COMP 549 – Brain-inspired AI

Code Analysis Assignment

Winter 2025

Due: January 31, 2025, before 11:59PM

In this assignment, you will analyze the code for a parallel distributed processing (PDP) model. Your primary goal is to link the code to the PDP framework (see the lecture and readings for Week 3). Specifically, you will need to identify each of the eight components of a model in the PDP framework, describe the algorithm being implemented, and give some thought to its wider behavours. You will submit your written answers in a pdf file.

The purpose of this assignment is three-fold:

1) To get you thinking in the PDP framework, and comfortable with the core theoretical tools it provides.

2) To force you to engage with someone's poorly commented code and figure it out (an all too common task in machine learning work).

3) To have you engage with and think more about computation using distributed representations and parallel processing.

Remember that the TAs and I are here to help you. Use office hours if you're getting stuck! But, also note that your marks not in this assignment depend on written answers. So, even if your network doesn't work perfectly you can still get a decent mark.

Submit your assignment on *myCourses*. You must submit your **pdf** document with your answers to the questions below. You will be marked on the correctness of your answers, but also the cogency of your reasoning. Note that you should not write more than necessary. Brief answers are not bad, as long as they answer the question fully using clear reasoning. For all of these reasons, you would be foolish to do this assignment with a large language model, note.

The assignment is out of 20 marks (see the marking scheme below).

Part 0 – Getting started (no marks, though if you don't do this you won't get any marks!)

- To do this assignment you need to have Python installed, as well as numpy, and a plotting library (e.g. matplotlib), and Jupyter notebook. One way to kill multiple birds with one stone here is to install Anaconda or Miniconda: https://docs.conda.io/en/latest/
- Make sure you can download the template code provided and open the Jupyter notebook (`mystery_network.ipynb`), which gives you the skeleton for your code.

To open it you use Jupyter, e.g., on a Linux system if you have Jupyter installed you can type this into the command prompt:
    - `$ jupyter notebook mystery_network.ipynb`
- You must put your written answers into a pdf file, following this naming convention:
    - `analysis_[firstname]_[lastname]_[mcgillid].pdf`
    - Where the items in brackets must be replaced with your specific info.

Part 1 – Answering the questions (20 marks)

First, open the code and run it. Once you see the output plot, start working backwards. How is that plot generated? What is it showing? How are those values calculated, etc.?

Now, answer the following questions:

- Question 1 (8 marks): *Can you successfully identify the eight aspects of a PDP model in the code? Which variables/lines of code represent/calculate which parts? Remember, the eight aspects we went over in Week 3 are:*
    1. *A set of processing units*
    2. *A state of activation for each unit*
    3. *An output function for each unit*
    4. *A pattern of connectivity between units*
    5. *A propagation rule for sending activity between units*
    6. *An activation rule for combining propagated activity with current activity*
    7. *A learning rule*
    8. *An environment*
- Question 2 (5 marks): *Can you describe in your own words what computation is being calculated and what algorithm is implement to perform this calculation? How did you reach this conclusion?*
    - *Hint: Consider what space the units are operating in at each stage of processing.*
- Question 3 (2 marks): *Can you predict what the algorithm will do with a novel input?*
    - *Hint: Consider what a "soft" version of the computation would look like.*
- Question 4 (3 marks): *Answer these three sub-questions by playing around with the last cell of the notebook and looking at the first pieces of code:*
    - *How does the network's behaviour change as you change the value of N from very low to very high? Why would it change in this way?*
    - *What happens if you set eta to be very high? Why would this be the impact?*
    - *What is the helper function doing? Why do we need it?*