CMSC 330: Organization of Programming Languages

Traits in Rust

Traits Overview

- Traits allow us to abstract behavior that types can have in common
  - In situations where we use generic type parameters, we can use trait bounds to specify that the generic type must implement a trait

- Traits are a bit like Java interfaces
  - But we can implement traits over any type, anywhere in the code, not only at the point we define the type

Defining a Trait

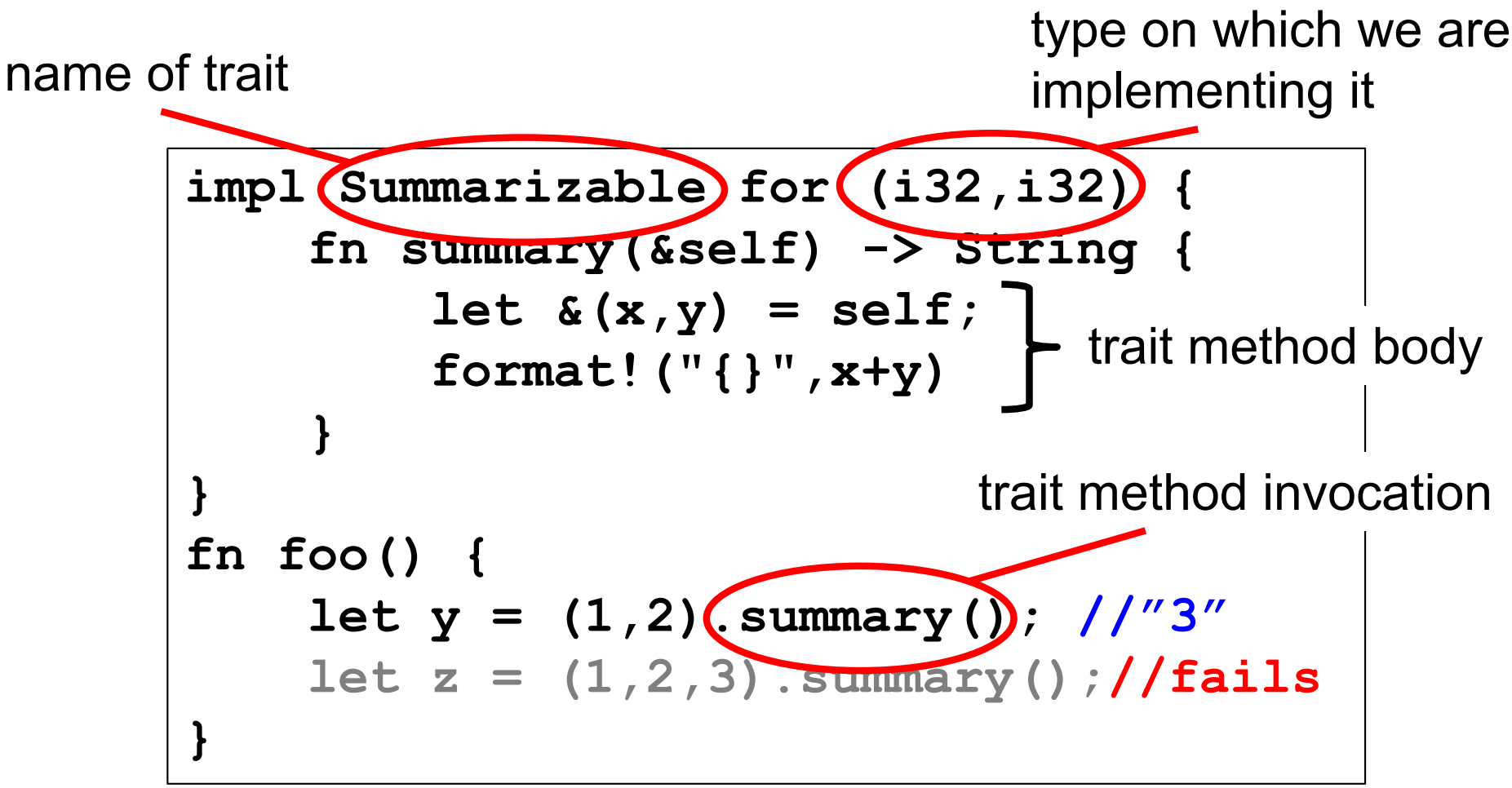
- Here is a trait with a single function

```
pub trait Summarizable {
   fn summary(&self) -> String;
}
```

  - Specify **`&self`** for "instance" methods
    - Note: can also specify "associated" methods
      - Like **`static`** methods in Java
  - Equivalent in Java:

```
public interface Summarizable {
   String summary();
}
```

Implementing a Trait on a Type




```
impl Summarizable for (i32,i32) {
    fn summary(&self) -> String {
        let &(x,y) = self;
        format!("{}",x+y)
    }
}
fn foo() {
    let y = (1,2).summary(); //"3"
    let z = (1,2,3).summary();//fails
}
```

Default Implementations

- Here is a trait with a default implementation

```
pub trait Summarizable {
   fn summary(&self) -> String {
     String::from("none")
   }
}
```

default impl

```
impl Summarizable for (i32,i32,i32) {}
fn foo() {
    let y = (1,2).summary(); //"3"
    let z = (1,2,3).summary();//"none"
}
```

Impl uses default

Trait Bounds

- With generics, you can specify that a type variable must implement a trait

```
pub fn notify<T: Summarizable>(item: T) {
  println!("Breaking news! {}",
             item.summary());
}
```

  - This method works on any type `T` that implements the `Summarizable` trait

- Can specify multiple Trait Bounds using `+`

```
fn foo<T:Clone + Summarizable>(…) -> i32 {…}
```

or

```
fn foo<T>(…) -> i32 where T:Clone + Summarizable {…}
```

Standard Traits

- We have seen several standard traits already
  - `Clone` holds if the object has a clone() method
  - `Copy` holds if you can copy it
    - I.e., it's a primitive
  - `Deref` holds if you can dereference it
    - I.e., it's a reference
- There are other useful ones too
  - `Display` if it can be converted to a string
  - `PartialOrd` if it implements a comparison operator

Putting all Together

- Finds the largest element in an array slice
  - Generic in the type `T` of the contents of the array

```
fn largest<T: PartialOrd + Copy>(list: &[T]) -> T
{
    let mut largest = list[0];
    for &item in list.iter() {
        if item > largest {
            largest = item;
        }
    }
    largest
}
```

Requires Copy trait

Requires PartialOrd trait

Putting all Together

- Finds the largest element in an array slice
  - Generic in the type **T** of the contents of the array

```
fn largest<T: PartialOrd + Copy>(list: &[T]) -> T
{…}
fn main() {
    let number_list = vec![34, 50, 25, 100, 65];
    let result = largest(&number_list);
    println!("The largest number is {}", result);
    let char_list = vec!['y', 'm', 'a', 'q'];
    let result = largest(&char_list);
    println!("The largest char is {}", result);
}
```

prints **The largest number is 100**

The largest char is y

Notes

- Trait implementations can be generic too

```
pub trait Queue<T> {
   fn enqueue(&mut self, ele: T) -> (); …
}
impl <T> Queue<T> for Vec<T> {
   fn enqueue(&mut self, ele:T) -> () {…} …
}
```

- Generic method implementations of structs and enums can include trait bounds