Data-Parallel Operations II

Parallel Programming in Scala

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Use-cases of the `fold` Operation

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  xs.par.fold(0)(_ + _)
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}
```

Implement the `max` method:

```
def max(xs: Array[Int]): Int = {
  xs.par.fold(Int.MinValue)(math.max)
}
```

Preconditions of the `fold` Operation

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Array("paper", "rock", "paper", "scissors")
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  .par.fold("")(play)

def play(a: String, b: String): String = List(a, b).sorted match {
  case List("paper", "scissors") => "scissors"
  case List("paper", "rock")     => "paper"
  case List("rock", "scissors")  => "rock"
  case List(a, b) if a == b      => a
  case List("", b)               => b
}
```

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Why does this happen?

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Why does this happen?

The `play` operator is *commutative*, but not *associative*.

Preconditions of the `fold` Operation

In order for the `fold` operation to work correctly, the following relations must hold:

```
f(a, f(b, c)) == f(f(a, b), c)
f(z, a) == f(a, z) == a
```

We say that the neutral element `z` and the binary operator `f` must form a *monoid*.

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Commutativity does not matter for `fold` – the following relation is not necessary:

```
f(a, b) == f(b, a)
```

Limitations of the `fold` Operation

Given an array of characters, use `fold` to return the vowel count:

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Given an array of characters, use `fold` to return the vowel count:

```
Array(‘E‘, ‘P‘, ‘F‘, ‘L‘).par
  .fold(0)((count, c) => if (isVowel(c)) count + 1 else count)
```

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```
Array('E', 'P', 'F', 'L').par
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```

Question:

What does this snippet do?

- The program runs and returns the correct vowel count.
- The program is non-deterministic.
- The program returns incorrect vowel count.
- The program does not compile.

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```

The `fold` operation can only produce values of the same type as the collection that it is called on.

The `foldLeft` operation is *more expressive* than `fold`. Sanity check:

```
def fold(z: A)(op: (A, A) => A): A = foldLeft[A](z)(op)
```

The aggregate Operation

Let's examine the aggregate signature:

```
def aggregate[B](z: B)(f: (B, A) => B, g: (B, B) => B): B
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def aggregate[B](z: B)(f: (B, A) => B, g: (B, B) => B): B
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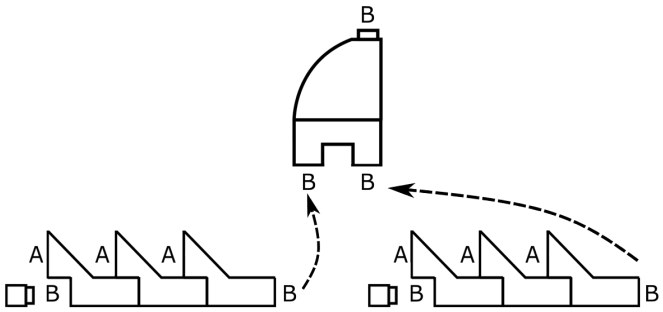

A combination of `foldLeft` and `fold`.

Using the aggregate Operation

Count the number of vowels in a character array:

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```
Array('E', 'P', 'F', 'L').par.aggregate(0)(
  (count, c) => if (isVowel(c)) count + 1 else count,
  _ + _
)
```

The Transformer Operations

So far, we saw the *accessor* combinators.

Transformer combinators, such as `map`, `filter`, `flatMap` and `groupBy`, do not return a single value, but instead return new collections as results.