CEDAR Demonstration

DFT Tutorial

ICDL 2022

Get CEDAR

- Please download the precompiled version of CEDAR for your operating system from `https://cedar.ini.rub.de` and extract the zip archive.
- Run Cedar by executing the `cedar.app` or `cedar.bat` file in the main folder.

1 Demonstration: Field Regimes

Creating the following three field regimes is demonstrated through a tutor. These explanations are just an additional resource for you.

1.1 Multi-peak detection

1. Create a two-dimensional field by dragging a `NeuralField` step onto the canvas.

   - This field may represent a two-dimensional surface, like a table top. Peaks in the field represent objects on that surface.

2. Create three Gaussian functions (`GaussInput` step) and feed them all into a `Sum` step.

   - The field may receive input from sensors, for instance a vision sensor. For the tutorial, we simplify this and work with simulated input that we create with a combination of 2D Gaussian functions at different positions.

3. Plot the output of the `Sum` step and tune the parameters of the Gaussian functions such that their centers are in three different positions in the two-dimensional space.

   - This now simulates neural activation that we may receive from a sensor, where high values represent objects in the scene.

4. Feed the output of the `Sum` step into a `StaticGain` step. You are now able to change the overall strength of that activation. Feed the output of the StaticGain into your two-dimensional field.

5. Tune the field so that it forms a stabilized peak at every input location. This requires that the strength of the input is large enough to drive the field activation above threshold at the input locations.

6. Once that works, try (slowly) moving the "objects in the scene" and observe whether the peaks follow the moving input. What happens when you move the objects too quickly?

1.2 Working memory

1. Create a copy of the field (`Ctrl+D`).

2. Let it receive input from our simulated scene, i.e.the `StaticGain` step after the `Sum` step.

3. We want the field to be in a *self-sustained* regime. That is, peaks that form in this field should not decay, even if the input that brought them about is removed.

    ➤ You can simulate removing an object by switching the amplitude of the corresponding `GaussInput` to zero.

4. Increase the local excitation by increasing the amplitude of the kernel

    ➤ To bring a field into a self-sustained regime, it needs strong local excitation such that active positions in the field excite themselves and their neighbors so much that they will not drop below threshold when the input is removed.

    ➤ You will notice that this regime requires such strong local excitation that the peaks merge or spread along the entire feature dimension.

    ➤ Remember, when this happens, you can reset the activation of the entire architecture by clicking the "Reset" button in the top left.

5. Turn off the global inhibition by setting the corresponding parameter to zero.

    ➤ Since we want multiple self-sustained peaks, we introduce mid-range as opposed to global inhibition.

    ➤ Global inhibition will additionally make the field selective and allow only a single peak. We will use this feature in the next task.

6. Counteract the strong local excitation with local inhibition.

   - In CEDAR, mid-range inhibition can be added through an additional lateral kernel. Under “lateral kernels”, select “Gauss (cedar.aux.kernel)” and click the small “+” button. Now you should have two “lateral kernel” sections underneath, numbered “[0]” and “[1]”.
   - Number zero is our excitatory kernel, modeling local excitation with a positive amplitude, while number one is our inhibitory kernel, modeling mid-range inhibition with a negative amplitude and a wider width (try twice as wide as the excitatory mode).
   - Depending on your chosen parameters, you may be able to see the typical “Mexican hat” shape when you plot the kernel: right-click the field, then select plot→full lateral kernel.

7. Now tune the strengths of your local excitation and inhibition until you can remove an input without losing the suprathreshold activation

1.3 Selection

1. Create another copy of the field, which then also receives input from the simulated scene, as above.

2. We want to tune this field to make a selection decision, that is, it should only form a peak at a single position, even when multiple objects are in the scene.

3. Make sure that the field is not in a working memory regime, that is, the peak should disappear when you remove the object from the scene.

   - For this, you should only have a single excitatory kernel mode. If you still have an inhibitory kernel mode in your parameters, you can delete it by clicking the small “X” in the top right corner of the parameters of the kernel mode.

4. Replace the mid-range inhibition by global inhibition.

   - Global inhibition is a separate parameter with a negative scalar value. Be careful with this parameter as even small values will have a large impact.

5. Once the field is in a selective regime, play with adding and removing objects to and from the scene.

   - At the position of which objects does the peak form?
   - Can you control this by the relative strengths of the individual inputs (objects)?
   - When all objects have the same strength, at the position of which object does the peak form?