Artificial Neural Networks in Akka

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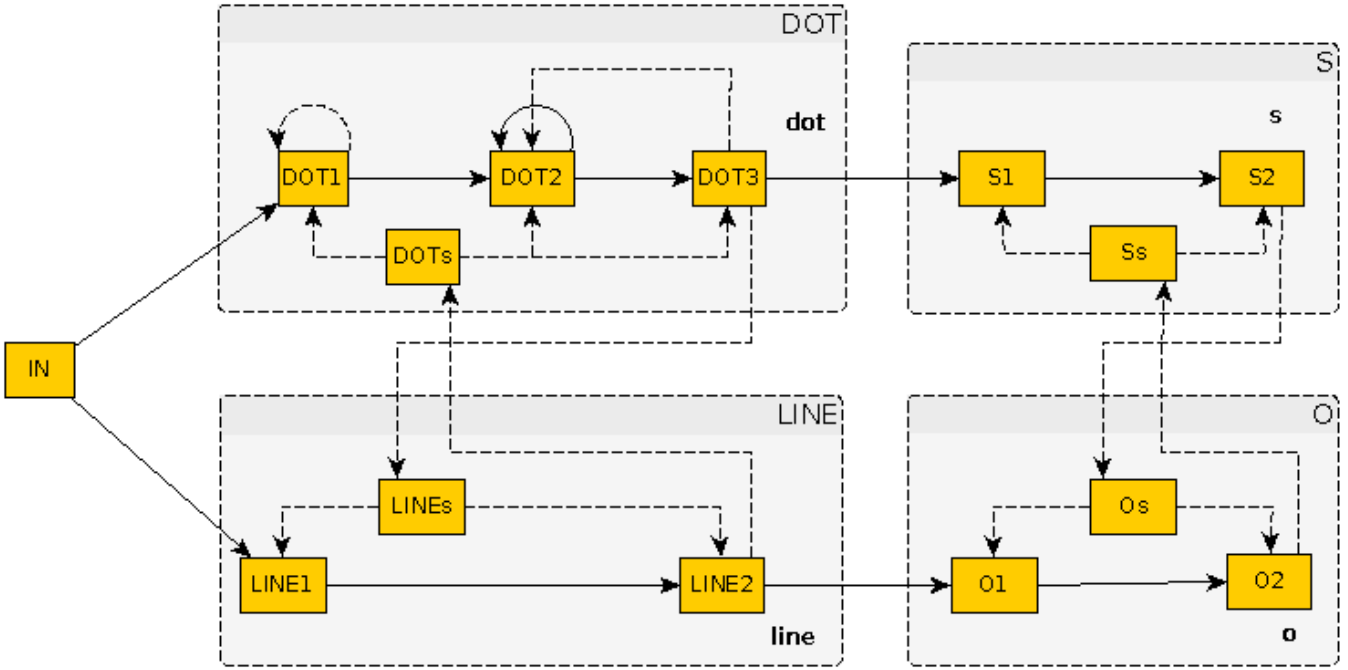


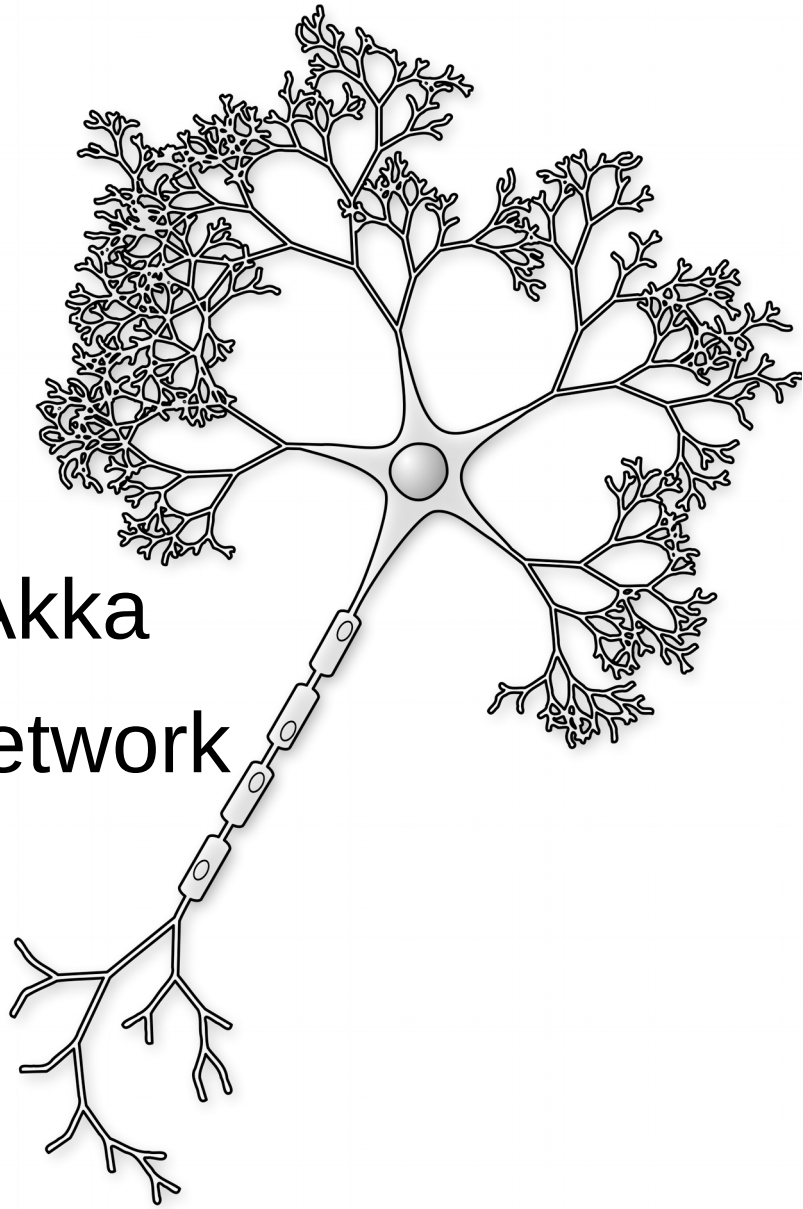
wire

http://wire.com

The Plan

- Introduction
- A few words about neurons
- Similarities to Akka actors
- How to model a neuron with Akka
- Building blocks of a neuron network
- An example:

  the S.O.S. signal recognition

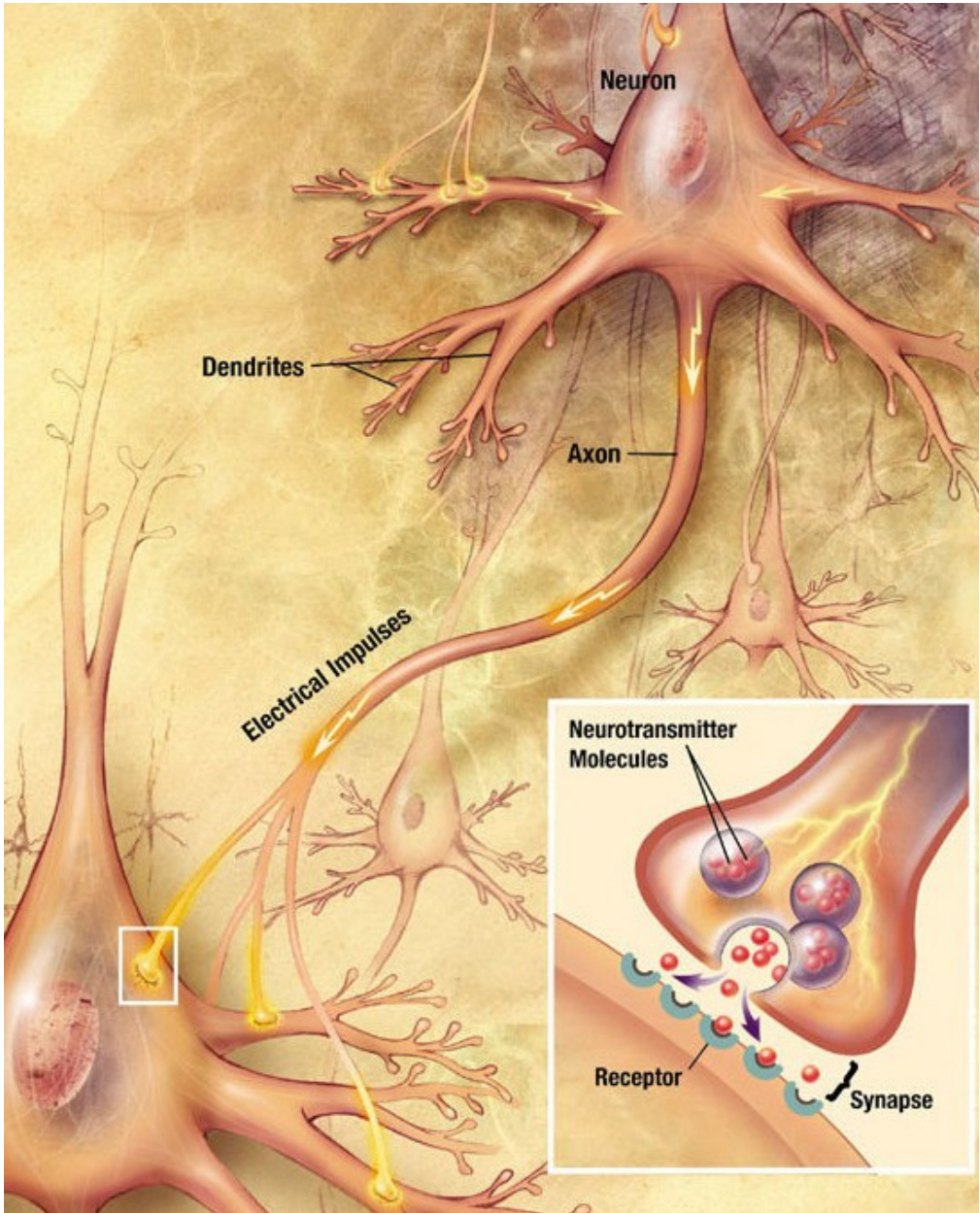


Instead… bees!

- Approximately 900,000 neurons in total
- Mostly hardwired
- Work on unreliable, insufficient data
- Still able to do amazing feats

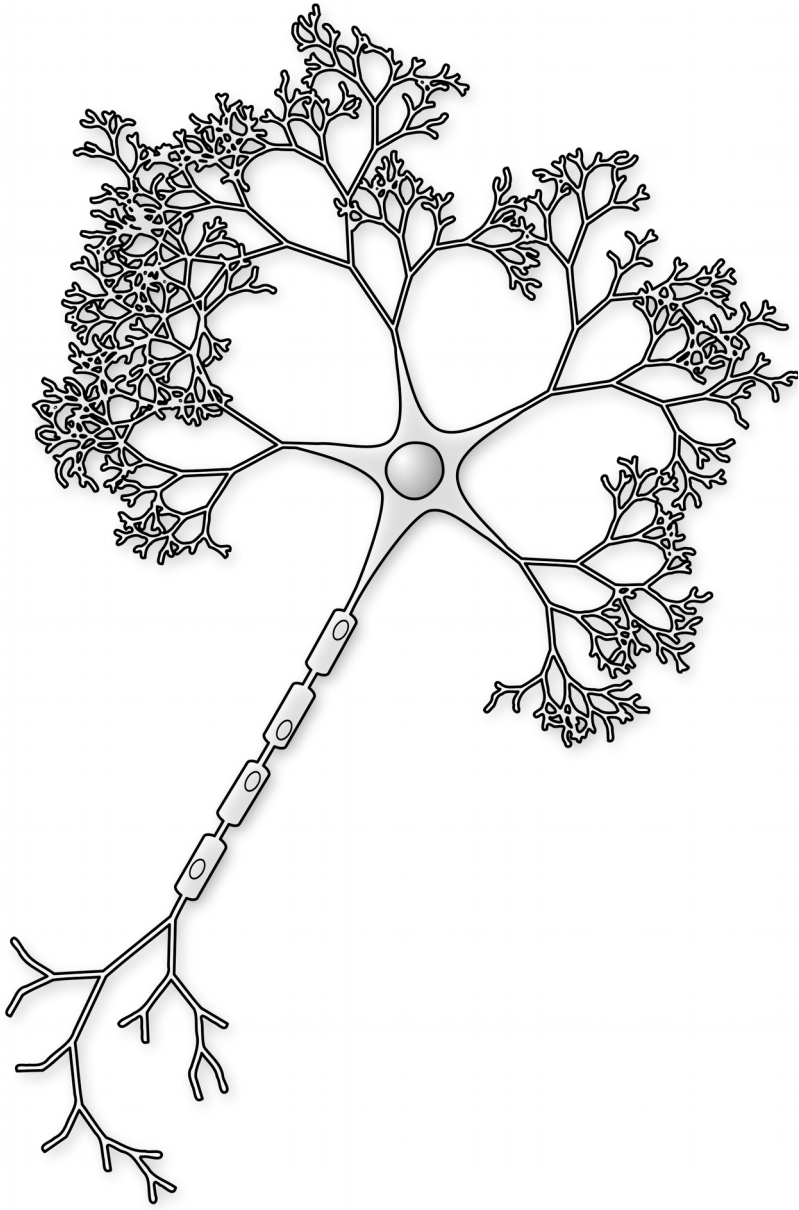
Basic info about actual neurons

- Dendrites
- An axon
- Electrical and ...
- … electro-chemical signals
- Neurotransmitters: excitatory and inhibitory (GABA).

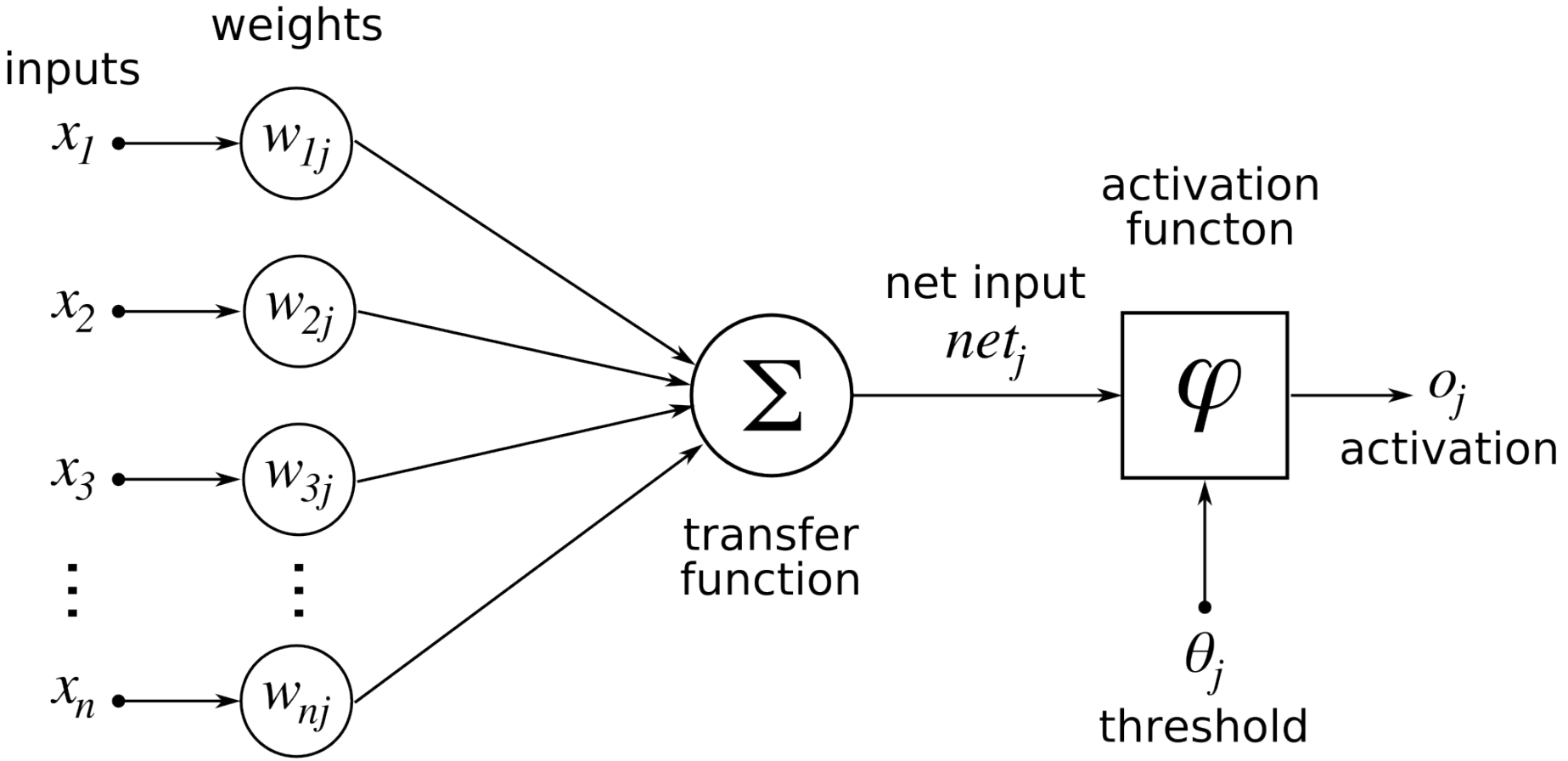


Reactive and asynchronous

- No external supervisor
- Only reacting to stimuli
- No bigger picture
  (a.k.a. what other neurons?)

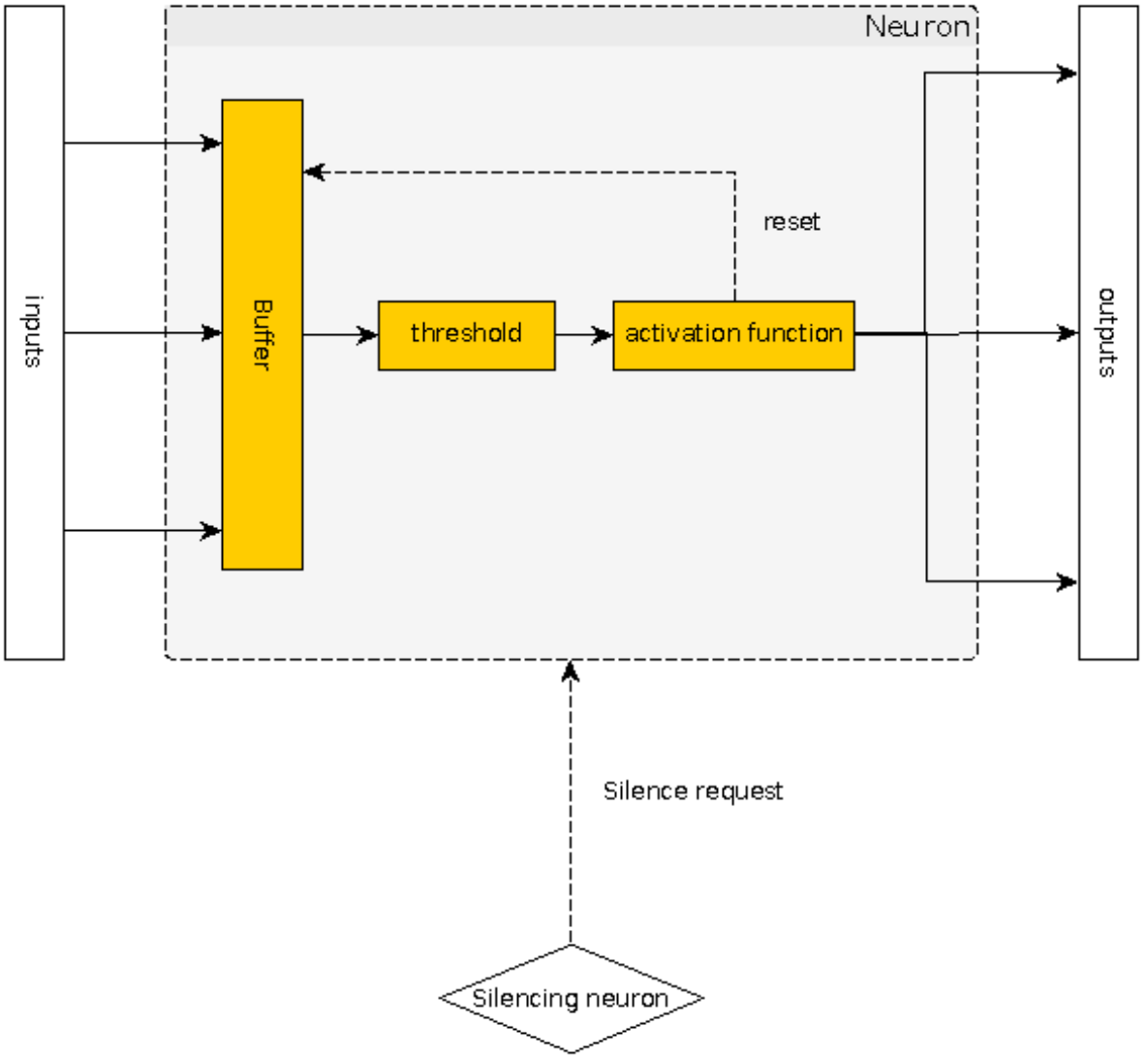


The traditional model of an artificial neuron



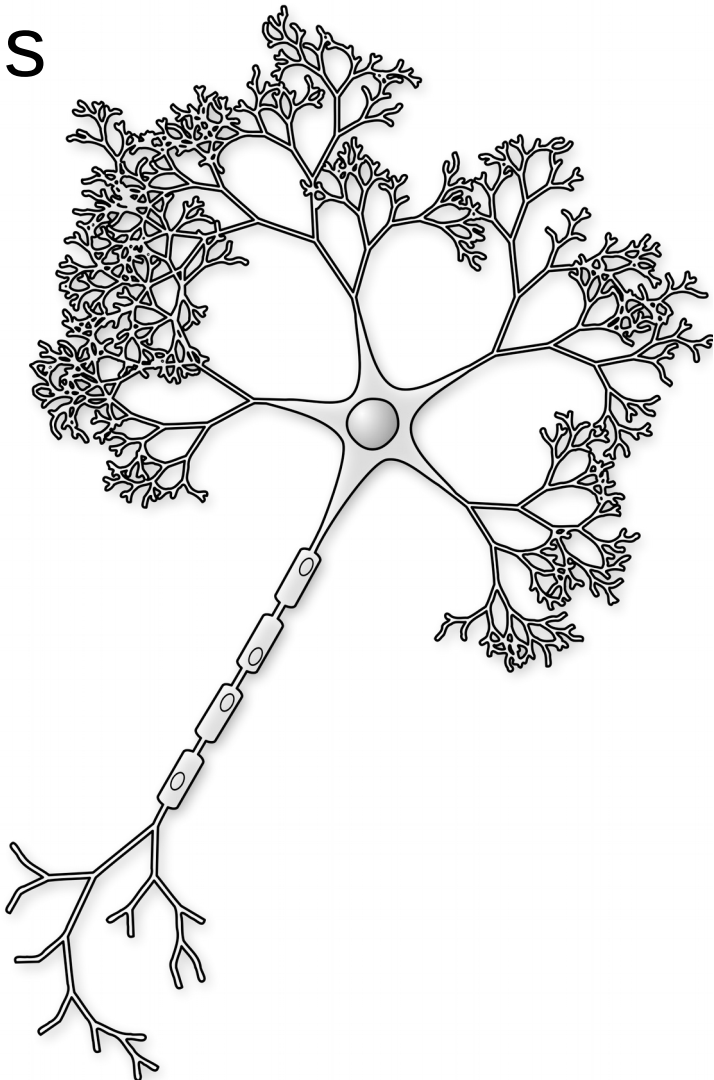
But do you know what else is reactive and asynchronous?

Akka Actor implementation of an artificial neuron



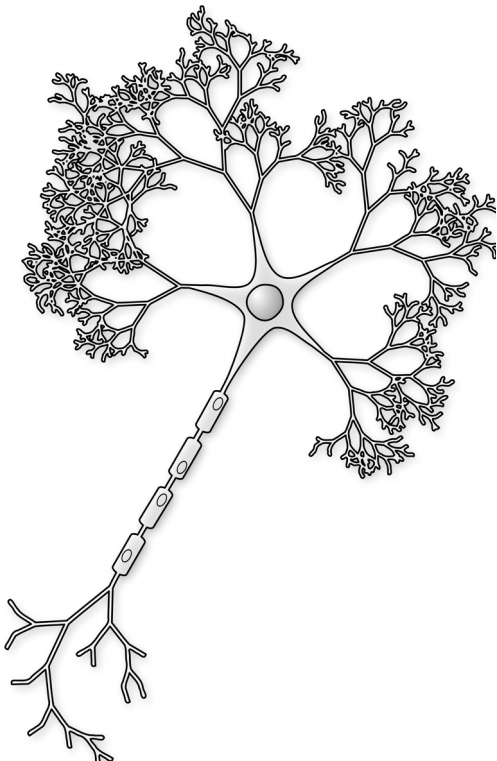
Interesting Akka traits

- Concurrent
- Communicate through messages
- Reactive
- Sending a message takes time
- Communication is unordered



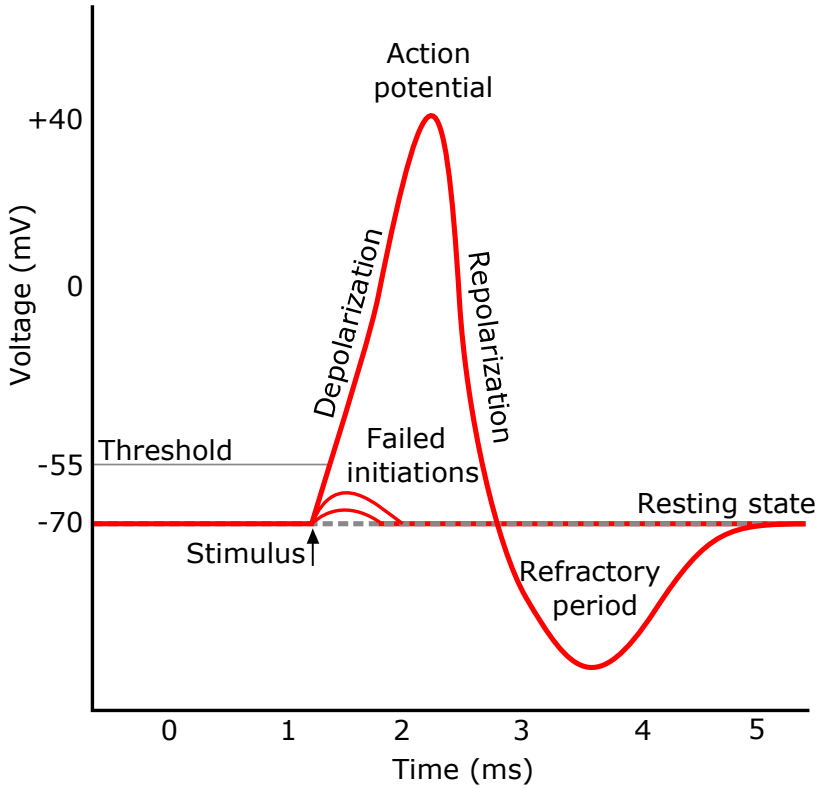
Local synchronization – why?

- Message time gaps **cannot** be controlled
- Neurons are triggered by messages
- In small interacting blocks of neurons their sequence of responses **have to** be controlled



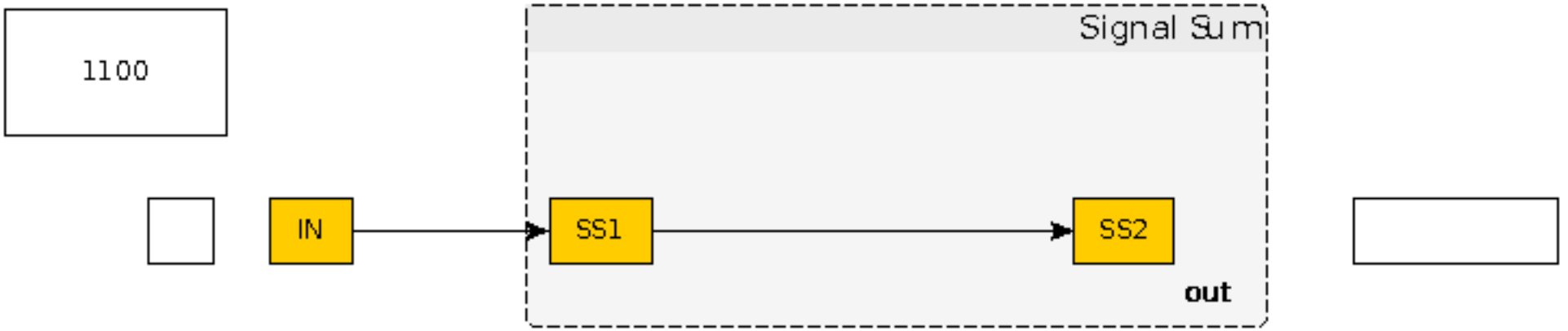
Local synchronization – how?

- Estimate the max time gap (an iteration)
- Simulate the refractory period
- Note that it works only for small blocks of interacting neurons



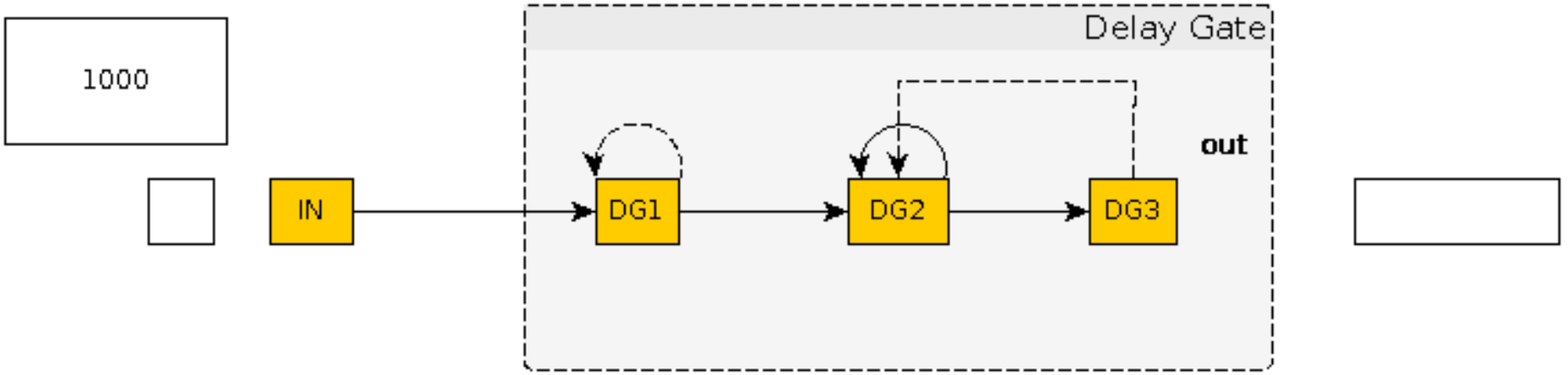
Neuron blocks – Signal Sum

- Promotes encapsulation



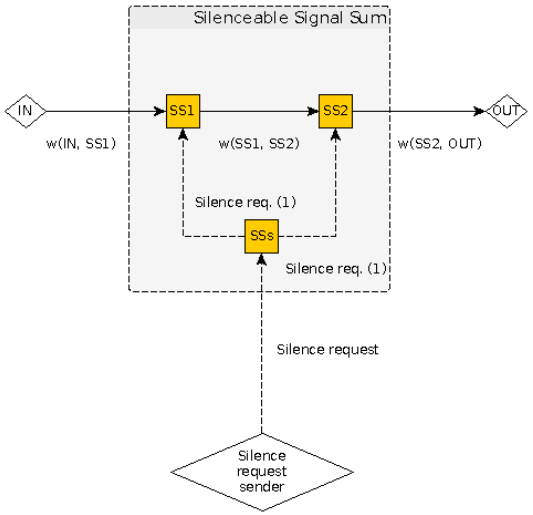
Neuron blocks – Delay Gate

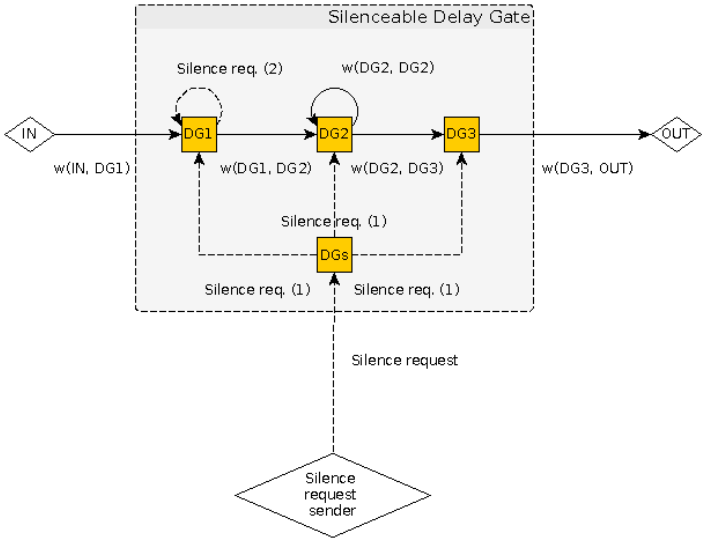
- Time gaps as a source of information



The silencing neurons

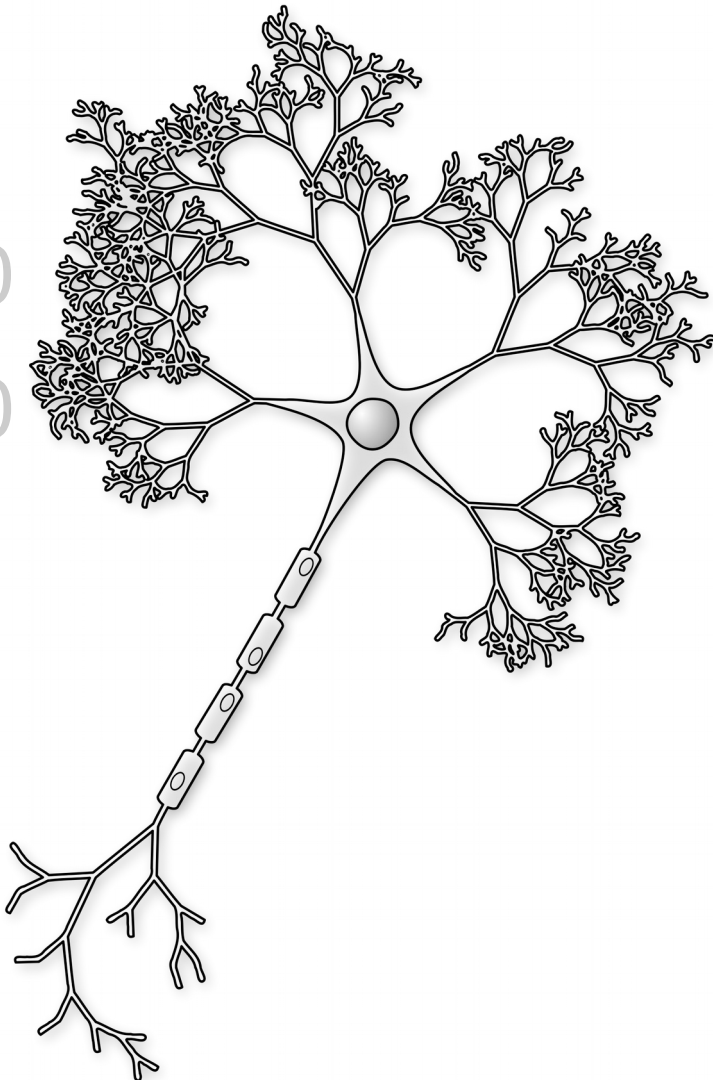
- Further encapsulation
- There are actual neurons working like that



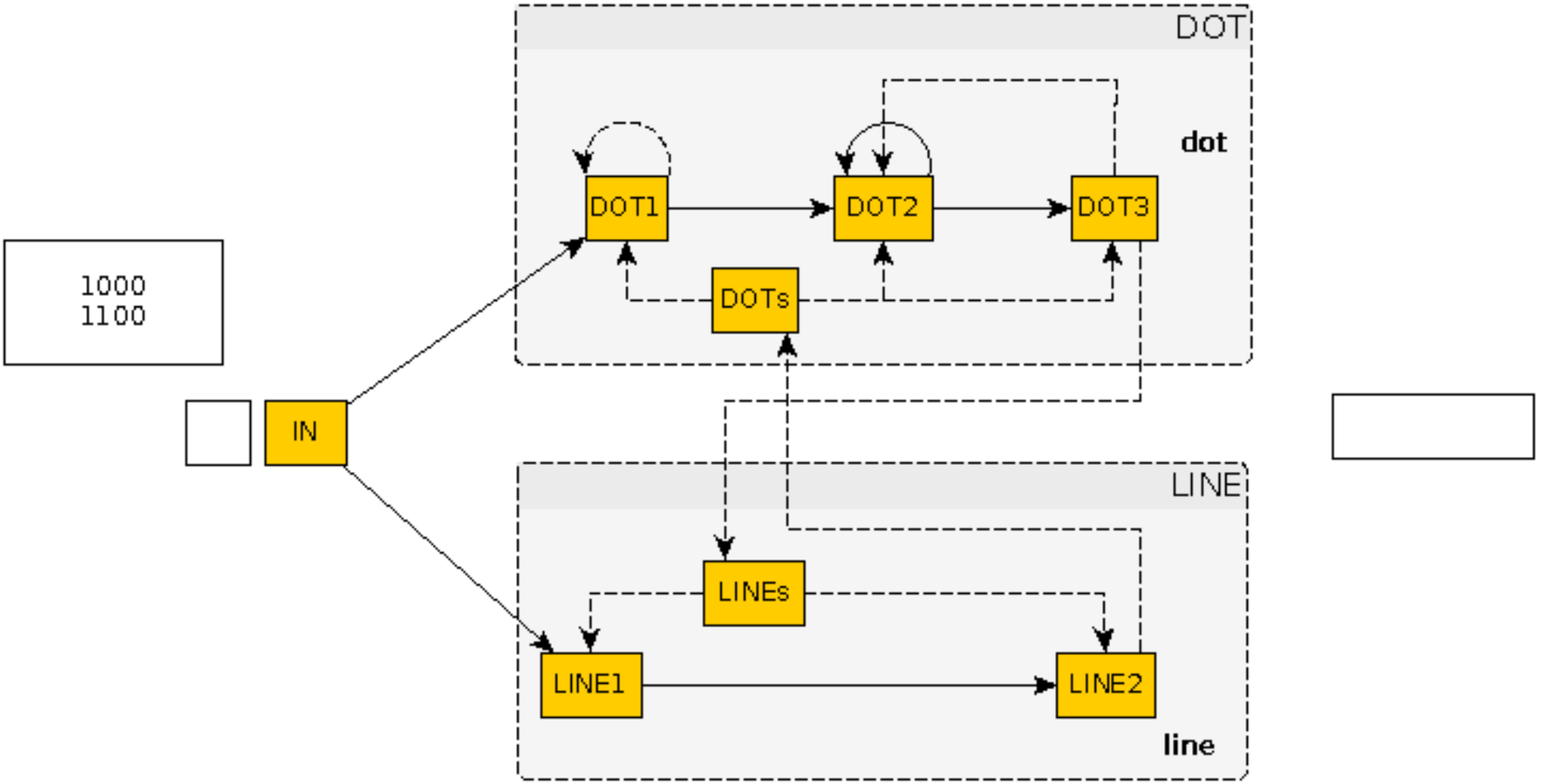


The S.O.S. example

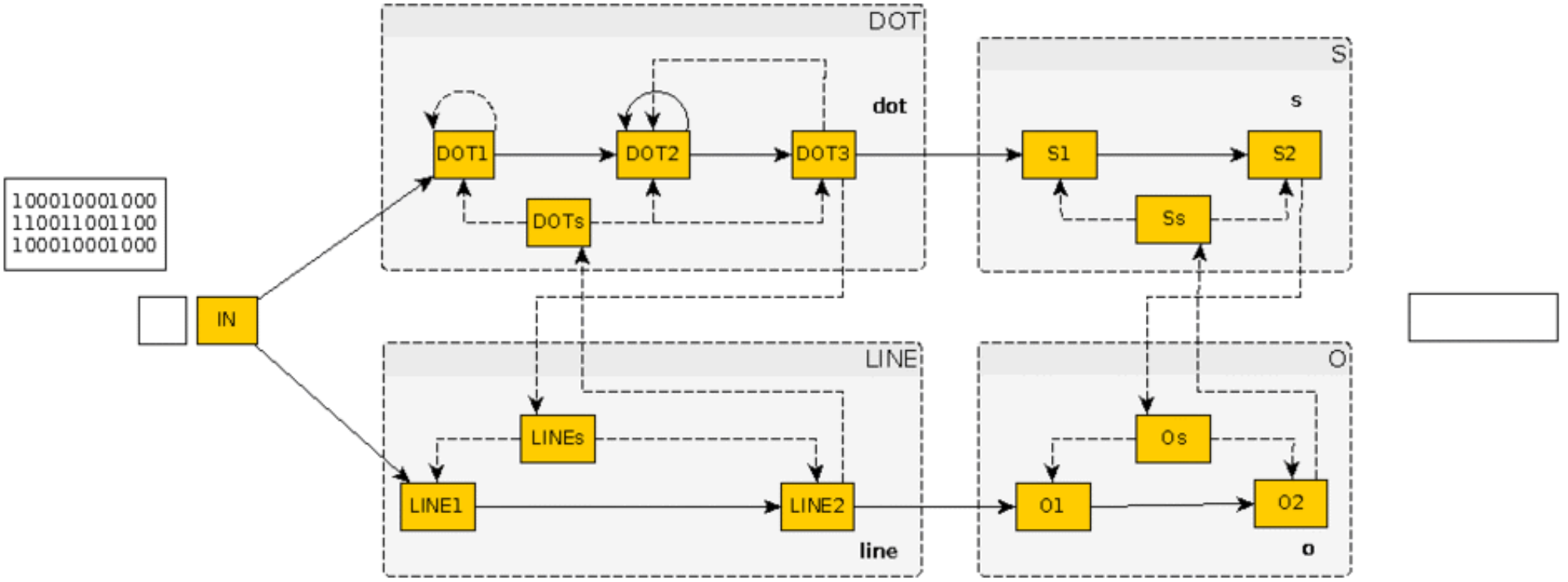
- Encoding the Morse code:
  - A dot = 1000
  - A line = 1100
- S = three dots = 1000100010000
- O = three lines = 110011001100



Recognizing dots and lines



Recognizing S and O and S

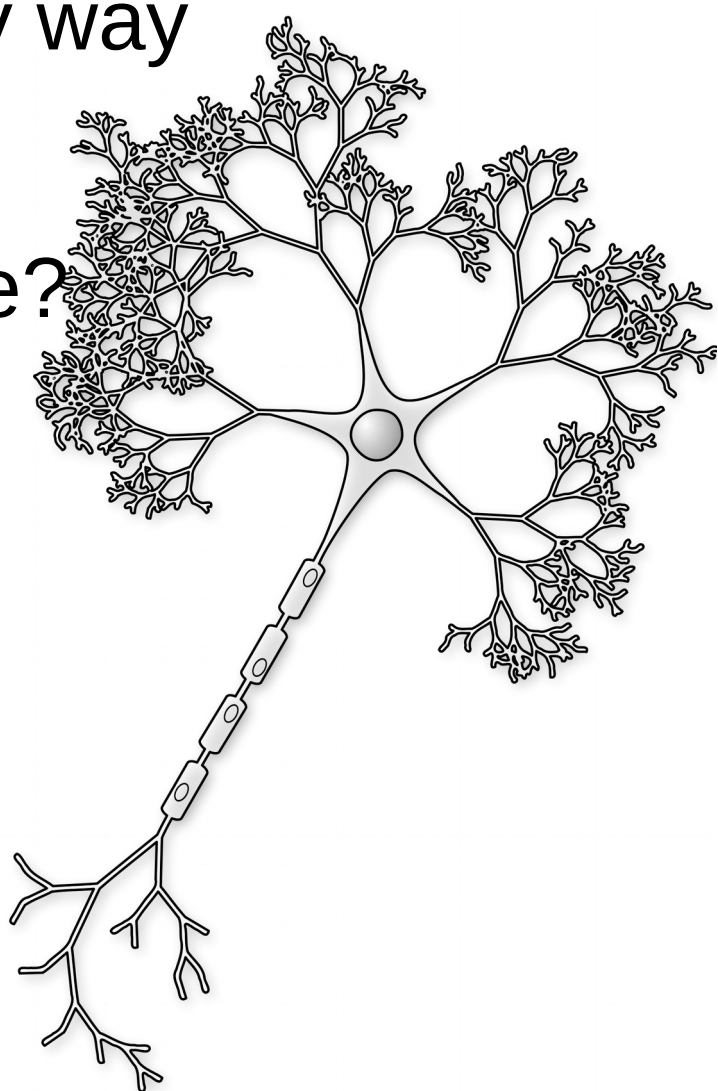


Dealing with noise

Input	Output	Input	Output
1,0,0,0,1,0,0,0,1,0,0,0	... → s	1,1,0,0,1,1,0,0,1,1,0,0	--- → o
1,0,0,0,1,0,0,0,1,0,0,**1**	... → s	1,1,0,0,1,1,0,0,1,**0**,**1**,0	--- → o
1,0,0,0,1,0,0,**1**,1,0,0,0	..-	1,1,0,0,1,**0**,**1**,0,1,1,0,0	--- → o
1,0,0,**1**,1,0,0,0,1,0,0,0	.-.	1,**0**,**1**,0,1,1,0,0,1,1,0,0	--- → o
1,0,0,0,1,0,0,0,**0**,**1**,0,0	... → s	1,1,0,0,1,1,0,0,1,**0**,**1**,**1**	---. → o
1,0,0,0,**0**,**1**,0,0,1,0,0,0	..	1,1,0,0,1,**0**,**1**,**1**,1,1,0,0	---. → o
0,**1**,0,0,1,0,0,0,1,0,0,0	.-	1,**0**,**1**,**1**,1,1,0,0,1,1,0,0	--.- → o
1,0,0,0,1,0,0,0,**0**,0,**1**,0	... → s	1,1,0,0,1,1,0,0,1,1,**1**,0	---. → o
1,0,0,0,**0**,0,**1**,0,1,0,0,0	.-	1,1,0,0,1,1,**1**,0,1,1,0,0	---. → o
0,0,**1**,0,1,0,0,0,1,0,0,0	-.	1,1,**1**,0,1,1,0,0,1,1,0,0	--.- → o
1,0,0,0,1,0,0,0,**0**,0,0,**1**	... → s	1,1,0,0,1,1,0,0,1,1,1,**1**	---- → o
1,0,0,0,**0**,0,0,**1**,1,0,0,0	.-	1,1,0,0,1,1,**1**,**1**,1,1,0,0	---- → o
0,0,0,**1**,1,0,0,0,1,0,0,0	-.	1,1,**1**,**1**,1,1,0,0,1,1,0,0	---- → o

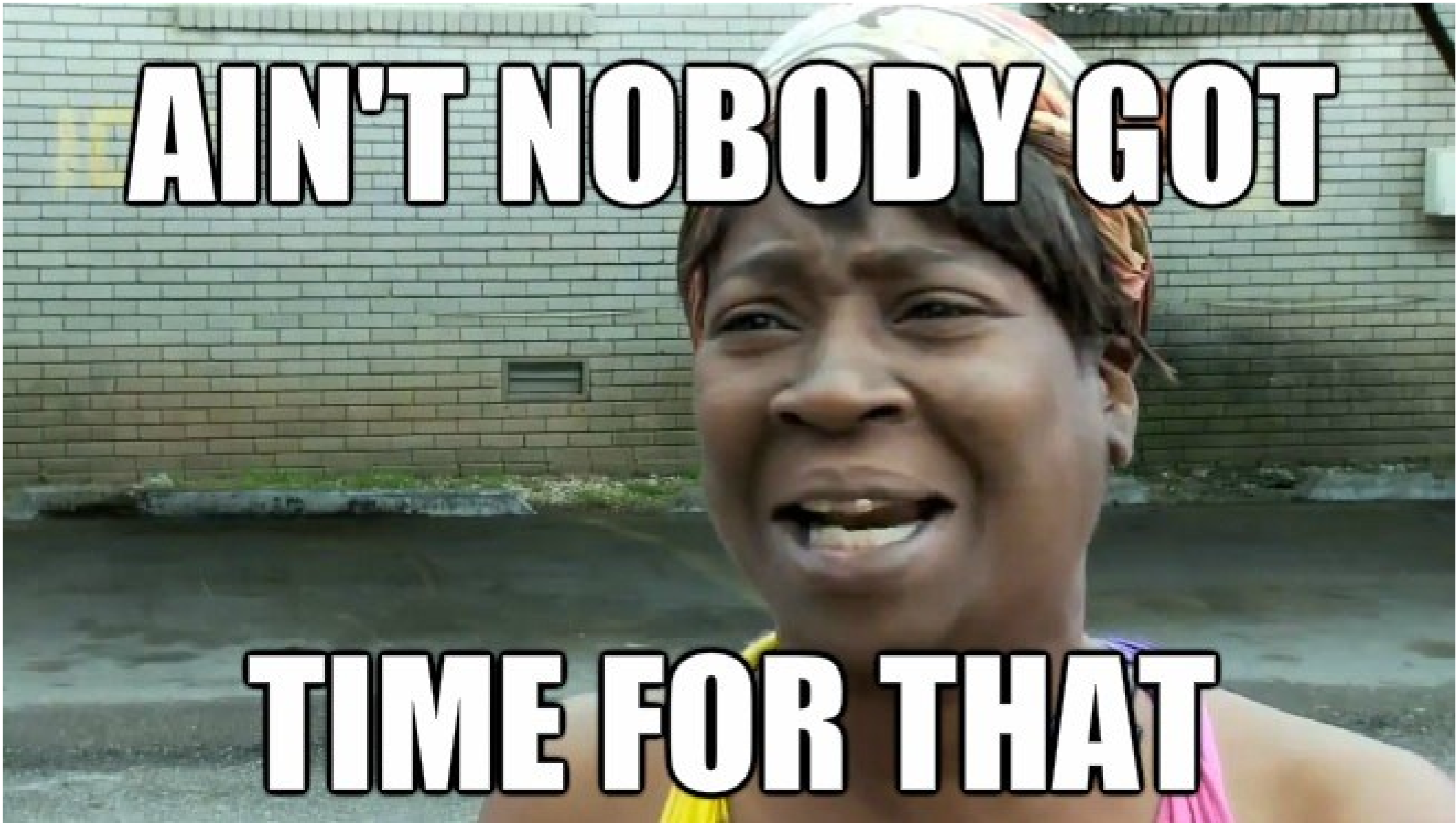
What have we learned (if anything)

- Considerable similarities between Akka actors and neurons, not inspired in any way
- Time gaps as information
- Distribution: a key to intelligence?

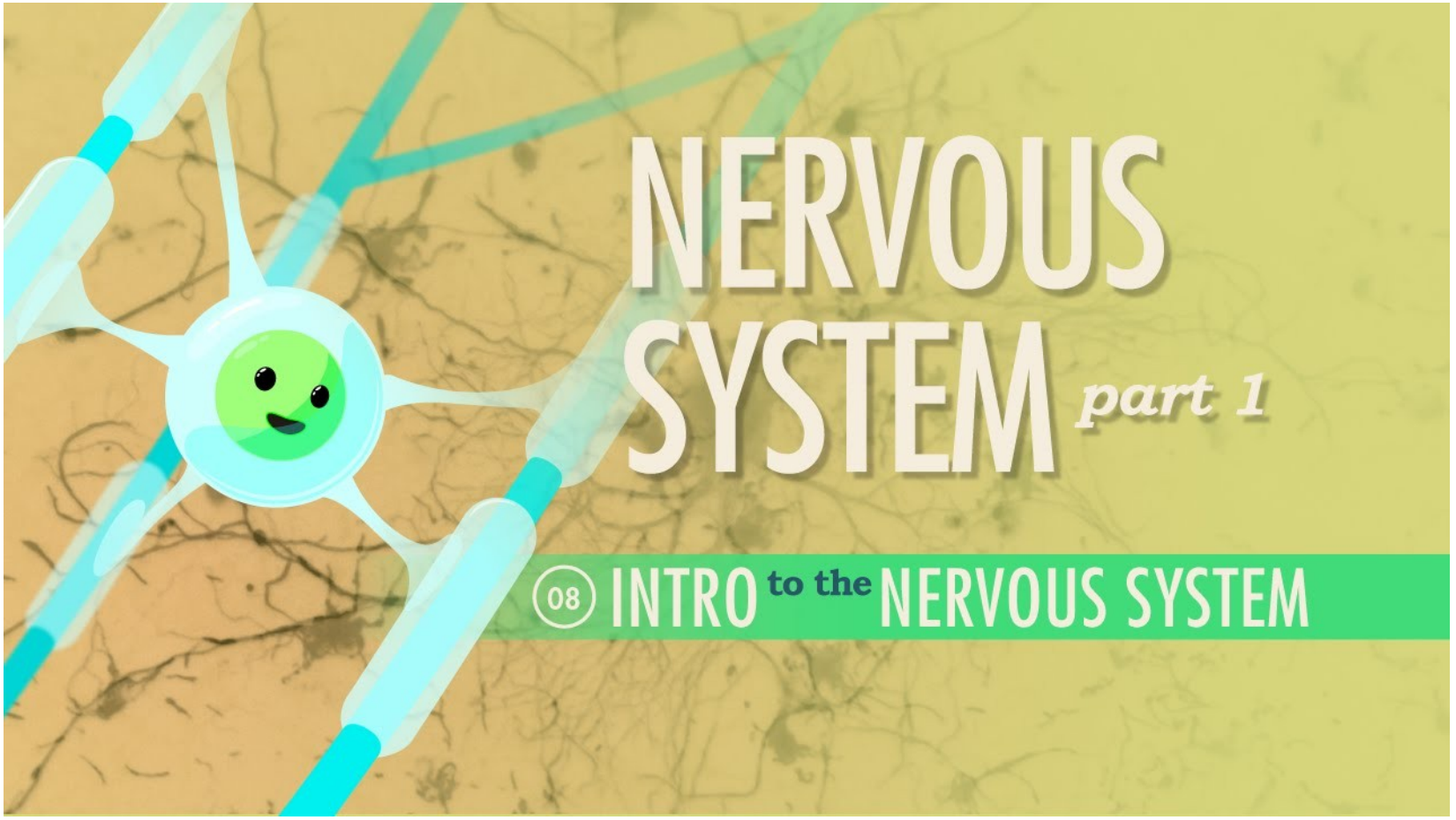


Where to search for more

- Akka: http://doc.akka.io/docs/akka/2.4/scala.html
- Neurobiology: “The Astonishing Hypothesis: The scientific search for the soul”, Francis Crick (1994)
- My own three eurocents: “Artificial Neural Networks in Akka”, Maciej Gorywoda, Scribd and Academia.edu


AIN'T NOBODY GOT
TIME FOR THAT

Crash Course Neurology



Thank You!

You can find the project at

http://github.com/makingthematrix/ann

You can find me somewhere near coffee

or at Wire: @maciek