



Ingeniería en Robótica y Sistemas Digitales

TE3002B.501

Implementación de Robótica Inteligente

Actividad

Entrenamiento de redes neuronales

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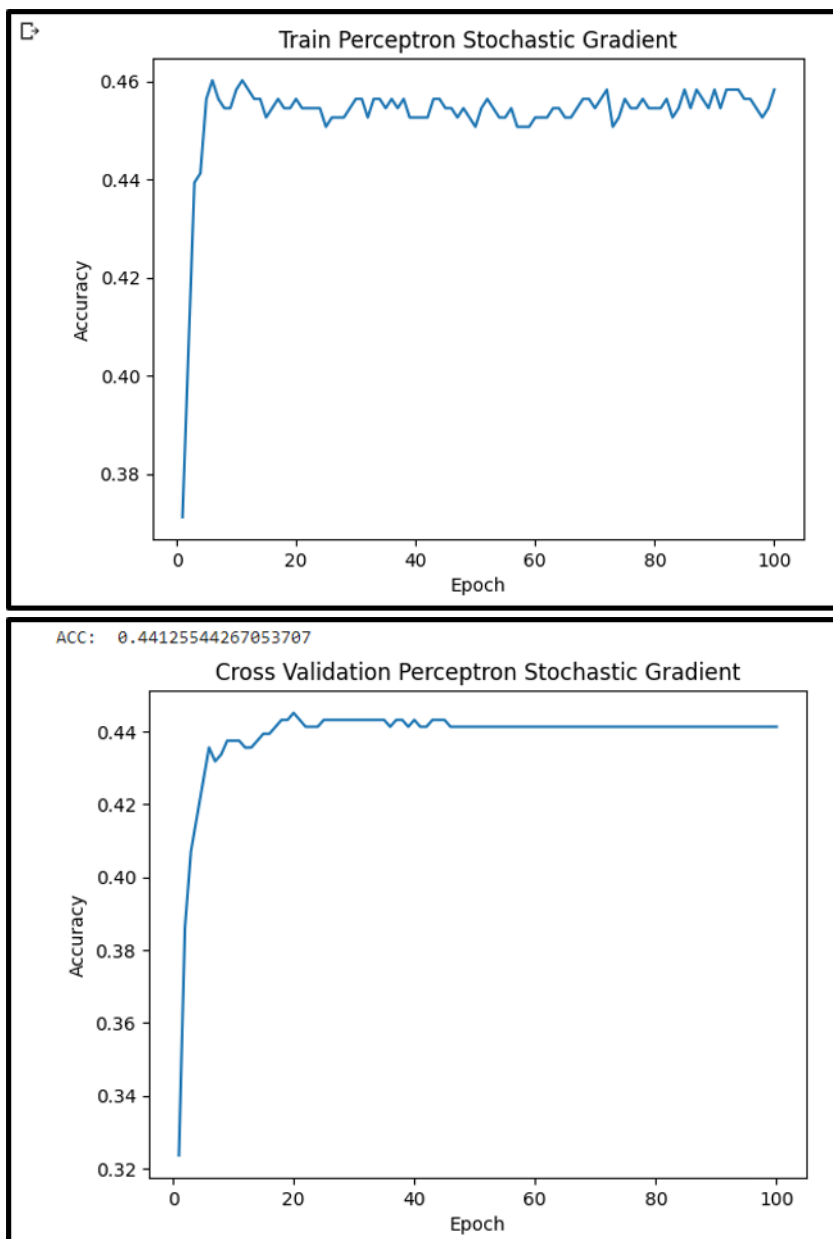
Manuel Eduardo Ochoa Obezo A00227718

Tec de Monterrey, Campus Guadalajara

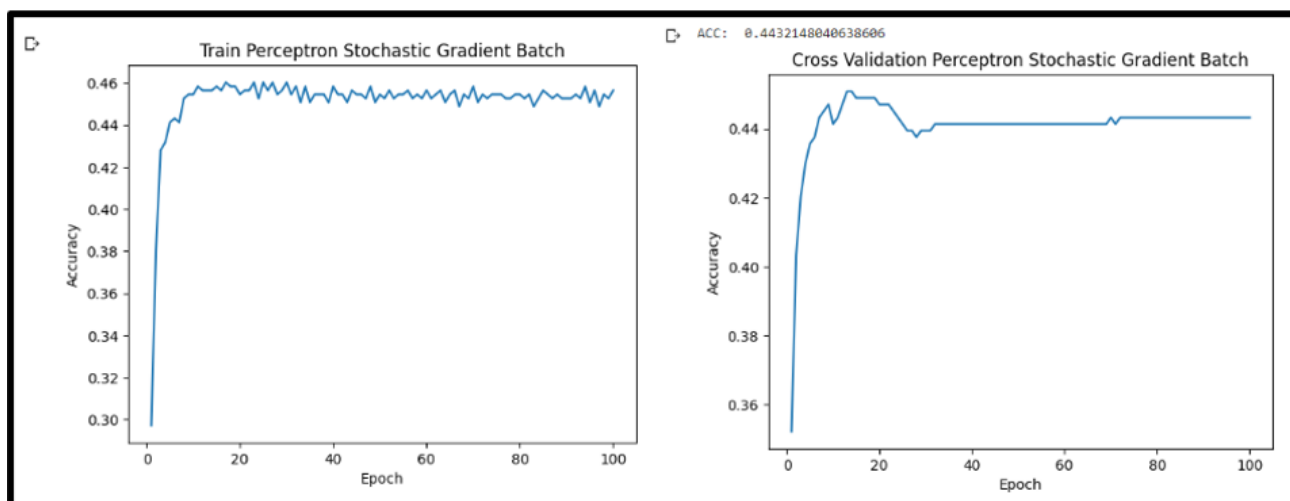
02 de junio de 2023

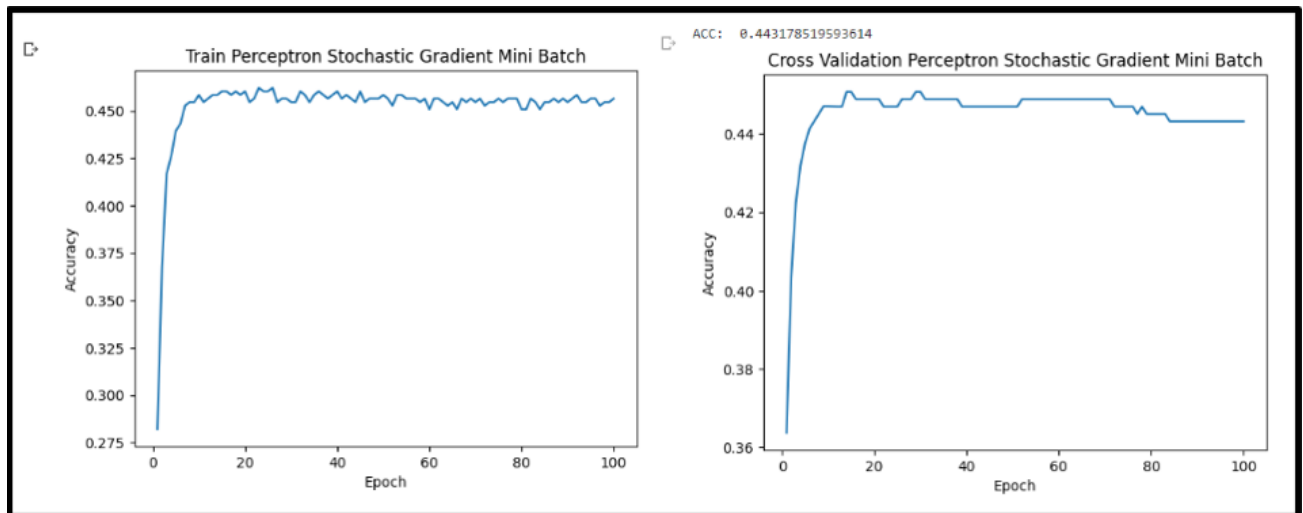
Ejercicio 1

• 1.1

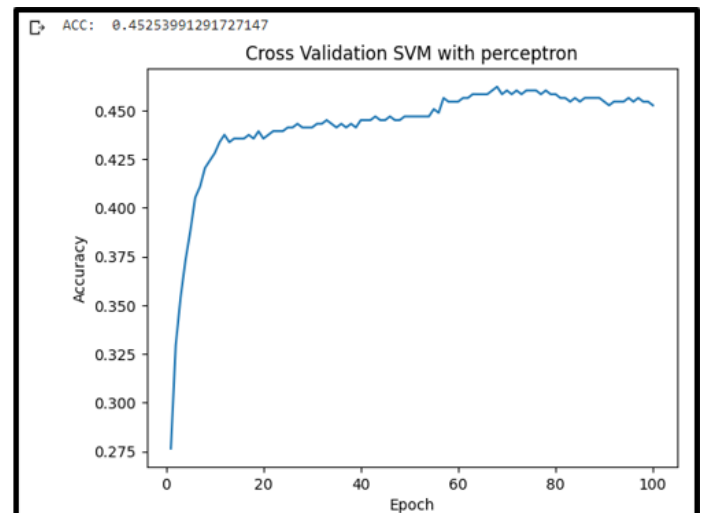
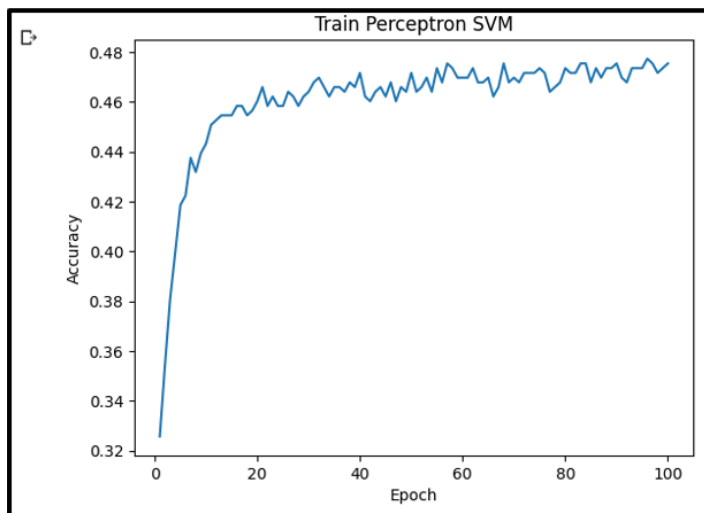


• 1.2





- 1.3



Link a colab: https://colab.research.google.com/drive/13hlSeABBB68kyu9xi_ga37dNvvrg-SOf?usp=sharing

Ejercicio 2

- **2.1**

```

Epoch 1/100
30/30 [=====] - 1s 2ms/step - loss: 29039.9941
Epoch 2/100
30/30 [=====] - 0s 2ms/step - loss: 28967.6484
Epoch 3/100
30/30 [=====] - 0s 2ms/step - loss: 28853.5410
Epoch 4/100
30/30 [=====] - 0s 2ms/step - loss: 28672.6445
Epoch 5/100
30/30 [=====] - 0s 2ms/step - loss: 28384.1465
Epoch 6/100
30/30 [=====] - 0s 2ms/step - loss: 27955.9395
Epoch 7/100
30/30 [=====] - 0s 2ms/step - loss: 27348.5918
Epoch 8/100
30/30 [=====] - 0s 2ms/step - loss: 26561.5234
Epoch 9/100
30/30 [=====] - 0s 2ms/step - loss: 25585.0391
Epoch 10/100
30/30 [=====] - 0s 2ms/step - loss: 24421.0391
Epoch 11/100
30/30 [=====] - 0s 2ms/step - loss: 23081.7969
Epoch 12/100
30/30 [=====] - 0s 3ms/step - loss: 21577.6094
Epoch 13/100
30/30 [=====] - 0s 3ms/step - loss: 19932.1711

```

```

Epoch 79/100
30/30 [=====] - 0s 2ms/step - loss: 3178.7202
Epoch 80/100
30/30 [=====] - 0s 2ms/step - loss: 3171.6448
Epoch 81/100
30/30 [=====] - 0s 2ms/step - loss: 3165.1074
Epoch 82/100
30/30 [=====] - 0s 3ms/step - loss: 3155.5808
Epoch 83/100
30/30 [=====] - 0s 2ms/step - loss: 3148.1201
Epoch 84/100
30/30 [=====] - 0s 2ms/step - loss: 3142.3447
Epoch 85/100
30/30 [=====] - 0s 2ms/step - loss: 3133.1785
Epoch 86/100
30/30 [=====] - 0s 2ms/step - loss: 3127.1279
Epoch 87/100
30/30 [=====] - 0s 2ms/step - loss: 3119.1167
Epoch 88/100
30/30 [=====] - 0s 2ms/step - loss: 3117.7542
Epoch 89/100
30/30 [=====] - 0s 3ms/step - loss: 3106.5811
Epoch 90/100
30/30 [=====] - 0s 3ms/step - loss: 3099.8523
Epoch 91/100
30/30 [=====] - 0s 3ms/step - loss: 3097.7727
Epoch 92/100
30/30 [=====] - 0s 2ms/step - loss: 3088.9355
Epoch 93/100
30/30 [=====] - 0s 3ms/step - loss: 3084.4216

```

```

Epoch 94/100
30/30 [=====] - 0s 3ms/step - loss: 3077.5557
Epoch 95/100
30/30 [=====] - 0s 3ms/step - loss: 3070.2825
Epoch 96/100
30/30 [=====] - 0s 2ms/step - loss: 3067.0361
Epoch 97/100
30/30 [=====] - 0s 2ms/step - loss: 3064.9561
Epoch 98/100
30/30 [=====] - 0s 2ms/step - loss: 3056.0903
Epoch 99/100
30/30 [=====] - 0s 2ms/step - loss: 3051.7939
Epoch 100/100
30/30 [=====] - 0s 2ms/step - loss: 3046.2048
<keras.callbacks.History at 0x7f231ea36bf0>

```

Evaluación de rendimiento con Cross Validation

```

4/4 [=====] - 0s 3ms/step
4/4 [=====] - 0s 3ms/step
4/4 [=====] - 0s 3ms/step
4/4 [=====] - 0s 3ms/step
4/4 [=====] - 0s 3ms/step
ACC = 0.7708176100628931

```

Link a colab:

https://colab.research.google.com/drive/1DI_wimcmO_v51Ss8fQL6c9Xr0uam3XRY?usp=sharing

- **2.2**

```
Epoch 1/100
52/52 [-----] - 1s 2ms/step - loss: 1.0900 - accuracy: 0.5174
Epoch 2/100
52/52 [-----] - 0s 2ms/step - loss: 0.7077 - accuracy: 0.6293
Epoch 3/100
52/52 [-----] - 0s 2ms/step - loss: 0.4049 - accuracy: 0.8147
Epoch 4/100
52/52 [-----] - 0s 2ms/step - loss: 0.2074 - accuracy: 0.9266
Epoch 5/100
52/52 [-----] - 0s 2ms/step - loss: 0.1385 - accuracy: 0.9575
Epoch 6/100
52/52 [-----] - 0s 2ms/step - loss: 0.1265 - accuracy: 0.9575
Epoch 7/100
52/52 [-----] - 0s 2ms/step - loss: 0.1202 - accuracy: 0.9653
Epoch 8/100
52/52 [-----] - 0s 2ms/step - loss: 0.0946 - accuracy: 0.9575
Epoch 9/100
52/52 [-----] - 0s 2ms/step - loss: 0.0882 - accuracy: 0.9653
Epoch 10/100
52/52 [-----] - 0s 2ms/step - loss: 0.0776 - accuracy: 0.9807
Epoch 11/100
52/52 [-----] - 0s 2ms/step - loss: 0.0773 - accuracy: 0.9768
Epoch 12/100
52/52 [-----] - 0s 2ms/step - loss: 0.0573 - accuracy: 0.9846
Epoch 13/100
52/52 [-----] - 0s 2ms/step - loss: 0.0687 - accuracy: 0.9730
Epoch 14/100
52/52 [-----] - 0s 2ms/step - loss: 0.0730 - accuracy: 0.9730
Epoch 15/100
52/52 [-----] - 0s 2ms/step - loss: 0.0641 - accuracy: 0.9807
```

```
Epoch 16/100
52/52 [=====] - 0s 2ms/step - loss: 0.0538 - accuracy: 0.9846
Epoch 17/100
52/52 [=====] - 0s 2ms/step - loss: 0.0539 - accuracy: 0.9768
Epoch 18/100
52/52 [=====] - 0s 2ms/step - loss: 0.0567 - accuracy: 0.9807
Epoch 19/100
52/52 [=====] - 0s 2ms/step - loss: 0.0493 - accuracy: 0.9846
Epoch 20/100
52/52 [=====] - 0s 2ms/step - loss: 0.0462 - accuracy: 0.9884
Epoch 21/100
52/52 [=====] - 0s 2ms/step - loss: 0.0483 - accuracy: 0.9846
Epoch 22/100
52/52 [=====] - 0s 2ms/step - loss: 0.0509 - accuracy: 0.9887
Epoch 23/100
52/52 [=====] - 0s 2ms/step - loss: 0.0463 - accuracy: 0.9846
Epoch 24/100
52/52 [=====] - 0s 2ms/step - loss: 0.0686 - accuracy: 0.9730
Epoch 25/100
52/52 [=====] - 0s 2ms/step - loss: 0.0358 - accuracy: 0.9884
Epoch 26/100
52/52 [=====] - 0s 2ms/step - loss: 0.0366 - accuracy: 0.9884
Epoch 27/100
52/52 [=====] - 0s 2ms/step - loss: 0.0332 - accuracy: 0.9923
Epoch 28/100
52/52 [=====] - 0s 2ms/step - loss: 0.0373 - accuracy: 0.9884
Epoch 29/100
52/52 [=====] - 0s 2ms/step - loss: 0.0295 - accuracy: 0.9923
Epoch 30/100
52/52 [=====] - 0s 2ms/step - loss: 0.0348 - accuracy: 0.9884
```

```
Epoch 31/100
52/52 [-----] - 0s 2ms/step - loss: 0.0292 - accuracy: 0.9923
Epoch 32/100
52/52 [-----] - 0s 2ms/step - loss: 0.0383 - accuracy: 0.9768
Epoch 33/100
52/52 [-----] - 0s 2ms/step - loss: 0.0257 - accuracy: 0.9884
Epoch 34/100
52/52 [-----] - 0s 2ms/step - loss: 0.0256 - accuracy: 0.9846
Epoch 35/100
52/52 [-----] - 0s 2ms/step - loss: 0.0243 - accuracy: 0.9923
Epoch 36/100
52/52 [-----] - 0s 2ms/step - loss: 0.0194 - accuracy: 0.9923
Epoch 37/100
52/52 [-----] - 0s 2ms/step - loss: 0.0212 - accuracy: 0.9961
Epoch 38/100
52/52 [-----] - 0s 2ms/step - loss: 0.0171 - accuracy: 0.9961
Epoch 39/100
52/52 [-----] - 0s 2ms/step - loss: 0.0181 - accuracy: 0.9961
Epoch 40/100
52/52 [-----] - 0s 2ms/step - loss: 0.0163 - accuracy: 1.0000
Epoch 41/100
52/52 [-----] - 0s 2ms/step - loss: 0.0155 - accuracy: 1.0000
Epoch 42/100
52/52 [-----] - 0s 2ms/step - loss: 0.0153 - accuracy: 0.9923
Epoch 43/100
52/52 [-----] - 0s 2ms/step - loss: 0.0156 - accuracy: 1.0000
Epoch 44/100
52/52 [-----] - 0s 2ms/step - loss: 0.0150 - accuracy: 0.9961
Epoch 45/100
52/52 [-----] - 0s 2ms/step - loss: 0.0376 - accuracy: 0.9884
```

```
Epoch 46/100
S2/S2 [=====] - 0s 2ms/step - loss: 0.0143 - accuracy: 0.9961
Epoch 47/100
S2/S2 [=====] - 0s 2ms/step - loss: 0.0695 - accuracy: 0.9730
Epoch 48/100
S2/S2 [=====] - 0s 2ms/step - loss: 0.0264 - accuracy: 0.9923
Epoch 49/100
S2/S2 [=====] - 0s 2ms/step - loss: 0.0112 - accuracy: 1.0000
Epoch 50/100
S2/S2 [=====] - 0s 2ms/step - loss: 0.0104 - accuracy: 1.0000
Epoch 51/100
S2/S2 [=====] - 0s 2ms/step - loss: 0.0112 - accuracy: 1.0000
Epoch 52/100
S2/S2 [=====] - 0s 2ms/step - loss: 0.0154 - accuracy: 0.9961
Epoch 53/100
S2/S2 [=====] - 0s 2ms/step - loss: 0.0117 - accuracy: 0.9961
Epoch 54/100
S2/S2 [=====] - 0s 2ms/step - loss: 0.0093 - accuracy: 1.0000
Epoch 55/100
S2/S2 [=====] - 0s 2ms/step - loss: 0.0096 - accuracy: 1.0000
Epoch 56/100
S2/S2 [=====] - 0s 2ms/step - loss: 0.0073 - accuracy: 1.0000
Epoch 57/100
S2/S2 [=====] - 0s 2ms/step - loss: 0.0065 - accuracy: 1.0000
Epoch 58/100
S2/S2 [=====] - 0s 2ms/step - loss: 0.0070 - accuracy: 1.0000
Epoch 59/100
S2/S2 [=====] - 0s 2ms/step - loss: 0.0086 - accuracy: 1.0000
Epoch 60/100
S2/S2 [=====] - 0s 2ms/step - loss: 0.0051 - accuracy: 1.0000
```

```
Epoch 61/100
52/52 [-----] - 0s 2ms/step - loss: 0.0064 - accuracy: 1.0000
Epoch 62/100
52/52 [-----] - 0s 2ms/step - loss: 0.0134 - accuracy: 0.9923
Epoch 63/100
52/52 [-----] - 0s 2ms/step - loss: 0.0192 - accuracy: 0.9961
Epoch 64/100
52/52 [-----] - 0s 2ms/step - loss: 0.0116 - accuracy: 1.0000
Epoch 65/100
52/52 [-----] - 0s 2ms/step - loss: 0.0058 - accuracy: 1.0000
Epoch 66/100
52/52 [-----] - 0s 2ms/step - loss: 0.0043 - accuracy: 1.0000
Epoch 67/100
52/52 [-----] - 0s 2ms/step - loss: 0.0055 - accuracy: 1.0000
Epoch 68/100
52/52 [-----] - 0s 2ms/step - loss: 0.0109 - accuracy: 1.0000
Epoch 69/100
52/52 [-----] - 0s 2ms/step - loss: 0.0037 - accuracy: 1.0000
Epoch 70/100
52/52 [-----] - 0s 2ms/step - loss: 0.0114 - accuracy: 0.9923
Epoch 71/100
52/52 [-----] - 0s 2ms/step - loss: 0.0030 - accuracy: 1.0000
Epoch 72/100
52/52 [-----] - 0s 2ms/step - loss: 0.0033 - accuracy: 1.0000
Epoch 73/100
52/52 [-----] - 0s 3ms/step - loss: 0.0113 - accuracy: 0.9961
Epoch 74/100
52/52 [-----] - 0s 2ms/step - loss: 0.0098 - accuracy: 1.0000
Epoch 75/100
52/52 [-----] - 0s 2ms/step - loss: 0.0048 - accuracy: 1.0000
```

```
Epoch 76/100
52/52 [=====] - 0s 2ms/step - loss: 0.0140 - accuracy: 0.9961
Epoch 77/100
52/52 [=====] - 0s 2ms/step - loss: 0.0089 - accuracy: 0.9653
Epoch 78/100
52/52 [=====] - 0s 3ms/step - loss: 0.0065 - accuracy: 1.0000
Epoch 79/100
52/52 [=====] - 0s 2ms/step - loss: 0.0040 - accuracy: 1.0000
Epoch 80/100
52/52 [=====] - 0s 2ms/step - loss: 0.0038 - accuracy: 1.0000
Epoch 81/100
52/52 [=====] - 0s 2ms/step - loss: 0.0028 - accuracy: 1.0000
Epoch 82/100
52/52 [=====] - 0s 3ms/step - loss: 0.0028 - accuracy: 1.0000
Epoch 83/100
52/52 [=====] - 0s 2ms/step - loss: 0.0020 - accuracy: 1.0000
Epoch 84/100
52/52 [=====] - 0s 2ms/step - loss: 0.0021 - accuracy: 1.0000
Epoch 85/100
52/52 [=====] - 0s 2ms/step - loss: 0.0018 - accuracy: 1.0000
Epoch 86/100
52/52 [=====] - 0s 2ms/step - loss: 0.0020 - accuracy: 1.0000
Epoch 87/100
52/52 [=====] - 0s 2ms/step - loss: 0.0017 - accuracy: 1.0000
Epoch 88/100
52/52 [=====] - 0s 2ms/step - loss: 0.0016 - accuracy: 1.0000
Epoch 89/100
52/52 [=====] - 0s 2ms/step - loss: 0.0017 - accuracy: 1.0000
Epoch 90/100
52/52 [=====] - 0s 2ms/step - loss: 0.0020 - accuracy: 1.0000
Epoch 91/100
52/52 [=====] - 0s 2ms/step - loss: 0.0020 - accuracy: 1.0000
```



```

Epoch 91/100
52/52 [=====] - 0s 3ms/step - loss: 0.0016 - accuracy: 1.0000
Epoch 92/100
52/52 [=====] - 0s 2ms/step - loss: 0.0016 - accuracy: 1.0000
Epoch 93/100
52/52 [=====] - 0s 2ms/step - loss: 0.0014 - accuracy: 1.0000
Epoch 94/100
52/52 [=====] - 0s 3ms/step - loss: 0.0013 - accuracy: 1.0000
Epoch 95/100
52/52 [=====] - 0s 3ms/step - loss: 0.0011 - accuracy: 1.0000
Epoch 96/100
52/52 [=====] - 0s 2ms/step - loss: 0.0029 - accuracy: 1.0000
Epoch 97/100
52/52 [=====] - 0s 2ms/step - loss: 0.0011 - accuracy: 1.0000
Epoch 98/100
52/52 [=====] - 0s 2ms/step - loss: 0.0014 - accuracy: 1.0000
Epoch 99/100
52/52 [=====] - 0s 2ms/step - loss: 0.0011 - accuracy: 1.0000
Epoch 100/100
52/52 [=====] - 0s 2ms/step - loss: 0.0011 - accuracy: 1.0000
<keras.callbacks.History at 0x7f3d308aa470>

```

Evaluación de rendimiento con Cross Validation

```

2/2 [=====] - 0s 4ms/step
2/2 [=====] - 0s 7ms/step
2/2 [=====] - 0s 8ms/step
2/2 [=====] - 0s 7ms/step
WARNING:tensorflow:5 out of the last 9 calls to <function
2/2 [=====] - 0s 4ms/step
ACC = 0.67579185520362
RECALL = [0.8 1. 1. ]

```

Link a colab:

https://colab.research.google.com/drive/18u9F0k5z9UzLs20ufYVGzcU9J5ELf_hW#scrollTo=yrvKXq2oNY5Z

• 2.3

```

Epoch 1/100
106/106 [=====] - 1s 2ms/step - loss: 0.7826 - accuracy: 0.5114
Epoch 2/100
106/106 [=====] - 0s 2ms/step - loss: 0.6069 - accuracy: 0.6402
Epoch 3/100
106/106 [=====] - 0s 2ms/step - loss: 0.5084 - accuracy: 0.7367
Epoch 4/100
106/106 [=====] - 0s 2ms/step - loss: 0.4262 - accuracy: 0.8011
Epoch 5/100
106/106 [=====] - 0s 2ms/step - loss: 0.3630 - accuracy: 0.8409
Epoch 6/100
106/106 [=====] - 0s 2ms/step - loss: 0.3165 - accuracy: 0.8769
Epoch 7/100
106/106 [=====] - 0s 2ms/step - loss: 0.2830 - accuracy: 0.8977
Epoch 8/100
106/106 [=====] - 0s 2ms/step - loss: 0.2558 - accuracy: 0.9015
Epoch 9/100
106/106 [=====] - 0s 2ms/step - loss: 0.2299 - accuracy: 0.9205
Epoch 10/100
106/106 [=====] - 0s 2ms/step - loss: 0.2039 - accuracy: 0.9356
Epoch 11/100
106/106 [=====] - 0s 2ms/step - loss: 0.1821 - accuracy: 0.9451
Epoch 12/100
106/106 [=====] - 0s 2ms/step - loss: 0.1695 - accuracy: 0.9432
Epoch 13/100
106/106 [=====] - 0s 2ms/step - loss: 0.1448 - accuracy: 0.9640
Epoch 14/100
106/106 [=====] - 0s 2ms/step - loss: 0.1255 - accuracy: 0.9659

```

```

Epoch 15/100
106/106 [=====] - 0s 2ms/step - loss: 0.1091 - accuracy: 0.9773
Epoch 16/100
106/106 [=====] - 0s 2ms/step - loss: 0.0978 - accuracy: 0.9735
Epoch 17/100
106/106 [=====] - 0s 2ms/step - loss: 0.0839 - accuracy: 0.9867
Epoch 18/100
106/106 [=====] - 0s 2ms/step - loss: 0.0704 - accuracy: 0.9905
Epoch 19/100
106/106 [=====] - 0s 2ms/step - loss: 0.0619 - accuracy: 0.9924
Epoch 20/100
106/106 [=====] - 0s 2ms/step - loss: 0.0560 - accuracy: 0.9886
Epoch 21/100
106/106 [=====] - 0s 2ms/step - loss: 0.0506 - accuracy: 0.9924
Epoch 22/100
106/106 [=====] - 0s 2ms/step - loss: 0.0418 - accuracy: 0.9943
Epoch 23/100
106/106 [=====] - 0s 2ms/step - loss: 0.0349 - accuracy: 0.9943
Epoch 24/100
106/106 [=====] - 0s 2ms/step - loss: 0.0295 - accuracy: 0.9962
Epoch 25/100
106/106 [=====] - 0s 2ms/step - loss: 0.0263 - accuracy: 0.9962
Epoch 26/100
106/106 [=====] - 0s 2ms/step - loss: 0.0226 - accuracy: 0.9981
Epoch 27/100
106/106 [=====] - 0s 2ms/step - loss: 0.0201 - accuracy: 0.9981
Epoch 28/100
106/106 [=====] - 0s 2ms/step - loss: 0.0170 - accuracy: 0.9981

```

```
[9] Epoch 29/100
30/30 [=====] - 0s 3ms/step - loss: 4958.0596
Epoch 30/100
30/30 [=====] - 0s 3ms/step - loss: 4664.7979
Epoch 31/100
30/30 [=====] - 0s 3ms/step - loss: 4473.9468
Epoch 32/100
30/30 [=====] - 0s 2ms/step - loss: 4317.6973
Epoch 33/100
30/30 [=====] - 0s 2ms/step - loss: 4213.2217
Epoch 34/100
30/30 [=====] - 0s 3ms/step - loss: 4133.6343
Epoch 35/100
30/30 [=====] - 0s 3ms/step - loss: 4082.2078
Epoch 36/100
30/30 [=====] - 0s 3ms/step - loss: 4032.3416
Epoch 37/100
30/30 [=====] - 0s 3ms/step - loss: 3996.6780
Epoch 38/100
30/30 [=====] - 0s 3ms/step - loss: 3966.8091
Epoch 39/100
30/30 [=====] - 0s 2ms/step - loss: 3935.7085
Epoch 40/100
30/30 [=====] - 0s 4ms/step - loss: 3907.2139
Epoch 41/100
30/30 [=====] - 0s 3ms/step - loss: 3883.7017
Epoch 42/100
30/30 [=====] - 0s 3ms/step - loss: 3858.1514
Epoch 43/100
30/30 [=====] - 0s 3ms/step - loss: 3835.0774
```

```
[9] Epoch 44/100
30/30 [=====] - 0s 3ms/step - loss: 3814.5999
Epoch 45/100
30/30 [=====] - 0s 4ms/step - loss: 3791.2356
Epoch 46/100
30/30 [=====] - 0s 3ms/step - loss: 3771.9424
Epoch 47/100
30/30 [=====] - 0s 3ms/step - loss: 3749.5679
Epoch 48/100
30/30 [=====] - 0s 3ms/step - loss: 3728.9309
Epoch 49/100
30/30 [=====] - 0s 3ms/step - loss: 3709.9995
Epoch 50/100
30/30 [=====] - 0s 4ms/step - loss: 3686.1482
Epoch 51/100
30/30 [=====] - 0s 3ms/step - loss: 3662.3887
Epoch 52/100
30/30 [=====] - 0s 3ms/step - loss: 3640.9287
Epoch 53/100
30/30 [=====] - 0s 4ms/step - loss: 3618.6025
Epoch 54/100
30/30 [=====] - 0s 3ms/step - loss: 3598.1711
Epoch 55/100
30/30 [=====] - 0s 4ms/step - loss: 3576.7175
Epoch 56/100
30/30 [=====] - 0s 3ms/step - loss: 3560.3926
Epoch 57/100
30/30 [=====] - 0s 3ms/step - loss: 3539.4600
Epoch 58/100
30/30 [=====] - 0s 2ms/step - loss: 3519.4089
```

```
▶ Epoch 59/100
30/30 [=====] - 0s 3ms/step - loss: 3500.7261
Epoch 60/100
30/30 [=====] - 0s 3ms/step - loss: 3483.8577
Epoch 61/100
30/30 [=====] - 0s 2ms/step - loss: 3466.8291
Epoch 62/100
30/30 [=====] - 0s 2ms/step - loss: 3450.8230
Epoch 63/100
30/30 [=====] - 0s 2ms/step - loss: 3434.4272
Epoch 64/100
30/30 [=====] - 0s 2ms/step - loss: 3419.3911
Epoch 65/100
30/30 [=====] - 0s 2ms/step - loss: 3403.5750
Epoch 66/100
30/30 [=====] - 0s 14ms/step - loss: 3394.1340
Epoch 67/100
30/30 [=====] - 0s 2ms/step - loss: 3374.1448
Epoch 68/100
30/30 [=====] - 0s 3ms/step - loss: 3361.1343
Epoch 69/100
30/30 [=====] - 0s 2ms/step - loss: 3348.2896
Epoch 70/100
30/30 [=====] - 0s 3ms/step - loss: 3336.0471
Epoch 71/100
30/30 [=====] - 0s 2ms/step - loss: 3322.8154
Epoch 72/100
30/30 [=====] - 0s 3ms/step - loss: 3311.3518
Epoch 73/100
30/30 [=====] - 0s 3ms/step - loss: 3297.5015
```

```
▶ Epoch 74/100
30/30 [=====] - 0s 2ms/step - loss: 3286.0142
Epoch 75/100
30/30 [=====] - 0s 4ms/step - loss: 3273.8267
Epoch 76/100
30/30 [=====] - 0s 3ms/step - loss: 3262.7678
Epoch 77/100
30/30 [=====] - 0s 3ms/step - loss: 3252.9111
Epoch 78/100
30/30 [=====] - 0s 3ms/step - loss: 3242.3433
Epoch 79/100
30/30 [=====] - 0s 4ms/step - loss: 3229.1555
Epoch 80/100
30/30 [=====] - 0s 4ms/step - loss: 3219.9844
Epoch 81/100
30/30 [=====] - 0s 3ms/step - loss: 3211.4890
Epoch 82/100
30/30 [=====] - 0s 2ms/step - loss: 3202.4324
Epoch 83/100
30/30 [=====] - 0s 2ms/step - loss: 3193.0623
Epoch 84/100
30/30 [=====] - 0s 4ms/step - loss: 3183.8398
Epoch 85/100
30/30 [=====] - 0s 3ms/step - loss: 3176.1289
Epoch 86/100
30/30 [=====] - 0s 2ms/step - loss: 3166.0198
Epoch 87/100
30/30 [=====] - 0s 3ms/step - loss: 3158.1790
Epoch 88/100
30/30 [=====] - 0s 3ms/step - loss: 3149.9050
```

```
Epoch 89/100
30/30 [=====] - 0s 2ms/step - loss: 3141.5430
Epoch 90/100
30/30 [=====] - 0s 2ms/step - loss: 3135.0129
Epoch 91/100
30/30 [=====] - 0s 2ms/step - loss: 3128.0996
Epoch 92/100
30/30 [=====] - 0s 3ms/step - loss: 3121.8960
Epoch 93/100
30/30 [=====] - 0s 3ms/step - loss: 3112.0410
Epoch 94/100
30/30 [=====] - 0s 2ms/step - loss: 3105.7148
Epoch 95/100
30/30 [=====] - 0s 2ms/step - loss: 3101.0239
Epoch 96/100
30/30 [=====] - 0s 4ms/step - loss: 3091.9585
Epoch 97/100
30/30 [=====] - 0s 3ms/step - loss: 3086.3069
Epoch 98/100
30/30 [=====] - 0s 3ms/step - loss: 3083.0288
Epoch 99/100
30/30 [=====] - 0s 3ms/step - loss: 3074.6631
Epoch 100/100
30/30 [=====] - 0s 2ms/step - loss: 3070.8464
<keras.callbacks.History at 0x7f4765b16bc0>
```


Evaluación de rendimiento con Cross Validation

```

3/3 [=====] - 0s 4ms/step
mse = 3105.194119869278
r^2= 0.4787372497671115
3/3 [=====] - 0s 4ms/step
mse = 3891.809469494988
r^2= 0.3923464526662185
3/3 [=====] - 0s 3ms/step
mse = 3443.1624462977566
r^2= 0.3886781851221942
3/3 [=====] - 0s 2ms/step
mse = 3486.1524722996633
r^2= 0.4014738688537143
3/3 [=====] - 0s 3ms/step
mse = 3062.9767358163035
r^2= 0.44436877793201224
MSE = 3397.859048755598
R^2 = 0.42112090686825016

```

Link a colab:

https://colab.research.google.com/drive/1e6lWYVHfSC6TcbN_L4tNrPkK_C07G60f#scrollTo=l-FqwtTFaU8C

Conclusión

Gracias a esta actividad pudimos observar las diferentes formas de implementar y entrenar una neurona perceptrón con el gradiente estocástico, además de el entrenamiento con sus variantes como lo son gradiente estocástico batch y gradiente estocástico mini batch, mediante un archivo de dataset. Asimismo, pudimos observar los resultados al modelar un perceptrón multicapa con dos clases, cuatro clases así como un modelo de regresión perceptrón multicapa.