Tweet Emotion Recognition: Natural Language Processing with TensorFlow

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Dataset: Tweet Emotion Dataset

This is a starter notebook for the guided project Tweet Emotion Recognition with TensorFlow

A complete version of this notebook is available in the course resources

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Task 1: Introduction

Task 2: Setup and Imports

1. Installing Hugging Face's nlp package
2. Importing libraries

In [1]:
```
!pip install nlp
```

```
Requirement already satisfied: nlp in /usr/local/lib/python3.7/dist-packages (0.
4.0)
Requirement already satisfied: pyarrow>=0.16.0 in /usr/local/lib/python3.7/dist-
packages (from nlp) (6.0.1)
Requirement already satisfied: filelock in /usr/local/lib/python3.7/dist-package
s (from nlp) (3.6.0)
Requirement already satisfied: xxhash in /usr/local/lib/python3.7/dist-packages
(from nlp) (3.0.0)
Requirement already satisfied: dill in /usr/local/lib/python3.7/dist-packages (f
rom nlp) (0.3.4)
Requirement already satisfied: requests>=2.19.0 in /usr/local/lib/python3.7/dist
-packages (from nlp) (2.23.0)
Requirement already satisfied: numpy in /usr/local/lib/python3.7/dist-packages
(from nlp) (1.21.5)
Requirement already satisfied: pandas in /usr/local/lib/python3.7/dist-packages
(from nlp) (1.3.5)
Requirement already satisfied: tqdm>=4.27 in /usr/local/lib/python3.7/dist-packa
ges (from nlp) (4.63.0)
Requirement already satisfied: idna<3,>=2.5 in /usr/local/lib/python3.7/dist-pac
kages (from requests>=2.19.0->nlp) (2.10)
Requirement already satisfied: chardet<4,>=3.0.2 in /usr/local/lib/python3.7/dis
t-packages (from requests>=2.19.0->nlp) (3.0.4)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.7/di
st-packages (from requests>=2.19.0->nlp) (2021.10.8)
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in /usr/l
ocal/lib/python3.7/dist-packages (from requests>=2.19.0->nlp) (1.24.3)
Requirement already satisfied: python-dateutil>=2.7.3 in /usr/local/lib/python3.
7/dist-packages (from pandas->nlp) (2.8.2)
Requirement already satisfied: pytz>=2017.3 in /usr/local/lib/python3.7/dist-pac
kages (from pandas->nlp) (2018.9)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/dist-package
s (from python-dateutil>=2.7.3->pandas->nlp) (1.15.0)
```

In [2]:
```
%matplotlib inline

import tensorflow as tf
```

```
import numpy as np
import matplotlib.pyplot as plt
import nlp
import random


def show_history(h):
    epochs_trained = len(h.history['loss'])
    plt.figure(figsize=(16, 6))

    plt.subplot(1, 2, 1)
    plt.plot(range(0, epochs_trained), h.history.get('accuracy'), label='Trainin
    plt.plot(range(0, epochs_trained), h.history.get('val_accuracy'), label='Val
    plt.ylim([0., 1.])
    plt.xlabel('Epochs')
    plt.ylabel('Accuracy')
    plt.legend()

    plt.subplot(1, 2, 2)
    plt.plot(range(0, epochs_trained), h.history.get('loss'), label='Training')
    plt.plot(range(0, epochs_trained), h.history.get('val_loss'), label='Validat
    plt.xlabel('Epochs')
    plt.ylabel('Loss')
    plt.legend()
    plt.show()


def show_confusion_matrix(y_true, y_pred, classes):
    from sklearn.metrics import confusion_matrix

    cm = confusion_matrix(y_true, y_pred, normalize='true')

    plt.figure(figsize=(8, 8))
    sp = plt.subplot(1, 1, 1)
    ctx = sp.matshow(cm)
    plt.xticks(list(range(0, 6)), labels=classes)
    plt.yticks(list(range(0, 6)), labels=classes)
    plt.colorbar(ctx)
    plt.show()


print('Using TensorFlow version', tf.__version__)
```

```
Using TensorFlow version 2.8.0
```

Task 3: Importing Data

1. Importing the Tweet Emotion dataset
2. Creating train, validation and test sets
3. Extracting tweets and labels from the examples

In [3]:
```
dataset = nlp.load_dataset('emotion')
```

```
Using custom data configuration default
```

In [4]:
```
dataset
```

Out[4]:
```
{'test': Dataset(features: {'text': Value(dtype='string', id=None), 'label': Val
```

```
ue(dtype='string', id=None)}, num_rows: 2000),
 'train': Dataset(features: {'text': Value(dtype='string', id=None), 'label': Va
lue(dtype='string', id=None)}, num_rows: 16000),
 'validation': Dataset(features: {'text': Value(dtype='string', id=None), 'labe
l': Value(dtype='string', id=None)}, num_rows: 2000)}
```

In [5]:
```
train=dataset['train']
val=dataset['validation']
test=dataset['test']
train.shape, val.shape, test.shape
```

Out[5]:
```
((16000, 2), (2000, 2), (2000, 2))
```

In [6]:
```
train[0]
```

Out[6]:
```
{'label': 'sadness', 'text': 'i didnt feel humiliated'}
```

In [7]:
```
def get_tweets(data):
  texts = [x['text'] for x in data]
  labels = [x['label'] for x in data]
  return texts, labels
```

In [8]:
```
tweets, labels = get_tweets(train)
for i in range(5):
  print(tweets[i],'\n=', labels[i])
```

```
i didnt feel humiliated
= sadness
i can go from feeling so hopeless to so damned hopeful just from being around so
meone who cares and is awake
= sadness
im grabbing a minute to post i feel greedy wrong
= anger
i am ever feeling nostalgic about the fireplace i will know that it is still on
the property
= love
i am feeling grouchy
= anger
```

Task 4: Tokenizer

1. Tokenizing the tweets

In [9]:
```
from tensorflow.keras.preprocessing.text import Tokenizer
```

In [10]:
```
tokenizer = Tokenizer(num_words=10_000, oov_token='<UNK>')
tokenizer.fit_on_texts(tweets)
tokenizer
```

Out[10]:
```
<keras_preprocessing.text.Tokenizer at 0x7f83b5a29cd0>
```

In [11]:
```
tokenizer.texts_to_sequences([tweets[0]]), tweets[0]
```

Out[11]:
```
([[2, 139, 3, 679]], 'i didnt feel humiliated')
```

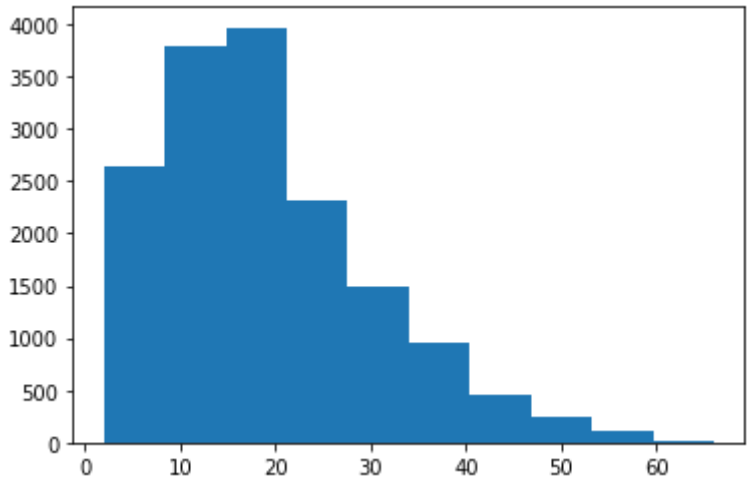
Task 5: Padding and Truncating Sequences

1. Checking length of the tweets
2. Creating padded sequences

In [12]:
```
lengths = [len(t.split(' ')) for t in tweets]
min(lengths), max(lengths)
```

Out[12]:
```
(2, 66)
```

In [13]:
```
plt.hist(lengths,)# bins=len(set(lengths)))
plt.show()
```



In [14]:
```
from tensorflow.keras.preprocessing.sequence import pad_sequences
```

In [15]:
```
maxlen = 50
```

In [16]:
```
def get_seqs(tokenizer, tweets):
  sequences = tokenizer.texts_to_sequences(tweets)
  padded = pad_sequences(sequences, truncating='post', padding='post', maxlen=ma
  return padded
```

In [17]:
```
padded_train = get_seqs(tokenizer, tweets)
padded_train[:3]
```

Out[17]:
```
array([[   2,  139,    3,  679,    0,    0,    0,    0,    0,    0,    0,
           0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
           0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
           0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
           0,    0,    0,    0,    0,    0],
       [   2,   40,  101,   60,    8,   15,  494,    5,   15, 3496,  553,
          32,   60,   61,  128,  148,   76, 1480,    4,   22, 1255,    0,
           0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
           0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
           0,    0,    0,    0,    0,    0],
       [  17, 3060,    7, 1149,    5,  286,    2,    3,  495,  438,    0,
           0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
           0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
           0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
           0,    0,    0,    0,    0,    0]], dtype=int32)
```

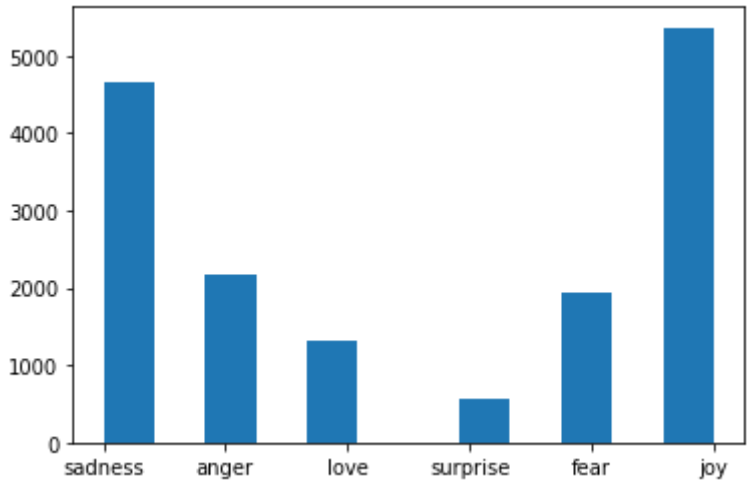
Task 6: Preparing the Labels

1. Creating classes to index and index to classes dictionaries
2. Converting text labels to numeric labels

In [18]:
```
classes = sorted(list(set(labels)))
classes
```

Out[18]:
```
['anger', 'fear', 'joy', 'love', 'sadness', 'surprise']
```

In [19]:
```
plt.hist(labels, bins=len(classes)*2)
plt.show()
```



In [20]:
```
class_to_index = {i:c for c,i in enumerate(classes)}
class_to_index
```

Out[20]:
```
{'anger': 0, 'fear': 1, 'joy': 2, 'love': 3, 'sadness': 4, 'surprise': 5}
```

In [21]:
```
index_to_class = {v:k for k,v in class_to_index.items()}
index_to_class
```

Out[21]:
```
{0: 'anger', 1: 'fear', 2: 'joy', 3: 'love', 4: 'sadness', 5: 'surprise'}
```

In [22]:
```
labels[:9]
```

Out[22]:
```
['sadness',
 'sadness',
 'anger',
 'love',
 'anger',
 'sadness',
 'surprise',
 'fear',
 'joy']
```

In [23]:
```
#names_to_ids = lambda labels: np.array([class_to_index.get(x) for x in labels])
def names_to_ids(labels):
  idxs = [class_to_index[x] for x in labels]
  #print(idxs)
  return np.array(idxs)
```

In [24]:
```
train_labels = names_to_ids(labels)
train_labels[:5]
```

Out[24]:
```
array([4, 4, 0, 3, 0])
```

Task 7: Creating the Model

1. Creating the model
2. Compiling the model

In [25]:
```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Embedding
from tensorflow.keras.layers import Bidirectional
from tensorflow.keras.layers import LSTM
from tensorflow.keras.layers import Dense
```

In [26]:
```
model = Sequential([
                    Embedding(10_000, 16, input_length=maxlen),
                    Bidirectional(LSTM(20, return_sequences=True)),
                    Bidirectional(LSTM(20)),
                    Dense(6, activation='softmax')
])
model.compile(loss='sparse_categorical_crossentropy',
              optimizer='adam',
              metrics=['accuracy'])
```

In [27]:
```
model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 embedding (Embedding)       (None, 50, 16)            160000

 bidirectional (Bidirectiona  (None, 50, 40)           5920
 l)

 bidirectional_1 (Bidirectio  (None, 40)               9760
 nal)

 dense (Dense)               (None, 6)                 246

=================================================================
Total params: 175,926
Trainable params: 175,926
Non-trainable params: 0
_________________________________________________________________
```

Task 8: Training the Model

1. Preparing a validation set
2. Training the model

In [28]:
```
val_tweets, val_labels = get_tweets(val)
val_tweets[0], val_labels[0]
```

Out[28]:
```
('im feeling quite sad and sorry for myself but ill snap out of it soon',
 'sadness')
```

In [29]:
```
val_seqs = get_seqs(tokenizer, val_tweets)
```

```
val_seqs[:3]
```

Out[29]:
```
array([[  17,    8,  157,  260,    4,  343,   16,   51,   19,  212,    1,
          50,   10,   13,  533,    0,    0,    0,    0,    0,    0,    0,
           0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
           0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
           0,    0,    0,    0,    0,    0],
       [   2,    3,   14,    2,   24,   72,  253,   33,    7,  618, 2743,
         618, 1418,   10, 1104,    0,    0,    0,    0,    0,    0,    0,
           0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
           0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
           0,    0,    0,    0,    0,    0],
       [   2,    3,   14,    7,  614,    1,    0,    0,    0,    0,    0,
           0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
           0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
           0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
           0,    0,    0,    0,    0,    0]], dtype=int32)
```

In [30]:
```
val_labels = names_to_ids(val_labels)
val_labels[:3]
```

Out[30]:
```
array([4, 4, 3])
```

In [31]:
```
val_tweets[0], val_labels[0], index_to_class[val_labels[0]]
```

Out[31]:
```
('im feeling quite sad and sorry for myself but ill snap out of it soon',
 4,
 'sadness')
```

In [32]:
```
h = model.fit(padded_train,
              train_labels,
              validation_data=(val_seqs, val_labels),
              epochs=20,
              callbacks=[tf.keras.callbacks.EarlyStopping(monitor='val_accuracy'
                                                          patience=2)])
```

```
Epoch 1/20
500/500 [==============================] - 43s 60ms/step - loss: 1.3281 - accura
cy: 0.4686 - val_loss: 0.8800 - val_accuracy: 0.6400
Epoch 2/20
500/500 [==============================] - 28s 57ms/step - loss: 0.6271 - accura
cy: 0.7757 - val_loss: 0.5918 - val_accuracy: 0.8035
Epoch 3/20
500/500 [==============================] - 29s 57ms/step - loss: 0.3624 - accura
cy: 0.8798 - val_loss: 0.5090 - val_accuracy: 0.8330
Epoch 4/20
500/500 [==============================] - 28s 57ms/step - loss: 0.2655 - accura
cy: 0.9109 - val_loss: 0.4570 - val_accuracy: 0.8520
Epoch 5/20
500/500 [==============================] - 28s 56ms/step - loss: 0.2111 - accura
cy: 0.9308 - val_loss: 0.4523 - val_accuracy: 0.8650
Epoch 6/20
500/500 [==============================] - 28s 57ms/step - loss: 0.1602 - accura
cy: 0.9466 - val_loss: 0.4038 - val_accuracy: 0.8780
Epoch 7/20
500/500 [==============================] - 29s 57ms/step - loss: 0.1321 - accura
cy: 0.9564 - val_loss: 0.4188 - val_accuracy: 0.8775
Epoch 8/20
500/500 [==============================] - 28s 57ms/step - loss: 0.1064 - accura
cy: 0.9659 - val_loss: 0.4355 - val_accuracy: 0.8840
Epoch 9/20
500/500 [==============================] - 29s 57ms/step - loss: 0.0876 - accura
cy: 0.9729 - val_loss: 0.4871 - val_accuracy: 0.8825
```

```
Epoch 10/20
500/500 [==============================] - 28s 57ms/step - loss: 0.0717 - accura
cy: 0.9779 - val_loss: 0.4842 - val_accuracy: 0.8820
```

In [33]:
```
model.save('emotion')
```

```
WARNING:absl:Found untraced functions such as lstm_cell_1_layer_call_fn, lstm_ce
ll_1_layer_call_and_return_conditional_losses, lstm_cell_2_layer_call_fn, lstm_c
ell_2_layer_call_and_return_conditional_losses, lstm_cell_4_layer_call_fn while
saving (showing 5 of 8). These functions will not be directly callable after loa
ding.
INFO:tensorflow:Assets written to: emotion/assets
INFO:tensorflow:Assets written to: emotion/assets
WARNING:absl:<keras.layers.recurrent.LSTMCell object at 0x7f83b57d8410> has the
same name 'LSTMCell' as a built-in Keras object. Consider renaming <class 'kera
s.layers.recurrent.LSTMCell'> to avoid naming conflicts when loading with `tf.ke
ras.models.load_model`. If renaming is not possible, pass the object in the `cus
tom_objects` parameter of the load function.
WARNING:absl:<keras.layers.recurrent.LSTMCell object at 0x7f83b56c9690> has the
same name 'LSTMCell' as a built-in Keras object. Consider renaming <class 'kera
s.layers.recurrent.LSTMCell'> to avoid naming conflicts when loading with `tf.ke
ras.models.load_model`. If renaming is not possible, pass the object in the `cus
tom_objects` parameter of the load function.
WARNING:absl:<keras.layers.recurrent.LSTMCell object at 0x7f83b56f0650> has the
same name 'LSTMCell' as a built-in Keras object. Consider renaming <class 'kera
s.layers.recurrent.LSTMCell'> to avoid naming conflicts when loading with `tf.ke
ras.models.load_model`. If renaming is not possible, pass the object in the `cus
tom_objects` parameter of the load function.
WARNING:absl:<keras.layers.recurrent.LSTMCell object at 0x7f83b56f7350> has the
same name 'LSTMCell' as a built-in Keras object. Consider renaming <class 'kera
s.layers.recurrent.LSTMCell'> to avoid naming conflicts when loading with `tf.ke
ras.models.load_model`. If renaming is not possible, pass the object in the `cus
tom_objects` parameter of the load function.
```

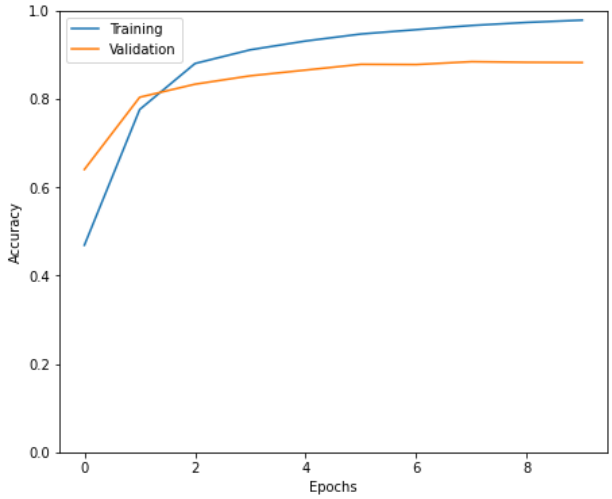
In [34]:
```
!ls -lh emotion
```

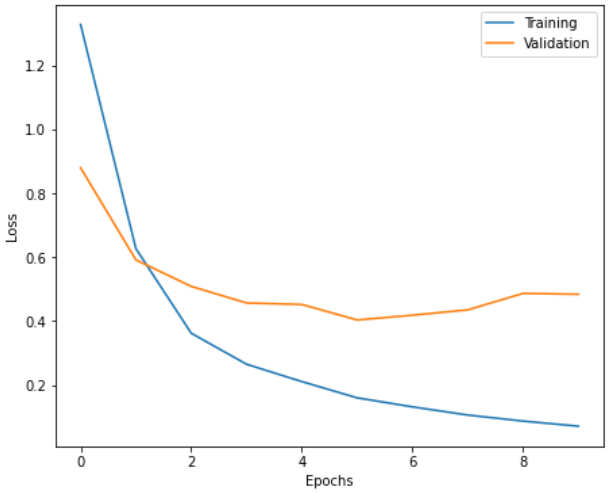
```
total 4.2M
drwxr-xr-x 2 root root 4.0K Apr 13 17:50 assets
-rw-r--r-- 1 root root  23K Apr 13 19:16 keras_metadata.pb
-rw-r--r-- 1 root root 4.2M Apr 13 19:16 saved_model.pb
drwxr-xr-x 2 root root 4.0K Apr 13 19:16 variables
```

Task 9: Evaluating the Model

1. Visualizing training history
2. Prepraring a test set
3. A look at individual predictions on the test set
4. A look at all predictions on the test set

In [35]:
```
show_history(h)
```





In [36]:
```
test_tweets, test_labels = get_tweets(test)
test_seqs = get_seqs(tokenizer, test_tweets)
test_labels = names_to_ids(test_labels)
test_seqs[:3], test_labels[:3]
```

Out[36]:
```
(array([[  17,    8,  203,  715,   15,   17,   26,   46, 5595,  114,   58,
             0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
             0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
             0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
             0,    0,    0,    0,    0,    0],
        [  17,    1,   11,  243,   37,    2,    3,  469,    0,    0,    0,
             0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
             0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
             0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
             0,    0,    0,    0,    0,    0],
        [   2,  145,   80,   68, 2971,   60,   18,   37,    2,  104,   43,
           165,   67,   68,    5,    3,   14,    2,   93,  406,   25,   68,
             0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
             0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
             0,    0,    0,    0,    0,    0]], dtype=int32), array([4, 4, 4]))
```

In [37]:
```
_ = model.evaluate(test_seqs, test_labels)
```

```
63/63 [==============================] - 1s 20ms/step - loss: 0.4454 - accuracy:
0.8855
```

In [39]:
```
ri = random.randint(0, len(test_labels)-1)
print('text:', test_tweets[ri])
print('emotion:',index_to_class[test_labels[ri]])

p = model.predict(np.expand_dims(test_seqs[ri], axis=0))[0]
#print(p)
#print(np.argmax(p).astype('uint8'))
pred_class = index_to_class[np.argmax(p).astype('uint8')]
print('predicted emotion:', pred_class)
```

```
text: i feel very glad that finland s well known visual artist vesa kivinen had
called me to work with him
emotion: joy
predicted emotion: joy
```

In [40]:
```
preds = model.predict(test_seqs)
preds[:3]
```

Out[40]:
```
array([[5.3437601e-05, 1.3775818e-04, 5.0045300e-04, 2.3412636e-06,
```

```
        9.9930131e-01, 4.6082191e-06],
       [1.1040812e-04, 1.4068747e-04, 6.9764274e-04, 6.3507732e-06,
        9.9903655e-01, 8.2818960e-06],
       [2.3266915e-04, 4.0700633e-04, 1.2912998e-03, 1.7250766e-05,
        9.9803668e-01, 1.5093929e-05]], dtype=float32)
```

In [41]:
```
# https://stackoverflow.com/questions/68883510/attributeerror-sequential-object-
pred_classes = [np.argmax(p) for p in preds]
pred_classes[:3]
```

Out[41]:
```
[4, 4, 4]
```

In [42]:
```
test_labels, preds, classes
```

Out[42]:
```
(array([4, 4, 4, ..., 2, 2, 1]),
 array([[5.3437601e-05, 1.3775818e-04, 5.0045300e-04, 2.3412636e-06,
         9.9930131e-01, 4.6082191e-06],
        [1.1040812e-04, 1.4068747e-04, 6.9764274e-04, 6.3507732e-06,
         9.9903655e-01, 8.2818960e-06],
        [2.3266915e-04, 4.0700633e-04, 1.2912998e-03, 1.7250766e-05,
         9.9803668e-01, 1.5093929e-05],
        ...,
        [5.7535917e-06, 1.5243269e-05, 9.9954802e-01, 2.0398323e-04,
         2.2395719e-04, 2.9947412e-06],
        [5.1393172e-06, 1.1024529e-05, 9.9963987e-01, 2.1398377e-04,
         1.2702710e-04, 2.8141130e-06],
        [2.7145093e-02, 4.1656557e-02, 2.2515282e-04, 1.6364462e-04,
         1.1855655e-03, 9.2962396e-01]], dtype=float32),
 ['anger', 'fear', 'joy', 'love', 'sadness', 'surprise'])
```

In [43]:
```
show_confusion_matrix(test_labels, pred_classes, classes)
```