with_back

November 13, 2019

[1]:

```python
from numpy.random import seed
seed(1)
from tensorflow import set_random_seed
set_random_seed(2)

import numpy as np
import pandas as pd
import warnings

with warnings.catch_warnings():
    warnings.filterwarnings("ignore",category=FutureWarning)
    import tensorflow as tf
    from tensorflow import keras
    from tensorflow.keras.preprocessing.text import Tokenizer
    print('Supressed Warnings..')

from keras.preprocessing.image import ImageDataGenerator, load_img
from keras.utils import to_categorical
from sklearn.model_selection import train_test_split
import matplotlib.pyplot as plt
import random
import os

FAST_RUN = True
IMAGE_WIDTH=50
IMAGE_HEIGHT=50
IMAGE_SIZE=(IMAGE_WIDTH, IMAGE_HEIGHT)
IMAGE_CHANNELS=3
```

```
/home/karan/.local/lib/python3.6/site-
packages/tensorflow/python/framework/dtypes.py:516: FutureWarning: Passing
(type, 1) or '1type' as a synonym of type is deprecated; in a future version of
numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_qint8 = np.dtype([("qint8", np.int8, 1)])
/home/karan/.local/lib/python3.6/site-
packages/tensorflow/python/framework/dtypes.py:517: FutureWarning: Passing
(type, 1) or '1type' as a synonym of type is deprecated; in a future version of
numpy, it will be understood as (type, (1,)) / '(1,)type'.
```

```
  _np_quint8 = np.dtype([("quint8", np.uint8, 1)])
/home/karan/.local/lib/python3.6/site-
packages/tensorflow/python/framework/dtypes.py:518: FutureWarning: Passing
(type, 1) or '1type' as a synonym of type is deprecated; in a future version of
numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_qint16 = np.dtype([("qint16", np.int16, 1)])
/home/karan/.local/lib/python3.6/site-
packages/tensorflow/python/framework/dtypes.py:519: FutureWarning: Passing
(type, 1) or '1type' as a synonym of type is deprecated; in a future version of
numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_quint16 = np.dtype([("quint16", np.uint16, 1)])
/home/karan/.local/lib/python3.6/site-
packages/tensorflow/python/framework/dtypes.py:520: FutureWarning: Passing
(type, 1) or '1type' as a synonym of type is deprecated; in a future version of
numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_qint32 = np.dtype([("qint32", np.int32, 1)])
/home/karan/.local/lib/python3.6/site-
packages/tensorflow/python/framework/dtypes.py:525: FutureWarning: Passing
(type, 1) or '1type' as a synonym of type is deprecated; in a future version of
numpy, it will be understood as (type, (1,)) / '(1,)type'.
  np_resource = np.dtype([("resource", np.ubyte, 1)])
/home/karan/.local/lib/python3.6/site-
packages/tensorboard/compat/tensorflow_stub/dtypes.py:541: FutureWarning:
Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future
version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_qint8 = np.dtype([("qint8", np.int8, 1)])
/home/karan/.local/lib/python3.6/site-
packages/tensorboard/compat/tensorflow_stub/dtypes.py:542: FutureWarning:
Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future
version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_quint8 = np.dtype([("quint8", np.uint8, 1)])
/home/karan/.local/lib/python3.6/site-
packages/tensorboard/compat/tensorflow_stub/dtypes.py:543: FutureWarning:
Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future
version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_qint16 = np.dtype([("qint16", np.int16, 1)])
/home/karan/.local/lib/python3.6/site-
packages/tensorboard/compat/tensorflow_stub/dtypes.py:544: FutureWarning:
Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future
version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_quint16 = np.dtype([("quint16", np.uint16, 1)])
/home/karan/.local/lib/python3.6/site-
packages/tensorboard/compat/tensorflow_stub/dtypes.py:545: FutureWarning:
Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future
version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_qint32 = np.dtype([("qint32", np.int32, 1)])
/home/karan/.local/lib/python3.6/site-
packages/tensorboard/compat/tensorflow_stub/dtypes.py:550: FutureWarning:
```

```
Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future
version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
  np_resource = np.dtype([("resource", np.ubyte, 1)])
Using TensorFlow backend.
```

```
Supressed Warnings..
```

[2]:

```
filenames = os.listdir("./background/train")
categories = []
for filename in filenames:
    category = filename.split('.')[0]
    if category == 'next':
        categories.append(1)
    elif category == 'prev':
        categories.append(2)
    elif category == 'pause':
        categories.append(3)
    elif category == 'others':
        categories.append(4)
#     print(filename)
```

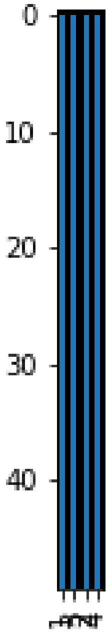
[3]:

```
df = pd.DataFrame({
    'filename': filenames,
    'category': categories
})
print(df.head(20))
df.tail()
df['category'].value_counts().plot.bar()
sample = random.choice(filenames)
image = load_img("./background/train/"+sample)
plt.imshow(image)
```

```
          filename  category
0    next.1299.png         1
1    next.1145.png         1
2   others.584.png         4
3    pause.544.png         3
4     next.966.png         1
5     prev.401.png         2
6     prev.485.png         2
7   pause.1138.png         3
8   others.591.png         4
9    pause.299.png         3
10  others.437.png         4
11  pause.1328.png         3
12    prev.172.png         2
13     prev.28.png         2
14  others.367.png         4
```

```
15    next.242.png        1
16    next.388.png        1
17    next.218.png        1
18    next.432.png        1
19    prev.613.png        2
```

```
[3]: <matplotlib.image.AxesImage at 0x7f361febdd68>
```



```
[4]: from keras.models import Sequential
     from keras.layers import Conv2D, MaxPooling2D, Dropout, Flatten, Dense,␣
      ↪Activation, BatchNormalization
```

```
[5]: from keras import optimizers
     model = Sequential()
     # ----------------PHASE 0
     # model.add(Conv2D(32, (3, 3), activation='relu', input_shape=(IMAGE_WIDTH,␣
      ↪IMAGE_HEIGHT, IMAGE_CHANNELS)))
     # model.add(BatchNormalization())
     # model.add(MaxPooling2D(pool_size=(2, 2)))
     # model.add(Dropout(0.25))

     # model.add(Conv2D(64, (3, 3), activation='relu'))
     # model.add(BatchNormalization())
     # model.add(MaxPooling2D(pool_size=(2, 2)))
     # model.add(Dropout(0.25))
     # model.add(Conv2D(128, (3, 3), activation='relu'))
     # model.add(BatchNormalization())
     # model.add(MaxPooling2D(pool_size=(2, 2)))
     # model.add(Dropout(0.25))

     # model.add(Flatten())
     # model.add(Dense(512, activation='relu'))
     # model.add(BatchNormalization())
     # model.add(Dropout(0.5))
     # model.add(Dense(2, activation='softmax')) # 2 because we have cat and dog␣
      ↪classes

     #-----PHASE 1
     model.add(Conv2D(32, (2, 2), input_shape=(IMAGE_WIDTH, IMAGE_HEIGHT,␣
      ↪IMAGE_CHANNELS)))
     model.add(Activation('relu'))
     model.add(MaxPooling2D(pool_size=(2, 2)))

     model.add(Conv2D(32, (2, 2)))
     model.add(Activation('relu'))
     model.add(MaxPooling2D(pool_size=(2, 2)))

     model.add(Conv2D(64, (2, 2)))
     model.add(Activation('relu'))
     model.add(MaxPooling2D(pool_size=(2, 2)))

     model.add(Flatten())
     model.add(Dense(64))
     model.add(Activation('relu'))
     model.add(Dropout(0.5))
     model.add(Dense(4))
     model.add(Activation('softmax'))

     #-------PHASE 2
     # model.add(Conv2D(6, (3, 3), input_shape=(IMAGE_WIDTH, IMAGE_HEIGHT,␣
      ↪IMAGE_CHANNELS)))
     # model.add(Activation('relu'))
     # model.add(MaxPooling2D(pool_size=(2, 2)))

     # model.add(Conv2D(32, (2, 2)))
     # model.add(Activation('relu'))
     # model.add(MaxPooling2D(pool_size=(2, 2)))

     # model.add(Conv2D(64, (2, 2)))
     # model.add(Activation('relu'))
     # model.add(MaxPooling2D(pool_size=(2, 2)))
```

```python
# model.add(Flatten())
# model.add(Dense(64))
# model.add(Activation('relu'))
# model.add(Dropout(0.5))
# model.add(Dense(4))
# model.add(Activation('sigmoid'))

sgd = optimizers.SGD(lr=0.01, decay=1e-6, momentum=0.9, nesterov=True)
model.compile(loss='categorical_crossentropy', optimizer=sgd, metrics=['accuracy'])

# model.compile(loss='categorical_crossentropy', optimizer='rmsprop', metrics=['accuracy'])
# model.compile(loss='binary_crossentropy', optimizer='rmsprop', metrics=['accuracy'])


model.summary()
```

```
WARNING:tensorflow:From /home/karan/.local/lib/python3.6/site-
packages/keras/backend/tensorflow_backend.py:4070: The name tf.nn.max_pool is
deprecated. Please use tf.nn.max_pool2d instead.

Model: "sequential_1"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_1 (Conv2D)            (None, 49, 49, 32)        416
_________________________________________________________________
activation_1 (Activation)    (None, 49, 49, 32)        0
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 24, 24, 32)        0
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 23, 23, 32)        4128
_________________________________________________________________
activation_2 (Activation)    (None, 23, 23, 32)        0
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 11, 11, 32)        0
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 10, 10, 64)        8256
_________________________________________________________________
activation_3 (Activation)    (None, 10, 10, 64)        0
_________________________________________________________________
max_pooling2d_3 (MaxPooling2 (None, 5, 5, 64)          0
_________________________________________________________________
flatten_1 (Flatten)          (None, 1600)              0
_________________________________________________________________
```

```
dense_1 (Dense)              (None, 64)                102464
-----------------------------------------------------------------
activation_4 (Activation)    (None, 64)                0
-----------------------------------------------------------------
dropout_1 (Dropout)          (None, 64)                0
-----------------------------------------------------------------
dense_2 (Dense)              (None, 4)                 260
-----------------------------------------------------------------
activation_5 (Activation)    (None, 4)                 0
=================================================================
Total params: 115,524
Trainable params: 115,524
Non-trainable params: 0
-----------------------------------------------------------------
```

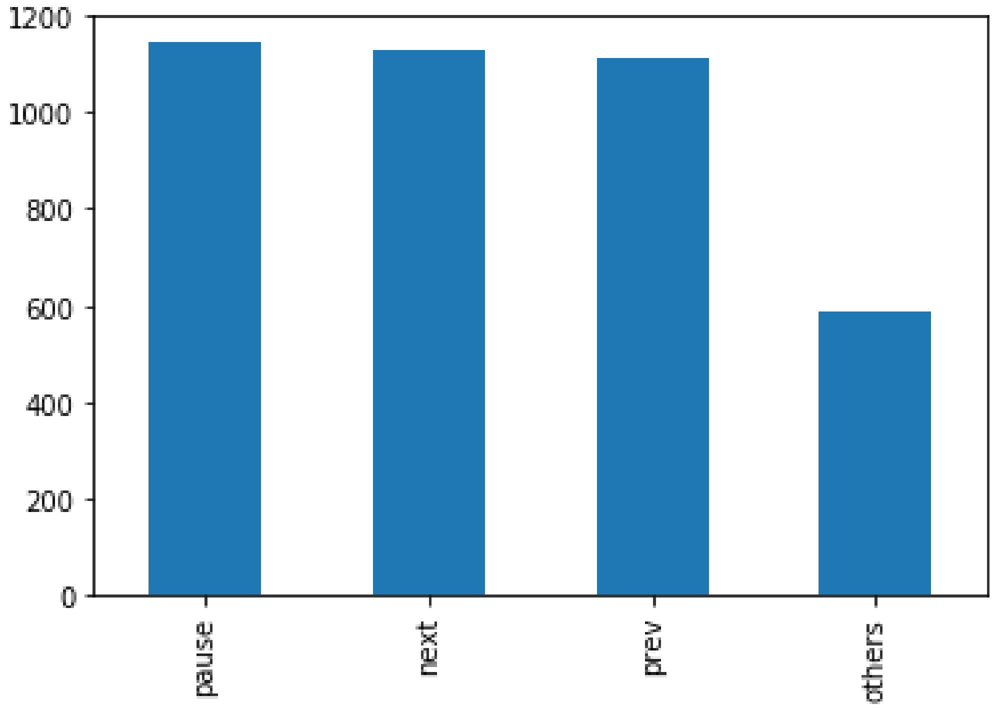
[6]:

```
from keras.callbacks import EarlyStopping, ReduceLROnPlateau
earlystop = EarlyStopping(patience=5)
learning_rate_reduction = ReduceLROnPlateau(monitor='val_acc',
                                            patience=2,
                                            verbose=1,
                                            factor=0.5,
                                            min_lr=0.00001)

callbacks = [earlystop, learning_rate_reduction]
df["category"] = df["category"].replace({3: 'pause', 1: 'next', 2: 'prev', 4:␣
 ↪'others'})


# 2 - cross validation
train_df, validate_df = train_test_split(df, test_size=0.20, random_state=42)
train_df = train_df.reset_index(drop=True)
validate_df = validate_df.reset_index(drop=True)

train_df['category'].value_counts().plot.bar()
validate_df['category'].value_counts().plot.bar()
total_train = train_df.shape[0]
total_validate = validate_df.shape[0]
batch_size=16
```



[7]:

```
import cv2
def prepro(img):
    gray_image = cv2.cvtColor(np.float32(img), cv2.COLOR_BGR2GRAY)
    print(gray_image.shape)
    return gray_image

train_datagen = ImageDataGenerator(
    rotation_range=15,
    rescale=1./255,
    shear_range=0.1,
    zoom_range=0.2,
    horizontal_flip=False,
#     vertical_flip=True,
#     preprocessing_function=prepro,
    width_shift_range=0.1,
    height_shift_range=0.1
)

train_generator = train_datagen.flow_from_dataframe(
    train_df,
    "./background/train/",
    x_col='filename',
    y_col='category',
    target_size=IMAGE_SIZE,
    class_mode='categorical',
    batch_size=batch_size
)

validation_datagen = ImageDataGenerator(rescale=1./255)
validation_generator = validation_datagen.flow_from_dataframe(
    validate_df,
    "./background/train/",
    x_col='filename',
    y_col='category',
    target_size=IMAGE_SIZE,
    class_mode='categorical',
    batch_size=batch_size
)

# plt.figure(figsize=(12, 12))
# for i in range(0, 15):
#     plt.subplot(5, 3, i+1)
#     for X_batch, Y_batch in example_generator:
#         image = X_batch[0]
#         plt.imshow(image)
#         break
# plt.tight_layout()
# plt.show()
```

```
Found 3976 validated image filenames belonging to 4 classes.
Found 995 validated image filenames belonging to 4 classes.
```

[8]:
```
print(train_df)
```

```
            filename category
0      pause.176.png    pause
1      pause.179.png    pause
2     others.147.png   others
3       prev.780.png     prev
4      pause.902.png    pause
…                …        …
3971      next.8.png     next
3972  others.573.png   others
3973  others.601.png   others
3974  pause.1225.png    pause
3975    prev.666.png     prev

[3976 rows x 2 columns]
```

[9]:
```
print(validate_df)
```

```
           filename category
```

```
0      prev.210.png     prev
1    pause.1191.png    pause
2     prev.1159.png     prev
3    pause.1227.png    pause
4     next.1152.png     next
..              …       …
990    next.683.png     next
991     prev.71.png     prev
992    prev.303.png     prev
993  others.415.png   others
994  others.230.png   others

[995 rows x 2 columns]
```

[10]:

```
epochs=35 if FAST_RUN else 10
history = model.fit_generator(
    train_generator,
    epochs=epochs,
    validation_data=validation_generator,
    validation_steps=total_validate//batch_size,
    steps_per_epoch=total_train//batch_size,
    callbacks=callbacks
)
```

```
WARNING:tensorflow:From /home/karan/.local/lib/python3.6/site-
packages/keras/backend/tensorflow_backend.py:422: The name tf.global_variables
is deprecated. Please use tf.compat.v1.global_variables instead.

Epoch 1/35
248/248 [==============================] - 9s 37ms/step - loss: 1.0599 -
accuracy: 0.5000 - val_loss: 0.8102 - val_accuracy: 0.6512
Epoch 2/35
  5/248 […] - ETA: 8s - loss: 0.8916 - accuracy:
0.5750
```

```
/home/karan/.local/lib/python3.6/site-
packages/keras/callbacks/callbacks.py:1042: RuntimeWarning: Reduce LR on plateau
conditioned on metric `val_acc` which is not available. Available metrics are:
val_loss,val_accuracy,loss,accuracy,lr
  (self.monitor, ','.join(list(logs.keys()))), RuntimeWarning
```

```
248/248 [==============================] - 9s 38ms/step - loss: 0.8380 -
accuracy: 0.6131 - val_loss: 0.4329 - val_accuracy: 0.7436
Epoch 3/35
248/248 [==============================] - 9s 37ms/step - loss: 0.7367 -
accuracy: 0.6722 - val_loss: 0.4463 - val_accuracy: 0.7640
Epoch 4/35
248/248 [==============================] - 9s 37ms/step - loss: 0.6618 -
accuracy: 0.7073 - val_loss: 0.9204 - val_accuracy: 0.8182
```

```
Epoch 5/35
248/248 [==============================] - 9s 37ms/step - loss: 0.6277 -
accuracy: 0.7227 - val_loss: 0.3504 - val_accuracy: 0.8570
Epoch 6/35
248/248 [==============================] - 9s 37ms/step - loss: 0.5858 -
accuracy: 0.7545 - val_loss: 0.6463 - val_accuracy: 0.8631
Epoch 7/35
248/248 [==============================] - 9s 38ms/step - loss: 0.5424 -
accuracy: 0.7702 - val_loss: 0.3499 - val_accuracy: 0.9070
Epoch 8/35
248/248 [==============================] - 10s 39ms/step - loss: 0.5101 -
accuracy: 0.7924 - val_loss: 0.2410 - val_accuracy: 0.8764
Epoch 9/35
248/248 [==============================] - 10s 41ms/step - loss: 0.4813 -
accuracy: 0.8028 - val_loss: 0.3277 - val_accuracy: 0.8897
Epoch 10/35
248/248 [==============================] - 9s 38ms/step - loss: 0.4575 -
accuracy: 0.8217 - val_loss: 0.2453 - val_accuracy: 0.9275
Epoch 11/35
248/248 [==============================] - 9s 38ms/step - loss: 0.4081 -
accuracy: 0.8379 - val_loss: 0.0647 - val_accuracy: 0.9183
Epoch 12/35
248/248 [==============================] - 9s 37ms/step - loss: 0.4055 -
accuracy: 0.8444 - val_loss: 0.0350 - val_accuracy: 0.9081
Epoch 13/35
248/248 [==============================] - 9s 37ms/step - loss: 0.3714 -
accuracy: 0.8561 - val_loss: 0.8205 - val_accuracy: 0.9346
Epoch 14/35
248/248 [==============================] - 9s 37ms/step - loss: 0.3639 -
accuracy: 0.8629 - val_loss: 0.2453 - val_accuracy: 0.9499
Epoch 15/35
248/248 [==============================] - 9s 37ms/step - loss: 0.3543 -
accuracy: 0.8631 - val_loss: 0.1654 - val_accuracy: 0.9642
Epoch 16/35
248/248 [==============================] - 9s 38ms/step - loss: 0.3370 -
accuracy: 0.8760 - val_loss: 0.2216 - val_accuracy: 0.9367
Epoch 17/35
248/248 [==============================] - 9s 38ms/step - loss: 0.3320 -
accuracy: 0.8730 - val_loss: 0.1409 - val_accuracy: 0.9459
```

[11]:

```
model.save_weights("model_background.h5")
```

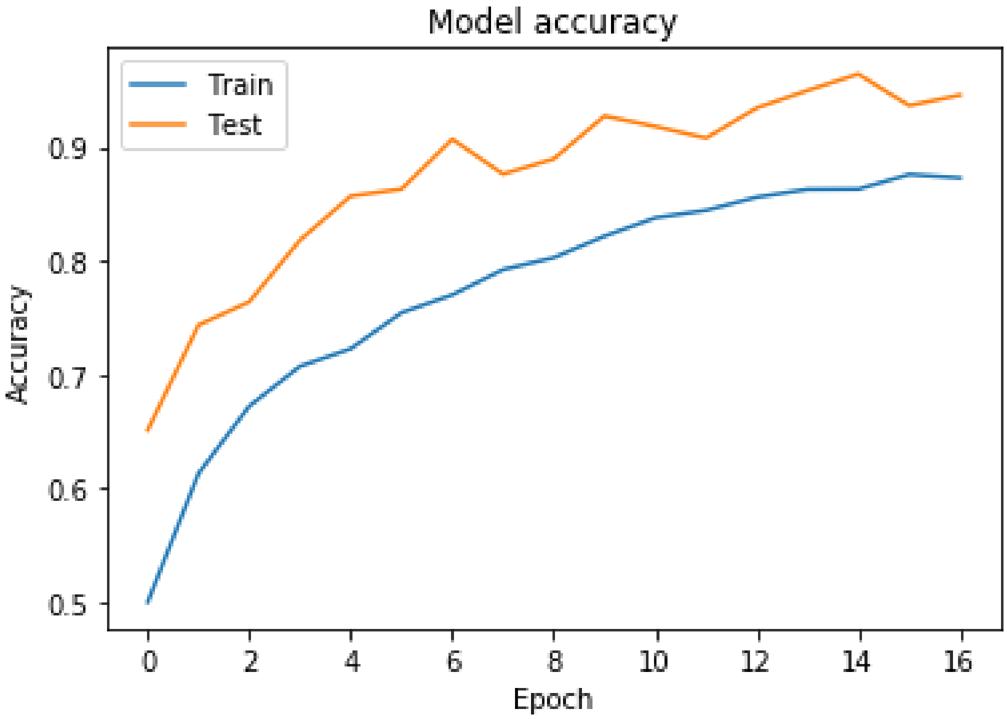
[12]:

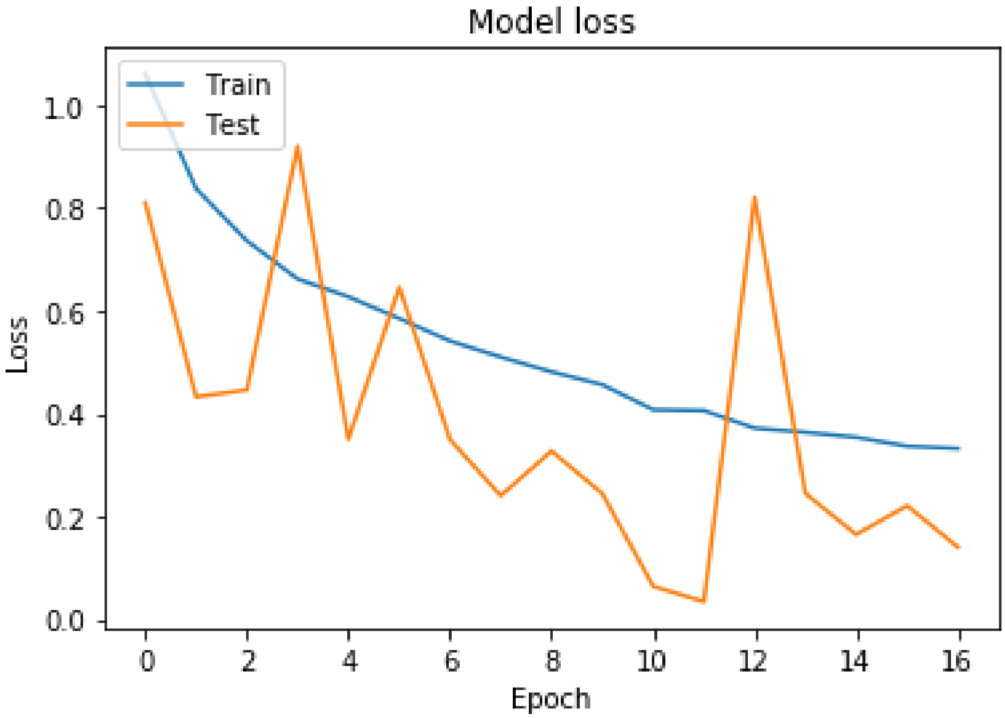
```
# visualize training
# fig, (ax1, ax2) = plt.subplots(2, 1, figsize=(12, 12))
# ax1.plot(history.history['loss'], color='b', label="Training loss")
# ax1.plot(history.history['val_loss'], color='r', label="validation loss")
# ax1.set_xticks(np.arange(1, epochs, 1))
# ax1.set_yticks(np.arange(0, 1, 0.1))

# ax2.plot(history.history['accuracy'], color='b', label="Training accuracy")
# ax2.plot(history.history['val_accuracy'], color='r',label="Validation␣
 ↪accuracy")
# ax2.set_xticks(np.arange(1, epochs, 1))

# legend = plt.legend(loc='best', shadow=True)
# plt.tight_layout()
# Plot training & validation accuracy values
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('Model accuracy')
plt.ylabel('Accuracy')
plt.xlabel('Epoch')
plt.legend(['Train', 'Test'], loc='upper left')
plt.show()

# Plot training & validation loss values
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.title('Model loss')
plt.ylabel('Loss')
plt.xlabel('Epoch')
plt.legend(['Train', 'Test'], loc='upper left')
plt.show()
```





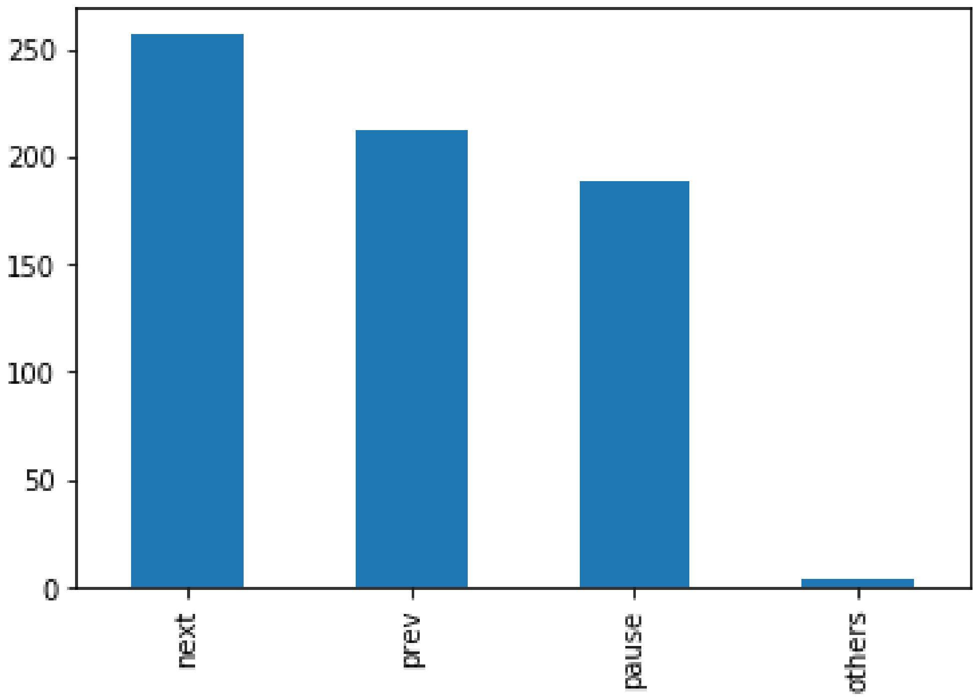
[13]:
```
test_filenames = os.listdir('./background/test1')
test_df = pd.DataFrame({
    'filename': test_filenames
})
nb_samples = test_df.shape[0]

test_gen = ImageDataGenerator(rescale=1./255)
test_generator = test_gen.flow_from_dataframe(
    test_df,
    "./background/test1/",
    x_col='filename',
    y_col=None,
    class_mode=None,
    target_size=IMAGE_SIZE,
    batch_size=batch_size,
    shuffle=False
)

predict = model.predict_generator(test_generator, steps=np.ceil(nb_samples/
 ↪batch_size))
print(test_df.shape)
print(predict.shape)
test_df['category'] = np.argmax(predict, axis=-1)
label_map = dict((v,k) for k,v in train_generator.class_indices.items())
test_df['category'] = test_df['category'].replace(label_map)
# test_df['category'] = test_df['category'].replace({ 'next': 1, 'pause': 0 })
test_df['category'].value_counts().plot.bar()

sample_test = test_df.tail(18)
print('------------------Testing Data---------------------')
print(sample_test)
```

```
Found 662 validated image filenames.
(662, 1)
(662, 4)
------------------Testing Data---------------------
          filename category
644    next.93.png     next
645    prev.74.png     prev
646    next.31.png     next
647   prev.200.png     prev
648   prev.149.png     prev
649    next.27.png     prev
650    prev.38.png     prev
651  pause.120.png    pause
652   prev.112.png     prev
653    prev.55.png     prev
654  pause.103.png    pause
655   next.135.png    pause
656    pause.6.png    pause
657   prev.127.png     next
658  pause.166.png     prev
659    prev.19.png     prev
660  pause.141.png     next
661    next.26.png     prev
```



[14]:

```python
import json

model_json = model.to_json()
with open("model_in_json_back.json", "w") as json_file:
    json.dump(model_json, json_file)

model.save_weights("model_weights_back.h5")
```

[15]:

```python
print(predict[1])
# print(test_df.at(3))
```

```
[8.2880251e-06 3.9273075e-08 1.5105519e-03 9.9848109e-01]
```

[ ]:

```python

```