Rust : Performance **et** Sécurité

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Checks à la compilation ou à l'exécution ?

Exemple : type checking

basic.py

```python
from sys import argv, exit, stderr

try:
    arg = int(argv[1])
except (IndexError, ValueError):
    print(
        "Usage: {} <number>"
        .format(argv[0]),
        file=stderr,
    )
    exit(1)

if arg != 42:
    print("This is not a very interesting number...")
else:
    print("The answer is indeed " + arg + "!")
```

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$ python3 basic.py 27
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$ python3 basic.py 27
This is not a very interesting number...


$ python3 basic.py 42
Traceback (most recent call last):
  File "basic.py", line 16, in <module>
    print("The answer is indeed " + arg + "!")
TypeError: Can't convert 'int' object to str implicitly
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Traceback (most recent call last):
  File "basic.py", line 16, in <module>
    print("The answer is indeed " + arg + "!")
TypeError: Can't convert 'int' object to str implicitly


$ python3 -m mypy basic.py  # (no input number)
basic.py:16: error: Unsupported operand types for + ...
```

Exemple : type checking en Rust

basic.rs

```rust
use ::std::env::args;

fn main ()
{
    let arg: String =
        args()
            // impl Iterator<Item = String>
            .nth(1)
            // Option<String>
            .expect("Missing parameter `<number>`")
            // String
    ;
    if arg != 42 {
        println!("This is not a very interesting number...");
    } else {
        println!("The answer is indeed {}!", arg);
    }
}
```

Exemple : type checking en Rust

cargo check

```
user@DESKTOP-DHB5CKG:~/Documents/git/presentation/example$ cargo check
    Checking example v0.1.0 (/mnt/c/Users/CakeIsAPie/Documents/git/presentation/example)
error[E0277]: can't compare `std::string::String` with `{integer}`
  --> src/main.rs:13:12
   |
13 |     if arg != 42 {
   |            ^^ no implementation for `std::string::String == {integer}`
   |
   = help: the trait `std::cmp::PartialEq<{integer}>` is not implemented for `std::string::String`

error: aborting due to previous error

For more information about this error, try `rustc --explain E0277`.
error: Could not compile `example`.

To learn more, run the command again with --verbose.
```

- Playground

C'est tout ?

Et encore plus de checks !

L'analyse statique de Rust peut faire bien plus que juste du "type checking" :

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  - ↪ Plusieurs threads : "Fearless Concurrency"

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- Empêche les *Data races*
  - ↪ Plusieurs threads : "Fearless Concurrency"
  - ↪ Un seul thread : plus de *dangling pointer* (par exemple : plus d'invalidation d'itérateur)

Data races en environnement multithreadé

Data races en environnement multithreadé : Python

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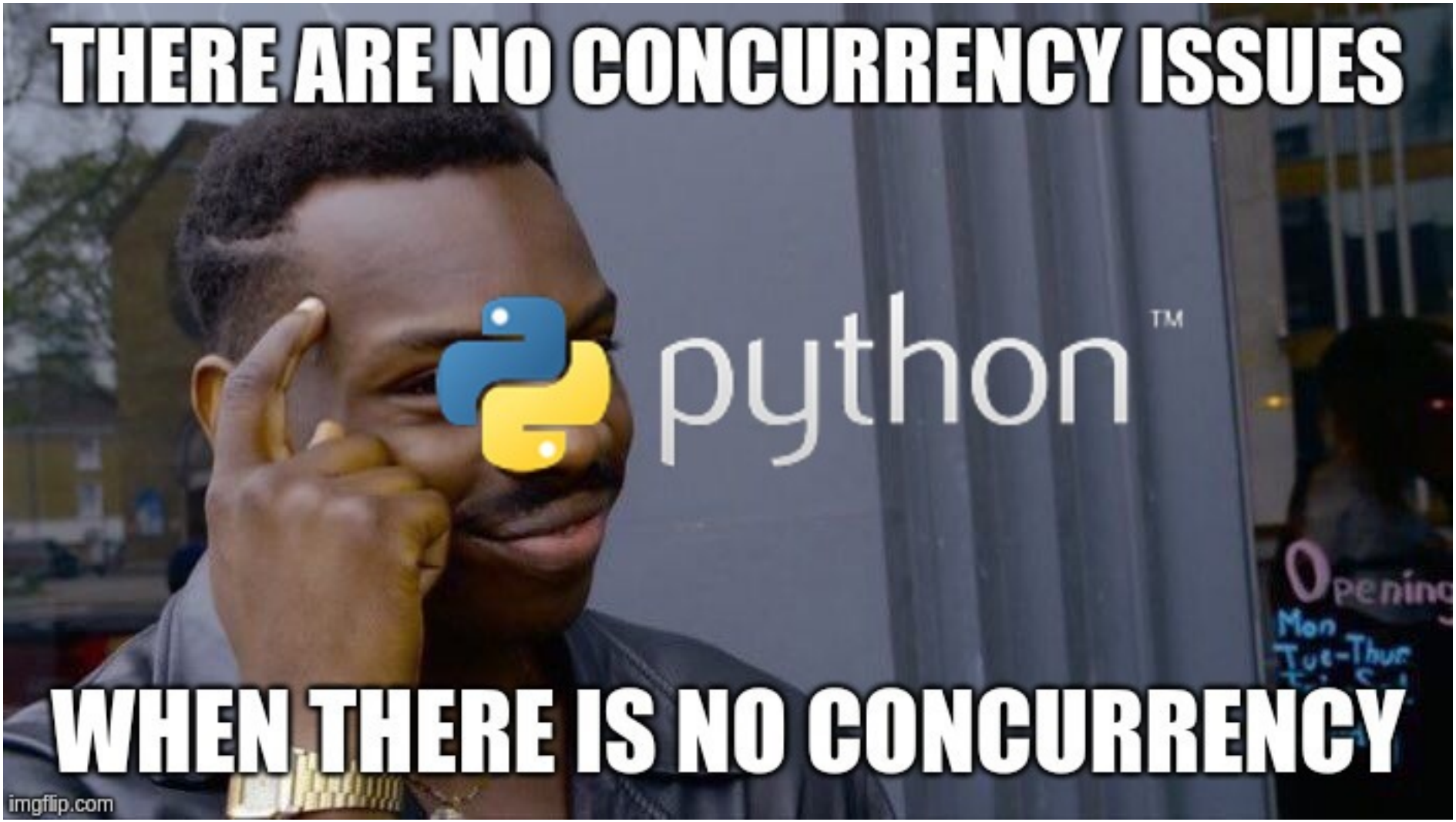

Data races en environnement multithreadé : C

data-race.c

```c
void increment (int * at_x) {
    for (size_t i = 0; i < N; ++i) {
        *at_x += 1;
    }
}
int main (void) {
    int x = 0;
    pthread_t other_thread;
    // spawn a new thread that calls increment(&x)
    if (pthread_create(&other_thread, NULL, increment, &x) != 0)
        exit(EXIT_FAILURE);
    increment(&x);
```

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    // spawn a new thread that calls increment(&x)
    if (pthread_create(&other_thread, NULL, increment, &x) != 0)
        exit(EXIT_FAILURE);
    increment(&x);

    // wait for the other_thread to finish too
    pthread_join(other_thread, NULL);
    printf("x = %d (%.1f%% of expected value)\n",
            x, ((double) x) * 50. / ((double) N));
    return EXIT_SUCCESS;
}
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    printf("x = %d (%.1f%% of expected value)\n",
            x, ((double) x) * 50. / ((double) N));
    return EXIT_SUCCESS;
}
// x = 5488566 (54.9% of expected value)
```

Data races en environnement multithreadé : Rust

data-race.rs

```rust
const N: usize = 50_000_000;

fn increment (at_x: &mut i32) {
    for i in 0 .. N {
        *at_x += 1;
    }
}

fn main () {
    let mut x: i32 = 0;
    ::crossbeam::scope(|scope| {
        scope.spawn(|_| increment(&mut x));
        scope.spawn(|_| increment(&mut x));
    }) // wait for all threads to finish
      .expect("Some thread panicked.");
    println!("x = {}", x);
}
```

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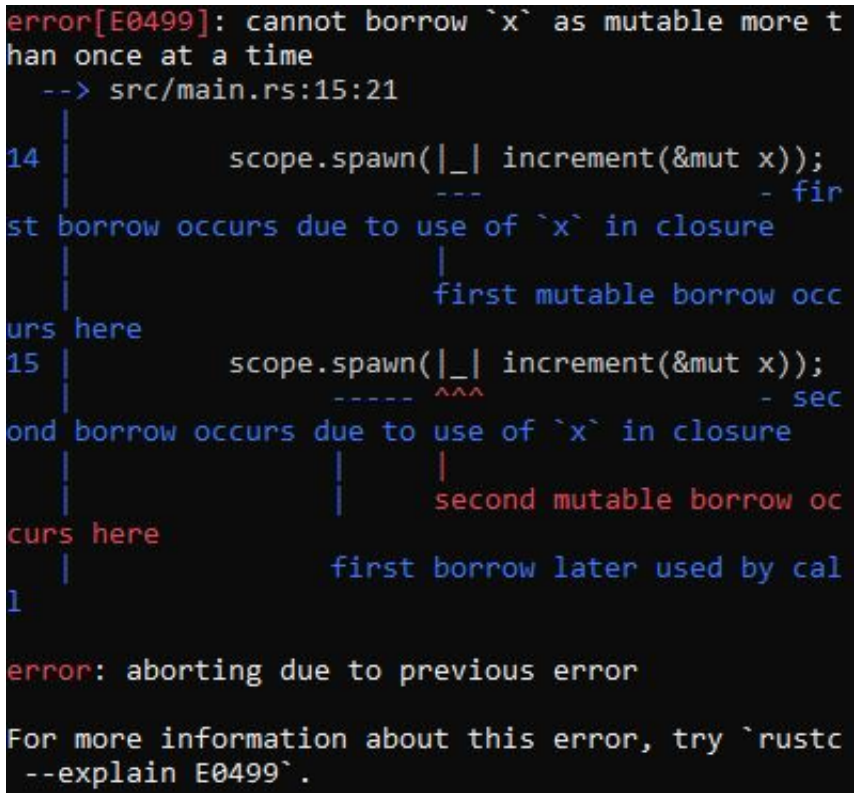
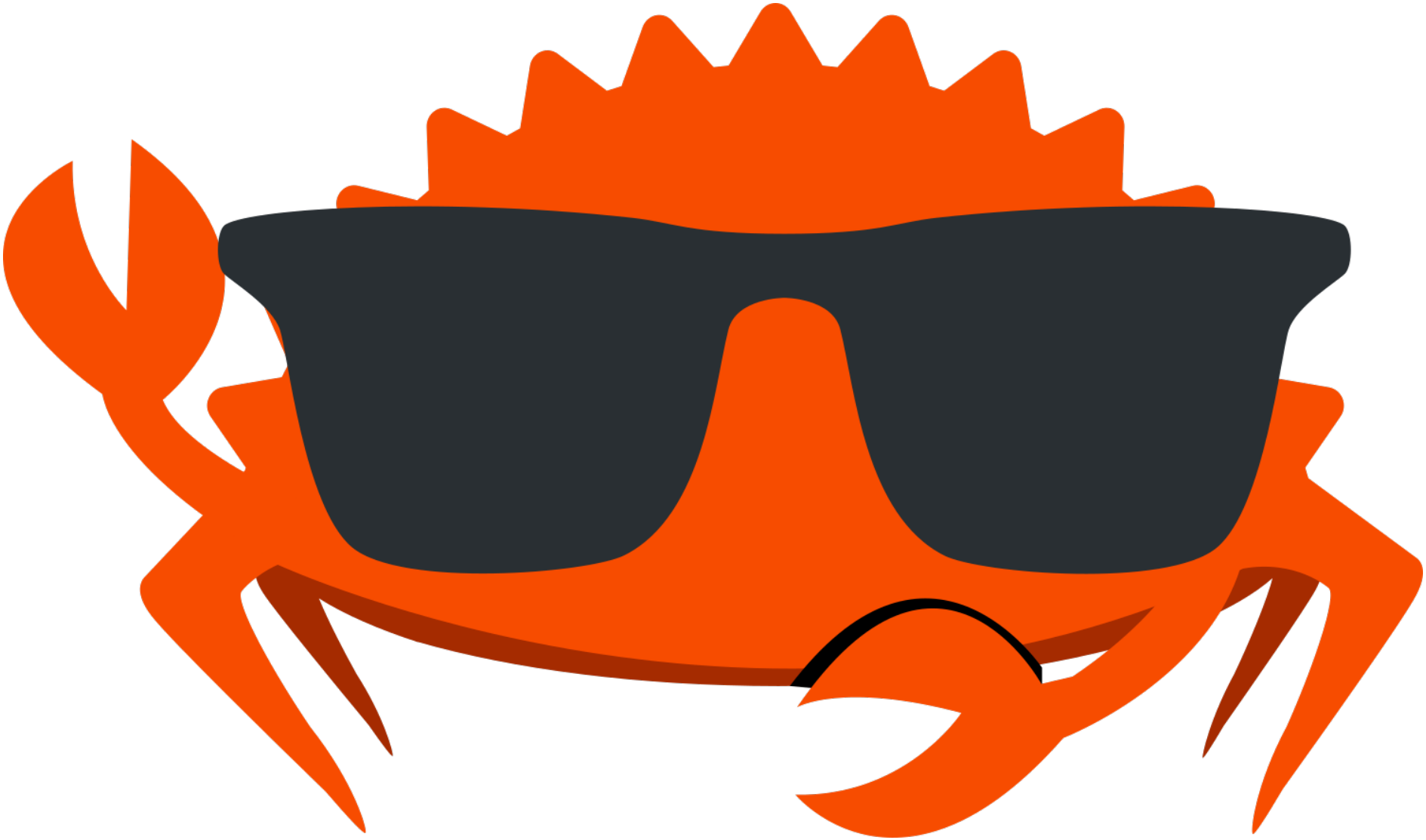
```

$ cargo check



- Playground

Data races en environnement multithreadé : Rust



by TheZoq2

Data races en environnement multithreadé : Rust

no-data-race.rs

```rust
fn increment (at_x: & AtomicCell<i32>) {
    for i in 0 .. N {
        at_x.fetch_add(1);
    }
}

fn main () {
    let x = <AtomicCell<i32>>::new(0);
    ::crossbeam::scope(|scope| {
        scope.spawn(|_| increment(& x));
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    }) // wait for all threads to finish
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    println!("x = {}", x.load());
}
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Nul besoin de parallélisme pour avoir des "data races"

C++ : Dangling pointer

dangling-pointer.cpp

```cpp
#include <iostream>
#include <vector>
using namespace std;

int main ()
{
    vector<int> vector(1);
    int * at_first = &vector[0];
    vector.push_back(42);
    cout << *at_first;
}
```

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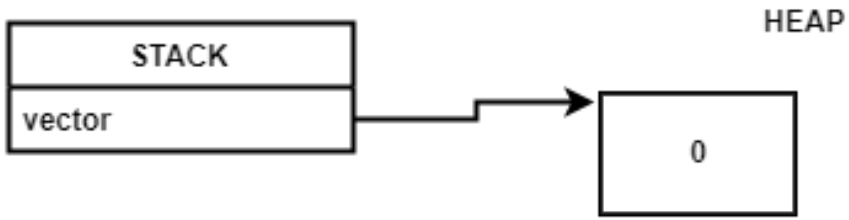

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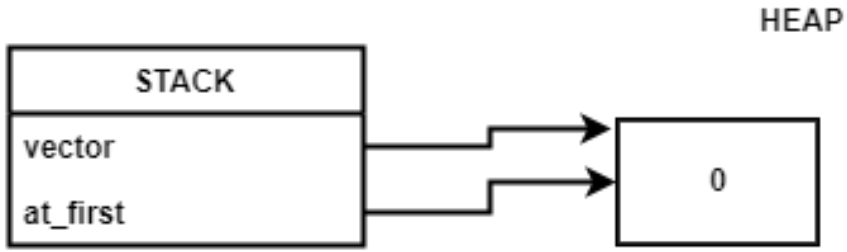

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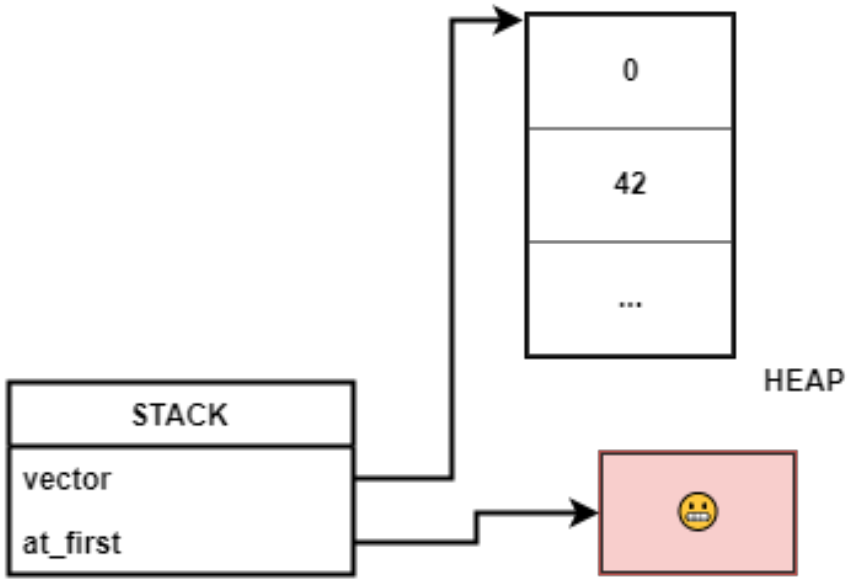

Rust : Dangling pointer ?

dangling-pointer.cpp

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Rust : Dangling pointer ?

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dangling-pointer.rs

```rust
fn main ()
{
    let mut vector: Vec<i32> = vec![0];
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    vector.push(42);
    println!("{}", *at_first);
}
```
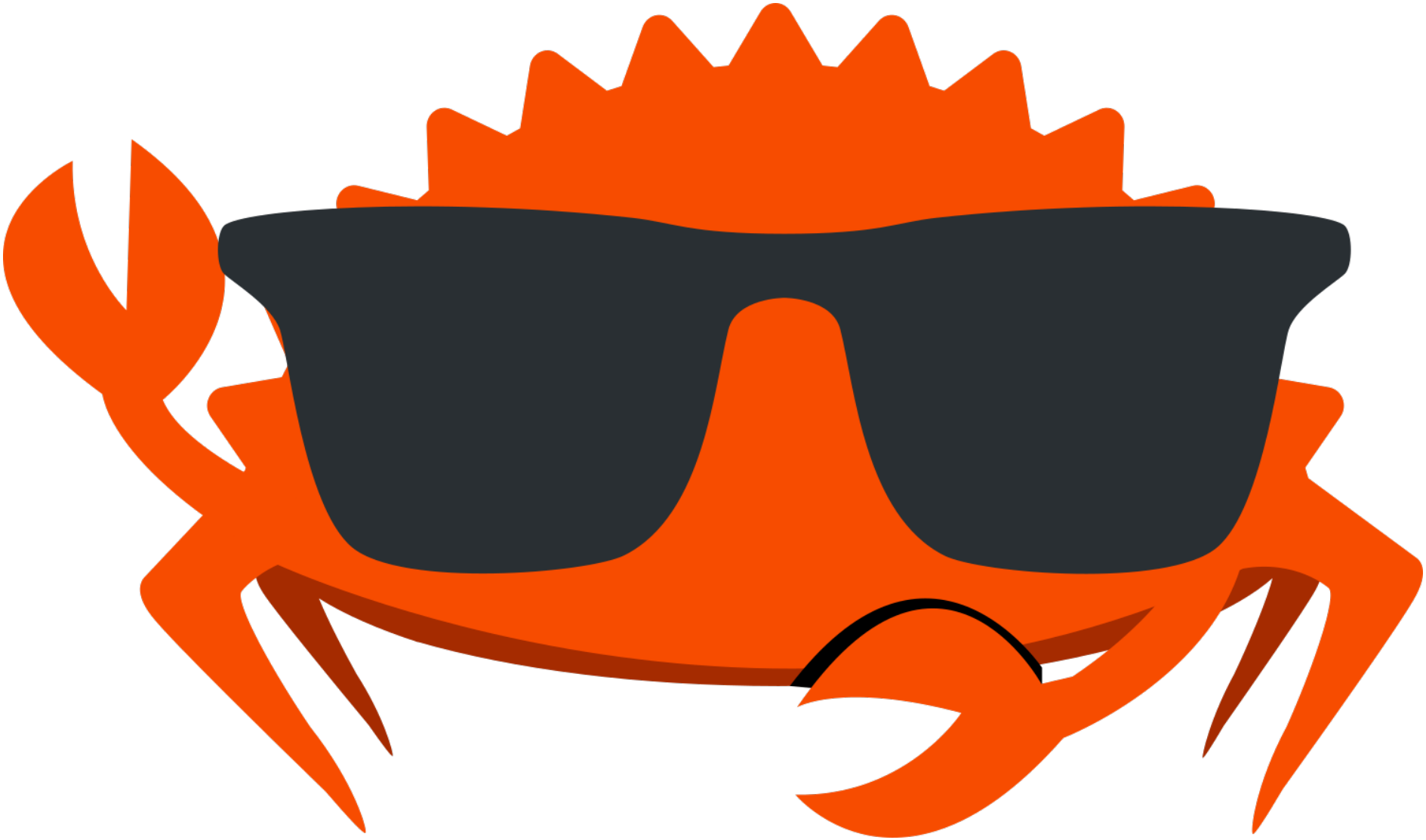

```
error[E0502]: cannot borrow `vector` as mutable because it is also borrowed as immutable
 --> /home/user/Documents/git/presentation/dangling-pointer.rs:5:5
  |
4 |     let at_first: &i32 = &vector[0];
  |                          ------ immutable borrow occurs here
5 |     vector.push(42);
  |     ^^^^^^ mutable borrow occurs here
6 |     println!("{}", *at_first);
7 | }
  | - immutable borrow ends here
```

- Playground

Rust : Dangling pointer ?



by TheZoq2

Python : invalidation d'itérateur

iterator-bug.py

```
2   def append_all(
3       out_list,
4       elements,
5   ):
6       for x in elements:
7           out_list.append(x)
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Python : invalidation d'itérateur

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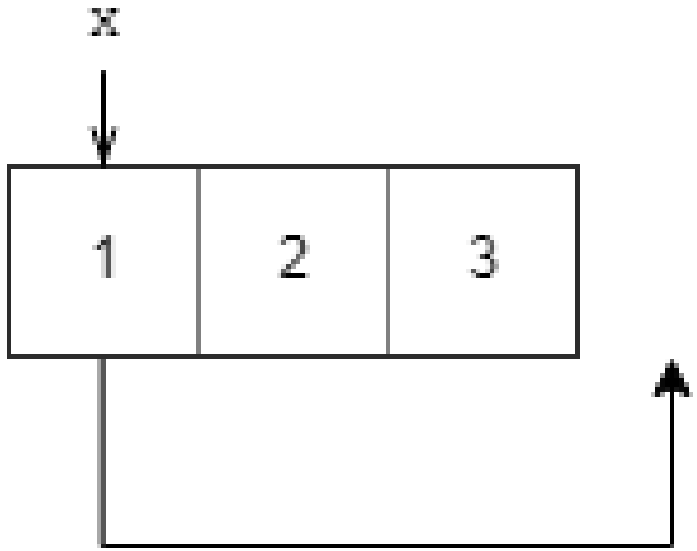

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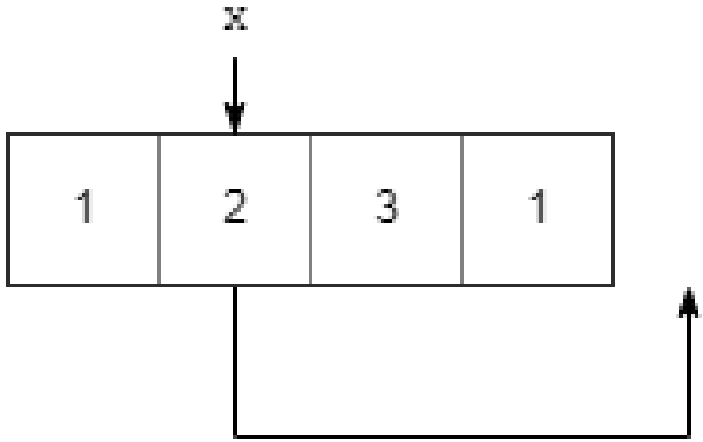

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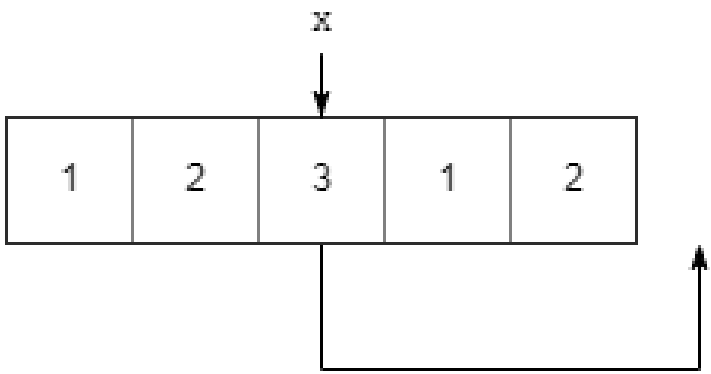

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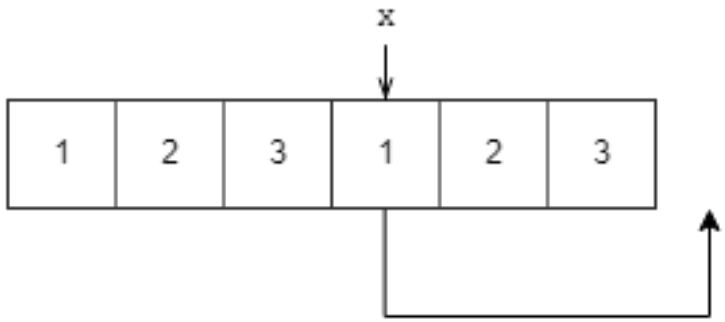

Rust : Invalidation d'itérateur ?

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main()
```

Rust : Invalidation d'itérateur ?

iterator-bug.py

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iterator-bug.rs

```rust
fn main () {
    fn append_all (
        out_vec: &mut Vec<i32>,
        elements: &[i32],
    ) {
        for &x in elements {
            out_vec.push(x)
        }
    }
    let mut l = vec![1, 2, 3];
    append_all(&mut l, &l);
}
```

Rust : Invalidation d'itérateur ?

- Playground

iterator-bug.rs

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fn main () {
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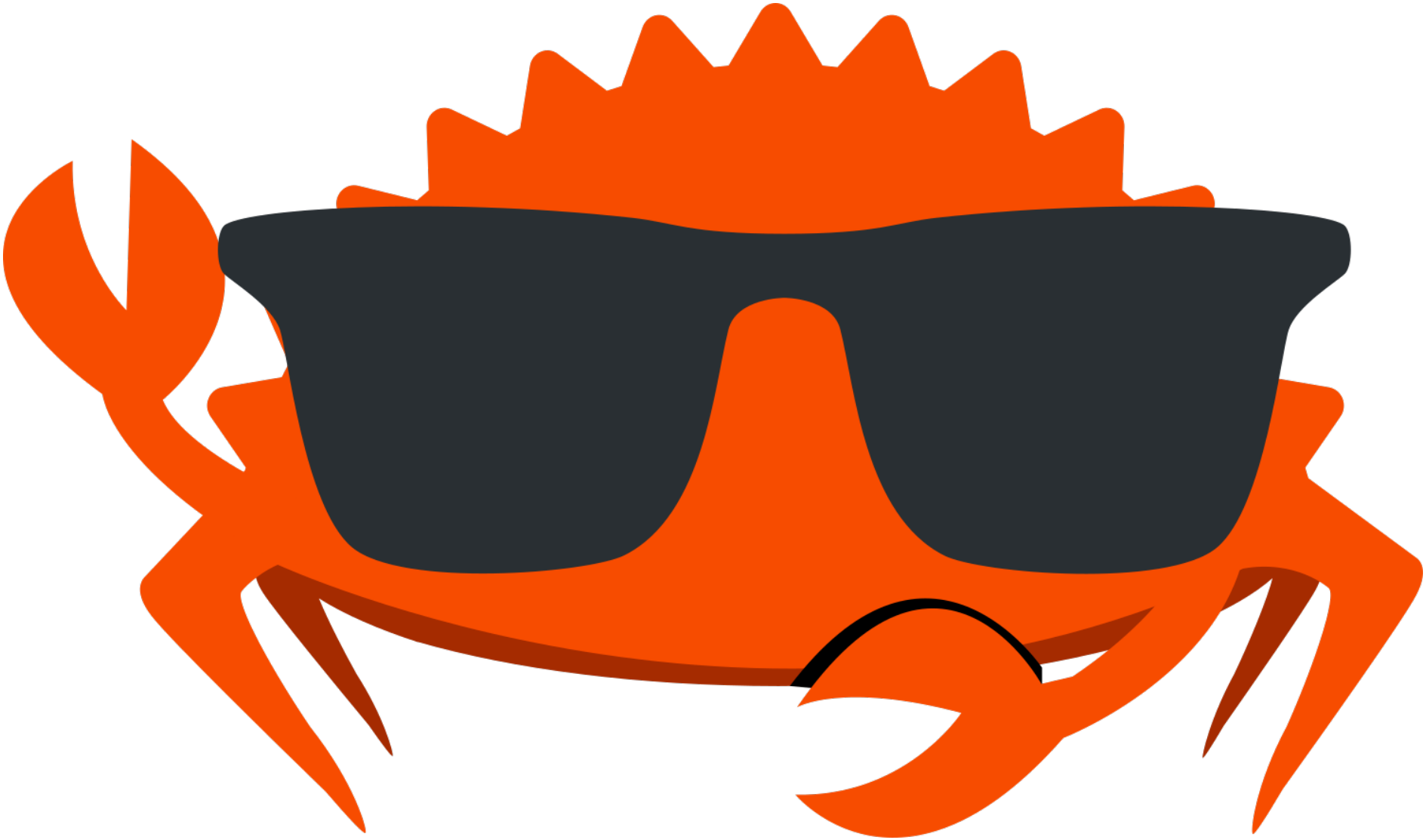
    append_all(&mut l, &l);
}
```

```
error[E0502]: cannot borrow `l` as immutable because it is also borrowed as mutable
  --> /home/user/Documents/git/presentation/iterator-bug.rs:11:25
   |
11 |     append_all(&mut l, &l);
   |                -    ^- mutable borrow ends here
   |                |    |
   |                |    immutable borrow occurs here
   |                mutable borrow occurs here
```

Rust : Invalidation d'itérateur ?



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Conclusion

Questions ?