MNIST

September 13, 2023

[2]:
```
import pandas as pd
import numpy as np
from tqdm.notebook import tqdm
from keras.preprocessing.image import img_to_array, load_img
import tensorflow as tf
import matplotlib.pyplot as plt
%matplotlib inline
import warnings

warnings.filterwarnings('ignore')
```

[1]:
```
# !unzip Train_UQcUa52.zip
```

[4]:
```
df = pd.read_csv('train.csv')
df.head()
```

[4]:

	filename	label
0	0.png	4
1	1.png	9
2	2.png	1
3	3.png	7
4	4.png	3

[5]:
```
!pwd
```

```
/content
```

[6]:
```
image_path = 'Images/train/'
```

[8]:
```
X = np.array([img_to_array(load_img(image_path+df['filename'][i],␣
 ↪target_size=(28,28,1), grayscale=True))
              for i in tqdm(range(df.shape[0]))
              ]).astype('float32')
```

```
HBox(children=(FloatProgress(value=0.0, max=49000.0), HTML(value='')))
```

[9]:
```
y = df['label']
```

[10]:
```
print(X.shape, y.shape)
```

```
(49000, 28, 28, 1) (49000,)
```

[11]:
```
image_index = 0
print(y[image_index])
plt.imshow(X[image_index].reshape(28,28), cmap='Greys')
```

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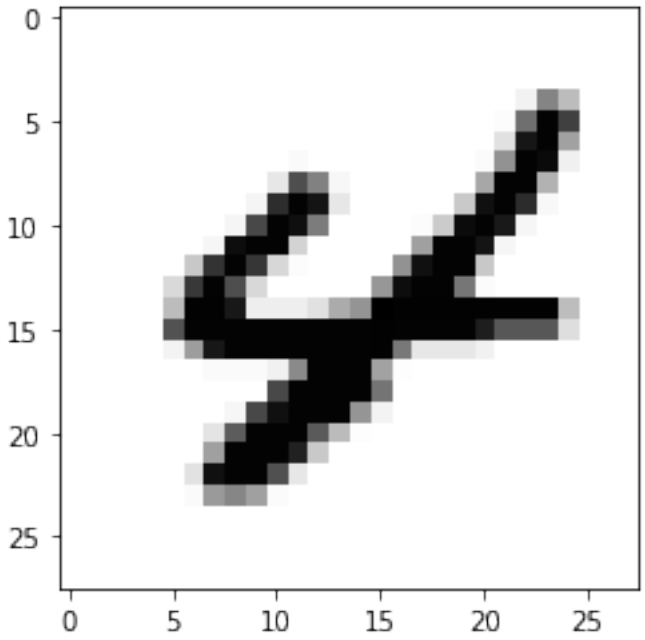
4
```

[11]: <matplotlib.image.AxesImage at 0x7f813cbf4e48>



[12]:
```
image_index = 10
print(y[image_index])
plt.imshow(X[image_index].reshape(28,28), cmap='Greys')
```

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2
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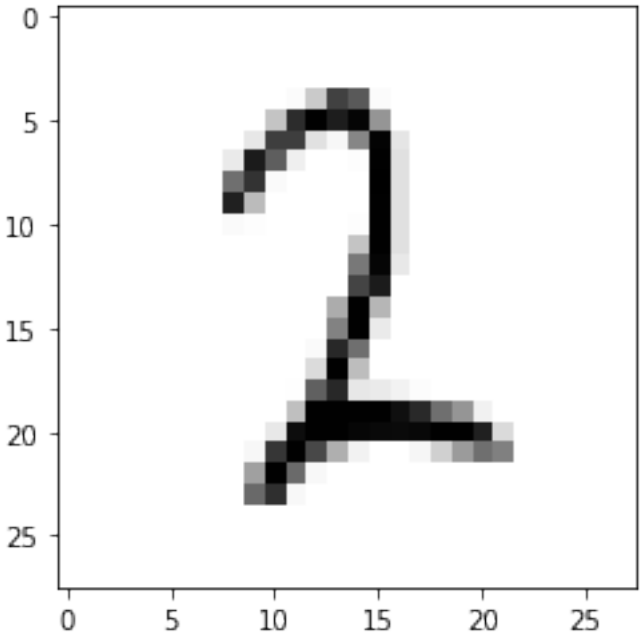
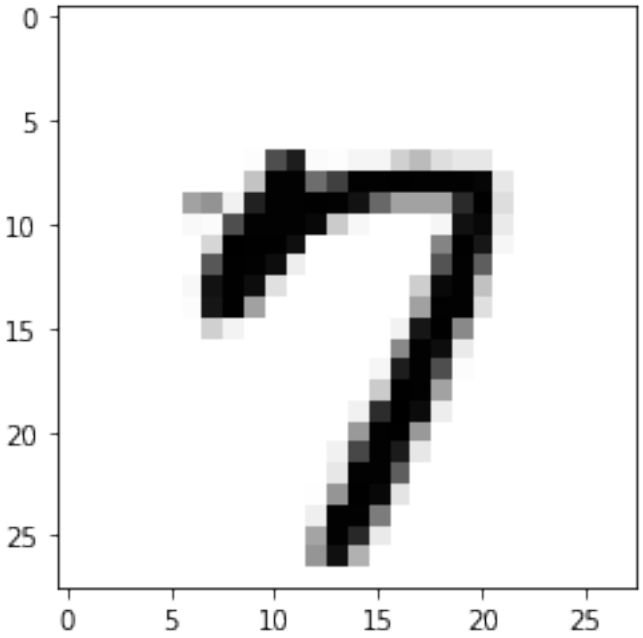
[12]: <matplotlib.image.AxesImage at 0x7f813cb8e668>



[13]:
```
image_index = 100
print(y[image_index])
plt.imshow(X[image_index].reshape(28,28), cmap='Greys')
```

```
7
```

[13]:
```
<matplotlib.image.AxesImage at 0x7f813c629c50>
```



[14]:
```
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(X, y, test_size=0.25,␣
 ↪random_state=42, stratify=np.array(y))
```

[16]:
```
# x_train[0]
```

[17]:
```
x_train /= 255
x_test /= 255
```

[19]:
```
# x_train[0]
```

[20]:
```
input_shape = (28,28,1)
output_class = 10
```

[23]:
```
from keras.models import Sequential
from keras.layers import Dense, Conv2D, Dropout, Flatten, MaxPooling2D

# define the model
model = Sequential()
model.add(Conv2D(28, kernel_size=(3,3), input_shape=input_shape))
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Flatten())
model.add(Dense(128, activation=tf.nn.relu))
model.add(Dropout(0.3))
model.add(Dense(output_class, activation=tf.nn.softmax))

model.compile(optimizer='adam', loss='sparse_categorical_crossentropy',␣
 ↪metrics='accuracy')
```

[24]:
```
# train the model
model.fit(x=x_train, y=y_train, batch_size=32, epochs=30,␣
 ↪validation_data=(x_test, y_test))
```

```
Epoch 1/30
1149/1149 [==============================] - 10s 3ms/step - loss: 0.4816 -
accuracy: 0.8475 - val_loss: 0.1202 - val_accuracy: 0.9637
Epoch 2/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.1336 -
accuracy: 0.9605 - val_loss: 0.0848 - val_accuracy: 0.9743
Epoch 3/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0863 -
accuracy: 0.9732 - val_loss: 0.0807 - val_accuracy: 0.9742
Epoch 4/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0685 -
accuracy: 0.9783 - val_loss: 0.0734 - val_accuracy: 0.9788
```

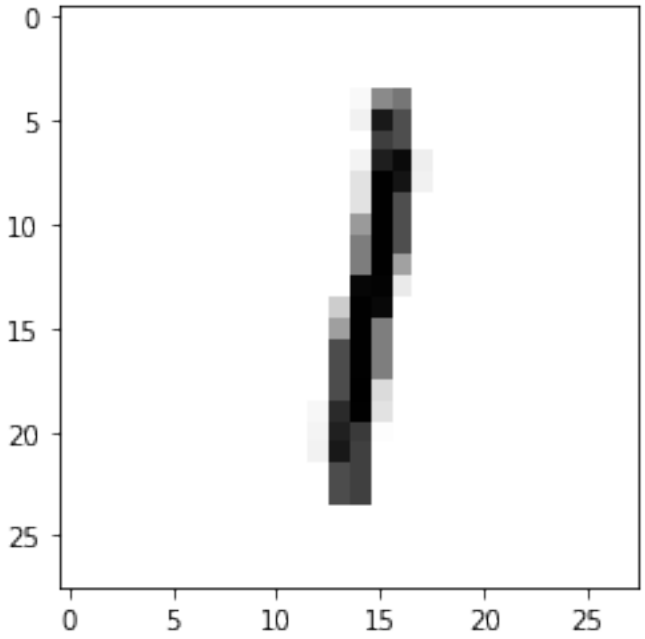
```
Epoch 5/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0543 -
accuracy: 0.9825 - val_loss: 0.0690 - val_accuracy: 0.9809
Epoch 6/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0461 -
accuracy: 0.9844 - val_loss: 0.0684 - val_accuracy: 0.9808
Epoch 7/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0360 -
accuracy: 0.9873 - val_loss: 0.0743 - val_accuracy: 0.9798
Epoch 8/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0318 -
accuracy: 0.9884 - val_loss: 0.0733 - val_accuracy: 0.9811
Epoch 9/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0319 -
accuracy: 0.9891 - val_loss: 0.0658 - val_accuracy: 0.9838
Epoch 10/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0242 -
accuracy: 0.9919 - val_loss: 0.0728 - val_accuracy: 0.9827
Epoch 11/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0218 -
accuracy: 0.9926 - val_loss: 0.0815 - val_accuracy: 0.9818
Epoch 12/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0286 -
accuracy: 0.9895 - val_loss: 0.0766 - val_accuracy: 0.9829
Epoch 13/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0199 -
accuracy: 0.9928 - val_loss: 0.0762 - val_accuracy: 0.9820
Epoch 14/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0239 -
accuracy: 0.9918 - val_loss: 0.0754 - val_accuracy: 0.9836
Epoch 15/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0160 -
accuracy: 0.9938 - val_loss: 0.0865 - val_accuracy: 0.9820
Epoch 16/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0196 -
accuracy: 0.9935 - val_loss: 0.0842 - val_accuracy: 0.9822
Epoch 17/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0152 -
accuracy: 0.9951 - val_loss: 0.0825 - val_accuracy: 0.9828
Epoch 18/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0155 -
accuracy: 0.9943 - val_loss: 0.0889 - val_accuracy: 0.9817
Epoch 19/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0207 -
accuracy: 0.9930 - val_loss: 0.0886 - val_accuracy: 0.9822
Epoch 20/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0122 -
accuracy: 0.9955 - val_loss: 0.0958 - val_accuracy: 0.9822
```

```
Epoch 21/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0135 -
accuracy: 0.9957 - val_loss: 0.0986 - val_accuracy: 0.9824
Epoch 22/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0166 -
accuracy: 0.9949 - val_loss: 0.0987 - val_accuracy: 0.9824
Epoch 23/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0153 -
accuracy: 0.9949 - val_loss: 0.0917 - val_accuracy: 0.9832
Epoch 24/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0147 -
accuracy: 0.9950 - val_loss: 0.0967 - val_accuracy: 0.9838
Epoch 25/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0112 -
accuracy: 0.9957 - val_loss: 0.1057 - val_accuracy: 0.9816
Epoch 26/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0134 -
accuracy: 0.9959 - val_loss: 0.1024 - val_accuracy: 0.9830
Epoch 27/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0085 -
accuracy: 0.9968 - val_loss: 0.1256 - val_accuracy: 0.9795
Epoch 28/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0127 -
accuracy: 0.9958 - val_loss: 0.1099 - val_accuracy: 0.9832
Epoch 29/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0136 -
accuracy: 0.9952 - val_loss: 0.1043 - val_accuracy: 0.9824
Epoch 30/30
1149/1149 [==============================] - 4s 3ms/step - loss: 0.0132 -
accuracy: 0.9959 - val_loss: 0.1162 - val_accuracy: 0.9827
```

[24]:
```
<tensorflow.python.keras.callbacks.History at 0x7f80dc057278>
```

[27]:
```
image_index = 10
# print("Original output:",y_test[image_index])
plt.imshow(x_test[image_index].reshape(28,28), cmap='Greys')
pred = model.predict(x_test[image_index].reshape(1,28,28,1))
print("Predicted output:", pred.argmax())
```

```
Predicted output: 1
```



[28]:
```
image_index = 100
# print("Original output:",y_test[image_index])
plt.imshow(x_test[image_index].reshape(28,28), cmap='Greys')
pred = model.predict(x_test[image_index].reshape(1,28,28,1))
print("Predicted output:", pred.argmax())
```

```
Predicted output: 8
```