Lista #8
Curso: Ciência da Computação
Disciplina: Inteligência Artificial
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Perceptron:

Perceptron é um algoritmo que visa simular um neurônio. O Algoritmo recebe N entradas e as "conecta" com o neurônio por arestas com pesos. As entradas multiplicadas por seus pesos são somadas e passa-se esse valor por uma função de ativação.
Após, para treinar o neurônio, a saída da função de ativação (saída) é comparada com a resposta correta e o erro calculado.
Com base nesse erro, os pesos de conexão das entradas são recalculados.

Backpropagation:

Backpropagation é uma forma de atualização dos pesos em uma rede de vários perceptrons, uma MLP, Multi-Layer Perceptron. Como há mais de um neurônio e, pelo menos, uma camada de neurônios entre as entradas e o(s) neurônio(s) de saída, é necessário estabelecer o erro de cada neurônio em cada camada.
A forma que backpropagation realiza isso é calcular o erro de cada neurônio em cada camada de trás para frente. Começa-se com a camada de saída e o erro vai sendo propagado para trás.
Utiliza-se a derivada parcial da função de ativação do neurônio para determinar o quanto o peso daquele neurônio deve ser alterado, de forma que uma derivada positiva implica que aquela entrada está aumentando o erro, logo seu peso deve ser diminuído. Se negativa, aquela aresta contribui para o acerto, e seu valor deve ser aumentado.

Link para o repositório: https://github.com/phlc/ia_lista_8

Resultados das duas implementações para função AND:

2 Entradas:

```
---- PERCEPTRON TRAINING for AND ----
Training Model
Model Trained - Erros: 0

---- PERCEPTRON TEST for AND ----
Input: [0, 0]. Output: 0
Input: [0, 1]. Output: 0
Input: [1, 0]. Output: 0
Input: [1, 1]. Output: 1


---- MLP TRAINING for AND ----
Training Model
Model Trained - Erros: 0

---- MLP TEST for AND ----
Input: [0, 0]. Output: 0
Input: [0, 1]. Output: 0
Input: [1, 0]. Output: 0
Input: [1, 1]. Output: 1
```

3 Entradas:

```
---- PERCEPTRON TRAINING for AND ----
Training Model
Model Trained - Erros: 0

---- PERCEPTRON TEST for AND ----
Input: [0, 0, 0]. Output: 0
Input: [0, 0, 1]. Output: 0
Input: [0, 1, 0]. Output: 0
Input: [0, 1, 1]. Output: 0
Input: [1, 0, 0]. Output: 0
Input: [1, 0, 1]. Output: 0
Input: [1, 1, 0]. Output: 0
Input: [1, 1, 1]. Output: 1


---- MLP TRAINING for AND ----
Training Model
Model Trained - Erros: 0

---- MLP TEST for AND ----
Input: [0, 0, 0]. Output: 0
Input: [0, 0, 1]. Output: 0
Input: [0, 1, 0]. Output: 0
Input: [0, 1, 1]. Output: 0
Input: [1, 0, 0]. Output: 0
Input: [1, 0, 1]. Output: 0
Input: [1, 1, 0]. Output: 0
Input: [1, 1, 1]. Output: 1
```

4 Entradas:

```
---- PERCEPTRON TRAINING for AND ----
Training Model
Model Trained - Erros: 0

---- PERCEPTRON TEST for AND ----
Input: [0, 0, 0, 0]. Output: 0
Input: [0, 0, 0, 1]. Output: 0
Input: [0, 0, 1, 0]. Output: 0
Input: [0, 0, 1, 1]. Output: 0
Input: [0, 1, 0, 0]. Output: 0
Input: [0, 1, 0, 1]. Output: 0
Input: [0, 1, 1, 0]. Output: 0
Input: [0, 1, 1, 1]. Output: 0
Input: [1, 0, 0, 0]. Output: 0
Input: [1, 0, 0, 1]. Output: 0
Input: [1, 0, 1, 0]. Output: 0
Input: [1, 0, 1, 1]. Output: 0
Input: [1, 1, 0, 0]. Output: 0
Input: [1, 1, 0, 1]. Output: 0
Input: [1, 1, 1, 0]. Output: 0
Input: [1, 1, 1, 1]. Output: 1


---- MLP TRAINING for AND ----
Training Model
Model Trained - Erros: 0

---- MLP TEST for AND ----
Input: [0, 0, 0, 0]. Output: 0
Input: [0, 0, 0, 1]. Output: 0
Input: [0, 0, 1, 0]. Output: 0
Input: [0, 0, 1, 1]. Output: 0
Input: [0, 1, 0, 0]. Output: 0
Input: [0, 1, 0, 1]. Output: 0
Input: [0, 1, 1, 0]. Output: 0
Input: [0, 1, 1, 1]. Output: 0
Input: [1, 0, 0, 0]. Output: 0
Input: [1, 0, 0, 1]. Output: 0
Input: [1, 0, 1, 0]. Output: 0
Input: [1, 0, 1, 1]. Output: 0
Input: [1, 1, 0, 0]. Output: 0
Input: [1, 1, 0, 1]. Output: 0
Input: [1, 1, 1, 0]. Output: 0
Input: [1, 1, 1, 1]. Output: 1
```

Resultados das duas implementações para função OR:

2 Entradas:

```
---- PERCEPTRON TRAINING for OR ----
Training Model
Model Trained - Erros: 0

---- PERCEPTRON TEST for OR ----
Input: [0, 0]. Output: 0
Input: [0, 1]. Output: 1
Input: [1, 0]. Output: 1
Input: [1, 1]. Output: 1


---- MLP TRAINING for OR ----
Training Model
Model Trained - Erros: 0

---- MLP TEST for OR ----
Input: [0, 0]. Output: 0
Input: [0, 1]. Output: 1
Input: [1, 0]. Output: 1
Input: [1, 1]. Output: 1
```

3 Entradas:

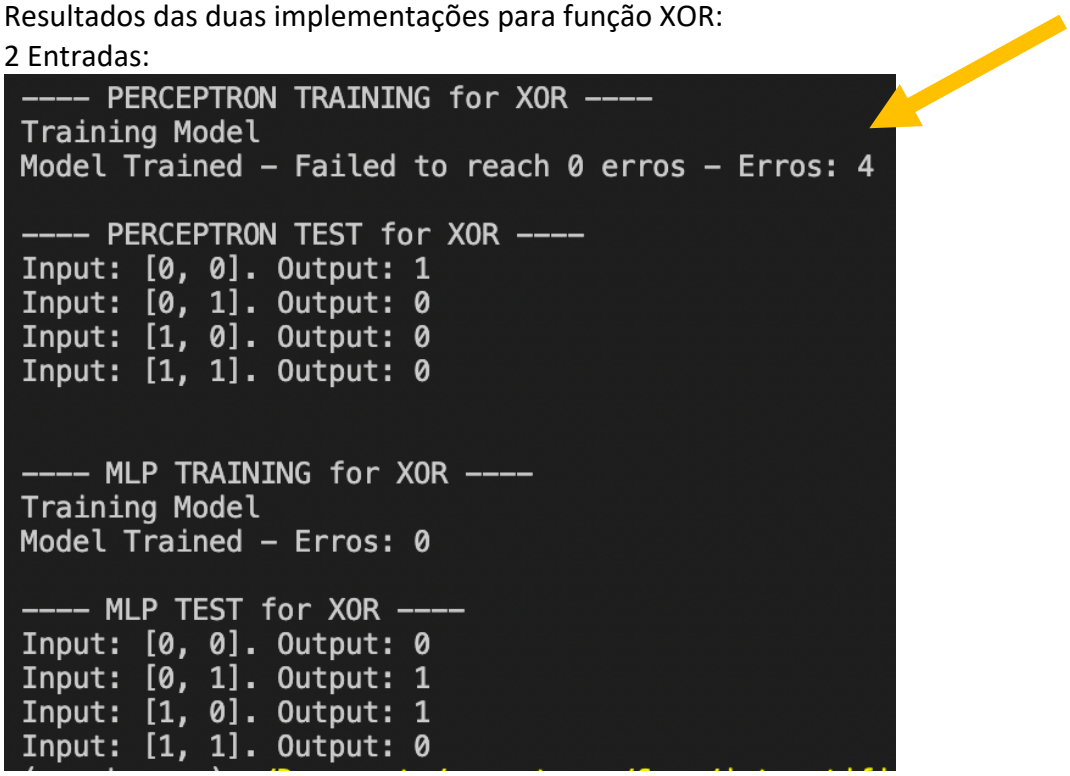
```
---- PERCEPTRON TRAINING for OR ----
Training Model
Model Trained - Erros: 0

---- PERCEPTRON TEST for OR ----
Input: [0, 0, 0]. Output: 0
Input: [0, 0, 1]. Output: 1
Input: [0, 1, 0]. Output: 1
Input: [0, 1, 1]. Output: 1
Input: [1, 0, 0]. Output: 1
Input: [1, 0, 1]. Output: 1
Input: [1, 1, 0]. Output: 1
Input: [1, 1, 1]. Output: 1


---- MLP TRAINING for OR ----
Training Model
Model Trained - Erros: 0

---- MLP TEST for OR ----
Input: [0, 0, 0]. Output: 0
Input: [0, 0, 1]. Output: 1
Input: [0, 1, 0]. Output: 1
Input: [0, 1, 1]. Output: 1
Input: [1, 0, 0]. Output: 1
Input: [1, 0, 1]. Output: 1
Input: [1, 1, 0]. Output: 1
Input: [1, 1, 1]. Output: 1
```

4 Entradas:

```
---- PERCEPTRON TRAINING for OR ----
Training Model
Model Trained - Erros: 0

---- PERCEPTRON TEST for OR ----
Input: [0, 0, 0, 0]. Output: 0
Input: [0, 0, 0, 1]. Output: 1
Input: [0, 0, 1, 0]. Output: 1
Input: [0, 0, 1, 1]. Output: 1
Input: [0, 1, 0, 0]. Output: 1
Input: [0, 1, 0, 1]. Output: 1
Input: [0, 1, 1, 0]. Output: 1
Input: [0, 1, 1, 1]. Output: 1
Input: [1, 0, 0, 0]. Output: 1
Input: [1, 0, 0, 1]. Output: 1
Input: [1, 0, 1, 0]. Output: 1
Input: [1, 0, 1, 1]. Output: 1
Input: [1, 1, 0, 0]. Output: 1
Input: [1, 1, 0, 1]. Output: 1
Input: [1, 1, 1, 0]. Output: 1
Input: [1, 1, 1, 1]. Output: 1


---- MLP TRAINING for OR ----
Training Model
Model Trained - Erros: 0

---- MLP TEST for OR ----
Input: [0, 0, 0, 0]. Output: 0
Input: [0, 0, 0, 1]. Output: 1
Input: [0, 0, 1, 0]. Output: 1
Input: [0, 0, 1, 1]. Output: 1
Input: [0, 1, 0, 0]. Output: 1
Input: [0, 1, 0, 1]. Output: 1
Input: [0, 1, 1, 0]. Output: 1
Input: [0, 1, 1, 1]. Output: 1
Input: [1, 0, 0, 0]. Output: 1
Input: [1, 0, 0, 1]. Output: 1
Input: [1, 0, 1, 0]. Output: 1
Input: [1, 0, 1, 1]. Output: 1
Input: [1, 1, 0, 0]. Output: 1
Input: [1, 1, 0, 1]. Output: 1
Input: [1, 1, 1, 0]. Output: 1
Input: [1, 1, 1, 1]. Output: 1
```

Resultados das duas implementações para função XOR:

2 Entradas:

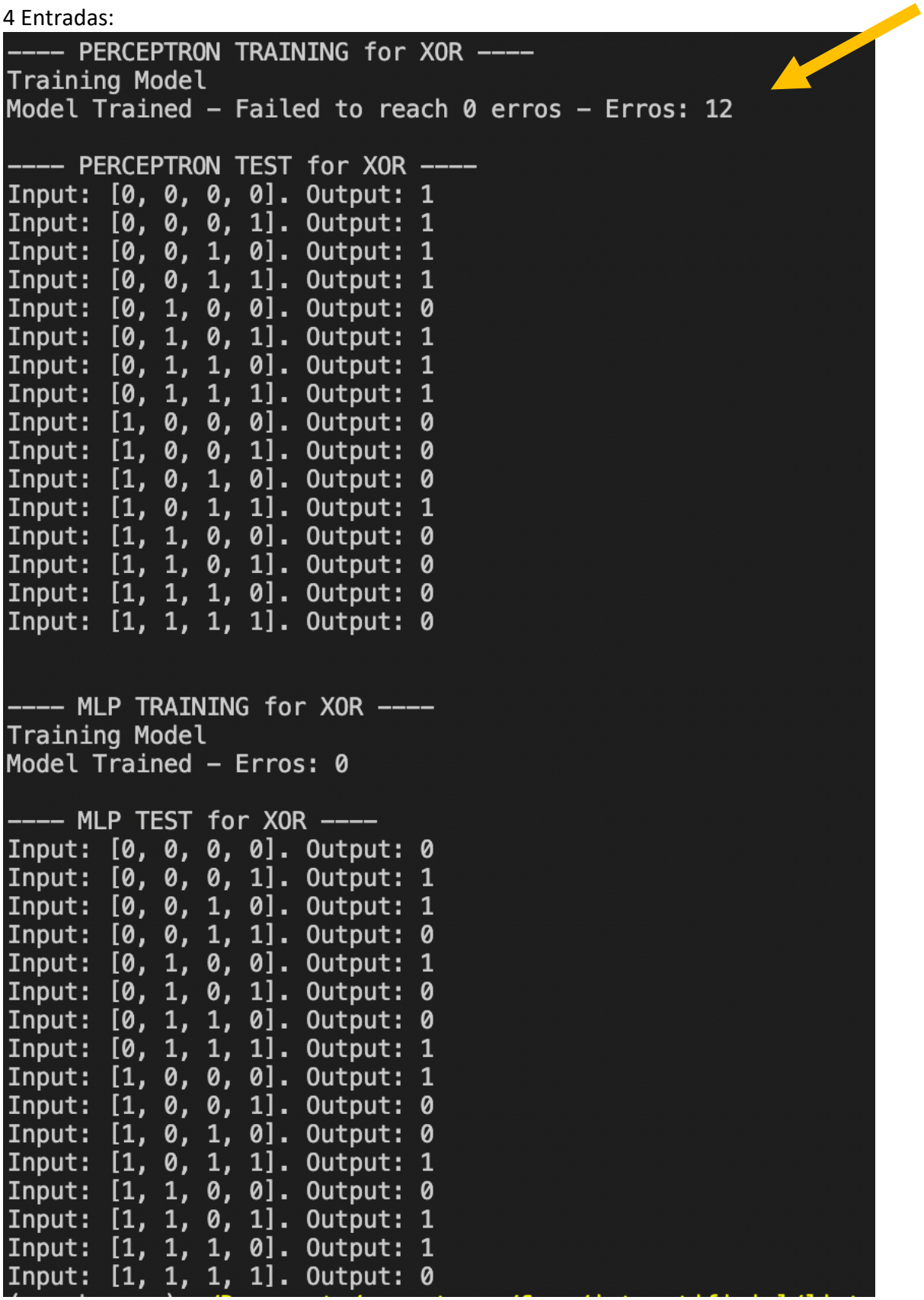


```
---- PERCEPTRON TRAINING for XOR ----
Training Model
Model Trained - Failed to reach 0 erros - Erros: 4

---- PERCEPTRON TEST for XOR ----
Input: [0, 0]. Output: 1
Input: [0, 1]. Output: 0
Input: [1, 0]. Output: 0
Input: [1, 1]. Output: 0


---- MLP TRAINING for XOR ----
Training Model
Model Trained - Erros: 0

---- MLP TEST for XOR ----
Input: [0, 0]. Output: 0
Input: [0, 1]. Output: 1
Input: [1, 0]. Output: 1
Input: [1, 1]. Output: 0
```

3 entradas:


```
---- PERCEPTRON TRAINING for XOR ----
Training Model
Model Trained - Failed to reach 0 erros - Erros: 4

---- PERCEPTRON TEST for XOR ----
Input: [0, 0, 0]. Output: 0
Input: [0, 0, 1]. Output: 0
Input: [0, 1, 0]. Output: 1
Input: [0, 1, 1]. Output: 1
Input: [1, 0, 0]. Output: 1
Input: [1, 0, 1]. Output: 1
Input: [1, 1, 0]. Output: 1
Input: [1, 1, 1]. Output: 1


---- MLP TRAINING for XOR ----
Training Model
Model Trained - Erros: 0

---- MLP TEST for XOR ----
Input: [0, 0, 0]. Output: 0
Input: [0, 0, 1]. Output: 1
Input: [0, 1, 0]. Output: 1
Input: [0, 1, 1]. Output: 0
Input: [1, 0, 0]. Output: 1
Input: [1, 0, 1]. Output: 0
Input: [1, 1, 0]. Output: 0
Input: [1, 1, 1]. Output: 1
```

4 Entradas:



```
---- PERCEPTRON TRAINING for XOR ----
Training Model
Model Trained - Failed to reach 0 erros - Erros: 12

---- PERCEPTRON TEST for XOR ----
Input: [0, 0, 0, 0]. Output: 1
Input: [0, 0, 0, 1]. Output: 1
Input: [0, 0, 1, 0]. Output: 1
Input: [0, 0, 1, 1]. Output: 1
Input: [0, 1, 0, 0]. Output: 0
Input: [0, 1, 0, 1]. Output: 1
Input: [0, 1, 1, 0]. Output: 1
Input: [0, 1, 1, 1]. Output: 1
Input: [1, 0, 0, 0]. Output: 0
Input: [1, 0, 0, 1]. Output: 0
Input: [1, 0, 1, 0]. Output: 0
Input: [1, 0, 1, 1]. Output: 1
Input: [1, 1, 0, 0]. Output: 0
Input: [1, 1, 0, 1]. Output: 0
Input: [1, 1, 1, 0]. Output: 0
Input: [1, 1, 1, 1]. Output: 0


---- MLP TRAINING for XOR ----
Training Model
Model Trained - Erros: 0

---- MLP TEST for XOR ----
Input: [0, 0, 0, 0]. Output: 0
Input: [0, 0, 0, 1]. Output: 1
Input: [0, 0, 1, 0]. Output: 1
Input: [0, 0, 1, 1]. Output: 0
Input: [0, 1, 0, 0]. Output: 1
Input: [0, 1, 0, 1]. Output: 0
Input: [0, 1, 1, 0]. Output: 0
Input: [0, 1, 1, 1]. Output: 1
Input: [1, 0, 0, 0]. Output: 1
Input: [1, 0, 0, 1]. Output: 0
Input: [1, 0, 1, 0]. Output: 0
Input: [1, 0, 1, 1]. Output: 1
Input: [1, 1, 0, 0]. Output: 0
Input: [1, 1, 0, 1]. Output: 1
Input: [1, 1, 1, 0]. Output: 1
Input: [1, 1, 1, 1]. Output: 0
```