Neural Computation
Theories of Learning

Brain-Inspired Computing

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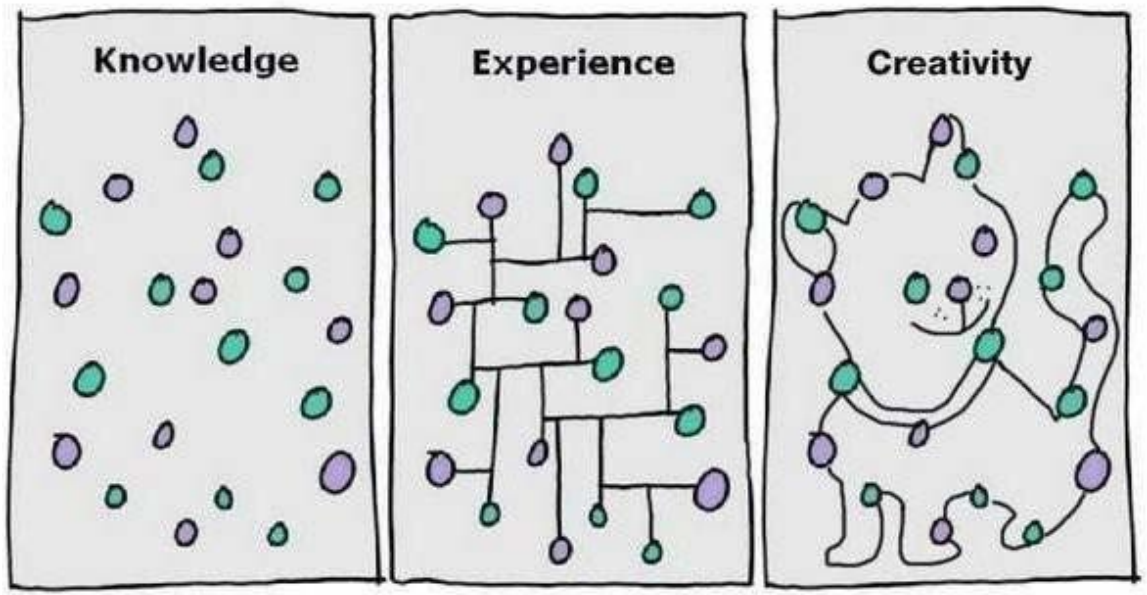
Logistics

- Pitch Talk
  - what we are asking
  - what we want from you
  - Top-5

- Assignment 2

- Assignment 1 is due ... shortly


Knowledge
Experience
Creativity

What does motor cortex encode

- ***Primary motor cortex neurons fire 5-100 msec before the onset of a movement***
- ***Primary motor cortex encodes the force of a movement***
- ***Primary motor cortex encodes the direction of movement***
- ***Primary motor cortex encodes the extent of movement***
- ***Primary motor cortex encodes the speed of movement***

Hubel & Wiesel, 1959

1981: Nobel Prize in Physiology

Question

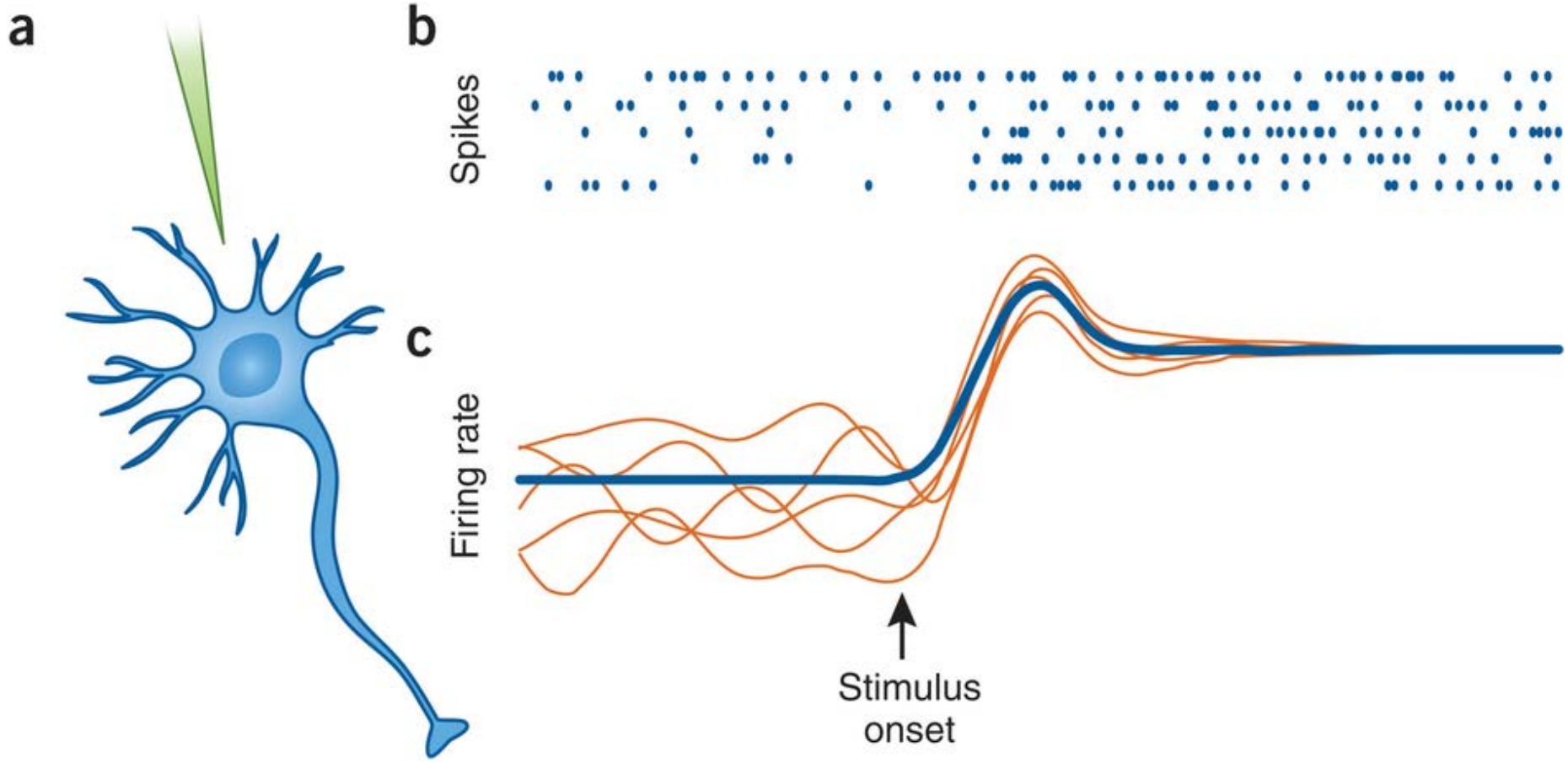
How you would combine simple cells to detect complex stimuli?

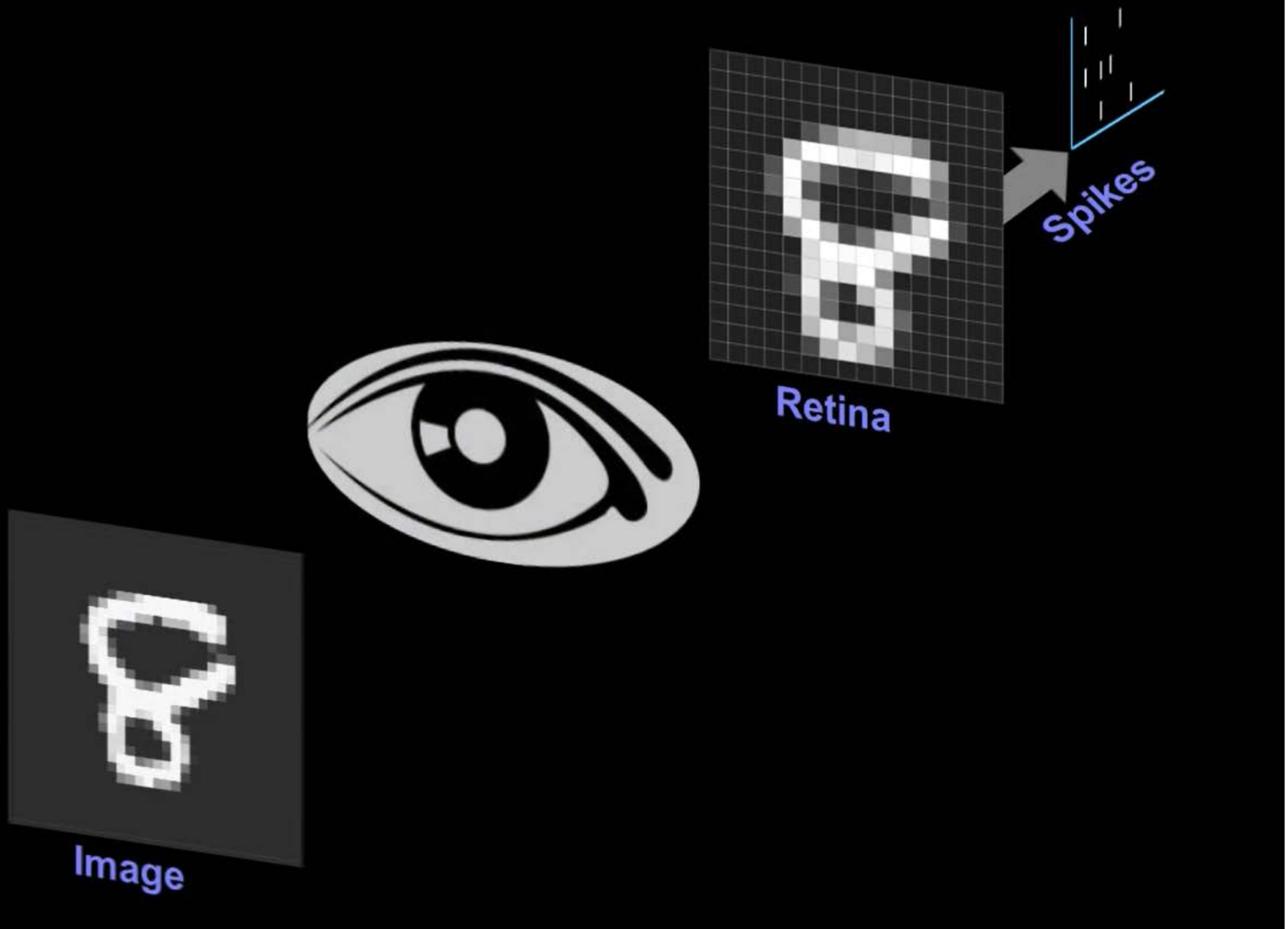
Questions

- How could we combine simple cells to detect complex stimuli?
- Why line detectors?
- Why orientation?
- How fast this process is?
    - How does the brain compensate for the lack of speed?

Encoding Data into Spikes

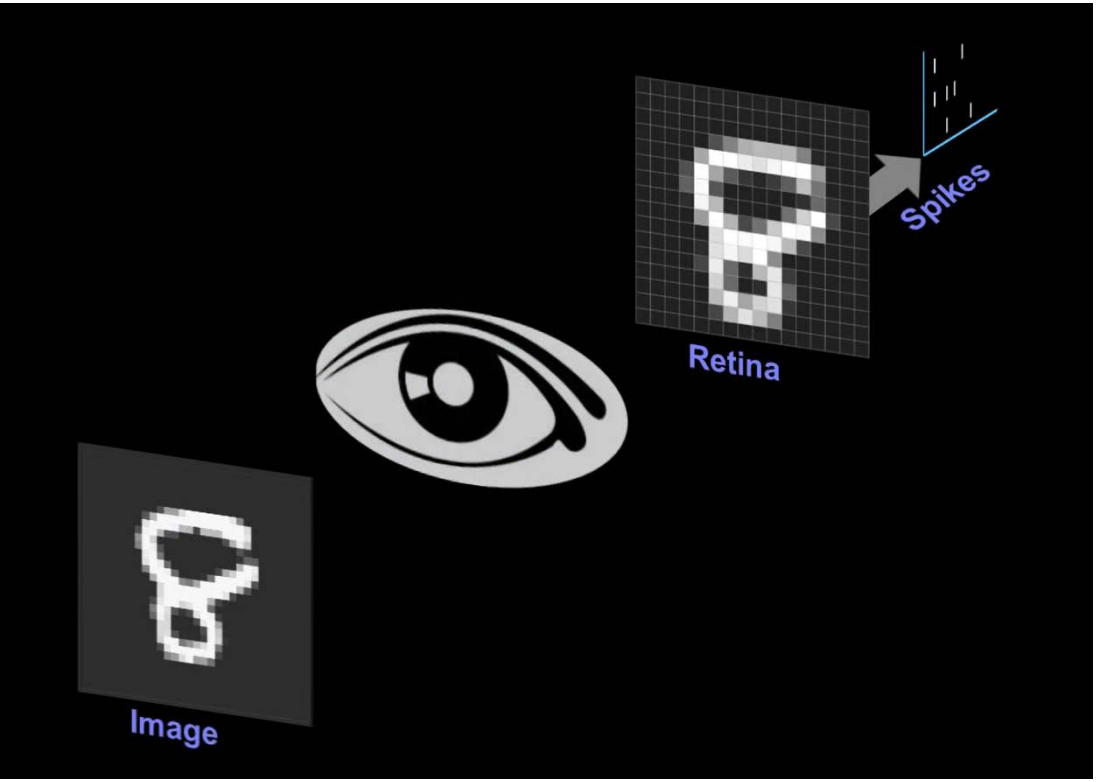
- Input = Spikes





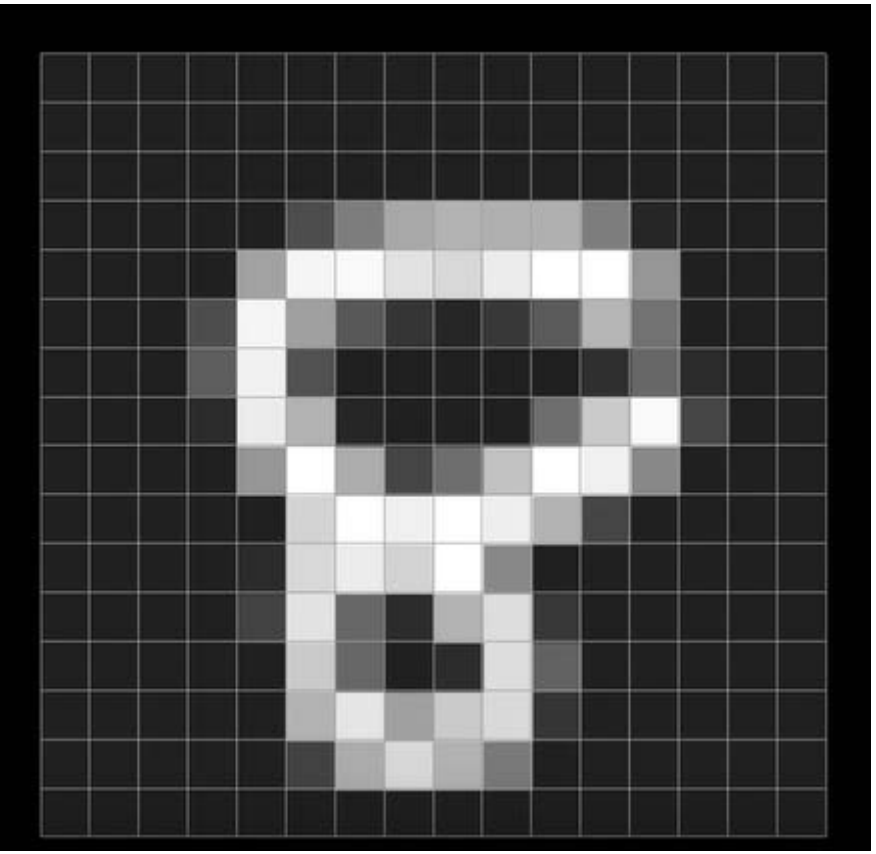
MNIST Data Set

Transduction of an image to spikes



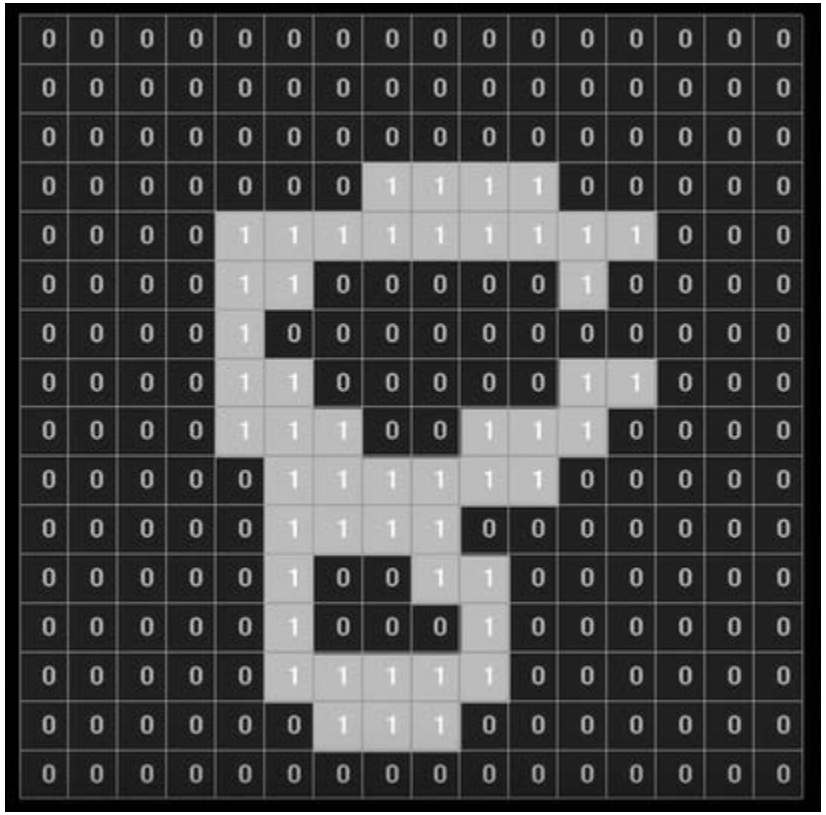
- Efficient retinal representation
- Maintains the key aspects of the input signal, but removes some of the data
  - How to decide on data removal?
- Convert the input information to a spiking representation over time

Image to spikes



0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0.2	0.3	0.6	0.6	0.6	0.6	0.3	0	0	0	0
0	0	0	0	0.5	0.9	1	0.8	0.8	0.9	1	1	0.5	0	0	0
0	0	0	0.2	0.9	0.5	0.2	0.1	0	0.1	0.2	0.6	0.3	0	0	0
0	0	0	0.2	0.9	0.2	0	0	0	0	0	0.1	0.3	0	0	0
0	0	0	0	0.9	0.6	0	0	0	0	0.3	0.7	1	0.1	0	0
0	0	0	0	0.5	1	0.6	0.1	0.3	0.7	1	0.9	0.4	0	0	0
0	0	0	0	0	0.8	1	0.9	1	0.9	0.6	0.1	0	0	0	0
0	0	0	0	0	0.8	0.9	0.8	1	0.4	0	0	0	0	0	0
0	0	0	0	0.1	0.8	0.3	0	0.6	0.8	0.1	0	0	0	0	0
0	0	0	0	0	0.7	0.3	0	0	0.8	0.2	0	0	0	0	0
0	0	0	0	0	0.6	0.8	0.5	0.7	0.8	0.1	0	0	0	0	0
0	0	0	0	0	0.1	0.6	0.8	0.6	0.3	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

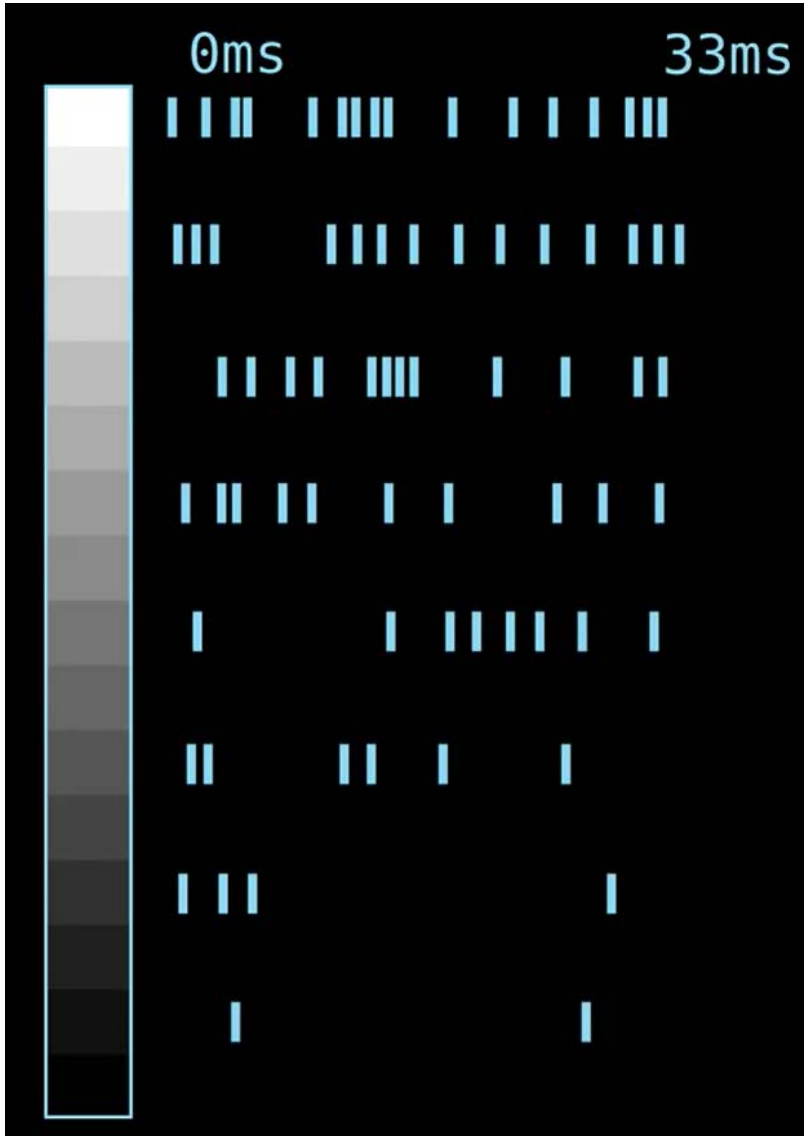
Encoding Images as Neural Spikes



Thresholding 1 spike for 1
0 spikes for 0

Encoding complicated images

Number of Spikes proportional to the intensity level of the edge



Timing of the spikes does not matter – we are just counting them