DEFINING MODEL
(SPRINT 2)

Team ID	PNT2022TMID26131
Project Name	A Novel Method for Handwritten Digit Recognition System

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from tensorflow.keras.datasets import mnist

(x_train, y_train),(x_test, y_test) = mnist.load_data()

x_train
```

```
array([[[0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0],
        ...,
        [0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0]],

       [[0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0],
        ...,
        [0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0]],

       [[0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0],
        ...,
        [0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0]],

       ...,

       [[0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0],
        ...,
        [0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0]],

       [[0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0],
```

```
        [[0, 0, 0, ..., 0, 0, 0],
         [0, 0, 0, ..., 0, 0, 0],
         [0, 0, 0, ..., 0, 0, 0],
         ...,
         [0, 0, 0, ..., 0, 0, 0],
         [0, 0, 0, ..., 0, 0, 0],
         [0, 0, 0, ..., 0, 0, 0]]], dtype=uint8)
```

```
x_train.shape
```

```
(60000, 28, 28)
```

```
one_img = x_train[0]
```

```
one_img.shape
```

```
(28, 28)
```

```
one_img
```

```
array([[  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
0,
          0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
0,
          0,   0],
       [  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
0,
          0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
0,
          0,   0],
       [  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
0,
          0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
0,
          0,   0],
       [  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
0,
          0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
0,
          0,   0],
       [  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
0,
          0,   0,   0,   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,
```

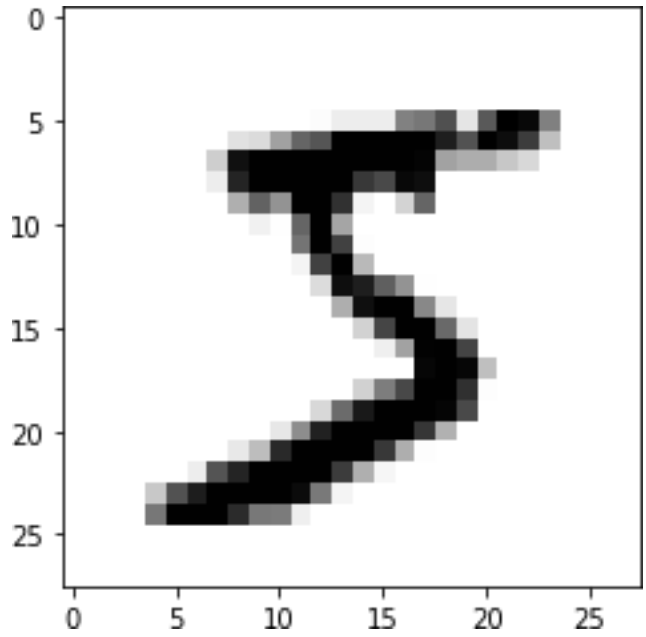
```
170,
        253, 253, 253, 253, 253, 225, 172, 253, 242, 195,  64,   0,
0,
          0,   0],
        [  0,   0,   0,   0,   0,   0,   0,  49, 238, 253, 253, 253,
253,
        253, 253, 253, 253, 251,  93,  82,  82,  56,  39,   0,   0,
0,
          0,   0],
        [  0,   0,   0,   0,   0,   0,   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]], dtype=uint8)
```

```
plt.imshow(one_img,cmap='binary')
```

```
<matplotlib.image.AxesImage at 0x23eacf70790>
```




```
y_train
```

```
array([5, 0, 4, ..., 5, 6, 8], dtype=uint8)
```

```
from tensorflow.keras.utils import to_categorical
```

```
y_train.shape
```

```
(60000,)
```

```
y_example = to_categorical(y_train)
print(y_example,y_example.shape)
```

```
[[0. 0. 0. ... 0. 0. 0.]
 [1. 0. 0. ... 0. 0. 0.]
 [0. 0. 0. ... 0. 0. 0.]
 ...
 [0. 0. 0. ... 0. 0. 0.]
```

```
 [0. 0. 0. ... 0. 0. 0.]
 [0. 0. 0. ... 0. 1. 0.]] (60000, 10)
```

```
y_example[0]
```

```
array([0., 0., 0., 0., 0., 1., 0., 0., 0., 0.], dtype=float32)
```

```
y_cat_test = to_categorical(y_test,num_classes=10)
```

```
y_cat_train = to_categorical(y_train,10)
```

```
one_img.max(),one_img.min()
```

```
(255, 0)
```

```
x_train = x_train/255
x_test = x_test/255
```

```
scaled_img = x_train[0]
scaled_img
```

```
array([[0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        ],
       [0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        ],
       [0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        ],
       [0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        ],
       [0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 0.        , 0.        , 0.        ,
        0.        , 0.        , 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.        , 0.        ,
 0.        , 0.        , 0.        ],
[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.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.04313725, 0.74509804, 0.99215686, 0.2745098 ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.1372549 , 0.94509804, 0.88235294,
```

```
 0.62745098, 0.42352941, 0.00392157, 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[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.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.97647059, 0.99215686, 0.97647059,
 0.25098039, 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[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.        , 0.        , 0.        , 0.        , 0.        ,
         0.        , 0.        , 0.        , 0.        , 0.        ,
         0.        , 0.        , 0.        , 0.        , 0.        ,
         0.        , 0.        , 0.        , 0.        , 0.        ,
         0.        , 0.        , 0.        ],
        [0.        , 0.        , 0.        , 0.        , 0.        ,
         0.        , 0.        , 0.        , 0.        , 0.        ,
         0.        , 0.        , 0.        , 0.        , 0.        ,
         0.        , 0.        , 0.        , 0.        , 0.        ,
         0.        , 0.        , 0.        , 0.        , 0.        ,
         0.        , 0.        , 0.        ],
        [0.        , 0.        , 0.        , 0.        , 0.        ,
         0.        , 0.        , 0.        , 0.        , 0.        ,
         0.        , 0.        , 0.        , 0.        , 0.        ,
         0.        , 0.        , 0.        , 0.        , 0.        ,
         0.        , 0.        , 0.        , 0.        , 0.        ,
         0.        , 0.        , 0.        ]])
```

```
x_train = x_train.reshape(60000,28,28,1)
x_test = x_test.reshape(10000,28,28,1)
```

```
x_train.shape,x_test.shape
```

```
((60000, 28, 28, 1), (10000, 28, 28, 1))
```

```
from keras.models import Sequential
from keras.layers import Dense, Dropout, Flatten
from keras.layers import Conv2D, MaxPool2D
```

```
model = Sequential()
model.add(Conv2D(filters=32,
```

```
kernel_size=(4,4),activation='relu',input_shape=(28,28,1)))
model.add(MaxPool2D(pool_size=(2,2)))
model.add(Flatten())
model.add(Dense(128,activation='relu'))
model.add(Dense(10,activation='softmax'))

model.compile(loss='categorical_crossentropy',optimizer='Adadelta',met
rics=['accuracy'])

from tensorflow.keras.callbacks import EarlyStopping

early_stop = EarlyStopping(monitor='val-loss', patience=1)

model.fit(x_train,y_cat_train,
          epochs=15,
          validation_data=(x_test,y_cat_test),
          callbacks=[early_stop])
```

```
Epoch 1/15
1871/1875 [============================>.] - ETA: 0s - loss: 2.1682 -
accuracy: 0.3869WARNING:tensorflow:Early stopping conditioned on
metric `val-loss` which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
1875/1875 [==============================] - 17s 9ms/step - loss:
2.1679 - accuracy: 0.3872 - val_loss: 2.0305 - val_accuracy: 0.5574
Epoch 2/15
1872/1875 [============================>.] - ETA: 0s - loss: 1.8816 -
accuracy: 0.6368WARNING:tensorflow:Early stopping conditioned on
metric `val-loss` which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
1875/1875 [==============================] - 17s 9ms/step - loss:
1.8813 - accuracy: 0.6369 - val_loss: 1.7081 - val_accuracy: 0.6938
Epoch 3/15
1869/1875 [============================>.] - ETA: 0s - loss: 1.5459 -
accuracy: 0.7291WARNING:tensorflow:Early stopping conditioned on
metric `val-loss` which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
1875/1875 [==============================] - 17s 9ms/step - loss:
1.5455 - accuracy: 0.7291 - val_loss: 1.3627 - val_accuracy: 0.7672
Epoch 4/15
1873/1875 [============================>.] - ETA: 0s - loss: 1.2271 -
accuracy: 0.7798WARNING:tensorflow:Early stopping conditioned on
metric `val-loss` which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
1875/1875 [==============================] - 17s 9ms/step - loss:
1.2269 - accuracy: 0.7798 - val_loss: 1.0714 - val_accuracy: 0.8101
Epoch 5/15
1872/1875 [============================>.] - ETA: 0s - loss: 0.9799 -
accuracy: 0.8116WARNING:tensorflow:Early stopping conditioned on
metric `val-loss` which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
```

```
1875/1875 [==============================] - 16s 9ms/step - loss:
0.9797 - accuracy: 0.8118 - val_loss: 0.8623 - val_accuracy: 0.8354
Epoch 6/15
1869/1875 [============================>.] - ETA: 0s - loss: 0.8091 -
accuracy: 0.8314WARNING:tensorflow:Early stopping conditioned on
metric `val-loss` which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
1875/1875 [==============================] - 16s 8ms/step - loss:
0.8088 - accuracy: 0.8315 - val_loss: 0.7219 - val_accuracy: 0.8488
Epoch 7/15
1869/1875 [============================>.] - ETA: 0s - loss: 0.6928 -
accuracy: 0.8446WARNING:tensorflow:Early stopping conditioned on
metric `val-loss` which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
1875/1875 [==============================] - 16s 8ms/step - loss:
0.6927 - accuracy: 0.8446 - val_loss: 0.6261 - val_accuracy: 0.8617
Epoch 8/15
1869/1875 [============================>.] - ETA: 0s - loss: 0.6130 -
accuracy: 0.8546WARNING:tensorflow:Early stopping conditioned on
metric `val-loss` which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
1875/1875 [==============================] - 16s 9ms/step - loss:
0.6130 - accuracy: 0.8546 - val_loss: 0.5600 - val_accuracy: 0.8713
Epoch 9/15
1874/1875 [============================>.] - ETA: 0s - loss: 0.5566 -
accuracy: 0.8635WARNING:tensorflow:Early stopping conditioned on
metric `val-loss` which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
1875/1875 [==============================] - 18s 9ms/step - loss:
0.5565 - accuracy: 0.8635 - val_loss: 0.5121 - val_accuracy: 0.8783
Epoch 10/15
1871/1875 [============================>.] - ETA: 0s - loss: 0.5148 -
accuracy: 0.8697WARNING:tensorflow:Early stopping conditioned on
metric `val-loss` which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
1875/1875 [==============================] - 17s 9ms/step - loss:
0.5146 - accuracy: 0.8698 - val_loss: 0.4757 - val_accuracy: 0.8827
Epoch 11/15
1873/1875 [============================>.] - ETA: 0s - loss: 0.4824 -
accuracy: 0.8754WARNING:tensorflow:Early stopping conditioned on
metric `val-loss` which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
1875/1875 [==============================] - 17s 9ms/step - loss:
0.4822 - accuracy: 0.8755 - val_loss: 0.4477 - val_accuracy: 0.8881
Epoch 12/15
1871/1875 [============================>.] - ETA: 0s - loss: 0.4567 -
accuracy: 0.8802WARNING:tensorflow:Early stopping conditioned on
metric `val-loss` which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
1875/1875 [==============================] - 17s 9ms/step - loss:
```

```
0.4566 - accuracy: 0.8802 - val_loss: 0.4254 - val_accuracy: 0.8920
Epoch 13/15
1874/1875 [============================>.] - ETA: 0s - loss: 0.4360 -
accuracy: 0.8842WARNING:tensorflow:Early stopping conditioned on
metric `val-loss` which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
1875/1875 [==============================] - 16s 8ms/step - loss:
0.4360 - accuracy: 0.8842 - val_loss: 0.4072 - val_accuracy: 0.8939
Epoch 14/15
1870/1875 [============================>.] - ETA: 0s - loss: 0.4189 -
accuracy: 0.8877WARNING:tensorflow:Early stopping conditioned on
metric `val-loss` which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
1875/1875 [==============================] - 16s 8ms/step - loss:
0.4189 - accuracy: 0.8877 - val_loss: 0.3922 - val_accuracy: 0.8971
Epoch 15/15
1874/1875 [============================>.] - ETA: 0s - loss: 0.4045 -
accuracy: 0.8899WARNING:tensorflow:Early stopping conditioned on
metric `val-loss` which is not available. Available metrics are:
loss,accuracy,val_loss,val_accuracy
1875/1875 [==============================] - 16s 8ms/step - loss:
0.4046 - accuracy: 0.8899 - val_loss: 0.3788 - val_accuracy: 0.9006

<keras.callbacks.History at 0x23eaa9abee0>
```