Redes neuronales con una capa oculta: Noisy XOR

Objetivo

- Crear una red neuronal con múltiples neuronas

Tabla de contenido

Veremos cuántas neuronas se necesitan para clasificar datos de noisy XOR en una red neuronal de 1 capa oculta

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Preparación

In [1]:
```
import os
os.environ['KMP_DUPLICATE_LIB_OK']='True'
```

In [2]:
```
# Import the libraries we need for this lab



import numpy as np
import torch
import torch.nn as nn
import torch.nn.functional as F
import matplotlib.pyplot as plt
from matplotlib.colors import ListedColormap
from torch.utils.data import Dataset, DataLoader
```

Para graficar:

In [3]:
```
# Plot the data

def plot_decision_regions_2class(model,data_set):
    cmap_light = ListedColormap(['#FFAAAA', '#AAFFAA', '#00AAFF'])
    cmap_bold = ListedColormap(['#FF0000', '#00FF00', '#00AAFF'])
    X = data_set.x.numpy()
    y = data_set.y.numpy()
    h = .02
    x_min, x_max = X[:, 0].min() - 0.1 , X[:, 0].max() + 0.1
    y_min, y_max = X[:, 1].min() - 0.1 , X[:, 1].max() + 0.1
    xx, yy = np.meshgrid(np.arange(x_min, x_max, h),np.arange(y_min, y_max, h))
    XX = torch.Tensor(np.c_[xx.ravel(), yy.ravel()])

    yhat = np.logical_not((model(XX)[:, 0] > 0.5).numpy()).reshape(xx.shape)
    plt.pcolormesh(xx, yy, yhat, cmap=cmap_light)
    plt.plot(X[y[:, 0] == 0, 0], X[y[:, 0] == 0, 1], 'o', label='y=0')
    plt.plot(X[y[:, 0] == 1, 0], X[y[:, 0] == 1, 1], 'ro', label='y=1')
    plt.title("decision region")
    plt.legend()
```

Función para calcular la precisión:

In [4]:
```
# Calculate the accuracy

def accuracy(model, data_set):
    return np.mean(data_set.y.view(-1).numpy() == (model(data_set.x)[:, 0] > 0.5).nump
```

Módulo red neuronal y función de entrenamiento

Definimos la clase red neuronal:

In [5]:
```
# Define the class Net with one hidden layer

class Net(nn.Module):

    # Constructor
    def __init__(self, D_in, H, D_out):
        super(Net, self).__init__()
        #hidden layer
        self.linear1 = nn.Linear(D_in, H)
        #output layer
        self.linear2 = nn.Linear(H, D_out)

    # Prediction
    def forward(self, x):
        x = torch.sigmoid(self.linear1(x))
        x = torch.sigmoid(self.linear2(x))
        return x
```

Función para entrenar el modelo:

In [6]:
```
# Define the train model

def train(data_set, model, criterion, train_loader, optimizer, epochs=5):
    COST = []
    ACC = []
    for epoch in range(epochs):
        total=0
        for x, y in train_loader:
            optimizer.zero_grad()
            yhat = model(x)
            loss = criterion(yhat, y)
            optimizer.zero_grad()
            loss.backward()
            optimizer.step()
            #cumulative loss
            total+=loss.item()
        ACC.append(accuracy(model, data_set))
        COST.append(total)

    fig, ax1 = plt.subplots()
    color = 'tab:red'
    ax1.plot(COST, color=color)
    ax1.set_xlabel('epoch', color=color)
    ax1.set_ylabel('total loss', color=color)
    ax1.tick_params(axis='y', color=color)

    ax2 = ax1.twinx()
    color = 'tab:blue'
    ax2.set_ylabel('accuracy', color=color)  # we already handled the x-label with ax
    ax2.plot(ACC, color=color)
    ax2.tick_params(axis='y', color=color)
    fig.tight_layout()  # otherwise the right y-label is slightly clipped

    plt.show()

    return COST
```

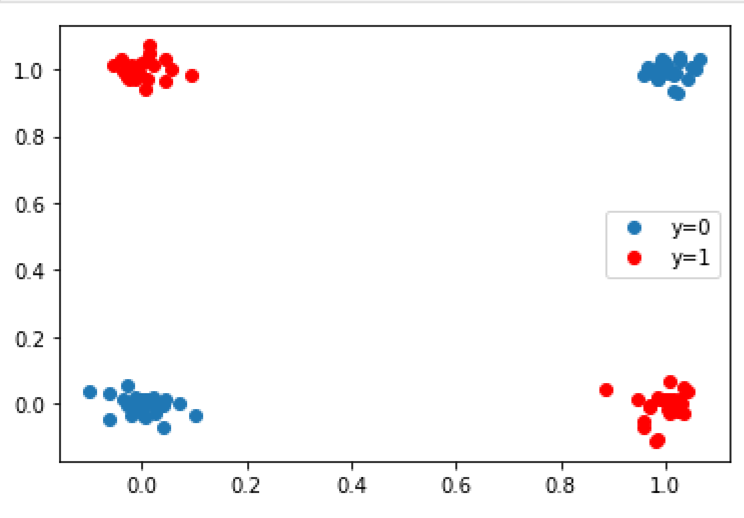
Crear algunos datos

Clase dataset:

In [7]:
```
# Define the class XOR_Data

class XOR_Data(Dataset):

    # Constructor
    def __init__(self, N_s=100):
        self.x = torch.zeros((N_s, 2))
        self.y = torch.zeros((N_s, 1))
        for i in range(N_s // 4):
            self.x[i, :] = torch.Tensor([0.0, 0.0])
            self.y[i, 0] = torch.Tensor([0.0])

            self.x[i + N_s // 4, :] = torch.Tensor([0.0, 1.0])
            self.y[i + N_s // 4, 0] = torch.Tensor([1.0])

            self.x[i + N_s // 2, :] = torch.Tensor([1.0, 0.0])
            self.y[i + N_s // 2, 0] = torch.Tensor([1.0])

            self.x[i + 3 * N_s // 4, :] = torch.Tensor([1.0, 1.0])
            self.y[i + 3 * N_s // 4, 0] = torch.Tensor([0.0])

            self.x = self.x + 0.01 * torch.randn((N_s, 2))
        self.len = N_s

    # Getter
    def __getitem__(self, index):
        return self.x[index],self.y[index]

    # Get Length
    def __len__(self):
        return self.len

    # Plot the data
    def plot_stuff(self):
        plt.plot(self.x[self.y[:, 0] == 0, 0].numpy(), self.x[self.y[:, 0] == 0, 1].nu
        plt.plot(self.x[self.y[:, 0] == 1, 0].numpy(), self.x[self.y[:, 0] == 1, 1].nu
        plt.legend()
```

Objeto dataset:

In [8]:
```
# Create dataset object

data_set = XOR_Data()
data_set.plot_stuff()
```

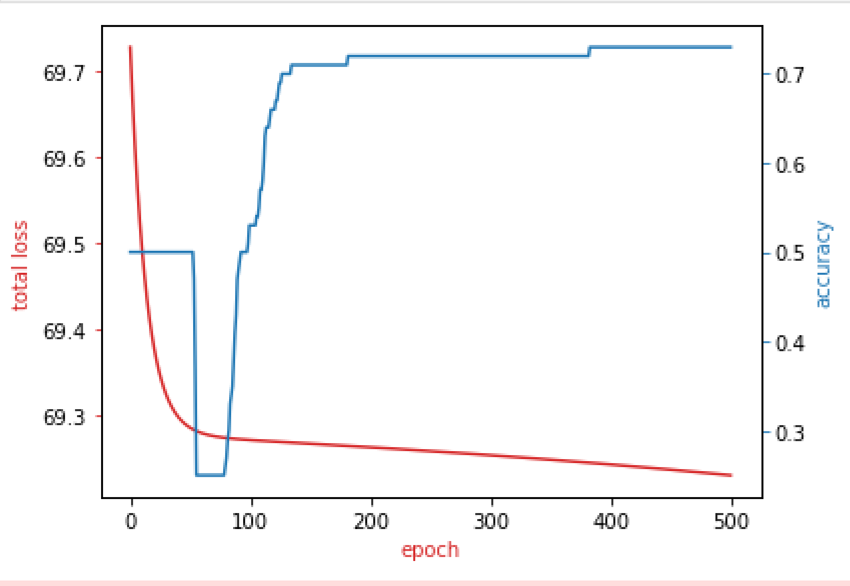


1 neurona

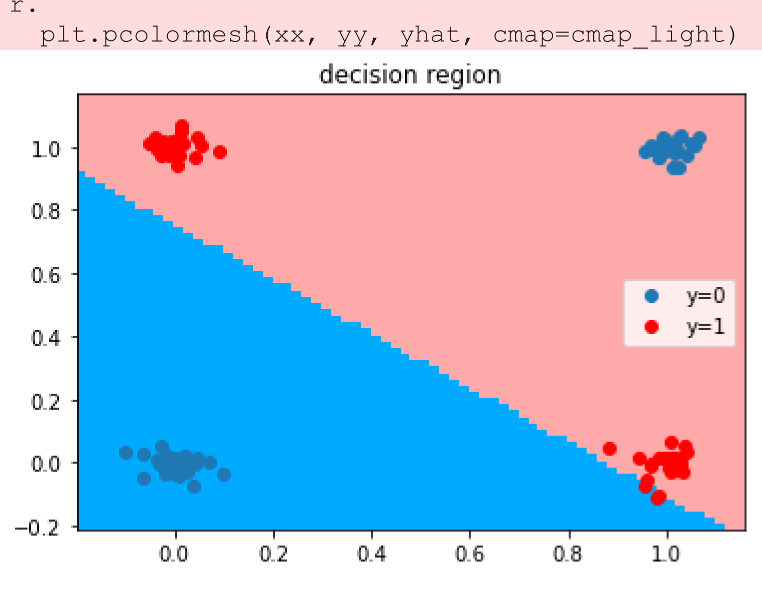
Creamos un modelo de red neuronal con 1 neurona y luego lo entrenamos:

In [10]:
```
# Practice: create a model with one neuron

model = Net(2, 1, 1)
```

In [11]:
```
# Train the model

learning_rate = 0.001
criterion = nn.BCELoss()
optimizer = torch.optim.SGD(model.parameters(), lr=learning_rate)
train_loader = DataLoader(dataset=data_set, batch_size=1)
LOSS12 = train(data_set, model, criterion, train_loader, optimizer, epochs=500)
plot_decision_regions_2class(model, data_set)
```




```
<ipython-input-3-5f7825ab7e98>:15: MatplotlibDeprecationWarning: shading='flat' when X and Y have the same dimensions as C is deprecated since 3.3.  Either specify the corners of the quadrilaterals with X and Y, or pass shading='auto', 'nearest' or 'gouraud', or set rcParams['pcolor.shading'].  This will become an error two minor releases later.
  plt.pcolormesh(xx, yy, yhat, cmap=cmap_light)
```

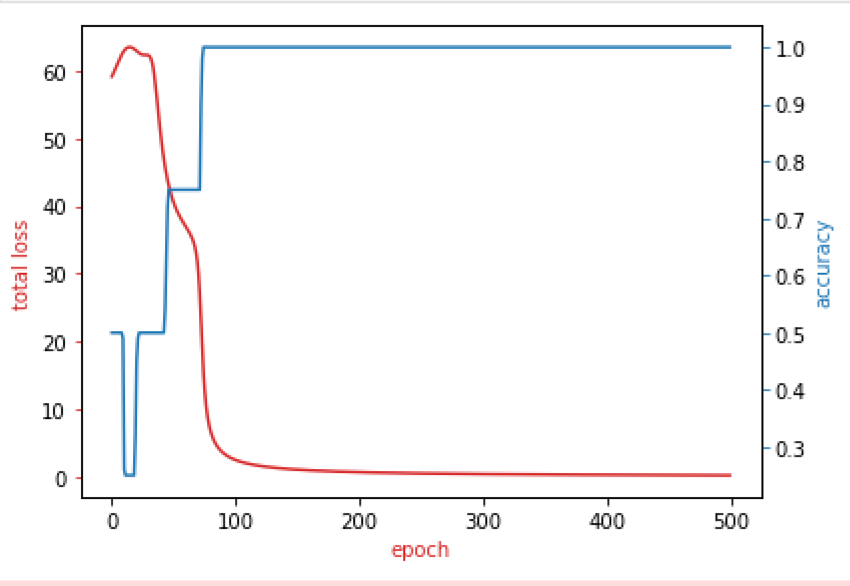


2 neuronas

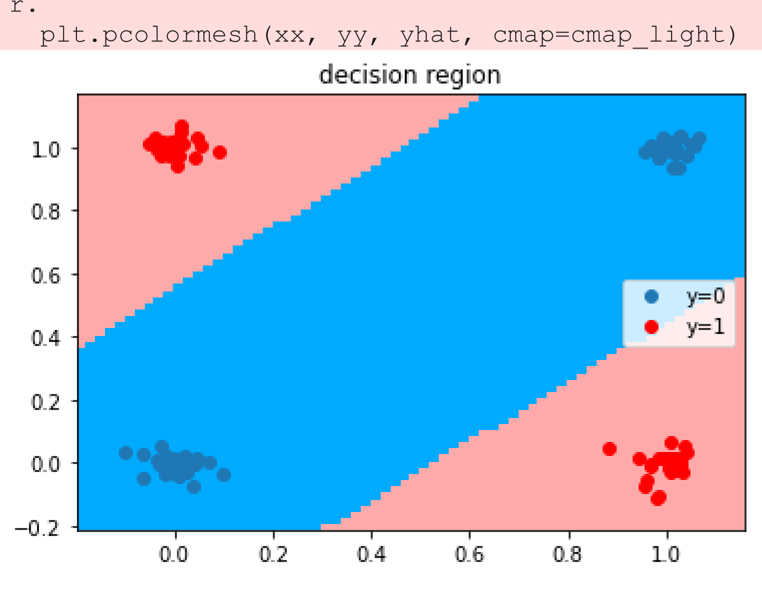
Creamos una red neuronal con 2 neuronas y la entrenamos:

In [12]:
```
# Practice: create a model with two neuron

model = Net(2, 2, 1)
```

In [13]:
```
# Train the model

learning_rate = 0.1
criterion = nn.BCELoss()
optimizer = torch.optim.SGD(model.parameters(), lr=learning_rate)
train_loader = DataLoader(dataset=data_set, batch_size=1)
LOSS12 = train(data_set, model, criterion, train_loader, optimizer, epochs=500)
plot_decision_regions_2class(model, data_set)
```




```
<ipython-input-3-5f7825ab7e98>:15: MatplotlibDeprecationWarning: shading='flat' when X and Y have the same dimensions as C is deprecated since 3.3.  Either specify the corners of the quadrilaterals with X and Y, or pass shading='auto', 'nearest' or 'gouraud', or set rcParams['pcolor.shading'].  This will become an error two minor releases later.
  plt.pcolormesh(xx, yy, yhat, cmap=cmap_light)
```

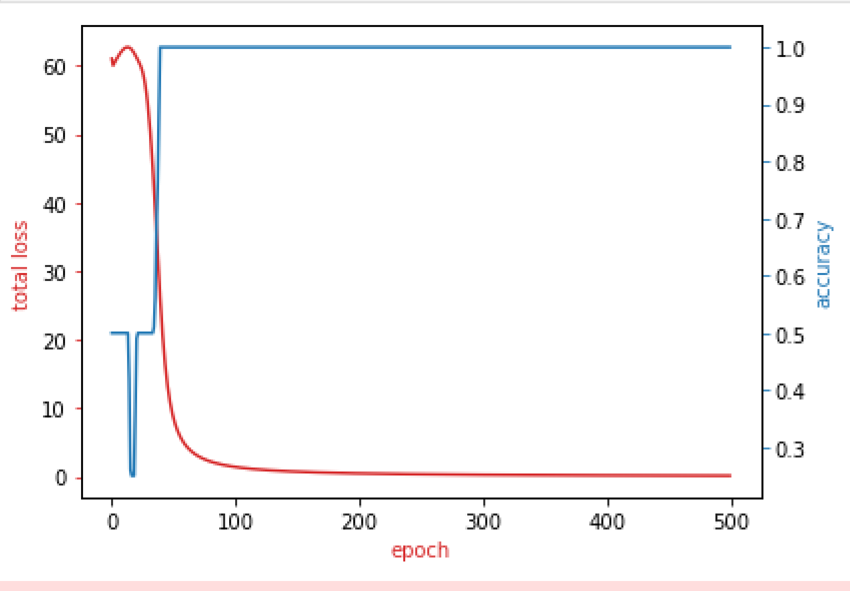


3 neuronas

Creamos un modelo de red neuronal con 3 neuronas y lo entrenamos:

In [14]:
```
# Practice: create a model with two neuron
model = Net(2, 4, 1)
# Type your code here
```

In [15]:
```
# Train the model

learning_rate = 0.1
criterion = nn.BCELoss()
optimizer = torch.optim.SGD(model.parameters(), lr=learning_rate)
train_loader = DataLoader(dataset=data_set, batch_size=1)
LOSS12 = train(data_set, model, criterion, train_loader, optimizer, epochs=500)
plot_decision_regions_2class(model, data_set)
```




```
<ipython-input-3-5f7825ab7e98>:15: MatplotlibDeprecationWarning: shading='flat' when X and Y have the same dimensions as C is deprecated since 3.3.  Either specify the corners of the quadrilaterals with X and Y, or pass shading='auto', 'nearest' or 'gouraud', or set rcParams['pcolor.shading'].  This will become an error two minor releases later.
  plt.pcolormesh(xx, yy, yhat, cmap=cmap_light)
```