Moore Machine architecture implemented purely on a multi-layer Hopfield network

A perspective of sequential memory in humans

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❖ Abstract

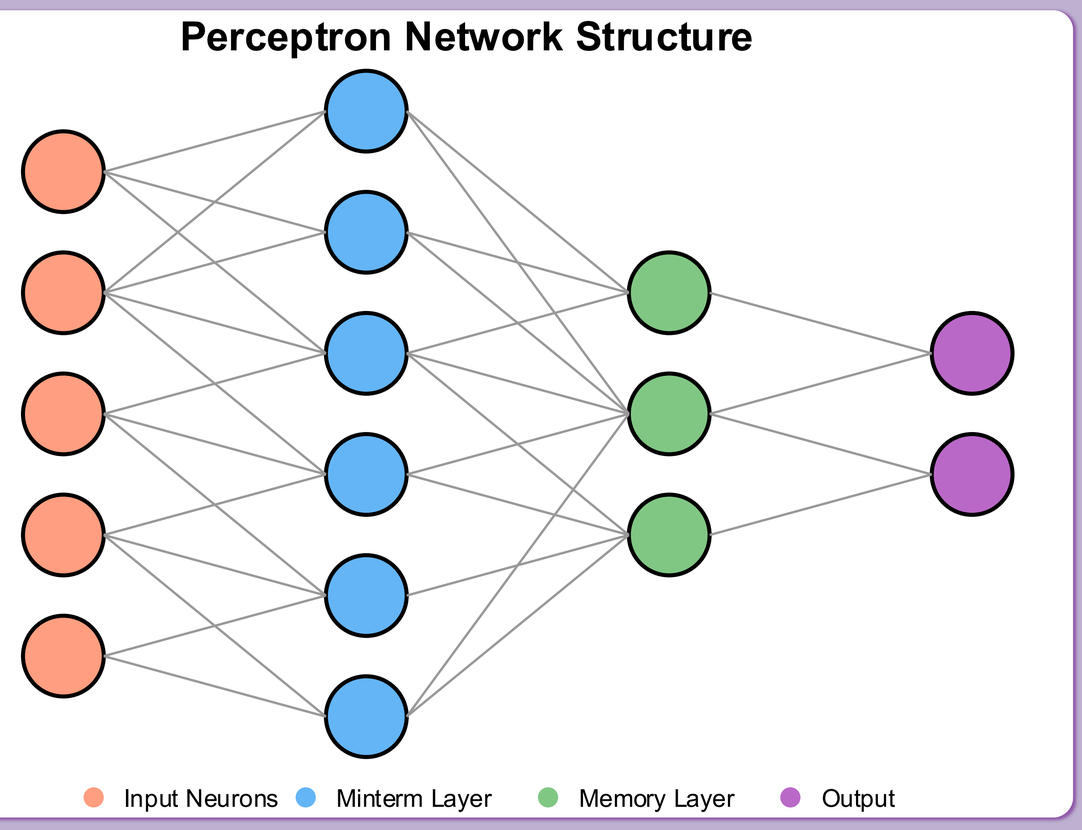
- We aim to look at how **sequential memory**, and by extension some elementary data processing, might work in neural circuits
- We assume **Moore's paradigm** for as the basis of processing, transitions are aided by **Hopfield networks** to reduce errors
- We analyze a possible perceptron network and a more **biologically focused** one

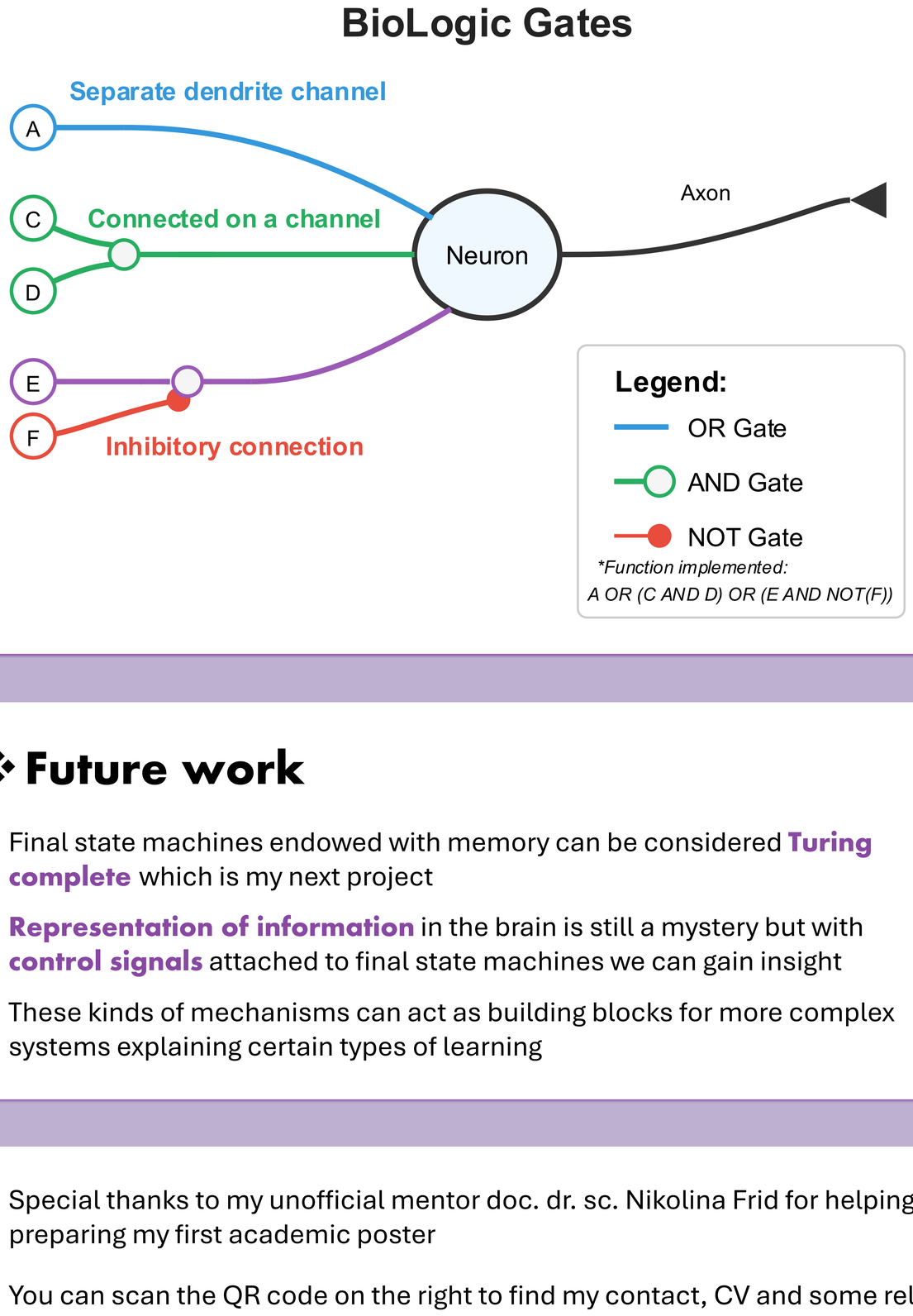
❖ Theoretical introduction

- Multilayer networks are used to simulate different layers of memory needs.
- Basic perceptron networks use standard connectivity models and an extra processing **minterm layer** for transitions
- Neural networks use the concept of **BioLogic** to exploit the topology of Hodgkin-Huxley model neurons for transitions

❖ *BioLogic*

- Topology of neural connections can be exploited to implement Boolean functions
- Separated **dendrite channels** can be treated as OR gates, as achieving the trigger limit in any will make the whole neuron fire.
- In a single dendrite channel, there can be multiple neural connections and setting the **firing threshold** correctly can act as an AND gate.
- **Strong inhibitory connections** can stop the neuron from reaching the trigger limit acting as NOT gates.





❖ Model

- For perceptron networks the effects of *BioLogic* can be replicated by adding the **minterm layer** between input and memory
- For neural networks we can achieve transitions by connecting a select number of neurons inside the memory layer as well as the input layer
- We can also achieve the transitions using a Hopfield network as memory and treating the input as an **energy source**
- Both models have advantages and disadvantages

❖ Future work

- Final state machines endowed with memory can be considered **Turing complete** which is my next project
- **Representation of information** in the brain is still a mystery but with **control signals** attached to final state machines we can gain insight
- These kinds of mechanisms can act as building blocks for more complex systems explaining certain types of learning

❖ Analysis & Discussion

- Network size requirements are dependent on the connectivity density to solve the issues of **memory differentiation**
- This is a possible model of sequential memory in humans. It stores memory sequences with options for transitions so it's a good model of **procedural knowledge**
- The model is very limited in its computational power and requires specific learning mechanisms

- Special thanks to my unofficial mentor doc. dr. sc. Nikolina Frid for helping with all the questions in preparing my first academic poster

- You can scan the QR code on the right to find my contact, CV and some related relevant works to this

❖ Contact, Sources & more: