Лабораторная работа №5

Применение сверточных нейронных сетей (бинарная классификация)

Набор данных *DogsVsCats*, который состоит из изображений различной размерности, содержащих фотографии собак и кошек.

Обучающая выборка включает в себя 25 тыс. изображений (12,5 тыс. кошек: *cat.0.jpg*, ..., *cat.12499.jpg* и 12,5 тыс. собак: *dog.0.jpg*, …, *dog.12499.jpg*), а контрольная выборка содержит 12,5 тыс. неразмеченных изображений.

Скачать данные, а также проверить качество классификатора на тестовой выборке можно на сайте *Kaggle*: https://www.kaggle.com/c/dogs-vs-cats/data (https://www.kaggle.com/c/dogs-vs-cats/data)

Задание 1

Загрузите данные. Разделите исходный набор данных на обучающую, валидационную и контрольную выборки.

In [0]:

```
import warnings

warnings.filterwarnings('ignore')
```

In [2]:

```
from google.colab import drive

drive.mount('/content/drive', force_remount = True)
```

```
Mounted at /content/drive
```

In [0]:

```
BASE_DIR = '/content/drive/My Drive/Colab Files/mo-2/dogs-vs-cats'

import sys

sys.path.append(BASE_DIR)

import os
```

In [0]:

```
TRAIN_ARCHIVE_NAME = 'train.zip'
TEST_ARCHIVE_NAME = 'test1.zip'

LOCAL_DIR_NAME = 'dogs-vs-cats'
```

In [0]:

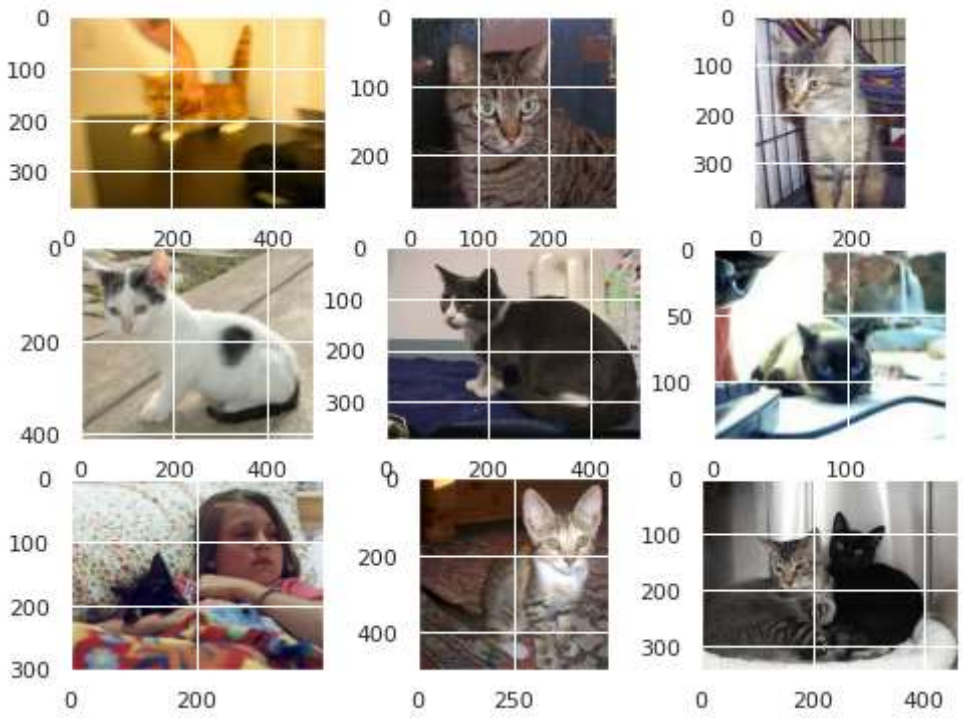
```
from zipfile import ZipFile

with ZipFile(os.path.join(BASE_DIR, TRAIN_ARCHIVE_NAME), 'r') as zip_:
    zip_.extractall(path = os.path.join(LOCAL_DIR_NAME, 'train'))

with ZipFile(os.path.join(BASE_DIR, TEST_ARCHIVE_NAME), 'r') as zip_:
    zip_.extractall(path = os.path.join(LOCAL_DIR_NAME, 'test-1'))
```

In [0]:

```
%matplotlib inline

import matplotlib.pyplot as plt
import seaborn as sns
from matplotlib import rcParams

rcParams['figure.figsize'] = 8, 6

sns.set()
sns.set_palette(sns.color_palette('hls'))

def plot_accuracy(_history,
                  _train_acc_name = 'accuracy',
                  _val_acc_name = 'val_accuracy'):

    plt.plot(_history.history[_train_acc_name])
    plt.plot(_history.history[_val_acc_name])

    plt.title('Model accuracy')

    plt.ylabel('Accuracy')
    plt.xlabel('Epoch')

    plt.legend(['Train', 'Validation'], loc = 'right')

    plt.show()

def plot_loss(_history):

    plt.plot(_history.history['loss'])
    plt.plot(_history.history['val_loss'])

    plt.title('Model loss')

    plt.ylabel('Loss')
    plt.xlabel('Epoch')

    plt.legend(['Train', 'Validation'], loc = 'right')

    plt.show()
```

In [7]:

```
from matplotlib.image import imread

dir_ = 'dogs-vs-cats/train/train'

for i in range(9):

    plt.subplot(330 + 1 + i)

    image_ = imread('{}/cat.{}.jpg'.format(dir_, i))

    plt.imshow(image_)

plt.show()
```



Изображения необходимо привести к одному размеру.

In [0]:

```
NEW_IMAGE_WIDTH = 100
```

In [9]:

```
from os import listdir
from os.path import join
from numpy import asarray
from numpy import save
from keras.preprocessing.image import load_img
from keras.preprocessing.image import img_to_array

def dir_to_dataset(_dir_path):

    photos_, labels_ = [], []

    for file_ in listdir(_dir_path):

        if file_.startswith('cat'):
            label_ = 1.0
        else:
            label_ = 0.0

        photo_ = load_img(join(_dir_path, file_),
                          target_size = (NEW_IMAGE_WIDTH, NEW_IMAGE_WIDTH))

        photo_ = img_to_array(photo_)

        photos_.append(photo_)
        labels_.append(label_)

    photos_norm_ = tf.keras.utils.normalize(photos_, axis = 1)

    return asarray(photos_norm_), asarray(labels_)
```

```
Using TensorFlow backend.
```

In [0]:

```
! pip install tensorflow-gpu --pre --quiet
```

In [0]:

```
import tensorflow as tf
```

In [0]:

```
import numpy as np
```

In [0]:

```
X_all, y_all = dir_to_dataset('dogs-vs-cats/train/train')
```

In [0]:

```
TEST_LEN_HALF = 1000
```

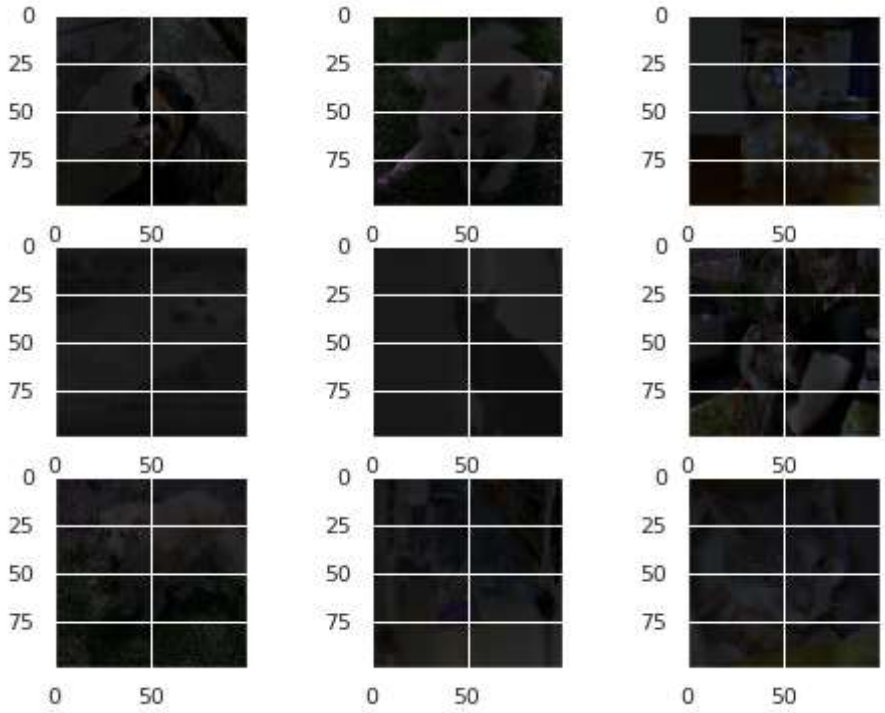
In [15]:

```
test_interval = np.r_[0:TEST_LEN_HALF, -TEST_LEN_HALF:-0]

X, y = X_all[TEST_LEN_HALF:-TEST_LEN_HALF], y_all[TEST_LEN_HALF:-TEST_LEN_HALF]
X_test, y_test = X_all[test_interval], y_all[test_interval]

print(X.shape, y.shape)
print(X_test.shape, y_test.shape)
```

```
(23000, 100, 100, 3) (23000,)
(2000, 100, 100, 3) (2000,)
```

In [16]:

```
for i in range(9):

    plt.subplot(330 + 1 + i)

    plt.imshow(X[i])

plt.show()
```



Выделение валидационной выборки произойдёт автоматически по параметру `validation_split` метода `model.fit()` .

Задание 2

Реализуйте глубокую нейронную сеть с как минимум тремя сверточными слоями. Какое качество классификации получено?

In [0]:

```
from tensorflow import keras
```

In [18]:

```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten, Dense

model = tf.keras.Sequential()

model.add(Conv2D(16, 3, padding = 'same', activation = 'relu',
                 input_shape = (NEW_IMAGE_WIDTH, NEW_IMAGE_WIDTH, 3)))
model.add(MaxPooling2D())
model.add(Conv2D(32, 3, padding = 'same', activation = 'relu'))
model.add(MaxPooling2D())
model.add(Conv2D(64, 3, padding = 'same', activation = 'relu'))
model.add(MaxPooling2D())
model.add(Flatten())
model.add(Dense(512, activation = 'relu'))
model.add(Dense(1, activation = 'sigmoid'))

model.compile(optimizer = 'sgd',
              loss = 'binary_crossentropy',
              metrics = ['accuracy'])

model.summary()
```

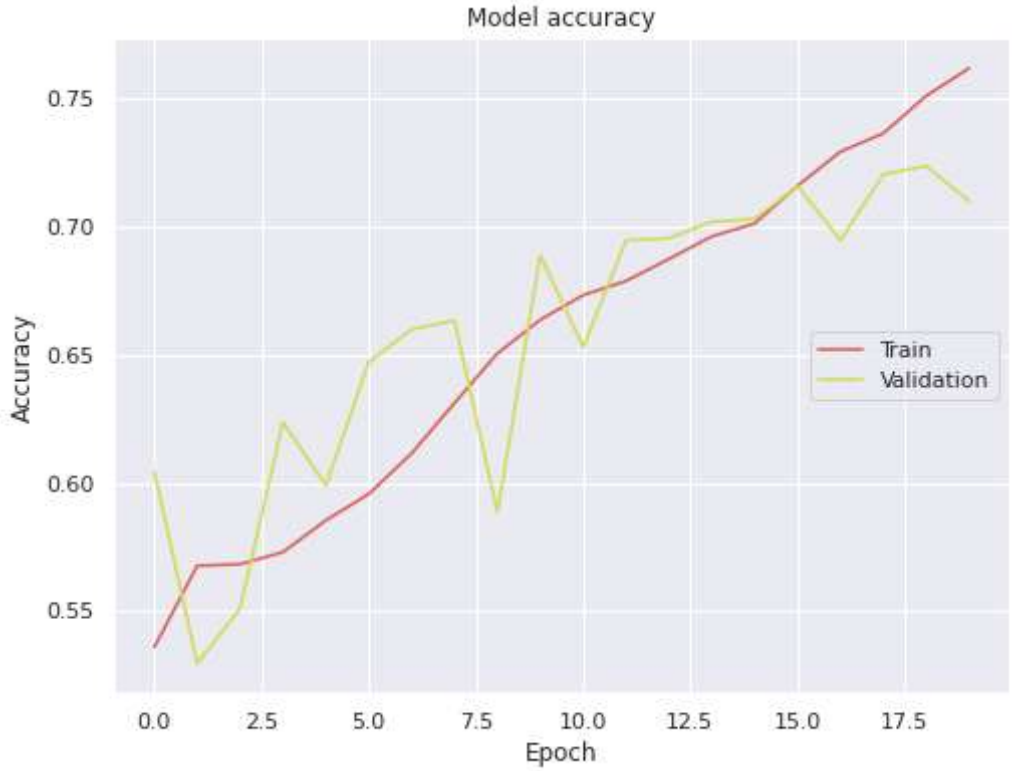
```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d (Conv2D)              (None, 100, 100, 16)      448
_________________________________________________________________
max_pooling2d (MaxPooling2D) (None, 50, 50, 16)        0
_________________________________________________________________
conv2d_1 (Conv2D)            (None, 50, 50, 32)        4640
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 25, 25, 32)        0
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 25, 25, 64)        18496
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 12, 12, 64)        0
_________________________________________________________________
flatten (Flatten)            (None, 9216)              0
_________________________________________________________________
dense (Dense)                (None, 512)               4719104
_________________________________________________________________
dense_1 (Dense)              (None, 1)                 513
=================================================================
Total params: 4,743,201
Trainable params: 4,743,201
Non-trainable params: 0
_________________________________________________________________
```

In [0]:

```
history = model.fit(x = X, y = y, epochs = 20,
                    validation_split = 0.15, verbose = 0)
```

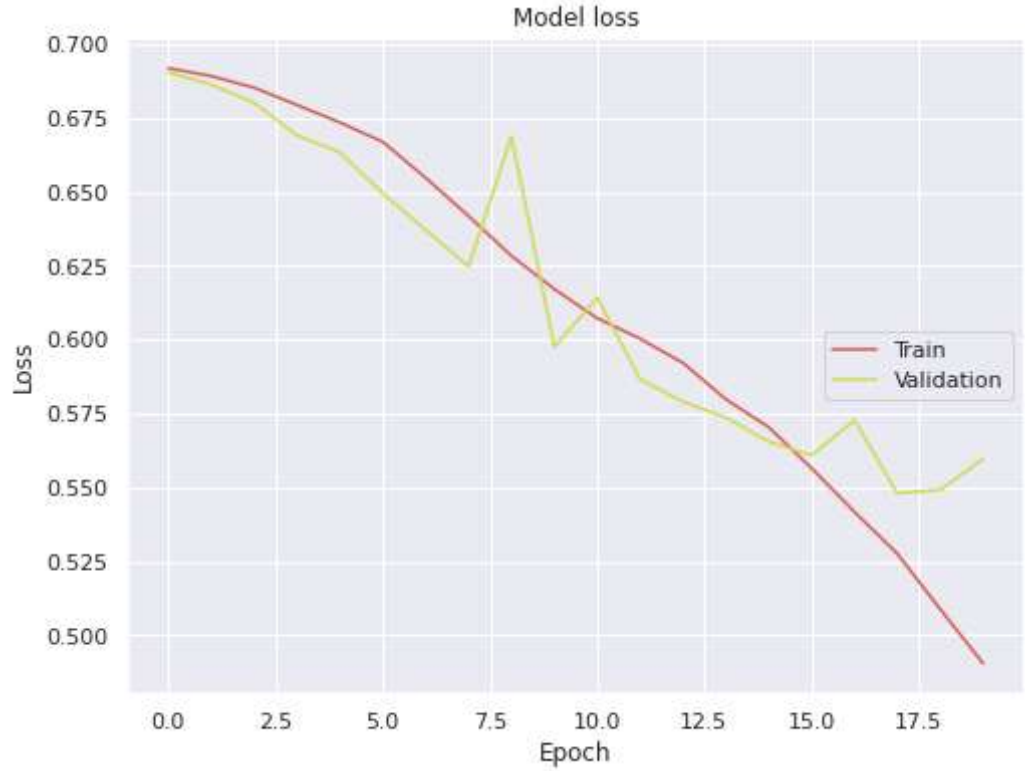
In [20]:

```
plot_accuracy(history)
```



In [21]:

```
plot_loss(history)
```



In [22]:

```
results = model.evaluate(X_test, y_test)

print('Test loss, test accuracy:', results)
```

```
63/63 [==============================] - 0s 4ms/step - loss: 0.5706 - accura
cy: 0.6935
Test loss, test accuracy: [0.5705881118774414, 0.6934999823570251]
```

Результат — 69% на тестовой выборке.

Задание 3

Примените дополнение данных (*data augmentation*). Как это повлияло на качество классификатора?

In [0]:

```
def augment_image(image):

  image = tf.image.convert_image_dtype(image, tf.float32)
  image = tf.image.resize_with_crop_or_pad(image,
                                           NEW_IMAGE_WIDTH + 40,
                                           NEW_IMAGE_WIDTH + 40)
  image = tf.image.random_crop(image,
                               size = [NEW_IMAGE_WIDTH, NEW_IMAGE_WIDTH, 3])

  return image.numpy()
```

In [24]:

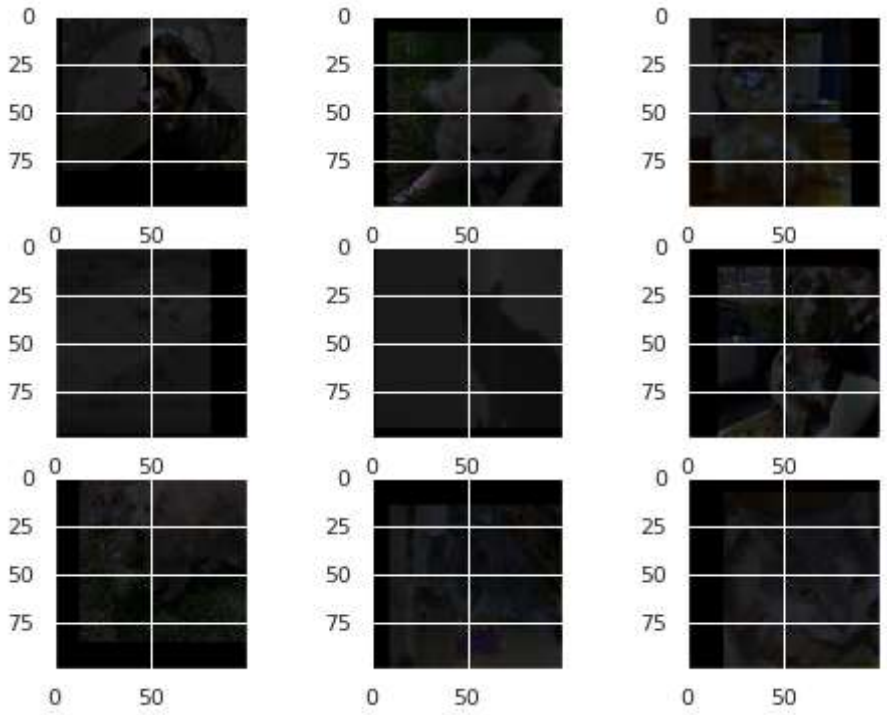
```
X_augmented = np.zeros_like(X)

for i, img in enumerate(X):

    X_augmented[i] = augment_image(img)

X_augmented.shape
```

Out[24]:

```
(23000, 100, 100, 3)
```

In [25]:

```
for i in range(9):

    plt.subplot(330 + 1 + i)

    plt.imshow(X_augmented[i])

plt.show()
```



In [0]:

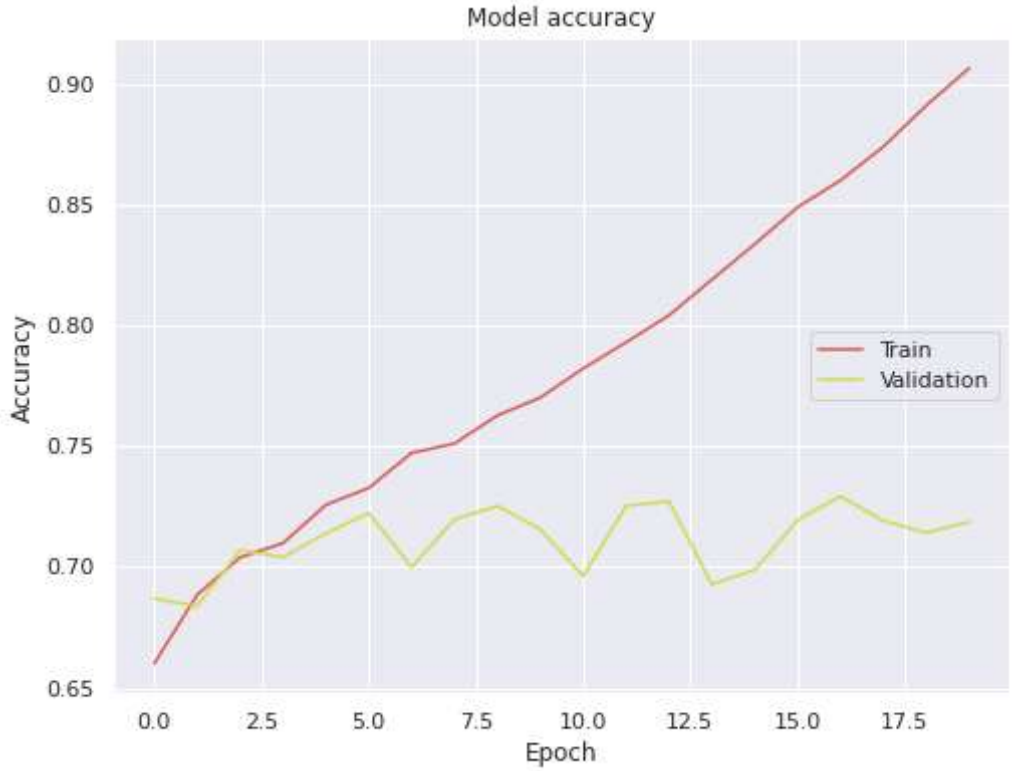
```
y_augmented = y
```

In [0]:

```
history_2 = model.fit(x = X_augmented, y = y_augmented, epochs = 20,
                      validation_split = 0.15, verbose = 0)
```

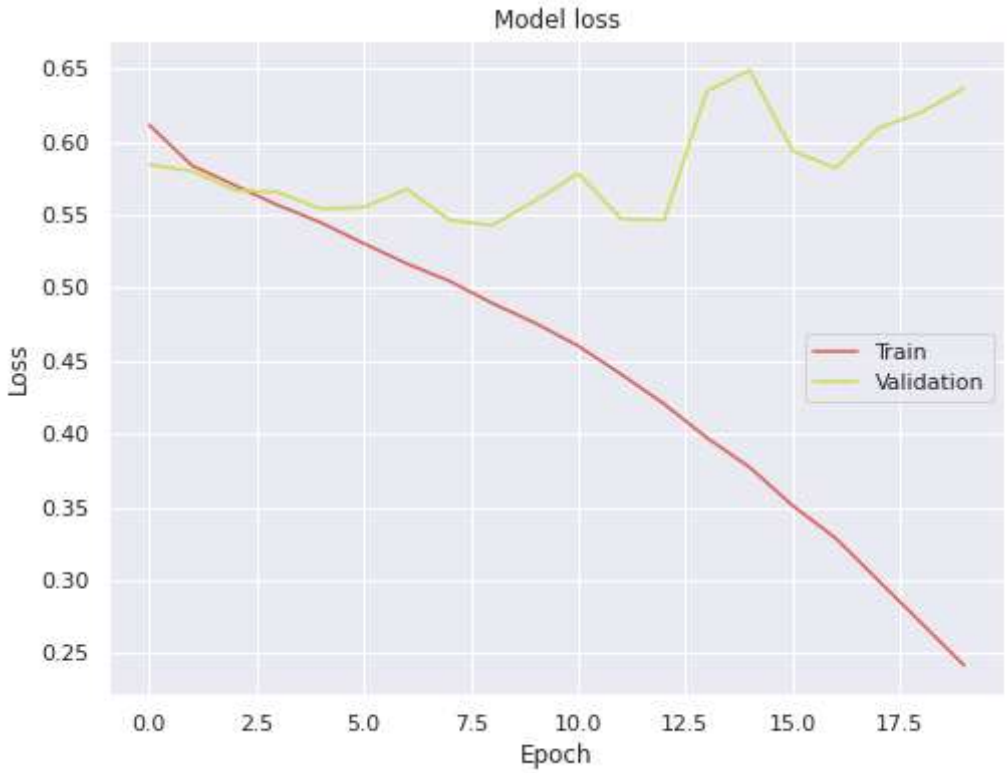
In [28]:

```
plot_accuracy(history_2)
```



In [29]:

```
plot_loss(history_2)
```



In [30]:

```
results_2 = model.evaluate(X_test, y_test)

print('Test loss, test accuracy:', results_2)
```

```
63/63 [==============================] - 0s 4ms/step - loss: 0.6174 - accura
cy: 0.7590
Test loss, test accuracy: [0.6173917651176453, 0.7590000033378601]
```

После того, как сеть обучилась на тех же данных, к которым был применён data augmentation, точность предсказания увеличилась — до 75%.

Задание 4

Поэкспериментируйте с готовыми нейронными сетями (например, *AlexNet*, *VGG16*, *Inception* и т.п.), применив передаточное обучение. Как это повлияло на качество классификатора?

Какой максимальный результат удалось получить на сайте *Kaggle*? Почему?