Review Test Submission: Problems 4 - 7

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Course	EN.605.647.81.SP21 Neural Networks
Test	Problems 4 - 7
Started	5/11/21 7:44 PM
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Status	Completed
Attempt Score	20 out of 40 points
Time Elapsed	1 minute out of 30 minutes
Instructions	Make sure you review the appropriate material. Three of the questions that follow require you to download an attachment and use the data therein (the data can be embedded into an Excel spreadsheet for convenience
Results Displayed	Submitted Answers, Feedback, Incorrectly Answered Questions

Question 1

0 out of 5 points

Recall that in Restricted Boltzmann Machines, the following relationship, referred to as Contrastive Divergence was proven:

$$\frac{\partial \ln p(\mathbf{v})}{\partial w_{ij}} = \frac{\partial}{\partial w_{ij}} \ln \sum_{g} e^{-E(\mathbf{v},\mathbf{h}^g)} - \frac{\partial}{\partial w_{ij}} \ln \sum_{u,g} e^{-E(\mathbf{v}^u,\mathbf{h}^g)}$$
$$= \langle v_i \cdot h_j \rangle_{\mathbf{v}} - \langle v_i \cdot h_j \rangle_{\mathbf{vh}}$$

where the latter refers to expectation values over vector sets **v** and **vh** respectively and can be used in a learning rule where $\Delta w_{ij} = \varepsilon\left[\langle v_i \cdot h_j \rangle_{\mathbf{v}} - \langle v_i \cdot h_j \rangle_{\mathbf{vh}}\right]$ and ε corresponds to a learning parameter, to update weights so as to maximize the value of ln p(v). Recall that the brackets indicate expectation values of the quantity inside and the subscript corresponds to the domain over which the expectation is calculated. Given the following table of vector values where the first column corresponds to a visible vector, the second column corresponds to hidden vectors produced when that visible vector is presented to the RBM and their corresponding probabilities in the third column, calculate the value of Δw_{11} where ε = 1. You can assume that $\langle v_1 h_1 \rangle$ = 0.3. (Hint: this one is quite easy, so don't overcomplicate it!).

Visible Vector	Hidden Vector	Probability of Hidden Vector
(1,0)	(0,0,1)	0.20
	(1,0,1)	0.35
	(0,1,1)	0.15
	(1,1,1)	0.30

For this problem, you will need to keep in mind what the basic definition of an expectation value is.

Selected Answer: 0

Response Feedback: Remember, that an expectation value is the sum over all values of a random variable times its probability of that value occuring. Write it out long hand if you have to.

Question 2

5 out of 5 points

Review this attachment FinalExamRBMquestion.pdf and this spreadsheet ContrastiveDivergenceStudent.xlsx. Given the spreadsheet data indicating the probability of configurations, what is the probability that the vector [0,1] occurs? Answer to 4 significant decimal digits.

Selected Answer: 0.0520

Response Feedback: Very good. You understand total probability and have reviewed the slides well.

Question 3

0 out of 15 points

Andy Analyst wants to increase the probability of reconstructing the visible vector [0,1] without changing any of the weights. He has decided that his best approach would be to modify the visible layer biases. Using the method of steepest ascent where $\eta = 1$, he has defined what a change in the bias values should be using the expression below.

$$\Delta a_i = \eta \frac{\partial \ln p(\mathbf{v})}{\partial a_i}$$

Derive a proper expression based on Contrastive Divergence. Using the attached spreadsheet data, calculate the change in the bias value of visible layer node 1, that is, determine the value Δa_1 based on the equation above in order to increase the probability of the visible vector [0,1]? Answer to 4 significant decimal places.

Selected Answer: -0.9481

Response Feedback: Review the material from Module 11 regarding Contrastive Divergence and modify the equations appropriately to reflect the derivatives with respect to the bias value a_1.

Question 4

15 out of 15 points

Using the value of Δa_1 that you calculated in the previous answer, what is the updated probability of the vector [0,1]? That is, once you modify the bias of visible node 1, what is the probability of vector [0,1] occuring? Answer to 4 significant decimal digits.

Selected Answer: 0.1232

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