## Declarative distributed concurrency in Scala

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## Talk summary

How I learned to forget semaphores and to love concurrency

Chymyst = an implementation of the Chemical Machine (CM) paradigm

- ullet CM pprox Actors made purely functional and auto-parallelized
- Intuitions about why CM works better than other concurrency models
  - ► Comparison with related work: ING Baker, BPMN (workflow)
- New extension for distributed programming: DCM
- Code examples and demos

Not in this talk: academic theory

- ullet Petri nets,  $\pi$ -calculus, join calculus, joinads, mobile agent calculus...
- DCM formulated within some theory of distributed programming

## Concurrent & parallel programming: How we cope

*Imperative* concurrency & parallelism is difficult to reason about:

- low-level API: callbacks, threads, semaphores, mutex locks
- hard to reason about mutable state and running processes
- hard to test non-deterministic runtime behavior!
  - race conditions, deadlocks, livelocks
    Known declarative approaches to avoid these problems:

Kind of concurrency	Formal structure	Scala implementation
synchronous parallelism	applicative functor	Spark, .par.map()
asynchronous streaming	monadic functor	Future, async/await,
DAG		RxJava, Akka Streams
unrestricted streaming	recursive monad+	Flink, fs2, ZIO
unrestricted concurrency	?	Akka, Chymyst

For distributed computing: challenges remain

- coordination and consensus, persistence and fault tolerance
- cluster configuration and discovery
  - distributed coordination as a service: Apache ZooKeeper, etcd