PSYC 51.09: Problem Set 5

Introduction

This problem set is intended to solidify the concepts you learned about in this week's lectures and readings. Your responses will be worth 5% of your final grade. You are encouraged to work together with your classmates in small groups, and/or to post and answer questions on the courses Canvas site. ***However, you must clearly indicate who your collaborated with and submit your own (uniquely worded) responses.***

We will go over the answers to this problem set in class on **Thursday, February 16, 2017 at 10:10 am**. You must upload your answers before then in order to receive credit. No late submissions will be accepted.

Readings

1. Read Chapter 5 of *Foundations of Human Memory* (if you have not already done so). What were your thoughts on the reading? **(Ungraded)**
2. Read Chapter 6 of *Foundations of Human Memory*. What were your thoughts on the reading? **(Ungraded)**

Graded questions

For this problem set, your job is to create your own neural network model of memory (a Hopfield network). Below are two memories, $\mathbf{m}_1$ and $\mathbf{m}_2$ that you will store in your network. Use the techniques we discussed in class (and in the book), along with the provided equations, to answer the following questions. Show your work!

$$\mathbf{m}_1 = \begin{pmatrix} 1 \\ -1 \\ -1 \\ 1 \\ -1 \\ -1 \end{pmatrix} \quad \mathbf{m}_2 = \begin{pmatrix} -1 \\ -1 \\ 1 \\ -1 \\ -1 \\ 1 \end{pmatrix} \quad \mathbf{x}_1 = \begin{pmatrix} -1 \\ -1 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix} \quad \mathbf{x}_2 = \begin{pmatrix} 1 \\ -1 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

Learning rule:

$$W(i, j) = \sum_{k=1}^{L} a_k(i) a_k(j)$$

Dynamic rule:

$$a(i) = \text{sign}\left(\sum_{j=1}^{N} W(i, j) a(j) \right)$$

1. **(2.5 points)** Create a weight matrix, using Hebbian learning, that contains both $\mathbf{m}_1$ and $\mathbf{m}_2$ as stable memories.
2. **(2.5 points)** For each of the partial cues, $\mathbf{x}_1$ and $\mathbf{x}_2$, the activity of the first two neurons is known. Use **asynchronous updating** to calculate the activities of the remaining four neurons (in whatever order you want). Can the network retrieve both memories? Hint: update neurons 3, 4, 5, and 6 (in any order). Then continue updating those 4 neurons until none of the values change to show that the network has stabilized.