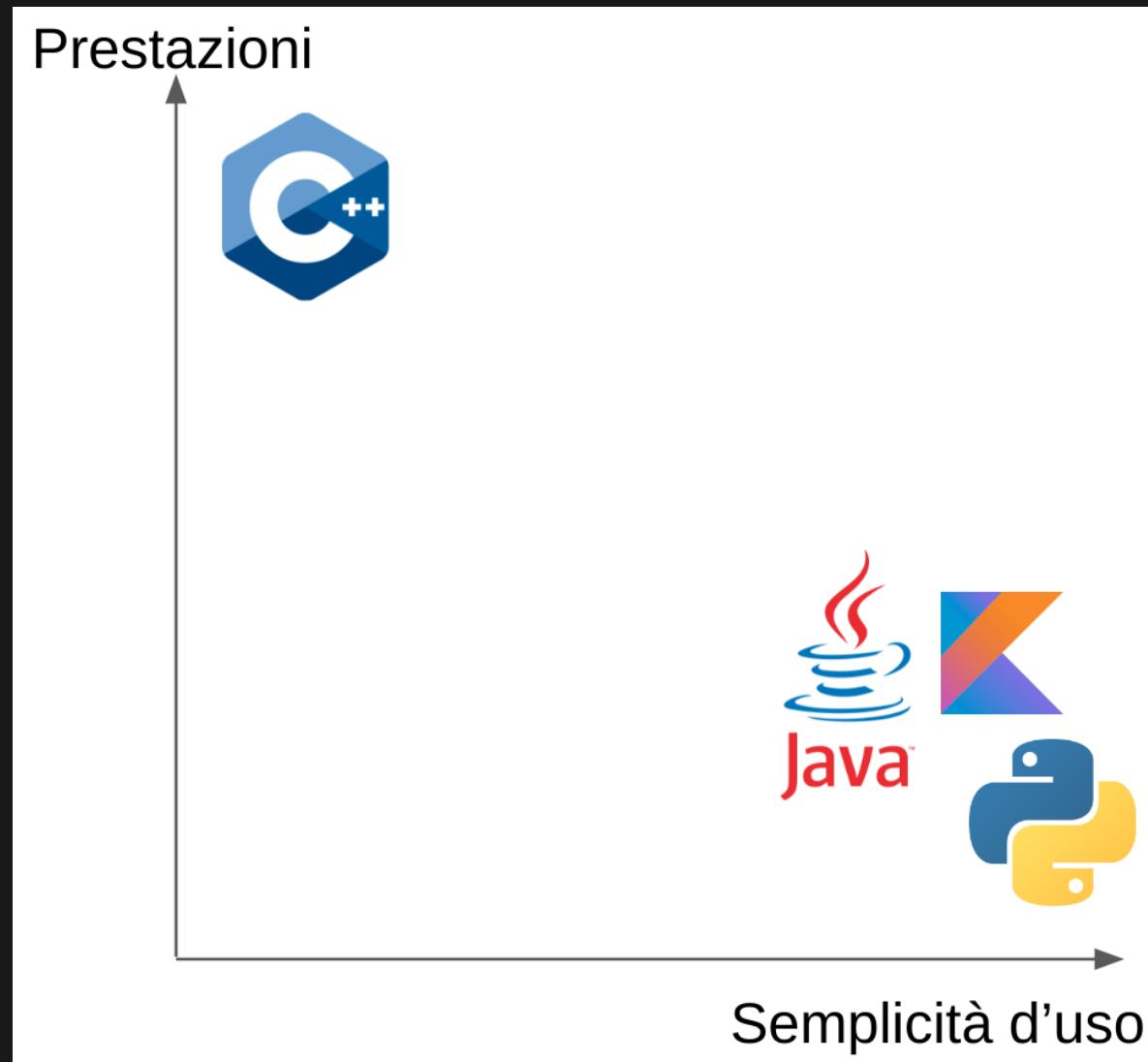
BAD ERROR HANDLING - RUST

```
1 use std::fs::read_to_string;  
2  
3 fn main() {  
4     let content = read_to_string("content.txt").unwrap();  
5     println!("{}", content);  
6 }
```

```
thread 'main' panicked at 'called `Result::unwrap()` on an  
`Err` value: Os { code: 2, kind: NotFound, message:  
"No such file or directory" }', src/main.rs:4:49
```



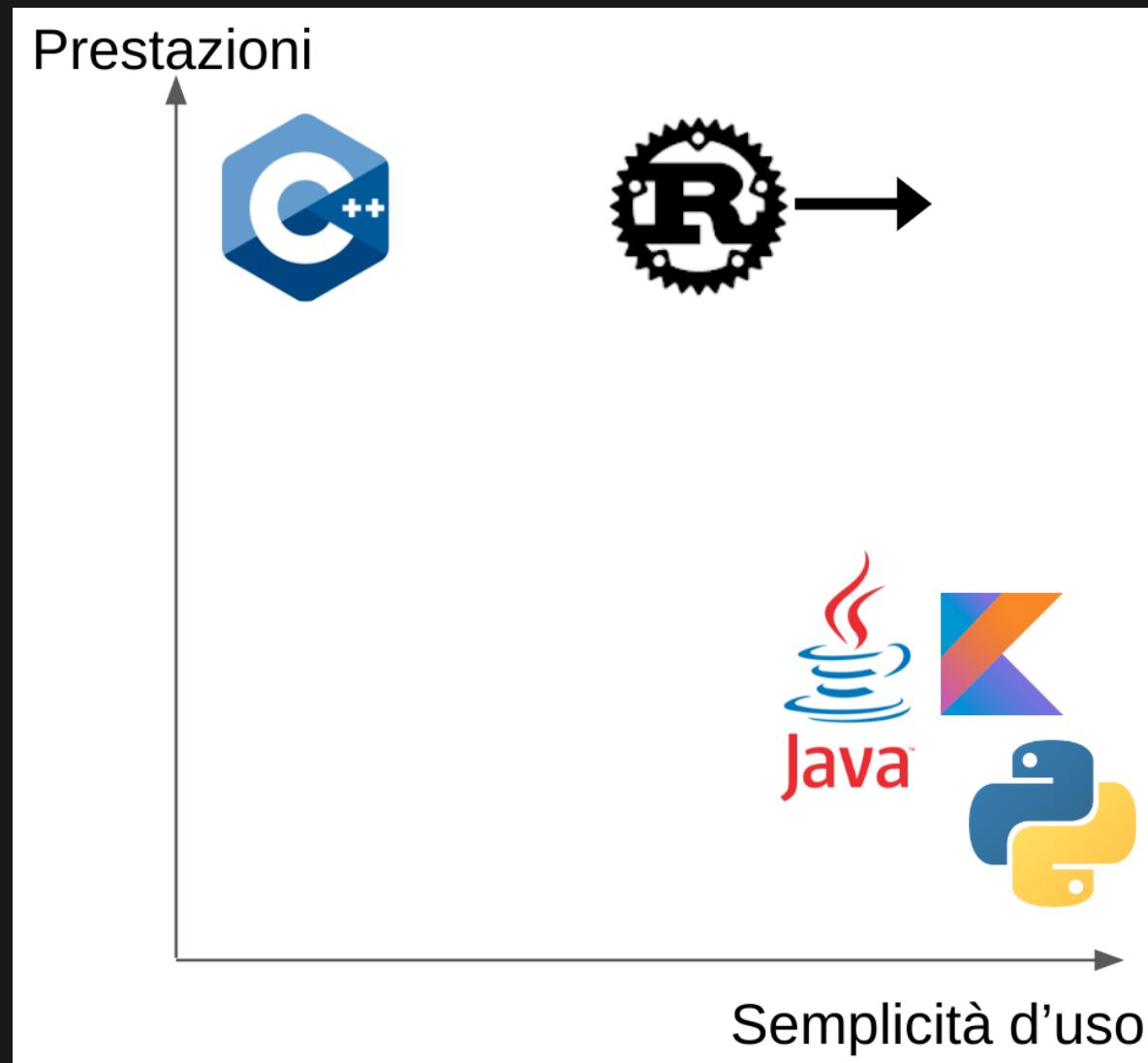
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Rust in Italy
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INIZIO? 

<https://www.rust-lang.org/it/learn>

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