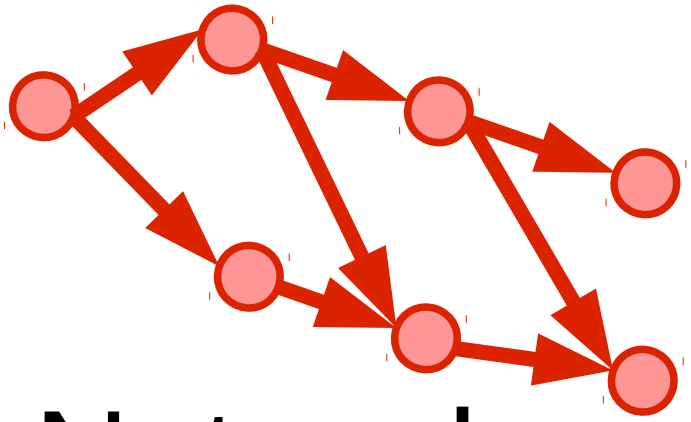
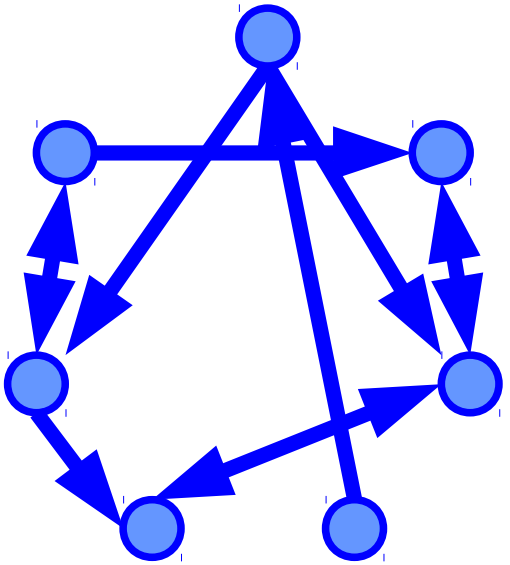


Dynamics of Neural Networks with Different Motif Distributions



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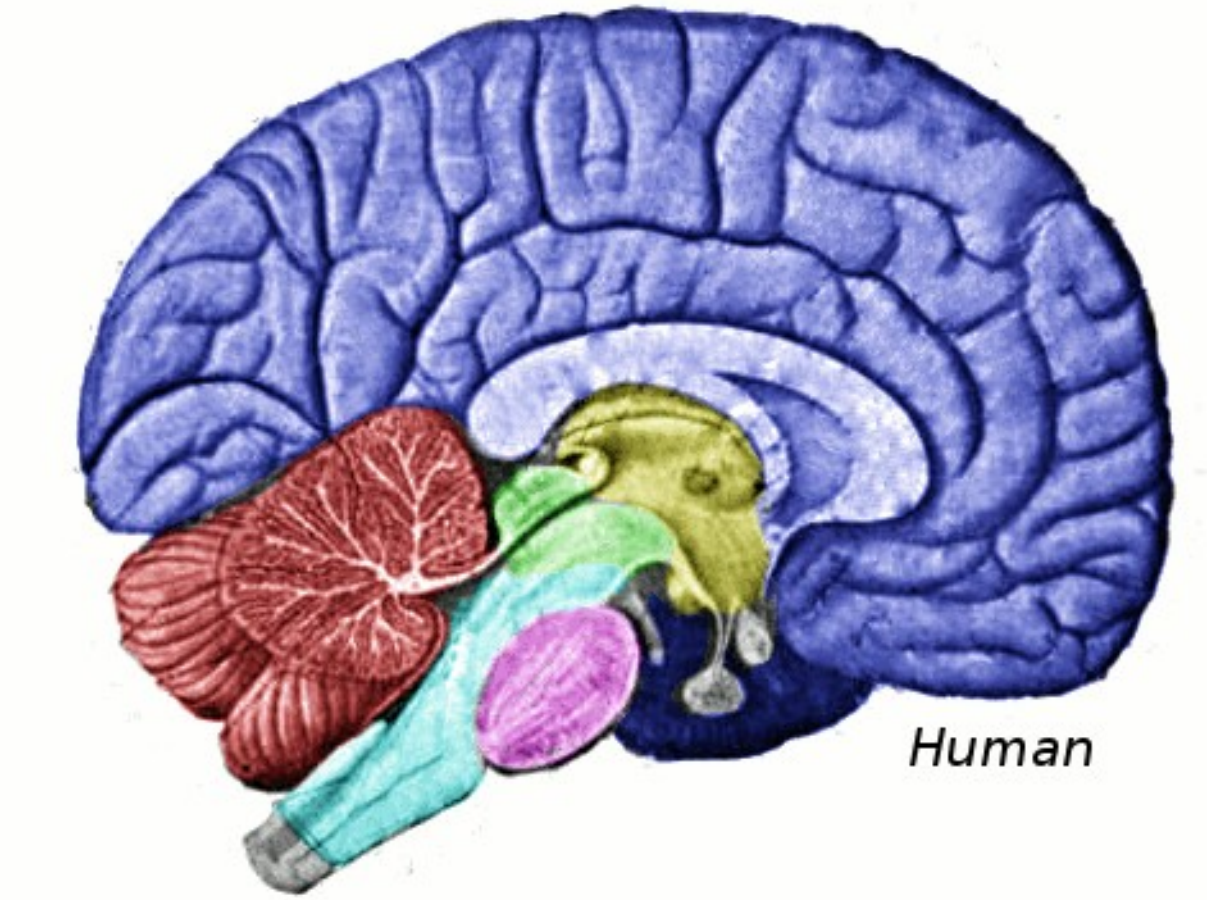
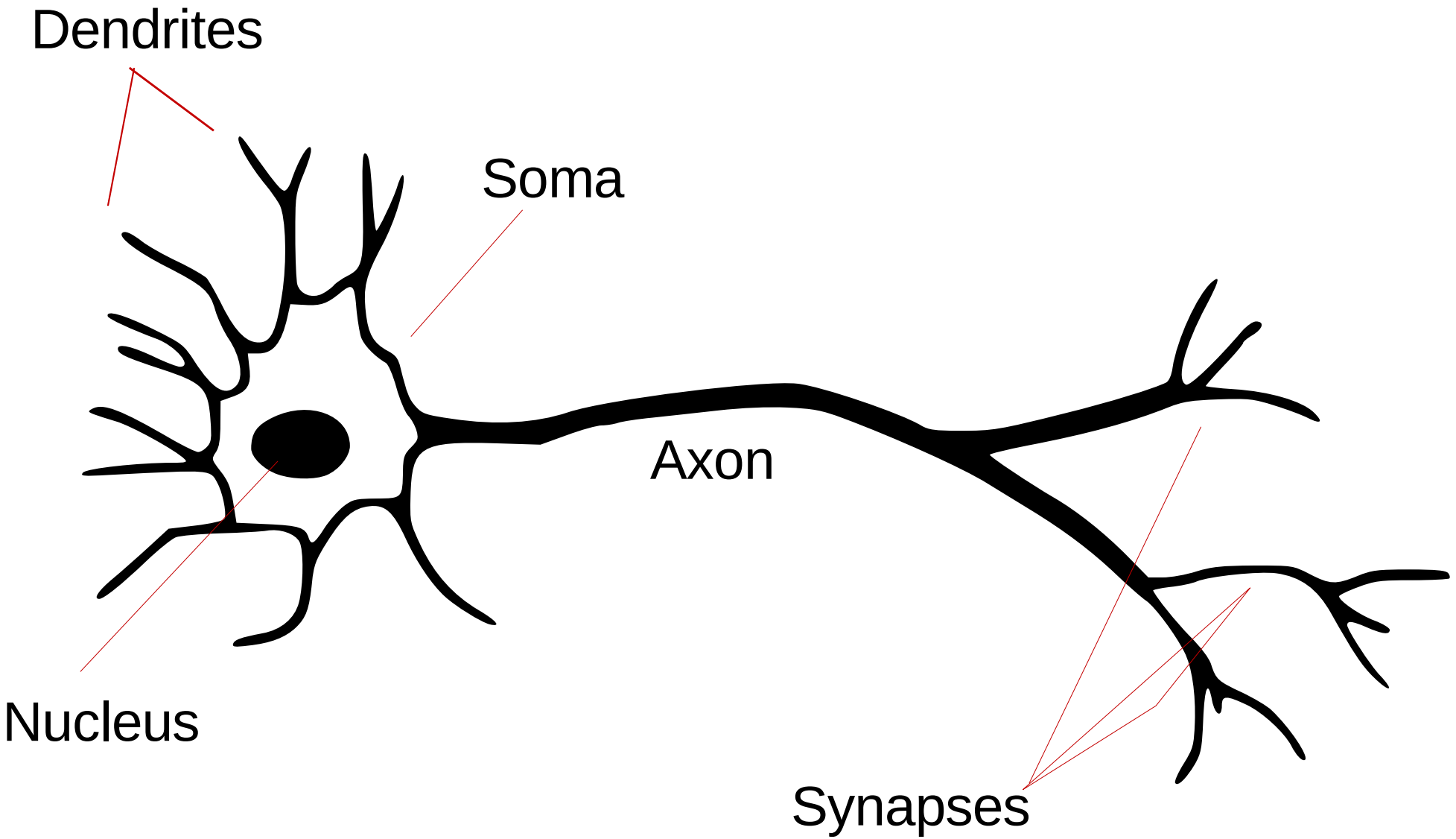
2nd year PhD

The Brain



http://upload.wikimedia.org/wikipedia/commons/b/b3/Vertebrate-brain-regions.png

Neurons

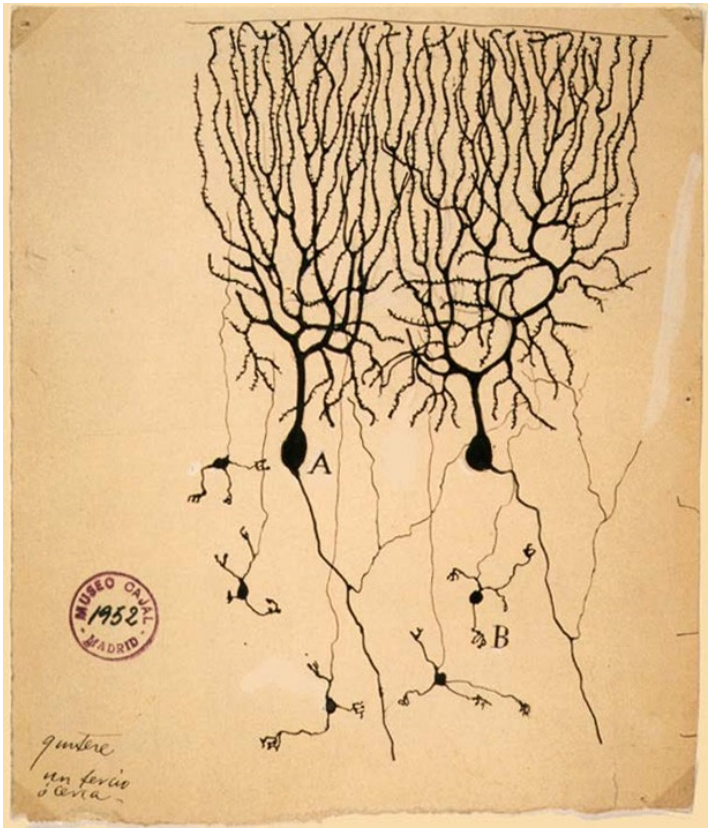


http://upload.wikimedia.org/wikipedia/commons/5/52/Neuron_-_annotated.svg

Brain Networks

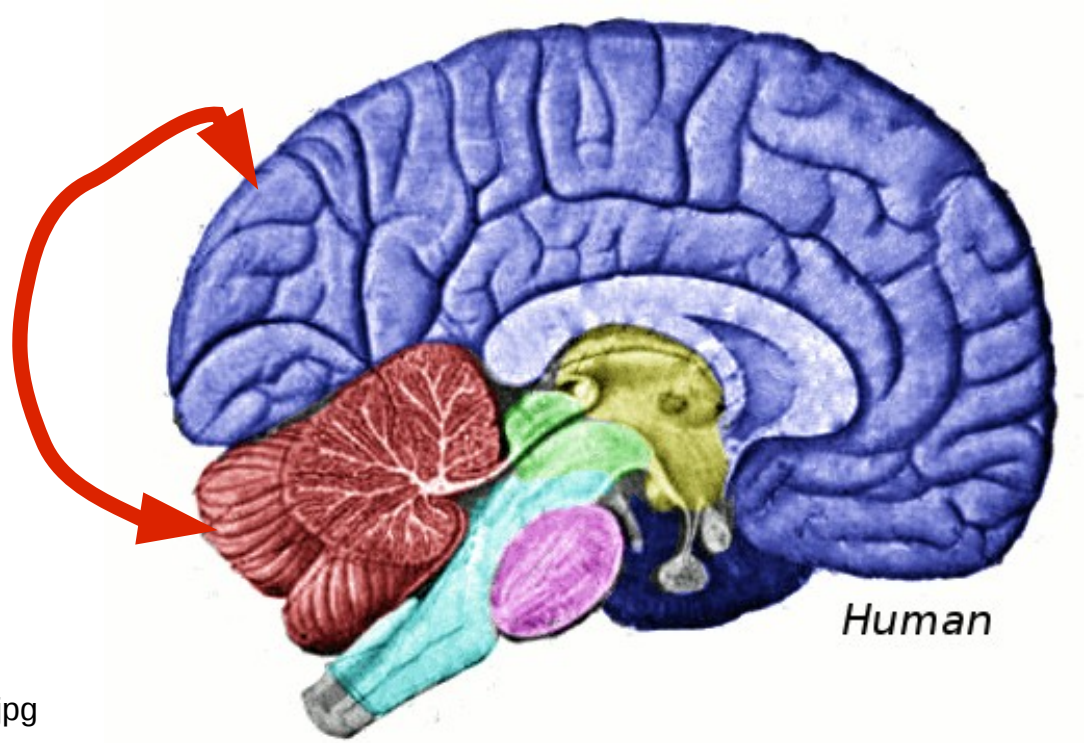
Exist at different scales:

Individual neurons



http://upload.wikimedia.org/wikipedia/commons/1/15/PurkinjeCell.jpg

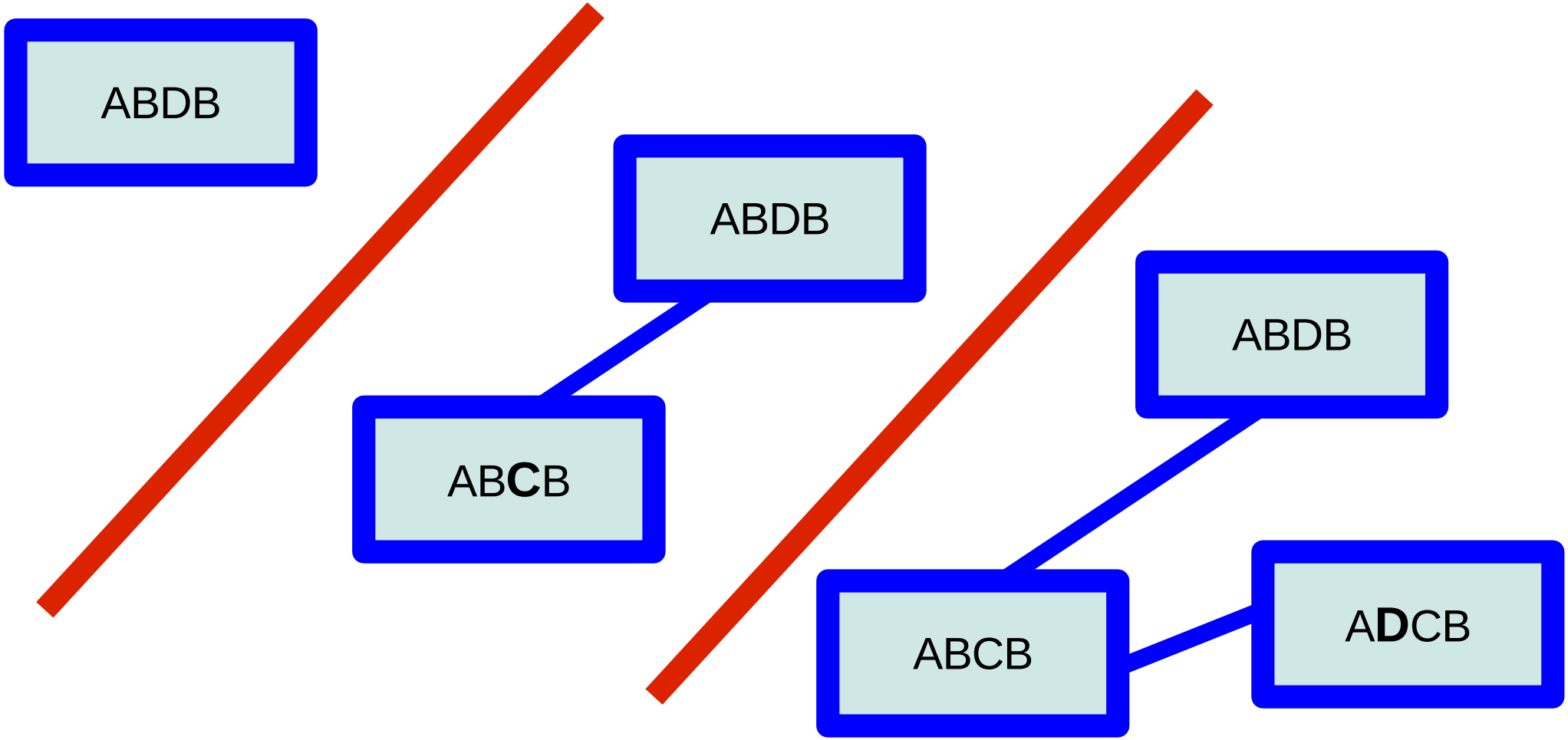
Brain regions



http://upload.wikimedia.org/wikipedia/commons/b/b3/Vertebrate-brain-regions.png

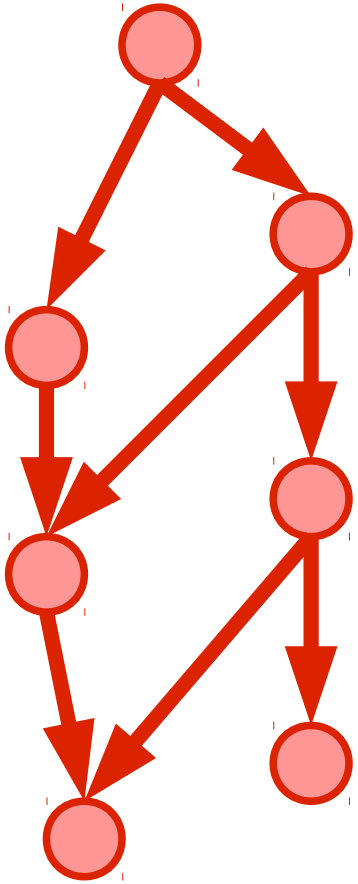
Structured Node Model (SN model)

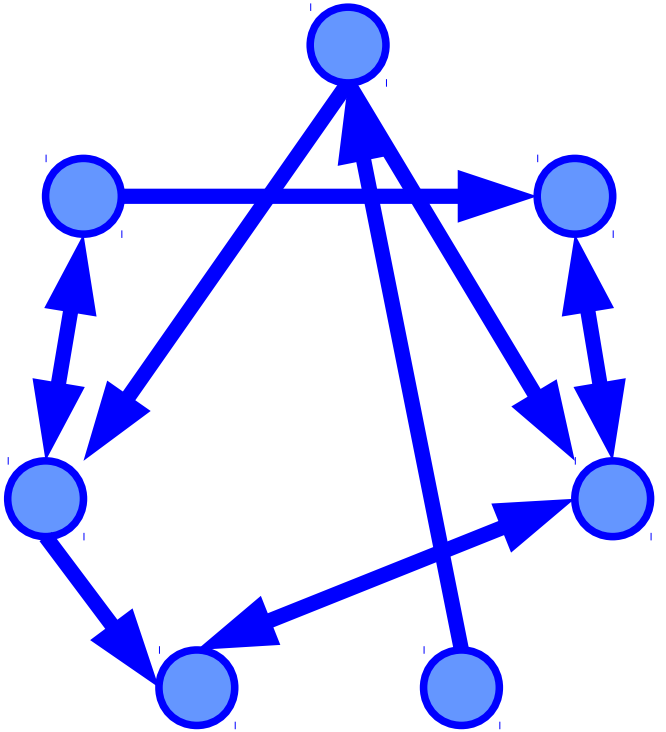
An algorithm for constructing a network



The Two Networks

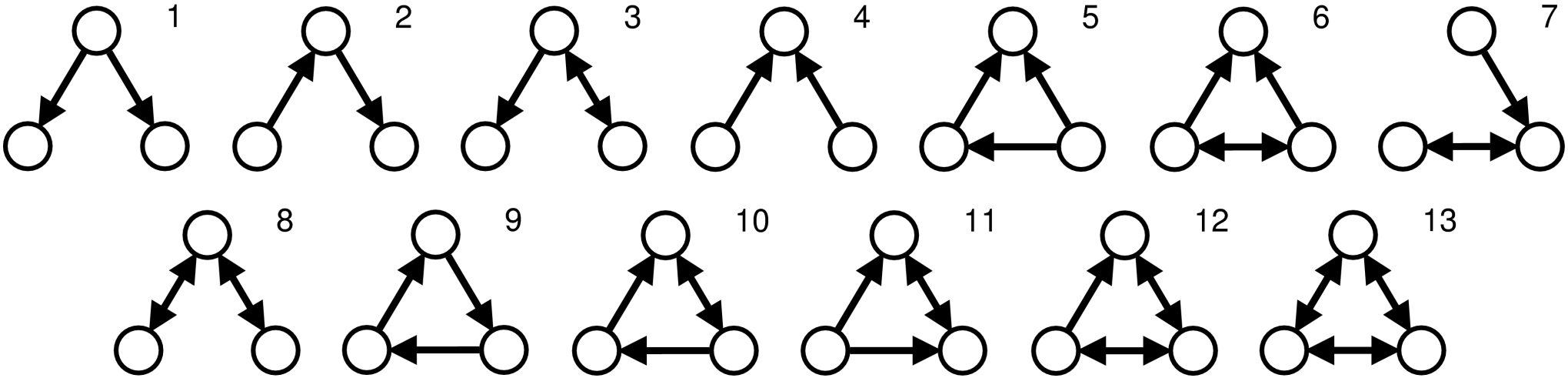
Very different networks



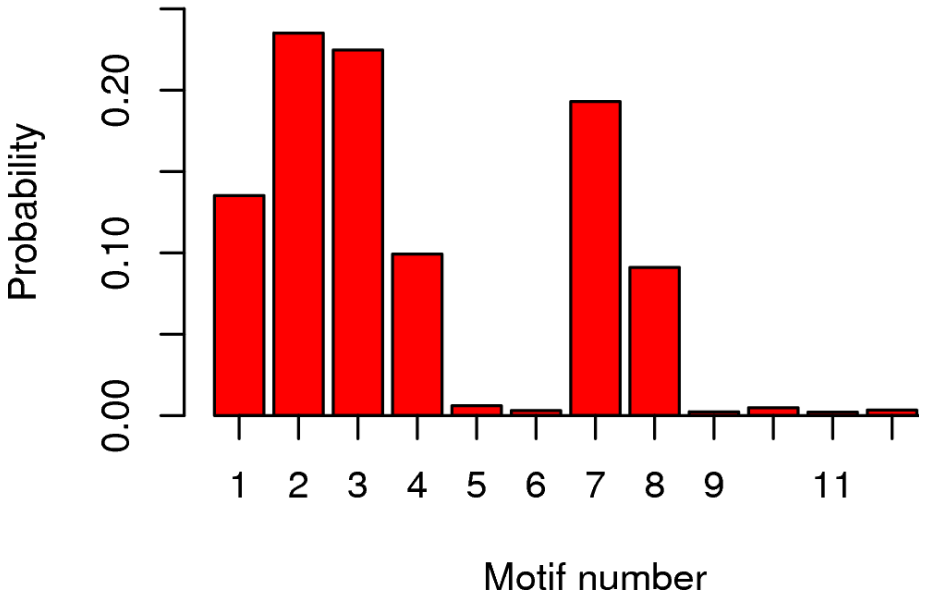


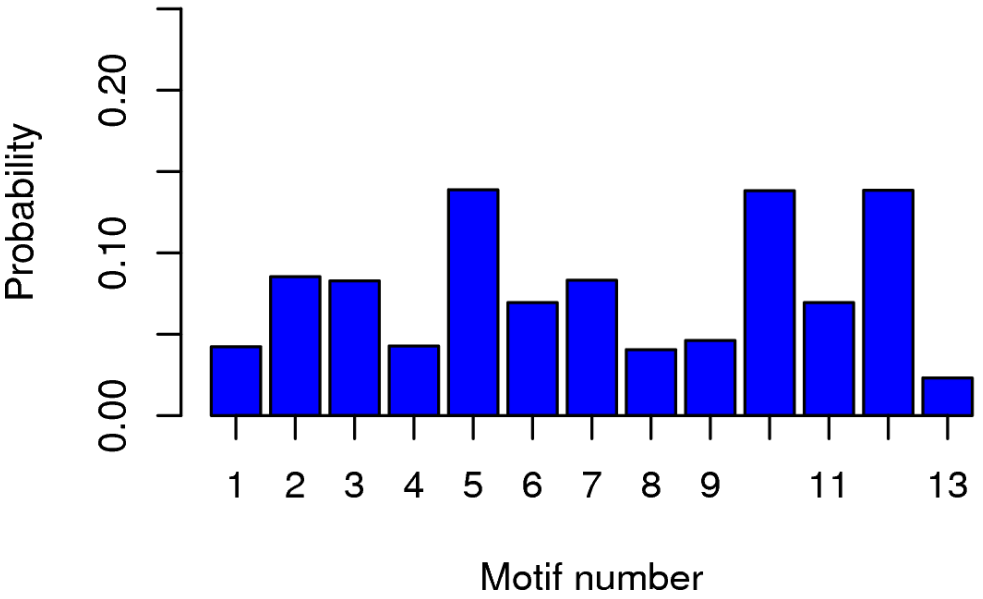
Motifs

"patterns of interconnections that are found in significantly higher numbers in complex networks than random networks" Milo, R. et al. Network Motifs: Simple Building Blocks of Complex Networks, Science, 2002, 298, 824-827



Motif Distributions

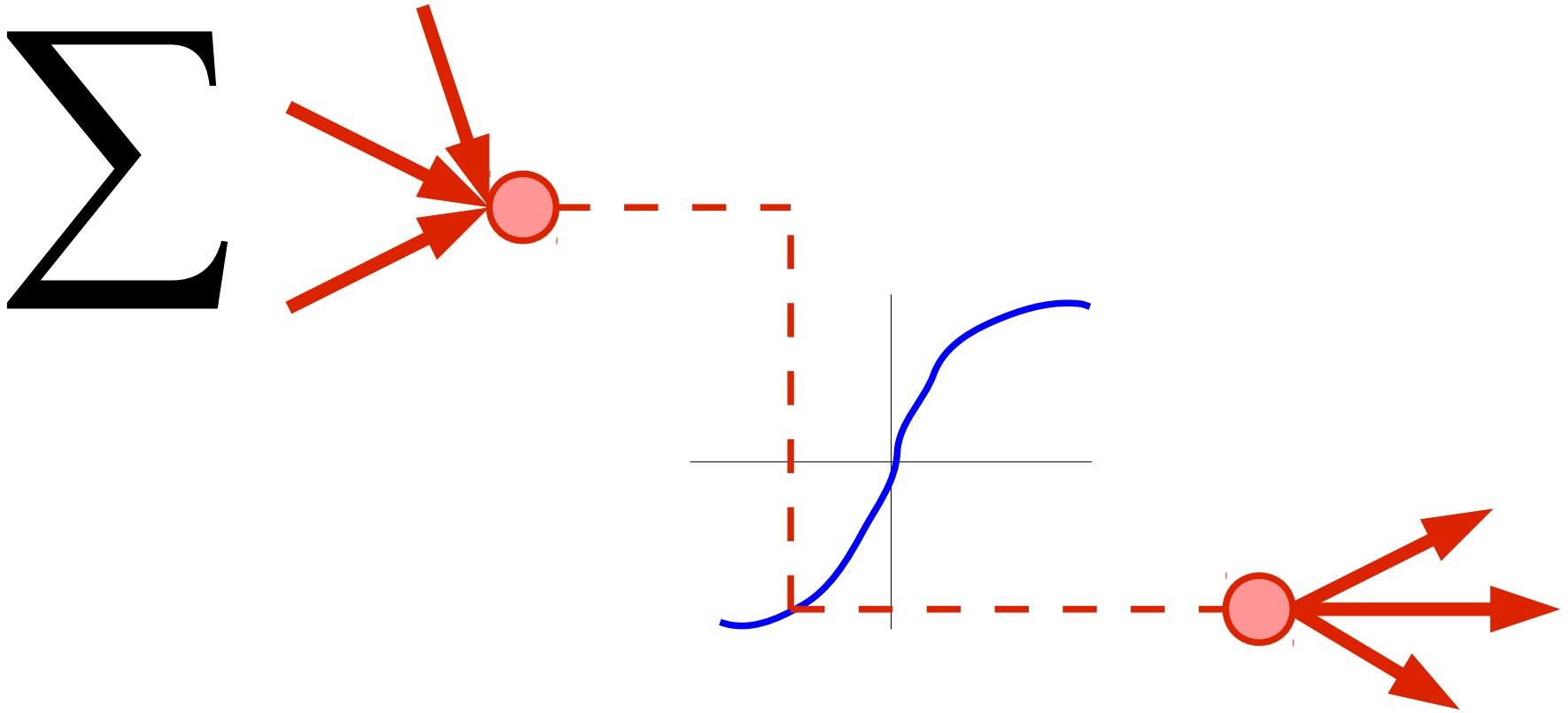




Random Recurrent Neural Networks

(RRNNs)

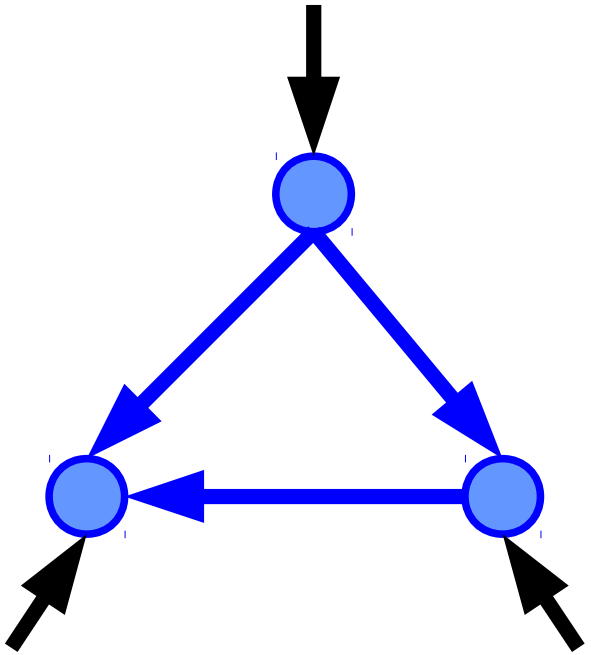
Simple model of a neural network



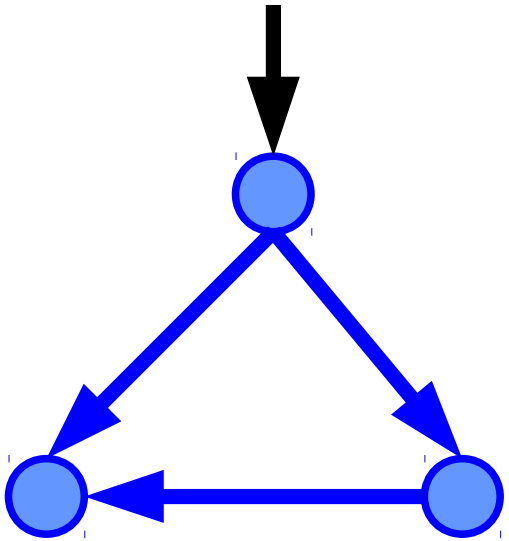
Adding an Influence

Three different methods of adding an influence were used

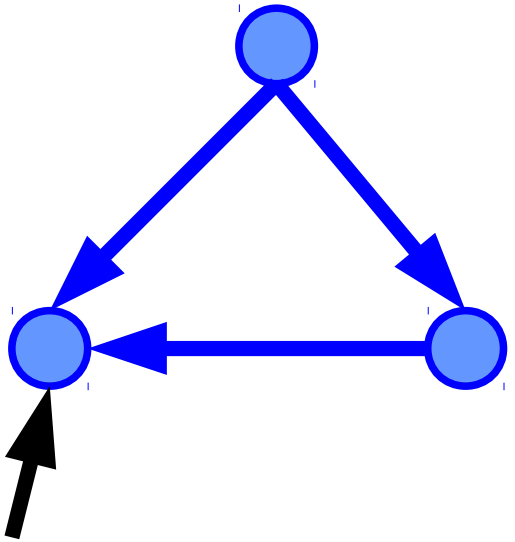
All Neurons



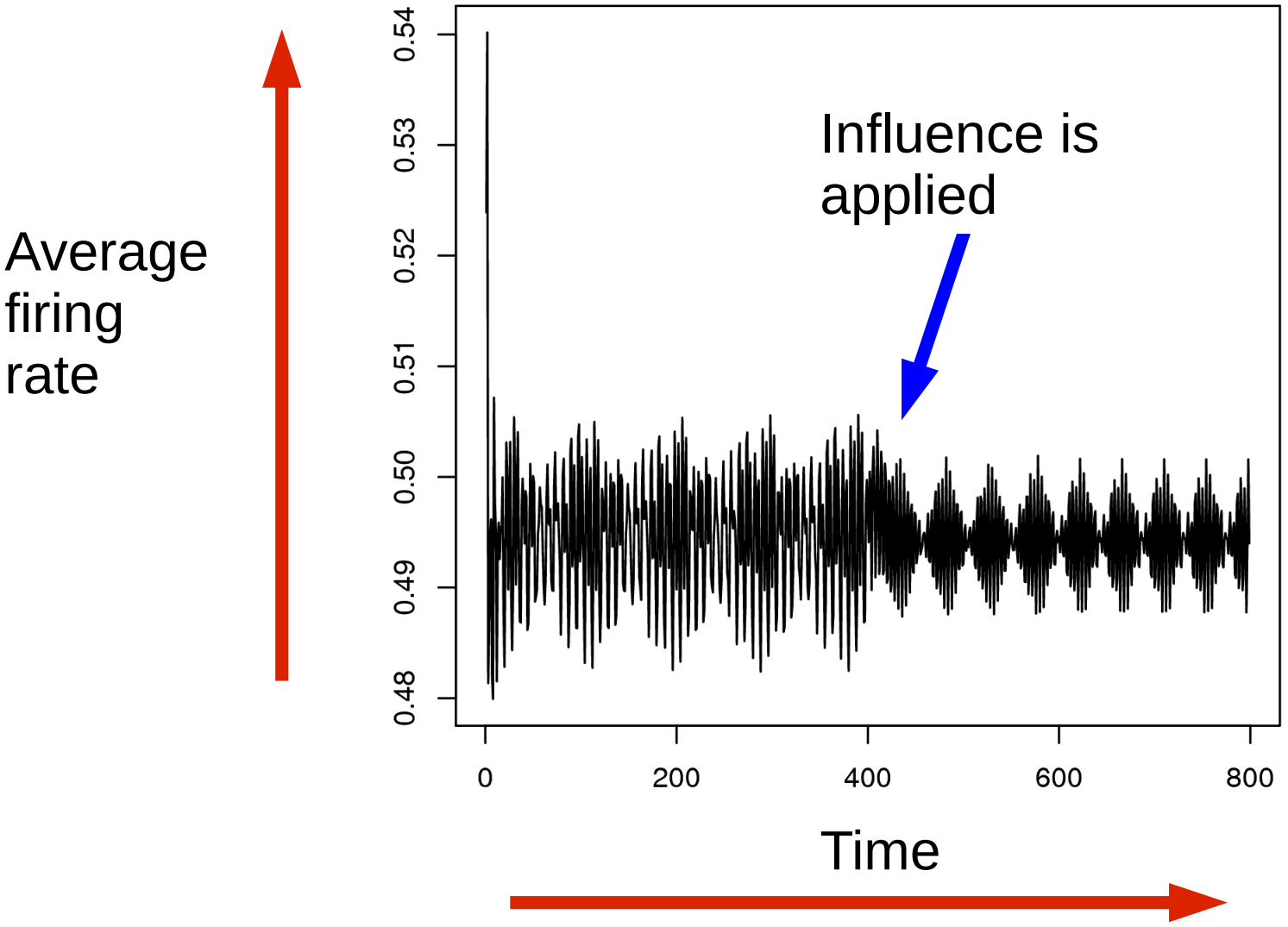
Most Outgoing Synapses



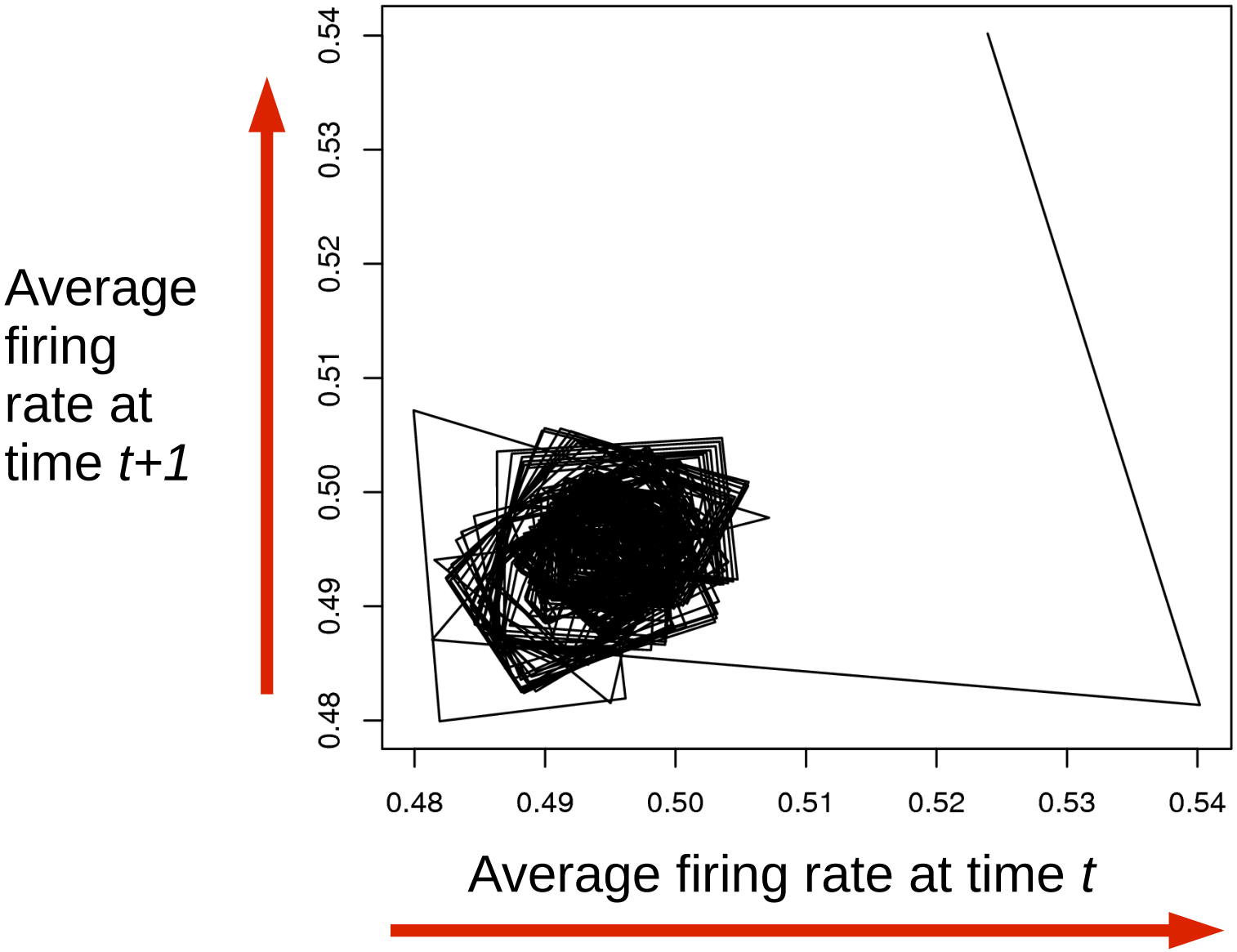
Least Outgoing Synapses



Observing the Dynamics

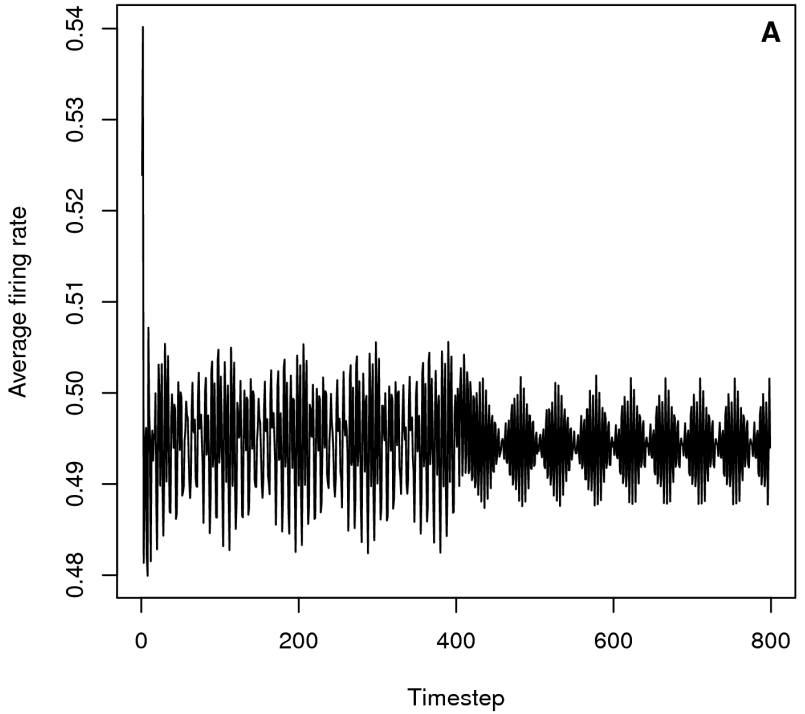


Trajectories of Dynamics

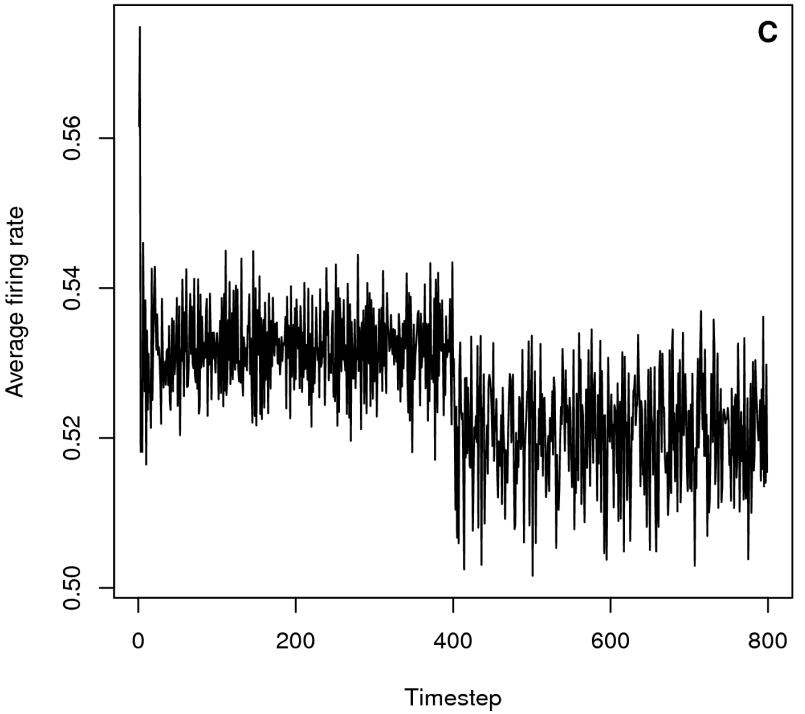


Regular Dynamics

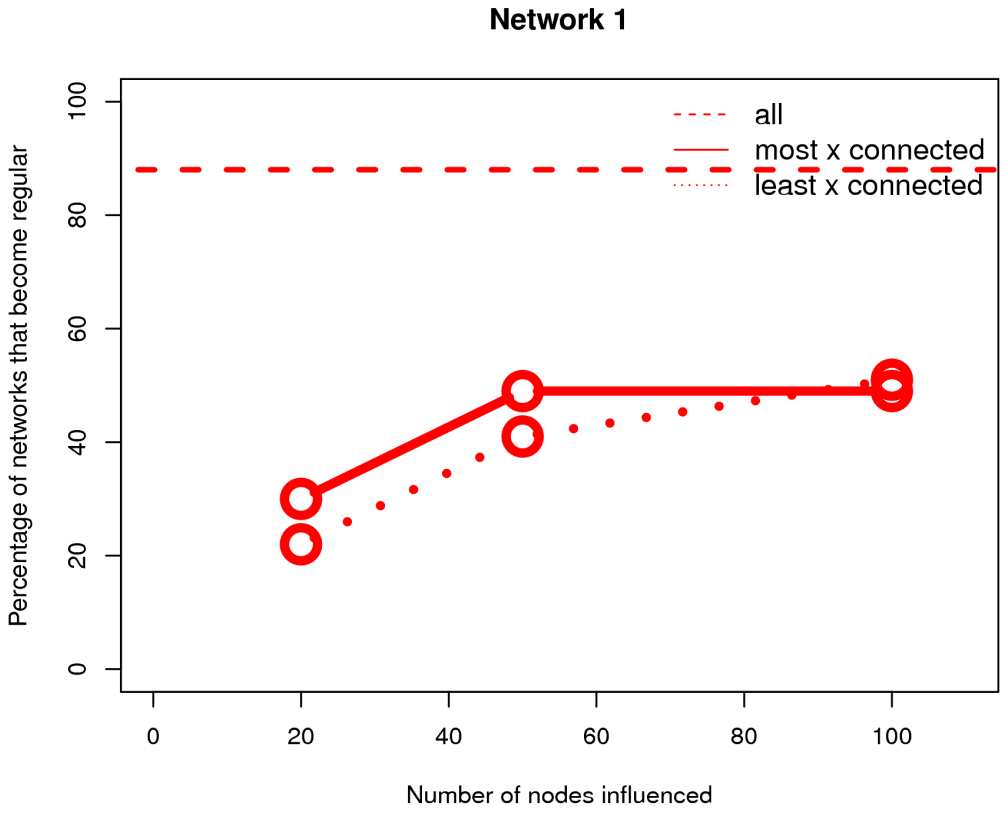
Regular

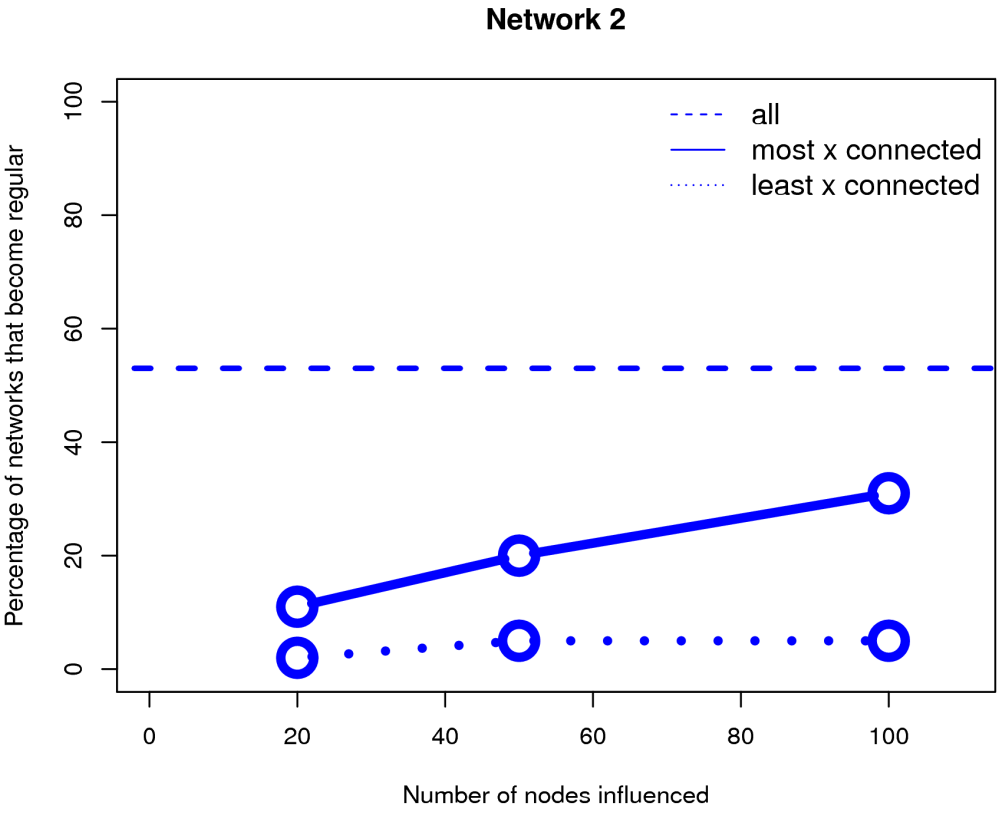


Not Regular



Results


Network 1
Percentage of networks that become regular
0
20
40
60
80
100
all
most x connected
least x connected
0
20
40
60
80
100
Number of nodes influenced


Network 2
Percentage of networks that become regular
0
20
40
60
80
100
all
most x connected
least x connected
0
20
40
60
80
100
Number of nodes influenced

Summary

Used SN model to create many networks

Chose two with different motif distributions

Simulated them as RRNNs using three different methods of applying a stimulus

Compared how often each network became regular

Conclusions

SN model able to create networks with a variety of different motif distributions

Networks with different motif distributions have different dynamics

Networks with more feedback loops will be more likely to have chaotic dynamics

Networks of a more feed forward nature will be easier to control

Further Work

We only looked at the motif distribution, there are other measures that are different between the two networks

Current work is finding links between the average degree and the dynamics

Look at whether networks that are easier to control are as adapt at training to recognise patterns