Лабораторная работа №2

Выполнил студент группы БВТ2003 Глазков Даниил

In [35]:
```
import numpy as np
import math
import matplotlib.pyplot as plt
import matplotlib.colors as mclr
from tensorflow.keras import layers
from tensorflow.keras import models
import pandas
from tensorflow.keras.layers import Dense
from tensorflow.keras.models import Sequential
from tensorflow.keras.utils import to_categorical
from sklearn.preprocessing import LabelEncoder
```

In [36]:
```
dataframe = pandas.read_csv("C:\\Users\\loprz\\Downloads\\sonar.csv", header=Nor
dataset = dataframe.values
X = dataset[:,0:60].astype(float)
Y = dataset[:,60]
```

In [37]:
```
encoder = LabelEncoder()
encoder.fit(Y)
encoded_Y = encoder.transform(Y)
```

In [38]:
```
model = models.Sequential()
model.add(layers.Dense(60, input_dim=60, kernel_initializer='normal', activatior
model.add(layers.Dense(1, activation='sigmoid'))

model2 = models.Sequential()
model2.add(layers.Dense(30, input_dim=60, kernel_initializer='normal', activatic
model2.add(layers.Dense(1, activation='sigmoid'))

model3 = models.Sequential()
model3.add(layers.Dense(60, input_dim=60, kernel_initializer='normal', activatic
model3.add(layers.Dense(15, input_dim=60, kernel_initializer='normal', activatic
model3.add(layers.Dense(1, activation='sigmoid'))
```

In [39]:
```
model.compile(optimizer='adam',loss='binary_crossentropy', metrics=['accuracy'])
model2.compile(optimizer='adam',loss='binary_crossentropy', metrics=['accuracy']
model3.compile(optimizer='adam',loss='binary_crossentropy', metrics=['accuracy']
```

In [40]:
```
H = model.fit(X, encoded_Y, epochs=100, batch_size=10, validation_split=0.1)
H2 = model2.fit(X, encoded_Y, epochs=100, batch_size=10, validation_split=0.1)
H3 = model3.fit(X, encoded_Y, epochs=100, batch_size=10, validation_split=0.1)
```

```
Epoch 1/100
19/19 [==============================] - 1s 12ms/step - loss: 0.6921 - accuracy:
0.5294 - val_loss: 0.6996 - val_accuracy: 0.3333
Epoch 2/100
19/19 [==============================] - 0s 4ms/step - loss: 0.6659 - accuracy:
0.6631 - val_loss: 0.6884 - val_accuracy: 0.4762
Epoch 3/100
19/19 [==============================] - 0s 4ms/step - loss: 0.6414 - accuracy:
0.7273 - val_loss: 0.7091 - val_accuracy: 0.3810
Epoch 4/100
19/19 [==============================] - 0s 4ms/step - loss: 0.6211 - accuracy:
0.7380 - val_loss: 0.7133 - val_accuracy: 0.3810
Epoch 5/100
19/19 [==============================] - 0s 4ms/step - loss: 0.6008 - accuracy:
0.7326 - val_loss: 0.6927 - val_accuracy: 0.4286
Epoch 6/100
19/19 [==============================] - 0s 4ms/step - loss: 0.5816 - accuracy:
0.7326 - val_loss: 0.7702 - val_accuracy: 0.2857
Epoch 7/100
19/19 [==============================] - 0s 4ms/step - loss: 0.5727 - accuracy:
0.7219 - val_loss: 0.7308 - val_accuracy: 0.3810
Epoch 8/100
19/19 [==============================] - 0s 4ms/step - loss: 0.5562 - accuracy:
0.7219 - val_loss: 0.7186 - val_accuracy: 0.3810
Epoch 9/100
19/19 [==============================] - 0s 4ms/step - loss: 0.5349 - accuracy:
0.7380 - val_loss: 0.7197 - val_accuracy: 0.3810
Epoch 10/100
19/19 [==============================] - 0s 4ms/step - loss: 0.5234 - accuracy:
0.7380 - val_loss: 0.6799 - val_accuracy: 0.4286
Epoch 11/100
19/19 [==============================] - 0s 4ms/step - loss: 0.5138 - accuracy:
0.7380 - val_loss: 0.7129 - val_accuracy: 0.3810
Epoch 12/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4993 - accuracy:
0.7594 - val_loss: 0.7080 - val_accuracy: 0.4286
Epoch 13/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4907 - accuracy:
0.7754 - val_loss: 0.6691 - val_accuracy: 0.4762
Epoch 14/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4850 - accuracy:
0.7701 - val_loss: 0.6438 - val_accuracy: 0.5238
Epoch 15/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4778 - accuracy:
0.7861 - val_loss: 0.7494 - val_accuracy: 0.3810
Epoch 16/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4743 - accuracy:
0.7861 - val_loss: 0.6879 - val_accuracy: 0.4762
Epoch 17/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4637 - accuracy:
0.7807 - val_loss: 0.6321 - val_accuracy: 0.5714
Epoch 18/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4560 - accuracy:
0.7701 - val_loss: 0.6075 - val_accuracy: 0.5714
Epoch 19/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4553 - accuracy:
0.7968 - val_loss: 0.7377 - val_accuracy: 0.3810
Epoch 20/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4501 - accuracy:
0.7807 - val_loss: 0.5887 - val_accuracy: 0.6190
```

```
Epoch 21/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4397 - accuracy:
0.7968 - val_loss: 0.5877 - val_accuracy: 0.6190
Epoch 22/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4423 - accuracy:
0.8075 - val_loss: 0.6250 - val_accuracy: 0.5714
Epoch 23/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4416 - accuracy:
0.7754 - val_loss: 0.4991 - val_accuracy: 0.7619
Epoch 24/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4364 - accuracy:
0.7968 - val_loss: 0.4856 - val_accuracy: 0.7619
Epoch 25/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4319 - accuracy:
0.7968 - val_loss: 0.5117 - val_accuracy: 0.7619
Epoch 26/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4167 - accuracy:
0.8128 - val_loss: 0.5663 - val_accuracy: 0.6190
Epoch 27/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4156 - accuracy:
0.8182 - val_loss: 0.4942 - val_accuracy: 0.7619
Epoch 28/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4070 - accuracy:
0.8182 - val_loss: 0.5893 - val_accuracy: 0.6190
Epoch 29/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4103 - accuracy:
0.7968 - val_loss: 0.5385 - val_accuracy: 0.7143
Epoch 30/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4114 - accuracy:
0.8128 - val_loss: 0.5592 - val_accuracy: 0.6667
Epoch 31/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3976 - accuracy:
0.8182 - val_loss: 0.5084 - val_accuracy: 0.7619
Epoch 32/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3982 - accuracy:
0.8235 - val_loss: 0.5052 - val_accuracy: 0.7619
Epoch 33/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3937 - accuracy:
0.8128 - val_loss: 0.4516 - val_accuracy: 0.7619
Epoch 34/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3924 - accuracy:
0.8235 - val_loss: 0.5629 - val_accuracy: 0.6190
Epoch 35/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3889 - accuracy:
0.8182 - val_loss: 0.3967 - val_accuracy: 0.8571
Epoch 36/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3927 - accuracy:
0.8235 - val_loss: 0.6118 - val_accuracy: 0.6190
Epoch 37/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3840 - accuracy:
0.8449 - val_loss: 0.3772 - val_accuracy: 0.9048
Epoch 38/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3865 - accuracy:
0.8289 - val_loss: 0.5023 - val_accuracy: 0.7619
Epoch 39/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3809 - accuracy:
0.8342 - val_loss: 0.5275 - val_accuracy: 0.7143
Epoch 40/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3726 - accuracy:
0.8342 - val_loss: 0.3871 - val_accuracy: 0.8571
```

```
Epoch 41/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3862 - accuracy:
0.8128 - val_loss: 0.4372 - val_accuracy: 0.7619
Epoch 42/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3707 - accuracy:
0.8449 - val_loss: 0.4967 - val_accuracy: 0.7619
Epoch 43/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3627 - accuracy:
0.8503 - val_loss: 0.4725 - val_accuracy: 0.7619
Epoch 44/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3657 - accuracy:
0.8396 - val_loss: 0.5280 - val_accuracy: 0.7143
Epoch 45/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3636 - accuracy:
0.8182 - val_loss: 0.3222 - val_accuracy: 0.9048
Epoch 46/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3718 - accuracy:
0.8556 - val_loss: 0.5325 - val_accuracy: 0.6667
Epoch 47/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3560 - accuracy:
0.8610 - val_loss: 0.4315 - val_accuracy: 0.7619
Epoch 48/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3533 - accuracy:
0.8449 - val_loss: 0.5006 - val_accuracy: 0.7143
Epoch 49/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3477 - accuracy:
0.8770 - val_loss: 0.3770 - val_accuracy: 0.8571
Epoch 50/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3468 - accuracy:
0.8556 - val_loss: 0.4188 - val_accuracy: 0.7619
Epoch 51/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3471 - accuracy:
0.8503 - val_loss: 0.4188 - val_accuracy: 0.7619
Epoch 52/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3390 - accuracy:
0.8770 - val_loss: 0.3947 - val_accuracy: 0.8095
Epoch 53/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3457 - accuracy:
0.8877 - val_loss: 0.4028 - val_accuracy: 0.8095
Epoch 54/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3673 - accuracy:
0.8342 - val_loss: 0.2554 - val_accuracy: 0.9524
Epoch 55/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3456 - accuracy:
0.8717 - val_loss: 0.4028 - val_accuracy: 0.8095
Epoch 56/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3339 - accuracy:
0.8770 - val_loss: 0.3888 - val_accuracy: 0.8095
Epoch 57/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3363 - accuracy:
0.8717 - val_loss: 0.4898 - val_accuracy: 0.7143
Epoch 58/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3328 - accuracy:
0.8824 - val_loss: 0.3195 - val_accuracy: 0.9048
Epoch 59/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3338 - accuracy:
0.8717 - val_loss: 0.4089 - val_accuracy: 0.8095
Epoch 60/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3579 - accuracy:
0.8503 - val_loss: 0.5496 - val_accuracy: 0.6190
```

```
Epoch 61/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3282 - accuracy:
0.8824 - val_loss: 0.2679 - val_accuracy: 0.9524
Epoch 62/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3384 - accuracy:
0.8396 - val_loss: 0.3983 - val_accuracy: 0.8095
Epoch 63/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3166 - accuracy:
0.8930 - val_loss: 0.4420 - val_accuracy: 0.8095
Epoch 64/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3196 - accuracy:
0.8824 - val_loss: 0.3222 - val_accuracy: 0.9048
Epoch 65/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3092 - accuracy:
0.8877 - val_loss: 0.4007 - val_accuracy: 0.8095
Epoch 66/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3083 - accuracy:
0.8930 - val_loss: 0.4123 - val_accuracy: 0.8095
Epoch 67/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3106 - accuracy:
0.8770 - val_loss: 0.3743 - val_accuracy: 0.8095
Epoch 68/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3033 - accuracy:
0.8770 - val_loss: 0.3535 - val_accuracy: 0.8095
Epoch 69/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3020 - accuracy:
0.8877 - val_loss: 0.3302 - val_accuracy: 0.9048
Epoch 70/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2971 - accuracy:
0.8877 - val_loss: 0.3989 - val_accuracy: 0.8095
Epoch 71/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3035 - accuracy:
0.8877 - val_loss: 0.2624 - val_accuracy: 0.9048
Epoch 72/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3073 - accuracy:
0.8877 - val_loss: 0.3456 - val_accuracy: 0.8095
Epoch 73/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2937 - accuracy:
0.8930 - val_loss: 0.3105 - val_accuracy: 0.9048
Epoch 74/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2917 - accuracy:
0.8877 - val_loss: 0.3681 - val_accuracy: 0.8095
Epoch 75/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2910 - accuracy:
0.8930 - val_loss: 0.3417 - val_accuracy: 0.8095
Epoch 76/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2872 - accuracy:
0.8930 - val_loss: 0.2997 - val_accuracy: 0.9048
Epoch 77/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2856 - accuracy:
0.8984 - val_loss: 0.3219 - val_accuracy: 0.9048
Epoch 78/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2838 - accuracy:
0.8984 - val_loss: 0.2952 - val_accuracy: 0.9048
Epoch 79/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2801 - accuracy:
0.8930 - val_loss: 0.3804 - val_accuracy: 0.8095
Epoch 80/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2801 - accuracy:
0.9037 - val_loss: 0.3481 - val_accuracy: 0.8095
```

```
Epoch 81/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2748 - accuracy:
0.9037 - val_loss: 0.3056 - val_accuracy: 0.9048
Epoch 82/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2738 - accuracy:
0.9037 - val_loss: 0.3274 - val_accuracy: 0.8571
Epoch 83/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2725 - accuracy:
0.9091 - val_loss: 0.3489 - val_accuracy: 0.8095
Epoch 84/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2693 - accuracy:
0.9091 - val_loss: 0.3370 - val_accuracy: 0.8095
Epoch 85/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2733 - accuracy:
0.9091 - val_loss: 0.2445 - val_accuracy: 0.9524
Epoch 86/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2775 - accuracy:
0.8984 - val_loss: 0.3330 - val_accuracy: 0.8095
Epoch 87/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2646 - accuracy:
0.9037 - val_loss: 0.3265 - val_accuracy: 0.8571
Epoch 88/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2598 - accuracy:
0.9144 - val_loss: 0.3093 - val_accuracy: 0.8571
Epoch 89/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2601 - accuracy:
0.9144 - val_loss: 0.2684 - val_accuracy: 0.9048
Epoch 90/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2574 - accuracy:
0.8930 - val_loss: 0.2919 - val_accuracy: 0.9048
Epoch 91/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2529 - accuracy:
0.9198 - val_loss: 0.2972 - val_accuracy: 0.9048
Epoch 92/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2553 - accuracy:
0.9198 - val_loss: 0.2575 - val_accuracy: 0.9524
Epoch 93/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2499 - accuracy:
0.9091 - val_loss: 0.3247 - val_accuracy: 0.8095
Epoch 94/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2487 - accuracy:
0.9091 - val_loss: 0.2730 - val_accuracy: 0.9048
Epoch 95/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2481 - accuracy:
0.9091 - val_loss: 0.4036 - val_accuracy: 0.7619
Epoch 96/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2488 - accuracy:
0.9305 - val_loss: 0.1957 - val_accuracy: 1.0000
Epoch 97/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2562 - accuracy:
0.9144 - val_loss: 0.2510 - val_accuracy: 0.9524
Epoch 98/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2446 - accuracy:
0.9144 - val_loss: 0.2877 - val_accuracy: 0.9048
Epoch 99/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2401 - accuracy:
0.9144 - val_loss: 0.2420 - val_accuracy: 0.9524
Epoch 100/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2384 - accuracy:
0.9305 - val_loss: 0.2750 - val_accuracy: 0.9048
```

```
Epoch 1/100
19/19 [==============================] - 1s 11ms/step - loss: 0.6870 - accuracy:
0.5294 - val_loss: 0.7685 - val_accuracy: 0.0000e+00
Epoch 2/100
19/19 [==============================] - 0s 4ms/step - loss: 0.6735 - accuracy:
0.6310 - val_loss: 0.7617 - val_accuracy: 0.0000e+00
Epoch 3/100
19/19 [==============================] - 0s 4ms/step - loss: 0.6620 - accuracy:
0.6738 - val_loss: 0.7467 - val_accuracy: 0.1429
Epoch 4/100
19/19 [==============================] - 0s 4ms/step - loss: 0.6492 - accuracy:
0.6898 - val_loss: 0.7625 - val_accuracy: 0.0952
Epoch 5/100
19/19 [==============================] - 0s 4ms/step - loss: 0.6367 - accuracy:
0.7219 - val_loss: 0.7543 - val_accuracy: 0.2381
Epoch 6/100
19/19 [==============================] - 0s 4ms/step - loss: 0.6239 - accuracy:
0.7166 - val_loss: 0.7940 - val_accuracy: 0.0952
Epoch 7/100
19/19 [==============================] - 0s 4ms/step - loss: 0.6113 - accuracy:
0.7273 - val_loss: 0.7757 - val_accuracy: 0.2381
Epoch 8/100
19/19 [==============================] - 0s 4ms/step - loss: 0.5987 - accuracy:
0.7380 - val_loss: 0.7678 - val_accuracy: 0.3333
Epoch 9/100
19/19 [==============================] - 0s 4ms/step - loss: 0.5873 - accuracy:
0.7219 - val_loss: 0.8029 - val_accuracy: 0.2857
Epoch 10/100
19/19 [==============================] - 0s 4ms/step - loss: 0.5722 - accuracy:
0.7380 - val_loss: 0.7588 - val_accuracy: 0.3810
Epoch 11/100
19/19 [==============================] - 0s 4ms/step - loss: 0.5627 - accuracy:
0.7433 - val_loss: 0.8200 - val_accuracy: 0.3333
Epoch 12/100
19/19 [==============================] - 0s 4ms/step - loss: 0.5560 - accuracy:
0.7487 - val_loss: 0.7858 - val_accuracy: 0.3333
Epoch 13/100
19/19 [==============================] - 0s 4ms/step - loss: 0.5489 - accuracy:
0.7166 - val_loss: 0.8541 - val_accuracy: 0.3333
Epoch 14/100
19/19 [==============================] - 0s 4ms/step - loss: 0.5298 - accuracy:
0.7540 - val_loss: 0.7598 - val_accuracy: 0.3810
Epoch 15/100
19/19 [==============================] - 0s 4ms/step - loss: 0.5214 - accuracy:
0.7647 - val_loss: 0.8120 - val_accuracy: 0.3333
Epoch 16/100
19/19 [==============================] - 0s 4ms/step - loss: 0.5114 - accuracy:
0.7701 - val_loss: 0.7430 - val_accuracy: 0.4286
Epoch 17/100
19/19 [==============================] - 0s 4ms/step - loss: 0.5050 - accuracy:
0.7914 - val_loss: 0.7334 - val_accuracy: 0.4286
Epoch 18/100
19/19 [==============================] - 0s 4ms/step - loss: 0.5107 - accuracy:
0.7594 - val_loss: 0.6941 - val_accuracy: 0.4286
Epoch 19/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4915 - accuracy:
0.7807 - val_loss: 0.7276 - val_accuracy: 0.4286
Epoch 20/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4864 - accuracy:
0.7701 - val_loss: 0.7668 - val_accuracy: 0.3810
```

```
Epoch 21/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4776 - accuracy:
0.7968 - val_loss: 0.7102 - val_accuracy: 0.4286
Epoch 22/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4781 - accuracy:
0.8128 - val_loss: 0.7652 - val_accuracy: 0.3810
Epoch 23/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4752 - accuracy:
0.7487 - val_loss: 0.7574 - val_accuracy: 0.4286
Epoch 24/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4890 - accuracy:
0.7594 - val_loss: 0.6741 - val_accuracy: 0.4762
Epoch 25/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4718 - accuracy:
0.7647 - val_loss: 0.7535 - val_accuracy: 0.4286
Epoch 26/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4597 - accuracy:
0.8075 - val_loss: 0.6235 - val_accuracy: 0.5238
Epoch 27/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4545 - accuracy:
0.7968 - val_loss: 0.6407 - val_accuracy: 0.4762
Epoch 28/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4497 - accuracy:
0.7701 - val_loss: 0.6737 - val_accuracy: 0.4762
Epoch 29/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4455 - accuracy:
0.8075 - val_loss: 0.6434 - val_accuracy: 0.4762
Epoch 30/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4421 - accuracy:
0.7754 - val_loss: 0.6683 - val_accuracy: 0.4762
Epoch 31/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4445 - accuracy:
0.8075 - val_loss: 0.6303 - val_accuracy: 0.4762
Epoch 32/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4454 - accuracy:
0.7701 - val_loss: 0.5946 - val_accuracy: 0.6667
Epoch 33/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4344 - accuracy:
0.7914 - val_loss: 0.6124 - val_accuracy: 0.4762
Epoch 34/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4323 - accuracy:
0.8182 - val_loss: 0.6267 - val_accuracy: 0.4762
Epoch 35/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4265 - accuracy:
0.8075 - val_loss: 0.6084 - val_accuracy: 0.5238
Epoch 36/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4247 - accuracy:
0.7861 - val_loss: 0.5532 - val_accuracy: 0.6667
Epoch 37/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4198 - accuracy:
0.8182 - val_loss: 0.5888 - val_accuracy: 0.6667
Epoch 38/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4164 - accuracy:
0.8128 - val_loss: 0.5762 - val_accuracy: 0.6667
Epoch 39/100
19/19 [==============================] - 0s 16ms/step - loss: 0.4121 - accuracy:
0.8128 - val_loss: 0.5976 - val_accuracy: 0.6190
Epoch 40/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4122 - accuracy:
0.8182 - val_loss: 0.5974 - val_accuracy: 0.6190
```

```
Epoch 41/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4142 - accuracy:
0.8021 - val_loss: 0.5398 - val_accuracy: 0.7143
Epoch 42/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4104 - accuracy:
0.8075 - val_loss: 0.5958 - val_accuracy: 0.6190
Epoch 43/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4036 - accuracy:
0.8075 - val_loss: 0.5620 - val_accuracy: 0.6667
Epoch 44/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4073 - accuracy:
0.7914 - val_loss: 0.5699 - val_accuracy: 0.6667
Epoch 45/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4001 - accuracy:
0.8182 - val_loss: 0.5599 - val_accuracy: 0.6667
Epoch 46/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3974 - accuracy:
0.8075 - val_loss: 0.5740 - val_accuracy: 0.6667
Epoch 47/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3947 - accuracy:
0.8235 - val_loss: 0.4899 - val_accuracy: 0.7619
Epoch 48/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3918 - accuracy:
0.8396 - val_loss: 0.5585 - val_accuracy: 0.6667
Epoch 49/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3891 - accuracy:
0.8182 - val_loss: 0.5637 - val_accuracy: 0.6667
Epoch 50/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3918 - accuracy:
0.8235 - val_loss: 0.5545 - val_accuracy: 0.6667
Epoch 51/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3845 - accuracy:
0.8289 - val_loss: 0.5482 - val_accuracy: 0.6667
Epoch 52/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3844 - accuracy:
0.8396 - val_loss: 0.5328 - val_accuracy: 0.7143
Epoch 53/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3818 - accuracy:
0.8289 - val_loss: 0.5290 - val_accuracy: 0.7143
Epoch 54/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3781 - accuracy:
0.8289 - val_loss: 0.5214 - val_accuracy: 0.7143
Epoch 55/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3797 - accuracy:
0.8235 - val_loss: 0.5619 - val_accuracy: 0.6667
Epoch 56/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3802 - accuracy:
0.8182 - val_loss: 0.4913 - val_accuracy: 0.7619
Epoch 57/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3795 - accuracy:
0.8449 - val_loss: 0.5075 - val_accuracy: 0.7619
Epoch 58/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3689 - accuracy:
0.8449 - val_loss: 0.5084 - val_accuracy: 0.7143
Epoch 59/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3667 - accuracy:
0.8449 - val_loss: 0.5273 - val_accuracy: 0.7143
Epoch 60/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3734 - accuracy:
0.8449 - val_loss: 0.4931 - val_accuracy: 0.7619
```

```
Epoch 61/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3704 - accuracy:
0.8396 - val_loss: 0.5094 - val_accuracy: 0.7143
Epoch 62/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3645 - accuracy:
0.8503 - val_loss: 0.4378 - val_accuracy: 0.7619
Epoch 63/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3611 - accuracy:
0.8503 - val_loss: 0.4884 - val_accuracy: 0.7619
Epoch 64/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3624 - accuracy:
0.8449 - val_loss: 0.5232 - val_accuracy: 0.7143
Epoch 65/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3526 - accuracy:
0.8503 - val_loss: 0.4787 - val_accuracy: 0.7619
Epoch 66/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3549 - accuracy:
0.8503 - val_loss: 0.4954 - val_accuracy: 0.7619
Epoch 67/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3583 - accuracy:
0.8503 - val_loss: 0.4676 - val_accuracy: 0.7619
Epoch 68/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3492 - accuracy:
0.8556 - val_loss: 0.4872 - val_accuracy: 0.7619
Epoch 69/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3478 - accuracy:
0.8610 - val_loss: 0.4718 - val_accuracy: 0.7619
Epoch 70/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3474 - accuracy:
0.8717 - val_loss: 0.4404 - val_accuracy: 0.7619
Epoch 71/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3427 - accuracy:
0.8770 - val_loss: 0.4721 - val_accuracy: 0.7619
Epoch 72/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3438 - accuracy:
0.8717 - val_loss: 0.4892 - val_accuracy: 0.7143
Epoch 73/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3448 - accuracy:
0.8610 - val_loss: 0.4088 - val_accuracy: 0.7619
Epoch 74/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3564 - accuracy:
0.8449 - val_loss: 0.4996 - val_accuracy: 0.7143
Epoch 75/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3389 - accuracy:
0.8663 - val_loss: 0.4516 - val_accuracy: 0.7619
Epoch 76/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3368 - accuracy:
0.8930 - val_loss: 0.5123 - val_accuracy: 0.7143
Epoch 77/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3336 - accuracy:
0.8824 - val_loss: 0.4677 - val_accuracy: 0.7619
Epoch 78/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3328 - accuracy:
0.8717 - val_loss: 0.4297 - val_accuracy: 0.7619
Epoch 79/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3315 - accuracy:
0.8824 - val_loss: 0.4820 - val_accuracy: 0.7143
Epoch 80/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3299 - accuracy:
0.8824 - val_loss: 0.4758 - val_accuracy: 0.7619
```

```
Epoch 81/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3285 - accuracy:
0.8877 - val_loss: 0.4373 - val_accuracy: 0.7619
Epoch 82/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3267 - accuracy:
0.8824 - val_loss: 0.4181 - val_accuracy: 0.7619
Epoch 83/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3266 - accuracy:
0.8824 - val_loss: 0.4453 - val_accuracy: 0.7619
Epoch 84/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3218 - accuracy:
0.8877 - val_loss: 0.4373 - val_accuracy: 0.7619
Epoch 85/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3205 - accuracy:
0.8877 - val_loss: 0.4406 - val_accuracy: 0.7619
Epoch 86/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3182 - accuracy:
0.8930 - val_loss: 0.4438 - val_accuracy: 0.7619
Epoch 87/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3208 - accuracy:
0.8877 - val_loss: 0.3976 - val_accuracy: 0.8095
Epoch 88/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3226 - accuracy:
0.8610 - val_loss: 0.5478 - val_accuracy: 0.6190
Epoch 89/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3248 - accuracy:
0.8824 - val_loss: 0.4159 - val_accuracy: 0.7619
Epoch 90/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3190 - accuracy:
0.8824 - val_loss: 0.4040 - val_accuracy: 0.8095
Epoch 91/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3094 - accuracy:
0.8877 - val_loss: 0.4718 - val_accuracy: 0.7619
Epoch 92/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3074 - accuracy:
0.8930 - val_loss: 0.3930 - val_accuracy: 0.8095
Epoch 93/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3049 - accuracy:
0.8930 - val_loss: 0.4590 - val_accuracy: 0.7619
Epoch 94/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3076 - accuracy:
0.8877 - val_loss: 0.4096 - val_accuracy: 0.8095
Epoch 95/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3101 - accuracy:
0.8930 - val_loss: 0.4146 - val_accuracy: 0.8095
Epoch 96/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3041 - accuracy:
0.8930 - val_loss: 0.4571 - val_accuracy: 0.7619
Epoch 97/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2997 - accuracy:
0.8984 - val_loss: 0.4180 - val_accuracy: 0.8095
Epoch 98/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3025 - accuracy:
0.8877 - val_loss: 0.3985 - val_accuracy: 0.8095
Epoch 99/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2982 - accuracy:
0.8877 - val_loss: 0.4229 - val_accuracy: 0.8095
Epoch 100/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3020 - accuracy:
0.8877 - val_loss: 0.3918 - val_accuracy: 0.8095
```

```
Epoch 1/100
19/19 [==============================] - 1s 12ms/step - loss: 0.6909 - accuracy:
0.5348 - val_loss: 0.6997 - val_accuracy: 0.3333
Epoch 2/100
19/19 [==============================] - 0s 4ms/step - loss: 0.6765 - accuracy:
0.6845 - val_loss: 0.7159 - val_accuracy: 0.2381
Epoch 3/100
19/19 [==============================] - 0s 4ms/step - loss: 0.6534 - accuracy:
0.7219 - val_loss: 0.7052 - val_accuracy: 0.3810
Epoch 4/100
19/19 [==============================] - 0s 4ms/step - loss: 0.6280 - accuracy:
0.7219 - val_loss: 0.7613 - val_accuracy: 0.2857
Epoch 5/100
19/19 [==============================] - 0s 4ms/step - loss: 0.5957 - accuracy:
0.7326 - val_loss: 0.8031 - val_accuracy: 0.2381
Epoch 6/100
19/19 [==============================] - 0s 4ms/step - loss: 0.5590 - accuracy:
0.7701 - val_loss: 0.6601 - val_accuracy: 0.4762
Epoch 7/100
19/19 [==============================] - 0s 4ms/step - loss: 0.5410 - accuracy:
0.7112 - val_loss: 0.7882 - val_accuracy: 0.3333
Epoch 8/100
19/19 [==============================] - 0s 4ms/step - loss: 0.5086 - accuracy:
0.7807 - val_loss: 0.9441 - val_accuracy: 0.2857
Epoch 9/100
19/19 [==============================] - 0s 4ms/step - loss: 0.5080 - accuracy:
0.7487 - val_loss: 0.7572 - val_accuracy: 0.4286
Epoch 10/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4919 - accuracy:
0.7540 - val_loss: 0.3805 - val_accuracy: 0.9524
Epoch 11/100
19/19 [==============================] - 0s 4ms/step - loss: 0.5034 - accuracy:
0.7540 - val_loss: 0.6513 - val_accuracy: 0.4762
Epoch 12/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4486 - accuracy:
0.8128 - val_loss: 0.5709 - val_accuracy: 0.6667
Epoch 13/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4396 - accuracy:
0.8021 - val_loss: 0.5919 - val_accuracy: 0.6190
Epoch 14/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4489 - accuracy:
0.7647 - val_loss: 0.6446 - val_accuracy: 0.4762
Epoch 15/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4192 - accuracy:
0.8289 - val_loss: 0.4728 - val_accuracy: 0.8571
Epoch 16/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4076 - accuracy:
0.8342 - val_loss: 0.6953 - val_accuracy: 0.4762
Epoch 17/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3960 - accuracy:
0.8396 - val_loss: 0.3880 - val_accuracy: 0.9048
Epoch 18/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4001 - accuracy:
0.7968 - val_loss: 0.6342 - val_accuracy: 0.5238
Epoch 19/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3846 - accuracy:
0.8235 - val_loss: 0.6778 - val_accuracy: 0.4762
Epoch 20/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3911 - accuracy:
0.8182 - val_loss: 0.4586 - val_accuracy: 0.8095
```

```
Epoch 21/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3670 - accuracy:
0.8556 - val_loss: 0.5818 - val_accuracy: 0.6190
Epoch 22/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3696 - accuracy:
0.8342 - val_loss: 0.6465 - val_accuracy: 0.5238
Epoch 23/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3460 - accuracy:
0.8503 - val_loss: 0.3299 - val_accuracy: 0.9524
Epoch 24/100
19/19 [==============================] - 0s 4ms/step - loss: 0.4047 - accuracy:
0.7968 - val_loss: 0.2016 - val_accuracy: 1.0000
Epoch 25/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3985 - accuracy:
0.8182 - val_loss: 0.4907 - val_accuracy: 0.7619
Epoch 26/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3347 - accuracy:
0.8984 - val_loss: 0.6709 - val_accuracy: 0.5238
Epoch 27/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3363 - accuracy:
0.8877 - val_loss: 0.4522 - val_accuracy: 0.7619
Epoch 28/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3216 - accuracy:
0.8877 - val_loss: 0.5137 - val_accuracy: 0.6667
Epoch 29/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3152 - accuracy:
0.8824 - val_loss: 0.4243 - val_accuracy: 0.7619
Epoch 30/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3085 - accuracy:
0.8824 - val_loss: 0.7425 - val_accuracy: 0.4762
Epoch 31/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3175 - accuracy:
0.8824 - val_loss: 0.5776 - val_accuracy: 0.6190
Epoch 32/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3494 - accuracy:
0.8717 - val_loss: 0.3933 - val_accuracy: 0.8095
Epoch 33/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3289 - accuracy:
0.8503 - val_loss: 0.2984 - val_accuracy: 0.9524
Epoch 34/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3134 - accuracy:
0.8663 - val_loss: 0.1951 - val_accuracy: 0.9524
Epoch 35/100
19/19 [==============================] - 0s 4ms/step - loss: 0.3112 - accuracy:
0.8717 - val_loss: 0.5564 - val_accuracy: 0.6190
Epoch 36/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2852 - accuracy:
0.9037 - val_loss: 0.5415 - val_accuracy: 0.6667
Epoch 37/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2720 - accuracy:
0.9144 - val_loss: 0.3880 - val_accuracy: 0.8095
Epoch 38/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2673 - accuracy:
0.9091 - val_loss: 0.3925 - val_accuracy: 0.7619
Epoch 39/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2636 - accuracy:
0.9251 - val_loss: 0.4222 - val_accuracy: 0.7619
Epoch 40/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2514 - accuracy:
0.9144 - val_loss: 0.2720 - val_accuracy: 0.9524
```

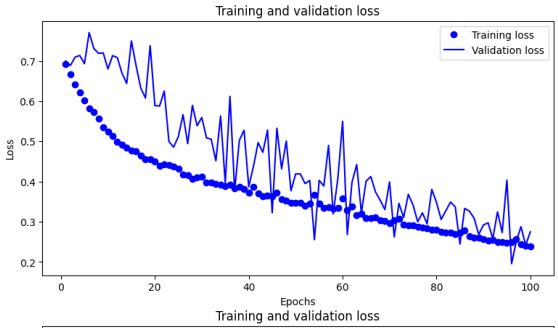
```
Epoch 41/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2670 - accuracy:
0.9144 - val_loss: 0.2463 - val_accuracy: 0.9524
Epoch 42/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2735 - accuracy:
0.8824 - val_loss: 0.5792 - val_accuracy: 0.6190
Epoch 43/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2443 - accuracy:
0.9198 - val_loss: 0.4073 - val_accuracy: 0.7143
Epoch 44/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2383 - accuracy:
0.9305 - val_loss: 0.3268 - val_accuracy: 0.9048
Epoch 45/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2268 - accuracy:
0.9412 - val_loss: 0.2864 - val_accuracy: 0.9048
Epoch 46/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2320 - accuracy:
0.9251 - val_loss: 0.4172 - val_accuracy: 0.7619
Epoch 47/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2425 - accuracy:
0.8930 - val_loss: 0.2254 - val_accuracy: 0.9524
Epoch 48/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2067 - accuracy:
0.9412 - val_loss: 0.4321 - val_accuracy: 0.7143
Epoch 49/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2117 - accuracy:
0.9358 - val_loss: 0.3940 - val_accuracy: 0.7619
Epoch 50/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2384 - accuracy:
0.9091 - val_loss: 0.2879 - val_accuracy: 0.9048
Epoch 51/100
19/19 [==============================] - 0s 4ms/step - loss: 0.2087 - accuracy:
0.9412 - val_loss: 0.2973 - val_accuracy: 0.9048
Epoch 52/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1976 - accuracy:
0.9519 - val_loss: 0.3428 - val_accuracy: 0.8571
Epoch 53/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1982 - accuracy:
0.9412 - val_loss: 0.3324 - val_accuracy: 0.9048
Epoch 54/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1865 - accuracy:
0.9412 - val_loss: 0.2254 - val_accuracy: 0.9524
Epoch 55/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1863 - accuracy:
0.9305 - val_loss: 0.2562 - val_accuracy: 0.9524
Epoch 56/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1822 - accuracy:
0.9465 - val_loss: 0.3623 - val_accuracy: 0.7619
Epoch 57/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1788 - accuracy:
0.9251 - val_loss: 0.1556 - val_accuracy: 1.0000
Epoch 58/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1668 - accuracy:
0.9465 - val_loss: 0.3727 - val_accuracy: 0.7619
Epoch 59/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1654 - accuracy:
0.9465 - val_loss: 0.2196 - val_accuracy: 0.9524
Epoch 60/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1672 - accuracy:
0.9465 - val_loss: 0.0808 - val_accuracy: 1.0000
```

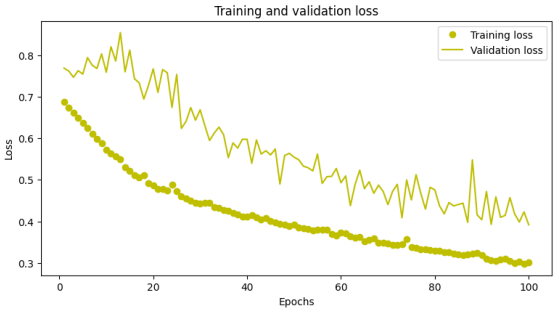
```
Epoch 61/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1743 - accuracy:
0.9358 - val_loss: 0.1604 - val_accuracy: 1.0000
Epoch 62/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1550 - accuracy:
0.9626 - val_loss: 0.5664 - val_accuracy: 0.5714
Epoch 63/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1874 - accuracy:
0.9412 - val_loss: 0.3316 - val_accuracy: 0.8095
Epoch 64/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1488 - accuracy:
0.9465 - val_loss: 0.2262 - val_accuracy: 0.9524
Epoch 65/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1359 - accuracy:
0.9626 - val_loss: 0.0921 - val_accuracy: 1.0000
Epoch 66/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1435 - accuracy:
0.9572 - val_loss: 0.2091 - val_accuracy: 0.9524
Epoch 67/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1372 - accuracy:
0.9679 - val_loss: 0.2189 - val_accuracy: 0.9524
Epoch 68/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1324 - accuracy:
0.9572 - val_loss: 0.1968 - val_accuracy: 0.9524
Epoch 69/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1244 - accuracy:
0.9840 - val_loss: 0.1262 - val_accuracy: 1.0000
Epoch 70/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1344 - accuracy:
0.9626 - val_loss: 0.1132 - val_accuracy: 1.0000
Epoch 71/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1161 - accuracy:
0.9733 - val_loss: 0.1741 - val_accuracy: 1.0000
Epoch 72/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1176 - accuracy:
0.9679 - val_loss: 0.1868 - val_accuracy: 1.0000
Epoch 73/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1073 - accuracy:
0.9786 - val_loss: 0.3189 - val_accuracy: 0.8095
Epoch 74/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1168 - accuracy:
0.9893 - val_loss: 0.3476 - val_accuracy: 0.7619
Epoch 75/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1064 - accuracy:
0.9786 - val_loss: 0.1915 - val_accuracy: 0.9524
Epoch 76/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1062 - accuracy:
0.9733 - val_loss: 0.2474 - val_accuracy: 0.9048
Epoch 77/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1080 - accuracy:
0.9786 - val_loss: 0.2530 - val_accuracy: 0.8571
Epoch 78/100
19/19 [==============================] - 0s 4ms/step - loss: 0.1002 - accuracy:
0.9840 - val_loss: 0.2641 - val_accuracy: 0.8571
Epoch 79/100
19/19 [==============================] - 0s 4ms/step - loss: 0.0897 - accuracy:
0.9840 - val_loss: 0.2413 - val_accuracy: 0.9048
Epoch 80/100
19/19 [==============================] - 0s 4ms/step - loss: 0.0890 - accuracy:
0.9893 - val_loss: 0.1856 - val_accuracy: 0.9524
```

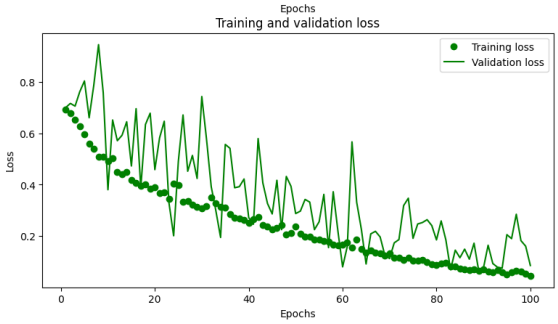
```
Epoch 81/100
19/19 [==============================] - 0s 4ms/step - loss: 0.0928 - accuracy:
0.9893 - val_loss: 0.2593 - val_accuracy: 0.8571
Epoch 82/100
19/19 [==============================] - 0s 4ms/step - loss: 0.0952 - accuracy:
0.9840 - val_loss: 0.1853 - val_accuracy: 1.0000
Epoch 83/100
19/19 [==============================] - 0s 4ms/step - loss: 0.0834 - accuracy:
0.9893 - val_loss: 0.0697 - val_accuracy: 1.0000
Epoch 84/100
19/19 [==============================] - 0s 4ms/step - loss: 0.0825 - accuracy:
0.9893 - val_loss: 0.1457 - val_accuracy: 1.0000
Epoch 85/100
19/19 [==============================] - 0s 4ms/step - loss: 0.0741 - accuracy:
0.9947 - val_loss: 0.1163 - val_accuracy: 1.0000
Epoch 86/100
19/19 [==============================] - 0s 4ms/step - loss: 0.0723 - accuracy:
0.9947 - val_loss: 0.1497 - val_accuracy: 1.0000
Epoch 87/100
19/19 [==============================] - 0s 4ms/step - loss: 0.0692 - accuracy:
0.9947 - val_loss: 0.1107 - val_accuracy: 1.0000
Epoch 88/100
19/19 [==============================] - 0s 4ms/step - loss: 0.0713 - accuracy:
0.9893 - val_loss: 0.1728 - val_accuracy: 1.0000
Epoch 89/100
19/19 [==============================] - 0s 4ms/step - loss: 0.0662 - accuracy:
0.9947 - val_loss: 0.0651 - val_accuracy: 1.0000
Epoch 90/100
19/19 [==============================] - 0s 4ms/step - loss: 0.0712 - accuracy:
0.9947 - val_loss: 0.0759 - val_accuracy: 1.0000
Epoch 91/100
19/19 [==============================] - 0s 4ms/step - loss: 0.0633 - accuracy:
0.9947 - val_loss: 0.1648 - val_accuracy: 1.0000
Epoch 92/100
19/19 [==============================] - 0s 4ms/step - loss: 0.0600 - accuracy:
0.9947 - val_loss: 0.0938 - val_accuracy: 1.0000
Epoch 93/100
19/19 [==============================] - 0s 4ms/step - loss: 0.0697 - accuracy:
0.9893 - val_loss: 0.0793 - val_accuracy: 1.0000
Epoch 94/100
19/19 [==============================] - 0s 4ms/step - loss: 0.0606 - accuracy:
0.9947 - val_loss: 0.0761 - val_accuracy: 1.0000
Epoch 95/100
19/19 [==============================] - 0s 4ms/step - loss: 0.0526 - accuracy:
0.9947 - val_loss: 0.2060 - val_accuracy: 0.9048
Epoch 96/100
19/19 [==============================] - 0s 4ms/step - loss: 0.0585 - accuracy:
0.9893 - val_loss: 0.1904 - val_accuracy: 1.0000
Epoch 97/100
19/19 [==============================] - 0s 4ms/step - loss: 0.0642 - accuracy:
0.9947 - val_loss: 0.2852 - val_accuracy: 0.8095
Epoch 98/100
19/19 [==============================] - 0s 4ms/step - loss: 0.0614 - accuracy:
0.9893 - val_loss: 0.1826 - val_accuracy: 1.0000
Epoch 99/100
19/19 [==============================] - 0s 4ms/step - loss: 0.0552 - accuracy:
0.9947 - val_loss: 0.1612 - val_accuracy: 1.0000
Epoch 100/100
19/19 [==============================] - 0s 4ms/step - loss: 0.0463 - accuracy:
0.9947 - val_loss: 0.0861 - val_accuracy: 1.0000
```

In [41]:
```
loss = H.history['loss']
val_loss = H.history['val_loss']
acc = H.history['accuracy']
val_acc = H.history['val_accuracy']
epochs = range(1, len(loss) + 1)

loss2 = H2.history['loss']
val_loss2 = H2.history['val_loss']
acc2 = H2.history['accuracy']
val_acc2 = H2.history['val_accuracy']
epochs2 = range(1, len(loss2) + 1)

loss3 = H3.history['loss']
val_loss3 = H3.history['val_loss']
acc3 = H3.history['accuracy']
val_acc3 = H3.history['val_accuracy']
epochs3 = range(1, len(loss3) + 1)
```

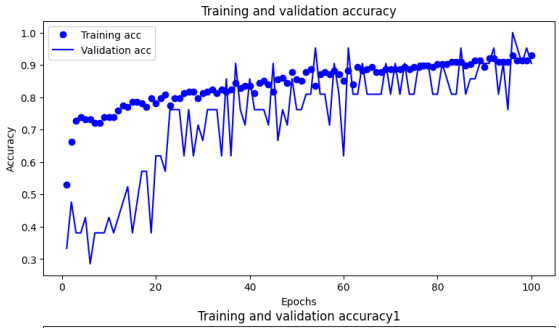
In [42]:
```
plt.figure(figsize=(20, 10))
plt.subplot(2, 2, 1)
plt.plot(epochs, loss, 'bo', label='Training loss')
plt.plot(epochs, val_loss, 'b', label='Validation loss')
plt.title('Training and validation loss')
plt.xlabel('Epochs')
plt.ylabel('Loss')
plt.legend()

plt.subplot(2, 2, 2)
plt.plot(epochs2, loss2, 'yo', label='Training loss')
plt.plot(epochs2, val_loss2, 'y', label='Validation loss')
plt.title('Training and validation loss')
plt.xlabel('Epochs')
plt.ylabel('Loss')
plt.legend()

plt.subplot(2, 2, 3)
plt.plot(epochs3, loss3, 'go', label='Training loss')
plt.plot(epochs3, val_loss3, 'g', label='Validation loss')
plt.title('Training and validation loss')
plt.xlabel('Epochs')
plt.ylabel('Loss')
plt.legend()

plt.show()
```

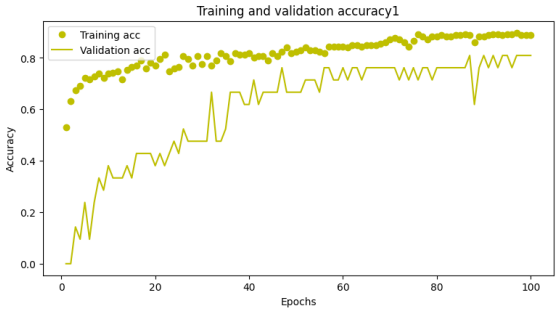


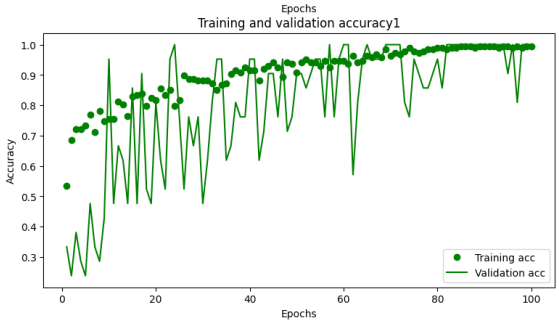




In [43]:
```
#Построение графика точности
plt.figure(figsize=(20, 10))
plt.subplot(2, 2, 1)
plt.plot(epochs, acc, 'bo', label='Training acc')
plt.plot(epochs, val_acc, 'b', label='Validation acc')
plt.title('Training and validation accuracy')
plt.xlabel('Epochs')
plt.ylabel('Accuracy')
plt.legend()

plt.subplot(2, 2, 2)
plt.plot(epochs2, acc2, 'yo', label='Training acc')
plt.plot(epochs2, val_acc2, 'y', label='Validation acc')
plt.title('Training and validation accuracy1')
plt.xlabel('Epochs')
plt.ylabel('Accuracy')
plt.legend()

plt.subplot(2, 2, 3)
plt.plot(epochs3, acc3, 'go', label='Training acc')
plt.plot(epochs3, val_acc3, 'g', label='Validation acc')
plt.title('Training and validation accuracy1')
plt.xlabel('Epochs')
plt.ylabel('Accuracy')
plt.legend()

plt.show()
```







Вывод: мы изучили влияние количества нейронов на слое и количества слоев на результат обучения модели, а так же построили графики ошибок и точности в ходе обучения и сравнили полученные сети. Количество слоев и нейронов в нейронной сети имеет двустороннее влияние на ее эффективность. Более глубокая и широкая сеть может позволить решать более сложные задачи, но требует более тщательной тренировки и может быть более подвержена переобучению. Поэтому выбор количества слоев и неронов в нейронной сети должен быть основан на анализе конкретной задачи и доступных ресурсов. доступных ресурсов.