worksheet_23

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1 Worksheet 23

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1.0.1 Topics

- Tuning Neural Networks

1.1 Tuning Neural Networks

Nothing to do in this worksheet except follow along in lecture / use this code to better understand Neural Networks.

[2]:
```
import math as m
import numpy as np
import matplotlib.pyplot as plt
import sklearn.datasets as datasets
from tensorflow import keras, math, random, stack
from tensorflow.keras import layers, initializers
from tensorflow.keras.activations import relu

# Set random seed for reproducibility
np.random.seed(1)
random.set_seed(1)

# Data generation - don't modify
centers = [[0, 0]]
t, _ = datasets.make_blobs(n_samples=200, centers=centers, cluster_std=1,
                           random_state=1)

colors = np.array([x for x in 'bgrcmyk'])

# CURVE
def generate_curve_data(t):
    # create some space between the classes
    X = np.array(list(filter(lambda x : m.cos(4*x[0]) - x[1] < -.5 or m.
 ↪cos(4*x[0]) - x[1] > .5, t)))
```

```
    Y = np.array([1 if m.cos(4*x[0]) - x[1] >= 0 else 0 for x in X])
    return X, Y

# The model - modify this
model = keras.models.Sequential()
model.add(layers.Dense(3, input_dim=2, activation="sigmoid"))
model.add(layers.Dense(1, activation="sigmoid"))
model.compile(loss="binary_crossentropy")

X, Y = generate_curve_data(t)

# plot the data
plt.scatter(X[:,0],X[:,1],color=colors[Y].tolist(), s=100, alpha=.9)
plt.show()

history = model.fit(X, Y, batch_size=50, epochs=200)

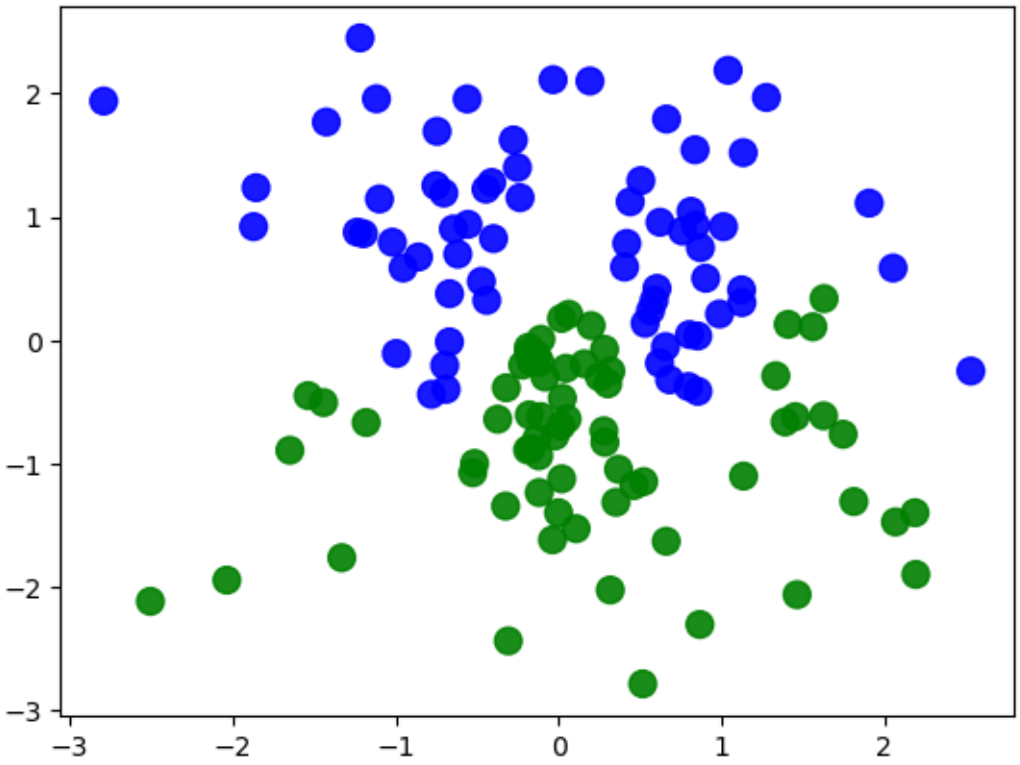
# Plot the decision boundary

# create a mesh to plot in
h = .02  # step size in the mesh
x_min, x_max = X[:, 0].min() - .5, X[:, 0].max() + 1
y_min, y_max = X[:, 1].min() - .5, X[:, 1].max() + 1
xx, yy = np.meshgrid(np.arange(x_min, x_max, h),
                     np.arange(y_min, y_max, h))
meshData = np.c_[xx.ravel(), yy.ravel()]

fig, ax = plt.subplots()
Z = model.predict(meshData)
Z = np.array([0 if x < .5 else 1 for x in Z])
Z = Z.reshape(xx.shape)
ax.contourf(xx, yy, Z, alpha=.3, cmap=plt.cm.Paired)
ax.axis('off')

# Plot also the training points
ax.scatter(X[:, 0], X[:, 1], color=colors[Y].tolist(), s=100, alpha=.9)
plt.title("Decision Boundary")
plt.show()
```

```
/Users/qjzheng/anaconda3/lib/python3.11/site-
packages/keras/src/layers/core/dense.py:87: UserWarning: Do not pass an
`input_shape`/`input_dim` argument to a layer. When using Sequential models,
prefer using an `Input(shape)` object as the first layer in the model instead.
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
```




```
Epoch 1/200
3/3             0s 1ms/step - loss:
0.8602
Epoch 2/200
3/3             0s 621us/step - loss:
0.8542
Epoch 3/200
3/3             0s 542us/step - loss:
0.8502
Epoch 4/200
3/3             0s 578us/step - loss:
0.8468
Epoch 5/200
3/3             0s 627us/step - loss:
0.8437
Epoch 6/200
3/3             0s 703us/step - loss:
0.8408
Epoch 7/200
3/3             0s 673us/step - loss:
0.8381
Epoch 8/200
```

```
3/3             0s 719us/step - loss:
0.8354
Epoch 9/200
3/3             0s 664us/step - loss:
0.8328
Epoch 10/200
3/3             0s 698us/step - loss:
0.8303
Epoch 11/200
3/3             0s 561us/step - loss:
0.8278
Epoch 12/200
3/3             0s 738us/step - loss:
0.8253
Epoch 13/200
3/3             0s 686us/step - loss:
0.8229
Epoch 14/200
3/3             0s 580us/step - loss:
0.8205
Epoch 15/200
3/3             0s 578us/step - loss:
0.8181
Epoch 16/200
3/3             0s 745us/step - loss:
0.8158
Epoch 17/200
3/3             0s 611us/step - loss:
0.8134
Epoch 18/200
3/3             0s 688us/step - loss:
0.8111
Epoch 19/200
3/3             0s 704us/step - loss:
0.8089
Epoch 20/200
3/3             0s 656us/step - loss:
0.8066
Epoch 21/200
3/3             0s 667us/step - loss:
0.8043
Epoch 22/200
3/3             0s 629us/step - loss:
0.8021
Epoch 23/200
3/3             0s 627us/step - loss:
0.7999
Epoch 24/200
```

```
3/3             0s 629us/step - loss:
0.7977
Epoch 25/200
3/3             0s 610us/step - loss:
0.7956
Epoch 26/200
3/3             0s 757us/step - loss:
0.7934
Epoch 27/200
3/3             0s 638us/step - loss:
0.7913
Epoch 28/200
3/3             0s 697us/step - loss:
0.7892
Epoch 29/200
3/3             0s 617us/step - loss:
0.7871
Epoch 30/200
3/3             0s 610us/step - loss:
0.7850
Epoch 31/200
3/3             0s 586us/step - loss:
0.7830
Epoch 32/200
3/3             0s 500us/step - loss:
0.7810
Epoch 33/200
3/3             0s 607us/step - loss:
0.7790
Epoch 34/200
3/3             0s 631us/step - loss:
0.7770
Epoch 35/200
3/3             0s 622us/step - loss:
0.7750
Epoch 36/200
3/3             0s 548us/step - loss:
0.7731
Epoch 37/200
3/3             0s 559us/step - loss:
0.7711
Epoch 38/200
3/3             0s 529us/step - loss:
0.7692
Epoch 39/200
3/3             0s 1ms/step - loss:
0.7673
Epoch 40/200
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3/3             0s 553us/step - loss:
0.7655
Epoch 41/200
3/3             0s 556us/step - loss:
0.7636
Epoch 42/200
3/3             0s 501us/step - loss:
0.7618
Epoch 43/200
3/3             0s 487us/step - loss:
0.7600
Epoch 44/200
3/3             0s 543us/step - loss:
0.7582
Epoch 45/200
3/3             0s 608us/step - loss:
0.7565
Epoch 46/200
3/3             0s 478us/step - loss:
0.7547
Epoch 47/200
3/3             0s 525us/step - loss:
0.7530
Epoch 48/200
3/3             0s 497us/step - loss:
0.7513
Epoch 49/200
3/3             0s 1ms/step - loss:
0.7496
Epoch 50/200
3/3             0s 602us/step - loss:
0.7479
Epoch 51/200
3/3             0s 443us/step - loss:
0.7463
Epoch 52/200
3/3             0s 517us/step - loss:
0.7447
Epoch 53/200
3/3             0s 2ms/step - loss:
0.7431
Epoch 54/200
3/3             0s 597us/step - loss:
0.7415
Epoch 55/200
3/3             0s 450us/step - loss:
0.7399
Epoch 56/200
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3/3             0s 496us/step - loss:
0.7384
Epoch 57/200
3/3             0s 2ms/step - loss:
0.7368
Epoch 58/200
3/3             0s 553us/step - loss:
0.7353
Epoch 59/200
3/3             0s 499us/step - loss:
0.7338
Epoch 60/200
3/3             0s 502us/step - loss:
0.7324
Epoch 61/200
3/3             0s 2ms/step - loss:
0.7309
Epoch 62/200
3/3             0s 535us/step - loss:
0.7295
Epoch 63/200
3/3             0s 506us/step - loss:
0.7281
Epoch 64/200
3/3             0s 551us/step - loss:
0.7267
Epoch 65/200
3/3             0s 1ms/step - loss:
0.7254
Epoch 66/200
3/3             0s 573us/step - loss:
0.7240
Epoch 67/200
3/3             0s 527us/step - loss:
0.7227
Epoch 68/200
3/3             0s 519us/step - loss:
0.7214
Epoch 69/200
3/3             0s 867us/step - loss:
0.7201
Epoch 70/200
3/3             0s 1ms/step - loss:
0.7188
Epoch 71/200
3/3             0s 514us/step - loss:
0.7176
Epoch 72/200
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3/3             0s 486us/step - loss:
0.7164
Epoch 73/200
3/3             0s 511us/step - loss:
0.7151
Epoch 74/200
3/3             0s 626us/step - loss:
0.7140
Epoch 75/200
3/3             0s 493us/step - loss:
0.7128
Epoch 76/200
3/3             0s 524us/step - loss:
0.7116
Epoch 77/200
3/3             0s 661us/step - loss:
0.7105
Epoch 78/200
3/3             0s 483us/step - loss:
0.7094
Epoch 79/200
3/3             0s 605us/step - loss:
0.7083
Epoch 80/200
3/3             0s 461us/step - loss:
0.7072
Epoch 81/200
3/3             0s 645us/step - loss:
0.7062
Epoch 82/200
3/3             0s 540us/step - loss:
0.7051
Epoch 83/200
3/3             0s 595us/step - loss:
0.7041
Epoch 84/200
3/3             0s 609us/step - loss:
0.7031
Epoch 85/200
3/3             0s 552us/step - loss:
0.7021
Epoch 86/200
3/3             0s 494us/step - loss:
0.7012
Epoch 87/200
3/3             0s 504us/step - loss:
0.7002
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Epoch 88/200
3/3             0s 520us/step - loss:
0.6993
Epoch 89/200
3/3             0s 525us/step - loss:
0.6984
Epoch 90/200
3/3             0s 490us/step - loss:
0.6975
Epoch 91/200
3/3             0s 528us/step - loss:
0.6966
Epoch 92/200
3/3             0s 507us/step - loss:
0.6957
Epoch 93/200
3/3             0s 551us/step - loss:
0.6949
Epoch 94/200
3/3             0s 576us/step - loss:
0.6941
Epoch 95/200
3/3             0s 517us/step - loss:
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Epoch 96/200
3/3             0s 580us/step - loss:
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Epoch 97/200
3/3             0s 553us/step - loss:
0.6917
Epoch 98/200
3/3             0s 487us/step - loss:
0.6909
Epoch 99/200
3/3             0s 527us/step - loss:
0.6902
Epoch 100/200
3/3             0s 529us/step - loss:
0.6895
Epoch 101/200
3/3             0s 514us/step - loss:
0.6888
Epoch 102/200
3/3             0s 587us/step - loss:
0.6881
Epoch 103/200
3/3             0s 520us/step - loss:
0.6874
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Epoch 104/200
3/3             0s 453us/step - loss:
0.6867
Epoch 105/200
3/3             0s 579us/step - loss:
0.6861
Epoch 106/200
3/3             0s 569us/step - loss:
0.6854
Epoch 107/200
3/3             0s 595us/step - loss:
0.6848
Epoch 108/200
3/3             0s 585us/step - loss:
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Epoch 109/200
3/3             0s 475us/step - loss:
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Epoch 110/200
3/3             0s 517us/step - loss:
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Epoch 111/200
3/3             0s 515us/step - loss:
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Epoch 112/200
3/3             0s 571us/step - loss:
0.6818
Epoch 113/200
3/3             0s 590us/step - loss:
0.6812
Epoch 114/200
3/3             0s 522us/step - loss:
0.6806
Epoch 115/200
3/3             0s 556us/step - loss:
0.6800
Epoch 116/200
3/3             0s 530us/step - loss:
0.6795
Epoch 117/200
3/3             0s 674us/step - loss:
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Epoch 118/200
3/3             0s 596us/step - loss:
0.6783
Epoch 119/200
3/3             0s 575us/step - loss:
0.6778
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Epoch 120/200
3/3             0s 573us/step - loss:
0.6772
Epoch 121/200
3/3             0s 512us/step - loss:
0.6767
Epoch 122/200
3/3             0s 559us/step - loss:
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Epoch 123/200
3/3             0s 551us/step - loss:
0.6755
Epoch 124/200
3/3             0s 559us/step - loss:
0.6750
Epoch 125/200
3/3             0s 549us/step - loss:
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Epoch 126/200
3/3             0s 529us/step - loss:
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Epoch 127/200
3/3             0s 565us/step - loss:
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Epoch 128/200
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Epoch 129/200
3/3             0s 579us/step - loss:
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Epoch 130/200
3/3             0s 1ms/step - loss:
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Epoch 131/200
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Epoch 132/200
3/3             0s 555us/step - loss:
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Epoch 133/200
3/3             0s 506us/step - loss:
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Epoch 134/200
3/3             0s 492us/step - loss:
0.6692
Epoch 135/200
3/3             0s 577us/step - loss:
0.6686
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Epoch 136/200
3/3             0s 499us/step - loss:
0.6680
Epoch 137/200
3/3             0s 620us/step - loss:
0.6674
Epoch 138/200
3/3             0s 646us/step - loss:
0.6668
Epoch 139/200
3/3             0s 1ms/step - loss:
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Epoch 140/200
3/3             0s 553us/step - loss:
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Epoch 141/200
3/3             0s 687us/step - loss:
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Epoch 142/200
3/3             0s 571us/step - loss:
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Epoch 143/200
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Epoch 144/200
3/3             0s 594us/step - loss:
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Epoch 145/200
3/3             0s 512us/step - loss:
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Epoch 146/200
3/3             0s 497us/step - loss:
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Epoch 147/200
3/3             0s 585us/step - loss:
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Epoch 148/200
3/3             0s 639us/step - loss:
0.6607
Epoch 149/200
3/3             0s 541us/step - loss:
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Epoch 150/200
3/3             0s 791us/step - loss:
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Epoch 151/200
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Epoch 152/200
3/3             0s 569us/step - loss:
0.6581
Epoch 153/200
3/3             0s 589us/step - loss:
0.6574
Epoch 154/200
3/3             0s 583us/step - loss:
0.6568
Epoch 155/200
3/3             0s 660us/step - loss:
0.6561
Epoch 156/200
3/3             0s 659us/step - loss:
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Epoch 157/200
3/3             0s 582us/step - loss:
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Epoch 158/200
3/3             0s 532us/step - loss:
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Epoch 159/200
3/3             0s 660us/step - loss:
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Epoch 160/200
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Epoch 161/200
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Epoch 162/200
3/3             0s 633us/step - loss:
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Epoch 163/200
3/3             0s 688us/step - loss:
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Epoch 164/200
3/3             0s 556us/step - loss:
0.6500
Epoch 165/200
3/3             0s 561us/step - loss:
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Epoch 166/200
3/3             0s 508us/step - loss:
0.6486
Epoch 167/200
3/3             0s 569us/step - loss:
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0.6479
Epoch 168/200
3/3             0s 623us/step - loss:
0.6472
Epoch 169/200
3/3             0s 533us/step - loss:
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Epoch 170/200
3/3             0s 538us/step - loss:
0.6458
Epoch 171/200
3/3             0s 522us/step - loss:
0.6451
Epoch 172/200
3/3             0s 531us/step - loss:
0.6443
Epoch 173/200
3/3             0s 723us/step - loss:
0.6436
Epoch 174/200
3/3             0s 550us/step - loss:
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Epoch 175/200
3/3             0s 634us/step - loss:
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Epoch 176/200
3/3             0s 531us/step - loss:
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Epoch 177/200
3/3             0s 515us/step - loss:
0.6407
Epoch 178/200
3/3             0s 487us/step - loss:
0.6399
Epoch 179/200
3/3             0s 510us/step - loss:
0.6392
Epoch 180/200
3/3             0s 545us/step - loss:
0.6384
Epoch 181/200
3/3             0s 597us/step - loss:
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Epoch 182/200
3/3             0s 678us/step - loss:
0.6369
Epoch 183/200
3/3             0s 676us/step - loss:
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0.6362
Epoch 184/200
3/3             0s 520us/step - loss:
0.6354
Epoch 185/200
3/3             0s 536us/step - loss:
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Epoch 186/200
3/3             0s 522us/step - loss:
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Epoch 187/200
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Epoch 188/200
3/3             0s 559us/step - loss:
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Epoch 189/200
3/3             0s 567us/step - loss:
0.6316
Epoch 190/200
3/3             0s 516us/step - loss:
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Epoch 191/200
3/3             0s 515us/step - loss:
0.6300
Epoch 192/200
3/3             0s 538us/step - loss:
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Epoch 193/200
3/3             0s 619us/step - loss:
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Epoch 194/200
3/3             0s 515us/step - loss:
0.6276
Epoch 195/200
3/3             0s 526us/step - loss:
0.6268
Epoch 196/200
3/3             0s 502us/step - loss:
0.6260
Epoch 197/200
3/3             0s 527us/step - loss:
0.6252
Epoch 198/200
3/3             0s 728us/step - loss:
0.6244
Epoch 199/200
3/3             0s 530us/step - loss:
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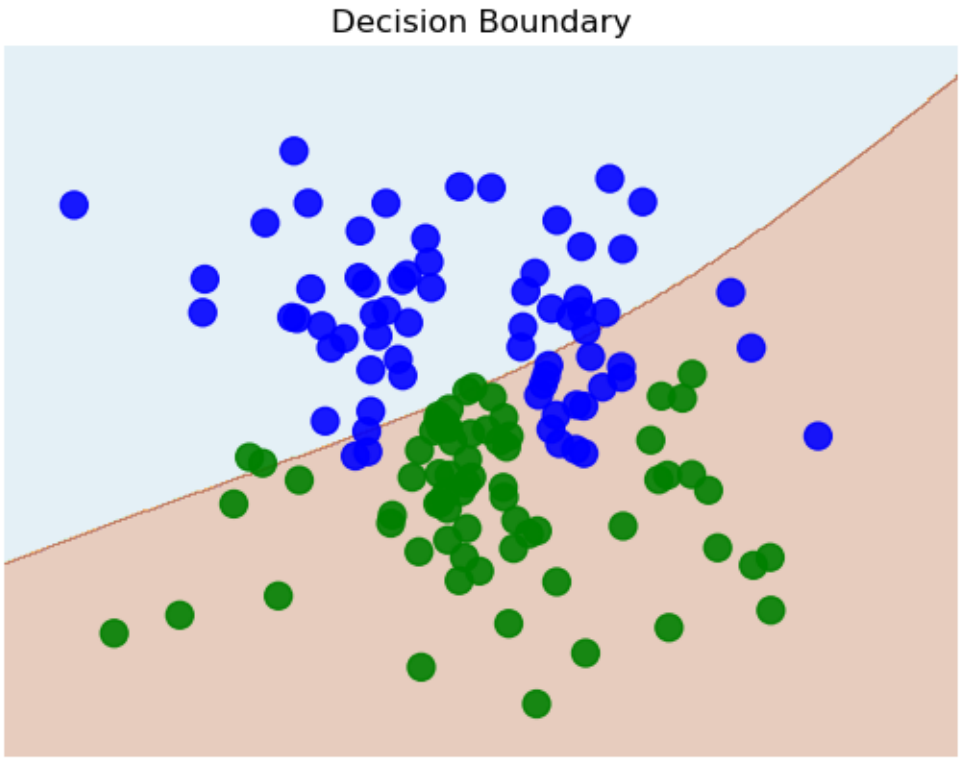
```
0.6236
Epoch 200/200
3/3             0s 569us/step - loss:
0.6228
3602/3602             1s 157us/step
```



[ ]: