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# Exercise 9 – Using Cedar to Evaluate the Memory-Trace Variations

## 1 Using a Boost to read-out the Memory Trace

In todays tutorial, you will assemble a small DFT architecture that connects two specific inputs (modeled as Gaussians) to a selective decision field, which itself is connected to a memory trace. You will modulate the amplitudes of the specific inputs to form peaks in the decision field, thus building up the memory trace. After that the decision field will be connected to a global activation boost, which allows you to read out the most active memorized position.

**Step by Step Instructions:**

1. Start off by adding a Gaussian input (called GaussInput) from the Sources tab
2. Set the dimensionality of this input to one by first selecting the element and changing the dimensionality in the property pane
3. Right-click the element and choose plot all
4. Select the element, change the parameters *centers, sigmas, and amplitude*, watch what happens

This Input will resemble one of our specific Inputs. We will now connect it to a Neural-Field.

5. Add a neural field (called NeuralField) from the DFT tab
6. Set the dimensionality and size of the field to match the Gaussian input
7. Drag a connection from the output circle on the right of the Gaussian input to the field's input diamond (to the left)
8. Right-click the field and choose field plot, then right-click the opened plot and pick legend
9. Start the simulation by clicking the play button in the tool bar

10. Watch what happens in the plot after starting the simulation, then start increasing the field's resting level (found in the property pane when the field is selected) until a peak forms

Now we will add the second specific input to the architecture and change the neural interaction kernel of the field to bring it into a selective regime.

11. Get a second Gaussian input by either repeating steps 1-4 or just duplicating your existent one. To duplicate select the input and press Ctrl+D.

12. Change the center of the second input to another value and connect it to the field (see 7.)

13. You will probably have two peaks in your field right now. Click on the field and change the global inhibition parameter of the field to a higher value until the field forms a single peak.

In this part of the exercise the memory-trace will be implemented as a neural field operating on a slower timescale than the connected field.

14. Add a new neural field to the architecture. Change the dimension to 1 and name it "memory trace"

15. Increase the field's time scale parameter to 10000.

16. Connect the output of our neural field to the memory trace.

17. Right-click on the memory trace and choose field plot. Change the resting level of the memory trace until a peak forms. Watch what happens as you change the peaks in the neural field by manipulating the amplitudes of the Gaussian inputs.

The next step is now feeding the memory trace output back to the neural field.

18. Add a StaticGain from the Algebra-Tab, which will allow us to tune the memory trace influence back to our field.

19. Click on the StaticGain and change the gain parameter to 0.1.

20. Connect the output of the memory-trace to the StaticGain and the output of the StaticGain to the neural field.

21. Build up some memory trace by forming peaks in the neural field and watch what happens. Once you are satisfied with the result, pause the simulation by pressing the button in the top-left corner.

We will now read-out the memory trace in the absence of a specific input by boosting the whole field.

22. Reduce the amplitude of the Gaussian inputs to 0.

23. Add a Boost from the Sources Tab to the Architecture and connect it to the Neural Field.

24. Increase the Strength of the Boost to match the previous amplitude of your highest Gauss input

25. Press play in the top left corner and afterwards activate the boost. Does a peak form in the Neural Field and why?

# 2 Evaluating different Memory Trace Rules

We will now try out a Memory Trace with different time scales for build-up and decay.

1. Add a Preshape to the Architecture from the DFT-Tab. Preshape in this case stands for the exact memory trace implementation that we want.

2. Change the dimension of the Preshape to 1 and change the build-up and decay parameters to 100 and 10000 respectively.

3. Put the Preshape in place of the old memory trace field by clicking on the connections and deleting them by pressing del.

4. Right-click on the Preshape and choose Plot-all.

5. Build up memory trace like before and observe the changes in build-up and decay time.

6. Experiment with different parameters for build-up and decay as much as you like.