Dynamics of Neural Networks with Different Motif Distributions

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The Brain

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

Dendrites
Soma
Axon
Nucleus
Synapses

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

Exist at different scales:

Individual neurons

Brain regions

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

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

![Graph 1: Motif Distributions](image1)

- **X-axis:** Motif number
- **Y-axis:** Probability

![Graph 2: Motif Distributions](image2)

- **X-axis:** Motif number
- **Y-axis:** Probability
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

Average firing rate

Time

Influence is applied
Trajectories of Dynamics

Average firing rate at time $t+1$

Average firing rate at time $t$
Regular Dynamics

Regular

Not Regular
Results

Network 1

Network 2
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.