

Using of the Braid Theory for Description of Neural Networks

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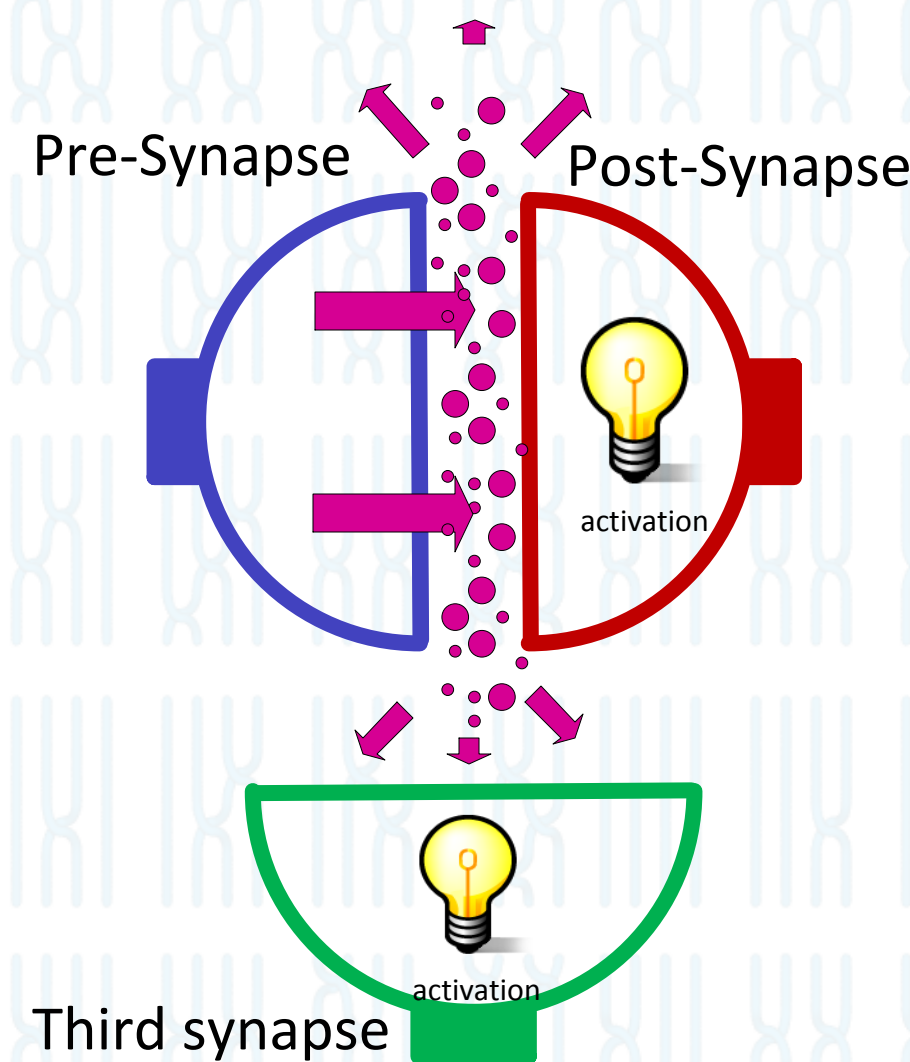
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Problem background



Real nervous system consists of many intersected neuronal paths

And each path performs information processing.



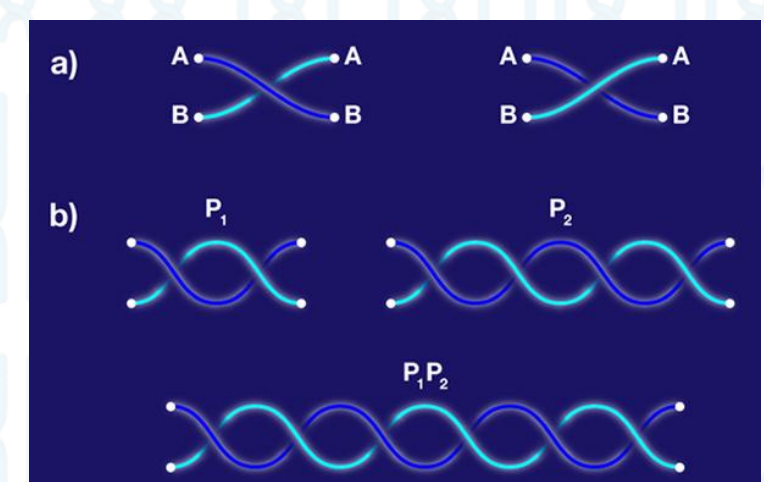
Intersections lead to extrasyaptic contacts

And it can lead to signal distortions!

Thus, we need to describe these intersections

Braid theory

Special branch of topology is studying intersections of paths (or braids)



Hypothesis:

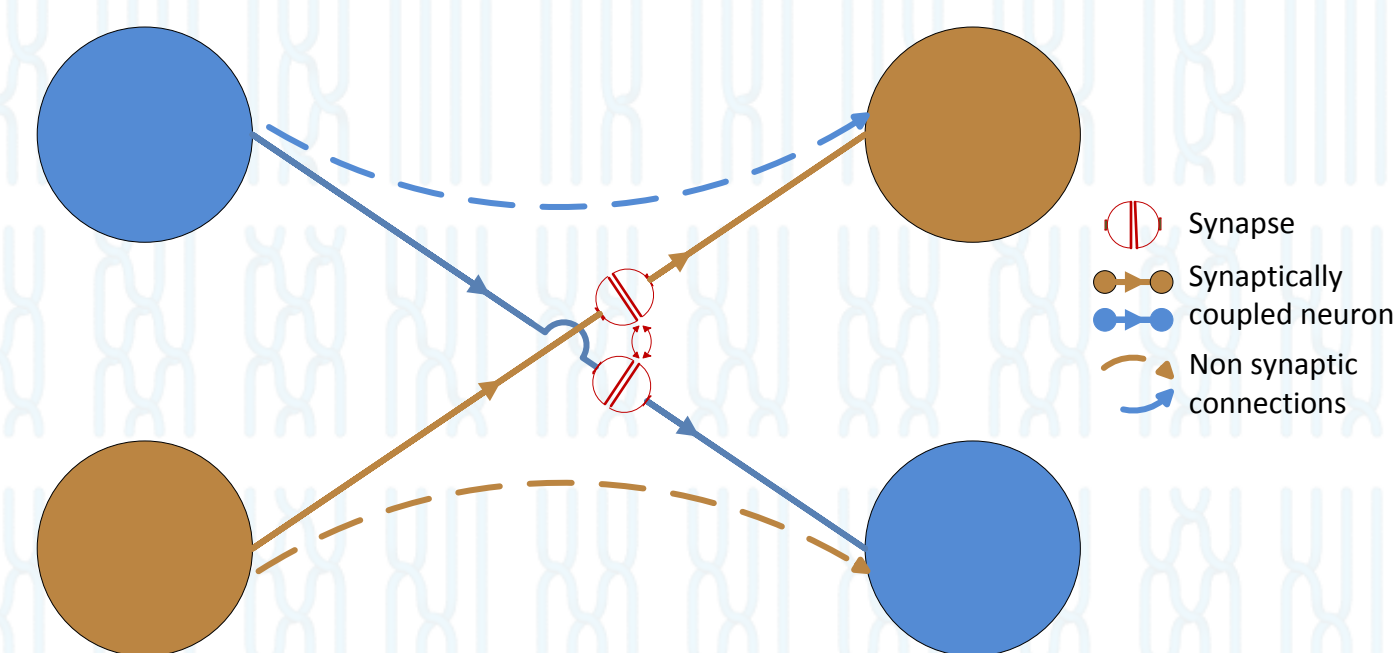
Extrasynaptic contacts lead to non-linear associations and these associations can be regulated using braid theory.

Research questions:

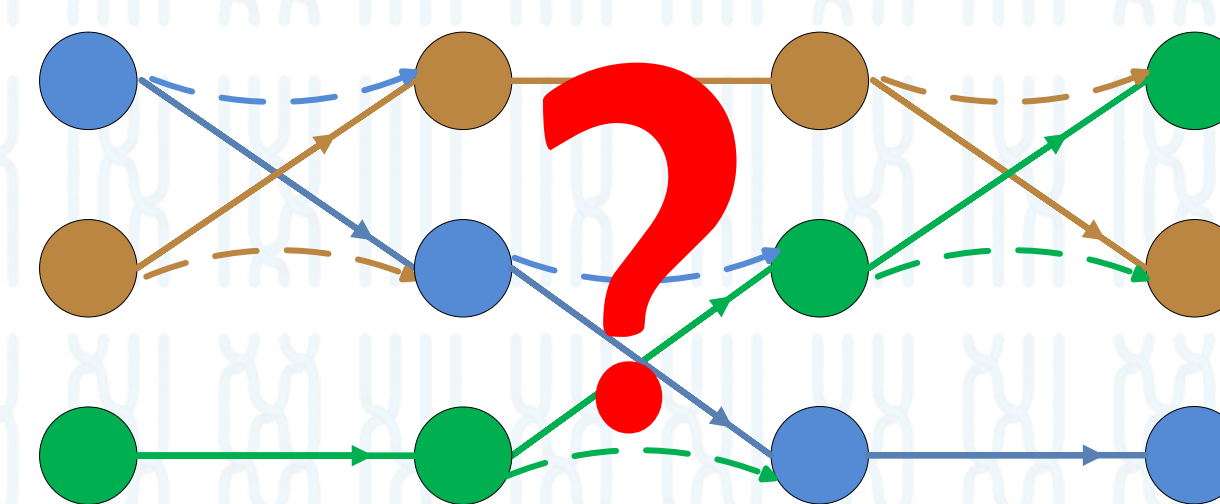
How closeness of synapses affect informational processing?

What types of distortions are affected by different neuronal topologies?

Non-synaptic talking between neurons:



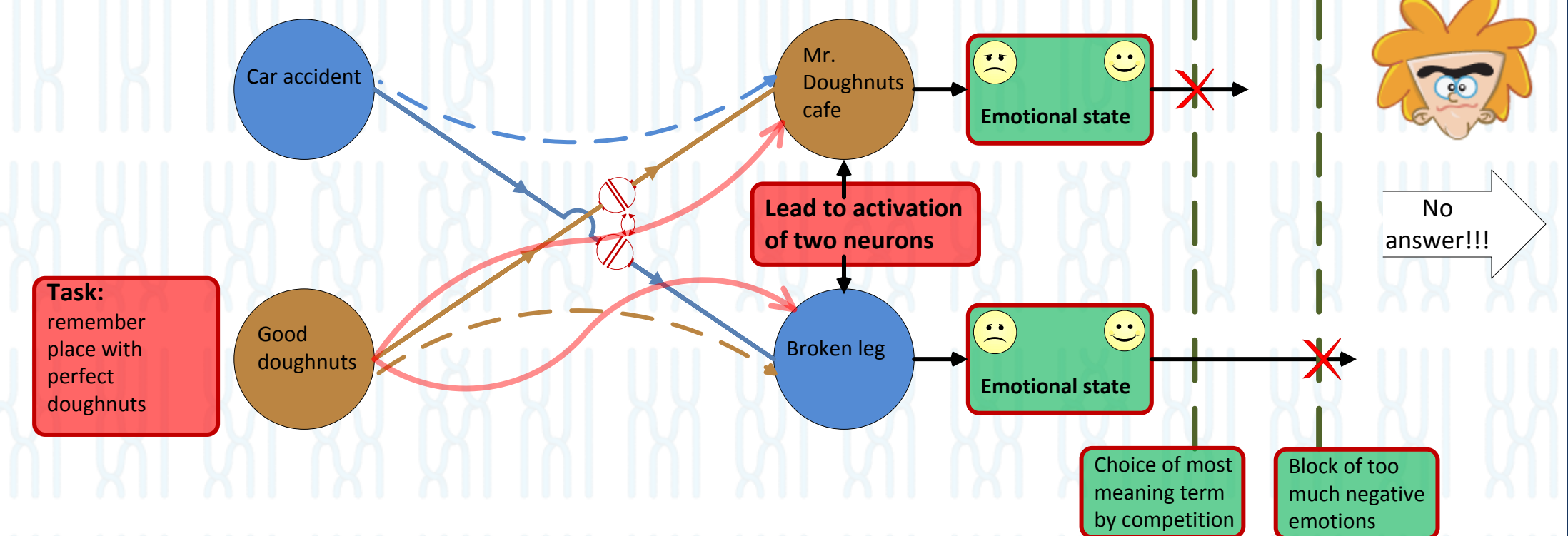
What if we will take Braid of neurons?



Braids can be described using special "Braid words". For the braid above: aBa. These braid words can be used for simple description of paths topology in evolutionary modeling/ optimization.

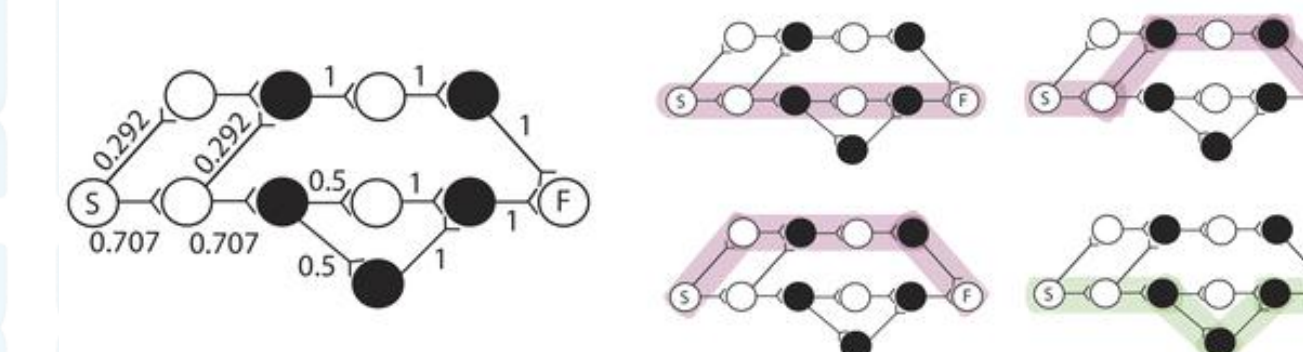
Topology allows handling and reduction in braid structure. It can be interesting from information processing view to reduce neuronal braids and look what happened with associations and information.

Case of remembering:



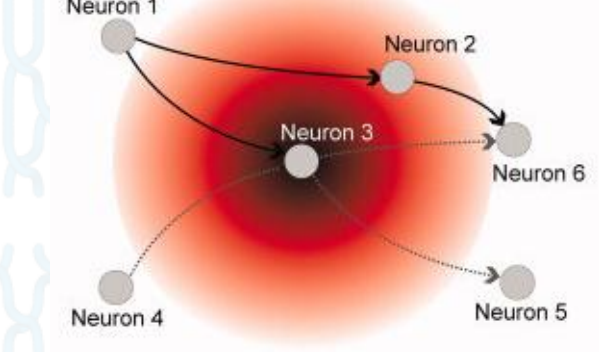
Some related works:

Evolvable Neuronal Paths



From Fernando C. et al. (2011)

GasNets



From Husbands P. et al. (2010)

Potential extentions:

- Topological descriptions of networks instead of paths
- Using braid words as descriptors for development of neuronal networks

References:

Husbands P., Philippides A., Vargan P., Buckley C., Fine P., Di Paolo E and O'Shea M. (2010) Spatial, temporal and modulatory factors affecting GasNet evolvability, Complexity 16(2):35-44.
 Fernando C., Vasas V., Szathmáry E., Husbands P. (2011) Evolvable Neuronal Paths: A Novel Basis for Information and Search in the Brain. PLoS ONE 6(8): e23534. doi:10.1371/journal.pone.0023534
 Kassel C., Turaeu V. (2008) Braid groups, Graduate Texts in Mathematics 247, Springer.
 Rusakov D.A. and Kullmann D.M. (1998). Extrasynaptic glutamate diffusion in the hippocampus: ultrastructural constraints, uptake, and receptor activation. J. Neurosci. 18, 3158-3170