Polymorphism

A closer look at types....

polymorphism ≡ comes from Greek meaning ‘many forms’

In programming:

<u>Def</u>: A function or operator is <u>polymorphic</u> if it has at least two possible types.

Read MPL Chap 8

Polymorphism

Different types of polymorphisms

Polymorphism

Parametric
Types with type variables
Rust: vec<T>

Duck Typing
“the duck test”*
Asteroid & Python

Ad hoc (overloading)
Asteroid & Python: operator overloading,
e.g. 1+2, “Hello” + ”There”

Subtyping
Python: Class inheritance

*If it looks like a duck, swims like a duck, and quacks like a duck, then it probably *is* a duck. --Wikipedia

Ad Hoc Polymorphism (overloading)

Def: An overloaded function name or operator is one that has at least two definitions, all of different types.

Example: In Asteroid the '+' operator is overloaded. It can function as a string concatenation operator or as an addition operator depending on the type context – polymorphism!

```
Asteroid Version 1.1.3
(c) University of Rhode Island
Type "asteroid -h" for help
Press CTRL-D to exit
ast> "abc"+"def" == "abcdef"
true
ast> 3+5 == 8
true
ast>
```

Parametric Polymorphism

Def: A function/structure exhibits parametric polymorphism if it has a type that contains one or more type variables.

Example: Rust

```rust
struct Data<T> {
    value:T,    // T is a type variable
}

fn main() {
    // instantiating Data with i32 data
    let t:Data<i32> = Data{value:350};
    println!("value is :{} ",t.value);

    // instantiating Data with String data
    let t2:Data<String> = Data{value:"Tom".to_string()};
    println!("value is :{} ",t2.value);
}
```

Source: https://www.tutorialspoint.com/rust/rust_generic_types.htm

Subtype Polymorphism

Def: A function or operator exhibits subtype polymorphism if one or more of its types have subtypes.

Subtype Polymorphism

Example: Java

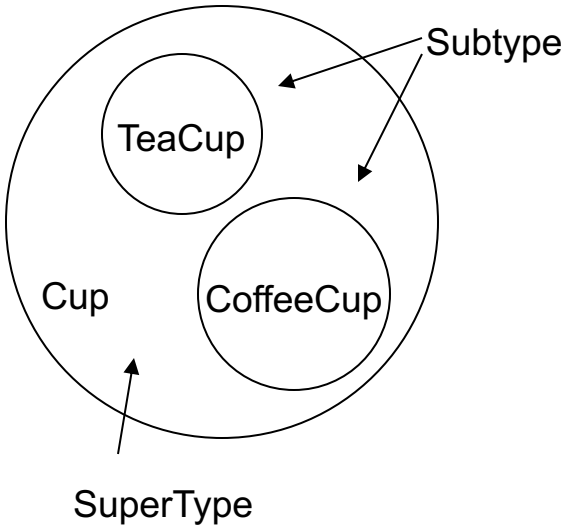
```
class Cup { ... };
class CoffeeCup extends Cup { ... };
class TeaCup extends Cup { ... };

TeaCup t = new TeaCup();
Cup c = t;
```

type coercion: TeaCup → Cup

safe!

```
void fill (Cup c) {...}

TeaCup t = new TeaCup();
CoffeeCup k = new CoffeeCup();

fill(t);
fill(k);
```

subtype polymorphism



Duck Typing

- Duck typing in computer programming is an application of the duck test—"*If it walks like a duck and it quacks like a duck, then it must be a duck*"—to determine if an object can be used for a particular purpose.
  - With normal typing, suitability is determined by an object's type.
  - In duck typing, **an object's suitability is determined by the presence of certain methods and properties, rather than the type of the object itself. No common base type!**

https://en.wikipedia.org/wiki/Duck_typing

Duck Typing

- Example: a polymorphic list with Duck Typing.

```
lutz$ asteroid ducktyping.ast
a duck can fly
a plane can fly
lutz$
```

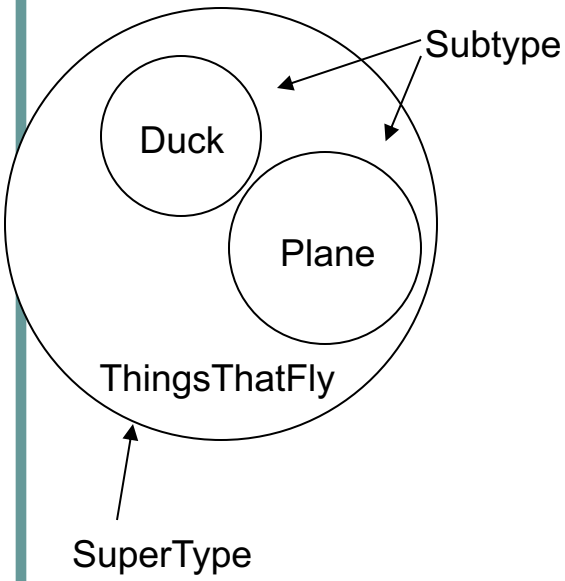
```
-- A demonstration of duck typing
load system io.

-- define some types with the property 'fly'
structure Duck with
    function fly with none do
        io @println "a duck can fly".
    end
end

structure Plane with
    function fly with none do
        io @println "a plane can fly".
    end
end

-- create a polymorphic list
let l = [Duck(),Plane()].

-- use the interface that is common to all the objects
for e in l do
    e @fly ().
end
```

Polymorphic list: list with many different types

Duck Typing

- Duck typing is not possible in statically typed languages like Rust, C++, and Java
- Instead, in this languages one has to rely on subtype polymorphism in order to construct a polymorphic list.

Duck Typing




```
javac Main.java
java Main
a duck can fly
a plane can fly
```

```java
import java.util.*;

abstract class ThingsThatFly { // base class of the hierarchy
  abstract void fly();
}

class Duck extends ThingsThatFly {
  void fly() {
    System.out.println("a duck can fly");
  }
}

class Plane extends ThingsThatFly {
  void fly() {
    System.out.println("a plane can fly");
  }
}

class Main {
  public static void main(String args[]) {
    // create a list of ThingsThatFly
    ArrayList<ThingsThatFly> list = new ArrayList<ThingsThatFly>();
    list.add(new Duck());
    list.add(new Plane());
    // print the arraylist objects
    for (int i = 0; i < list.size(); i++) {
      list.get(i).fly();
    }
  }
}
```

Can only declare lists of a single type!

Reading

- MPL chap 8