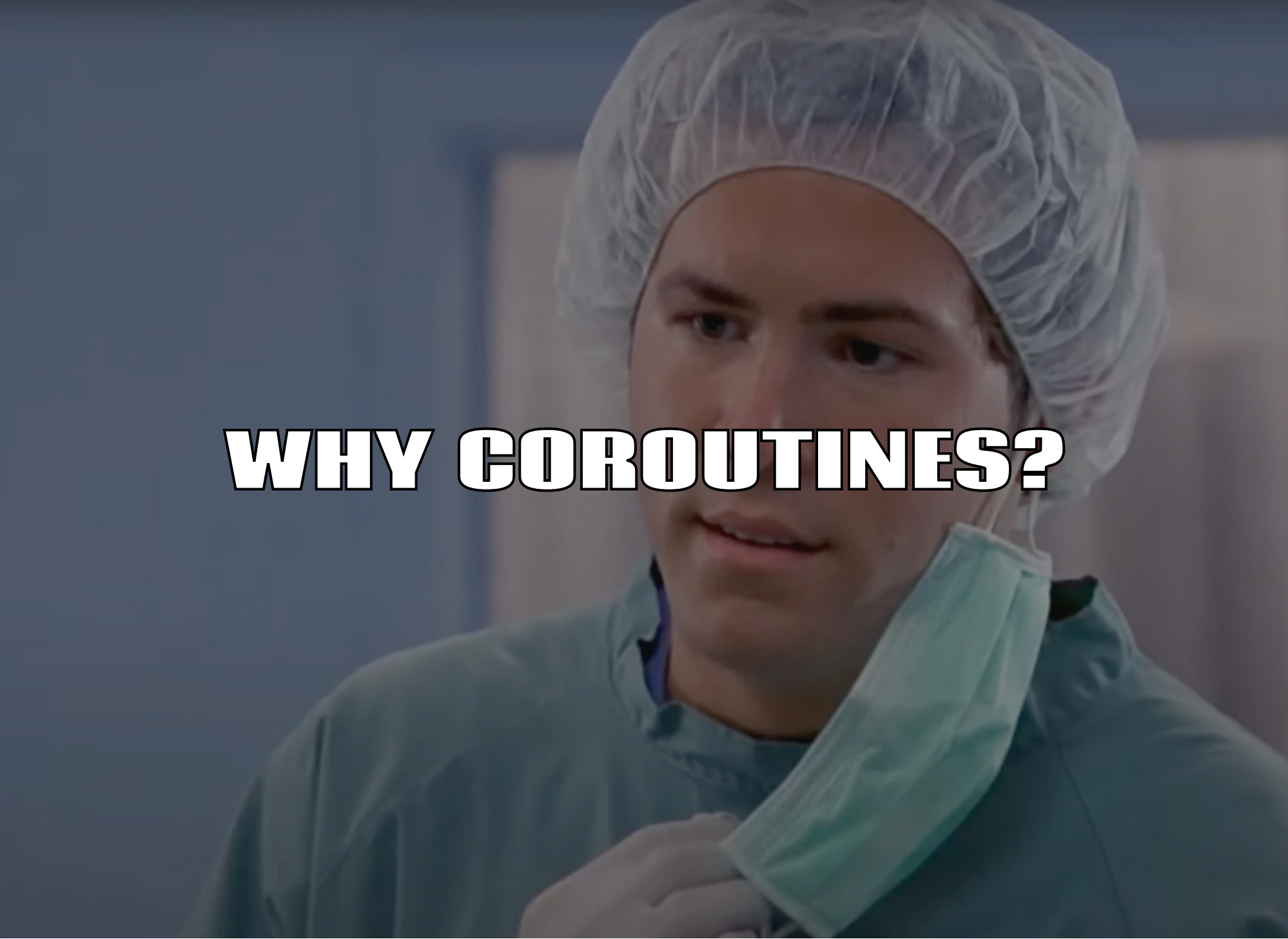

EXPLORING KOTLIN
COROUTINES
Stefan Bissell

Examples and slides:

https://github.com/weaselflink/exploring-kotlin-coroutines


WHY COROUTINES?

WHY DO WE USE THREADS?

Threads are used to …

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Threads are used to …

- utilize multiple processors

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Threads are used to …

- utilize multiple processors
- **WAIT**

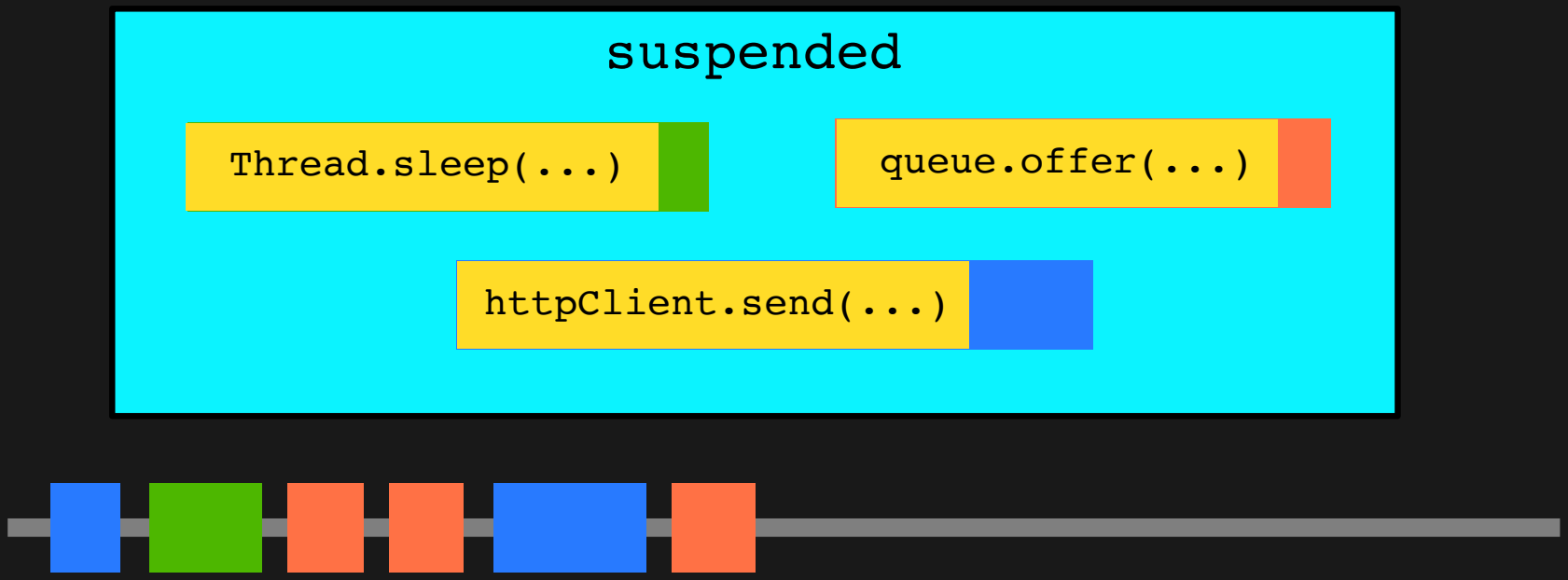
WHAT DOES A THREAD COST?

```
1 while (true) {
2   thread {
3     TimeUnit.MINUTES.sleep(1)
4   }
5 }
```

You will get a OutOfMemoryError relatively soon (a few thousand threads on my machine).

THREADS MOSTLY WAIT

ONE THREAD SHOULD BE ENOUGH



COROUTINES ARE CHEAP

Coroutines love waiting for something.

```
runBlocking {
  repeat(1_000_000) {
    launch {
      delay(TimeUnit.MINUTES.toMillis(1))
    }
  }
}
```

NO MORE THREADS?

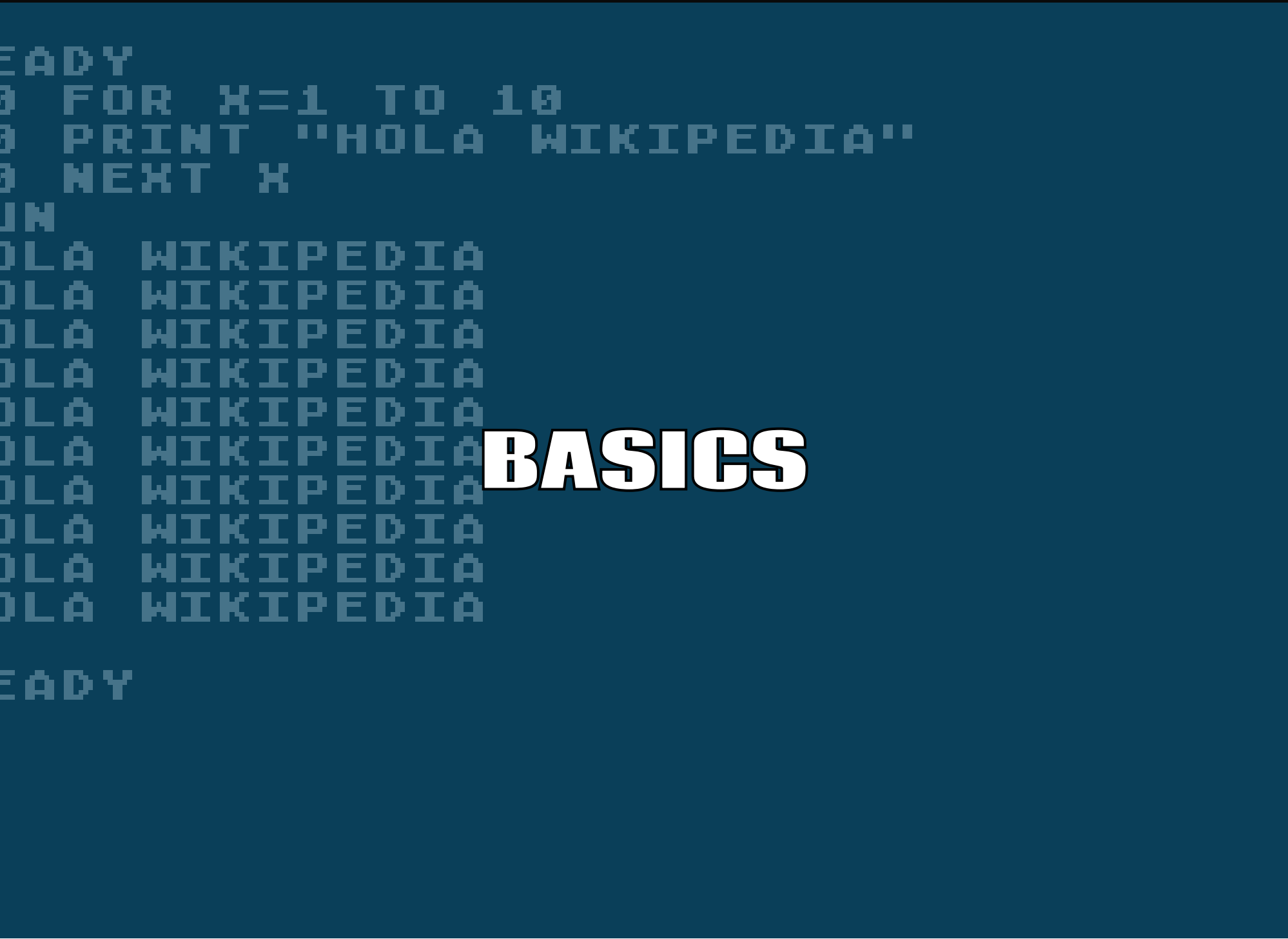
Coroutines still need threads to execute them.

```
1 val context = newSingleThreadContext("single thread")
2 runBlocking {
3     launch(context) {
4         println(Thread.currentThread().name)
5     }
6 }
```

BREAKING COROUTINES

Blocking the thread inside a coroutine is a bad idea!

```
1 val context = newSingleThreadContext("single thread")
2 runBlocking {
3     launch(context) {
4         TimeUnit.MINUTES.sleep(1)
5     }
6     launch(context) {
7         println("I have to wait a minute")
8     }
9 }
```


EADY
0 FOR X=1 TO 10
0 PRINT "HOLA WIKIPEDIA"
0 NEXT X
UN
OLA WIKIPEDIA
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EADY
BASICS


LAUNCHING COROUTINES

THE LAUNCH() METHOD

```
public fun CoroutineScope.launch(...): Job
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THE LAUNCH() METHOD

```
public fun CoroutineScope.launch(...): Job
```

- has no `suspend` keyword
- needs a `CoroutineScope`
- returns a `Job`

NOT SUSPENDING

```
1 launch {
2     println("I am second")
3 }
4 println("I am first")
```

NOT SUSPENDING

```
1 launch {
2     println("I am first")
3 }
4 yield() // allows launch to run
5 println("I am second")
```

NEEDS A SCOPE

```
1 CoroutineScope(someContext).launch {
2     // ...
3 }
```

NEEDS A SCOPE

```
runBlocking {
    launch {
        // ...
    }
}
```

NEEDS A SCOPE

```
1 suspend fun bla() {
2     coroutineScope {
3         launch {
4             // ...
5         }
6     }
7 }
```

NEEDS A SCOPE

```
1 suspend fun CoroutineScope.bla() {
2     launch {
3         // ...
4     }
5 }
```

RETURNS A JOB

```
1 val job: Job = launch {
2     // ...
3 }
4 if (job.isActive) {
5     // react to coroutine state
6 }
7 job.cancel()
8 job.join()
```

DEFERRED IS ALSO A JOB

```
1 val result: Deferred<Int> = async {
2     5
3 }
4 val value = result.await() // 5
5 val job: Job = result
6 job.cancel()
```

CANCELLING COROUTINES

EXCEPTION

Cancels whole scope.

```
launch {
    launch {
        // cancelled
    }
    throw Exception()
}
launch {
    // cancelled
}
// cancelled
```

MANUAL CANCELLATION

Cancels only self and children.

```
launch {
    launch {
        // cancelled
    }
    cancel()
}
launch {
    // runs fine
}
// runs fine
```

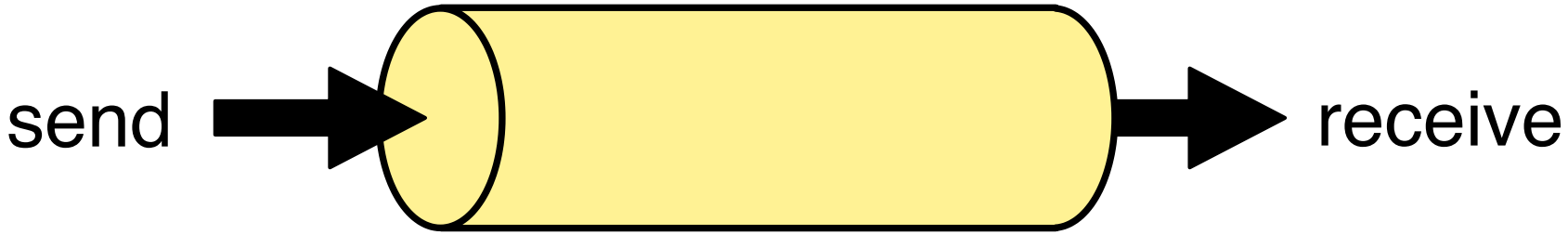
SUPERVISORJOB

Exception cancellation is contained in children.

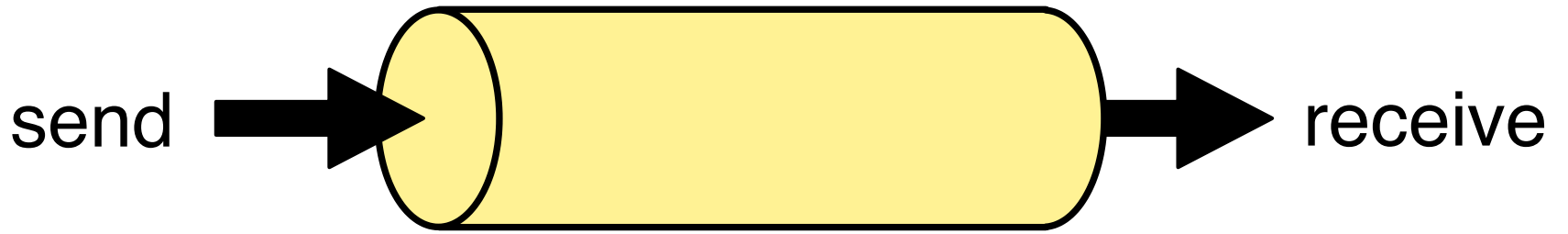
```
supervisorScope {
    launch {
        launch {
            // cancelled
        }
        throw Exception()
    }
    launch {
        // runs fine
    }
}
```

CHANNELS

SUSPENDING METHODS



SUSPENDING METHODS




```
suspend fun send(element: E)
suspend fun receive(): E
```

DEFAULT CAPACITY

```
1 runBlocking {
2     val channel = Channel<Int>()
3     channel.send(7)
4     println(channel.receive())
5 }
```

DEFAULT CAPACITY

```
1 runBlocking {
2     val channel = Channel<Int>()
3     channel.send(7) // suspends forever
4     println(channel.receive())
5 }
```

DEFAULT CAPACITY

```
1 runBlocking {
2     val channel = Channel<Int>()
3     launch {
4         channel.send(7)
5     }
6     println(channel.receive())
7 }
```

DEFAULT CAPACITY

```
1 runBlocking {
2     val channel = Channel<Int>(capacity = 1)
3     channel.send(7)
4     println(channel.receive())
5 }
```

CAN BRIDGE ACROSS CONTEXTS

Channel instances are not bound to coroutine scopes.

```
1 val channel = Channel<Int>()
```

CAN BRIDGE ACROSS CONTEXTS

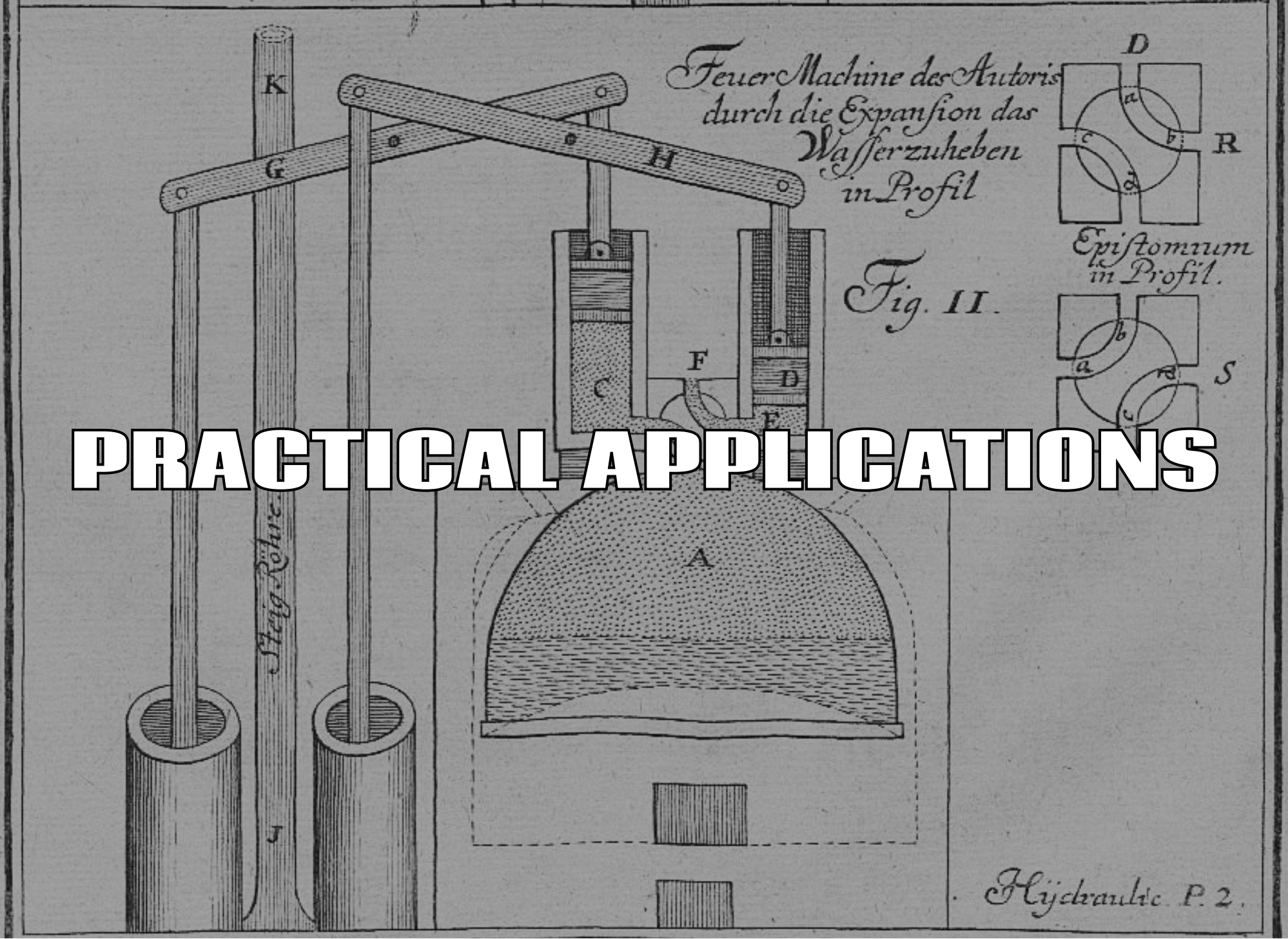
Channel instances are not bound to coroutine scopes.

```
1 val channel = Channel<Int>()
2 scope1.launch {
3     var sum = 0
4     for (message in channel) {
5         sum += message
6     }
7     println(sum)
8 }
```

CAN BRIDGE ACROSS CONTEXTS

Channel instances are not bound to coroutine scopes.

```
1  val channel = Channel<Int>()
2  scope1.launch {
3      var sum = 0
4      for (message in channel) {
5          sum += message
6      }
7      println(sum)
8  }
9  scope2.launch {
10     channel.send(1)
11     channel.close()
12 }
```



PRACTICAL APPLICATIONS

WORKER POOLS

HTTP WORKERS

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Problem: calling slow services exhausts thread pool

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Old solution: separate thread pool per service

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Old solution: separate thread pool per service

Problem: a few slow calls can block service

NON-BLOCKING HTTP

Non-blocking clients (e.g. java.net.http) can be easily used from coroutines.

```
suspend fun get(url: String): HttpResponse<String> =
    HttpClient
        .newHttpClient()
        .sendAsync(
            HttpRequest.newBuilder(URI(url)).GET().build(),
            HttpResponse.BodyHandlers.ofString()
        )
        .await()
```

NO MORE THREAD POOLS

```
 1 supervisorScope {
 2     repeat(1_000) {
 3         launch {
 4             get("https://httpbin.org/delay/5")
 5                 .also {
 6                     println(it.statusCode())
 7                 }
 8         }
 9     }
10 }
```

WEB SERVERS

ONE THREAD PER REQUEST

Classic Java web server way of handling requests.

More requests, more threads, more resources consumed.

KTOR

One (or more) coroutines per request.

```
1  get("/balance/{customerId}") {
2      findAccounts(call.parameters["customerId"])
3          .map {
4              async { // launch + return value
5                  getBalance(it)
6              }
7          }
8          .sumOf {
9              it.await()
10         }
11 }
```

KTOR

Every call can take as much time as it likes.

```
1 get("/sales.csv") {
2     call.respondBytesWriter {
3         getSoldItemLines() // produce lines on demand
4             .forEach {
5                 writeAvailable(it.toByteBuffer())
6             }
7     }
8 }
```


ACTORS

ACTOR MODEL

When an actor receives a message, it can (in any order)

- send messages to other actors
- create new actors
- modify it's behaviour

ENCAPSULATING STATE

```
1  actor<CounterAction> {
2      var counter = 0 // <- mutable state
3      for (message in channel) {
4          when (message) {
5              is CounterAction.Add -> {
6                  counter += message.value
7              }
8              is CounterAction.Get -> {
9                  message.answer.complete(counter)
10             }
11         }
12     }
13 }
```

FAN OUT

```
1  actor<ShoppingCartPriceRequest> {
2      for (message in channel) {
3          val aggregator = aggregatorActor(message.result)
4          getShoppingCart(message.id)
5              .forEach {
6                  aggregator.send(ItemPriceRequest(it))
7              }
8          aggregator.close()
9      }
10 }
```

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