cnn_tf_keras

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1 Digit Recognition

1.1 Convolutional Neural Network implementation using TensorFlow - Keras

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[1]:
```
import tensorflow as tf
tf.__version__
```

[1]:
```
'2.4.0'
```

[2]:
```
import tensorflow.keras as keras
print('TensorFlow version:',tf.__version__)
print('Keras version:',keras.__version__)
```

```
TensorFlow version: 2.4.0
Keras version: 2.4.0
```

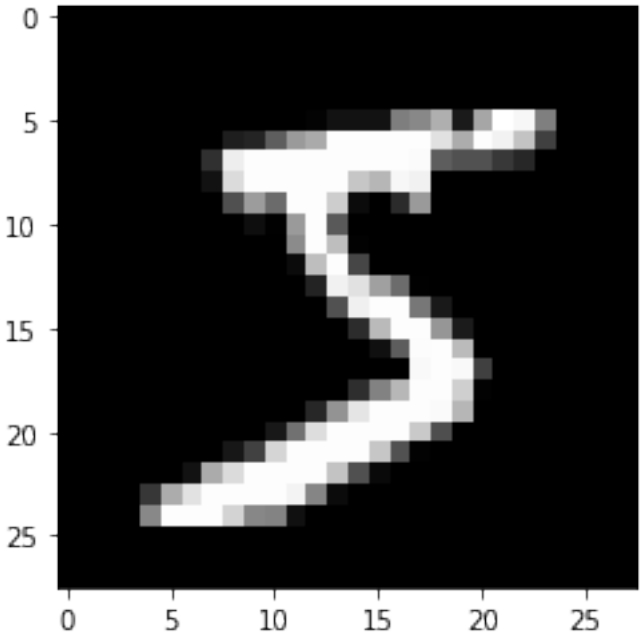
[3]:
```
mnist = tf.keras.datasets.mnist.load_data(path='mnist.npz')
```

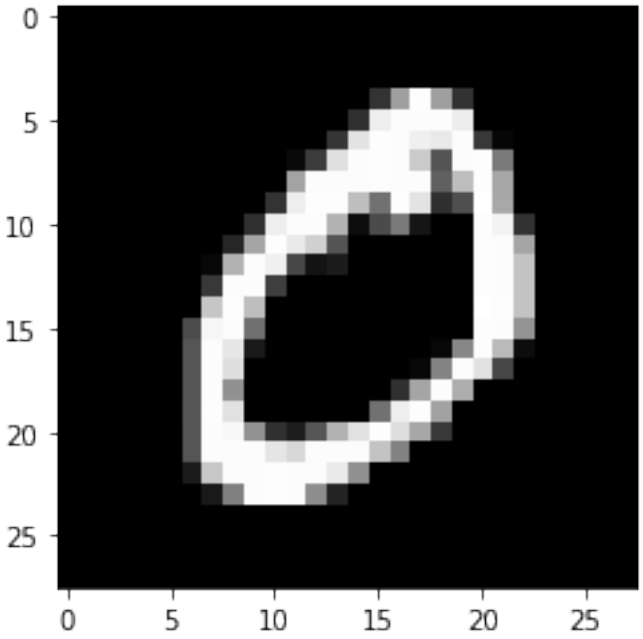
```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-
datasets/mnist.npz
11493376/11490434 [==============================] - 0s 0us/step
```

[25]:
```
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
import os
%matplotlib inline
```

[26]:
```
(train_X, train_Y), (test_X, test_Y) = mnist
```

[29]:
```
for i in range(2):
    plt.imshow(train_X[i])
    plt.show()
```





[6]:
```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Dropout, Flatten,␣
↪Dense
```

[7]:
```
model = Sequential()
inputShape = (28,28,1)
# The input layer accepts an image and applies a convolution that uses 32 6x6␣
 ↪filters and a rectified linear unit activation function
model.add(Conv2D(32,␣
 ↪kernel_size=(6,6),strides=(1,1),activation='relu',input_shape = inputShape))
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Conv2D(32, kernel_size=(6,6),strides=(1,1),activation='relu'))
model.add(MaxPooling2D(pool_size=(2,2)))
# model.add(Conv2D(32, kernel_size=(3,3),strides=(1,1),activation='relu'))
# model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Dropout(0.1))
model.add(Flatten())
model.add(Dense(10,activation='softmax'))
```

[8]:
```
# With the layers defined, we can now compile the model for categorical␣
 ↪(multi-class) classification
model.compile(loss='categorical_crossentropy',
              optimizer='adam',
              metrics=['accuracy'])

print(model.summary())
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d (Conv2D)              (None, 23, 23, 32)        1184
_________________________________________________________________
max_pooling2d (MaxPooling2D) (None, 11, 11, 32)        0
_________________________________________________________________
conv2d_1 (Conv2D)            (None, 6, 6, 32)          36896
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 3, 3, 32)          0
_________________________________________________________________
dropout (Dropout)            (None, 3, 3, 32)          0
_________________________________________________________________
flatten (Flatten)            (None, 288)               0
_________________________________________________________________
dense (Dense)                (None, 10)                2890
=================================================================
Total params: 40,970
Trainable params: 40,970
Non-trainable params: 0
_________________________________________________________________
None
```

[9]:
```
train_X.shape
train_X = train_X.reshape(-1,28,28,1)
train_X.shape
```

[9]:
```
(60000, 28, 28, 1)
```

[10]:
```
#import numpy as np
y = tf.keras.utils.to_categorical(train_Y, num_classes=10)
y
```

[10]:
```
array([[0., 0., 0., …, 0., 0., 0.],
       [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., 1., 0.]], dtype=float32)
```

[11]:
```
# Train the model over 5 epochs using 30-image batches and using the validation␣
 ↪holdout dataset for validation
num_epochs = 5
batch_size = 30
history = model.fit(train_X,y,batch_size=batch_size,epochs = num_epochs)
```

```
Epoch 1/5
2000/2000 [==============================] - 43s 21ms/step - loss: 1.7607 -
accuracy: 0.8177
Epoch 2/5
2000/2000 [==============================] - 43s 21ms/step - loss: 0.1073 -
accuracy: 0.9689
Epoch 3/5
2000/2000 [==============================] - 42s 21ms/step - loss: 0.0813 -
accuracy: 0.9756
Epoch 4/5
2000/2000 [==============================] - 43s 21ms/step - loss: 0.0771 -
accuracy: 0.9770
Epoch 5/5
2000/2000 [==============================] - 43s 21ms/step - loss: 0.0658 -
accuracy: 0.9813
```

[12]:
```
model.save('nn_tfTrained.mdl')
```

```
INFO:tensorflow:Assets written to: nn_tfTrained.mdl/assets
```

[17]:
```
#from google.colab import files

# with open('nn_tfTrained.mdl', 'w') as f:
#   f.write('some content')
```

```
files.download('/content/nn_tfTrained.mdl')
```

```
<IPython.core.display.Javascript object>
```

```
<IPython.core.display.Javascript object>
```

[ ]:
```
testY = tf.keras.utils.to_categorical(test_Y,num_classes = 10)
```

[ ]:
```
test_X[1].shape[1]
```

[ ]:
```
28
```

[ ]:
```
from tensorflow.keras import models
import numpy as np
from random import randint
import os
%matplotlib inline
```

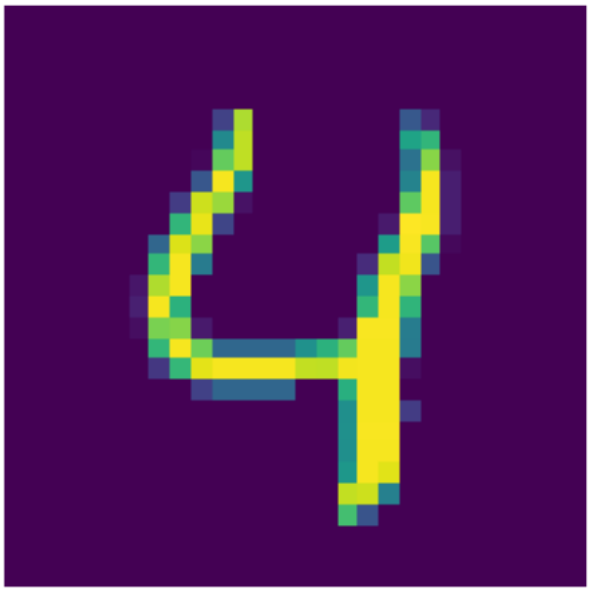
[ ]:
```
classnames = list(range(10))
classnames
```

[ ]:
```
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
```

[ ]:
```
# Function to predict the class of an image
def predict_image(classifier, image):
    from tensorflow import convert_to_tensor
    # The model expects a batch of images as input, so we'll create an array of␣
 ↪1 image
    imgfeatures = img.reshape(1, img.shape[0], img.shape[1], 1)

    # We need to format the input to match the training data
    # The generator loaded the values as floating point numbers
    # and normalized the pixel values, so...
    imgfeatures = imgfeatures.astype('float32')
    #imgfeatures /= 255

    # Use the model to predict the image class
    class_probabilities = classifier.predict(imgfeatures)

    # Find the class predictions with the highest predicted probability
    index = int(np.argmax(class_probabilities, axis=1)[0])
    return index

# Create a random test image
img = test_X[4]
```

```
plt.axis('off')
plt.imshow(img)

# Use the classifier to predict the class
model1 = models.load_model('nn_tfTrained.mdl') # loads the saved model
class_idx = predict_image(model1, img)
print('index is ',class_idx)
print ('class is ',classnames[class_idx])
```

```
WARNING:tensorflow:5 out of the last 5 calls to <function
Model.make_predict_function.<locals>.predict_function at 0x7fd19c9961e0>
triggered tf.function retracing. Tracing is expensive and the excessive number
of tracings could be due to (1) creating @tf.function repeatedly in a loop, (2)
passing tensors with different shapes, (3) passing Python objects instead of
tensors. For (1), please define your @tf.function outside of the loop. For (2),
@tf.function has experimental_relax_shapes=True option that relaxes argument
shapes that can avoid unnecessary retracing. For (3), please refer to
https://www.tensorflow.org/guide/function#controlling_retracing and
https://www.tensorflow.org/api_docs/python/tf/function for  more details.
index is  4
class is  4
```



[ ]: