TEAM ID: PNT2022TMID30518 TEAM NAME: A Novel Method for Handwritten Digit Recognition System

In [3]:

**!**pip install keras

**!**pip install tensorflow

Requirement already satisfied: keras in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (2.2.4)

Requirement already satisfied: numpy>=1.9.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from keras) (1.20.3)

Requirement already satisfied: keras-applications>=1.0.6 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from keras) (1.0.8)

Requirement already satisfied: pyyaml in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from keras) (5.4.1)

Requirement already satisfied: six>=1.9.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from keras) (1.15.0)

Requirement already satisfied: keras-preprocessing>=1.0.5 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from keras) (1.1.2)

Requirement already satisfied: h5py in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from keras) (3.2.1)

Requirement already satisfied: scipy>=0.14 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from keras) (1.7.3)

Requirement already satisfied: tensorflow in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (2.7.2)

Requirement already satisfied: termcolor>=1.1.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (1.1.0)

Requirement already satisfied: astunparse>=1.6.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (1.6.3)

Requirement already satisfied: protobuf>=3.9.2 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (3.19.1)

Requirement already satisfied: wrapt>=1.11.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (1.12.1)

Collecting keras<2.8,>=2.7.0

Downloading keras-2.7.0-py2.py3-none-any.whl (1.3 MB)

|████████████████████████████████| 1.3 MB 17.2 MB/s eta 0:00:01

Requirement already satisfied: h5py>=2.9.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (3.2.1)

Requirement already satisfied: grpcio<2.0,>=1.24.3 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (1.42.0)

Requirement already satisfied: keras-preprocessing>=1.1.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (1.1.2)

Requirement already satisfied: tensorflow-io-gcs-filesystem>=0.21.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (0.23.1)

Requirement already satisfied: wheel<1.0,>=0.32.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (0.37.0)

Requirement already satisfied: opt-einsum>=2.3.2 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (3.3.0)

Requirement already satisfied: flatbuffers<3.0,>=1.12 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (2.0)

Requirement already satisfied: numpy>=1.14.5 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (1.20.3)

Requirement already satisfied: gast<0.5.0,>=0.2.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (0.4.0)

Requirement already satisfied: six>=1.12.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (1.15.0)

Requirement already satisfied: absl-py>=0.4.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (0.12.0)

Requirement already satisfied: tensorboard~=2.7 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (2.7.0)

Requirement already satisfied: tensorflow-estimator<2.8,~=2.7.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (2.7.0)

Requirement already satisfied: typing-extensions>=3.6.6 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (4.1.1)

Requirement already satisfied: google-pasta>=0.1.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (0.2.0)

Requirement already satisfied: werkzeug>=0.11.15 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorboard~=2.7->tensorflow) (2.0.2)

Requirement already satisfied: google-auth-oauthlib<0.5,>=0.4.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorboard~=2.7->tensorflow) (0.4.4)

Requirement already satisfied: requests<3,>=2.21.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorboard~=2.7->tensorflow) (2.26.0)

Requirement already satisfied: tensorboard-plugin-wit>=1.6.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorboard~=2.7->tensorflow) (1.6.0)

Requirement already satisfied: tensorboard-data-server<0.7.0,>=0.6.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorboard~=2.7->tensorflow) (0.6.1)

Requirement already satisfied: google-auth<3,>=1.6.3 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorboard~=2.7->tensorflow) (1.23.0)

Requirement already satisfied: setuptools>=41.0.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorboard~=2.7->tensorflow) (58.0.4)

Requirement already satisfied: markdown>=2.6.8 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorboard~=2.7->tensorflow) (3.3.3)

Requirement already satisfied: rsa<5,>=3.1.4 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from google-auth<3,>=1.6.3->tensorboard~=2.7->tensorflow) (4.7.2)

Requirement already satisfied: pyasn1-modules>=0.2.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from google-auth<3,>=1.6.3->tensorboard~=2.7->tensorflow) (0.2.8)

Requirement already satisfied: cachetools<5.0,>=2.0.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from google-auth<3,>=1.6.3->tensorboard~=2.7->tensorflow) (4.2.2)

Requirement already satisfied: requests-oauthlib>=0.7.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from google-auth-oauthlib<0.5,>=0.4.1->tensorboard~=2.7->tensorflow) (1.3.0)

Requirement already satisfied: pyasn1<0.5.0,>=0.4.6 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from pyasn1-modules>=0.2.1->google-auth<3,>=1.6.3->tensorboard~=2.7->tensorflow) (0.4.8)

Requirement already satisfied: charset-normalizer~=2.0.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests<3,>=2.21.0->tensorboard~=2.7->tensorflow) (2.0.4)

Requirement already satisfied: certifi>=2017.4.17 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests<3,>=2.21.0->tensorboard~=2.7->tensorflow) (2022.9.24)

Requirement already satisfied: idna<4,>=2.5 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests<3,>=2.21.0->tensorboard~=2.7->tensorflow) (3.3)

Requirement already satisfied: urllib3<1.27,>=1.21.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests<3,>=2.21.0->tensorboard~=2.7->tensorflow) (1.26.7)

Requirement already satisfied: oauthlib>=3.0.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests-oauthlib>=0.7.0->google-auth-oauthlib<0.5,>=0.4.1->tensorboard~=2.7->tensorflow) (3.2.1)

Installing collected packages: keras

Attempting uninstall: keras

Found existing installation: Keras 2.2.4

Uninstalling Keras-2.2.4:

Successfully uninstalled Keras-2.2.4

Successfully installed keras-2.7.0

In [2]:

pwd

Out[2]:

'/home/wsuser/work'

In [9]:

**import** tensorflow **as** tf

**from** matplotlib **import** pyplot **as** plt

**import** numpy **as** np

In [10]:

**from** keras.datasets **import** mnist

objects**=**mnist

(train\_img,train\_lab),(test\_img,test\_lab)**=**objects**.**load\_data()

In [11]:

**for** i **in** range(20):

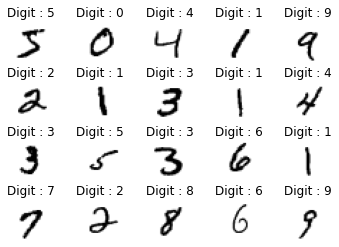
plt**.**subplot(4,5,i**+**1)

plt**.**imshow(train\_img[i],cmap**=**'gray\_r')

plt**.**title("Digit : {}"**.**format(train\_lab[i]))

plt**.**subplots\_adjust(hspace**=**0.5)

plt**.**axis('off')



print('Training images shape : ',train\_img**.**shape)

print('Testing images shape : ',test\_img**.**shape)

Training images shape : (60000, 28, 28)

Testing images shape : (10000, 28, 28)

In [13]:

print('How image looks like : ')

print(train\_img[0])

How image looks like :

[[ 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

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 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 0 0]

[ 0 0 0 0 0 0 0 0 0 0 0 0 3 18 18 18 126 136

175 26 166 255 247 127 0 0 0 0]

[ 0 0 0 0 0 0 0 0 30 36 94 154 170 253 253 253 253 253

225 172 253 242 195 64 0 0 0 0]

[ 0 0 0 0 0 0 0 49 238 253 253 253 253 253 253 253 253 251

93 82 82 56 39 0 0 0 0 0]

[ 0 0 0 0 0 0 0 18 219 253 253 253 253 253 198 182 247 241

0 0 0 0 0 0 0 0 0 0]

[ 0 0 0 0 0 0 0 0 80 156 107 253 253 205 11 0 43 154

0 0 0 0 0 0 0 0 0 0]

[ 0 0 0 0 0 0 0 0 0 14 1 154 253 90 0 0 0 0

0 0 0 0 0 0 0 0 0 0]

[ 0 0 0 0 0 0 0 0 0 0 0 139 253 190 2 0 0 0

0 0 0 0 0 0 0 0 0 0]

[ 0 0 0 0 0 0 0 0 0 0 0 11 190 253 70 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 35 241 225 160 108 1

0 0 0 0 0 0 0 0 0 0]

[ 0 0 0 0 0 0 0 0 0 0 0 0 0 81 240 253 253 119

25 0 0 0 0 0 0 0 0 0]

[ 0 0 0 0 0 0 0 0 0 0 0 0 0 0 45 186 253 253

150 27 0 0 0 0 0 0 0 0]

[ 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 16 93 252

253 187 0 0 0 0 0 0 0 0]

[ 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 249

253 249 64 0 0 0 0 0 0 0]

[ 0 0 0 0 0 0 0 0 0 0 0 0 0 0 46 130 183 253

253 207 2 0 0 0 0 0 0 0]

[ 0 0 0 0 0 0 0 0 0 0 0 0 39 148 229 253 253 253

250 182 0 0 0 0 0 0 0 0]

[ 0 0 0 0 0 0 0 0 0 0 24 114 221 253 253 253 253 201

78 0 0 0 0 0 0 0 0 0]

[ 0 0 0 0 0 0 0 0 23 66 213 253 253 253 253 198 81 2

0 0 0 0 0 0 0 0 0 0]

[ 0 0 0 0 0 0 18 171 219 253 253 253 253 195 80 9 0 0

0 0 0 0 0 0 0 0 0 0]

[ 0 0 0 0 55 172 226 253 253 253 253 244 133 11 0 0 0 0

0 0 0 0 0 0 0 0 0 0]

[ 0 0 0 0 136 253 253 253 212 135 132 16 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 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 0 0 0 0 0 0 0 0]]

In [14]:

plt**.**hist(train\_img[0]**.**reshape(784),facecolor**=**'orange')

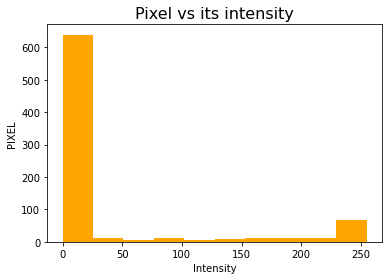
plt**.**title('Pixel vs its intensity',fontsize**=**16)

plt**.**ylabel('PIXEL')

plt**.**xlabel('Intensity')

Out[14]:

Text(0.5, 0, 'Intensity')



train\_img**=**train\_img**/**255.0

test\_img**=**test\_img**/**255.0

In [16]:

print('How image looks like after normalising: ')

print(train\_img[0])

How image looks like after normalising:

[[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.

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0. 0. 0. 0. 0. 0.

0. 0. 0. 0. ]

[0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0.

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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. 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.

0.01176471 0.07058824 0.07058824 0.07058824 0.49411765 0.53333333

0.68627451 0.10196078 0.65098039 1. 0.96862745 0.49803922

0. 0. 0. 0. ]

[0. 0. 0. 0. 0. 0.

0. 0. 0.11764706 0.14117647 0.36862745 0.60392157

0.66666667 0.99215686 0.99215686 0.99215686 0.99215686 0.99215686

0.88235294 0.6745098 0.99215686 0.94901961 0.76470588 0.25098039

0. 0. 0. 0. ]

[0. 0. 0. 0. 0. 0.

0. 0.19215686 0.93333333 0.99215686 0.99215686 0.99215686

0.99215686 0.99215686 0.99215686 0.99215686 0.99215686 0.98431373

0.36470588 0.32156863 0.32156863 0.21960784 0.15294118 0.

0. 0. 0. 0. ]

[0. 0. 0. 0. 0. 0.

0. 0.07058824 0.85882353 0.99215686 0.99215686 0.99215686

0.99215686 0.99215686 0.77647059 0.71372549 0.96862745 0.94509804

0. 0. 0. 0. 0. 0.

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[0. 0. 0. 0. 0. 0.

0. 0. 0.31372549 0.61176471 0.41960784 0.99215686

0.99215686 0.80392157 0.04313725 0. 0.16862745 0.60392157

0. 0. 0. 0. 0. 0.

0. 0. 0. 0. ]

[0. 0. 0. 0. 0. 0.

0. 0. 0. 0.05490196 0.00392157 0.60392157

0.99215686 0.35294118 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. 0.54509804

0.99215686 0.74509804 0.00784314 0. 0. 0.

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[0. 0. 0. 0. 0. 0.

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0.74509804 0.99215686 0.2745098 0. 0. 0.

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[0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0.

0.1372549 0.94509804 0.88235294 0.62745098 0.42352941 0.00392157

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[0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0.

0. 0.31764706 0.94117647 0.99215686 0.99215686 0.46666667

0.09803922 0. 0. 0. 0. 0.

0. 0. 0. 0. ]

[0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0.

0. 0. 0.17647059 0.72941176 0.99215686 0.99215686

0.58823529 0.10588235 0. 0. 0. 0.

0. 0. 0. 0. ]

[0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0.

0. 0. 0. 0.0627451 0.36470588 0.98823529

0.99215686 0.73333333 0. 0. 0. 0.

0. 0. 0. 0. ]

[0. 0. 0. 0. 0. 0.

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0.99215686 0.97647059 0.25098039 0. 0. 0.

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[0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0.

0. 0. 0.18039216 0.50980392 0.71764706 0.99215686

0.99215686 0.81176471 0.00784314 0. 0. 0.

0. 0. 0. 0. ]

[0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0.

0.15294118 0.58039216 0.89803922 0.99215686 0.99215686 0.99215686

0.98039216 0.71372549 0. 0. 0. 0.

0. 0. 0. 0. ]

[0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0.09411765 0.44705882

0.86666667 0.99215686 0.99215686 0.99215686 0.99215686 0.78823529

0.30588235 0. 0. 0. 0. 0.

0. 0. 0. 0. ]

[0. 0. 0. 0. 0. 0.

0. 0. 0.09019608 0.25882353 0.83529412 0.99215686

0.99215686 0.99215686 0.99215686 0.77647059 0.31764706 0.00784314

0. 0. 0. 0. 0. 0.

0. 0. 0. 0. ]

[0. 0. 0. 0. 0. 0.

0.07058824 0.67058824 0.85882353 0.99215686 0.99215686 0.99215686

0.99215686 0.76470588 0.31372549 0.03529412 0. 0.

0. 0. 0. 0. 0. 0.

0. 0. 0. 0. ]

[0. 0. 0. 0. 0.21568627 0.6745098

0.88627451 0.99215686 0.99215686 0.99215686 0.99215686 0.95686275

0.52156863 0.04313725 0. 0. 0. 0.

0. 0. 0. 0. 0. 0.

0. 0. 0. 0. ]

[0. 0. 0. 0. 0.53333333 0.99215686

0.99215686 0.99215686 0.83137255 0.52941176 0.51764706 0.0627451

0. 0. 0. 0. 0. 0.

0. 0. 0. 0. 0. 0.

0. 0. 0. 0. ]

[0. 0. 0. 0. 0. 0.

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[0. 0. 0. 0. 0. 0.

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[0. 0. 0. 0. 0. 0.

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0. 0. 0. 0. ]]

In [17]:

plt**.**hist(train\_img[0]**.**reshape(784),facecolor**=**'orange')

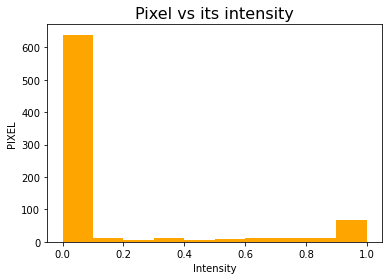
plt**.**title('Pixel vs its intensity',fontsize**=**16)

plt**.**ylabel('PIXEL')

plt**.**xlabel('Intensity')

Out[17]:

Text(0.5, 0, 'Intensity')



**from** keras.models **import** Sequential

**from** keras.layers **import** Flatten,Dense

model**=**Sequential()

input\_layer**=** Flatten(input\_shape**=**(28,28))

model**.**add(input\_layer)

hidden\_layer1**=**Dense(512,activation**=**'relu')

model**.**add(hidden\_layer1)

hidden\_layer2**=**Dense(512,activation**=**'relu')

model**.**add(hidden\_layer2)

output\_layer**=**Dense(10,activation**=**'softmax')

model**.**add(output\_layer)

In [22]:

*#compiling the sequential model*

model**.**compile(optimizer **=** 'adam',

loss **=** 'sparse\_categorical\_crossentropy',

metrics**=**['accuracy'])

In [23]:

model**.**fit(train\_img,train\_lab,epochs**=**50)

Epoch 1/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.1829 - accuracy: 0.9441

Epoch 2/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0801 - accuracy: 0.9755

Epoch 3/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0555 - accuracy: 0.9827

Epoch 4/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0441 - accuracy: 0.9860

Epoch 5/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0345 - accuracy: 0.9889

Epoch 6/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0293 - accuracy: 0.9906

Epoch 7/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0234 - accuracy: 0.9924

Epoch 8/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0218 - accuracy: 0.9931

Epoch 9/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0218 - accuracy: 0.9932

Epoch 10/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0193 - accuracy: 0.9941

Epoch 11/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0166 - accuracy: 0.9950

Epoch 12/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0147 - accuracy: 0.9956

Epoch 13/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0158 - accuracy: 0.9955

Epoch 14/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0164 - accuracy: 0.9957

Epoch 15/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0150 - accuracy: 0.9956

Epoch 16/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0117 - accuracy: 0.9962

Epoch 17/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0127 - accuracy: 0.9967

Epoch 18/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0143 - accuracy: 0.9962

Epoch 19/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0117 - accuracy: 0.9967

Epoch 20/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0132 - accuracy: 0.9967

Epoch 21/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0145 - accuracy: 0.9964

Epoch 22/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0120 - accuracy: 0.9971

Epoch 23/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0076 - accuracy: 0.9979

Epoch 24/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0143 - accuracy: 0.9965

Epoch 25/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0138 - accuracy: 0.9973

Epoch 26/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0116 - accuracy: 0.9973

Epoch 27/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0122 - accuracy: 0.9973

Epoch 28/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0108 - accuracy: 0.9976

Epoch 29/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0106 - accuracy: 0.9980

Epoch 30/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0121 - accuracy: 0.9975

Epoch 31/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0065 - accuracy: 0.9984

Epoch 32/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0112 - accuracy: 0.9980

Epoch 33/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0148 - accuracy: 0.9970

Epoch 34/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0083 - accuracy: 0.9982

Epoch 35/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0117 - accuracy: 0.9978

Epoch 36/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0103 - accuracy: 0.9980

Epoch 37/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0091 - accuracy: 0.9981

Epoch 38/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0103 - accuracy: 0.9983

Epoch 39/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0114 - accuracy: 0.9979

Epoch 40/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0124 - accuracy: 0.9977

Epoch 41/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0116 - accuracy: 0.9980

Epoch 42/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0083 - accuracy: 0.9985

Epoch 43/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0099 - accuracy: 0.9983

Epoch 44/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0094 - accuracy: 0.9984

Epoch 45/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0079 - accuracy: 0.9984

Epoch 46/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0110 - accuracy: 0.9982

Epoch 47/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0096 - accuracy: 0.9981

Epoch 48/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0102 - accuracy: 0.9984

Epoch 49/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0128 - accuracy: 0.9981

Epoch 50/50

1875/1875 [==============================] - 17s 9ms/step - loss: 0.0117 - accuracy: 0.9985

Out[23]:

In [32]:

model**.**save('project.h5')

In [33]:

**!**tar -zcvf project.tgz project.h5

project.h5

In [34]:

ls **-**1

project.h5

project.tgz

In [25]:

**!**pip install watson-machine-learning-client --upgrade

Collecting watson-machine-learning-client

Downloading watson\_machine\_learning\_client-1.0.391-py3-none-any.whl (538 kB)

|████████████████████████████████| 538 kB 9.1 MB/s eta 0:00:01

Requirement already satisfied: boto3 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (1.18.21)

Requirement already satisfied: tqdm in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (4.62.3)

Requirement already satisfied: requests in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (2.26.0)

Requirement already satisfied: ibm-cos-sdk in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (2.11.0)

Requirement already satisfied: certifi in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (2022.9.24)

Requirement already satisfied: lomond in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (0.3.3)

Requirement already satisfied: tabulate in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (0.8.9)

Requirement already satisfied: urllib3 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (1.26.7)

Requirement already satisfied: pandas in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (1.3.4)

Requirement already satisfied: jmespath<1.0.0,>=0.7.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from boto3->watson-machine-learning-client) (0.10.0)

Requirement already satisfied: botocore<1.22.0,>=1.21.21 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from boto3->watson-machine-learning-client) (1.21.41)

Requirement already satisfied: s3transfer<0.6.0,>=0.5.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from boto3->watson-machine-learning-client) (0.5.0)

Requirement already satisfied: python-dateutil<3.0.0,>=2.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from botocore<1.22.0,>=1.21.21->boto3->watson-machine-learning-client) (2.8.2)

Requirement already satisfied: six>=1.5 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from python-dateutil<3.0.0,>=2.1->botocore<1.22.0,>=1.21.21->boto3->watson-machine-learning-client) (1.15.0)

Requirement already satisfied: ibm-cos-sdk-core==2.11.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ibm-cos-sdk->watson-machine-learning-client) (2.11.0)

Requirement already satisfied: ibm-cos-sdk-s3transfer==2.11.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ibm-cos-sdk->watson-machine-learning-client) (2.11.0)

Requirement already satisfied: charset-normalizer~=2.0.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests->watson-machine-learning-client) (2.0.4)

Requirement already satisfied: idna<4,>=2.5 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests->watson-machine-learning-client) (3.3)

Requirement already satisfied: pytz>=2017.3 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from pandas->watson-machine-learning-client) (2021.3)

Requirement already satisfied: numpy>=1.17.3 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from pandas->watson-machine-learning-client) (1.20.3)

Installing collected packages: watson-machine-learning-client

Successfully installed watson-machine-learning-client-1.0.391

In [26]:

**from** ibm\_watson\_machine\_learning **import** APIClient

wml\_credentials **=** {

"url": "https://us-south.ml.cloud.ibm.com",

"apikey":"lqekv1q2qiHXlgu7j73HBBVXgv7oHvULPT\_rH5B29-Vr"

}

client **=** APIClient(wml\_credentials)

In [27]:

client **=** APIClient(wml\_credentials)

In [37]:

**def** guid\_from\_space\_name(client, space\_name):

space **=** client**.**spaces**.**get\_details()

*#print(space)*

**return**(next(item **for** item **in** space['resources'] **if** item['entity']["name"] **==** space\_name)['metadata']['id'])

In [38]:

space\_uid **=** guid\_from\_space\_name(client, "handwritten-digit-recognition")

print("Space UID = " **+** space\_uid)

Space UID = 05a5928a-31dc-470a-bb57-d62fe2280206

In [40]:

client**.**set**.**default\_space(space\_uid)

Out[40]:

'SUCCESS'

In [41]:

client**.**software\_specifications**.**list()

----------------------------- ------------------------------------ ----

NAME ASSET\_ID TYPE

default\_py3.6 0062b8c9-8b7d-44a0-a9b9-46c416adcbd9 base

kernel-spark3.2-scala2.12 020d69ce-7ac1-5e68-ac1a-31189867356a base

pytorch-onnx\_1.3-py3.7-edt 069ea134-3346-5748-b513-49120e15d288 base

scikit-learn\_0.20-py3.6 09c5a1d0-9c1e-4473-a344-eb7b665ff687 base

spark-mllib\_3.0-scala\_2.12 09f4cff0-90a7-5899-b9ed-1ef348aebdee base

pytorch-onnx\_rt22.1-py3.9 0b848dd4-e681-5599-be41-b5f6fccc6471 base

ai-function\_0.1-py3.6 0cdb0f1e-5376-4f4d-92dd-da3b69aa9bda base

shiny-r3.6 0e6e79df-875e-4f24-8ae9-62dcc2148306 base

tensorflow\_2.4-py3.7-horovod 1092590a-307d-563d-9b62-4eb7d64b3f22 base

pytorch\_1.1-py3.6 10ac12d6-6b30-4ccd-8392-3e922c096a92 base

tensorflow\_1.15-py3.6-ddl 111e41b3-de2d-5422-a4d6-bf776828c4b7 base

autoai-kb\_rt22.2-py3.10 125b6d9a-5b1f-5e8d-972a-b251688ccf40 base

runtime-22.1-py3.9 12b83a17-24d8-5082-900f-0ab31fbfd3cb base

scikit-learn\_0.22-py3.6 154010fa-5b3b-4ac1-82af-4d5ee5abbc85 base

default\_r3.6 1b70aec3-ab34-4b87-8aa0-a4a3c8296a36 base

pytorch-onnx\_1.3-py3.6 1bc6029a-cc97-56da-b8e0-39c3880dbbe7 base

kernel-spark3.3-r3.6 1c9e5454-f216-59dd-a20e-474a5cdf5988 base

pytorch-onnx\_rt22.1-py3.9-edt 1d362186-7ad5-5b59-8b6c-9d0880bde37f base

tensorflow\_2.1-py3.6 1eb25b84-d6ed-5dde-b6a5-3fbdf1665666 base

spark-mllib\_3.2 20047f72-0a98-58c7-9ff5-a77b012eb8f5 base

tensorflow\_2.4-py3.8-horovod 217c16f6-178f-56bf-824a-b19f20564c49 base

runtime-22.1-py3.9-cuda 26215f05-08c3-5a41-a1b0-da66306ce658 base

do\_py3.8 295addb5-9ef9-547e-9bf4-92ae3563e720 base

autoai-ts\_3.8-py3.8 2aa0c932-798f-5ae9-abd6-15e0c2402fb5 base

tensorflow\_1.15-py3.6 2b73a275-7cbf-420b-a912-eae7f436e0bc base

kernel-spark3.3-py3.9 2b7961e2-e3b1-5a8c-a491-482c8368839a base

pytorch\_1.2-py3.6 2c8ef57d-2687-4b7d-acce-01f94976dac1 base

spark-mllib\_2.3 2e51f700-bca0-4b0d-88dc-5c6791338875 base

pytorch-onnx\_1.1-py3.6-edt 32983cea-3f32-4400-8965-dde874a8d67e base

spark-mllib\_3.0-py37 36507ebe-8770-55ba-ab2a-eafe787600e9 base

spark-mllib\_2.4 390d21f8-e58b-4fac-9c55-d7ceda621326 base

autoai-ts\_rt22.2-py3.10 396b2e83-0953-5b86-9a55-7ce1628a406f base

xgboost\_0.82-py3.6 39e31acd-5f30-41dc-ae44-60233c80306e base

pytorch-onnx\_1.2-py3.6-edt 40589d0e-7019-4e28-8daa-fb03b6f4fe12 base

pytorch-onnx\_rt22.2-py3.10 40e73f55-783a-5535-b3fa-0c8b94291431 base

default\_r36py38 41c247d3-45f8-5a71-b065-8580229facf0 base

autoai-ts\_rt22.1-py3.9 4269d26e-07ba-5d40-8f66-2d495b0c71f7 base

autoai-obm\_3.0 42b92e18-d9ab-567f-988a-4240ba1ed5f7 base

pmml-3.0\_4.3 493bcb95-16f1-5bc5-bee8-81b8af80e9c7 base

spark-mllib\_2.4-r\_3.6 49403dff-92e9-4c87-a3d7-a42d0021c095 base

xgboost\_0.90-py3.6 4ff8d6c2-1343-4c18-85e1-689c965304d3 base

pytorch-onnx\_1.1-py3.6 50f95b2a-bc16-43bb-bc94-b0bed208c60b base

autoai-ts\_3.9-py3.8 52c57136-80fa-572e-8728-a5e7cbb42cde base

spark-mllib\_2.4-scala\_2.11 55a70f99-7320-4be5-9fb9-9edb5a443af5 base

spark-mllib\_3.0 5c1b0ca2-4977-5c2e-9439-ffd44ea8ffe9 base

autoai-obm\_2.0 5c2e37fa-80b8-5e77-840f-d912469614ee base

spss-modeler\_18.1 5c3cad7e-507f-4b2a-a9a3-ab53a21dee8b base

cuda-py3.8 5d3232bf-c86b-5df4-a2cd-7bb870a1cd4e base

autoai-kb\_3.1-py3.7 632d4b22-10aa-5180-88f0-f52dfb6444d7 base

pytorch-onnx\_1.7-py3.8 634d3cdc-b562-5bf9-a2d4-ea90a478456b base

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Note: Only first 50 records were displayed. To display more use 'limit' parameter.

In [89]:

software\_spec\_uid **=** client**.**software\_specifications**.**get\_uid\_by\_name("runtime-22.1-py3.9")

software\_spec\_uid

Out[89]:

'12b83a17-24d8-5082-900f-0ab31fbfd3cb'

In [90]:

model\_details **=** client**.**repository**.**store\_model(model**=**'project.tgz',meta\_props**=**{

client**.**repository**.**ModelMetaNames**.**NAME: "CNN",

client**.**repository**.**ModelMetaNames**.**TYPE: "tensorflow\_2.7",

client**.**repository**.**ModelMetaNames**.**SOFTWARE\_SPEC\_UID: software\_spec\_uid}

)

model\_id **=** client**.**repository**.**get\_model\_uid(model\_details)

This method is deprecated, please use get\_model\_id()

/opt/conda/envs/Python-3.9/lib/python3.9/site-packages/ibm\_watson\_machine\_learning/repository.py:1453: UserWarning: This method is deprecated, please use get\_model\_id()

warn("This method is deprecated, please use get\_model\_id()")

In [91]:

model\_id

Out[91]:

'403cbf90-c760-40a3-8ea3-bd4d8e533357'

In [ ]:

loss\_and\_acc**=**model**.**evaluate(test\_img,test\_lab,verbose**=**2)

print("Test Loss", loss\_and\_acc[0])

print("Test Accuracy", loss\_and\_acc[1])

Test Loss 0.582893428286937

Test Accuracy 0.9835000038146973

In [ ]:

In [ ]:

plt**.**imshow(test\_img[0],cmap**=**'gray\_r')

plt**.**title('Actual Value: {}'**.**format(test\_lab[0]))

prediction**=**model**.**predict(test\_img)

plt**.**axis('off')

print('Predicted Value: ',np**.**argmax(prediction[0]))

**if**(test\_lab[0]**==**(np**.**argmax(prediction[0]))):

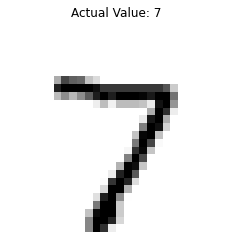
print('Successful prediction')

**else**:

print('Unsuccessful prediction')

Predicted Value: 7

Successful prediction



plt**.**imshow(test\_img[1],cmap**=**'gray\_r')

plt**.**title('Actual Value: {}'**.**format(test\_lab[1]))

prediction**=**model**.**predict(test\_img)

plt**.**axis('off')

print('Predicted Value: ',np**.**argmax(prediction[1]))

**if**(test\_lab[1]**==**(np**.**argmax(prediction[1]))):

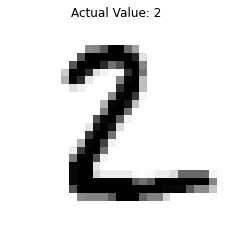
print('Successful prediction')

**else**:

print('Unsuccessful prediction')

Predicted Value: 2

Successful prediction



plt**.**imshow(test\_img[2],cmap**=**'gray\_r')

plt**.**title('Actual Value: {}'**.**format(test\_lab[2]))

prediction**=**model**.**predict(test\_img)

plt**.**axis('off')

print('Predicted Value: ',np**.**argmax(prediction[2]))

**if**(test\_lab[2]**==**(np**.**argmax(prediction[2]))):

print('Successful prediction')

**else**:

print('Unsuccessful prediction')

Predicted Value: 1

Successful prediction

