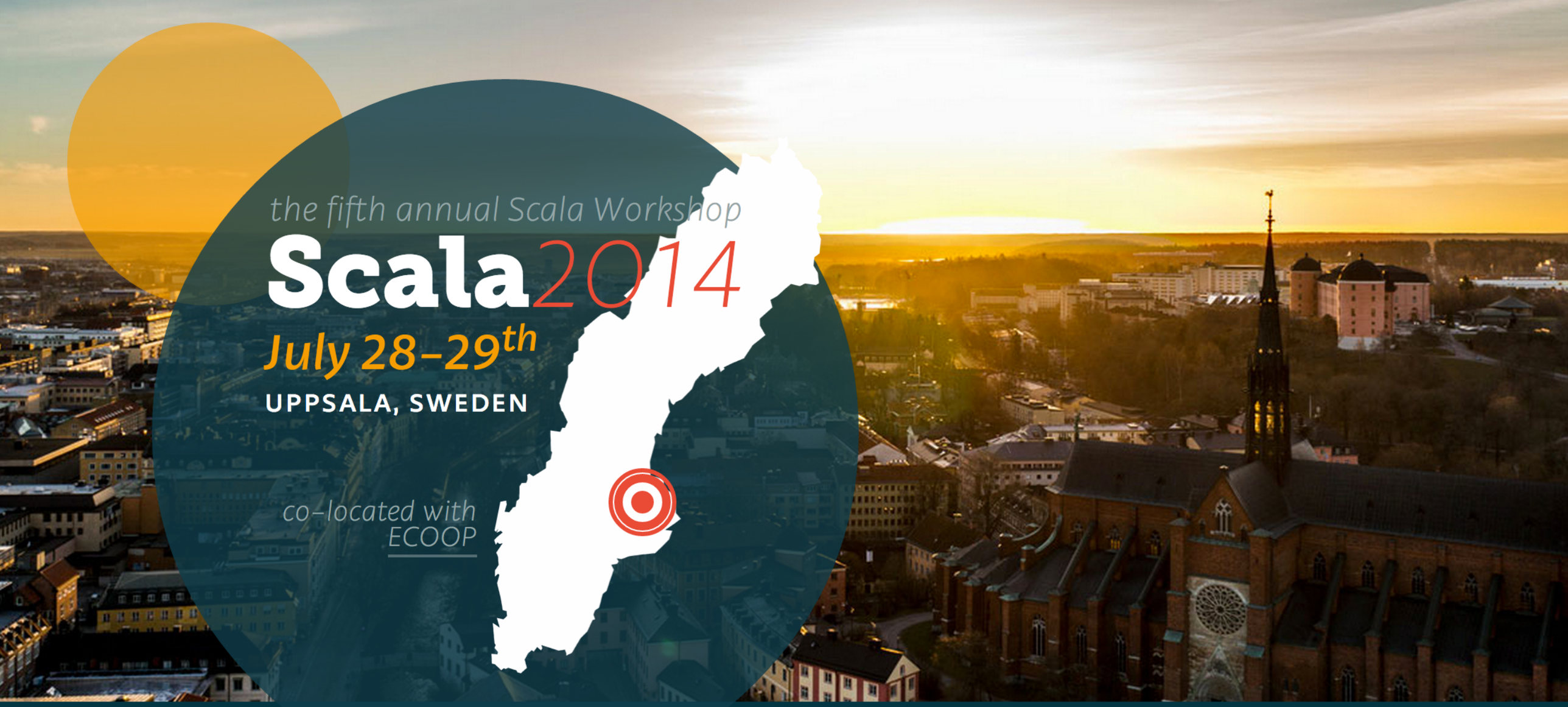
Futures and Async: When to Use Which?

Philipp Haller
@philippkhaller



The leading forum for research & development related to the Scala programming language.

Overview

- A brief guide to the Future of Scala
- What is a Promise good for?
- What is Async?
- Guidelines on when to use which

Future

Creation

```
object Future {
  // [use case]
  def apply[T](body: => T): Future[T]
  // ..
}
```

Example

```
val fstGoodDeal =
  Future {
    usedCars.find(car => isGoodDeal(car))
  }
```

Future

Type

```
trait Future[+T] extends Awaitable[T] {
  // [use case]
  def map[S](f: T => S): Future[S]
  // [use case]
  def flatMap[S](f: T => Future[S]): Future[S]
  // ..
}
```

Example

```
val fstGoodDeal: Future[Option[Car]] = ..
val fstPrice: Future[Int] =
  fstGoodDeal.map(opt => opt.get.price)
```

Future Pipelining

```
val lowestPrice: Future[Int] =
fstPrice.flatMap { p1 =>
  sndPrice.map { p2 =>
    math.min(p1, p2) }
}
```

Collections of Futures

```
val goodDeals: List[Future[Option[Car]]] = ..
```

```
val bestDeal: Future[Option[Car]] =
  Future.sequence(goodDeals).map(
    deals => deals.sorted.head
  )
```

Promise

Main purpose: create futures for non-lexically-scoped asynchronous code

Example

Function for creating a Future that is completed with ***value*** after ***delay*** milliseconds

```
def after[T](delay: Long, value: T): Future[T]
```

“after”, Version 1

```
def after1[T](delay: Long, value: T) =
  Future {
    Thread.sleep(delay)
    value
  }
```

“after”, Version 1

How does it behave?

```
assert(Runtime.getRuntime()
                .availableProcessors() == 8)

for (_ <- 1 to 8) yield
  after1(1000, true)

val later = after1(1000, true)
```

Quiz: when is “later” completed?

Answer: after either ~1 s or ~2 s (most often)

Promise

```
object Promise {
  def apply[T](): Promise[T]
}
```

```
trait Promise[T] {
  def success(value: T): this.type
  def failure(cause: Throwable): this.type

  def future: Future[T]
}
```

“after”, Version 2

```
def after2[T](delay: Long, value: T) = {
  val promise = Promise[T]()

  timer.schedule(new TimerTask {
    def run(): Unit = promise.success(value)
  }, delay)

  promise.future
}
```

Much better behaved!

Managing Blocking

What if there is no asynchronous variant of a required API?

```
import scala.concurrent.blocking

def after3[T](delay: Long, value: T) =
  Future {
    blocking { Thread.sleep(delay) }
    value
  }
```

ManagedBlocker

```
public static interface ManagedBlocker {
  boolean block() throws InterruptedException;
  boolean isReleasable();
}
```

What is Async?

- New Scala module
  - `"org.scala-lang.modules" %% "scala-async"`
- Purpose: ***simplify non-blocking concurrency***
- SIP-22 (June 2013)
- Releases for Scala 2.10 and 2.11

What Async Provides

- Future and Promise provide ***types*** and operations for managing ***data flow***

- There is very little support for control flow
  - For-comprehensions, ..?

- Async complements Future and Promise with new constructs to manage ***control flow***

Programming Model

Basis: ***suspendible computations***

- **async { ... }** — ***delimit*** suspendible computation
- **await(obj)** — ***suspend*** computation until an event is signaled to **obj**

Example: Future

Async

```
object Async {
  // [use case]
  def async[T](body: => T): Future[T]
  def await[T](future: Future[T]): T
}
```

Example

```
val fstGoodDeal: Future[Option[Car]] = ..
val sndGoodDeal: Future[Option[Car]] = ..

val goodCar = async {
  val car1 = await(fstGoodDeal).get
  val car2 = await(sndGoodDeal).get
  if (car1.price < car2.price) car1
  else car2
}
```

Guidelines

Item #1

Use async/await instead of (deeply-)nested map/flapMap calls

```
val goodCar = fstGoodDeal.flatMap { fstDeal =>
  val car1 = fstDeal.get
  sndGoodDeal.map { sndDeal =>
    val car2 = sndDeal.get
    if (car1.price < car2.price) car1
    else car2
  }
}
```

Item #1

Use async/await instead of (deeply-)nested map/flapMap calls

```
val goodCar = async {
  val car1 = await(fstGoodDeal).get
  val car2 = await(sndGoodDeal).get
  if (car1.price < car2.price) car1
  else car2
}
```

Item #2

Use async/await instead of complex for-comprehensions

```
def nameOfMonth(num: Int): Future[String] = ...
val date = """(\d+)/(\d+)""".r

for { doyResponse <- futureDOY
      dayOfYear = doyResponse.body
      response <- dayOfYear match {
        case date(month, day) =>
          for (name <- nameOfMonth(month.toInt))
            yield Ok(s"It's $name!")
        case _ =>
          Future.successful(NotFound("Not a..."))
      }
} yield response
```

BAD!

Item #2

Use async/await instead of complex for-comprehensions

```
def nameOfMonth(num: Int): Future[String] = ...
val date = """(\d+)/(\d+)""".r
```

```
async {
  await(futureDOY).body match {
    case date(month, day) =>
      Ok(s"It's ${await(nameOfMonth(month.toInt))}!")
    case _ =>
      NotFound("Not a date, mate!")
  }
}
```

Item #3

Use combinators for collections of futures instead of async/await and imperative while-loops

```
val futures = ..

async {
  var results = List[T]()
  var i = 0
  while (i < futures.size) {
    results = results :+ await(futures(i))
    i += 1
  }
  results
}
```

Item #3

Use combinators for collections of futures instead of async/await and imperative while-loops

```
val futures = ..

Future.sequence(futures)
```

Item #4

Do not accidentally sequentialize futures

```
for {
  x <- Future { .. }
  y <- Future { .. }
} yield {
  ..
}
```

Item #4

Do not accidentally sequentialize futures

```
futX = Future { .. }
futY = Future { .. }
```

```
async {
  val x = await(futX)
  val y = await(futY)
  ..
}
```

Item #5

Use Async to improve performance

- Async ***reduces closure allocations*** compared to code using higher-order functions like map, flatMap, etc.

- Async ***reduces boxing*** of primitive values in some cases

Item #6

Use Async because of future extensions

Since Async is a macro library, we will be able to do useful rewritings in the future:

- ***Automatic parallelization*** of Future-returning calls if no dependencies

- Optionally configure await calls to be blocking to maintain ***intact thread stack***

Conclusion

- Focus on Future, not Promise
- Use Promise only when necessary
- Async is there to simplify Future-based code
- Async is production-ready