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블록체인 개발 A to Z

Chapter 1

Rust Introduction

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What is Ownership? 2

References and Borrowing

References Borrowing

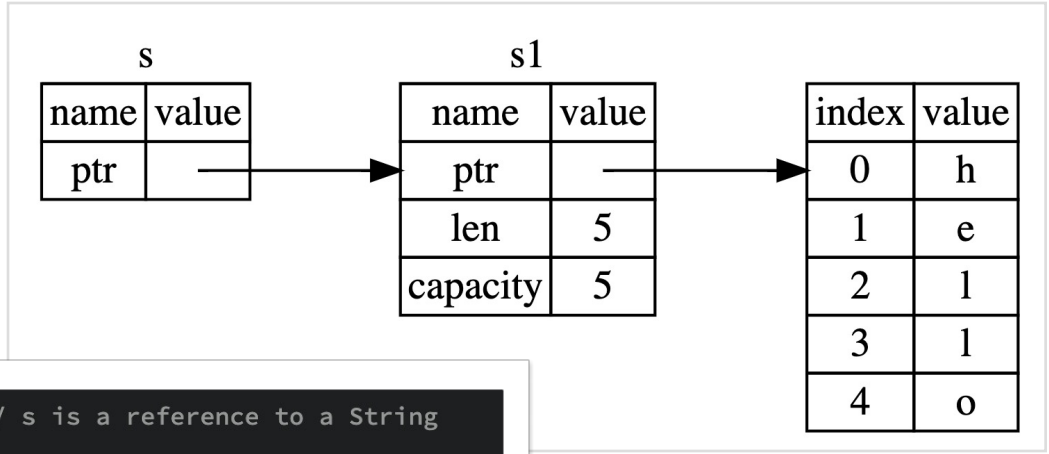
```
fn main() {
    let s1 = String::from("hello");

    let (s2, len) = calculate_length(s1);

    println!("The length of '{}' is {}.", s2, len);
}

fn calculate_length(s: String) -> (String, usize) {
    let length = s.len(); // len() returns the length of a String

    (s, length)
}
```

```
fn main() {
    let s1 = String::from("hello");

    let len = calculate_length(&s1);

    println!("The length of '{}' is {}.", s1, len);
}

fn calculate_length(s: &String) -> usize {
    s.len()
}
```

A reference is like a pointer in that it's an address we can follow to access the data stored at that address; that data is owned by some other variable. Unlike a pointer, a reference is guaranteed to point to a valid value of a particular type for the life of that reference.

References Borrowing

We call the action of creating a reference borrowing. As in real life, if a person owns something, you can borrow it from them. When you're done, you have to give it back. You don't own it.




```
fn calculate_length(s: &String) -> usize { // s is a reference to a String
    s.len()
} // Here, s goes out of scope. But because it does not have ownership of what
  // it refers to, it is not dropped.
```

Mutable Reference

What happens if we try to modify something we're borrowing?

```rust
fn main() {
    let s = String::from("hello");

    change(&s);
}

fn change(some_string: &String) {
    some_string.push_str(", world");
}
```

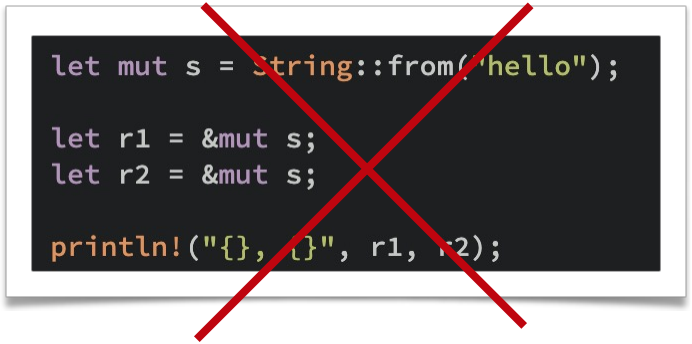
```
$ cargo run
   Compiling ownership v0.1.0 (file:///projects/ownership)
error[E0596]: cannot borrow `*some_string` as mutable, as it is behind a `&` reference
 --> src/main.rs:8:5
  |
7 | fn change(some_string: &String) {
  |                        ------- help: consider changing this to be a mutable reference
8 |     some_string.push_str(", world");
  |     ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^ `some_string` is a `&` reference, so the data it

For more information about this error, try `rustc --explain E0596`.
error: could not compile `ownership` due to previous error
```

Mutable Reference

Then we create a mutable reference with &mut s where we call the change function, and update the function signature to accept a mutable reference with some_string: &mut String. This makes it very clear that the change function will mutate the value it borrows.

Mutable references have one big restriction: if you have a mutable reference to a value, you can have no other references to that value.

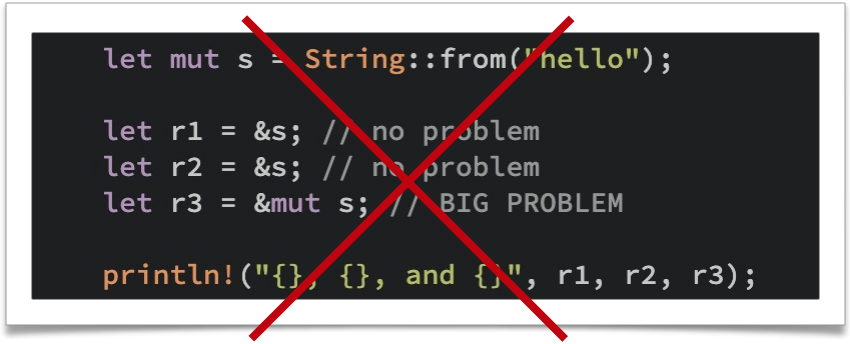
```
fn main() {
    let mut s = String::from("hello");

    change(&mut s);
}

fn change(some_string: &mut String) {
    some_string.push_str(", world");
}
```



Mutable Reference

The benefit of having this restriction is that Rust can prevent data races at compile time. A data race is similar to a race condition and happens when these three behaviors occur:

- Two or more pointers access the same data at the same time.
- At least one of the pointers is being used to write to the data.
- There's no mechanism being used to synchronize access to the data.



```
let mut s = String::from("hello");

let r1 = &s; // no problem
let r2 = &s; // no problem
let r3 = &mut s; // BIG PROBLEM

println!("{}, {}, and {}", r1, r2, r3);
```

```
let mut s = String::from("hello");

let r1 = &s; // no problem
let r2 = &s; // no problem
println!("{} and {}", r1, r2);
// variables r1 and r2 will not be used after this point

let r3 = &mut s; // no problem
println!("{}", r3);
```

Dangling Reference

A pointer that references a location in memory that may have been given to someone else--by freeing some memory while preserving a pointer to that memory. In Rust, by contrast, the compiler guarantees that references will never be dangling references: if you have a reference to some data, the compiler will ensure that the data will not go out of scope before the reference to the data does.

```rust
fn main() {
    let reference_to_nothing = dangle();
}

fn dangle() -> &String {
    let s = String::from("hello");

    &s
}
```

```
$ cargo run
   Compiling ownership v0.1.0 (file:///projects/ownership)
error[E0106]: missing lifetime specifier
 --> src/main.rs:5:16
  |
5 | fn dangle() -> &String {
  |                ^ expected named lifetime parameter
  |
  = help: this function's return type contains a borrowed value, but there is no value f
help: consider using the `'static` lifetime
  |
5 | fn dangle() -> &'static String {
  |                ~~~~~~~~

For more information about this error, try `rustc --explain E0106`.
error: could not compile `ownership` due to previous error
```

```
this function's return type contains a borrowed value, but there is no value
for it to be borrowed from
```

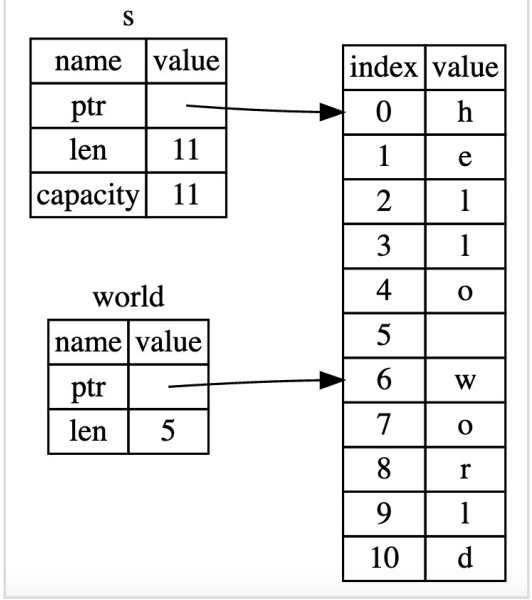
The Slice Type

String slice

Slices let you reference a contiguous sequence of elements in a collection rather than the whole collection. A slice is a kind of reference, so it does not have ownership.

A string slice is a reference to part of a String, and it looks like this:

```
let s = String::from("hello world");

let hello = &s[0..5];
let world = &s[6..11];
```



Range Syntax

```
let s = String::from("hello");

let slice = &s[0..2];
let slice = &s[..2];
```

```
let s = String::from("hello");

let len = s.len();

let slice = &s[3..len];
let slice = &s[3..];
```

```
let s = String::from("hello");

let len = s.len();

let slice = &s[0..len];
let slice = &s[..];
```

Slice Example

Here's a small programming problem: write a function that takes a string of words separated by spaces and returns the first word it finds in that string. If the function doesn't find a space in the string, the whole string must be one word, so the entire string should be returned.

```
fn first_word(s: &String) -> &str {
    let bytes = s.as_bytes();

    for (i, &item) in bytes.iter().enumerate() {
        if item == b' ' {
            return &s[0..i];
        }
    }

    &s[..]
}
```

```
fn main() {
    let mut s = String::from("hello world");

    let word = first_word(&s);

    s.clear(); // error!

    println!("the first word is: {}", word);
}
```