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Event-based computation:
Unsupervised elementary motion decomposition

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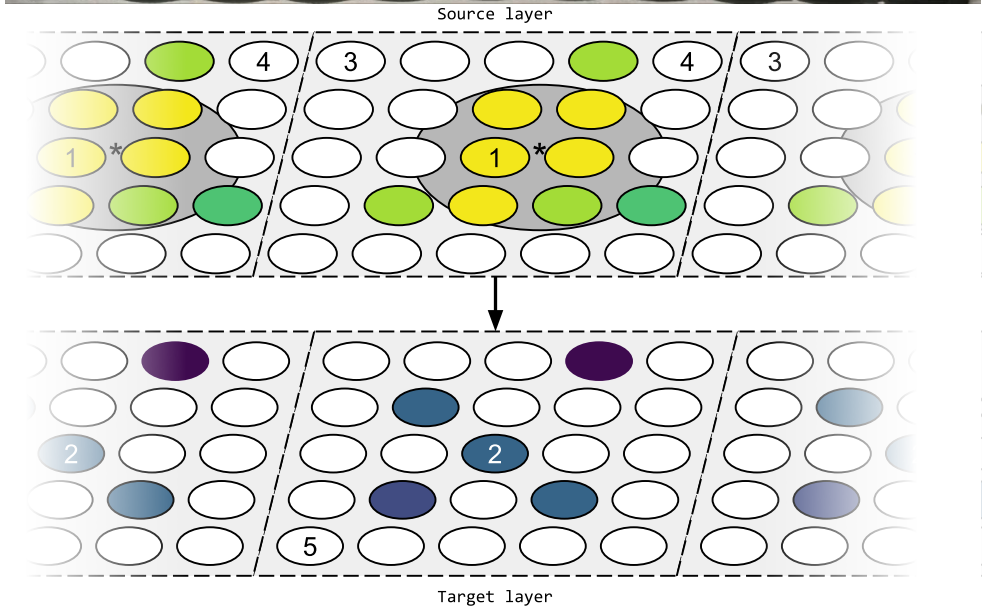
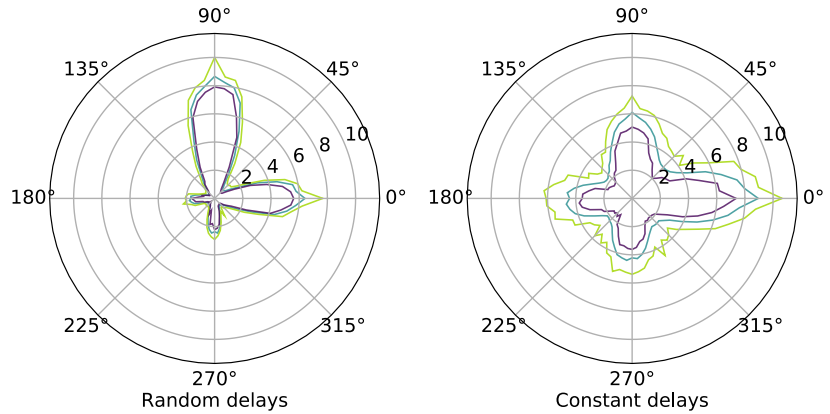
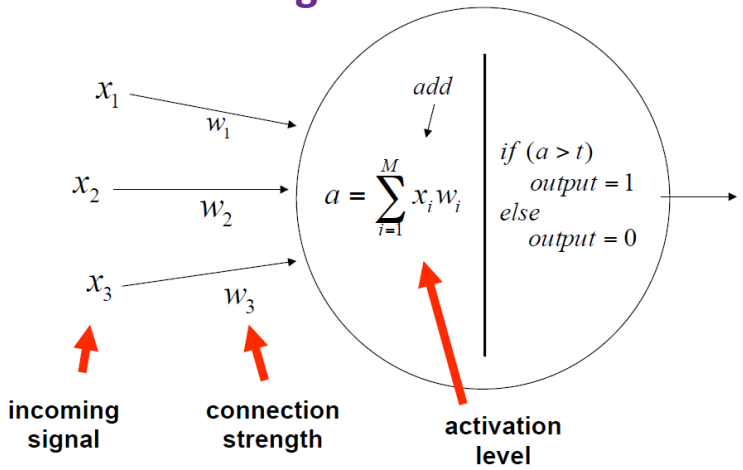
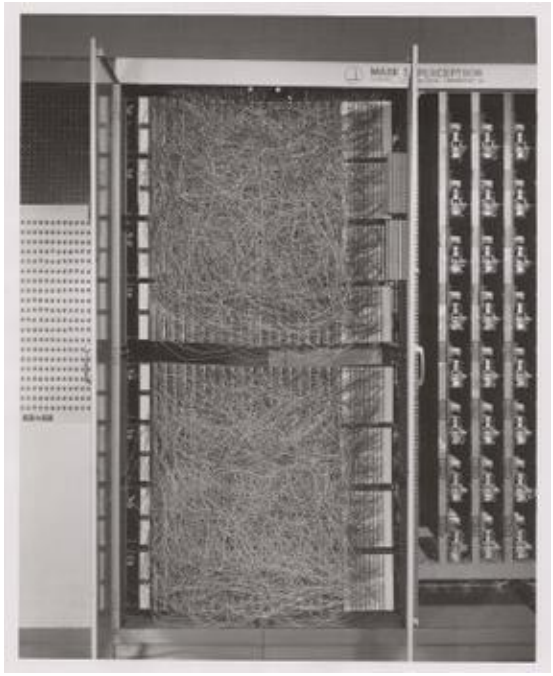


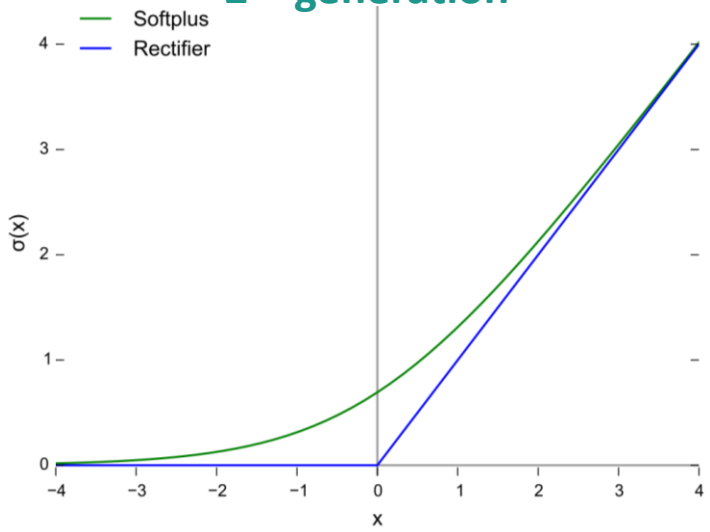


1st generation

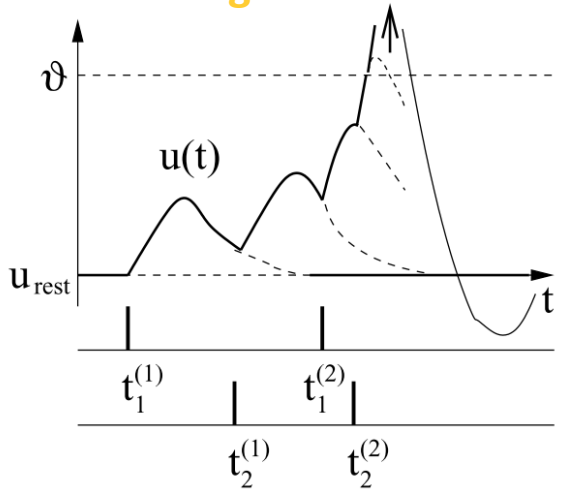


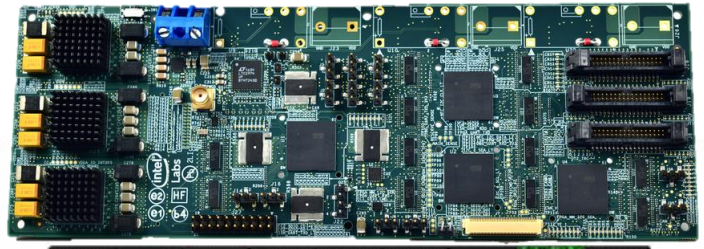


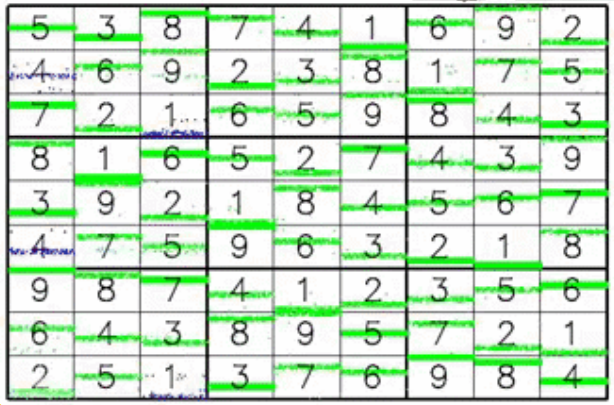
2nd generation



3rd generation

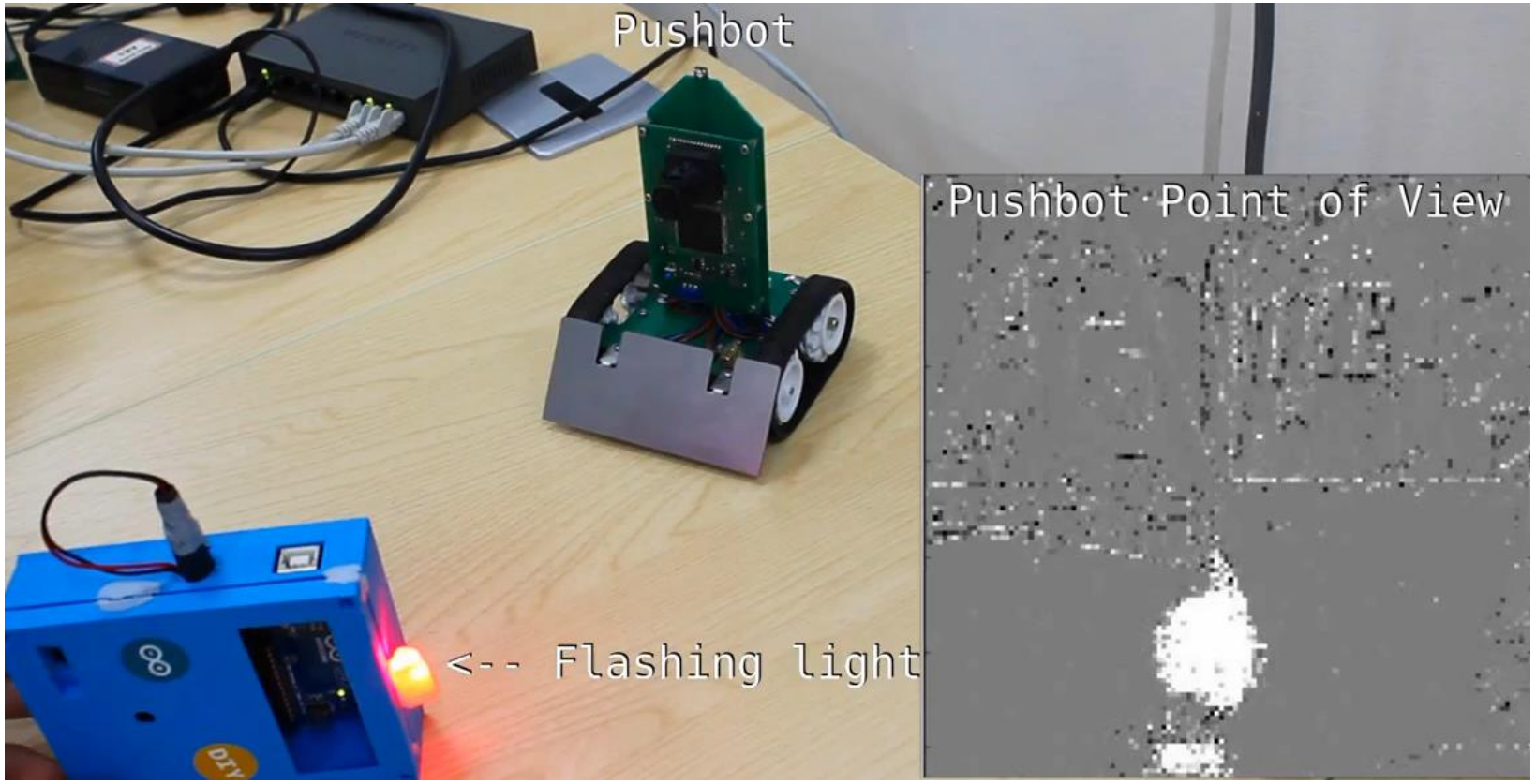


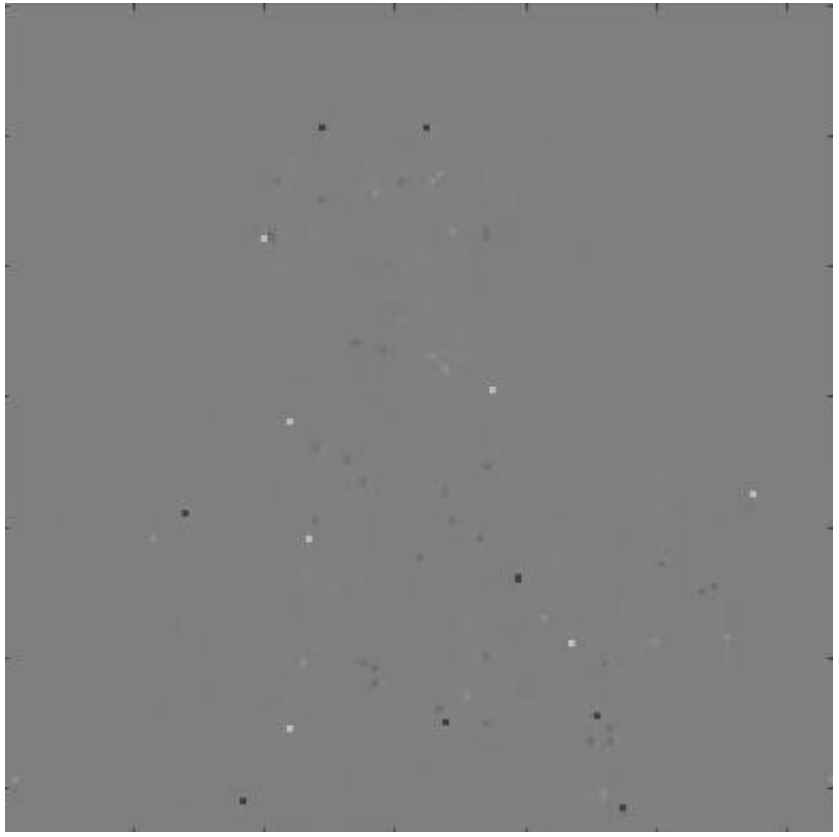




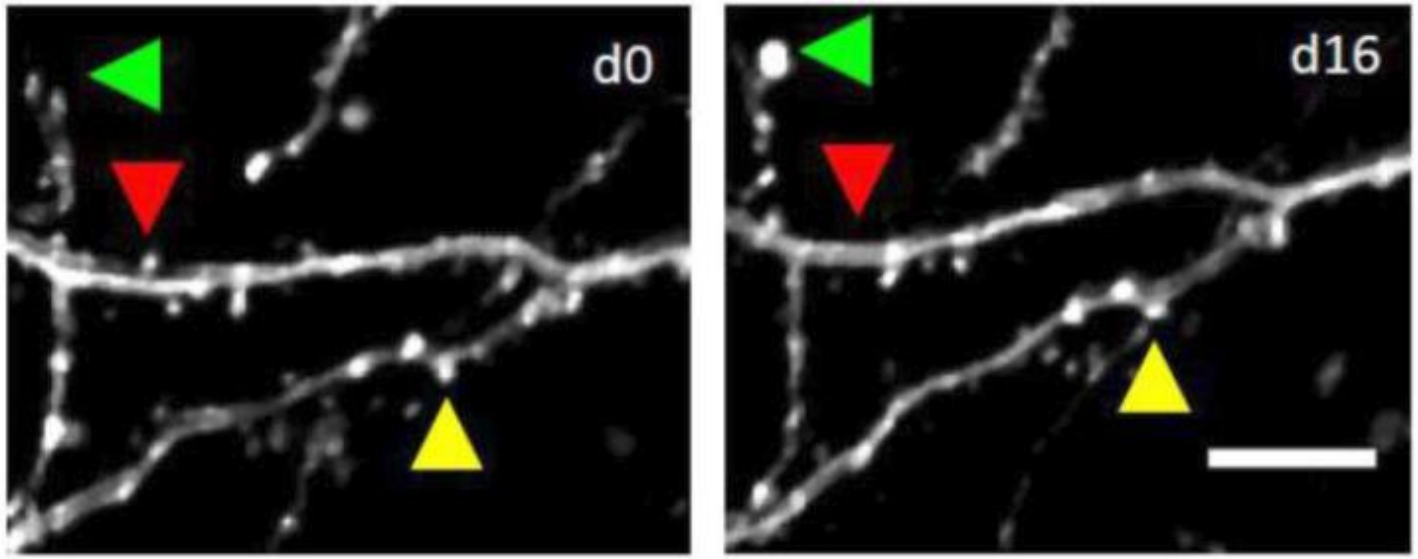
Maass et al. (1997)

Visual input

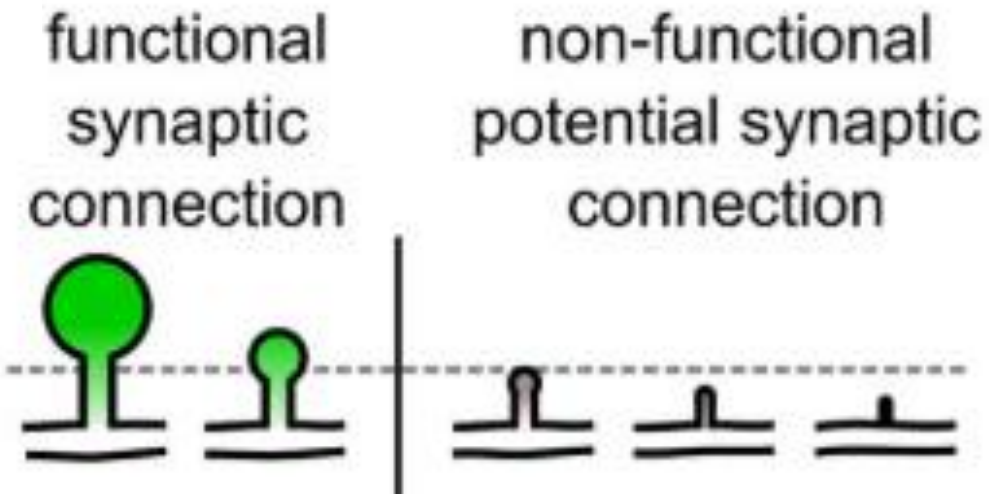




Structural plasticity



Mascaro et al. (2016)



Kappel et al. (2018)

Topographic map formation

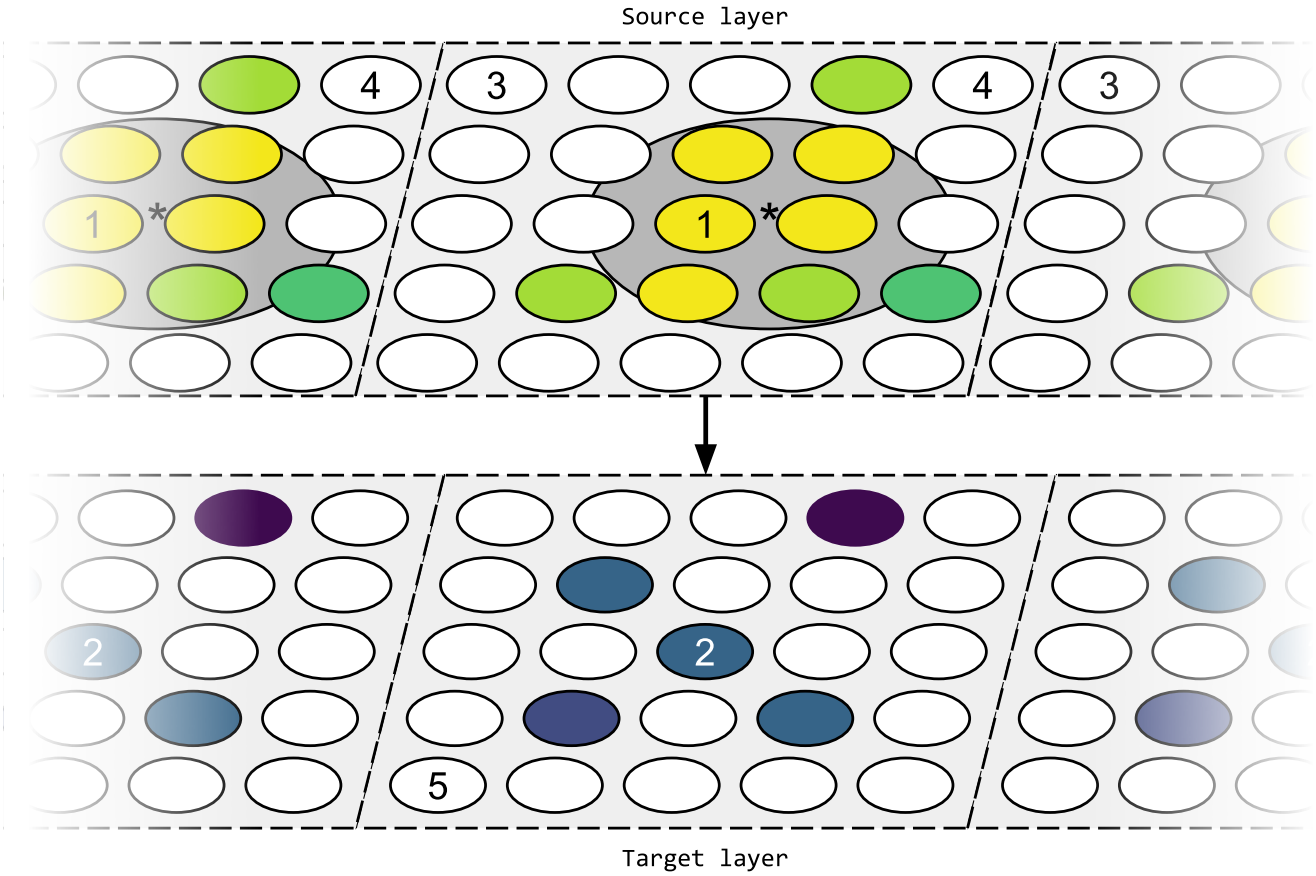
Synaptic rewiring rules (described in Bamford et al. 2010):

- Activity-dependent **removal rule**
  - **Weak synapses** are more likely to be removed
- Distance-dependent **formation rule**
  - Neuron **closer in space** are more likely to form a connection

✓Better neural topographic maps

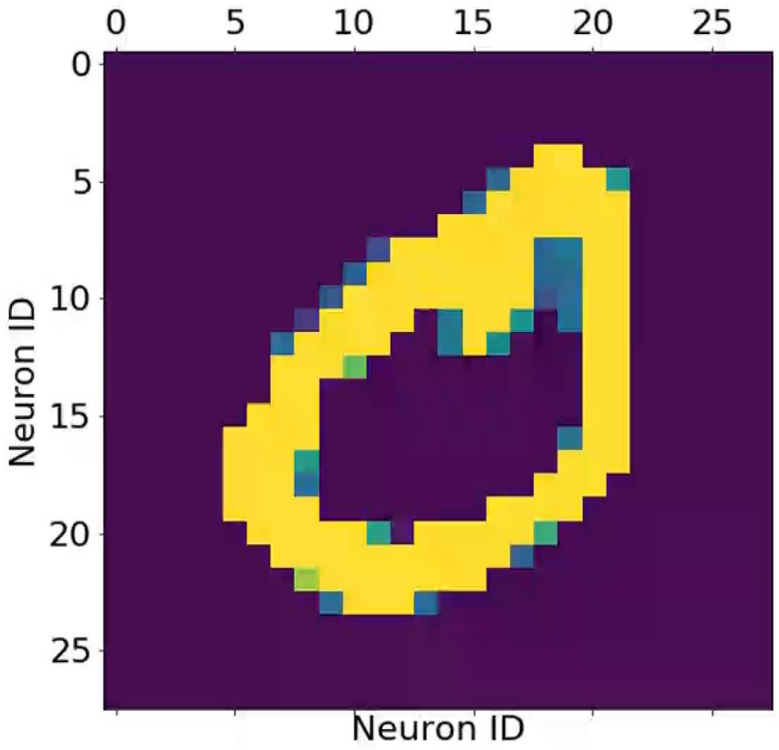
✓Stable with lateral inhibition

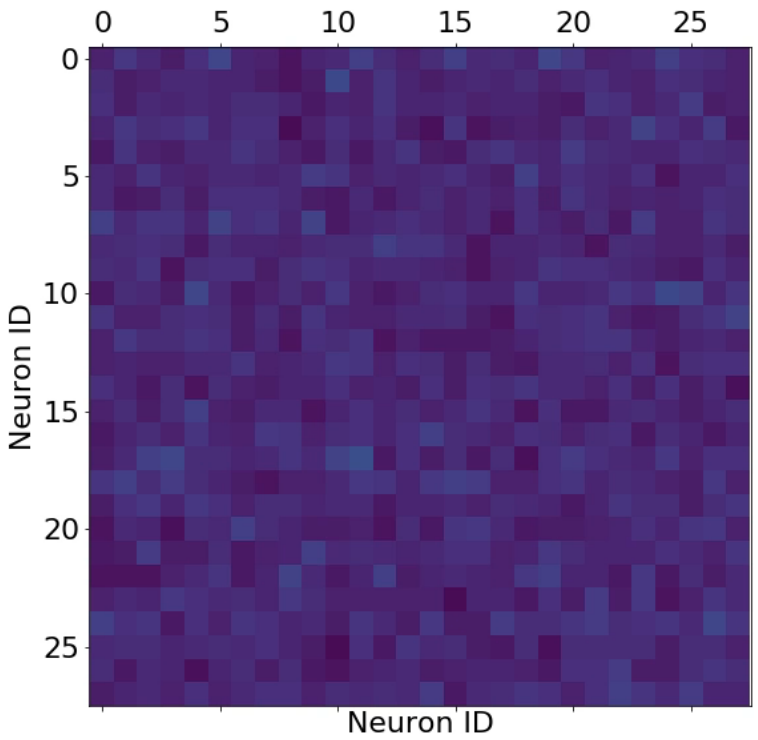
✓Modelling development

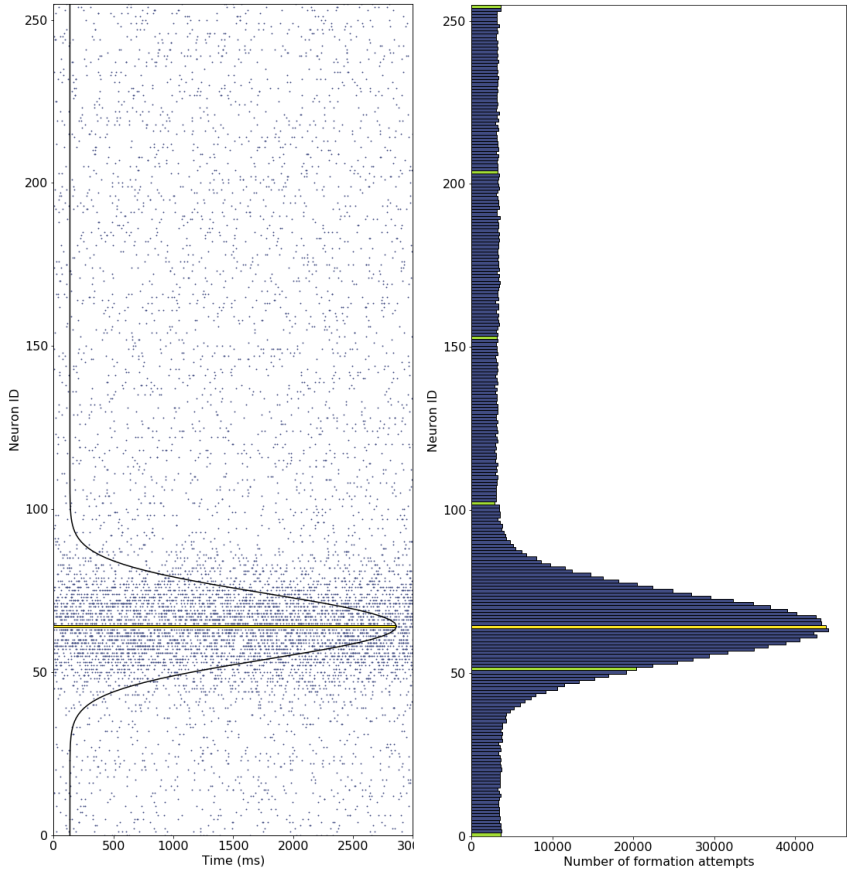


Bogdan, Rowley, Rhodes, Furber(2018)

Embedding input statistics into network connectivity

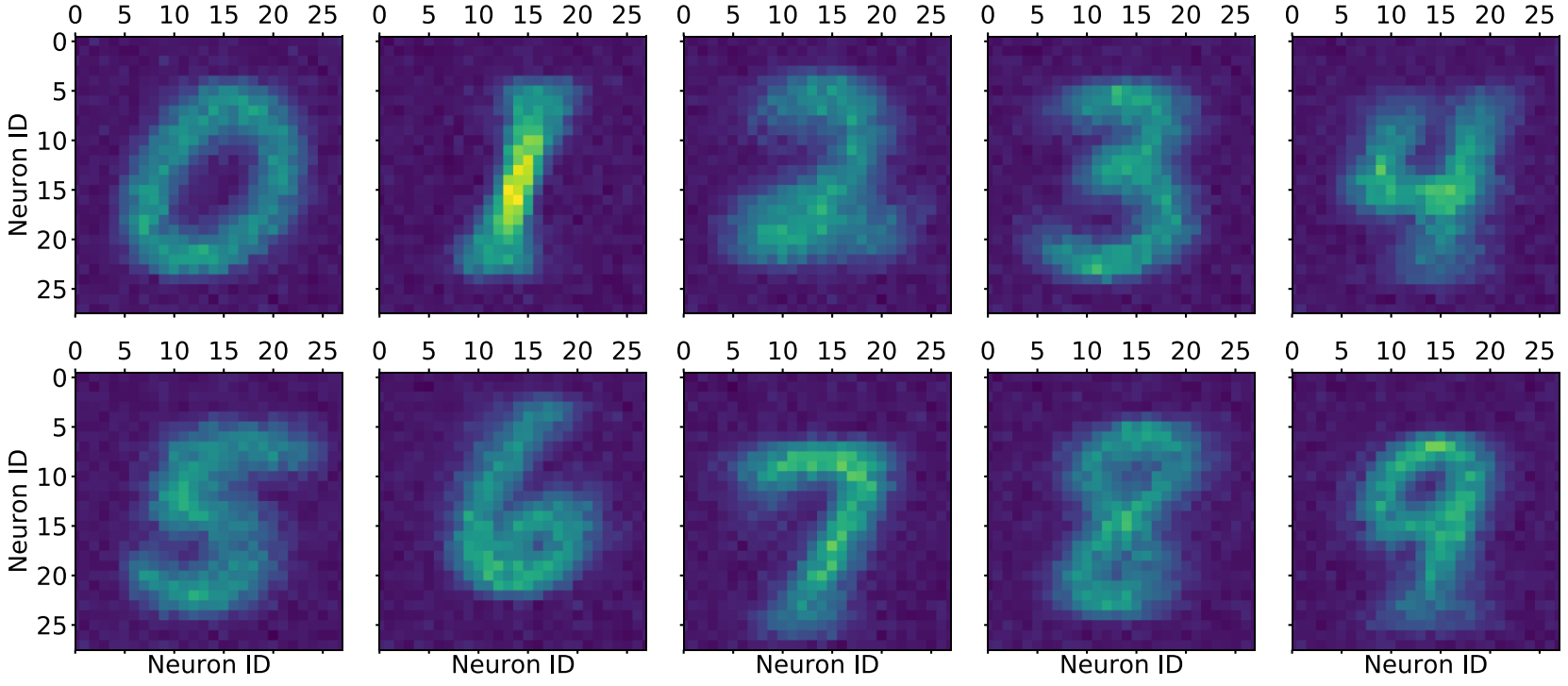


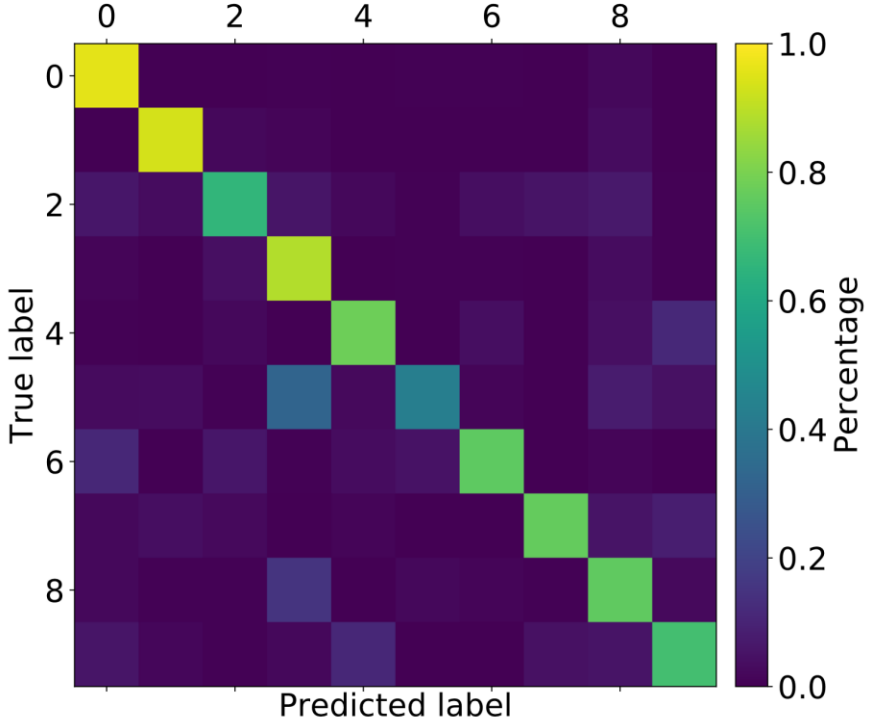




Hopkins, Pineda Garcia, Bogdan, Furber(2018)

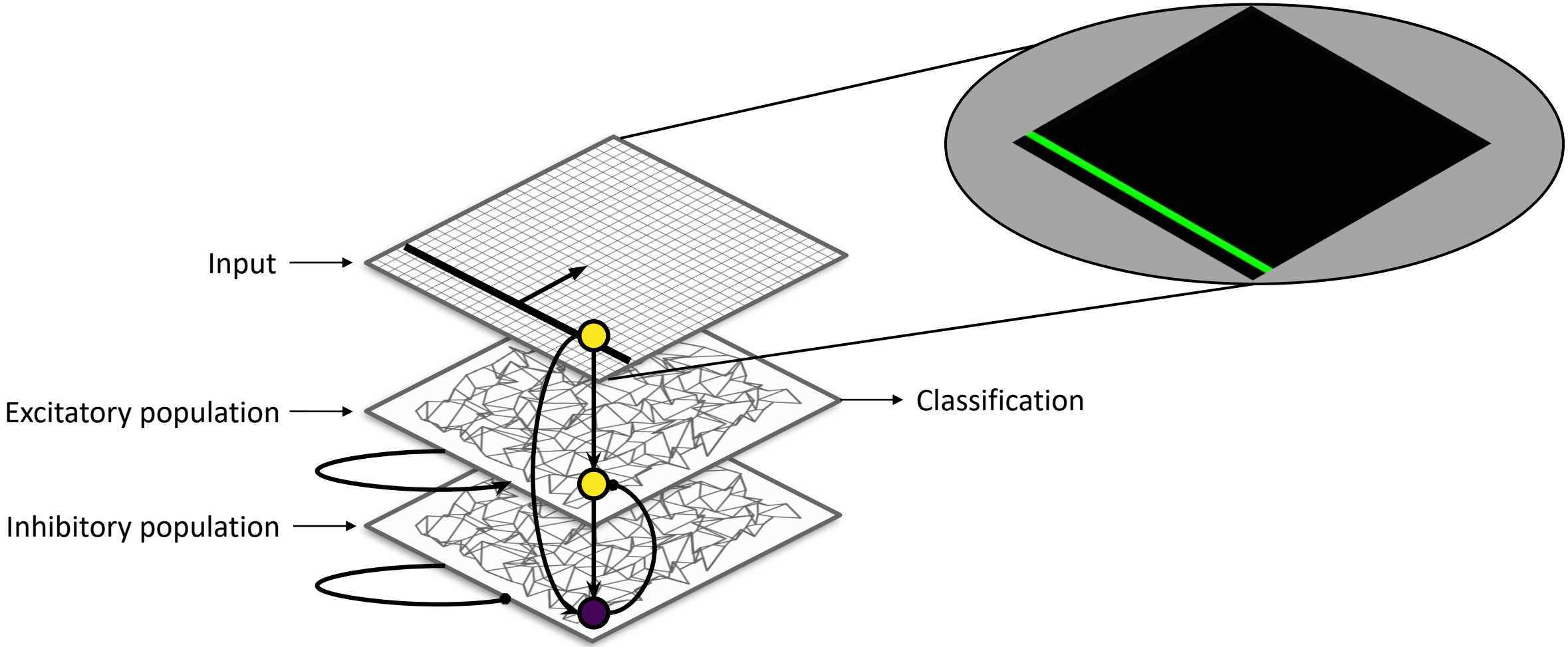
Digit reconstruction from connectivity



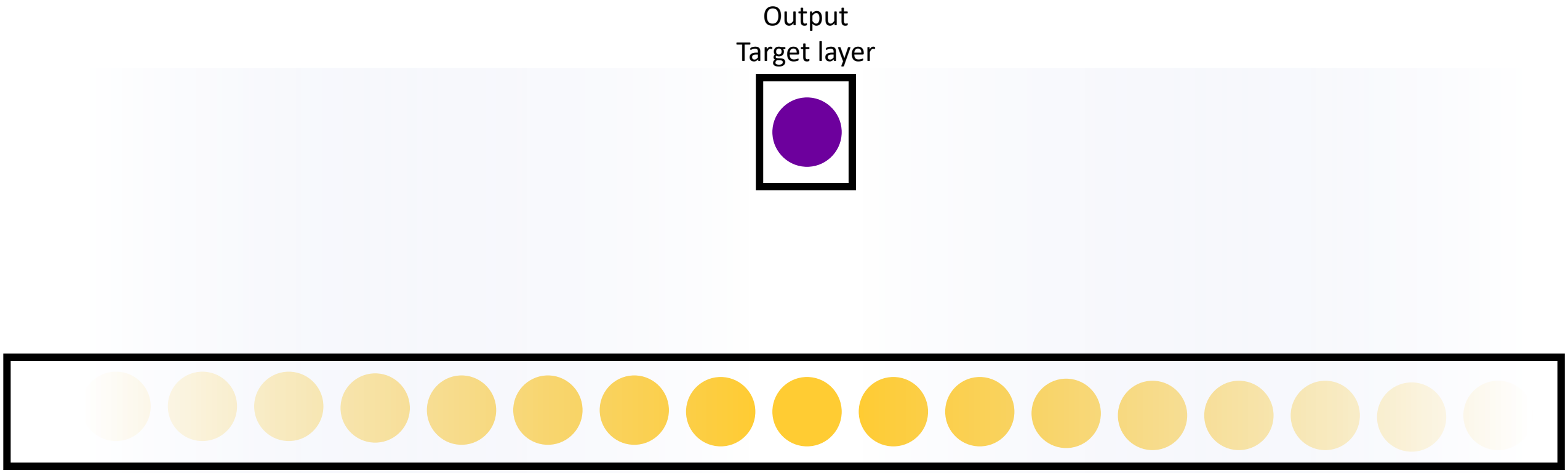


Hopkins, Pineda Garcia, Bogdan, Furber(2018)

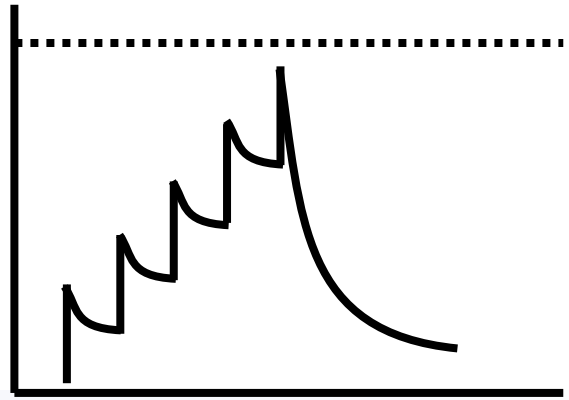
Unsupervised learning architecture



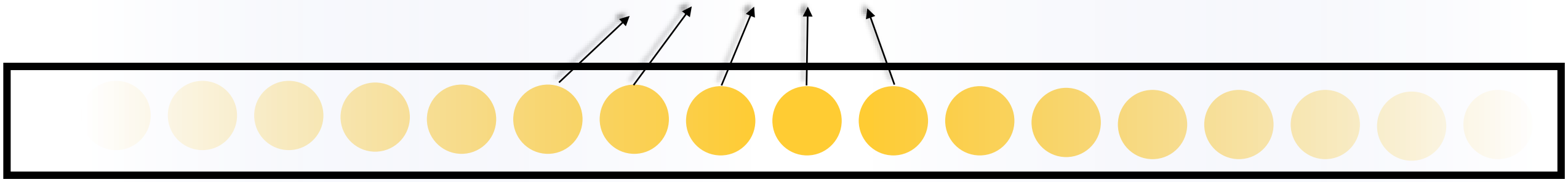
Intuition



Intuition

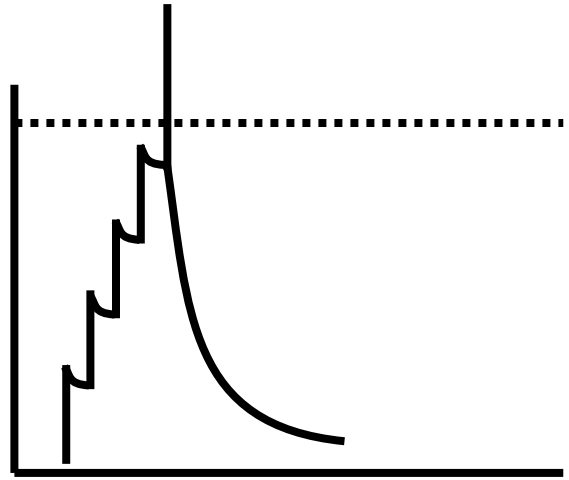


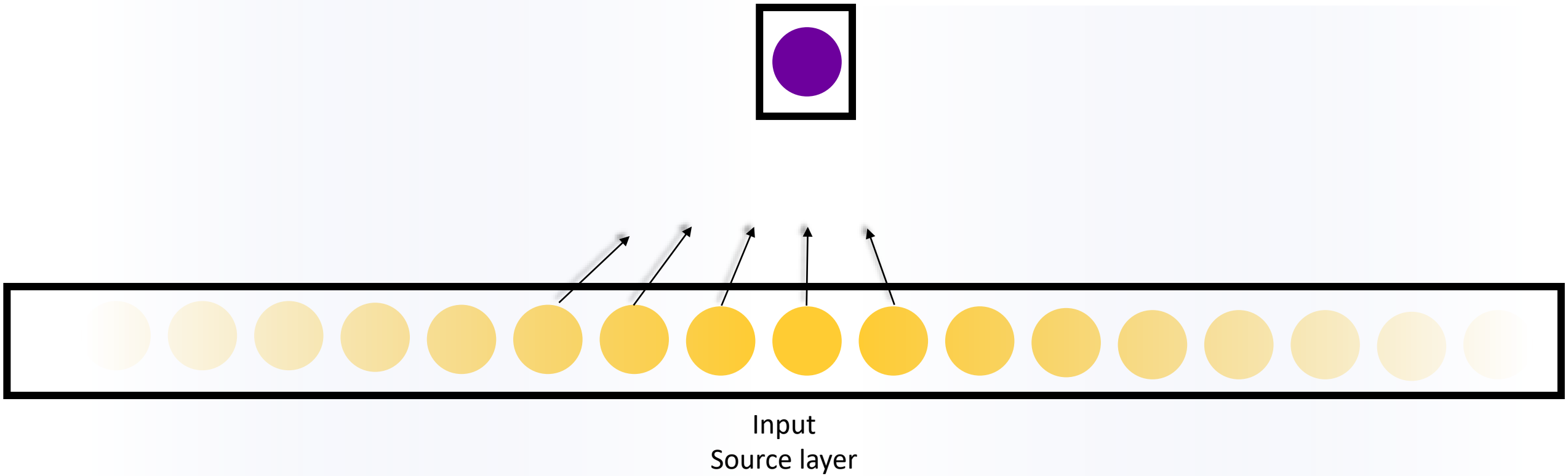
Output
Target layer



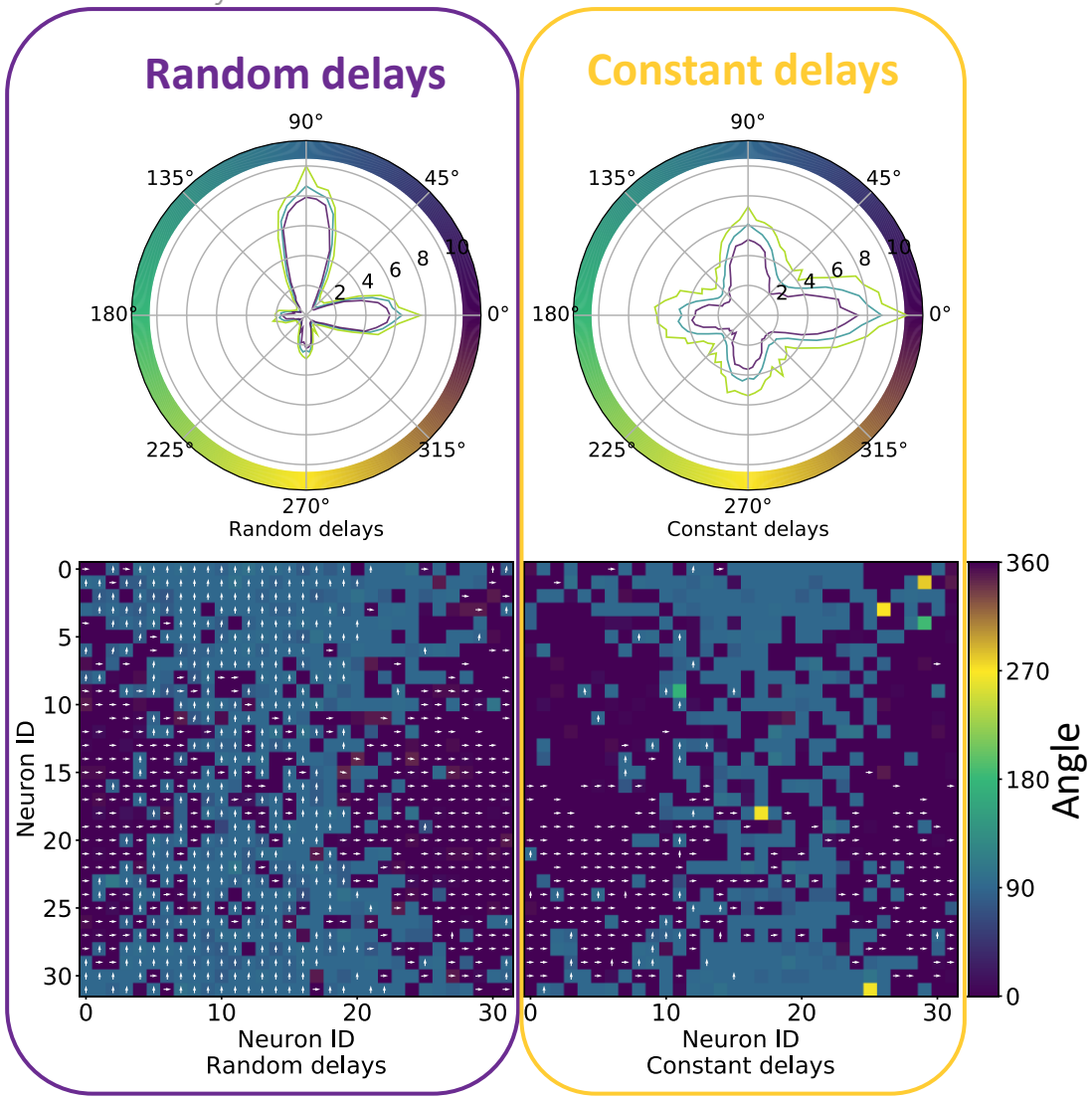
Input
Source layer

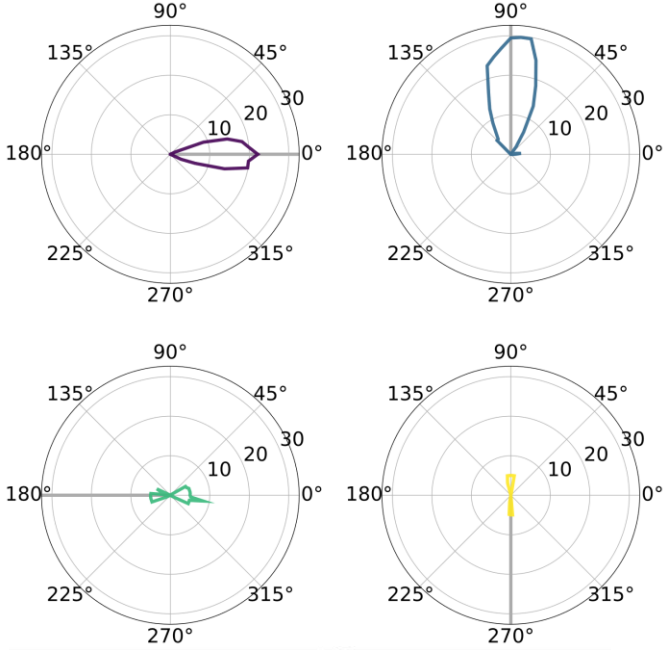
Intuition

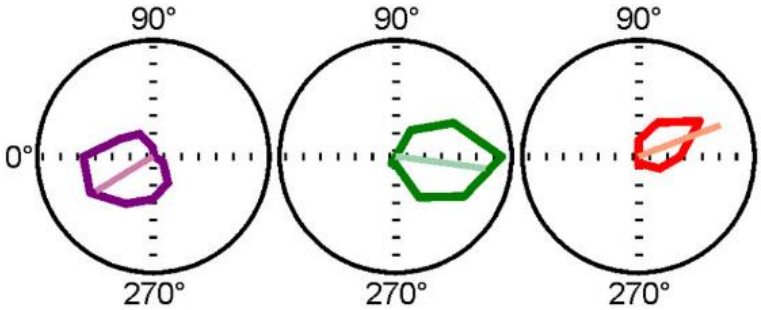




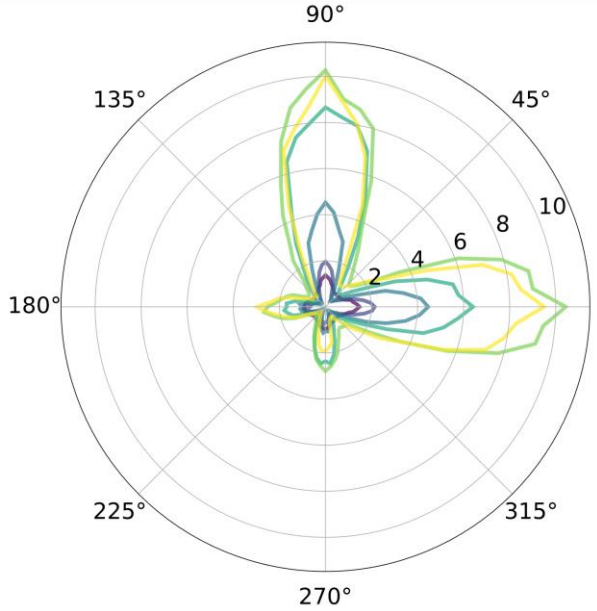
Population and individual neuron responses

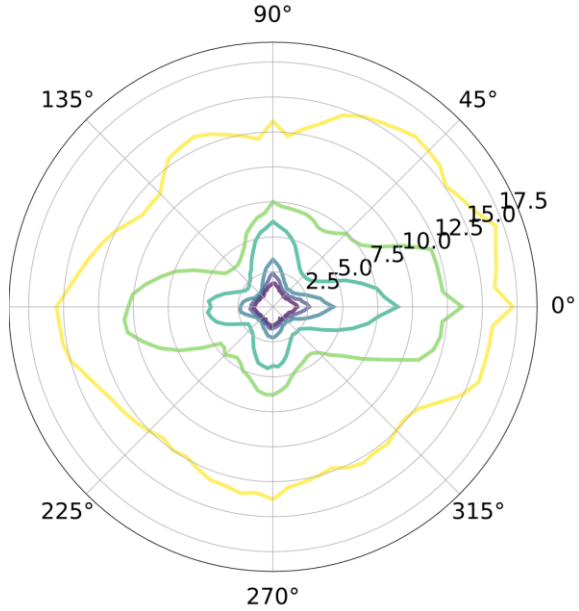






Inayat, Barchini et al. (2015)

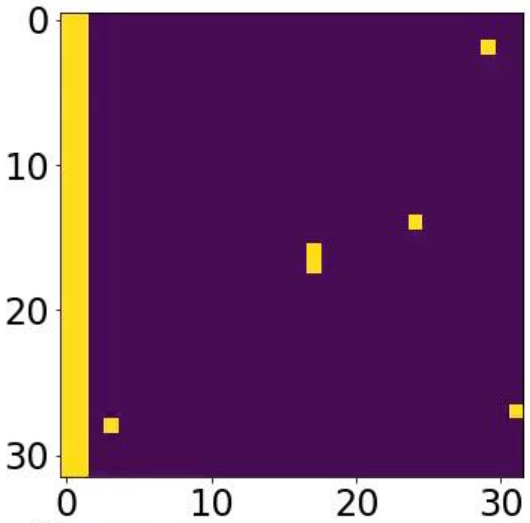


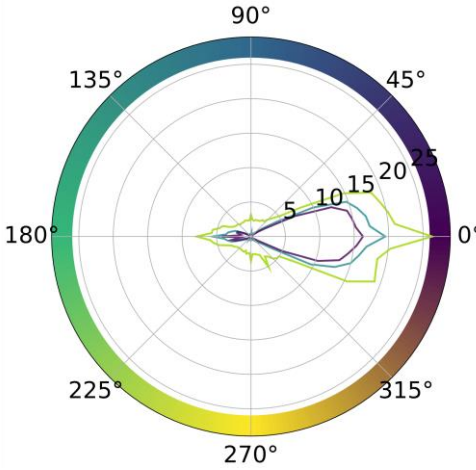


Network behaviour

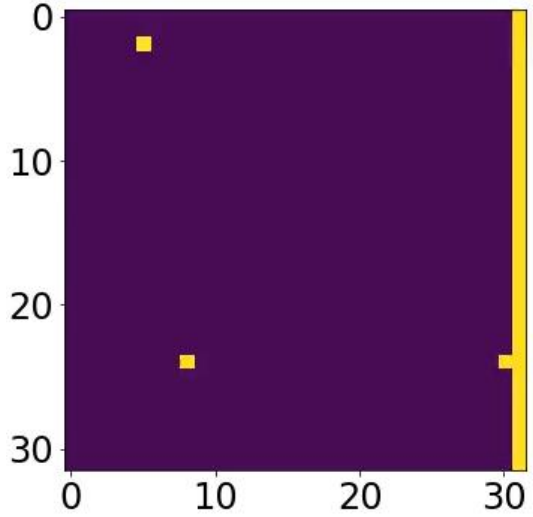
Input spikes

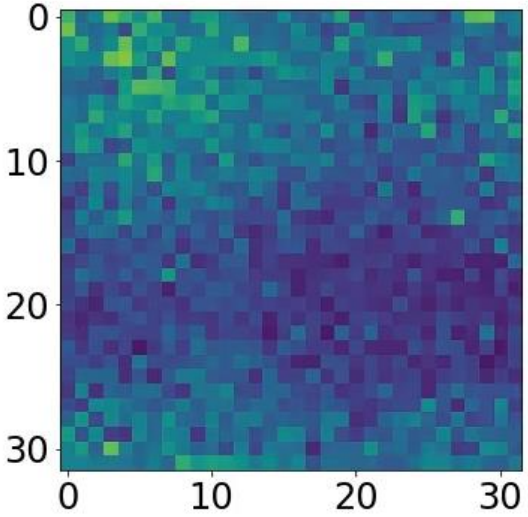
Preferred direction

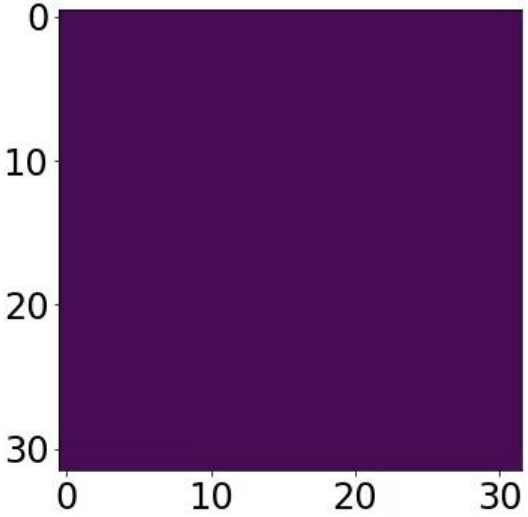


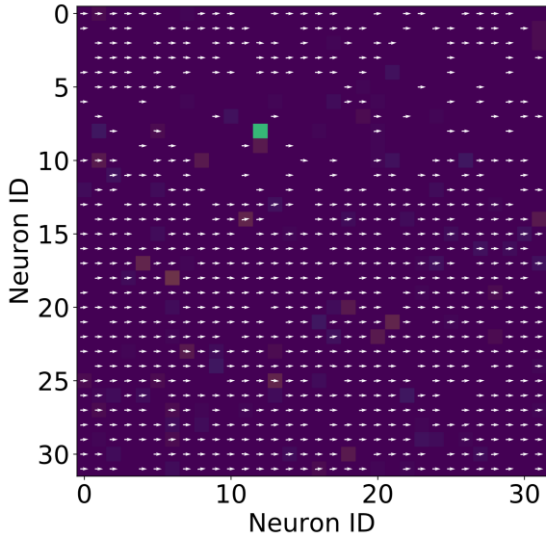


Opposite (Null) direction

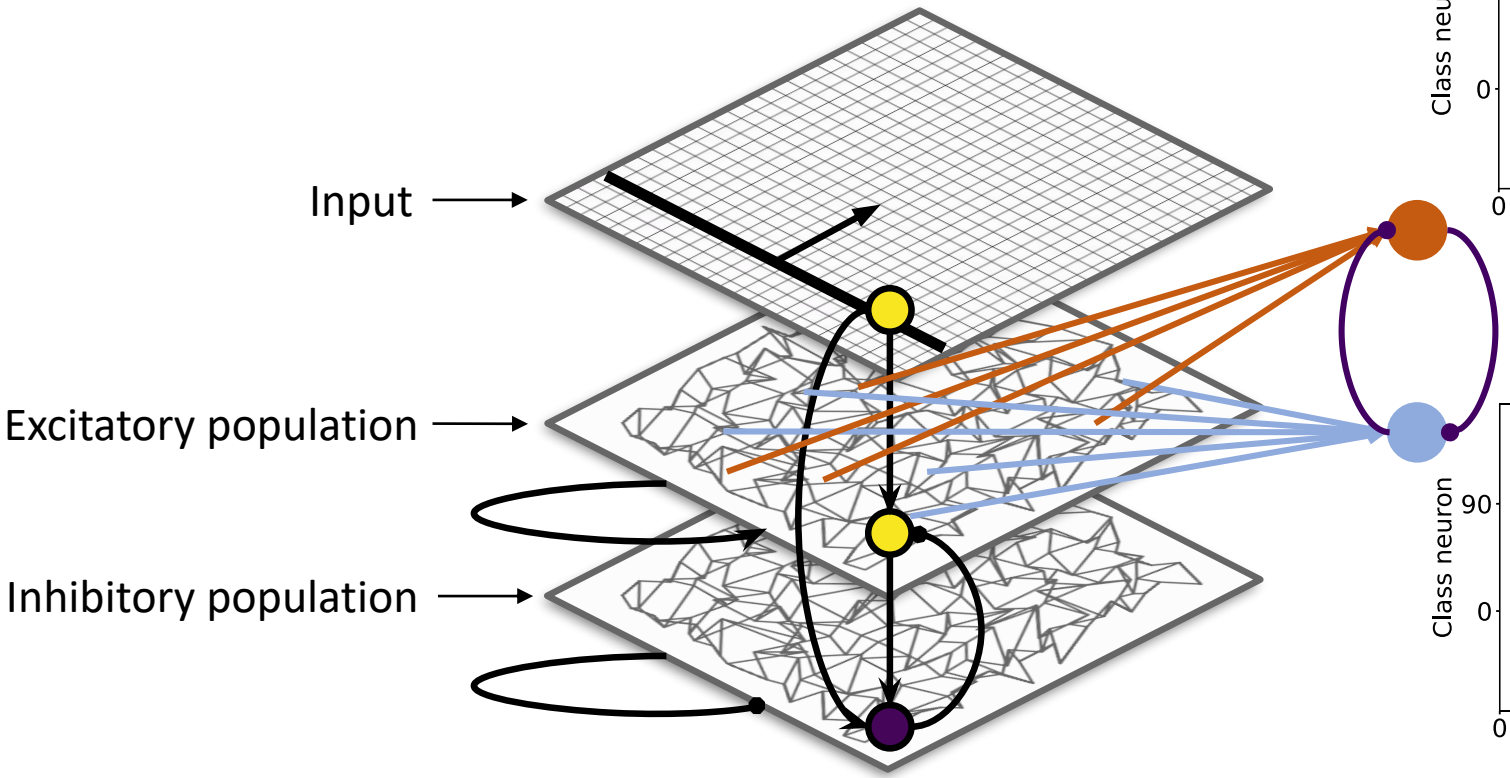


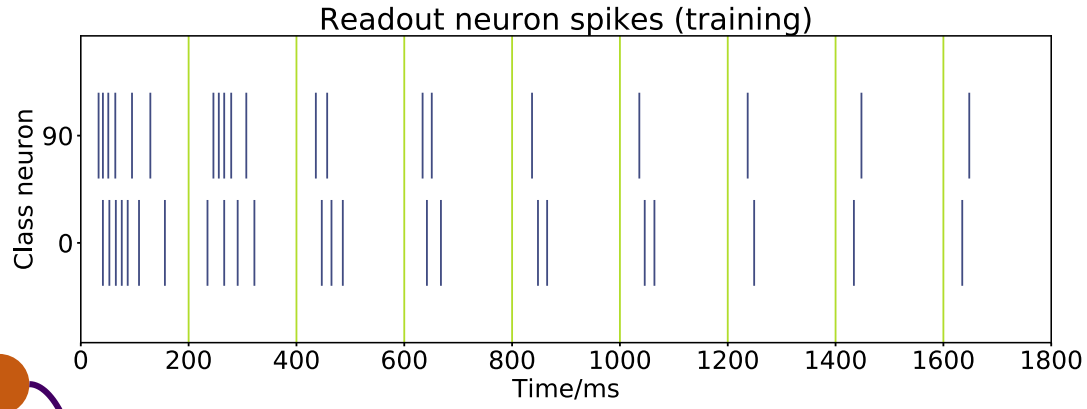


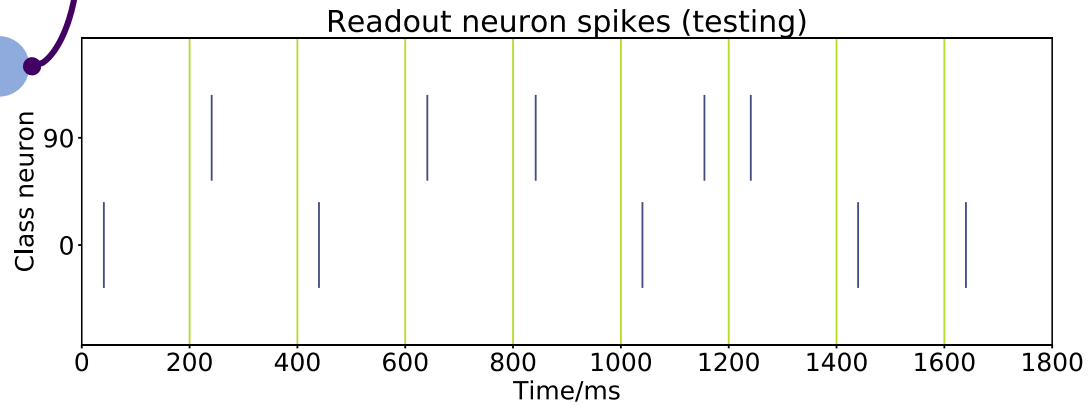




Classification

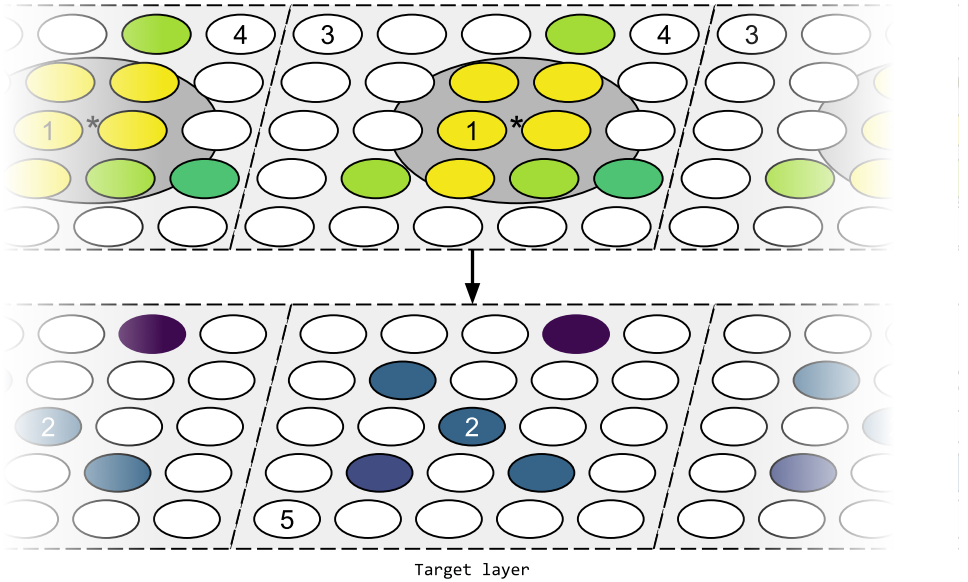


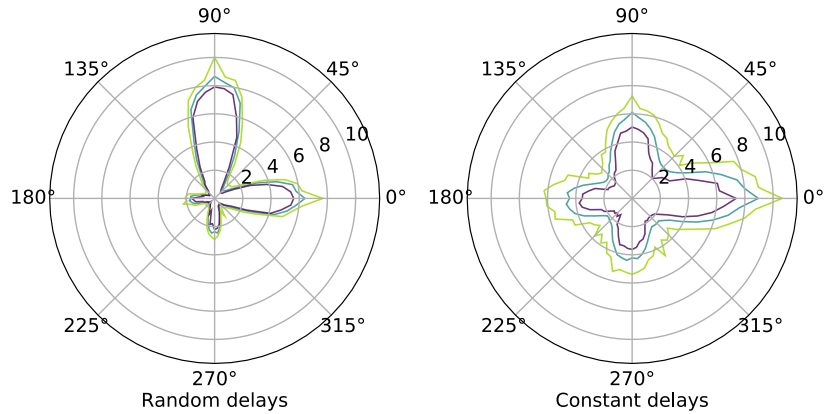




Summary

- Emerging technology: **neuromorphic**
  - **Academic** interest
  - **Commercial** interest
- Computing using **Spikes**
- Interesting applications
  - Computer **vision**
  - Elementary **motion** decomposition
- Powerful learning rule
  - **Structural Plasticity**





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Thank you!

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Human Brain Project

EPSRC

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