```
{
"nbformat": 4,
"nbformat_minor": 0,
 "metadata": {
  "colab": {
   "provenance": []
  },
  "kernelspec": {
   "name": "python3",
   "display_name": "Python 3"
  },
  "language_info": {
   "name": "python"
  }
},
"cells": [
  {
   "cell_type": "code",
   "source": [
    "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"
   ],
   "metadata": {
    "id": "yJs2eLRLOSHM"
   },
   "execution_count": 1,
   "outputs": []
  },
```

```
{
 "cell_type": "code",
 "source": [
  "(X_train, y_train), (X_test, y_test) = mnist.load_data()"
],
 "metadata": {
  "id": "-NoTriNEPBWI"
 },
 "execution_count": 3,
 "outputs": []
},
 "cell_type": "code",
 "source": [
  "plt.imshow(X_train[0], cmap=\"gray\")\n",
  "plt.show()\n",
  "print (y_train[0])"
],
 "metadata": {
  "colab": {
   "base_uri": "https://localhost:8080/",
   "height": 282
  },
  "id": "s_JYjDk2PGwL",
  "outputId": "b42ae095-36e0-4014-80ac-afabaead8ec7"
 },
 "execution_count": 4,
 "outputs": [
   "output_type": "display_data",
   "data": {
    "text/plain": [
     "<Figure size 432x288 with 1 Axes>"
    ],
```

"image/png":

"iVBORw0KGgoAAAANSUhEUgAAAPsAAAD4CAYAAAAq5pAIAAAABHNCSVQICAgIfAhkiAAAAAlwSFIzAAALEgAACxI B0t1+/AAAADh0RVh0U29mdHdhcmUAbWF0cGxvdGxpYiB2ZXJzaW9uMy4yLjIsIGh0dHA6Ly9tYXRwbG90bGliLm9y Zy+WH4yJAAAN9kIEQVR4nO3df4xV9ZnH8c+zWP6QojBrOhKKSyEGg8ZON4gbl6w1hvojGhw1TSexoZE4/YNJaLlhNe wf1WwwZBU2SzTNTKMWNl1qEzUgaQouoOzGhDgiKo5LdQ2mTEaowZEf/mCHefaPezBTnfu9w7nn3nOZ5/1Kbu69 57nnnicnfDi/7pmvubsATH5/VXYDAJqDsANBEHYgCMIOBEHYgSAuaubCzIxT/0CDubuNN72uLbuZ3Wpmh8zsPTN7sJ 7vAtBYlvc6u5lNkfRHSUslHZH0qqQudx9IzMOWHWiwRmzZF0t6z93fd/czkn4raVkd3weggeoJ+2xJfxrz/kg27S+YWbe Z9ZtZfx3LAlCnhp+gc/c+SX0Su/FAmerZsg9KmjPm/bezaQBaUD1hf1XSIWb2HTObKulHkrYV0xaAouXejXf3ETPrkbRD0 hRJT7n724V1BqBQuS+95VoYx+xAwzXkRzUALhyEHQiCsANBEHYgCMIOBEHYgSAIOxAEYQeCIOxAEIQdCIKwA0EQdi Alwg4EQdiBIAg7EARhB4lg7EAQhB0lgrADQRB2IAjCDgRB2IEgCDsQBGEHgiDsQBCEHQiCsANBEHYgCMIOBJF7yGZcG KZMmZKsX3rppQ1dfk9PT9XaxRdfnJx3wYIFyfrKlSuT9ccee6xgraurKznv559/ngvvW7cuWX/44YeT9TLUFXYzOyzppKS zkkbcfVERTQEoXhFb9pvc/aMCvgdAA3HMDgRRb9hd0k4ze83Musf7gJl1m1m/mfXXuSwAdah3N36Juw+a2bckvWh m/+Pue8d+wN37JPVJkpl5ncsDkFNdW3Z3H8yej0l6XtLilpoCULzcYTezaWY2/dxrST+QdLCoxgAUq57d+HZJz5vZue/5 D3f/QyFdTTJXXHFFsj516tRk/YYbbkjWlyxZUrU2Y8aM5Lz33HNPsl6mI0eOJOsbN25M1js7O6vWTp48mZz3jTfeSNZff vnlZL0V5Q67u78v6bsF9gKggbj0BgRB2IEgCDsQBGEHgiDsQBDm3rwftU3WX9B1dHQk67t3707WG32baasaHR1N1u +///5k/dSpU7mXPTQ0lKx//PHHyfqhQ4dyL7vR3N3Gm86WHQiCsANBEHYgCMIOBEHYgSAIOxAEYQeC4Dp7Adra2pL 1ffv2Jevz5s0rsp1C1ep9eHg4Wb/pppuq1s6cOZOcN+rvD+rFdXYgOMIOBEHYgSAIOxAEYQeCIOxAEIQdCIIhmwtw/Pjx ZH316tXJ+h133JGsv/7668l6rT+pnHLgwlFkfenSpcn66dOnk/Wrr766am3VqlXJeVEstuxAEIQdClKwA0EQdiAlwg4EQdi BIAg7EAT3s7eASy65JFmvNbxwb29v1dqKFSuS8953333J+pYtW5J1tJ7c97Ob2VNmdszMDo6Z1mZmL5rZu9nzzCKbB VC8iezG/1rSrV+Z9qCkXe5+paRd2XsALaxm2N19r6Sv/h50maRN2etNku4quC8ABcv72/h2dz83WNaHktqrfdDMuiV1 51wOgILUfSOMu3vqxJu790nqkzhBB5Qp76W3o2Y2S5Ky52PFtQSgEfKGfZuk5dnr5ZK2FtMOgEapuRtvZlskfV/SZWZ2 RNIvJK2T9DszWyHpA0k/bGSTk92JEyfqmv+TTz7JPe8DDzyQrD/zzDPJeq0x1tE6aobd3buqlG4uuBcADcTPZYEgCDsQB GEHgiDsQBCEHQiCW1wngWnTplWtvfDCC8l5b7zxxmT9tttuS9Z37tyZrKP5GLIZCI6wA0EQdiAlwg4EQdiBlAg7EARhB 4LgOvskN3/+/GR9//79yfrw8HCyvmfPnmS9v7+/au2JJ55IztvMf5uTCdfZgeAIOxAEYQeCIOxAEIQdCIKwA0EQdiAIrrM H19nZmaw//fTTyfr06dNzL3vNmjXJ+ubNm5P1oaGhZD0qrrMDwRF2IAjCDgRB2IEgCDsQBGEHgiDsQBBcZ0fSNddck6 xv2LAhWb/55vyD/fb29ibra9euTdYHBwdzL/tClvs6u5k9ZWbHzOzgmGkPmdmgmR3IHrcX2SyA4k1kN/7Xkm4dZ/q/u ntH9vh9sW0BKFrNsLv7XknHm9ALgAaq5wRdj5m9me3mz6z2ITPrNrN+M6v+x8gANFzesP9S0nxJHZKGJK2v9kF373P 3Re6+KOeyABQgV9jd/ai7n3X3UUm/krS42LYAFC1X2M1s1pi3nZIOVvssgNZQ8zq7mW2R9H1Jl0k6KukX2fsOSS7psK SfunvNm4u5zj75zJgxl1m/8847q9Zq3StvNu7l4i/t3r07WV+6dGmyPllVu85+0QRm7Bpn8pN1dwSgqfi5LBAEYQeClOx AEIQdCIKwA0FwiytK88UXXyTrF12Uvlg0MjKSrN9yyy1Vay+99FJy3gsZf0oaCl6wA0EQdiAlwg4EQdiBIAg7EARhB4Koe dcbYrv22muT9XvvvTdZv+6666rWal1Hr2VgYCBZ37t3b13fP9mwZQeCIOxAEIQdCIKwA0EQdiAlwg4EQdiBILjOPsktW LAgWe/p6UnW7777mT98ssvP++eJurs2bPJ+tBQ+q+Xj46OFtnOBY8tOxAEYQeClOxAEIQdClKwA0EQdiAlwg4EwXX 2COCta9ldXeMNtFtR6zr63Llz87RUiP7+/mR97dq1yfq2bduKbGfSq7llN7M5ZrbHzAbM7G0zW5VNbzOzF83s3ex5ZuP bBZDXRHbjRyT9o7svlPR3klaa2UJJD0ra5e5XStqVvQfQomqG3d2H3H1/9vqkpHckzZa0TNKm7GObJN3VqCYB1O+8jt nNbK6k70naJ6nd3c/90PlDSe1V5umW1J2/RQBFmPDZeDP7pqRnJf3M3U+MrXlldMhxB2109z53X+Tui+rqFEBdJhR2 M/uGKkH/jbs/I00+amazsvosScca0yKAItTcjTczk/SkpHfcfcOY0jZJyyWty563NqTDSaC9fdwjnC8tXLgwWX/88ceT9auu uuq8eyrKvn37kvVHH320am3r1vQ/GW5RLdZEjtn/XtKPJb1lZgeyaWtUCfnvzGyFpA8k/bAxLQIoQs2wu/t/Sxp3cHdJN xfbDoBG4eeyQBCEHQiCsANBEHYgCMIOBMEtrhPU1tZWtdbb25uct6Ojl1mfN29erp6K8MorryTr69evT9Z37NiRrH/2 2Wfn3RMagy07EARhB4Ig7EAQhB0IgrADQRB2IAiCDgQR5jr79ddfn6yvXr06WV+8eHHV2uzZs3P1VJRPP/20am3jxo3 JeR955JFk/fTp07l6Quthyw4EQdiBIAg7EARhB4Ig7EAQhB0IgrADQYS5zt7Z2VIXvR4DAwPJ+vbt25P1kZGRZD11z/nw8 HByXsTBIhOlgrADQRB2IAjCDgRB2IEgCDsQBGEHgjB3T3/AbI6kzZLaJbmkPnf/NzN7SNIDkv6cfXSNu/++xnelFwagbu4+ 7qjLEwn7LEmz3H2/mU2X9Jqku1QZj/2Uuz820SYIO9B41cl+kfHZhyQNZa9Pmtk7ksr90ywAztt5HbOb2VxJ35O0L5vU Y2ZvmtlTZjazyjzdZtZvZv11dQqgLjV347/8oNk3Jb0saa27P2dm7ZI+UuU4/p9V2dW/v8Z3sBsPNFjuY3ZJMrNvSNouaY e7bxinPlfSdne/psb3EHagwaqFveZuvJmZpCclvTM26NmJu3M6JR2st0kAjTORs/FLJP2XpLckjWaT10jqktShym78YUk/ zU7mpb6LLTvQYHXtxheFsAONl3s3HsDkQNiBIAg7EARhB4Ig7EAQhB0IgrADQRB2IAjCDgRB2IEgCDsQBGEHgiDsQBC EHQii2UM2fyTpgzHvL8umtaJW7a1V+5LoLa8ie/ubaoWm3s/+tYWb9bv7otlaSGjV3lq1L4ne8mpWb+zGA0EQdiClssP eV/LyU1q1t1btS6K3vJrSW6nH7ACap+wtO4AmlexAEKWE3cxuNbNDZvaemT1YRg/VmNlhM3vLzA6UPT5dNobeMT M70GZam5m9aGbvZs/jjrFXUm8Pmdlgtu4OmNntJfU2x8z2mNmAmb1tZquy6aWuu0RfTVIvTT9mN7Mpkv4oaamkI 5JeldTl7gNNbaQKMzssaZG7l/4DDDP7B0mnJG0+N7SWmf2LpOPuvi77j3Kmu/+8RXp7SOc5jHeDeqs2zPhPVOK6K3L 48zzK2LIvIvSeu7/v7mck/VbSshL6aHnuvIfS8a9MXiZpU/Z6kyr/WJquSm8twd2H3H1/9vqkpHPDjJe67hJ9NUUZYZ8t6 U9j3h9Ra4337pJ2mtlrZtZddjPjaB8zzNaHktrLbGYcNYfxbqavDDPeMusuz/Dn9eIE3dctcfe/IXSbpJXZ7mpL8soxWCtdO /2lpPmqiAE4JGl9mc1kw4w/K+ln7n5ibK3MdTdOX01Zb2WEfVDSnDHvv51NawnuPpg9H5P0vCqHHa3k6LkRdLPnYy

 $X38yV3P+ruZ919VNKvVOK6y4YZf1bSb9z9uWxy6etuvL6atd7KCPurkq40s++Y2VRJP5K0rYQ+vsbMpmUnTmRm0yT9\\ QK03FPU2Scuz18slbS2xl7/QKsN4VxtmXCWvu9KHP3f3pj8k3a7KGfn/lfRPZfRQpa95kt7lHm+X3ZukLars1v2fKuc2Vkj6a0m7JL0r6T8ltbVQb/+uytDeb6oSrFkl9bZElV30NyUdyB63l73uEn01Zb3xc1kgCE7QAUEQdiAlwg4EQdiBlAg7EARhB4lg7EAQ/w8ie3GmjcGk5QAAAABJRU5ErkJggg==<math>\n$ "

```
},
   "metadata": {
    "needs_background": "light"
   }
  },
   "output_type": "stream",
   "name": "stdout",
   "text":[
    "5\n"
   ]
  }
]
},
 "cell_type": "code",
 "source": [
  "print (\"Shape of X_train: {}\".format(X_train.shape))\n",
  "print (\"Shape of y_train: {}\".format(y_train.shape))\n",
  "print (\"Shape of X_test: {}\".format(X_test.shape))\n",
  "print (\"Shape of y_test: {}\".format(y_test.shape))"
 ],
 "metadata": {
  "colab": {
   "base uri": "https://localhost:8080/"
  },
  "id": "Us6HotvxPPco",
  "outputId": "df6fdfe3-e423-4c9a-9354-bad2e9ff1a7e"
 },
 "execution_count": 5,
 "outputs": [
```

```
{
   "output_type": "stream",
   "name": "stdout",
   "text":[
    "Shape of X_train: (60000, 28, 28)\n",
    "Shape of y_train: (60000,)\n",
    "Shape of X_test: (10000, 28, 28)\n",
    "Shape of y_test: (10000,)\n"
   ]
  }
 ]
},
 "cell_type": "code",
 "source": [
  "# Reshaping so as to convert images for our model\n",
  "X_train = X_train.reshape(60000, 28, 28, 1)\n",
  "X_test = X_test.reshape(10000, 28, 28, 1)"
],
 "metadata": {
  "id": "n962FFkFPUzH"
 },
 "execution_count": 6,
 "outputs": []
},
 "cell_type": "code",
 "source": [
  "print (\"Shape of X_train: {}\".format(X_train.shape))\n",
  "print (\"Shape of y_train: {}\".format(y_train.shape))\n",
  "print (\"Shape of X_test: {}\".format(X_test.shape))\n",
  "print (\"Shape of y_test: {}\".format(y_test.shape))"
],
 "metadata": {
```

```
"colab": {
   "base_uri": "https://localhost:8080/"
  },
  "id": "KZEPs_m5PZac",
  "outputId": "97de7d4c-aedf-4c45-f3e9-5a7942778088"
 },
 "execution_count": 7,
 "outputs": [
  {
   "output_type": "stream",
   "name": "stdout",
   "text": [
    "Shape of X_train: (60000, 28, 28, 1)\n",
    "Shape of y_train: (60000,)\n",
    "Shape of X_test: (10000, 28, 28, 1)\n",
    "Shape of y_test: (10000,)\n"
   ]
 }
 ]
}
```

]

}