EE401 Neural Networks Midterm 2
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10:45-12:45

1- The weight matrix $\underline{\underline{\mathbf{W}}}$ for a network with bipolar discrete network is given as

$$\underline{\underline{\mathbf{W}}} = \begin{bmatrix} 0 & -1 & 1 \\ 1 & 0 & -1 \\ 1 & -1 & 0 \end{bmatrix}$$

i. Discuss that the threshold and the external inputs are zero, then write the energy function $E(\underline{\mathbf{V}})$
ii. Compute the energy levels for all 8 binary bipolar vectors
iii. Identify the potential attractors that may be encoded in the system described by the specified matrix $\underline{\underline{\mathbf{W}}}$ by comparing the energy levels at each vertices of the $[-1,1]$ cube
iv. Analyze asynchronous updates for the following initial states;

$$V^{(0)} = \begin{bmatrix} 1 \\ -1 \\ 1 \end{bmatrix} \text{ and } V^{(0)} = \begin{bmatrix} 1 \\ -1 \\ -1 \end{bmatrix}$$

2-The truncated energy funtion $E(\underline{\mathbf{V}})$ of a continuous time neural network is

$$E(\underline{\mathbf{V}}) = -\frac{1}{2}(v_1^2 + 2v_1v_2 + 4v_2^2 + v_1) \quad \underline{\mathbf{V}} = \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$

i. Assuming high-gain neurons, find the weight matrix $\underline{\underline{\mathbf{W}}}$ and the bias current vector $\underline{\mathbf{I}}$;
ii. Is this network Hopfield Neural Network, explain
iii. Find the gradient vector of the energy function
iv. Find the Hessian matrix of the energy function
v. Does this neural network have “constrained minima or maxima” or “unconstrained minima or maxima”; Explain and find this/these extremum points
vi. Give the circuit of the neural network corresponding to the above energy function

3-The following linearly non-separable patterns belong to two categories(classes)

$$\underline{\mathbf{X_1}} = \begin{bmatrix} 1 \\ -1 \\ -1 \end{bmatrix}, \quad \underline{\mathbf{X_2}} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}, \quad \underline{\mathbf{X_3}} = \begin{bmatrix} -1 \\ -1 \\ 1 \end{bmatrix} \quad \text{belong to class 1}$$

$$\underline{\mathbf{X_4}} = \begin{bmatrix} 1 \\ -1 \\ 1 \end{bmatrix}, \quad \underline{\mathbf{X_5}} = \begin{bmatrix} -1 \\ 1 \\ 1 \end{bmatrix}, \quad \underline{\mathbf{X_6}} = \begin{bmatrix} -1 \\ 1 \\ -1 \end{bmatrix} \quad \text{belong to class 2}$$

i. Using Error Back-Propagation Training Algorithm, construct layered network
ii. Explain why this patterns are not linearly separable

Good Work!