

GENERIC FUNCTIONS PART 2

1. Generic functions accept **ALL** types

```
def map[From, To](list: List[From])(update: From => To): List[To]
```

```
map[String, Int](List(...))(...)
```

```
map[User, Address](List(...))(...)
```

2. All types must be treated **IN THE SAME WAY**

```
def map[From, To](list: List[From])(update: From => To): List[To] =  
  list match {  
    case ints    : List[Int]    => ...  
    case strings: List[String] => ...  
    case users   : List[User]   => ...  
    case _       => ...  
  }
```

All types must be treated **IN THE SAME WAY**

```
def format[A](value: A): String =  
  value match {  
    case x: String => x.toLowerCase  
    case x: Double => truncate(2, x)  
    case _         => "N/A"  
  }
```

```
format("Blue")  
// res0: String = "blue"  
format(123.123456)  
// res1: String = "123.12"  
format(true)  
// res2: String = "N/A"
```

Why? Type erasure

```
def format[A](value: A): String =  
  value match {  
    case x: String      => x.toLowerCase  
    case x: Double      => truncate(2, x)  
    case x: List[String] => x.map(_._toLowerCase).mkString(",")  
    case x: List[Double] => x.map(truncate(2, _)).mkString(",")  
    case _              => "N/A"  
  }
```

```
format("Blue")  
// res4: String = "blue"  
format(123.123456)  
// res5: String = "123.12"  
format(true)  
// res6: String = "N/A"  
format(List("Hello", "World"))  
// res7: String = "hello,world"
```

Why? Type erasure

```
def format[A](value: A): String =  
  value match {  
    case x: String      => x.toLowerCase  
    case x: Double      => truncate(2, x)  
    case x: List[String] => x.map(_._toLowerCase).mkString(",")  
    case x: List[Double] => x.map(truncate(2, _)).mkString(",")  
    case _              => "N/A"  
  }
```

```
format("Blue")  
// res4: String = "blue"  
format(123.123456)  
// res5: String = "123.12"  
format(true)  
// res6: String = "N/A"  
format(List("Hello", "World"))  
// res7: String = "hello,world"
```

```
format(List(123.123456, 0.1234))
```

Why? Type erasure

```
def format[A](value: A): String =  
  value match {  
    case x: String           => ...  
    case x: Double           => ...  
    case x: List[String]     => ...  
    case x: List[Double]    => ...  
    case _                   => ...  
  }
```

```
def format[A](value: A): String =  
    if(value.isInstanceOf[String]) ...  
  else if(value.isInstanceOf[Double]) ...  
  else if(value.isInstanceOf[List[String]]) ...  
  else if(value.isInstanceOf[List[Double]]) ...  
  else ...
```

Why? Type erasure

```
def format[A](value: A): String =  
  value match {  
    case x: String      => ...  
    case x: Double      => ...  
    case x: List[String] => ...  
    case x: List[Double] => ...  
    case _              => ...  
  }
```

```
def format[A](value: A): String =  
    if(value.isInstanceOf[String]) ...  
  else if(value.isInstanceOf[Double]) ...  
  else if(value.isInstanceOf[List[String]]) ...  
  else if(value.isInstanceOf[List[Double]]) ...  
  else ...
```

```
List(1.5,2.0).isInstanceOf[List[String]]  
// res8: Boolean = true
```

```
// warning: fruitless type test: a value of type  
// List[Double] cannot also be a List[String]
```


Why? Poor documentation

```
def format[A](value: A): String
```

Parametric polymorphism (`map`)

`!=`

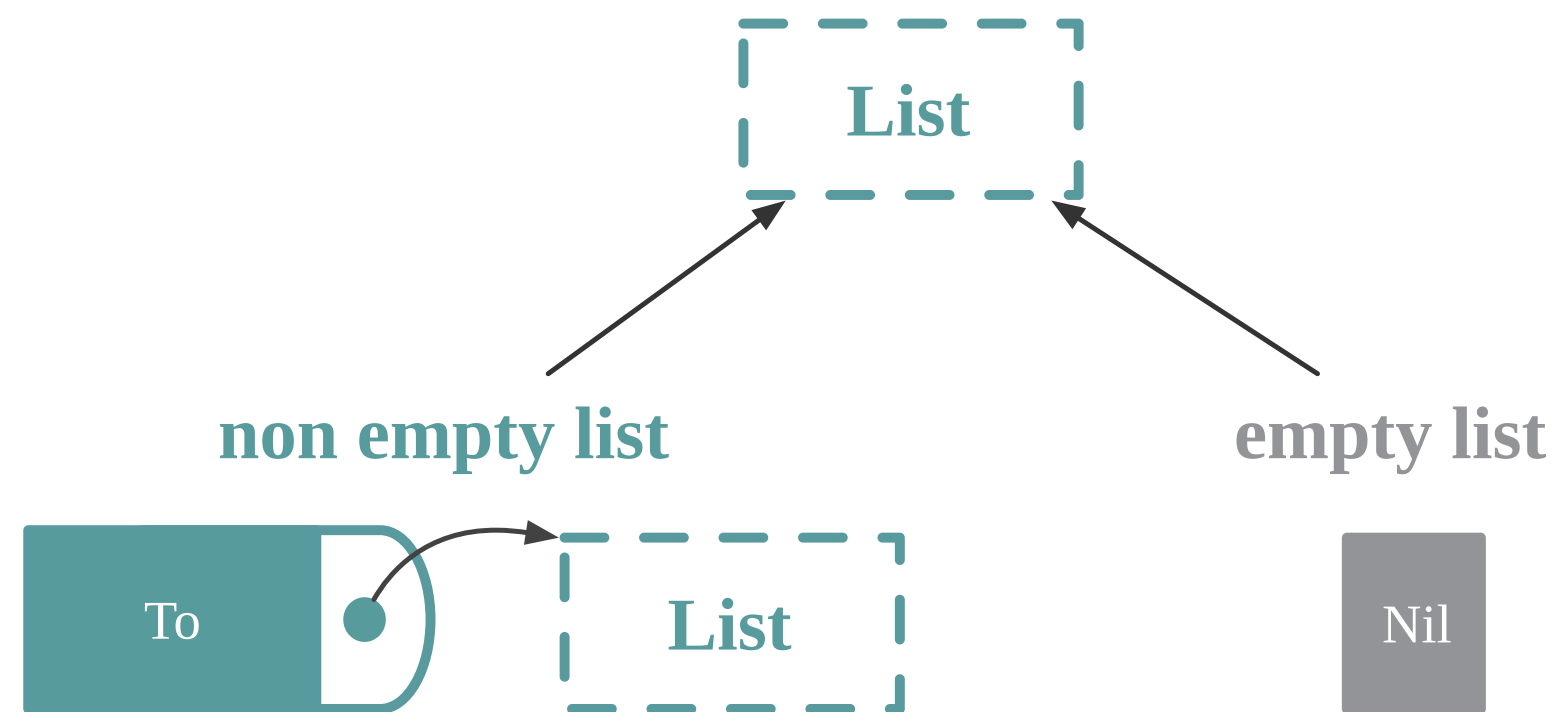
Ad hoc polymorphism (`format`)

How can we implement map?

```
def map[From, To](list: List[From])(update: From => To): List[To]
```

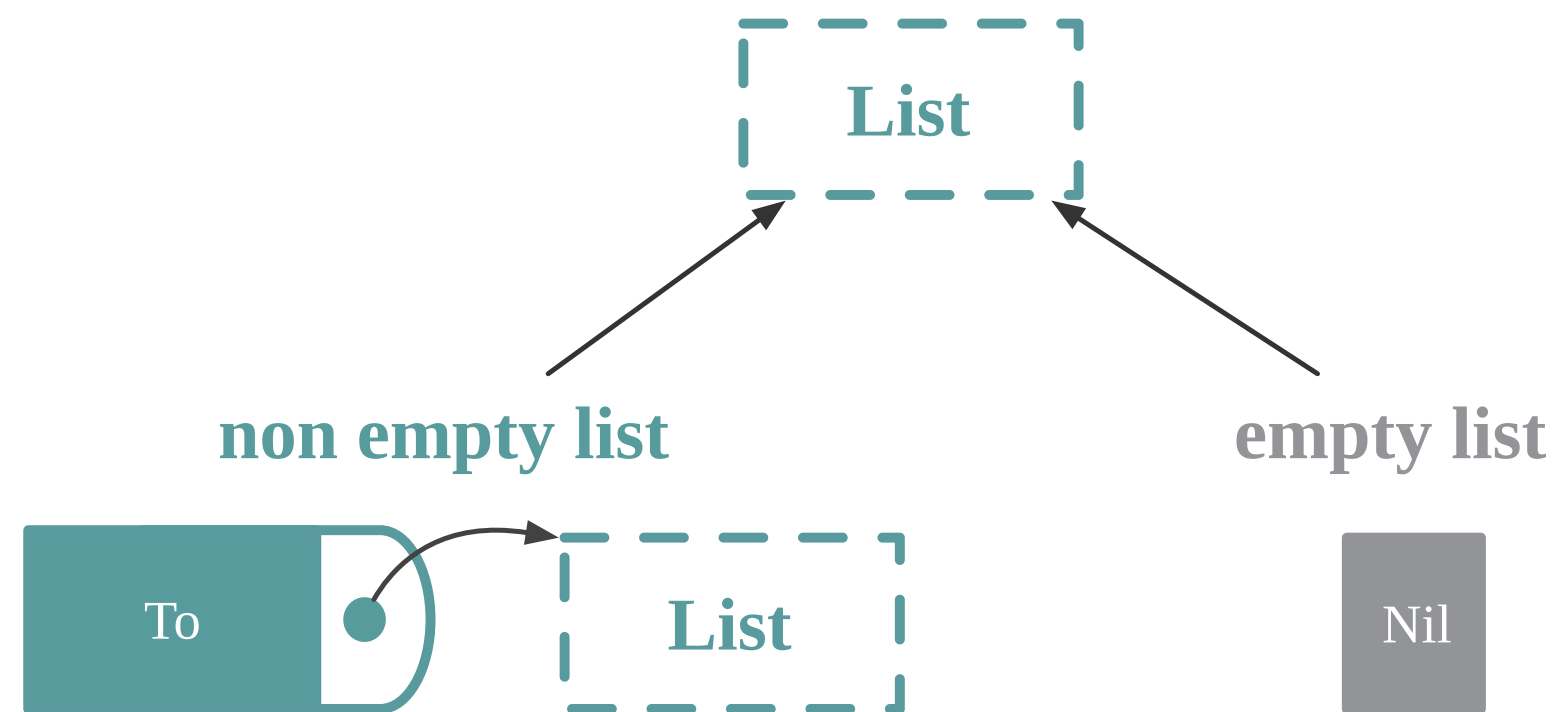
How can we implement map?

```
def map[From, To](list: List[From])(update: From => To): List[To]
```



How can we implement map?

```
def map[From, To](list: List[From])(update: From => To): List[To]
```



1. Return an empty list
2. Return an non empty list with values produced by update

Does it compile?

```
def map[From, To](list: List[From])(update: From => To): List[To] =  
  list
```

Does it compile?

```
def map[From, To](list: List[From])(update: From => To): List[To] =  
  list  
  // error: type mismatch;  
  // found   : List[From]  
  // required: List[To]  
  // list  
  // ^^^^
```

Does it compile?

```
def map[A](list: List[A])(update: A => A): List[A] =  
  list  
  
// success
```


Does it compile?

```
def map(list: List[Int])(update: Int => Int): List[Int] =  
  List(1, 2, 3)  
  
// success
```

How can we test map?

```
test("map"){  
  map(Nil)(_ => ???) shouldEqual Nil  
  
  map(List(1,2,3))(x => ???) shouldEqual ???  
  map(List(1,2,3,4,5))(x => ???) shouldEqual ???  
  
  map(List("Hello", "World"))(x => ???) shouldEqual ???  
  map(List("a", "b", "c", "d"))(x => ???) shouldEqual ???  
}
```

How can we test map?

```
test("map"){  
  map(Nil)(_ => ???) shouldEqual Nil  
  
  map(List(1,2,3))(x => ???) shouldEqual ???  
  map(List(1,2,3,4,5))(x => ???) shouldEqual ???  
  
  map(List("Hello", "World"))(x => ???) shouldEqual ???  
  map(List("a", "b", "c", "d"))(x => ???) shouldEqual ???  
}
```

All types must be treated in the same way

How can we test map?

```
test("map"){  
  map(Nil)(_ => ???) shouldEqual Nil  
  
  map(List(1,2,3))(_ + 1) shouldEqual List(2,3,4)  
  map(List(1,2,3,4,5))(_ + 1) shouldEqual List(2,3,4,5,6)  
  
  map(List(1,2,3))(_ > 2) shouldEqual List(false,false,true)  
  map(List(1,2,3,4,5))(_ > 2) shouldEqual List(false,false,true,true,true)  
}
```

How can we test map?

```
test("map"){  
  map(Nil)(_ => ???) shouldEqual Nil  
  
  map(List(1,2,3))(_ + 1) shouldEqual List(2,3,4)  
  map(List(1,2,3,4,5))(_ + 1) shouldEqual List(2,3,4,5,6)  
  
  map(List(1,2,3))(_ > 2) shouldEqual List(false,false,true)  
  map(List(1,2,3,4,5))(_ > 2) shouldEqual List(false,false,true,true,true)  
}
```

All output elements must be produced by
update

How can we test map?

```
test("map"){  
  map(Nil)(_ => ???) shouldEqual Nil  
  
  map(List(1,2,3))(x => x) shouldEqual List(1,2,3)  
  map(List(1,2,3,4,5))(x => x) shouldEqual List(1,2,3,4,5)  
}
```

How can we test map?

```
test("map"){  
  map(Nil)(_ => ???) shouldEqual Nil  
  
  map(List(1,2,3))(identity) shouldEqual List(1,2,3)  
  map(List(1,2,3,4,5))(identity) shouldEqual List(1,2,3,4,5)  
}
```

```
object Predef {  
  def identity[A](value: A): A = value  
}
```

Property Based Testing (PBT)

```
test("map"){  
  forAll((list: List[Int]) =>  
    map(list)(identity) shouldEqual list  
  )  
}
```


Summary

- More reusable
- Caller decides which type to use
- Implementation must be generic
 - better documentation
 - less tests

Not everything in a language should be used

```
class Spaceship {  
  private def autoDestroy(): Unit =  
    println("Boom!")  
}
```

```
val shuttle = new Spaceship()
```

```
shuttle.autoDestroy()  
// error: method autoDestroy in class Spaceship cannot be accessed as a member of App1.this.Spa  
// shuttle.autoDestroy()  
// ^^^^^^^^^^^^^^^^^^^^^^^^^^^
```

Not everything in a language should be used

```
class Spaceship {  
  private def autoDestroy(): Unit =  
    println("Boom!")  
}
```

```
val shuttle = new Spaceship()
```

```
val method = classOf[Spaceship].getDeclaredMethod("autoDestroy")  
method.setAccessible(true)
```

```
method.invoke(shuttle)  
// Boom!
```