# Failure Handling with Actors

Principles of Functional Programming

Roland Kuhn

## Failure Handling in Asynchronous Systems

Where shall failures go?

- reify as messages
- send to a known address

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The Actor Model is anthropomorphic:

- Actors work together in teams (systems)
- individual failure is handled by the team leader

## Supervision

Resilience demands *containment* and *delegation* of failure.

- failed Actor is terminated or restarted
- decision must be taken by one other Actor
- supervised Actors form a tree structure
- the supervisor needs to create its subordinate

## Supervisor Strategy

In Akka the parent declares how its child Actors are supervised:

```
class Manager extends Actor {
  override val supervisorStrategy = OneForOneStrategy() {
    case _: DBException           => Restart // reconnect to DB
    case _: ActorKilledException => Stop
    case _: ServiceDownException => Escalate
  }
  ...
  context.actorOf(Props[DBActor], ”db”)
  context.actorOf(Props[ImportantServiceActor], ”service”)
  ...
}
```

## Supervisor Strategy (cont'd)

Failure is sent and processed like a message:

```
class Manager extends Actor {
  var restarts = Map.empty[ActorRef, Int].withDefaultValue(0)
  override val supervisorStrategy = OneForOneStrategy() {
    case _: DBException =>
      restarts(sender()) match {
        case toomany if toomany > 10 =>
          restarts -= sender(); Stop
        case n =>
          restarts = restarts.updated(sender(), n + 1); Restart
      }
  }
}
```

## Supervisor Strategy (cont'd)

If decision applies to all children: `AllForOneStrategy`

Simple rate trigger included:

- allow a finite number of restarts
- allow a finite number of restarts in a time window
- if restriction violated then `Stop` instead of `Restart`

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```
OneForOneStrategy(maxNrOfRetries = 10, withinTimeRange = 1.minute) {
  case _: DBException => Restart // will turn into Stop
}
```

## Actor Identity

Recovery by restart requires stable identifier to refer to the service:

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- in Erlang a name is registered for the current PID

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What does restart mean?

- expected error conditions are handled explicitly
- unexpected error indicate invalidated actor state
- restart will install initial behavior / state

## Actor Lifecycle

- start
- (restart)*
- stop

## Actor Lifecycle Hooks

```scala
trait Actor {
  def preStart(): Unit = {}
  def preRestart(reason: Throwable, message: Option[Any]): Unit = {
    context.children foreach (context.stop(_))
    postStop()
  }
  def postRestart(reason: Throwable): Unit = {
    preStart()
  }
  def postStop(): Unit = {}
  ...
}
```

## The Default Lifecycle

```scala
class DBActor extends Actor {
  val db = DB.openConnection(...)
  ...
  override def postStop(): Unit = {
    db.close()
  }
}
```

In this model the actor is fully reinitialized during restart.

## Lifecycle Spanning Restarts

```scala
class Listener(source: ActorRef) extends Actor {
  override def preStart() { source ! RegisterListener(self) }
  override def preRestart(reason: Throwable, message: Option[Any]) {}
  override def postRestart(reason: Throwable) {}
  override def postStop() { source ! UnregisterListener(self) }
}
```

Actor-local state cannot be kept across restarts, only external state can be managed like this.

Child actors not stopped during restart will be restarted recursively.

## Summary

Actors work together in hierarchical systems.

Failures are handled by sending them upwards to the supervisor.

Actors are started, possibly restarted and finally stopped.