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"import cv2\n",

"import numpy as np\n",

"from keras.datasets import mnist\n",

"from keras.layers import Dense, Flatten, MaxPooling2D, Dropout\n",

"from keras.layers.convolutional import Conv2D\n",

"from keras.models import Sequential\n",

"from tensorflow.keras.utils import to\_categorical\n",

"import matplotlib.pyplot as plt"

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"(X\_train, y\_train), (X\_test, y\_test) = mnist.load\_data()"

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"plt.imshow(X\_train[0], cmap=\"gray\")\n",

"plt.show()\n",

"print (y\_train[0])"

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"print (\"Shape of X\_test: {}\".format(X\_test.shape))\n",

"print (\"Shape of y\_test: {}\".format(y\_test.shape))"

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"Shape of y\_test: (10000,)\n"

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"y\_train = to\_categorical(y\_train)\n",

"y\_test = to\_categorical(y\_test)"

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"model = Sequential()\n",

"\n",

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"layer\_1 = Conv2D(64, kernel\_size=3, activation='relu', input\_shape=(28, 28, 1))\n",

"layer\_2 = MaxPooling2D(pool\_size=2)\n",

"layer\_3 = Conv2D(32, kernel\_size=3, activation='relu')\n",

"layer\_4 = MaxPooling2D(pool\_size=2)\n",

"layer\_5 = Dropout(0.5)\n",

"layer\_6 = Flatten()\n",

"layer\_7 = Dense(128, activation=\"relu\")\n",

"layer\_8 = Dropout(0.5)\n",

"layer\_9 = Dense(10, activation='softmax')\n",

"\n",

"##ADD THE LAYERS TO THE MODEL\n",

"model.add(layer\_1)\n",

"model.add(layer\_2)\n",

"model.add(layer\_3)\n",

"model.add(layer\_4)\n",

"model.add(layer\_5)\n",

"model.add(layer\_6)\n",

"model.add(layer\_7)\n",

"model.add(layer\_8)\n",

"model.add(layer\_9)"

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"model.compile(optimizer='adam', loss='categorical\_crossentropy', metrics=['accuracy'])"

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"model.fit(X\_train, y\_train, validation\_data=(X\_test, y\_test), epochs=3)"

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"Epoch 2/3\n",

"1875/1875 [==============================] - 83s 44ms/step - loss: 0.2960 - accuracy: 0.9122 - val\_loss: 0.0714 - val\_accuracy: 0.9779\n",

"Epoch 3/3\n",

"1875/1875 [==============================] - 81s 43ms/step - loss: 0.2110 - accuracy: 0.9369 - val\_loss: 0.0559 - val\_accuracy: 0.9836\n"

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"example = X\_train[1]\n",

"prediction = model.predict(example.reshape(1, 28, 28, 1))\n",

"print (\"Prediction (Softmax) from the neural network:\\n\\n {}\".format(prediction))\n",

"hard\_maxed\_prediction = np.zeros(prediction.shape)\n",

"hard\_maxed\_prediction[0][np.argmax(prediction)] = 1\n",

"print (\"\\n\\nHard-maxed form of the prediction: \\n\\n {}\".format(hard\_maxed\_prediction))\n",

"\n",

"print (\"\\n\\n--------- Prediction --------- \\n\\n\")\n",

"plt.imshow(example.reshape(28, 28), cmap=\"gray\")\n",

"plt.show()\n",

"print(\"\\n\\nFinal Output: {}\".format(np.argmax(prediction)))"

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"1/1 [==============================] - 0s 114ms/step\n",

"Prediction (Softmax) from the neural network:\n",

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" 1.6004112e-10 1.7066007e-07 7.1788651e-11 4.5166394e-07 2.4545757e-08]]\n",

"\n",

"\n",

"Hard-maxed form of the prediction: \n",

"\n",

" [[1. 0. 0. 0. 0. 0. 0. 0. 0. 0.]]\n",

"\n",

"\n",

"--------- Prediction --------- \n",

"\n",

"\n"

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