Quiz 3:

The Training Process

* Indicates required question

1. Please enter your name: *

The dataset

Let us consider the following corpus

Raw Corpus

$\mathcal{D}_1 =$ Neural Networks are awesome

$\mathcal{D}_2 =$ LSTMs are Sequential Neural Networks

$\mathcal{D}_3 =$ Attention Models are awesome

The word2idx dictionary associated with the Raw Corpus is the following dictionary:

```
Word2idx = {  Neural      : 1,
              Networks    : 2,
              are         : 3,
              awesome     : 4,
              LSTMs       : 5,
              Sequential  : 6,
              Attention   : 7,
              Models      : 8  }
```

We consider the positive batch and the negative batch discussed in the previous quiz

$\mathcal{D}_2 =$ LSTMs are $\boxed{\text{Sequential}}$ Neural Networks

5 3 6 1 2

Positive Batch

(6, 5)	$\longrightarrow$	1
(6, 3)	$\longrightarrow$	1
(6, 1)	$\longrightarrow$	1
(6, 2)	$\longrightarrow$	1

$\mathcal{D}_2 =$ LSTMs are $\boxed{\text{Attention}}$ Neural Networks

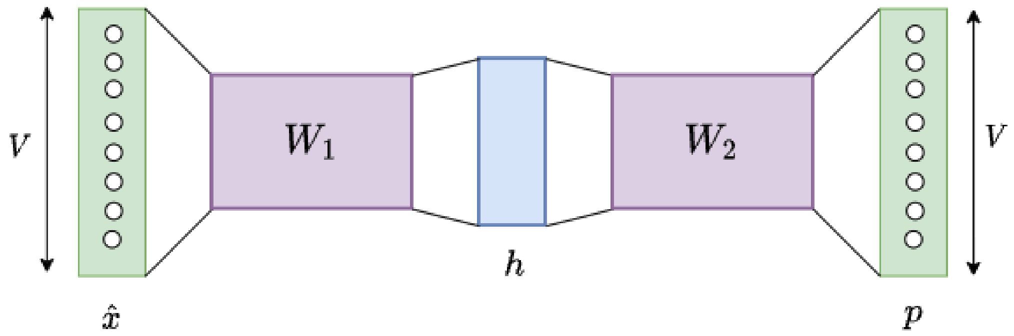
5 3 7 1 2

Negative Batch

(7, 5)	$\longrightarrow$	0
(7, 3)	$\longrightarrow$	0
(7, 1)	$\longrightarrow$	0
(7, 2)	$\longrightarrow$	0

The Forward Propagation

The following figure represents the Forward propagation. The objective is to predict the context words from the center word. We have the following hyperparameters: V=8, D=3



x_hat in the previous figure represents the one hot vector associated with an index x in {1, ..., V} representing a center word

The equations involved in the Forward propagation are summarized as follows:

A first linear transformation maps $\hat{x}$ to the D-dimensional vector h as follows:

$$h = W_1^T \hat{x}$$

A second transformation maps the hidden vector h to the V-dimensional vector $p = (p_1, \ldots, p_V)$ as follows:

$$p = \sigma\left(W_2^T h\right) \quad \text{where } \sigma \text{ is the sigmoid activation function.}$$

2. Which classification problem are we dealing with ? 1 point

Mark only one oval.

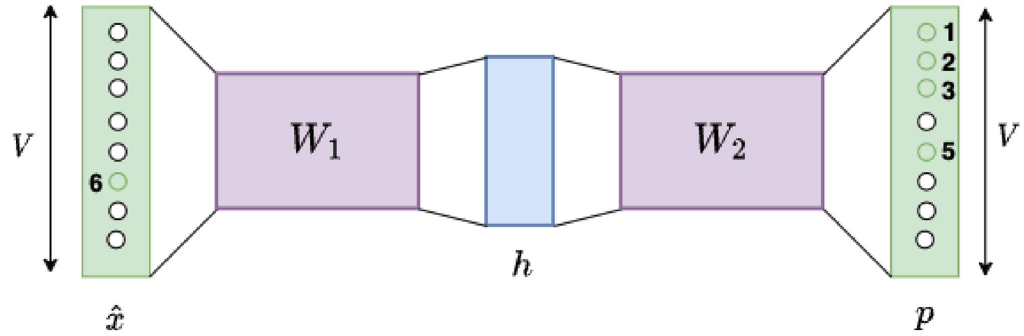
- A single binary classification problem
- A multiclass classification problem
- Several binary classification problems

3. Let us consider o in {1, ..., V}. What is the interpretation of p_o (the o-th dimension of the output vector p) ? 1 point

Mark only one oval.

- The probability that the word of index o is in the context of the center word x
- The probability that the couple (x, o) is a fake couple.

Let us consider the positive batch. From the true center word 6 we compute p_1, p_2, p_3 and p_5.



4. What is p_5 ? 1 point

Mark only one oval.

- The probability that the word "Neural" is in the context of "Sequential" ?
- The probability that the word "LSTMs" is in the context of "Sequential" ?
- The probability that the word "Sequential" is in the context of "Neural" ?

5. What is the loss function associated with a binary classification problem ? 1 point

Mark only one oval.

- The categorical cross entropy
- The binary cross entropy

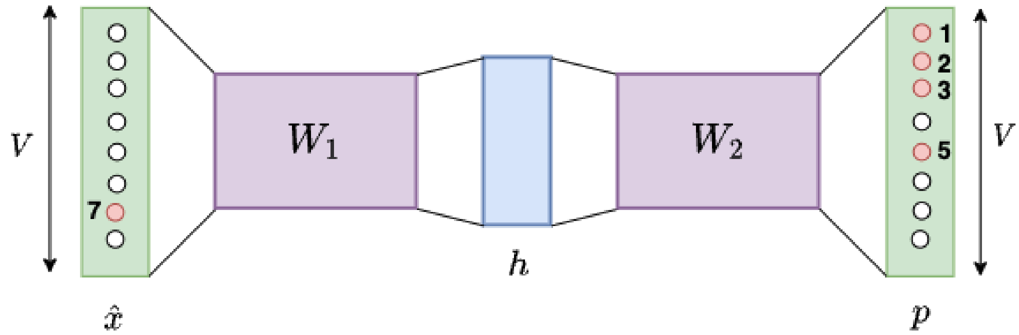
6. Here is the loss function associated with the positive batch. What are the elements of W_1 and W_2 which are involved in this expression ? 1 point

$$J_+ = -\frac{1}{4} \sum_{k \in \{1,2,3,5\}} \log(\sigma(W_1[6]^T W_2[k]))$$

Mark only one oval.

- The 6-th row of W_1 and the columns 1, 2, 3 and 5 of W_2
- The 6-th column of W_1 and the rows 1, 2, 3 and 5 of W_2
- All the rows and columns of W_1 and W_2

Let us consider the negative batch. From the fake center word 7 we compute p_1, p_2, p_3 and p_5.



7. What is p_5 ? 1 point

Mark only one oval.

- The probability that the word "Neural" is in the context of "Attention" ?
- The probability that the word "LSTMs" is in the context of "Sequential" ?
- The probability that the word "LSTMs" is in the context of "Attention" ?

8. Here is the loss function associated with the negative batch. What are the elements of W_1 and W_2 which are involved in this expression ? 1 point

$$J_{-} = -\frac{1}{4} \sum_{k \in \{1,2,3,5\}} \log(1 - \sigma(W_1[7]^T W_2[k]))$$

Mark only one oval.

- The row 7 of the matrix W_1 and the columns 1, 2, 3, 5 of the matrix W_2
- The column 7 of the matrix W_1 and the rows 1, 2, 3, 5 of the matrix W_2
- All the rows and columns in W_1, W_2

The Backward Propagation For the positive batch

We have the following expressions of the gradients:

$$\nabla_{W_1[6]} \left(\log(\sigma(W_1[6]^T W_2[k])\right) = \left(1 - \sigma(W_1[6]^T W_2[k])\right) W_2[k]$$
$$\nabla_{W_2[k]} \left(\log(\sigma(W_1[6]^T W_2[k])\right) = \left(1 - \sigma(W_1[6]^T W_2[k])\right) W_1[6] \quad k \in \{1,2,3,5\}$$

9. Which expression of the gradient is correct ? 1 point

$$\text{(a)} \quad \nabla_{W_1[6]} J_+ = \frac{1}{4} \sum_{k \in \{1,2,3,5\}} \left(\sigma(W_1[6]^T W_2[k]) - 1 \right) W_2[k]$$

$$\text{(b)} \quad \nabla_{W_1[6]} J_+ = -\frac{1}{4} \sum_{k \in \{1,2,3,5\}} \left(\sigma(W_1[6]^T W_2[k]) - 1 \right) W_2[k]$$

$$\text{(c)} \quad \nabla_{W_1[6]} J_+ = \sum_{k \in \{1,2,3,5\}} \left(\sigma(W_1[6]^T W_2[k]) - 1 \right) W_2[k]$$

Mark only one oval.

- (a)
- (b)
- (c)

10. We have the following update equations associated with the positive batch. What is the number of parameters updated ? 1 point

$$W_1[6] \leftarrow W_1[6] - \eta \nabla_{W_1[6]} J_+$$

$$W_2[k] \leftarrow W_2[k] - \eta \nabla_{W_2[k]} J_+ \quad k \in \{1,2,3,5\}$$

Mark only one oval.

- 5*D
- 4*D
- 2*V*D

The Backward Propagation For the negative batch

We have the following expressions of the gradients:

$$\nabla_{W_1[7]}\left(\log(1-\sigma(W_1[7]^T W_2[k])\right) = -\sigma\left(W_1[7]^T W_2[k]\right) W_2[k]$$
$$\nabla_{W_2[k]}\left(\log(1-\sigma(W_1[7]^T W_2[k])\right) = -\sigma\left(W_1[7]^T W_2[k]\right) W_1[7] \quad k \in \{1,2,3,5\}$$

11. Which expression of the gradient is correct ? 1 point

(a) $\nabla_{W_2[k]} J_- = \frac{1}{4} \sum_{k\in\{1,2,3,5\}} \left(\sigma(W_1[7]^T W_2[k]) - 1\right) W_1[7]$

(b) $\nabla_{W_2[k]} J_- = \frac{1}{4} \left(\sigma(W_1[7]^T W_2[k]) - 1\right) W_1[7]$

(c) $\nabla_{W_2[k]} J_- = \frac{1}{4} \left(\sigma(W_1[7]^T W_2[k])\right) W_1[7]$

Mark only one oval.

- (a)
- (b)
- (c)

12. Any question ?