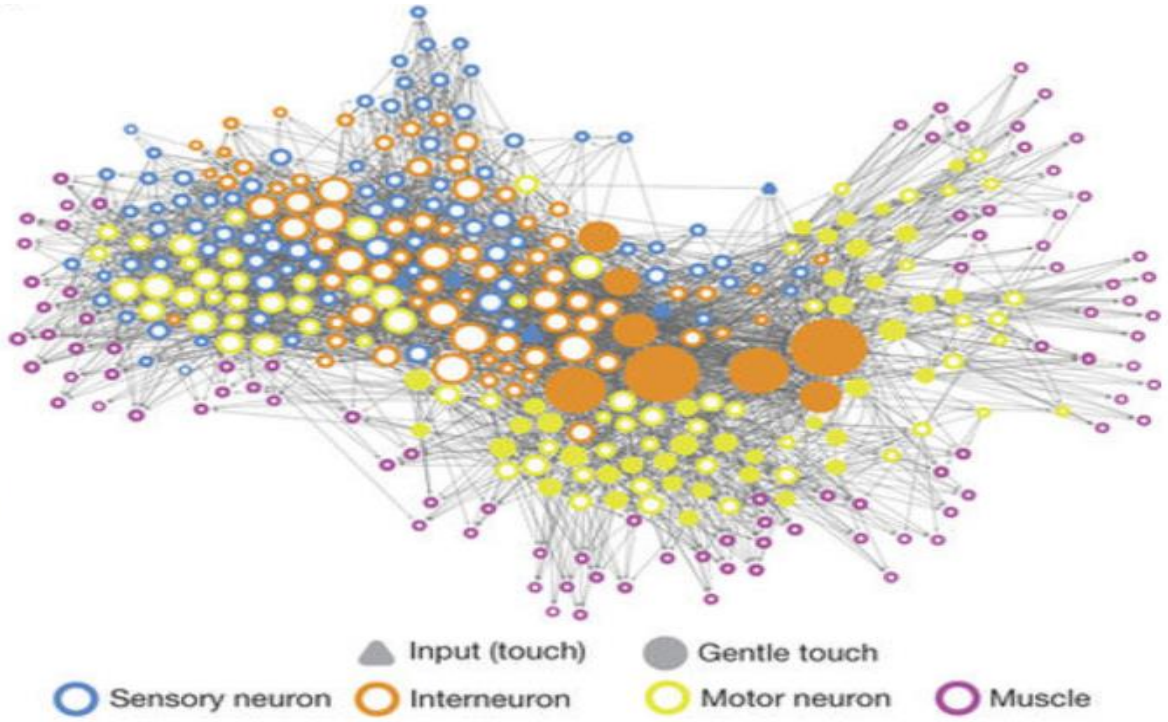
The Complete Connectome Of A Learning And Memory Centre In An Insect Brain

Eichler, Li, Kumar et. al.

Nature, 2017

What is Connectome?

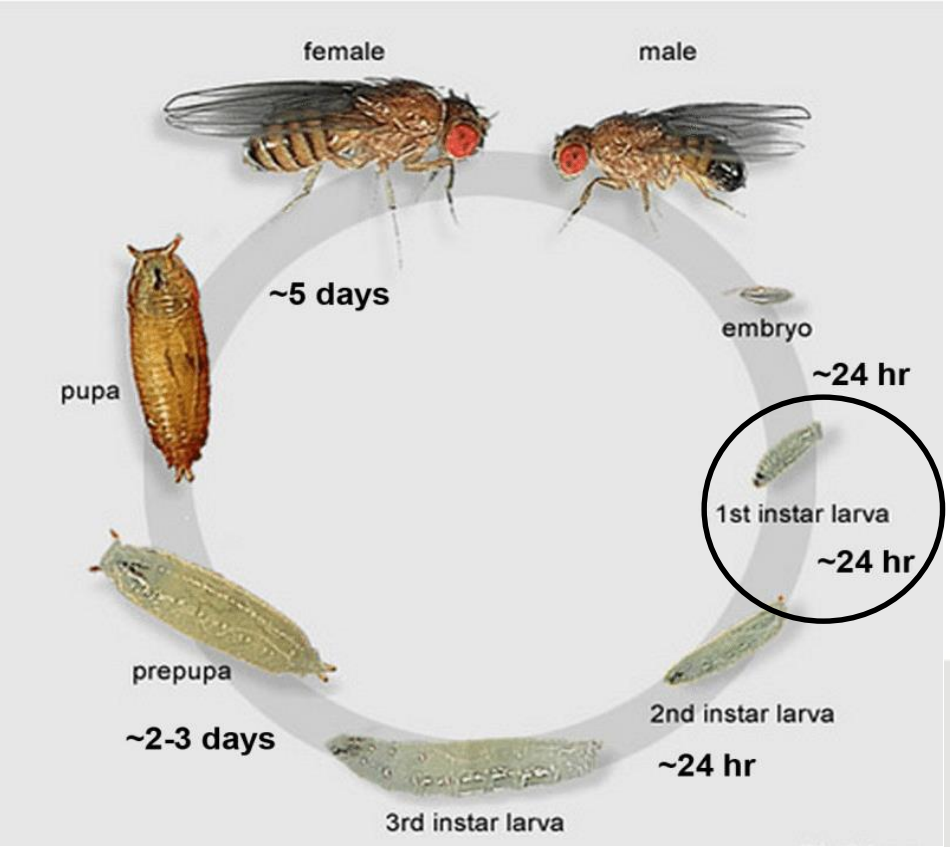
- Complete wiring diagram of a neural network
- Identify neural circuits for behaviour
- Debate: Is it worth the time and money?



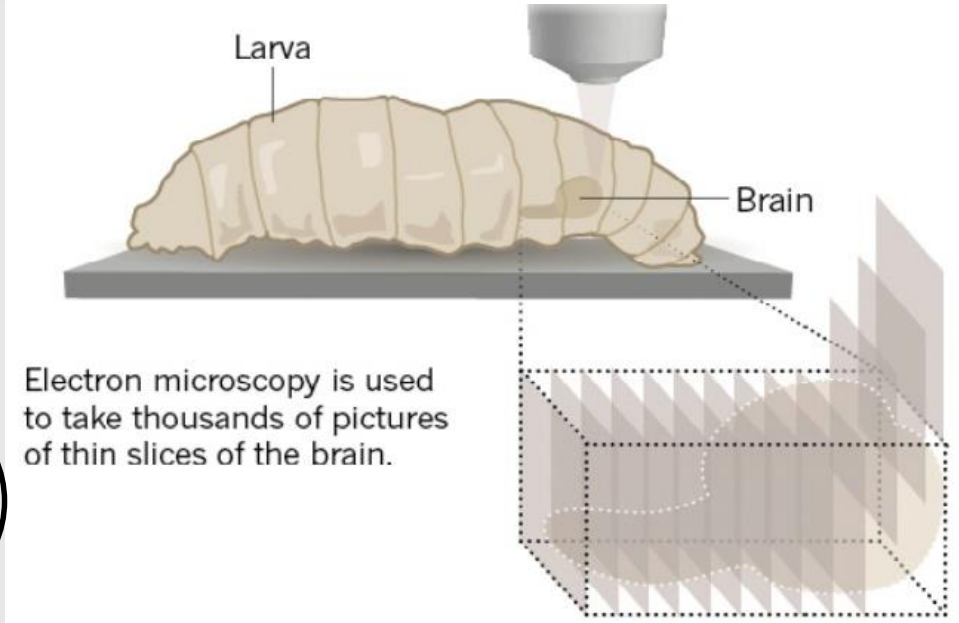
C. elegans connectome

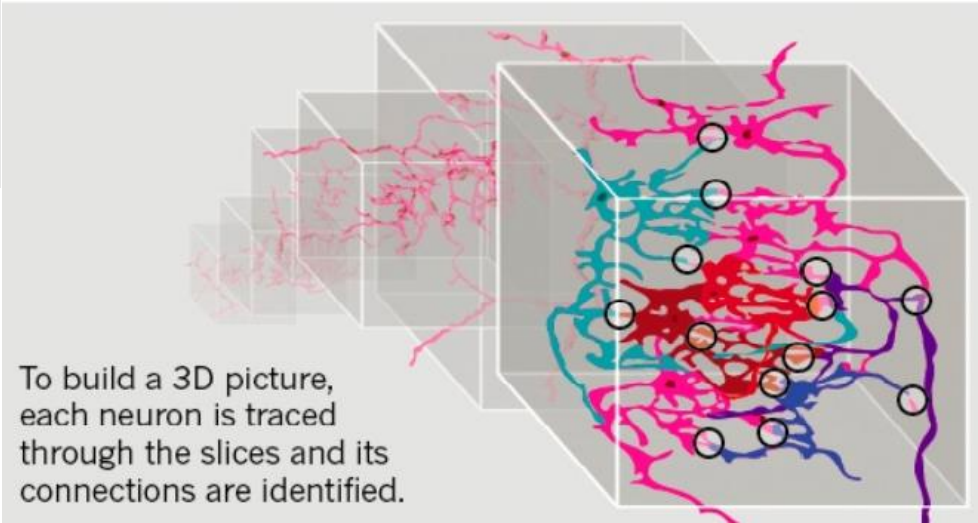
Gang Yan, et. al. 2017

Drosophila (Fruit Fly)



Jason Maynard, PhD Dissertation, 2009

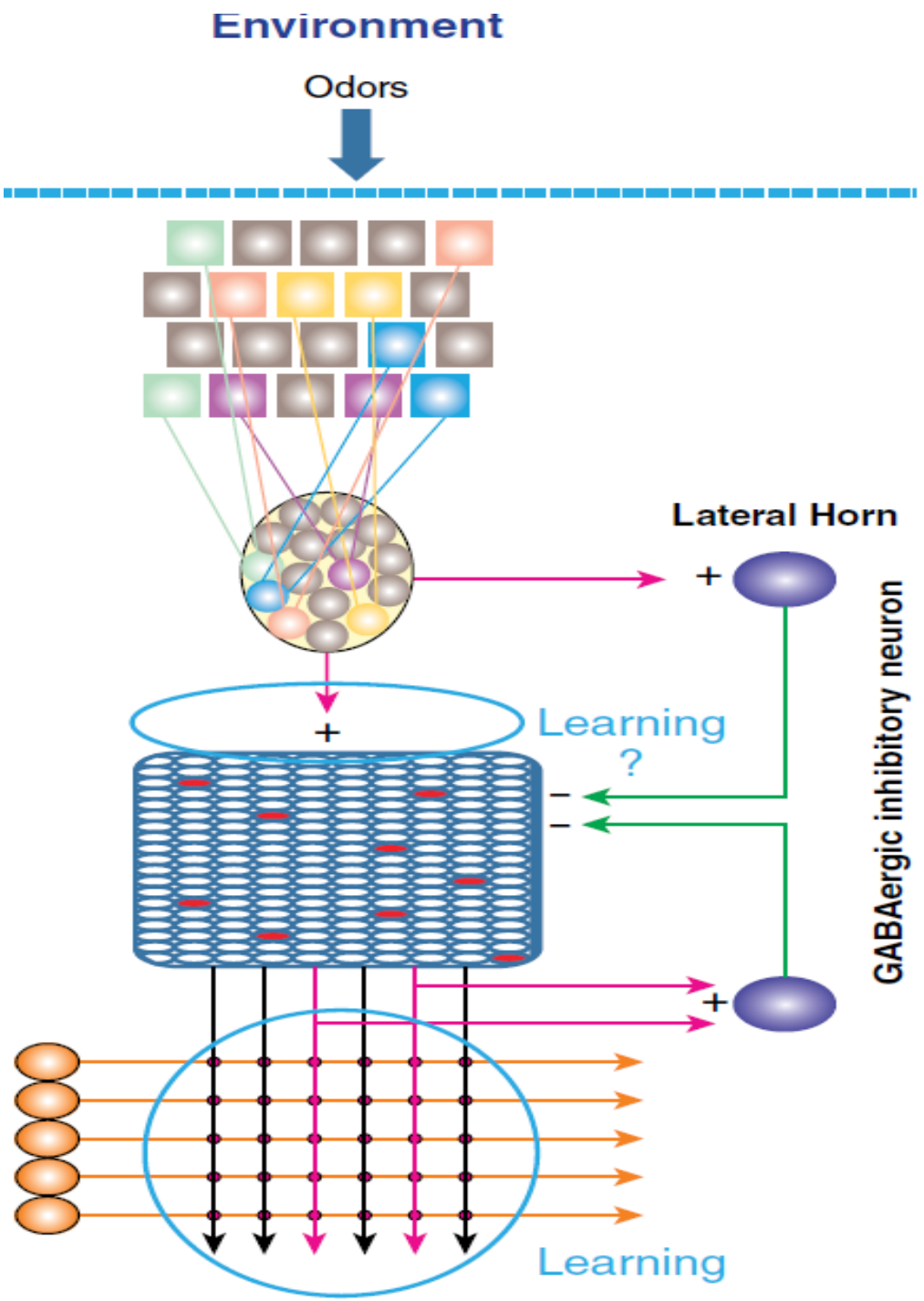




Kerri Smith, Nature 2017

Olfactory System

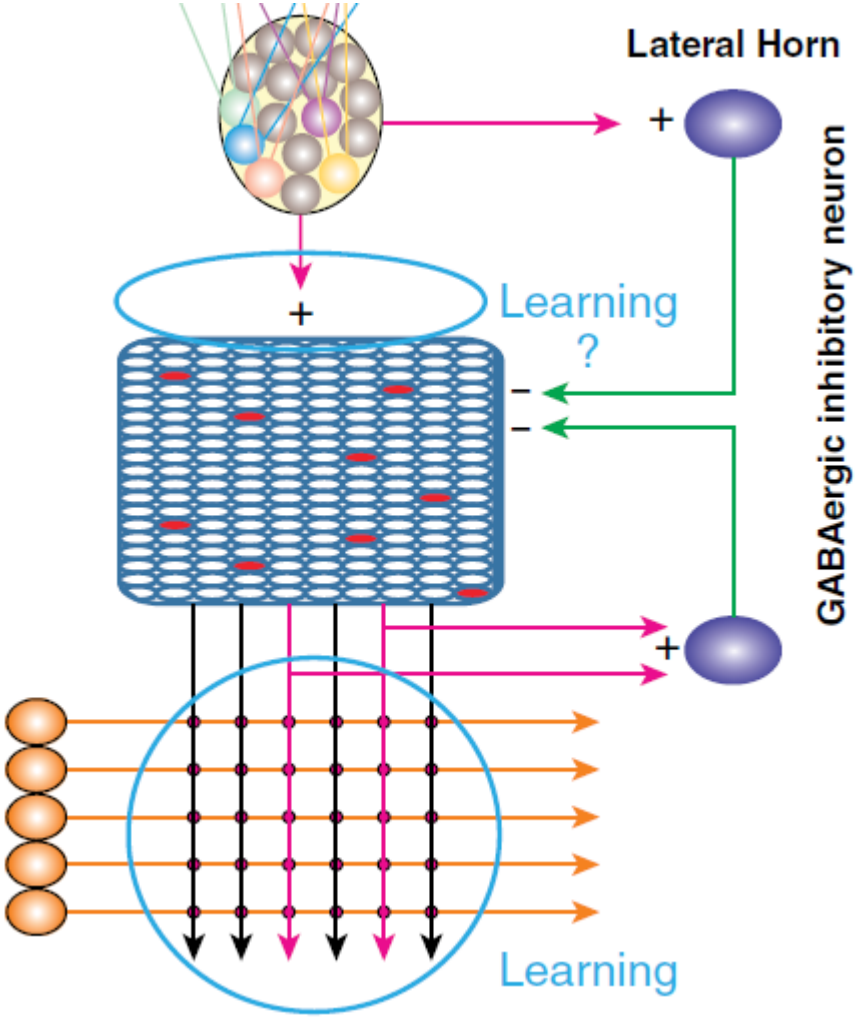
- Olfactory Reception Neuron(ORN)
- Antennal Lobe (AN)
- Projection Neuron (PN)
- Mushroom Body (MB)
- Kenyon Cells (KC)
- Output Neurons(MBON)
- MBIN: PN, DAN, OAN, APL



Ankur Gupta, et. al., 2018

Larval Mushroom Body

- 54 olfactory PN (30 others)
- 223 KC
- 24 MBONS
- 7 DANs
- 4 OANs
- 5 MBINS (mysterious)
- 2 APL



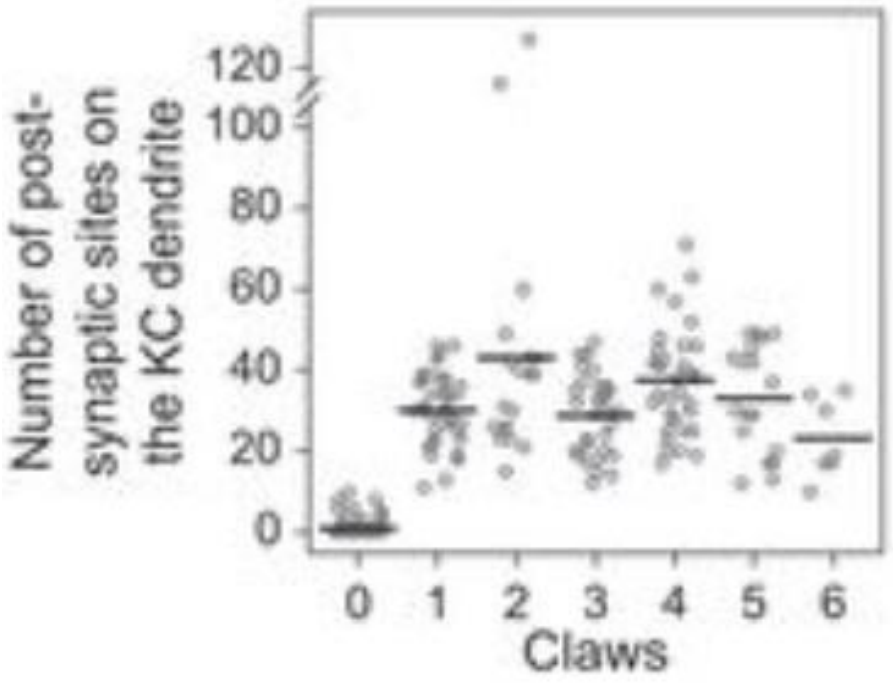
Ankur Gupta, et. al., 2018

Connectivities and Canonical Circuits

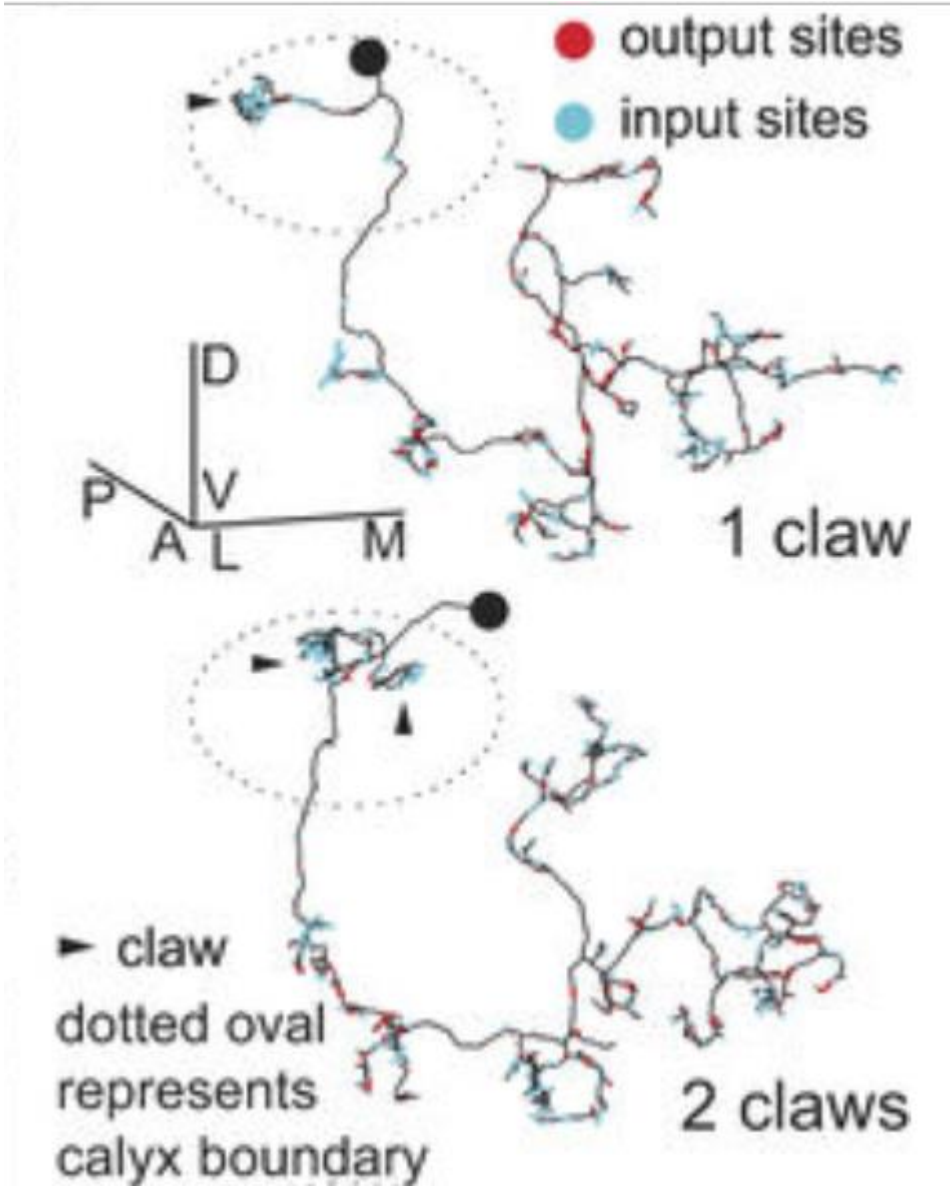
- PN-to-KC
- KC-to-KC
- KC-to-MBON/MBIN
- MBON-to-MBIN
- MBON-to-MBON

PN inputs to the KCs

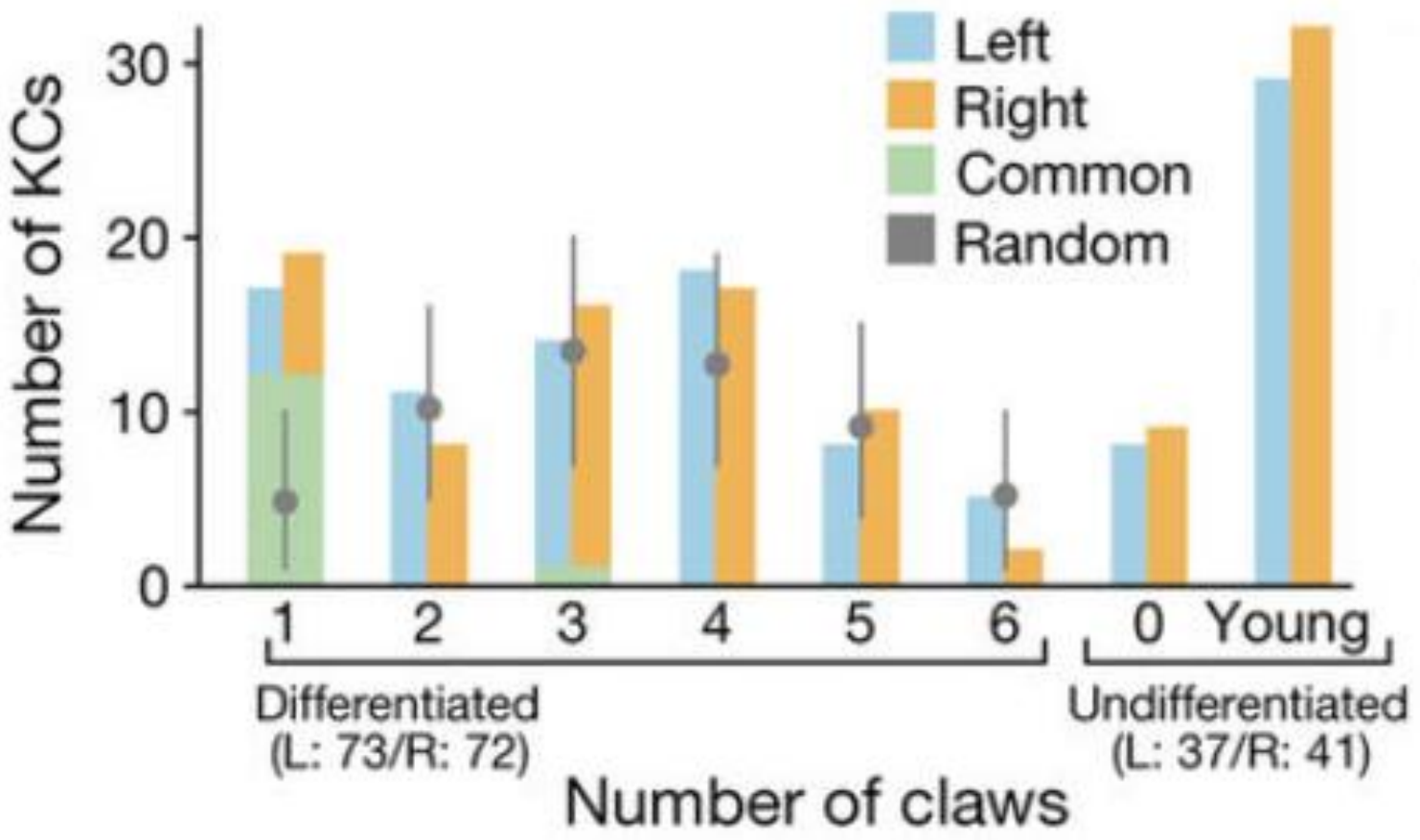
Total synapse~40

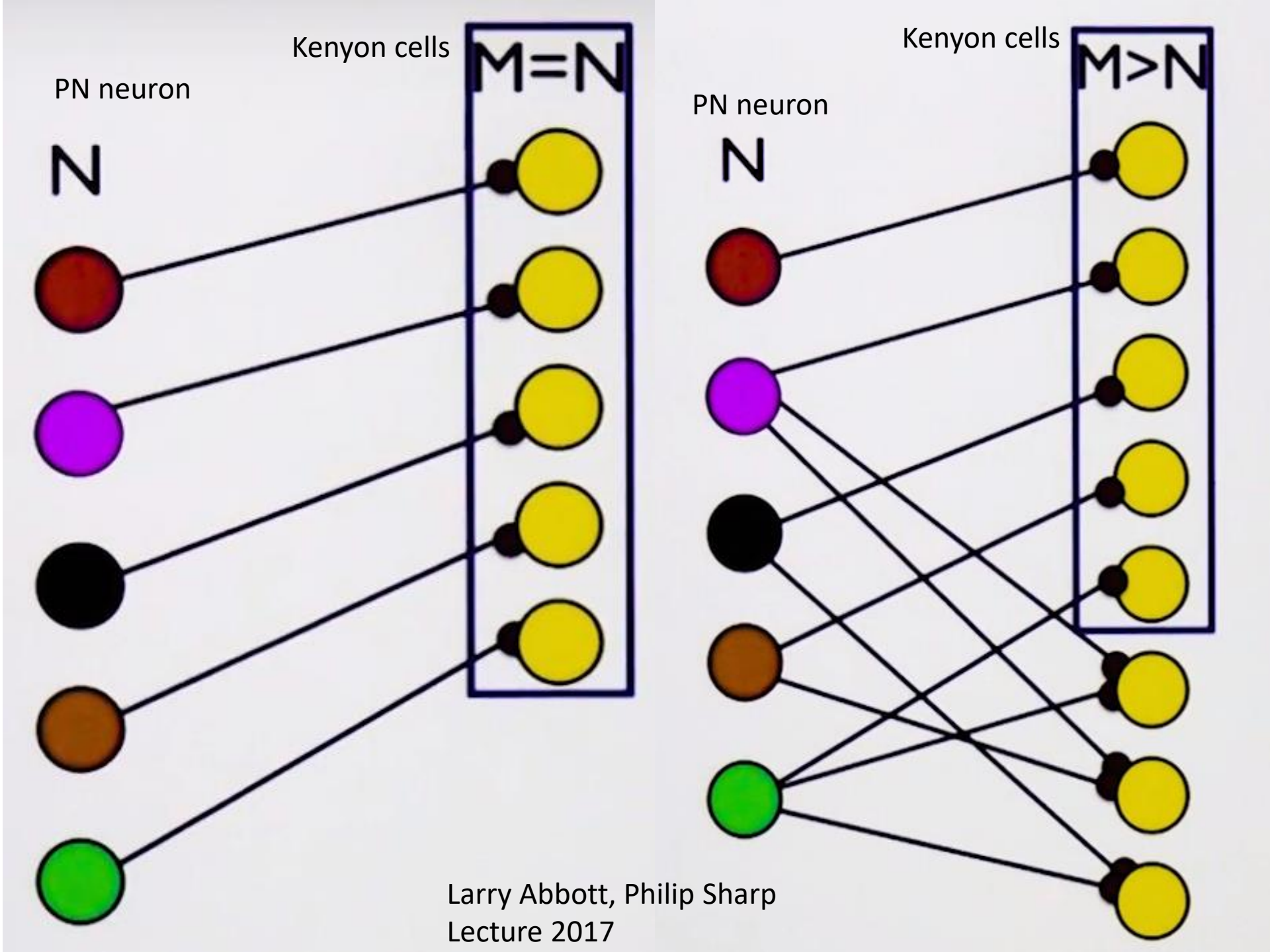


Eichler et. al. 2017



Overrepresentation of single claw KCs





Larry Abbott, Philip Sharp
Lecture 2017

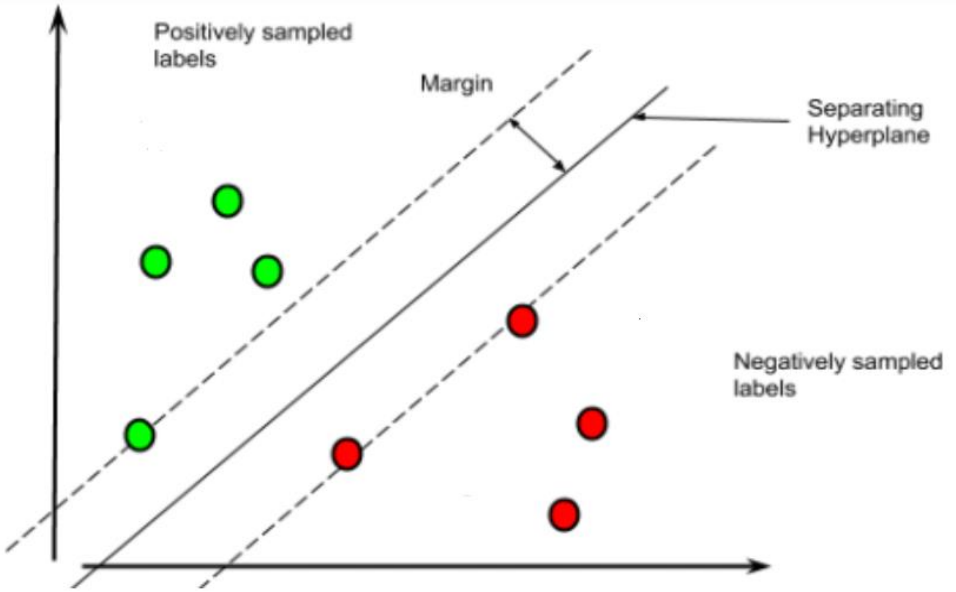
Eichler et. al. 2017

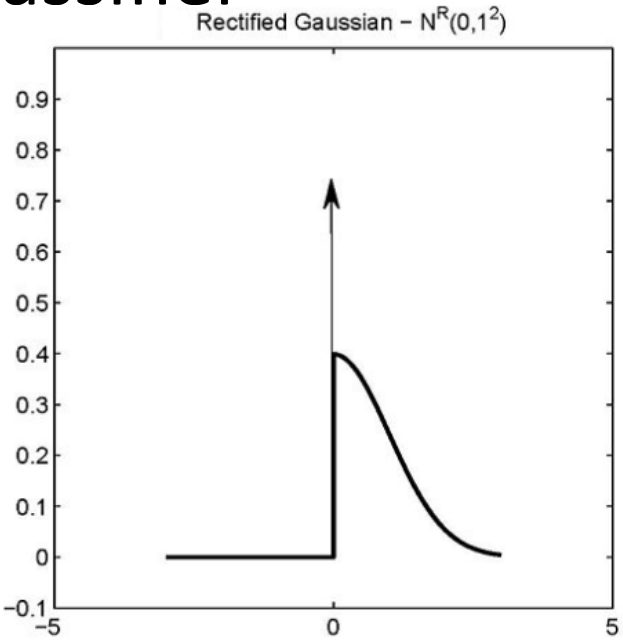
PN inputs to the KCs

- PN activity: $\vec{x}$
- KC activity: $\vec{s}$

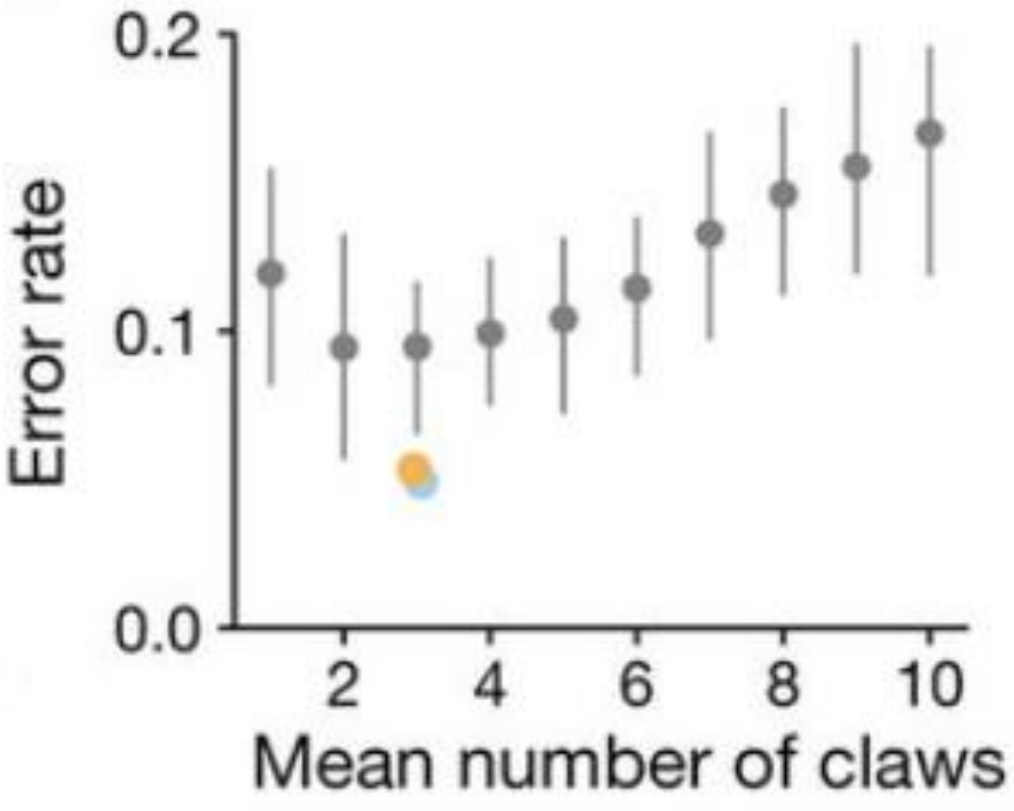
$$s_i = [\sum_j J_{ij} x_j - \theta_i]_+$$

- Training Set: 2 classes with 4 odors each
- Algorithm: Maximum Margin Classifier





Classification error

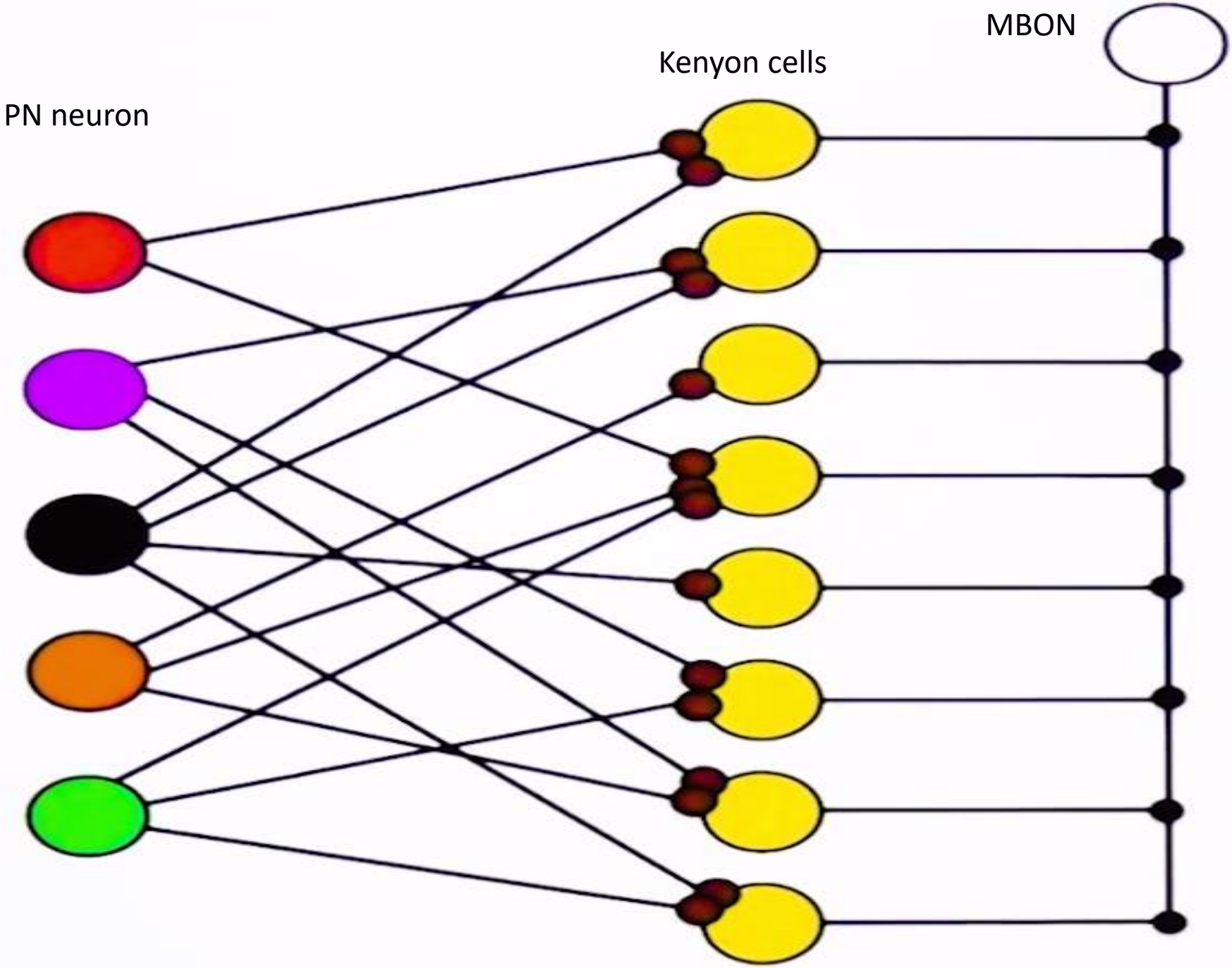


Random Models of PN-to-KC connectivity

$$s_i(t) = \Theta\left(\sum_j J_{ij} x_j + \sum_k J_{ik}^{\mathrm{rec}} s_k(t-1) - \theta_i\right)$$

Other observations

- KC-to-MBIN and KC-to-MBON connections were comparable
- MBINs connected directly to MBON


MBON
Kenyon cells
PN neuron