Tom and Jerry Emotion Detection Classifier

Python Version :- 3.6.9

How to Run :-

1. Change the hard coded path in the .py file.

```
df = pd.read_csv('/content/dataset/db5fcca9-f52b-42a9-87be-26f77b6f9d97_train.csv')
tdf = pd.read_csv('/content/final_test/c3b70bec-470d-4981-82ea-6e0693f2c8b0_test.csv')
tpath = os.path.join('/content/dataset/ntrain/',ti_path)
tepath = os.path.join('/content/final_test/test/',tei_path)
```

2. Install cv2.

Platform :- Google Colab

Pre-processing :- While taking the input, the image has been converted to grey scale for performance efficiency and reshaped to (360,640,1). Single channel for grey image.

Analysis and Model Selection and Observations :-

As these are the image data inputs. So Convolution Neural Networks first came into mind. Based on CNN the models have been developed. And also the small part of the big image contains the emotion. Tried using Haarcascade algo to detect the face but it resulted poorly.

1. **First Model :-**

```
model2 = Sequential()
model2.add(Conv2D(filters=64, kernel_size=(4, 4), activation='relu',input_shape=(360,640,1)))
model2.add(MaxPooling2D(pool_size=(2, 2)))
model2.add(Conv2D(filters=128, kernel_size=(3, 3), activation='relu'))
model2.add(MaxPooling2D(pool_size=(2, 2)))
model2.add(Conv2D(filters=256,kernel_size=(3, 3),activation='relu'))
model2.add(MaxPooling2D(pool_size=(2, 2)))
model2.add(Conv2D(filters=512,kernel_size=(3, 3), activation='relu'))
model2.add(MaxPooling2D(pool_size=(2, 2)))
model2.add(Conv2D(filters=512,kernel_size=(3, 3), activation='relu'))
model2.add(MaxPooling2D(pool_size=(2, 2)))
model2.add(Flatten())
```

```
model2.add(Dense(units=128, activation= 'relu'))
model2.add(Dense(units=64, activation = 'relu'))
model2.add(Dense(units=5, activation='softmax'))
model2.compile(loss=keras.losses.categorical_crossentropy,op
timizer='adam', metrics=['accuracy'])
model2.fit(x=fx_train,y=fy_train, epochs=75)
fpred3 = model2.predict_classes(fx_test)
```

CNN itself extracts important features from inputs. The first layers extract lower level features like vertical edges, horizontal edges. Whereas the last level layers extract higher level features.

The output layer contains 5 nodes because of 5 classes. And softmax function is used because the outputs are categorical.
75 epochs is used and batch size is not provided.

```
Epoch 1/75
1941/1941 [==============================] - 82s 42ms/step - loss: 22.8962 - accuracy: 0.2406
Epoch 2/75
1941/1941 [==============================] - 67s 35ms/step - loss: 1.5395 - accuracy: 0.3019
Epoch 3/75
1941/1941 [==============================] - 67s 35ms/step - loss: 1.4873 - accuracy: 0.3627
Epoch 4/75
1941/1941 [==============================] - 67s 35ms/step - loss: 1.3865 - accuracy: 0.4580
Epoch 5/75
1941/1941 [==============================] - 67s 35ms/step - loss: 1.2011 - accuracy: 0.5497
Epoch 6/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.9820 - accuracy: 0.6388
Epoch 7/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.7421 - accuracy: 0.7367
Epoch 8/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.5490 - accuracy: 0.7960
Epoch 9/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.4081 - accuracy: 0.8568
Epoch 10/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.2739 - accuracy: 0.9037
Epoch 11/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.1991 - accuracy: 0.9361
Epoch 12/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.1663 - accuracy: 0.9531
Epoch 13/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.1287 - accuracy: 0.9608
Epoch 14/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.1298 - accuracy: 0.9619
Epoch 15/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.0687 - accuracy: 0.9794
Epoch 16/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.0651 - accuracy: 0.9809
Epoch 17/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.0602 - accuracy: 0.9830
Epoch 18/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.0539 - accuracy: 0.9882
Epoch 19/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.0339 - accuracy: 0.9882
Epoch 20/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.0324 - accuracy: 0.9887
Epoch 21/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.0604 - accuracy: 0.9856
Epoch 22/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.0459 - accuracy: 0.9887
Epoch 23/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.0127 - accuracy: 0.9969
Epoch 24/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.0243 - accuracy: 0.9938
Epoch 25/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.0654 - accuracy: 0.9897
Epoch 26/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.0381 - accuracy: 0.9943
Epoch 27/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.0100 - accuracy: 0.9974
Epoch 28/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.0555 - accuracy: 0.9815
Epoch 29/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.0373 - accuracy: 0.9882
Epoch 30/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.1140 - accuracy: 0.9753
```

```
Epoch 31/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.1093 - accuracy: 0.9711
Epoch 32/75
1941/1941 [==============================] - 67s 34ms/step - loss: 0.0598 - accuracy: 0.9830
Epoch 33/75
1941/1941 [==============================] - 67s 34ms/step - loss: 0.0573 - accuracy: 0.9851
Epoch 34/75
1941/1941 [==============================] - 67s 34ms/step - loss: 0.0225 - accuracy: 0.9954
Epoch 35/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.0084 - accuracy: 0.9985
Epoch 36/75
1941/1941 [==============================] - 67s 34ms/step - loss: 0.0080 - accuracy: 0.9985
Epoch 37/75
1941/1941 [==============================] - 67s 35ms/step - loss: 0.0021 - accuracy: 0.9995
Epoch 38/75
1941/1941 [==============================] - 67s 35ms/step - loss: 3.6775e-04 - accuracy: 1.0000
Epoch 39/75
1941/1941 [==============================] - 67s 35ms/step - loss: 1.1276e-04 - accuracy: 1.0000
Epoch 40/75
1941/1941 [==============================] - 67s 35ms/step - loss: 8.7668e-05 - accuracy: 1.0000
Epoch 41/75
1941/1941 [==============================] - 67s 34ms/step - loss: 7.2669e-05 - accuracy: 1.0000
Epoch 42/75
1941/1941 [==============================] - 67s 34ms/step - loss: 6.1412e-05 - accuracy: 1.0000
Epoch 43/75
1941/1941 [==============================] - 67s 34ms/step - loss: 5.2423e-05 - accuracy: 1.0000
Epoch 44/75
1941/1941 [==============================] - 67s 34ms/step - loss: 4.6044e-05 - accuracy: 1.0000
Epoch 45/75
1941/1941 [==============================] - 67s 34ms/step - loss: 4.0093e-05 - accuracy: 1.0000
Epoch 46/75
1941/1941 [==============================] - 67s 35ms/step - loss: 3.5598e-05 - accuracy: 1.0000
Epoch 47/75
1941/1941 [==============================] - 67s 35ms/step - loss: 3.1777e-05 - accuracy: 1.0000
Epoch 48/75
1941/1941 [==============================] - 67s 35ms/step - loss: 2.8375e-05 - accuracy: 1.0000
Epoch 49/75
1941/1941 [==============================] - 67s 35ms/step - loss: 2.5574e-05 - accuracy: 1.0000
Epoch 50/75
1941/1941 [==============================] - 67s 35ms/step - loss: 2.3020e-05 - accuracy: 1.0000
Epoch 51/75
1941/1941 [==============================] - 67s 35ms/step - loss: 2.1087e-05 - accuracy: 1.0000
Epoch 52/75
1941/1941 [==============================] - 67s 35ms/step - loss: 1.9162e-05 - accuracy: 1.0000
Epoch 53/75
1941/1941 [==============================] - 67s 35ms/step - loss: 1.7470e-05 - accuracy: 1.0000
Epoch 54/75
1941/1941 [==============================] - 67s 35ms/step - loss: 1.5952e-05 - accuracy: 1.0000
Epoch 55/75
1941/1941 [==============================] - 67s 35ms/step - loss: 1.4523e-05 - accuracy: 1.0000
Epoch 56/75
1941/1941 [==============================] - 67s 35ms/step - loss: 1.3352e-05 - accuracy: 1.0000
Epoch 57/75
1941/1941 [==============================] - 67s 35ms/step - loss: 1.2124e-05 - accuracy: 1.0000
Epoch 58/75
1941/1941 [==============================] - 67s 35ms/step - loss: 1.1141e-05 - accuracy: 1.0000
Epoch 59/75
1941/1941 [==============================] - 67s 35ms/step - loss: 1.0203e-05 - accuracy: 1.0000
Epoch 60/75
1941/1941 [==============================] - 67s 35ms/step - loss: 9.1181e-06 - accuracy: 1.0000
```

```
Epoch 61/75
1941/1941 [==============================] - 67s 35ms/step - loss: 8.3233e-06 - accuracy: 1.0000
Epoch 62/75
1941/1941 [==============================] - 67s 35ms/step - loss: 7.2660e-06 - accuracy: 1.0000
Epoch 63/75
1941/1941 [==============================] - 67s 35ms/step - loss: 6.3622e-06 - accuracy: 1.0000
Epoch 64/75
1941/1941 [==============================] - 67s 34ms/step - loss: 5.2878e-06 - accuracy: 1.0000
Epoch 65/75
1941/1941 [==============================] - 67s 34ms/step - loss: 4.4425e-06 - accuracy: 1.0000
Epoch 66/75
1941/1941 [==============================] - 67s 34ms/step - loss: 3.6231e-06 - accuracy: 1.0000
Epoch 67/75
1941/1941 [==============================] - 67s 35ms/step - loss: 3.1212e-06 - accuracy: 1.0000
Epoch 68/75
1941/1941 [==============================] - 67s 34ms/step - loss: 2.7726e-06 - accuracy: 1.0000
Epoch 69/75
1941/1941 [==============================] - 67s 35ms/step - loss: 2.3693e-06 - accuracy: 1.0000
Epoch 70/75
1941/1941 [==============================] - 67s 35ms/step - loss: 2.0058e-06 - accuracy: 1.0000
Epoch 71/75
1941/1941 [==============================] - 67s 35ms/step - loss: 1.6289e-06 - accuracy: 1.0000
Epoch 72/75
1941/1941 [==============================] - 67s 35ms/step - loss: 1.3770e-06 - accuracy: 1.0000
Epoch 73/75
1941/1941 [==============================] - 67s 35ms/step - loss: 1.2220e-06 - accuracy: 1.0000
Epoch 74/75
1941/1941 [==============================] - 67s 35ms/step - loss: 1.0835e-06 - accuracy: 1.0000
Epoch 75/75
1941/1941 [==============================] - 67s 35ms/step - loss: 1.0057e-06 - accuracy: 1.0000
```

The model converges rightly so. But when testing validation set it was misclassifying. The problem because of the batch size was not provided and model was considering every single sample and updating weights as a result the model was not stable properly. It was also considering noise as an important feature to. So the new model is developed.

2. To overcome the problem new model is developed from previous model additional dense layer of 256 nodes is added and batch size is considered 16.

```
model2 = Sequential()
model2.add(Conv2D(filters=64, kernel_size=(4, 4), activation
='relu',input_shape=(360,640,1)))
model2.add(MaxPooling2D(pool_size=(2, 2)))
model2.add(Conv2D(filters=128, kernel_size=(3, 3), activatio
n='relu'))
model2.add(MaxPooling2D(pool_size=(2, 2)))
model2.add(Conv2D(filters=256,kernel_size=(3, 3),activation=
'relu'))
model2.add(MaxPooling2D(pool_size=(2, 2)))
model2.add(Conv2D(filters=512,kernel_size=(3, 3), activation
='relu'))
model2.add(MaxPooling2D(pool_size=(2, 2)))
model2.add(Conv2D(filters=512,kernel_size=(3, 3), activation
='relu'))
model2.add(MaxPooling2D(pool_size=(2, 2)))
model2.add(Flatten())
model2.add(Dense(units=256, activation= 'relu'))
```

```
model2.add(Dense(units=128, activation= 'relu'))
model2.add(Dense(units=64, activation = 'relu'))
model2.add(Dense(units=5, activation='softmax'))
model2.compile(loss=keras.losses.categorical_crossentropy,op
timizer='adam', metrics=['accuracy'])
model2.fit(x=fx_train,y=fy_train,batch_size=16, epochs=75)
fpred3 = model2.predict_classes(fx_test)
```

This model rightly converges and gives me desired result as expected.

```
Epoch 1/75
1941/1941 [==============================] - 20s 10ms/step - loss: 5.8523 - accuracy: 0.2540
Epoch 2/75
1941/1941 [==============================] - 19s 10ms/step - loss: 1.5501 - accuracy: 0.3256
Epoch 3/75
1941/1941 [==============================] - 19s 10ms/step - loss: 1.5029 - accuracy: 0.3519
Epoch 4/75
1941/1941 [==============================] - 19s 10ms/step - loss: 1.3938 - accuracy: 0.4317
Epoch 5/75
1941/1941 [==============================] - 19s 10ms/step - loss: 1.1935 - accuracy: 0.5554
Epoch 6/75
1941/1941 [==============================] - 19s 10ms/step - loss: 0.8664 - accuracy: 0.6909
Epoch 7/75
1941/1941 [==============================] - 19s 10ms/step - loss: 0.6300 - accuracy: 0.7862
Epoch 8/75
1941/1941 [==============================] - 19s 10ms/step - loss: 0.3696 - accuracy: 0.8810
Epoch 9/75
1941/1941 [==============================] - 19s 10ms/step - loss: 0.2004 - accuracy: 0.9408
Epoch 10/75
1941/1941 [==============================] - 19s 10ms/step - loss: 0.1169 - accuracy: 0.9696
Epoch 11/75
1941/1941 [==============================] - 19s 10ms/step - loss: 0.0968 - accuracy: 0.9701
Epoch 12/75
1941/1941 [==============================] - 19s 10ms/step - loss: 0.1111 - accuracy: 0.9727
Epoch 13/75
1941/1941 [==============================] - 19s 10ms/step - loss: 0.0677 - accuracy: 0.9820
Epoch 14/75
1941/1941 [==============================] - 19s 10ms/step - loss: 0.0767 - accuracy: 0.9794
Epoch 15/75
1941/1941 [==============================] - 19s 10ms/step - loss: 0.0853 - accuracy: 0.9794
Epoch 16/75
1941/1941 [==============================] - 19s 10ms/step - loss: 0.0301 - accuracy: 0.9907
Epoch 17/75
1941/1941 [==============================] - 19s 10ms/step - loss: 0.0420 - accuracy: 0.9876
Epoch 18/75
1941/1941 [==============================] - 19s 10ms/step - loss: 0.0411 - accuracy: 0.9861
Epoch 19/75
1941/1941 [==============================] - 19s 10ms/step - loss: 0.0911 - accuracy: 0.9794
Epoch 20/75
1941/1941 [==============================] - 19s 10ms/step - loss: 0.1761 - accuracy: 0.9552
Epoch 21/75
1941/1941 [==============================] - 19s 10ms/step - loss: 2.7808 - accuracy: 0.6435
Epoch 22/75
1941/1941 [==============================] - 18s 10ms/step - loss: 1.6213 - accuracy: 0.3457
Epoch 23/75
1941/1941 [==============================] - 18s 10ms/step - loss: 1.4769 - accuracy: 0.3663
Epoch 24/75
1941/1941 [==============================] - 18s 10ms/step - loss: 0.5405 - accuracy: 0.8326
Epoch 25/75
1941/1941 [==============================] - 18s 10ms/step - loss: 0.1061 - accuracy: 0.9717
Epoch 26/75
1941/1941 [==============================] - 18s 10ms/step - loss: 0.0721 - accuracy: 0.9845
Epoch 27/75
1941/1941 [==============================] - 18s 10ms/step - loss: 0.0271 - accuracy: 0.9928
Epoch 28/75
1941/1941 [==============================] - 18s 10ms/step - loss: 0.0101 - accuracy: 0.9974
Epoch 29/75
1941/1941 [==============================] - 18s 10ms/step - loss: 0.0069 - accuracy: 0.9985
Epoch 30/75
1941/1941 [==============================] - 18s 10ms/step - loss: 0.0010 - accuracy: 1.0000
```

```
Epoch 31/75
1941/1941 [==============================] - 18s 10ms/step - loss: 2.6031e-04 - accuracy: 1.0000
Epoch 32/75
1941/1941 [==============================] - 19s 10ms/step - loss: 1.6528e-04 - accuracy: 1.0000
Epoch 33/75
1941/1941 [==============================] - 18s 10ms/step - loss: 1.2187e-04 - accuracy: 1.0000
Epoch 34/75
1941/1941 [==============================] - 18s 10ms/step - loss: 9.5108e-05 - accuracy: 1.0000
Epoch 35/75
1941/1941 [==============================] - 18s 10ms/step - loss: 7.6602e-05 - accuracy: 1.0000
Epoch 36/75
1941/1941 [==============================] - 19s 10ms/step - loss: 6.3205e-05 - accuracy: 1.0000
Epoch 37/75
1941/1941 [==============================] - 18s 10ms/step - loss: 5.3175e-05 - accuracy: 1.0000
Epoch 38/75
1941/1941 [==============================] - 18s 10ms/step - loss: 4.5299e-05 - accuracy: 1.0000
Epoch 39/75
1941/1941 [==============================] - 18s 10ms/step - loss: 3.9006e-05 - accuracy: 1.0000
Epoch 40/75
1941/1941 [==============================] - 18s 10ms/step - loss: 3.3858e-05 - accuracy: 1.0000
Epoch 41/75
1941/1941 [==============================] - 18s 10ms/step - loss: 2.9589e-05 - accuracy: 1.0000
Epoch 42/75
1941/1941 [==============================] - 18s 10ms/step - loss: 2.5955e-05 - accuracy: 1.0000
Epoch 43/75
1941/1941 [==============================] - 18s 10ms/step - loss: 2.2892e-05 - accuracy: 1.0000
Epoch 44/75
1941/1941 [==============================] - 18s 10ms/step - loss: 2.0277e-05 - accuracy: 1.0000
Epoch 45/75
1941/1941 [==============================] - 18s 10ms/step - loss: 1.8012e-05 - accuracy: 1.0000
Epoch 46/75
1941/1941 [==============================] - 19s 10ms/step - loss: 1.6073e-05 - accuracy: 1.0000
Epoch 47/75
1941/1941 [==============================] - 19s 10ms/step - loss: 1.4309e-05 - accuracy: 1.0000
Epoch 48/75
1941/1941 [==============================] - 19s 10ms/step - loss: 1.2777e-05 - accuracy: 1.0000
Epoch 49/75
1941/1941 [==============================] - 19s 10ms/step - loss: 1.1440e-05 - accuracy: 1.0000
Epoch 50/75
1941/1941 [==============================] - 19s 10ms/step - loss: 1.0227e-05 - accuracy: 1.0000
Epoch 51/75
1941/1941 [==============================] - 19s 10ms/step - loss: 9.1718e-06 - accuracy: 1.0000
Epoch 52/75
1941/1941 [==============================] - 19s 10ms/step - loss: 8.2417e-06 - accuracy: 1.0000
Epoch 53/75
1941/1941 [==============================] - 19s 10ms/step - loss: 7.3914e-06 - accuracy: 1.0000
Epoch 54/75
1941/1941 [==============================] - 19s 10ms/step - loss: 6.6445e-06 - accuracy: 1.0000
Epoch 55/75
1941/1941 [==============================] - 19s 10ms/step - loss: 5.9654e-06 - accuracy: 1.0000
Epoch 56/75
1941/1941 [==============================] - 19s 10ms/step - loss: 5.3582e-06 - accuracy: 1.0000
Epoch 57/75
1941/1941 [==============================] - 19s 10ms/step - loss: 4.8103e-06 - accuracy: 1.0000
Epoch 58/75
1941/1941 [==============================] - 19s 10ms/step - loss: 4.3085e-06 - accuracy: 1.0000
Epoch 59/75
1941/1941 [==============================] - 19s 10ms/step - loss: 3.8629e-06 - accuracy: 1.0000
Epoch 60/75
1941/1941 [==============================] - 19s 10ms/step - loss: 3.4606e-06 - accuracy: 1.0000
```

```
Epoch 61/75
1941/1941 [==============================] - 19s 10ms/step - loss: 3.1009e-06 - accuracy: 1.0000
Epoch 62/75
1941/1941 [==============================] - 19s 10ms/step - loss: 2.7832e-06 - accuracy: 1.0000
Epoch 63/75
1941/1941 [==============================] - 19s 10ms/step - loss: 2.5046e-06 - accuracy: 1.0000
Epoch 64/75
1941/1941 [==============================] - 19s 10ms/step - loss: 2.2467e-06 - accuracy: 1.0000
Epoch 65/75
1941/1941 [==============================] - 19s 10ms/step - loss: 2.0236e-06 - accuracy: 1.0000
Epoch 66/75
1941/1941 [==============================] - 19s 10ms/step - loss: 1.8196e-06 - accuracy: 1.0000
Epoch 67/75
1941/1941 [==============================] - 19s 10ms/step - loss: 1.6362e-06 - accuracy: 1.0000
Epoch 68/75
1941/1941 [==============================] - 19s 10ms/step - loss: 1.4753e-06 - accuracy: 1.0000
Epoch 69/75
1941/1941 [==============================] - 19s 10ms/step - loss: 1.3274e-06 - accuracy: 1.0000
Epoch 70/75
1941/1941 [==============================] - 19s 10ms/step - loss: 1.1947e-06 - accuracy: 1.0000
Epoch 71/75
1941/1941 [==============================] - 19s 10ms/step - loss: 1.0719e-06 - accuracy: 1.0000
Epoch 72/75
1941/1941 [==============================] - 19s 10ms/step - loss: 9.6337e-07 - accuracy: 1.0000
Epoch 73/75
1941/1941 [==============================] - 19s 10ms/step - loss: 8.6302e-07 - accuracy: 1.0000
Epoch 74/75
1941/1941 [==============================] - 19s 10ms/step - loss: 7.7759e-07 - accuracy: 1.0000
Epoch 75/75
1941/1941 [==============================] - 19s 10ms/step - loss: 6.9928e-07 - accuracy: 1.0000
```

Final Model:-

```
model2 = Sequential()
model2.add(Conv2D(filters=64, kernel_size=(4, 4), activation
='relu',input_shape=(360,640,1)))
model2.add(MaxPooling2D(pool_size=(2, 2)))
model2.add(Conv2D(filters=128, kernel_size=(3, 3), activatio
n='relu'))
model2.add(MaxPooling2D(pool_size=(2, 2)))
model2.add(Conv2D(filters=256,kernel_size=(3, 3),activation=
'relu'))
model2.add(MaxPooling2D(pool_size=(2, 2)))
model2.add(Conv2D(filters=512,kernel_size=(3, 3), activation
='relu'))
model2.add(MaxPooling2D(pool_size=(2, 2)))
model2.add(Conv2D(filters=512,kernel_size=(3, 3), activation
='relu'))
model2.add(MaxPooling2D(pool_size=(2, 2)))
model2.add(Flatten())
model2.add(Dense(units=256, activation= 'relu'))
model2.add(Dense(units=128, activation= 'relu'))
model2.add(Dense(units=64, activation = 'relu'))
model2.add(Dense(units=5, activation='softmax'))
model2.compile(loss=keras.losses.categorical_crossentropy,op
timizer='adam', metrics=['accuracy'])
model2.fit(x=fx_train,y=fy_train,batch_size=16, epochs=75)
```

```
fpred3 = model2.predict_classes(fx_test)
```