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]
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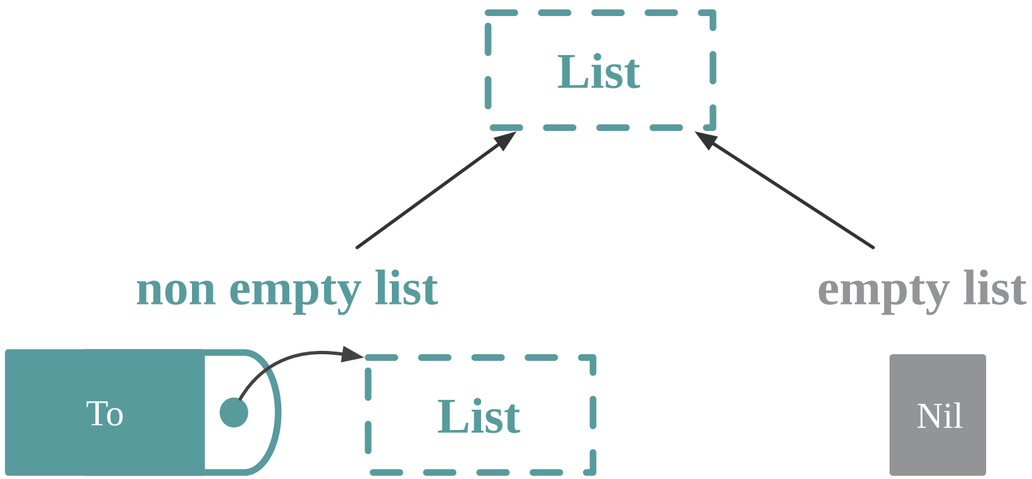

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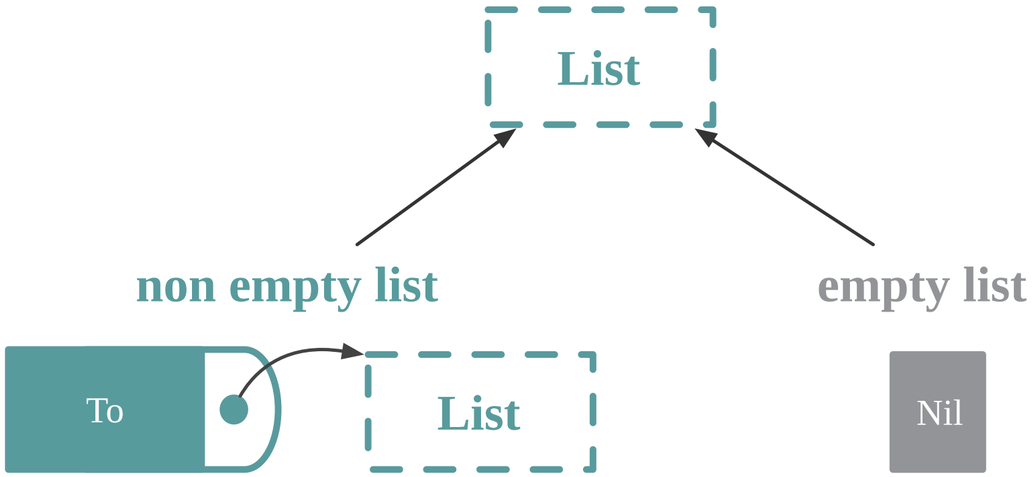

1. Return an empty list
2. Return an non empty list with values produced by update

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.Spaceship from class App1 in object Session
// 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!
```