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# Handwritten Digit Recognition

# using Python

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## Python Deep Learning Project

To make machines more intelligent, the developers are diving into machine learning and deep learning techniques. A human learns to perform a task by practicing and repeating it again and again so that it memorizes how to perform the tasks. Then the

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neurons in his

brain

automatically  
trigger and they

can quickly

perform the

task they have  
learned. Deep

learning is also  
very similar to

this. It uses  
different types

of neural

network

architectures  
for different

types of

problems. **For**

**example –**

object

recognition,

image and

sound

classification,

object

detection,

image

segmentation,

etc.

This is the 11th  
project in the  
DataFlair's  
series of 20

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Python projects.

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# What is Handwritten Digit Recognition?

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handwritten  
digit

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◆ Project – Handwritten Chara...

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◆ Project – Breast Cancer Classi...

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◆ Project – Gender & Age Detec...

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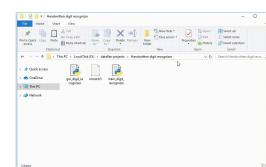
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recognition is  
the ability of  
computers to  
recognize  
human  
handwritten  
digits. It is a  
hard task for  
the machine  
because  
handwritten  
digits are not  
perfect and can  
be made with  
many different  
flavors. The  
handwritten  
digit  
recognition is  
the solution to  
this problem  
which uses the  
image of a digit  
and recognizes  
the digit present  
in the image.

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# About the Python Deep Learning Project



In this article, we are going to implement a handwritten digit recognition app using the MNIST dataset.

We will be using a special type of deep neural network that is

## Convolutional Neural Networks

In the end, we are going to build a GUI in which you can draw the digit and

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recognize it  
straight away.

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◆ **Project – Handwritten Di...**

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◆ Project – Stock Price Prediction

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◆ Project – Detecting Fake News

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◆ Project – Color Detection

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◆ Project – Face Mask Detection

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◆ Project – Music Genre Classif...

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◆ Project – Sign Language Reco...

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◆ Project – Speech Emotion Re...

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◆ Project – Handwritten Chara...

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◆ Project – Breast Cancer Classi...

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◆ Project – Gender & Age Detec...

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◆ Project – Image Segmentation

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## Prerequisites

The interesting Python project requires you to have basic knowledge of Python programming, deep learning with Keras library and the Tkinter library for building GUI.

Install the necessary libraries for this project using this command:

```
1. pip
   insta
   numpy
   tenso
   keras
   pillo
```

## The MNIST

# dataset

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This is probably one of the most popular datasets among machine learning and deep learning enthusiasts. The [MNIST dataset](#) contains 60,000 training images of handwritten digits from zero to nine and 10,000 images for testing. So, the MNIST dataset has 10 different classes. The handwritten digits images are represented as a  $28 \times 28$  matrix where each cell contains grayscale pixel value.

[Download the  
full source  
code for the  
project](#)

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# Building Python Deep Learning Project on Handwritten Digit Recognition

Below are the steps to implement the handwritten digit

recognition

project:

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# 1. Import the libraries and load the dataset

First, we are going to import all the modules that we are going to need for training our model. The Keras library already contains some datasets and MNIST is one of them. So we can easily import the dataset and start working with it. The **mnist.load\_data()** method returns us the training data, its labels and

also the testing  
data and its  
labels.

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```

1.  impo
2.  from
3.  impor
4.  from
5.  impor
6.  from
7.  #
8.  betwe
9.  (x_t
10. (x_te
11. prin
     , y_t
  
```

## 2. Preproce ss the data

The image data  
cannot be fed  
directly into the  
model so we  
need to  
**perform**  
**some**  
**operations**  
**and process**

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the data to make it ready for our neural network. The dimension of the training data is (60000,28,28). The CNN model will require one more dimension so we reshape the matrix to shape (60000,28,28,1).

```

1. x_tr
x_tr
28, 2
2. x_te
x_tes
28, 1
3. inpu
4.
5. # co
class
6. y_tr
keras
num_c
7. y_te
keras
num_c
8.
9. x_tr
x_tr
10. x_te
11. x_tr
12. x_te
13. prin
x_tr
14. prin
sampl
15. prin
sampl

```

### 3. Create the model

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Now we will **create our CNN model** in Python data science project. A CNN model generally consists of convolutional and pooling layers. It works better for data that are represented as grid structures, this is the reason why CNN works well for image classification problems. The dropout layer is used to deactivate some of the neurons and while training, it reduces over fitting of the

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model. We will then compile the model with the Adadelta optimizer.

```

1. batch_size
2. num_epochs
3. mode
4.
5. mode
6. mode
7. mode
8. mode
9. mode
10. mode
11. mode
12. mode
13. mode
14.
15. mode
['acc']

```

## 4. Train the model

The **model.fit()** function of Keras will start the training of the model. It takes the **training data, validation data, epochs, and batch size**.

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It takes some time to train ... model. After training, we save the weights and model definition in the ‘mnist.h5’ file.

- |    |       |
|----|-------|
| 1. | hist  |
|    | y_tra |
|    | y_tes |
| 2. | prin  |
| 3. |       |
| 4. | mode  |
| 5. | prin  |

## 5. Evaluate the model

We have 10,000 images in our dataset which will be used to **evaluate how good our model works.**

The testing data was not involved in the training of the data therefore, it is new data

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for our model.

The MNIST dataset is well balanced so we can get around 99% accuracy.

```
1. scor
model
y_tes
2. prin
score
3. prin
accur
```

## 6. Create GUI to predict digits

Now for the GUI, we have created a new file in which we **build an interactive window to draw digits on canvas** and with a button, we can recognize the digit. The Tkinter library comes in the

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Python standard library. We have created a function **predict\_digit()** that takes the image as input and then uses the trained model to predict the digit.

Then we **create the App class** which is responsible for building the GUI for our app. We create a canvas where we can draw by capturing the mouse event and with a button, we trigger the `predict_digit()` function and display the results.

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Here's the full  
code for our  
gui\_digit\_recog  
nizer.py file:

```

1.  from
2.  load_
3.  from
4.  impo
5.  from
6.  Image
7.  impo
8.  mode
9.
10. def
11. pixel
12.
13.
14.
15.
16. model
17. img.r
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21. [0]
22. max(r
23. clas
24.
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31. tk.Ca
32. heigh
33. curso
34. tk.La
35. text=
36. ("Hel
37. tk.Bu
38. "Reco
39. self.
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- Python Projects +
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## Summary

In this article, we have successfully built a Python deep learning project on handwritten digit recognition app.

We have built and trained the Convolutional neural network which is very effective for image

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classification purposes. Later, we build the GUI where we draw a digit on the canvas then we classify the digit and show the results.

**Want to get hired as a Python expert? Practice the 150+ Python Interview Questions by DataFlair**

Do share your views regarding the intermediate Python project in the comment section.

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Tags:

deep learning

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## 122 RESPONSES



**Comments 40**



**Pingbacks 0**

**uzmah**

① May 26,

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ply**kn187**May 31,  
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Hi!

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I was wonderin g if anyone else had this problem, as I'm

## Python Projects +

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July

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May

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**Bui Le****Ngoc Min**

⌚ June 3,

2021 at

11:21 pm

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[Reply](#)

**Bui Le**

**Ngoc Min**

⌚ June 4,

2021 at

12:44 am

I find the  
problem, I  
add this  
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img = 1 -

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It work  
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[Reply](#)

**arjun**

⌚

June

14,

2021

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### **Yogesh**

①

June

13,

2021

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### **Carina**

① June 7,

2021 at 1:45

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[Reply](#)

**kn187**

⌚ June 9,

2021 at

4:00 pm

@Bui Le

Ngoe Min

hi, can

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solution.

It still

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[Reply](#)

**Allwyn**

**Vincent**

⌚ June 12,

2021 at 3:12

pm

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## Python Projects +

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### Python Django Projects +

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◆ 70+ Project Ideas & Datasets

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## Deep Learning Projects +

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[Reply](#)

### **Yogesh**

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### **DataFlair**

10, 2021

at 5:53

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**Vamsi****Krishna**

⌚ June 15,

2021 at

10:21 am

it is

always

showing 2

with

different

accuracy

values

Reply**uzmah**

⌚ June 15,

2021 at

5:27 pm

same

issue

Reply

**uzmah**

① Jun 10,

2021 at

5:33 pm

please

check like

this we

add this

line .... it's

really

urgent!!!!

before

this???

img=1-

img

def

predict\_di

git(img):

#resize

image to

28×28

pixels

img =

img.resize

((28,28))

#convert

rgb to

grayscale

img =

img.conve

rt('L')

img =

np.array(i

mg)

#reshapin

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Python Projects +

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◆ 70+ Project Ideas &amp; Datasets

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Deep Learning Projects +

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AI Projects +

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Python Interview Questi... +

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Python Quiz +

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ng

img =

img.reshape(1,28,2

8,1)

img =

img/255.0

#predictin

g the class

res =

model.pre

dict([img]

)[o]

return

np.argmax

x(res),

max(res)

[Reply](#)

### Mamta

① [July 12,](#)

[2021 at](#)

[8:41 pm](#)

Very good

informati

on.

[Reply](#)

### Ritika

#### Budhiraja

① [July 14,](#)

[2021 at 1:37](#)

[am](#)

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Python Projects +

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Python Django Projects +

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Machine Learning Proj... ×

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Deep Learning Projects	+
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Python Interview Questi... +	
Python Quiz	+

named  
 ‘keras’  
 how to  
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 .h5 file in  
 python  
 Please tell  
 me how to  
 import the  
 module, I  
 am unable  
 to run the  
 code!!  
[Reply](#)

**Justin**

⌚  
[August](#)  
16,  
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**SHAFIN****JUNAYED**⌚ July 29,2021 at12:01 am

I am

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module

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no

attribute

Python Projects

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Python Django Projects

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Machine Learning Proj...

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◆ Machine Learning Projects wi...

◆ Project – Image Cartoonifier

◆ **Project – Handwritten Di...**

◆ Project – Stock Price Prediction

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◆ 70+ Project Ideas &amp; Datasets

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◆ Project – Drowsiness Detecti...	
◆ Project – Real-time Human D...	
◆ 70+ Project Ideas & Datasets	
Deep Learning Projects	+
AI Projects	+
Python Interview Questi... +	
Python Quiz	+

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shape:

(60000,

28, 28, 1)

60000

train

samples

10000

test

samples

2021-08-

09

16:32:45.9

19014: I

tensorflow

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form/cpu

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42] This

TensorFlo

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Library

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Python Projects +

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◆ 70+ Project Ideas & Datasets	
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AI Projects	+
Python Interview Questi...	+
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2021-08-

09

16:32:46.1

38644: I

tensorflow

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176] None

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Epoch

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p - loss:

2.3054 -

accuracy:

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2.2957 -

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◆ 70+ Project Ideas & Datasets

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Epoch

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26s

56ms/ste

p - loss:

2.2952 -

accuracy:

0.1102 -

val\_loss:

2.2854 -

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acy:

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Epoch

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31s

66ms/ste

p - loss:

2.2861 -

accuracy:

0.1230 -

val\_loss:

2.2750 -

val\_accur

Python Projects +

Python Django Projects +

Machine Learning Proj... ×

◆ Machine Learning Projects wi...

◆ Project – Image Cartoonifier

◆ **Project – Handwritten Di...**

◆ Project – Stock Price Prediction

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◆ 70+ Project Ideas & Datasets

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Epoch

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30s

63ms/ste

p - loss:

2.2764 -

accuracy:

0.1369 -

val\_loss:

2.2639 -

val\_accur

acy:

0.1136

Epoch

5/10

469/469

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27s

57ms/step

- loss:

2.2667 -

accuracy:

0.1486 -

val\_loss:

2.2518 -

val\_accur

Python Projects +

Python Django Projects +

Machine Learning Proj... ×

◆ Machine Learning Projects wi...

◆ Project – Image Cartoonifier

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◆ 70+ Project Ideas & Datasets

Deep Learning Projects +

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acy:

0.1296

Epoch

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27s

58ms/ste

p - loss:

2.2557 -

accuracy:

0.1612 -

val\_loss:

2.2382 -

val\_accur

acy:

0.1483

Epoch

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26s

56ms/ste

p - loss:

2.2435 -

accuracy:

0.1764 -

val\_loss:

2.2231 -

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Python Projects +

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Machine Learning Proj... ×

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◆ 70+ Project Ideas & Datasets

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Deep Learning Projects +

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acy:

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Epoch

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27s

57ms/step

- loss:

2.2302 -

accuracy:

0.1907 -

val\_loss:

2.2059 -

val\_accur

acy:

0.1919

Epoch

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469/469

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26s

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- loss:

2.2156 -

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Python Quiz +

acy:

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Epoch

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26s

55ms/step

- loss:

2.1998 -

accuracy:

0.2178 -

val\_loss:

2.1653 -

val\_accur

acy:

0.2797

The model

has

successful

ly trained

Test loss:

2.1652829

64706421

Test

accuracy:

0.279700

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835

Saving the

model as

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Process

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## Python Projects +

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◆ Project – Real-time Human D...

◆ 70+ Project Ideas & Datasets

### Deep Learning Projects +

### AI Projects +

### Python Interview Questi... +

### Python Quiz +

**Lukas**

① August

10, 2021 at

2:04 am

AttributeE

rror

Traceback

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18

19 #

convert

class

vectors to

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→ 20

y\_train =

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21 y\_test

=

keras.utils

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ses)

22

AttributeE

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module

'keras.util

s' has no

attribute

'to\_catego  
rical'

I am

getting

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message,

not sure

how to fix.

Can

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Reply**DataFlair**

①

November10, 2021

at 5:54

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Python Projects +

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Deep Learning Projects +

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◆ Project – Image Cartoonifier

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◆ **Project – Handwritten Di...**

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◆ Project – Stock Price Prediction

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◆ Project – Detecting Fake News

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◆ Project – Color Detection

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◆ 70+ Project Ideas & Datasets

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Deep Learning Projects +

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Python Projects +

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◆ **Project – Handwritten Di...**

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Deep Learning Projects +

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Re

ply

**Justin**① August16, 2021 at5:53 am

The code  
for  
opening  
the model  
is  
wrong!!!!

```
def
predict_di
git(img):
#resize
image to
28x28
pixels
img =
img.resize
((28,28))
#convert
rgb to
grayscale
img =
img.conve
```

Python Projects +

Python Django Projects +

Machine Learning Proj... ×

◆ Machine Learning Projects wi...

◆ Project – Image Cartoonifier

◆ **Project – Handwritten Di...**

◆ Project – Stock Price Prediction

◆ Project – Detecting Fake News

◆ Project – Color Detection

◆ Project – Face Mask Detection

◆ Project – Music Genre Classif...

◆ Project – Sign Language Reco...

◆ Project – Speech Emotion Re...

◆ Project – Handwritten Chara...

◆ Project – Breast Cancer Classi...

◆ Project – Gender &amp; Age Detec...

◆ Project – Image Segmentation

◆ Project – Drowsiness Detecti...

◆ Project – Real-time Human D...

◆ 70+ Project Ideas &amp; Datasets

Deep Learning Projects +

AI Projects +

Python Interview Questi... +

Python Quiz +

Python Projects	+
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Machine Learning Proj...	×
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◆ Project – Gender & Age Detec...	
◆ Project – Image Segmentation	
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◆ Project – Real-time Human D...	
◆ 70+ Project Ideas & Datasets	
Deep Learning Projects	+
AI Projects	+
Python Interview Questi... +	
Python Quiz	+

```

rt('L')
img =
ImageOps
.invert(im
g)
img =
np.array(i
mg)
#reshapin
g to
support
our model
input and
normalizi
ng
img =
img.resha
pe(1,28,2
8,1)
img =
img/255.0
#predictin
g the class
res =
model.pre
dict([img]
)[o]
return
np.argmax
x(res),
max(res)

Use this
instead!!
(Import
statement
) from PIL
import
ImageGra

```

b,

Image

Reason:

The image

is

inverted,

the black

is white

and the

white is

black, in

the

training

data the

writing is

white, but

in actual

testing

with real

hand

writing,

the

writing is

black,

which is

confusing

the neural

network!

[Reply](#)

**Jens**

**Nordmark**

⌚

[September](#)

[14, 2021 at](#)

[1:14 pm](#)

Apart

from the

issue with

Python Projects

+

Python Django Projects

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Machine Learning Proj...

×

◆ Machine Learning Projects wi...

◆ Project – Image Cartoonifier

◆ **Project – Handwritten Di...**

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◆ Project – Real-time Human D...

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Deep Learning Projects

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AI Projects

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Python Interview Questi... +

Python Quiz

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inverting

the im

the

learning

parameter

s differ

significant

ly between

the code

in the

Google

drive

repository

and the

text on

this

webpage.

Check

that out in

order to

get better

results.

[Reply](#)

**tho**

⌚ January

21, 2022 at

10:59 am

should

change

the

classify\_h

andwritin

g method:

def

classify\_h

andwritin

g(self):

HWND =

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Python Projects +

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Python Django Projects +

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Machine Learning Proj... ×

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◆ Machine Learning Projects wi...

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◆ Project – Image Cartoonifier

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◆ **Project – Handwritten Di...**

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Deep Learning Projects +

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Python Projects	+
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Machine Learning Proj...	×
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◆ Project – Speech Emotion Re...	
◆ Project – Handwritten Chara...	
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◆ Project – Gender & Age Detec...	
◆ Project – Image Segmentation	
◆ Project – Drowsiness Detecti...	
◆ Project – Real-time Human D...	
◆ 70+ Project Ideas & Datasets	
Deep Learning Projects	+
AI Projects	+
Python Interview Questi...	+
Python Quiz	+

```

self.canva
s.winf
() # get
the handle
of the
canvas
rect =
win32gui.
GetWindo
wRect(H
WND) #
get the
coordinat
e of the
canvas
a,b,c,d =
rect
rect=
(a+4,b+4,
c+100,d+1
00)
im =
ImageGra
b.grab(rec
t)

digit, acc
=
predict_di
git(im)
self.label.c
onfigure(t
ext=
str(digit)+
','+
str(int(acc
*100))+'%
')

```

[Reply](#)

**nugie**① Febr2, 2022 at9:44 pmHello, I'm  
using

Ubuntu

18.04,  
when I

tried the

“pip  
install  
pywin32”  
command  
I got the  
following  
error:ERROR:  
Could notfind a  
version  
thatsatisfies  
the  
requirement  
pywin32  
(fromversions:  
none)

ERROR:

No  
matching  
distribution found  
for  
pywin32

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Python Projects 

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Python Django Projects 

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Machine Learning Proj... 

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◆ Machine Learning Projects wi... 

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◆ Project – Image Cartoonifier 

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◆ **Project – Handwritten Di...** 

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Deep Learning Projects 

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AI Projects 

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Python Interview Questi... 

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Python Quiz 

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Any  
solution  
for this?

Thanks a  
lot for a  
great  
tutorial!

[Reply](#)

**Pankaj  
Sharma**

⌚ February  
3, 2022 at  
8:35 pm

Could not  
find “from  
keras.opti  
mizers  
import  
Adadelta”  
what  
should i  
do for this  
?

[Reply](#)

**Bin  
Mohammed  
Alahmady**

⌚  
March  
7,

2022  
at  
2:57  
am  
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sa

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Python Projects +

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Python Django Projects +

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Machine Learning Proj... ×

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Deep Learning Projects +

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Python Projects	+
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◆ 70+ Project Ideas & Datasets	
Deep Learning Projects	+
AI Projects	+
Python Interview Questi...	+
Python Quiz	+

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Re  
ply**Prajanya****Sahu**④ April 8,2022 at12:18 pm

what

should i

do

AttributeE

rror

Traceback

(most

recent call

last)

d:\COSIN

G VSC

C\gp1.ipynb

nb Cell 2'

in()

3

input\_sha

pe = (28,  
28, 1)

5 #

convert

class

vectors to

binary

class

matrices

--> 6

y\_train =

keras.utils

.to\_catego

rical(y\_tr

ain,

num\_clas

ses)

7 y\_test =

keras.utils

.to\_catego

rical(y\_te

st,

num\_clas

ses)

9 x\_train

=

x\_train.as

type('float

32')

AttributeE

rror:

module

'keras.util

s' has no

attribute

'to\_catego

rical'

[Reply](#)

**Owais**

**Imtiyaz**

**Mirajkar**

⌚ April 13,

2022 at

4:45 pm

This

should

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Python Projects +

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Python Django Projects +

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Machine Learning Proj... ×

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◆ Machine Learning Projects wi...

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◆ Project – Image Cartoonifier

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◆ **Project – Handwritten Di...**

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Python Projects	+
Python Django Projects	+
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◆ Project – Drowsiness Detecti...	
◆ Project – Real-time Human D...	
◆ 70+ Project Ideas & Datasets	
Deep Learning Projects	+
AI Projects	+
Python Interview Questi... +	
Python Quiz	+

work put  
 this at  
 start in  
 train\_digi  
 t  
 " import  
 tensorflow  
 as tf  
 from  
 tensorflow  
 import  
 keras "  
Reply  
**vijay**  
 Ⓜ May 1,  
2022 at  
4:16 pm  
 I am  
 getting  
 just  
 display...  
 with clear  
 and  
 recognize  
 command.  
 not even  
 space for  
 drawing...  
 Just tk  
 diaply is  
 opening .  
 I have no  
 errors, but  
 still not  
 getting  
 output.

Python Projects	+
Python Django Projects	+
Machine Learning Proj...	×
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◆ Project – Image Cartoonifier	
◆ <b>Project – Handwritten Di...</b>	
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◆ Project – Real-time Human D...	
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Deep Learning Projects	+
AI Projects	+
Python Interview Questi... +	
Python Quiz	+

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2022-05-  
01  
16:12:57.7  
05049: I  
tensorflow  
/core/plat  
form/cpu  
\_feature\_  
guard.cc:1  
51] This  
TensorFlo  
w binary  
is  
optimized  
with  
oneAPI  
Deep  
Neural  
Network  
Library  
(oneDNN)  
to use the  
following  
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ns in  
performa  
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critical  
operation  
s: AVX  
AVX2  
To enable  
them in

Python Projects	+
Python Django Projects	+
Machine Learning Proj...	×
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◆ <b>Project – Handwritten Di...</b>	
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AI Projects	+
Python Interview Questi...	+
Python Quiz	+

other  
operat  
s, rebuild  
TensorFlo  
w with the  
appropria  
te  
compiler  
flags.

Pls  
someone  
help in  
solving  
this.

tried on  
Visual  
studio  
code.

[Reply](#)

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apply.

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Python Projects +

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Python Django Projects +

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Machine Learning Proj... ×

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◆ Machine Learning Projects wi...

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◆ Project – Image Cartoonifier

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▲ [Project – Handwritten Di](#)

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◆ Project – Music Genre Classif...

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◆ Project – Sign Language Reco...

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◆ Project – Speech Emotion Re...

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◆ Project – Handwritten Chara...

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◆ Project – Drowsiness Detecti...

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AI Projects +

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Python Quiz +

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