Coursework 1

This coursework relates to the Hopfield network. In the `coursework1` folder you will find programmes `seven_segment.jl` and `seven_segment.py`. These contain a function for converting an 11-component vector of ones and -1's into an old-fashioned seven-segment digit[1] and a number: the first seven digits correspond to the seven-segment display and the remaining four code for the number in a sort of binary where the zeros have been replaced with -1. It also contains three patterns: one, three and six.

The goal of this coursework is to extend one or other of these programmes to include a Hopfield network to store these three patterns using the formula for w_{ij} when $i \neq j$

$$w_{ij} = \frac{1}{N} \sum_a x_i^a x_j^a \tag{1}$$

where a labels patterns, x_i^a is the activiation of the ith node in the ath pattern and N is the number of patterns. $w_{ii} = 0$.

In the code there are also two test patterns, your programme should update these synchronously until convergence and print out the patterns at each iteration.

This coursework is intended to check you understand Hopfield networks, you are not being asked to do anything over elaborate beyond that. In summary you should:

- Create a weight matrix of w_{ij}s.
- Fix the weight values to store the three patterns.
- Write a function to evolve the network according to the McCulloch-Pitts formula; this should be done synchronously so all the nodes are updated at each timestep. Assume the threshold $\theta = 0$.
- For each of the two test patterns, evolve the patterns until they stop changing, printing the pattern at each step.

[1] `https://en.wikipedia.org/wiki/Seven-segment_display`

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Add to the above a function to calculate the energy of a configuration

$$E = -\frac{1}{2}\sum_{ij} x_i w_{ij} x_j \tag{2}$$

and print out the energy of the three learned patterns, of the test patterns and any patterns formed as the patterns are updated.

Submission instructions

You are to submit your code and a pdf report on Blackboard to the assignment "Auto". The pdf report is automatically generated by the code, instructions are in `submission.README`. Please make sure you submit both the code and the python file; submit these as a joint zip file. Blackboard will not accept .py files anyway.

The submission deadline is 1pm on Monday 9th March 2020.