

This is the CLASSIFICATION jupyter notebook

```
In [1]: # general libraries
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import keras
```

```
In [2]: # models
from sklearn.svm import SVC
from sklearn.ensemble import RandomForestClassifier as RT
from keras.models import Sequential
from keras.layers import Dense
```

```
In [3]: # preprocessing and set up
import seaborn as sns
from sklearn.preprocessing import StandardScaler
from sklearn.preprocessing import LabelEncoder, OneHotEncoder
from sklearn.model_selection import train_test_split as tts
from imblearn.over_sampling import RandomOverSampler as ROS
from imblearn.under_sampling import RandomUnderSampler as RUS
from sklearn.model_selection import GridSearchCV
```

```
In [4]: # scoring
from sklearn.metrics import roc_auc_score as ARS, precision_score as PS, accuracy_score as ACC
from sklearn.metrics import recall_score as RS, f1_score as FS, confusion_matrix as CM
from sklearn.metrics import roc_curve as RC, roc_auc_score as RAS
```

```
In [5]: ccfd = pd.read_csv('creditcard.csv')
ccfd.dropna()
ccfd.info()
ccfd.describe()
print(ccfd["Class"].value_counts())
print(ccfd.shape)
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 284807 entries, 0 to 284806
Data columns (total 31 columns):
 #   Column      Non-Null Count  Dtype
---  -
 0   Time        284807 non-null  float64
 1   V1          284807 non-null  float64
 2   V2          284807 non-null  float64
 3   V3          284807 non-null  float64
 4   V4          284807 non-null  float64
 5   V5          284807 non-null  float64
 6   V6          284807 non-null  float64
 7   V7          284807 non-null  float64
 8   V8          284807 non-null  float64
 9   V9          284807 non-null  float64
10  V10         284807 non-null  float64
11  V11         284807 non-null  float64
12  V12         284807 non-null  float64
13  V13         284807 non-null  float64
14  V14         284807 non-null  float64
15  V15         284807 non-null  float64
16  V16         284807 non-null  float64
17  V17         284807 non-null  float64
18  V18         284807 non-null  float64
19  V19         284807 non-null  float64
20  V20         284807 non-null  float64
21  V21         284807 non-null  float64
22  V22         284807 non-null  float64
```

```

23  V23      284807 non-null float64
24  V24      284807 non-null float64
25  V25      284807 non-null float64
26  V26      284807 non-null float64
27  V27      284807 non-null float64
28  V28      284807 non-null float64
29  Amount   284807 non-null float64
30  Class    284807 non-null int64

```

```
dtypes: float64(30), int64(1)
```

```
memory usage: 67.4 MB
```

```
0      284315
```

```
1         492
```

```
Name: Class, dtype: int64
```

```
(284807, 31)
```

In [6]:

```

y = ccfd["Class"]
X = ccfd.drop("Class",axis = 1)
print(y.value_counts())

```

```
0      284315
```

```
1         492
```

```
Name: Class, dtype: int64
```

In [7]:

```
X.info()
```

```

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 284807 entries, 0 to 284806

```

```
Data columns (total 30 columns):
```

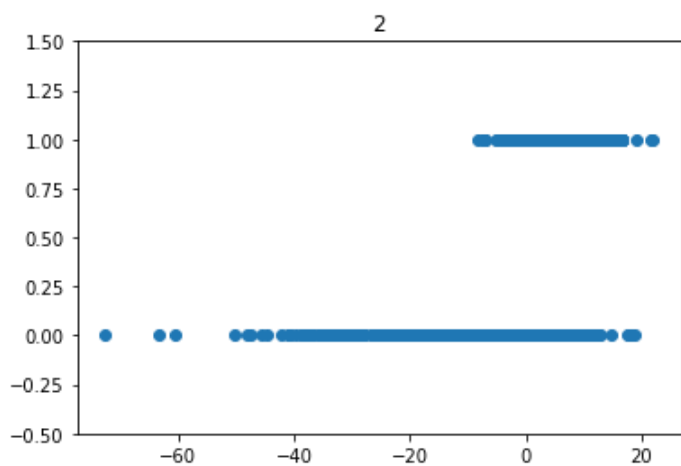
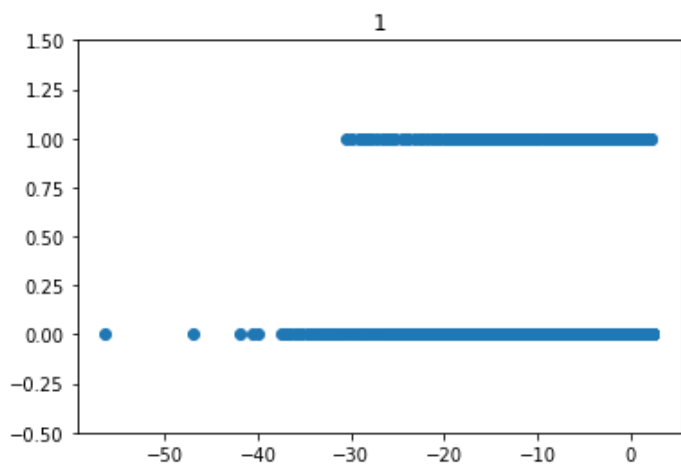
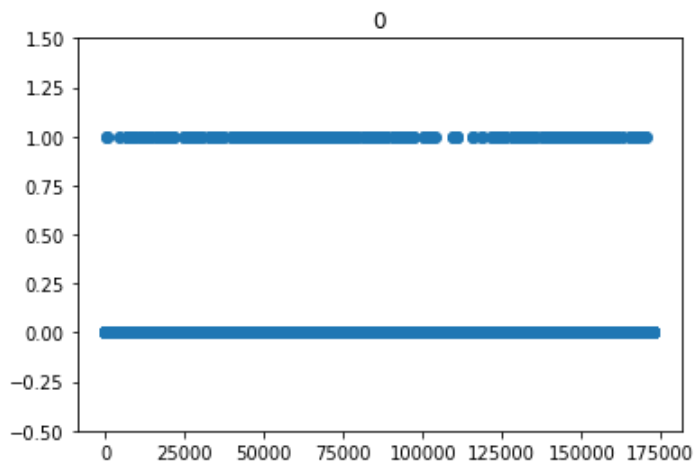
#	Column	Non-Null	Count	Dtype
0	Time	284807	non-null	float64
1	V1	284807	non-null	float64
2	V2	284807	non-null	float64
3	V3	284807	non-null	float64
4	V4	284807	non-null	float64
5	V5	284807	non-null	float64
6	V6	284807	non-null	float64
7	V7	284807	non-null	float64
8	V8	284807	non-null	float64
9	V9	284807	non-null	float64
10	V10	284807	non-null	float64
11	V11	284807	non-null	float64
12	V12	284807	non-null	float64
13	V13	284807	non-null	float64
14	V14	284807	non-null	float64
15	V15	284807	non-null	float64
16	V16	284807	non-null	float64
17	V17	284807	non-null	float64
18	V18	284807	non-null	float64
19	V19	284807	non-null	float64
20	V20	284807	non-null	float64
21	V21	284807	non-null	float64
22	V22	284807	non-null	float64
23	V23	284807	non-null	float64
24	V24	284807	non-null	float64
25	V25	284807	non-null	float64
26	V26	284807	non-null	float64
27	V27	284807	non-null	float64
28	V28	284807	non-null	float64
29	Amount	284807	non-null	float64

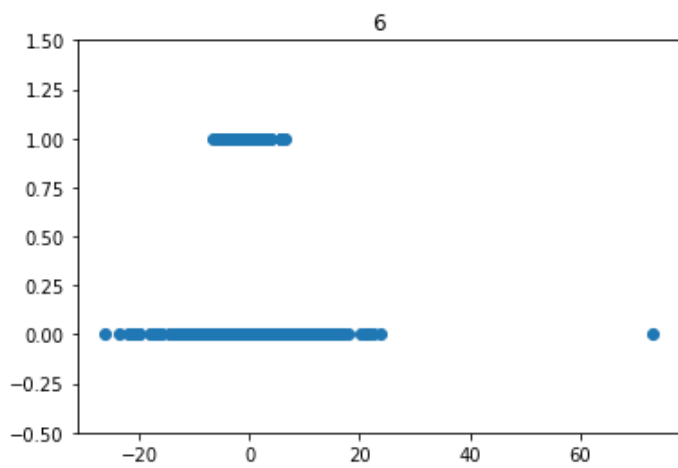
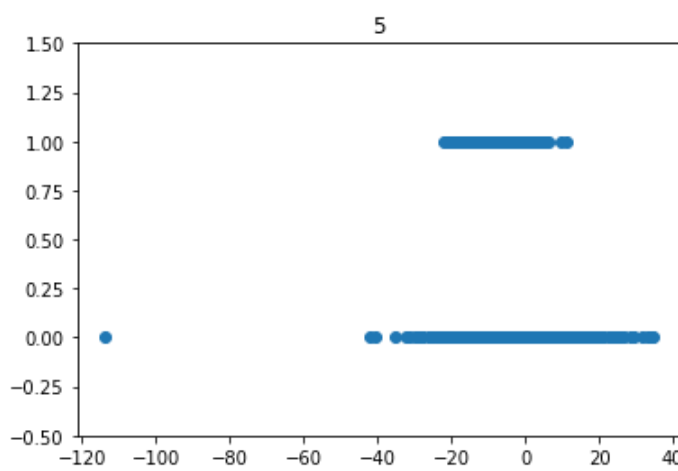
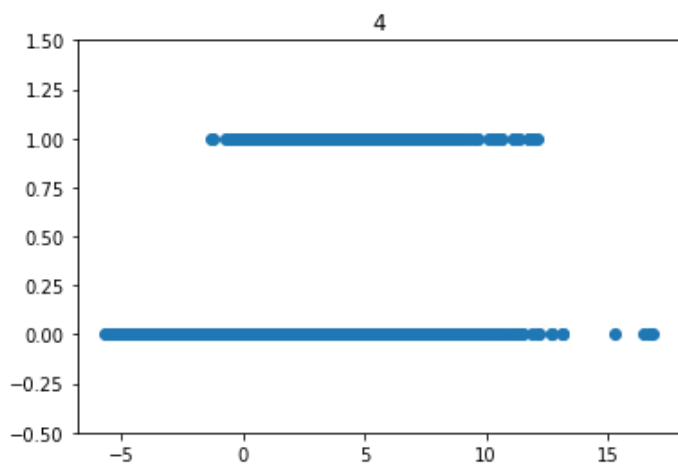
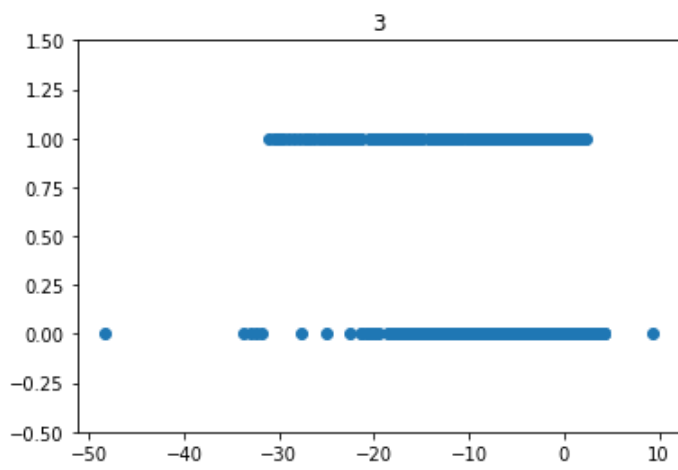
```
dtypes: float64(30)
```

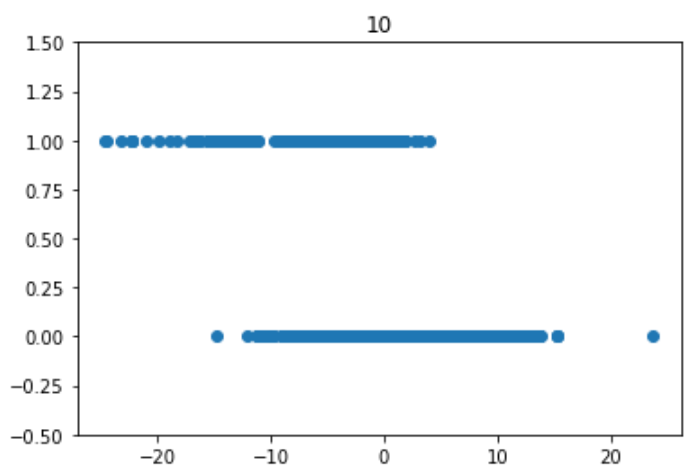
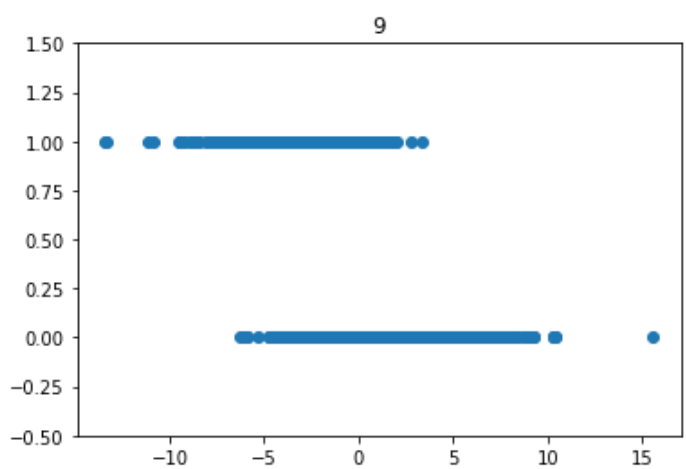
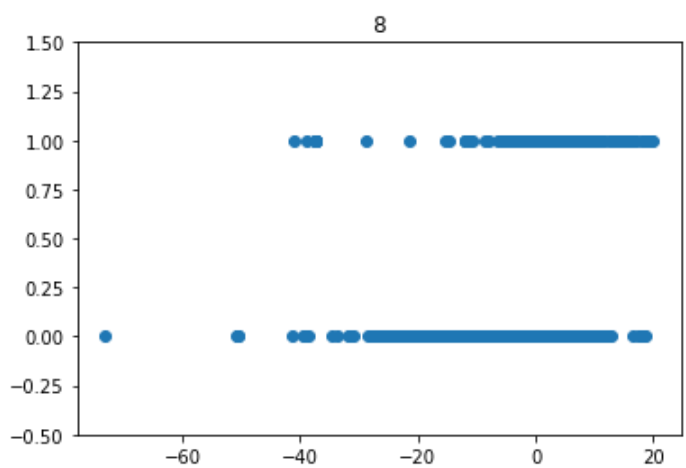
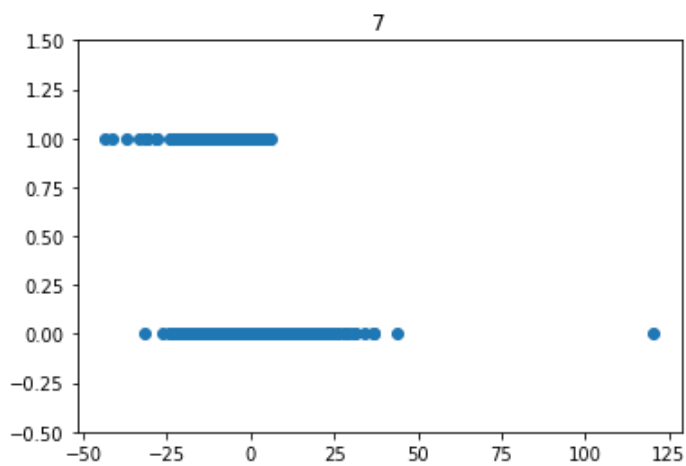
```
memory usage: 65.2 MB
```

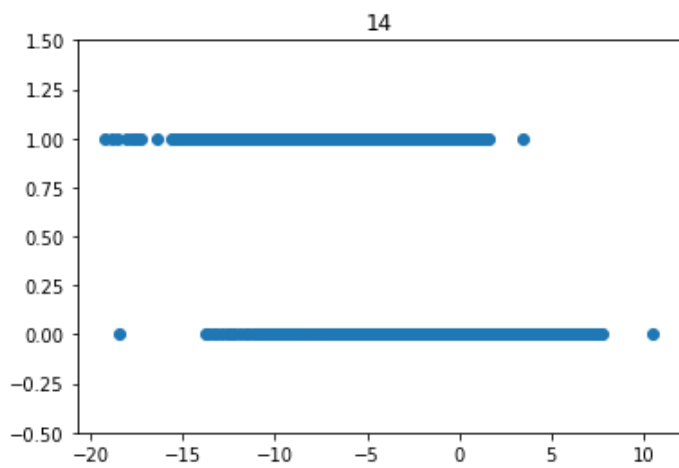
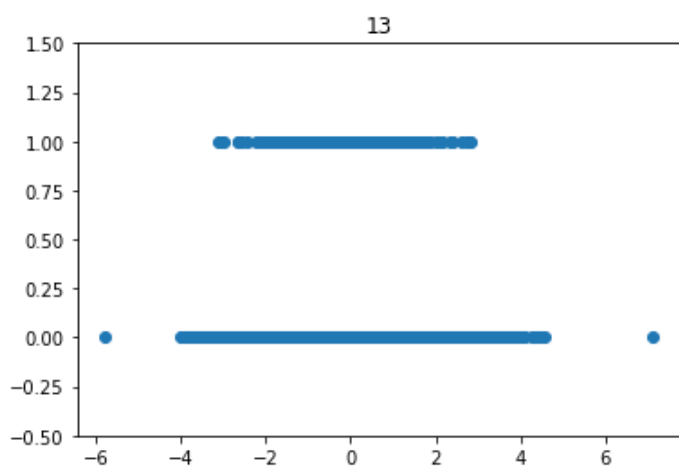
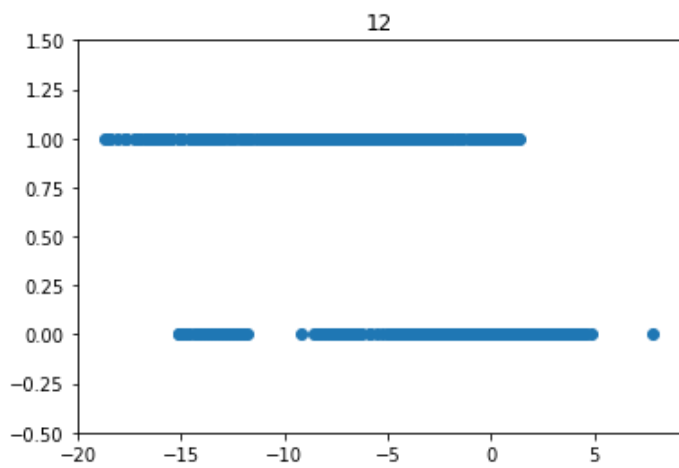
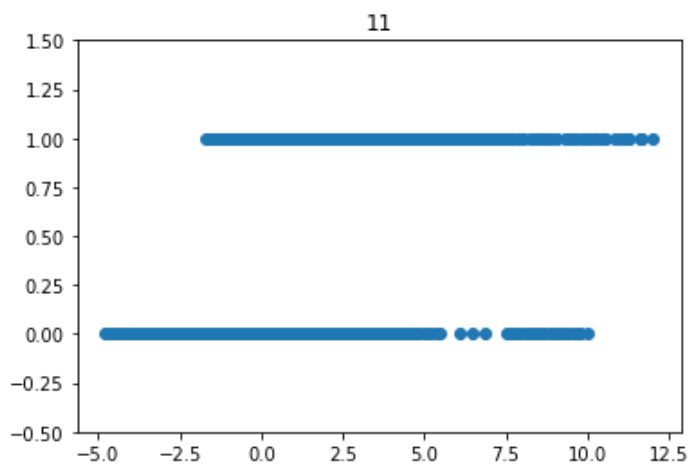
In [8]:

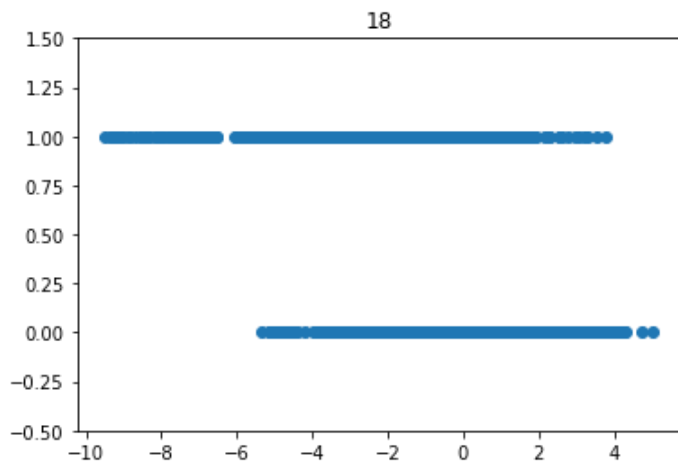
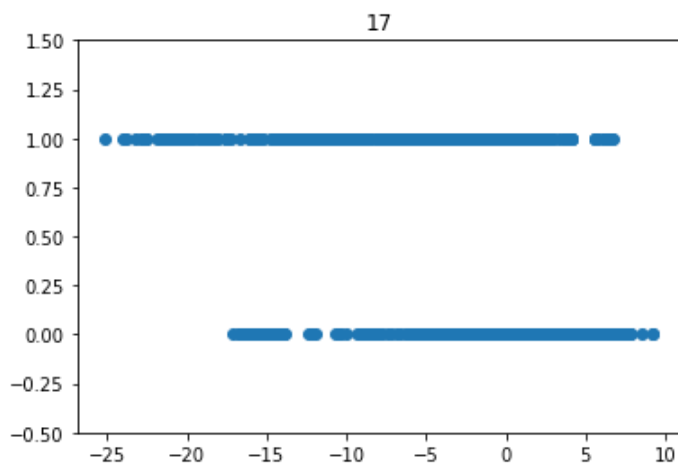
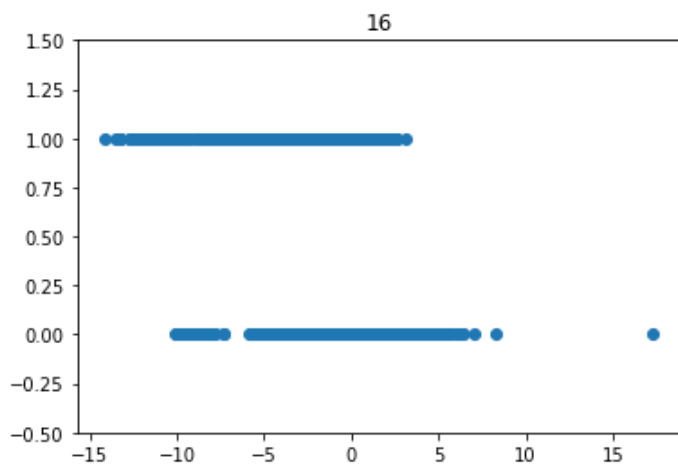
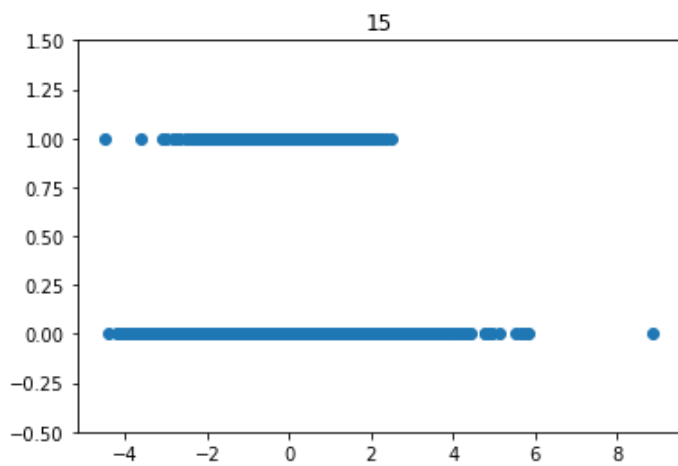
```
for i in range (0,30):  
    plt.title("%d" % i)  
    plt.scatter(X.iloc[:,[i]],y)  
    plt.ylim(-.5,1.5)  
    plt.show()
```

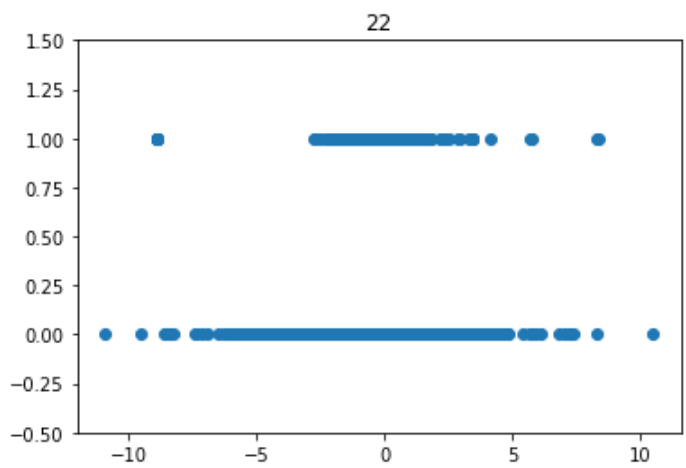
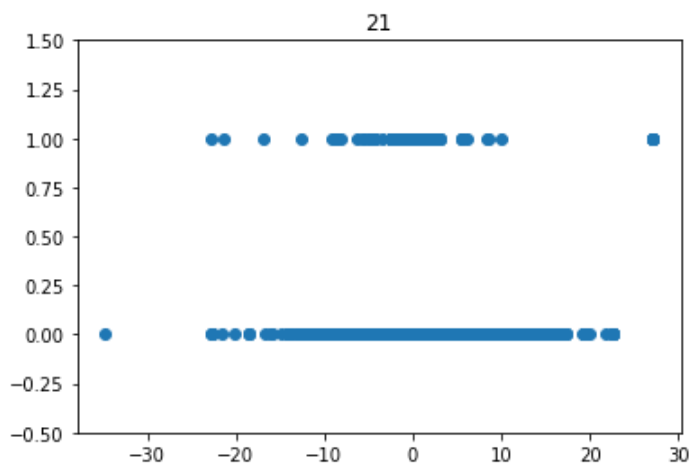
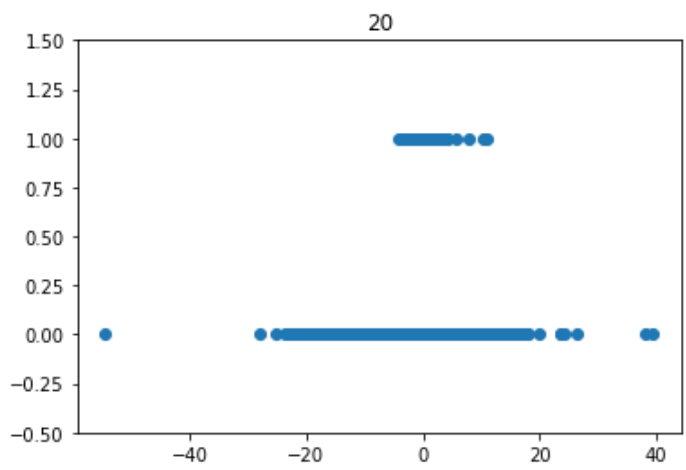
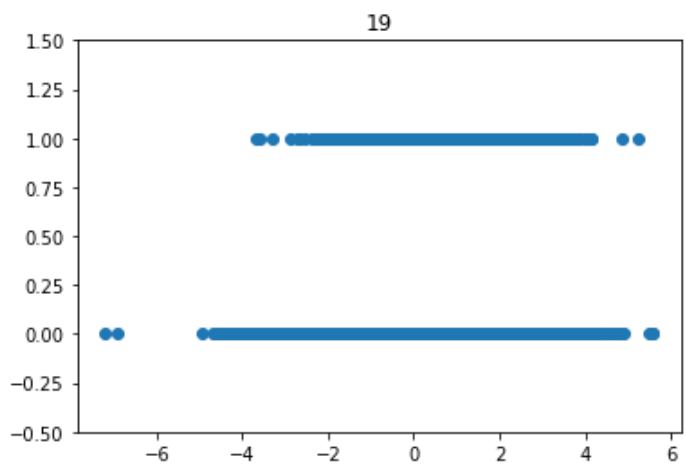




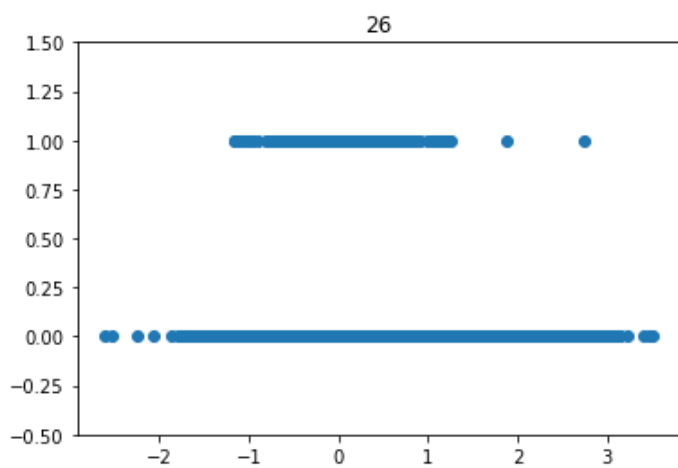
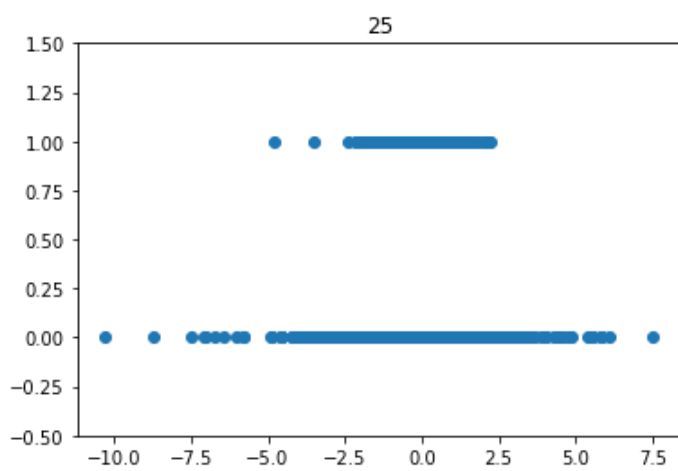
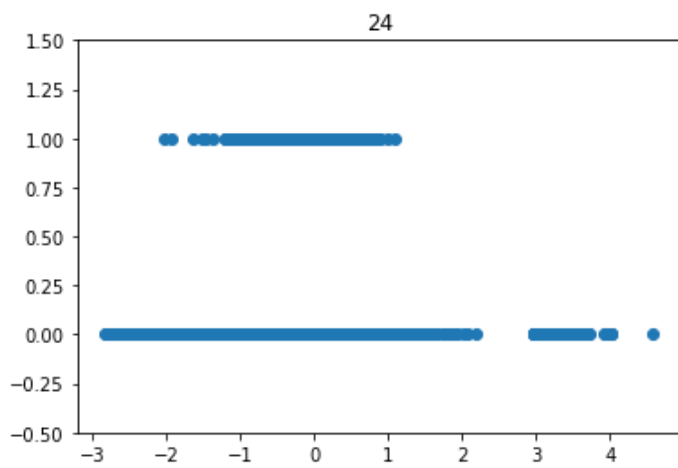
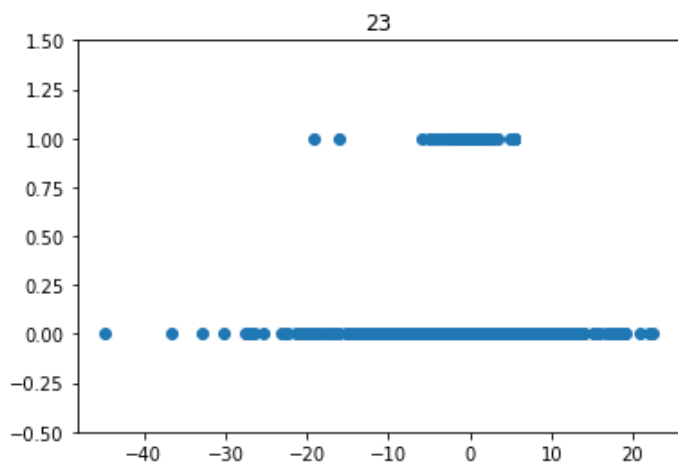


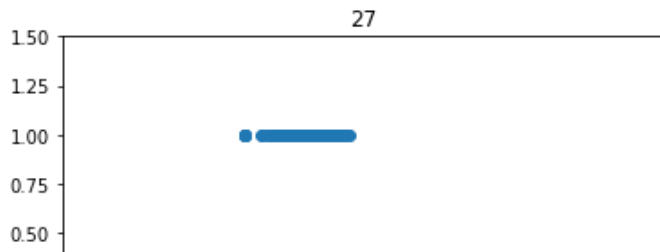












Looking at these graphs graph "0" is not really indicative of Fraud, because the min and max of legitimate and fraudulent credit card usage is almost the same and the gaps of time where there are no fraudulent credit card use are so minimal it would do nothing to actually help train the model. Also logically how would time affect someone trying to steal money?

In [9]:

```
X = X.drop("Time", axis = 1)
X.info()
X = X.values
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 284807 entries, 0 to 284806
Data columns (total 29 columns):
#   Column      Non-Null Count  Dtype
---  -
0   V1           284807 non-null float64
1   V2           284807 non-null float64
2   V3           284807 non-null float64
3   V4           284807 non-null float64
4   V5           284807 non-null float64
5   V6           284807 non-null float64
6   V7           284807 non-null float64
7   V8           284807 non-null float64
8   V9           284807 non-null float64
9   V10          284807 non-null float64
10  V11          284807 non-null float64
11  V12          284807 non-null float64
12  V13          284807 non-null float64
13  V14          284807 non-null float64
14  V15          284807 non-null float64
15  V16          284807 non-null float64
16  V17          284807 non-null float64
17  V18          284807 non-null float64
18  V19          284807 non-null float64
19  V20          284807 non-null float64
20  V21          284807 non-null float64
21  V22          284807 non-null float64
22  V23          284807 non-null float64
23  V24          284807 non-null float64
24  V25          284807 non-null float64
25  V26          284807 non-null float64
26  V27          284807 non-null float64
27  V28          284807 non-null float64
28  Amount       284807 non-null float64
dtypes: float64(29)
memory usage: 63.0 MB
```

In [10]:

```
print(X.shape)
```

```
(284807, 29)
```

I am not really sure which is really better: oversampling or undersampling. From seemingly common sense it should be oversampling because one keeps all the original data, but I am not an expert. So, let us find out by using both.

```
In [11]: # time to train because i want to go on a side of caution instead of 8:2 ration im go
x_tr_f, x_te, y_tr_f, y_te = tts(X,y, test_size = 0.3)
#over and under samplers
ros = ROS(random_state = 42) # why 42? why not 42 is the better question
rus = RUS(random_state = 42)
# resampling the training sets
xtr_os_f, ytr_os_f = ros.fit_resample(x_tr_f,y_tr_f) # (x) or (y) (TR)ain (u)ndersamp
xtr_us_f, ytr_us_f = rus.fit_resample(x_tr_f,y_tr_f) # (x) or (y) (TR)ain (U)ndersamp
# now for splitting for neural network i will revert to 8:2 for validation split
xtr_os, xtr_os_v, ytr_os, ytr_os_v = tts(xtr_os_f, ytr_os_f, test_size=0.2)
xtr_us, xtr_us_v, ytr_us, ytr_us_v = tts(xtr_us_f, ytr_us_f, test_size=0.2)
```

```
In [12]: # Scaling for SVC and DNN, since decision tree aren't sensitive to feature scaling
#oversampling
scaler_os = StandardScaler()
sc_xtr_os_f = scaler_os.fit_transform(xtr_os_f)
sc_xtr_os = scaler_os.transform(xtr_os)
sc_xte_os = scaler_os.transform(x_te)
sc_xte_os_v = scaler_os.transform(xtr_os_v)
#undersampling
scaler_us = StandardScaler()
sc_xtr_us_f = scaler_us.fit_transform(xtr_us_f)
sc_xtr_us = scaler_us.transform(xtr_us)
sc_xte_us = scaler_us.transform(x_te)
sc_xte_us_v = scaler_us.transform(xtr_us_v)
```

I have decided to break my classification into 3 notebooks so i can run them while my  
Random forest gridsearch is running

```
In [13]: print(sc_xtr_os.shape, sc_xte_os.shape, sc_xte_os_v.shape)
print(sc_xtr_us.shape, sc_xte_us.shape ,sc_xte_us_v.shape)

(318436, 29) (85443, 29) (79610, 29)
(545, 29) (85443, 29) (137, 29)
```

## DNN

I am going to try a triple hiddne layer model layer

```
In [14]: # DNN for the over sampled set
os_DNN = Sequential()
os_DNN.add(Dense(units = 15, kernel_initializer = 'uniform', activation = 'relu', inp
os_DNN.add(Dense(units = 15, activation = 'relu'))
os_DNN.add(Dense(units = 15, activation = 'relu'))
os_DNN.add(Dense(units = 15, activation = 'relu'))
os_DNN.add(Dense(1, activation='sigmoid'))
```

```
In [15]: # DNN for under sampled set
us_DNN = Sequential()
us_DNN.add(Dense(units = 29, kernel_initializer = 'uniform', activation = 'relu', inp
us_DNN.add(Dense(units = 29, activation = 'softmax'))
us_DNN.add(Dense(units = 29, kernel_initializer = 'uniform', activation = 'softmax'))
us_DNN.add(Dense(units = 29, activation = 'softmax'))
us_DNN.add(Dense(units = 29, kernel_initializer = 'uniform', activation = 'softmax'))
us_DNN.add(Dense(1, activation='sigmoid'))
```

In [16]:

```
os_DNN.compile(optimizer = 'adam', loss = 'binary_crossentropy', metrics = ['accuracy'])
us_DNN.compile(optimizer = 'adam', loss = 'binary_crossentropy', metrics = ['accuracy'])
```

so i did the math if i where to cut it down to a good size in the hundreds i can make the batch size 600 which in order to equal the same amount of samples being trained meaning batches would be  $284807/600$  which comes to 530.69 meaning about 531 samples

In [17]:

```
os_batch_size = 600
os_epochs = 530
os_history = os_DNN.fit(sc_xtr_os, ytr_os, batch_size=os_batch_size, epochs=os_epochs)
```

```
Epoch 1/530
531/531 [=====] - 1s 2ms/step - loss: 0.1607 - accuracy: 0.9495 - val_loss: 0.0634 - val_accuracy: 0.9784
Epoch 2/530
531/531 [=====] - 1s 1ms/step - loss: 0.0451 - accuracy: 0.9865 - val_loss: 0.0328 - val_accuracy: 0.9917
Epoch 3/530
531/531 [=====] - 1s 1ms/step - loss: 0.0259 - accuracy: 0.9939 - val_loss: 0.0207 - val_accuracy: 0.9952
Epoch 4/530
531/531 [=====] - 1s 1ms/step - loss: 0.0177 - accuracy: 0.9960 - val_loss: 0.0156 - val_accuracy: 0.9962
Epoch 5/530
531/531 [=====] - 1s 1ms/step - loss: 0.0133 - accuracy: 0.9970 - val_loss: 0.0129 - val_accuracy: 0.9972
Epoch 6/530
531/531 [=====] - 1s 1ms/step - loss: 0.0107 - accuracy: 0.9977 - val_loss: 0.0096 - val_accuracy: 0.9981
Epoch 7/530
531/531 [=====] - 1s 2ms/step - loss: 0.0093 - accuracy: 0.9980 - val_loss: 0.0099 - val_accuracy: 0.9978
Epoch 8/530
531/531 [=====] - 1s 1ms/step - loss: 0.0087 - accuracy: 0.9981 - val_loss: 0.0085 - val_accuracy: 0.9983
Epoch 9/530
531/531 [=====] - 1s 1ms/step - loss: 0.0076 - accuracy: 0.9983 - val_loss: 0.0074 - val_accuracy: 0.9984
Epoch 10/530
531/531 [=====] - 1s 2ms/step - loss: 0.0070 - accuracy: 0.9986 - val_loss: 0.0077 - val_accuracy: 0.9982
Epoch 11/530
531/531 [=====] - 1s 1ms/step - loss: 0.0062 - accuracy: 0.9987 - val_loss: 0.0113 - val_accuracy: 0.9971
Epoch 12/530
531/531 [=====] - 1s 1ms/step - loss: 0.0067 - accuracy: 0.9986 - val_loss: 0.0065 - val_accuracy: 0.9986
Epoch 13/530
531/531 [=====] - 1s 2ms/step - loss: 0.0062 - accuracy: 0.9987 - val_loss: 0.0065 - val_accuracy: 0.9988
Epoch 14/530
531/531 [=====] - 1s 2ms/step - loss: 0.0055 - accuracy: 0.9989 - val_loss: 0.0062 - val_accuracy: 0.9989
Epoch 15/530
531/531 [=====] - 1s 1ms/step - loss: 0.0053 - accuracy: 0.9989 - val_loss: 0.0054 - val_accuracy: 0.9989
Epoch 16/530
531/531 [=====] - 1s 1ms/step - loss: 0.0061 - accuracy: 0.9986 - val_loss: 0.0069 - val_accuracy: 0.9984
Epoch 17/530
531/531 [=====] - 1s 1ms/step - loss: 0.0050 - accuracy: 0.9990 - val_loss: 0.0052 - val_accuracy: 0.9990
Epoch 18/530
531/531 [=====] - 1s 1ms/step - loss: 0.0044 - accuracy: 0.9991 - val_loss: 0.0064 - val_accuracy: 0.9993
```

```
Epoch 19/530
531/531 [=====] - 1s 2ms/step - loss: 0.0045 - accuracy: 0.9
991 - val_loss: 0.0051 - val_accuracy: 0.9989
Epoch 20/530
531/531 [=====] - 1s 1ms/step - loss: 0.0053 - accuracy: 0.9
988 - val_loss: 0.0057 - val_accuracy: 0.9989
Epoch 21/530
531/531 [=====] - 1s 1ms/step - loss: 0.0044 - accuracy: 0.9
991 - val_loss: 0.0045 - val_accuracy: 0.9992
Epoch 22/530
531/531 [=====] - 1s 1ms/step - loss: 0.0037 - accuracy: 0.9
993 - val_loss: 0.0046 - val_accuracy: 0.9991
Epoch 23/530
531/531 [=====] - 1s 2ms/step - loss: 0.0041 - accuracy: 0.9
991 - val_loss: 0.0065 - val_accuracy: 0.9985
Epoch 24/530
531/531 [=====] - 1s 1ms/step - loss: 0.0041 - accuracy: 0.9
992 - val_loss: 0.0057 - val_accuracy: 0.9988
Epoch 25/530
531/531 [=====] - 1s 2ms/step - loss: 0.0049 - accuracy: 0.9
990 - val_loss: 0.0047 - val_accuracy: 0.9991
Epoch 26/530
531/531 [=====] - 1s 1ms/step - loss: 0.0036 - accuracy: 0.9
993 - val_loss: 0.0035 - val_accuracy: 0.9994
Epoch 27/530
531/531 [=====] - 1s 1ms/step - loss: 0.0043 - accuracy: 0.9
990 - val_loss: 0.0042 - val_accuracy: 0.9991
Epoch 28/530
531/531 [=====] - 1s 1ms/step - loss: 0.0036 - accuracy: 0.9
993 - val_loss: 0.0048 - val_accuracy: 0.9990
Epoch 29/530
531/531 [=====] - 1s 1ms/step - loss: 0.0031 - accuracy: 0.9
993 - val_loss: 0.0072 - val_accuracy: 0.9974
Epoch 30/530
531/531 [=====] - 1s 1ms/step - loss: 0.0040 - accuracy: 0.9
992 - val_loss: 0.0039 - val_accuracy: 0.9994
Epoch 31/530
531/531 [=====] - 1s 1ms/step - loss: 0.0039 - accuracy: 0.9
992 - val_loss: 0.0049 - val_accuracy: 0.9992
Epoch 32/530
531/531 [=====] - 1s 1ms/step - loss: 0.0035 - accuracy: 0.9
993 - val_loss: 0.0028 - val_accuracy: 0.9996
Epoch 33/530
531/531 [=====] - 1s 1ms/step - loss: 0.0028 - accuracy: 0.9
995 - val_loss: 0.0036 - val_accuracy: 0.9993
Epoch 34/530
531/531 [=====] - 1s 1ms/step - loss: 0.0034 - accuracy: 0.9
993 - val_loss: 0.0045 - val_accuracy: 0.9992
Epoch 35/530
531/531 [=====] - 1s 1ms/step - loss: 0.0030 - accuracy: 0.9
995 - val_loss: 0.0031 - val_accuracy: 0.9995
Epoch 36/530
531/531 [=====] - 1s 2ms/step - loss: 0.0032 - accuracy: 0.9
993 - val_loss: 0.0038 - val_accuracy: 0.9993
Epoch 37/530
531/531 [=====] - 1s 1ms/step - loss: 0.0028 - accuracy: 0.9
995 - val_loss: 0.0042 - val_accuracy: 0.9993
Epoch 38/530
531/531 [=====] - 1s 1ms/step - loss: 0.0034 - accuracy: 0.9
993 - val_loss: 0.0041 - val_accuracy: 0.9993
Epoch 39/530
531/531 [=====] - 1s 1ms/step - loss: 0.0031 - accuracy: 0.9
993 - val_loss: 0.0050 - val_accuracy: 0.9990
Epoch 40/530
531/531 [=====] - 1s 1ms/step - loss: 0.0026 - accuracy: 0.9
995 - val_loss: 0.0179 - val_accuracy: 0.9954
Epoch 41/530
531/531 [=====] - 1s 2ms/step - loss: 0.0029 - accuracy: 0.9
994 - val_loss: 0.0212 - val_accuracy: 0.9945
Epoch 42/530
```

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531/531 [=====] - 1s 1ms/step - loss: 0.0034 - accuracy: 0.9
993 - val_loss: 0.0038 - val_accuracy: 0.9994
Epoch 43/530
531/531 [=====] - 1s 2ms/step - loss: 0.0022 - accuracy: 0.9
996 - val_loss: 0.0031 - val_accuracy: 0.9996
Epoch 44/530
531/531 [=====] - 1s 1ms/step - loss: 0.0037 - accuracy: 0.9
992 - val_loss: 0.0035 - val_accuracy: 0.9994
Epoch 45/530
531/531 [=====] - 1s 1ms/step - loss: 0.0029 - accuracy: 0.9
994 - val_loss: 0.0040 - val_accuracy: 0.9994
Epoch 46/530
531/531 [=====] - 1s 1ms/step - loss: 0.0022 - accuracy: 0.9
996 - val_loss: 0.0043 - val_accuracy: 0.9992
Epoch 47/530
531/531 [=====] - 1s 1ms/step - loss: 0.0022 - accuracy: 0.9
996 - val_loss: 0.0040 - val_accuracy: 0.9995
Epoch 48/530
531/531 [=====] - 1s 1ms/step - loss: 0.0025 - accuracy: 0.9
995 - val_loss: 0.0037 - val_accuracy: 0.9993
Epoch 49/530
531/531 [=====] - 1s 1ms/step - loss: 0.0031 - accuracy: 0.9
994 - val_loss: 0.0036 - val_accuracy: 0.9994
Epoch 50/530
531/531 [=====] - 1s 1ms/step - loss: 0.0018 - accuracy: 0.9
997 - val_loss: 0.0036 - val_accuracy: 0.9994
Epoch 51/530
531/531 [=====] - 1s 1ms/step - loss: 0.0025 - accuracy: 0.9
995 - val_loss: 0.0030 - val_accuracy: 0.9995
Epoch 52/530
531/531 [=====] - 1s 1ms/step - loss: 0.0023 - accuracy: 0.9
995 - val_loss: 0.0036 - val_accuracy: 0.9994
Epoch 53/530
531/531 [=====] - 1s 1ms/step - loss: 0.0020 - accuracy: 0.9
996 - val_loss: 0.0039 - val_accuracy: 0.9994
Epoch 54/530
531/531 [=====] - 1s 1ms/step - loss: 0.0027 - accuracy: 0.9
994 - val_loss: 0.0032 - val_accuracy: 0.9995
Epoch 55/530
531/531 [=====] - 1s 1ms/step - loss: 0.0021 - accuracy: 0.9
996 - val_loss: 0.0034 - val_accuracy: 0.9994
Epoch 56/530
531/531 [=====] - 1s 2ms/step - loss: 0.0034 - accuracy: 0.9
993 - val_loss: 0.0033 - val_accuracy: 0.9995
Epoch 57/530
531/531 [=====] - 1s 1ms/step - loss: 0.0017 - accuracy: 0.9
997 - val_loss: 0.0032 - val_accuracy: 0.9995
Epoch 58/530
531/531 [=====] - 1s 1ms/step - loss: 0.0021 - accuracy: 0.9
996 - val_loss: 0.0029 - val_accuracy: 0.9996
Epoch 59/530
531/531 [=====] - 1s 1ms/step - loss: 0.0025 - accuracy: 0.9
995 - val_loss: 0.0044 - val_accuracy: 0.9992
Epoch 60/530
531/531 [=====] - 1s 1ms/step - loss: 0.0027 - accuracy: 0.9
995 - val_loss: 0.0088 - val_accuracy: 0.9983
Epoch 61/530
531/531 [=====] - 1s 1ms/step - loss: 0.0021 - accuracy: 0.9
996 - val_loss: 0.0028 - val_accuracy: 0.9995
Epoch 62/530
531/531 [=====] - 1s 1ms/step - loss: 0.0023 - accuracy: 0.9
995 - val_loss: 0.0023 - val_accuracy: 0.9997
Epoch 63/530
531/531 [=====] - 1s 1ms/step - loss: 0.0029 - accuracy: 0.9
994 - val_loss: 0.0036 - val_accuracy: 0.9995
Epoch 64/530
531/531 [=====] - 1s 1ms/step - loss: 0.0026 - accuracy: 0.9
995 - val_loss: 0.0027 - val_accuracy: 0.9996
Epoch 65/530
531/531 [=====] - 1s 1ms/step - loss: 0.0016 - accuracy: 0.9
```

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997 - val_loss: 0.0028 - val_accuracy: 0.9996
Epoch 66/530
531/531 [=====] - 1s 1ms/step - loss: 0.0024 - accuracy: 0.9
995 - val_loss: 0.0031 - val_accuracy: 0.9995
Epoch 67/530
531/531 [=====] - 1s 1ms/step - loss: 0.0017 - accuracy: 0.9
997 - val_loss: 0.0036 - val_accuracy: 0.9995
Epoch 68/530
531/531 [=====] - 1s 1ms/step - loss: 0.0022 - accuracy: 0.9
996 - val_loss: 0.0027 - val_accuracy: 0.9996
Epoch 69/530
531/531 [=====] - 1s 1ms/step - loss: 0.0017 - accuracy: 0.9
997 - val_loss: 0.0032 - val_accuracy: 0.9995
Epoch 70/530
531/531 [=====] - 1s 1ms/step - loss: 0.0025 - accuracy: 0.9
995 - val_loss: 0.0030 - val_accuracy: 0.9995
Epoch 71/530
531/531 [=====] - 1s 1ms/step - loss: 0.0015 - accuracy: 0.9
997 - val_loss: 0.0039 - val_accuracy: 0.9994
Epoch 72/530
531/531 [=====] - 1s 1ms/step - loss: 0.0032 - accuracy: 0.9
993 - val_loss: 0.0039 - val_accuracy: 0.9993
Epoch 73/530
531/531 [=====] - 1s 1ms/step - loss: 0.0024 - accuracy: 0.9
996 - val_loss: 0.0032 - val_accuracy: 0.9994
Epoch 74/530
531/531 [=====] - 1s 1ms/step - loss: 0.0015 - accuracy: 0.9
997 - val_loss: 0.0029 - val_accuracy: 0.9995
Epoch 75/530
531/531 [=====] - 1s 1ms/step - loss: 0.0023 - accuracy: 0.9
995 - val_loss: 0.0032 - val_accuracy: 0.9996
Epoch 76/530
531/531 [=====] - 1s 1ms/step - loss: 0.0016 - accuracy: 0.9
997 - val_loss: 0.0030 - val_accuracy: 0.9995
Epoch 77/530
531/531 [=====] - 1s 1ms/step - loss: 0.0015 - accuracy: 0.9
997 - val_loss: 0.0035 - val_accuracy: 0.9994
Epoch 78/530
531/531 [=====] - 1s 1ms/step - loss: 0.0017 - accuracy: 0.9
997 - val_loss: 0.0026 - val_accuracy: 0.9996
Epoch 79/530
531/531 [=====] - 1s 2ms/step - loss: 0.0027 - accuracy: 0.9
995 - val_loss: 0.0028 - val_accuracy: 0.9996
Epoch 80/530
531/531 [=====] - 1s 1ms/step - loss: 0.0018 - accuracy: 0.9
996 - val_loss: 0.0044 - val_accuracy: 0.9992
Epoch 81/530
531/531 [=====] - 1s 1ms/step - loss: 0.0018 - accuracy: 0.9
996 - val_loss: 0.0071 - val_accuracy: 0.9987
Epoch 82/530
531/531 [=====] - 1s 1ms/step - loss: 0.0020 - accuracy: 0.9
996 - val_loss: 0.0029 - val_accuracy: 0.9996
Epoch 83/530
531/531 [=====] - 1s 1ms/step - loss: 0.0012 - accuracy: 0.9
998 - val_loss: 0.0037 - val_accuracy: 0.9995
Epoch 84/530
531/531 [=====] - 1s 1ms/step - loss: 0.0019 - accuracy: 0.9
996 - val_loss: 0.0026 - val_accuracy: 0.9997
Epoch 85/530
531/531 [=====] - 1s 1ms/step - loss: 0.0017 - accuracy: 0.9
996 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 86/530
531/531 [=====] - 1s 1ms/step - loss: 0.0013 - accuracy: 0.9
998 - val_loss: 0.0057 - val_accuracy: 0.9990
Epoch 87/530
531/531 [=====] - 1s 1ms/step - loss: 0.0015 - accuracy: 0.9
997 - val_loss: 0.0029 - val_accuracy: 0.9995
Epoch 88/530
531/531 [=====] - 1s 1ms/step - loss: 0.0019 - accuracy: 0.9
996 - val_loss: 0.0053 - val_accuracy: 0.9979
```

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Epoch 89/530
531/531 [=====] - 1s 1ms/step - loss: 0.0016 - accuracy: 0.9
997 - val_loss: 0.0028 - val_accuracy: 0.9996
Epoch 90/530
531/531 [=====] - 1s 3ms/step - loss: 0.0011 - accuracy: 0.9
998 - val_loss: 0.0094 - val_accuracy: 0.9981
Epoch 91/530
531/531 [=====] - 1s 1ms/step - loss: 0.0018 - accuracy: 0.9
997 - val_loss: 0.0035 - val_accuracy: 0.9994
Epoch 92/530
531/531 [=====] - 1s 2ms/step - loss: 0.0011 - accuracy: 0.9
998 - val_loss: 0.0022 - val_accuracy: 0.9997
Epoch 93/530
531/531 [=====] - 1s 2ms/step - loss: 0.0017 - accuracy: 0.9
996 - val_loss: 0.0135 - val_accuracy: 0.9976
Epoch 94/530
531/531 [=====] - 1s 2ms/step - loss: 0.0025 - accuracy: 0.9
995 - val_loss: 0.0030 - val_accuracy: 0.9996
Epoch 95/530
531/531 [=====] - 1s 1ms/step - loss: 0.0017 - accuracy: 0.9
997 - val_loss: 0.0026 - val_accuracy: 0.9996
Epoch 96/530
531/531 [=====] - 1s 1ms/step - loss: 0.0012 - accuracy: 0.9
998 - val_loss: 0.0033 - val_accuracy: 0.9995
Epoch 97/530
531/531 [=====] - 1s 1ms/step - loss: 0.0013 - accuracy: 0.9
997 - val_loss: 0.0026 - val_accuracy: 0.9996
Epoch 98/530
531/531 [=====] - 1s 1ms/step - loss: 0.0012 - accuracy: 0.9
997 - val_loss: 0.0061 - val_accuracy: 0.9988
Epoch 99/530
531/531 [=====] - 1s 1ms/step - loss: 0.0019 - accuracy: 0.9
996 - val_loss: 0.0122 - val_accuracy: 0.9952
Epoch 100/530
531/531 [=====] - 1s 1ms/step - loss: 0.0013 - accuracy: 0.9
997 - val_loss: 0.0031 - val_accuracy: 0.9995
Epoch 101/530
531/531 [=====] - 1s 1ms/step - loss: 0.0014 - accuracy: 0.9
997 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 102/530
531/531 [=====] - 1s 1ms/step - loss: 9.4869e-04 - accuracy:
0.9998 - val_loss: 0.0025 - val_accuracy: 0.9996
Epoch 103/530
531/531 [=====] - 1s 1ms/step - loss: 0.0028 - accuracy: 0.9
994 - val_loss: 0.0025 - val_accuracy: 0.9997
Epoch 104/530
531/531 [=====] - 1s 1ms/step - loss: 0.0018 - accuracy: 0.9
996 - val_loss: 0.0030 - val_accuracy: 0.9995
Epoch 105/530
531/531 [=====] - 1s 1ms/step - loss: 7.9564e-04 - accuracy:
0.9999 - val_loss: 0.0033 - val_accuracy: 0.9994
Epoch 106/530
531/531 [=====] - 1s 2ms/step - loss: 0.0018 - accuracy: 0.9
996 - val_loss: 0.0029 - val_accuracy: 0.9996
Epoch 107/530
531/531 [=====] - 1s 2ms/step - loss: 0.0018 - accuracy: 0.9
997 - val_loss: 0.0031 - val_accuracy: 0.9995
Epoch 108/530
531/531 [=====] - 1s 1ms/step - loss: 8.3508e-04 - accuracy:
0.9999 - val_loss: 0.0024 - val_accuracy: 0.9996
Epoch 109/530
531/531 [=====] - 1s 1ms/step - loss: 0.0017 - accuracy: 0.9
997 - val_loss: 0.0031 - val_accuracy: 0.9995
Epoch 110/530
531/531 [=====] - 1s 1ms/step - loss: 0.0013 - accuracy: 0.9
997 - val_loss: 0.0038 - val_accuracy: 0.9995
Epoch 111/530
531/531 [=====] - 1s 1ms/step - loss: 9.3138e-04 - accuracy:
0.9998 - val_loss: 0.0028 - val_accuracy: 0.9996
Epoch 112/530
```



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531/531 [=====] - 1s 1ms/step - loss: 0.0018 - accuracy: 0.9
996 - val_loss: 0.0030 - val_accuracy: 0.9995
Epoch 113/530
531/531 [=====] - 1s 1ms/step - loss: 0.0015 - accuracy: 0.9
997 - val_loss: 0.0038 - val_accuracy: 0.9993
Epoch 114/530
531/531 [=====] - 1s 1ms/step - loss: 0.0015 - accuracy: 0.9
997 - val_loss: 0.0039 - val_accuracy: 0.9993
Epoch 115/530
531/531 [=====] - 1s 1ms/step - loss: 0.0015 - accuracy: 0.9
997 - val_loss: 0.0026 - val_accuracy: 0.9997
Epoch 116/530
531/531 [=====] - 1s 1ms/step - loss: 0.0010 - accuracy: 0.9
998 - val_loss: 0.0033 - val_accuracy: 0.9995
Epoch 117/530
531/531 [=====] - 1s 1ms/step - loss: 0.0014 - accuracy: 0.9
997 - val_loss: 0.0040 - val_accuracy: 0.9993
Epoch 118/530
531/531 [=====] - 1s 2ms/step - loss: 0.0017 - accuracy: 0.9
996 - val_loss: 0.0027 - val_accuracy: 0.9996
Epoch 119/530
531/531 [=====] - 1s 1ms/step - loss: 0.0015 - accuracy: 0.9
997 - val_loss: 0.0029 - val_accuracy: 0.9995
Epoch 120/530
531/531 [=====] - 1s 1ms/step - loss: 6.4952e-04 - accuracy:
0.9999 - val_loss: 0.0030 - val_accuracy: 0.9995
Epoch 121/530
531/531 [=====] - 1s 1ms/step - loss: 0.0010 - accuracy: 0.9
998 - val_loss: 0.0044 - val_accuracy: 0.9994
Epoch 122/530
531/531 [=====] - 1s 1ms/step - loss: 0.0018 - accuracy: 0.9
996 - val_loss: 0.0033 - val_accuracy: 0.9995
Epoch 123/530
531/531 [=====] - 1s 1ms/step - loss: 9.7409e-04 - accuracy:
0.9998 - val_loss: 0.0032 - val_accuracy: 0.9995
Epoch 124/530
531/531 [=====] - 1s 1ms/step - loss: 8.2941e-04 - accuracy:
0.9998 - val_loss: 0.0060 - val_accuracy: 0.9990
Epoch 125/530
531/531 [=====] - 1s 1ms/step - loss: 0.0012 - accuracy: 0.9
997 - val_loss: 0.0031 - val_accuracy: 0.9995
Epoch 126/530
531/531 [=====] - 1s 1ms/step - loss: 0.0022 - accuracy: 0.9
995 - val_loss: 0.0036 - val_accuracy: 0.9994
Epoch 127/530
531/531 [=====] - 1s 1ms/step - loss: 0.0011 - accuracy: 0.9
998 - val_loss: 0.0026 - val_accuracy: 0.9996
Epoch 128/530
531/531 [=====] - 1s 1ms/step - loss: 0.0014 - accuracy: 0.9
997 - val_loss: 0.0053 - val_accuracy: 0.9991
Epoch 129/530
531/531 [=====] - 1s 1ms/step - loss: 0.0016 - accuracy: 0.9
996 - val_loss: 0.0028 - val_accuracy: 0.9995
Epoch 130/530
531/531 [=====] - 1s 1ms/step - loss: 6.2833e-04 - accuracy:
0.9999 - val_loss: 0.0027 - val_accuracy: 0.9996
Epoch 131/530
531/531 [=====] - 1s 1ms/step - loss: 5.0921e-04 - accuracy:
0.9999 - val_loss: 0.0026 - val_accuracy: 0.9996
Epoch 132/530
531/531 [=====] - 1s 1ms/step - loss: 0.0018 - accuracy: 0.9
997 - val_loss: 0.0052 - val_accuracy: 0.9992
Epoch 133/530
531/531 [=====] - 1s 1ms/step - loss: 0.0013 - accuracy: 0.9
997 - val_loss: 0.0034 - val_accuracy: 0.9993
Epoch 134/530
531/531 [=====] - 1s 1ms/step - loss: 9.1180e-04 - accuracy:
0.9998 - val_loss: 0.0033 - val_accuracy: 0.9995
Epoch 135/530
531/531 [=====] - 1s 1ms/step - loss: 9.0041e-04 - accuracy:
```

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0.9998 - val_loss: 0.0042 - val_accuracy: 0.9993
Epoch 136/530
531/531 [=====] - 1s 1ms/step - loss: 8.9790e-04 - accuracy:
0.9998 - val_loss: 0.0025 - val_accuracy: 0.9996
Epoch 137/530
531/531 [=====] - 1s 1ms/step - loss: 0.0017 - accuracy: 0.9
997 - val_loss: 0.0032 - val_accuracy: 0.9994
Epoch 138/530
531/531 [=====] - 1s 1ms/step - loss: 9.4541e-04 - accuracy:
0.9998 - val_loss: 0.0047 - val_accuracy: 0.9979
Epoch 139/530
531/531 [=====] - 1s 1ms/step - loss: 9.9412e-04 - accuracy:
0.9998 - val_loss: 0.0028 - val_accuracy: 0.9996
Epoch 140/530
531/531 [=====] - 1s 1ms/step - loss: 0.0011 - accuracy: 0.9
998 - val_loss: 0.0030 - val_accuracy: 0.9995
Epoch 141/530
531/531 [=====] - 1s 1ms/step - loss: 0.0010 - accuracy: 0.9
998 - val_loss: 0.0022 - val_accuracy: 0.9997
Epoch 142/530
531/531 [=====] - 1s 1ms/step - loss: 0.0024 - accuracy: 0.9
996 - val_loss: 0.0050 - val_accuracy: 0.9991
Epoch 143/530
531/531 [=====] - 1s 1ms/step - loss: 0.0012 - accuracy: 0.9
997 - val_loss: 0.0028 - val_accuracy: 0.9996
Epoch 144/530
531/531 [=====] - 1s 1ms/step - loss: 7.3712e-04 - accuracy:
0.9999 - val_loss: 0.0027 - val_accuracy: 0.9995
Epoch 145/530
531/531 [=====] - 1s 1ms/step - loss: 8.0317e-04 - accuracy:
0.9999 - val_loss: 0.0023 - val_accuracy: 0.9997
Epoch 146/530
531/531 [=====] - 1s 1ms/step - loss: 0.0017 - accuracy: 0.9
997 - val_loss: 0.0027 - val_accuracy: 0.9995
Epoch 147/530
531/531 [=====] - 1s 1ms/step - loss: 9.5312e-04 - accuracy:
0.9998 - val_loss: 0.0021 - val_accuracy: 0.9997
Epoch 148/530
531/531 [=====] - 1s 1ms/step - loss: 7.8552e-04 - accuracy:
0.9999 - val_loss: 0.0023 - val_accuracy: 0.9997
Epoch 149/530
531/531 [=====] - 1s 1ms/step - loss: 0.0018 - accuracy: 0.9
996 - val_loss: 0.0023 - val_accuracy: 0.9996
Epoch 150/530
531/531 [=====] - 1s 1ms/step - loss: 8.4144e-04 - accuracy:
0.9998 - val_loss: 0.0033 - val_accuracy: 0.9994
Epoch 151/530
531/531 [=====] - 1s 1ms/step - loss: 8.6501e-04 - accuracy:
0.9998 - val_loss: 0.0023 - val_accuracy: 0.9996
Epoch 152/530
531/531 [=====] - 1s 1ms/step - loss: 0.0010 - accuracy: 0.9
998 - val_loss: 0.0035 - val_accuracy: 0.9995
Epoch 153/530
531/531 [=====] - 1s 1ms/step - loss: 0.0012 - accuracy: 0.9
997 - val_loss: 0.0028 - val_accuracy: 0.9996
Epoch 154/530
531/531 [=====] - 1s 1ms/step - loss: 6.0840e-04 - accuracy:
0.9998 - val_loss: 0.0055 - val_accuracy: 0.9991
Epoch 155/530
531/531 [=====] - 1s 1ms/step - loss: 0.0014 - accuracy: 0.9
997 - val_loss: 0.0053 - val_accuracy: 0.9980
Epoch 156/530
531/531 [=====] - 1s 1ms/step - loss: 8.4336e-04 - accuracy:
0.9998 - val_loss: 0.0035 - val_accuracy: 0.9995
Epoch 157/530
531/531 [=====] - 1s 1ms/step - loss: 0.0013 - accuracy: 0.9
997 - val_loss: 0.0026 - val_accuracy: 0.9997
Epoch 158/530
531/531 [=====] - 1s 1ms/step - loss: 0.0013 - accuracy: 0.9
998 - val_loss: 0.0027 - val_accuracy: 0.9996
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Epoch 159/530
531/531 [=====] - 1s 1ms/step - loss: 0.0010 - accuracy: 0.9
998 - val_loss: 0.0033 - val_accuracy: 0.9996
Epoch 160/530
531/531 [=====] - 1s 1ms/step - loss: 0.0013 - accuracy: 0.9
997 - val_loss: 0.0039 - val_accuracy: 0.9994
Epoch 161/530
531/531 [=====] - 1s 1ms/step - loss: 7.9788e-04 - accuracy:
0.9998 - val_loss: 0.0027 - val_accuracy: 0.9996
Epoch 162/530
531/531 [=====] - 1s 1ms/step - loss: 0.0011 - accuracy: 0.9
998 - val_loss: 0.0025 - val_accuracy: 0.9996
Epoch 163/530
531/531 [=====] - 1s 1ms/step - loss: 6.2059e-04 - accuracy:
0.9999 - val_loss: 0.0023 - val_accuracy: 0.9997
Epoch 164/530
531/531 [=====] - 1s 1ms/step - loss: 5.7806e-04 - accuracy:
0.9999 - val_loss: 0.0023 - val_accuracy: 0.9997
Epoch 165/530
531/531 [=====] - 1s 1ms/step - loss: 5.7651e-04 - accuracy:
0.9999 - val_loss: 0.0028 - val_accuracy: 0.9996
Epoch 166/530
531/531 [=====] - 1s 1ms/step - loss: 0.0015 - accuracy: 0.9
997 - val_loss: 0.0036 - val_accuracy: 0.9994
Epoch 167/530
531/531 [=====] - 1s 1ms/step - loss: 9.7116e-04 - accuracy:
0.9998 - val_loss: 0.0037 - val_accuracy: 0.9996
Epoch 168/530
531/531 [=====] - 1s 1ms/step - loss: 0.0012 - accuracy: 0.9
998 - val_loss: 0.0026 - val_accuracy: 0.9995
Epoch 169/530
531/531 [=====] - 1s 2ms/step - loss: 0.0013 - accuracy: 0.9
998 - val_loss: 0.0027 - val_accuracy: 0.9995
Epoch 170/530
531/531 [=====] - 1s 2ms/step - loss: 3.7263e-04 - accuracy:
0.9999 - val_loss: 0.0037 - val_accuracy: 0.9994
Epoch 171/530
531/531 [=====] - 1s 1ms/step - loss: 0.0014 - accuracy: 0.9
997 - val_loss: 0.0037 - val_accuracy: 0.9994
Epoch 172/530
531/531 [=====] - 1s 1ms/step - loss: 0.0013 - accuracy: 0.9
997 - val_loss: 0.0033 - val_accuracy: 0.9995
Epoch 173/530
531/531 [=====] - 1s 1ms/step - loss: 7.6294e-04 - accuracy:
0.9998 - val_loss: 0.0032 - val_accuracy: 0.9995
Epoch 174/530
531/531 [=====] - 1s 1ms/step - loss: 4.7754e-04 - accuracy:
0.9999 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 175/530
531/531 [=====] - 1s 1ms/step - loss: 8.1607e-04 - accuracy:
0.9998 - val_loss: 0.0038 - val_accuracy: 0.9995
Epoch 176/530
531/531 [=====] - 1s 1ms/step - loss: 4.4228e-04 - accuracy:
0.9999 - val_loss: 0.0059 - val_accuracy: 0.9992
Epoch 177/530
531/531 [=====] - 1s 1ms/step - loss: 0.0025 - accuracy: 0.9
995 - val_loss: 0.0030 - val_accuracy: 0.9996
Epoch 178/530
531/531 [=====] - 1s 2ms/step - loss: 5.0988e-04 - accuracy:
0.9999 - val_loss: 0.0034 - val_accuracy: 0.9995
Epoch 179/530
531/531 [=====] - 1s 1ms/step - loss: 9.5607e-04 - accuracy:
0.9998 - val_loss: 0.0026 - val_accuracy: 0.9998
Epoch 180/530
531/531 [=====] - 1s 2ms/step - loss: 8.5917e-04 - accuracy:
0.9998 - val_loss: 0.0026 - val_accuracy: 0.9996
Epoch 181/530
531/531 [=====] - 1s 1ms/step - loss: 7.4235e-04 - accuracy:
0.9999 - val_loss: 0.0023 - val_accuracy: 0.9997
Epoch 182/530
```

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531/531 [=====] - 1s 1ms/step - loss: 7.0005e-04 - accuracy:
0.9998 - val_loss: 0.0040 - val_accuracy: 0.9994
Epoch 183/530
531/531 [=====] - 1s 1ms/step - loss: 6.7962e-04 - accuracy:
0.9999 - val_loss: 0.0028 - val_accuracy: 0.9995
Epoch 184/530
531/531 [=====] - 1s 1ms/step - loss: 4.5777e-04 - accuracy:
0.9999 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 185/530
531/531 [=====] - 1s 1ms/step - loss: 2.9913e-04 - accuracy:
0.9999 - val_loss: 0.0024 - val_accuracy: 0.9998
Epoch 186/530
531/531 [=====] - 1s 1ms/step - loss: 0.0011 - accuracy: 0.9
998 - val_loss: 0.0054 - val_accuracy: 0.9991
Epoch 187/530
531/531 [=====] - 1s 1ms/step - loss: 0.0015 - accuracy: 0.9
997 - val_loss: 0.0049 - val_accuracy: 0.9992
Epoch 188/530
531/531 [=====] - 1s 1ms/step - loss: 6.2101e-04 - accuracy:
0.9999 - val_loss: 0.0027 - val_accuracy: 0.9996
Epoch 189/530
531/531 [=====] - 1s 1ms/step - loss: 5.4929e-04 - accuracy:
0.9999 - val_loss: 0.0026 - val_accuracy: 0.9997
Epoch 190/530
531/531 [=====] - 1s 1ms/step - loss: 7.1701e-04 - accuracy:
0.9999 - val_loss: 0.0026 - val_accuracy: 0.9996
Epoch 191/530
531/531 [=====] - 1s 1ms/step - loss: 5.5098e-04 - accuracy:
0.9999 - val_loss: 0.0025 - val_accuracy: 0.9997
Epoch 192/530
531/531 [=====] - 1s 1ms/step - loss: 0.0011 - accuracy: 0.9
998 - val_loss: 0.0027 - val_accuracy: 0.9996
Epoch 193/530
531/531 [=====] - 1s 1ms/step - loss: 9.7651e-04 - accuracy:
0.9998 - val_loss: 0.0032 - val_accuracy: 0.9995
Epoch 194/530
531/531 [=====] - 1s 1ms/step - loss: 5.6954e-04 - accuracy:
0.9999 - val_loss: 0.0027 - val_accuracy: 0.9997
Epoch 195/530
531/531 [=====] - 1s 1ms/step - loss: 3.0198e-04 - accuracy:
0.9999 - val_loss: 0.0041 - val_accuracy: 0.9995
Epoch 196/530
531/531 [=====] - 1s 1ms/step - loss: 4.2612e-04 - accuracy:
0.9999 - val_loss: 0.0032 - val_accuracy: 0.9996
Epoch 197/530
531/531 [=====] - 1s 1ms/step - loss: 8.8451e-04 - accuracy:
0.9998 - val_loss: 0.0053 - val_accuracy: 0.9992
Epoch 198/530
531/531 [=====] - 1s 1ms/step - loss: 0.0012 - accuracy: 0.9
997 - val_loss: 0.0027 - val_accuracy: 0.9996
Epoch 199/530
531/531 [=====] - 1s 1ms/step - loss: 8.4120e-04 - accuracy:
0.9998 - val_loss: 0.0019 - val_accuracy: 0.9998
Epoch 200/530
531/531 [=====] - 1s 1ms/step - loss: 4.0110e-04 - accuracy:
0.9999 - val_loss: 0.0019 - val_accuracy: 0.9998
Epoch 201/530
531/531 [=====] - 1s 1ms/step - loss: 6.2890e-04 - accuracy:
0.9999 - val_loss: 0.0029 - val_accuracy: 0.9996
Epoch 202/530
531/531 [=====] - 1s 1ms/step - loss: 9.9812e-04 - accuracy:
0.9998 - val_loss: 0.0020 - val_accuracy: 0.9997
Epoch 203/530
531/531 [=====] - 1s 1ms/step - loss: 6.2396e-04 - accuracy:
0.9999 - val_loss: 0.0086 - val_accuracy: 0.9984
Epoch 204/530
531/531 [=====] - 1s 1ms/step - loss: 7.2820e-04 - accuracy:
0.9998 - val_loss: 0.0060 - val_accuracy: 0.9991
Epoch 205/530
531/531 [=====] - 1s 1ms/step - loss: 9.7982e-04 - accuracy:
```

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0.9998 - val_loss: 0.0032 - val_accuracy: 0.9995
Epoch 206/530
531/531 [=====] - 1s 1ms/step - loss: 0.0018 - accuracy: 0.9
997 - val_loss: 0.0021 - val_accuracy: 0.9997
Epoch 207/530
531/531 [=====] - 1s 1ms/step - loss: 0.0010 - accuracy: 0.9
998 - val_loss: 0.0034 - val_accuracy: 0.9995
Epoch 208/530
531/531 [=====] - 1s 1ms/step - loss: 5.6348e-04 - accuracy:
0.9999 - val_loss: 0.0026 - val_accuracy: 0.9997
Epoch 209/530
531/531 [=====] - 1s 1ms/step - loss: 4.6684e-04 - accuracy:
0.9999 - val_loss: 0.0042 - val_accuracy: 0.9994
Epoch 210/530
531/531 [=====] - 1s 1ms/step - loss: 5.9237e-04 - accuracy:
0.9999 - val_loss: 0.0023 - val_accuracy: 0.9997
Epoch 211/530
531/531 [=====] - 1s 1ms/step - loss: 6.7933e-04 - accuracy:
0.9999 - val_loss: 0.0023 - val_accuracy: 0.9997
Epoch 212/530
531/531 [=====] - 1s 1ms/step - loss: 0.0011 - accuracy: 0.9
998 - val_loss: 0.0040 - val_accuracy: 0.9994
Epoch 213/530
531/531 [=====] - 1s 1ms/step - loss: 6.4426e-04 - accuracy:
0.9999 - val_loss: 0.0029 - val_accuracy: 0.9996
Epoch 214/530
531/531 [=====] - 1s 1ms/step - loss: 5.0682e-04 - accuracy:
0.9999 - val_loss: 0.0030 - val_accuracy: 0.9996
Epoch 215/530
531/531 [=====] - 1s 1ms/step - loss: 0.0011 - accuracy: 0.9
998 - val_loss: 0.0030 - val_accuracy: 0.9996
Epoch 216/530
531/531 [=====] - 1s 1ms/step - loss: 2.8736e-04 - accuracy:
0.9999 - val_loss: 0.0034 - val_accuracy: 0.9996
Epoch 217/530
531/531 [=====] - 1s 1ms/step - loss: 3.4153e-04 - accuracy:
0.9999 - val_loss: 0.0029 - val_accuracy: 0.9997
Epoch 218/530
531/531 [=====] - 1s 1ms/step - loss: 9.9552e-04 - accuracy:
0.9998 - val_loss: 0.0033 - val_accuracy: 0.9995
Epoch 219/530
531/531 [=====] - 1s 1ms/step - loss: 8.6702e-04 - accuracy:
0.9998 - val_loss: 0.0029 - val_accuracy: 0.9996
Epoch 220/530
531/531 [=====] - 1s 1ms/step - loss: 4.8893e-04 - accuracy:
0.9999 - val_loss: 0.0030 - val_accuracy: 0.9996
Epoch 221/530
531/531 [=====] - 1s 1ms/step - loss: 3.3635e-04 - accuracy:
0.9999 - val_loss: 0.0029 - val_accuracy: 0.9996
Epoch 222/530
531/531 [=====] - 1s 1ms/step - loss: 0.0010 - accuracy: 0.9
998 - val_loss: 0.0038 - val_accuracy: 0.9994
Epoch 223/530
531/531 [=====] - 1s 1ms/step - loss: 9.0588e-04 - accuracy:
0.9998 - val_loss: 0.0050 - val_accuracy: 0.9993
Epoch 224/530
531/531 [=====] - 1s 1ms/step - loss: 6.7456e-04 - accuracy:
0.9999 - val_loss: 0.0047 - val_accuracy: 0.9994
Epoch 225/530
531/531 [=====] - 1s 1ms/step - loss: 8.5766e-04 - accuracy:
0.9998 - val_loss: 0.0022 - val_accuracy: 0.9998
Epoch 226/530
531/531 [=====] - 1s 2ms/step - loss: 8.1089e-04 - accuracy:
0.9999 - val_loss: 0.0022 - val_accuracy: 0.9997
Epoch 227/530
531/531 [=====] - 1s 2ms/step - loss: 4.2111e-04 - accuracy:
0.9999 - val_loss: 0.0022 - val_accuracy: 0.9997
Epoch 228/530
531/531 [=====] - 1s 2ms/step - loss: 8.9213e-04 - accuracy:
0.9998 - val_loss: 0.0026 - val_accuracy: 0.9996
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Epoch 229/530
531/531 [=====] - 1s 2ms/step - loss: 9.2657e-04 - accuracy:
0.9998 - val_loss: 0.0026 - val_accuracy: 0.9996
Epoch 230/530
531/531 [=====] - 1s 1ms/step - loss: 5.0783e-04 - accuracy:
0.9999 - val_loss: 0.0027 - val_accuracy: 0.9996
Epoch 231/530
531/531 [=====] - 1s 1ms/step - loss: 5.8693e-04 - accuracy:
0.9999 - val_loss: 0.0028 - val_accuracy: 0.9996
Epoch 232/530
531/531 [=====] - 1s 1ms/step - loss: 5.6071e-04 - accuracy:
0.9999 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 233/530
531/531 [=====] - 1s 1ms/step - loss: 7.2847e-04 - accuracy:
0.9998 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 234/530
531/531 [=====] - 1s 1ms/step - loss: 4.0005e-04 - accuracy:
0.9999 - val_loss: 0.0036 - val_accuracy: 0.9995
Epoch 235/530
531/531 [=====] - 1s 1ms/step - loss: 6.9848e-04 - accuracy:
0.9998 - val_loss: 0.0027 - val_accuracy: 0.9997
Epoch 236/530
531/531 [=====] - 1s 2ms/step - loss: 3.1307e-04 - accuracy:
0.9999 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 237/530
531/531 [=====] - 1s 1ms/step - loss: 8.8156e-04 - accuracy:
0.9998 - val_loss: 0.0040 - val_accuracy: 0.9992
Epoch 238/530
531/531 [=====] - 1s 1ms/step - loss: 7.4775e-04 - accuracy:
0.9999 - val_loss: 0.0032 - val_accuracy: 0.9995
Epoch 239/530
531/531 [=====] - 1s 1ms/step - loss: 2.7312e-04 - accuracy:
0.9999 - val_loss: 0.0028 - val_accuracy: 0.9996
Epoch 240/530
531/531 [=====] - 1s 1ms/step - loss: 8.3751e-04 - accuracy:
0.9998 - val_loss: 0.0042 - val_accuracy: 0.9993
Epoch 241/530
531/531 [=====] - 1s 1ms/step - loss: 0.0011 - accuracy: 0.9
998 - val_loss: 0.0022 - val_accuracy: 0.9997
Epoch 242/530
531/531 [=====] - 1s 1ms/step - loss: 4.3562e-04 - accuracy:
0.9999 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 243/530
531/531 [=====] - 1s 2ms/step - loss: 5.4301e-04 - accuracy:
0.9999 - val_loss: 0.0032 - val_accuracy: 0.9996
Epoch 244/530
531/531 [=====] - 1s 1ms/step - loss: 8.9003e-04 - accuracy:
0.9998 - val_loss: 0.0026 - val_accuracy: 0.9997
Epoch 245/530
531/531 [=====] - 1s 1ms/step - loss: 2.4710e-04 - accuracy:
1.0000 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 246/530
531/531 [=====] - 1s 1ms/step - loss: 4.0748e-04 - accuracy:
0.9999 - val_loss: 0.0035 - val_accuracy: 0.9996
Epoch 247/530
531/531 [=====] - 1s 2ms/step - loss: 7.3719e-04 - accuracy:
0.9998 - val_loss: 0.0028 - val_accuracy: 0.9997
Epoch 248/530
531/531 [=====] - 1s 2ms/step - loss: 5.2130e-04 - accuracy:
0.9999 - val_loss: 0.0026 - val_accuracy: 0.9997
Epoch 249/530
531/531 [=====] - 1s 2ms/step - loss: 6.6241e-04 - accuracy:
0.9999 - val_loss: 0.0051 - val_accuracy: 0.9979
Epoch 250/530
531/531 [=====] - 1s 1ms/step - loss: 0.0014 - accuracy: 0.9
998 - val_loss: 0.0031 - val_accuracy: 0.9995
Epoch 251/530
531/531 [=====] - 1s 1ms/step - loss: 2.9290e-04 - accuracy:
1.0000 - val_loss: 0.0025 - val_accuracy: 0.9997
Epoch 252/530
```

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531/531 [=====] - 1s 1ms/step - loss: 5.8788e-04 - accuracy:
0.9999 - val_loss: 0.0029 - val_accuracy: 0.9996
Epoch 253/530
531/531 [=====] - 1s 1ms/step - loss: 2.8549e-04 - accuracy:
0.9999 - val_loss: 0.0028 - val_accuracy: 0.9996
Epoch 254/530
531/531 [=====] - 1s 1ms/step - loss: 2.0230e-04 - accuracy:
1.0000 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 255/530
531/531 [=====] - 1s 2ms/step - loss: 9.5520e-04 - accuracy:
0.9998 - val_loss: 0.0028 - val_accuracy: 0.9996
Epoch 256/530
531/531 [=====] - 1s 2ms/step - loss: 6.6408e-04 - accuracy:
0.9999 - val_loss: 0.0031 - val_accuracy: 0.9996
Epoch 257/530
531/531 [=====] - 1s 2ms/step - loss: 6.3150e-04 - accuracy:
0.9999 - val_loss: 0.0020 - val_accuracy: 0.9997
Epoch 258/530
531/531 [=====] - 1s 2ms/step - loss: 4.7800e-04 - accuracy:
0.9999 - val_loss: 0.0033 - val_accuracy: 0.9995
Epoch 259/530
531/531 [=====] - 1s 1ms/step - loss: 4.8614e-04 - accuracy:
0.9999 - val_loss: 0.0031 - val_accuracy: 0.9996
Epoch 260/530
531/531 [=====] - 1s 1ms/step - loss: 4.8521e-04 - accuracy:
0.9999 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 261/530
531/531 [=====] - 1s 1ms/step - loss: 0.0012 - accuracy: 0.9
997 - val_loss: 0.0023 - val_accuracy: 0.9997
Epoch 262/530
531/531 [=====] - 1s 1ms/step - loss: 0.0014 - accuracy: 0.9
997 - val_loss: 0.0025 - val_accuracy: 0.9996
Epoch 263/530
531/531 [=====] - 1s 1ms/step - loss: 5.5876e-04 - accuracy:
0.9999 - val_loss: 0.0024 - val_accuracy: 0.9996
Epoch 264/530
531/531 [=====] - 1s 1ms/step - loss: 3.6877e-04 - accuracy:
0.9999 - val_loss: 0.0026 - val_accuracy: 0.9996
Epoch 265/530
531/531 [=====] - 1s 1ms/step - loss: 6.2040e-04 - accuracy:
0.9999 - val_loss: 0.0041 - val_accuracy: 0.9994
Epoch 266/530
531/531 [=====] - 1s 2ms/step - loss: 6.7225e-04 - accuracy:
0.9998 - val_loss: 0.0026 - val_accuracy: 0.9996
Epoch 267/530
531/531 [=====] - 1s 1ms/step - loss: 4.0544e-04 - accuracy:
0.9999 - val_loss: 0.0031 - val_accuracy: 0.9996
Epoch 268/530
531/531 [=====] - 1s 1ms/step - loss: 5.4301e-04 - accuracy:
0.9999 - val_loss: 0.0031 - val_accuracy: 0.9997
Epoch 269/530
531/531 [=====] - 1s 1ms/step - loss: 3.1254e-04 - accuracy:
0.9999 - val_loss: 0.0037 - val_accuracy: 0.9995
Epoch 270/530
531/531 [=====] - 1s 1ms/step - loss: 2.5614e-04 - accuracy:
0.9999 - val_loss: 0.0028 - val_accuracy: 0.9996
Epoch 271/530
531/531 [=====] - 1s 1ms/step - loss: 2.3548e-04 - accuracy:
1.0000 - val_loss: 0.0029 - val_accuracy: 0.9996
Epoch 272/530
531/531 [=====] - 1s 1ms/step - loss: 6.1836e-04 - accuracy:
0.9999 - val_loss: 0.0031 - val_accuracy: 0.9996
Epoch 273/530
531/531 [=====] - 1s 1ms/step - loss: 4.4100e-04 - accuracy:
0.9999 - val_loss: 0.0028 - val_accuracy: 0.9997
Epoch 274/530
531/531 [=====] - 1s 1ms/step - loss: 0.0014 - accuracy: 0.9
997 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 275/530
531/531 [=====] - 1s 1ms/step - loss: 4.4471e-04 - accuracy:
```

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0.9999 - val_loss: 0.0025 - val_accuracy: 0.9996
Epoch 276/530
531/531 [=====] - 1s 1ms/step - loss: 4.2114e-04 - accuracy:
0.9999 - val_loss: 0.0028 - val_accuracy: 0.9997
Epoch 277/530
531/531 [=====] - 1s 1ms/step - loss: 0.0011 - accuracy: 0.9
998 - val_loss: 0.0026 - val_accuracy: 0.9996
Epoch 278/530
531/531 [=====] - 1s 1ms/step - loss: 4.3553e-04 - accuracy:
0.9999 - val_loss: 0.0027 - val_accuracy: 0.9997
Epoch 279/530
531/531 [=====] - 1s 2ms/step - loss: 2.0829e-04 - accuracy:
1.0000 - val_loss: 0.0025 - val_accuracy: 0.9997
Epoch 280/530
531/531 [=====] - 1s 2ms/step - loss: 3.4235e-04 - accuracy:
0.9999 - val_loss: 0.0026 - val_accuracy: 0.9997
Epoch 281/530
531/531 [=====] - 1s 1ms/step - loss: 4.2369e-04 - accuracy:
0.9999 - val_loss: 0.0031 - val_accuracy: 0.9996
Epoch 282/530
531/531 [=====] - 1s 1ms/step - loss: 5.7828e-04 - accuracy:
0.9999 - val_loss: 0.0025 - val_accuracy: 0.9997
Epoch 283/530
531/531 [=====] - 1s 1ms/step - loss: 6.2719e-04 - accuracy:
0.9999 - val_loss: 0.0022 - val_accuracy: 0.9997
Epoch 284/530
531/531 [=====] - 1s 1ms/step - loss: 3.9672e-04 - accuracy:
0.9999 - val_loss: 0.0026 - val_accuracy: 0.9997
Epoch 285/530
531/531 [=====] - 1s 1ms/step - loss: 0.0012 - accuracy: 0.9
998 - val_loss: 0.0029 - val_accuracy: 0.9996
Epoch 286/530
531/531 [=====] - 1s 1ms/step - loss: 6.9396e-04 - accuracy:
0.9999 - val_loss: 0.0034 - val_accuracy: 0.9995
Epoch 287/530
531/531 [=====] - 1s 1ms/step - loss: 6.7850e-04 - accuracy:
0.9999 - val_loss: 0.0036 - val_accuracy: 0.9995
Epoch 288/530
531/531 [=====] - 1s 2ms/step - loss: 6.0130e-04 - accuracy:
0.9999 - val_loss: 0.0027 - val_accuracy: 0.9997
Epoch 289/530
531/531 [=====] - 1s 1ms/step - loss: 2.7285e-04 - accuracy:
1.0000 - val_loss: 0.0028 - val_accuracy: 0.9996
Epoch 290/530
531/531 [=====] - 1s 1ms/step - loss: 5.6135e-04 - accuracy:
0.9999 - val_loss: 0.0026 - val_accuracy: 0.9997
Epoch 291/530
531/531 [=====] - 1s 1ms/step - loss: 7.0979e-04 - accuracy:
0.9998 - val_loss: 0.0026 - val_accuracy: 0.9997
Epoch 292/530
531/531 [=====] - 1s 1ms/step - loss: 2.7887e-04 - accuracy:
1.0000 - val_loss: 0.0027 - val_accuracy: 0.9997
Epoch 293/530
531/531 [=====] - 1s 1ms/step - loss: 3.3504e-04 - accuracy:
0.9999 - val_loss: 0.0034 - val_accuracy: 0.9995
Epoch 294/530
531/531 [=====] - 1s 1ms/step - loss: 2.8034e-04 - accuracy:
0.9999 - val_loss: 0.0031 - val_accuracy: 0.9996
Epoch 295/530
531/531 [=====] - 1s 1ms/step - loss: 0.0020 - accuracy: 0.9
996 - val_loss: 0.0027 - val_accuracy: 0.9996
Epoch 296/530
531/531 [=====] - 1s 1ms/step - loss: 5.3795e-04 - accuracy:
0.9999 - val_loss: 0.0036 - val_accuracy: 0.9997
Epoch 297/530
531/531 [=====] - 1s 1ms/step - loss: 4.7402e-04 - accuracy:
0.9999 - val_loss: 0.0041 - val_accuracy: 0.9996
Epoch 298/530
531/531 [=====] - 1s 1ms/step - loss: 3.9273e-04 - accuracy:
0.9999 - val_loss: 0.0024 - val_accuracy: 0.9997
```



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Epoch 299/530
531/531 [=====] - 1s 1ms/step - loss: 3.3106e-04 - accuracy:
0.9999 - val_loss: 0.0044 - val_accuracy: 0.9996
Epoch 300/530
531/531 [=====] - 1s 1ms/step - loss: 8.9679e-04 - accuracy:
0.9998 - val_loss: 0.0029 - val_accuracy: 0.9996
Epoch 301/530
531/531 [=====] - 1s 2ms/step - loss: 6.3545e-04 - accuracy:
0.9999 - val_loss: 0.0047 - val_accuracy: 0.9993
Epoch 302/530
531/531 [=====] - 1s 1ms/step - loss: 0.0012 - accuracy: 0.9
998 - val_loss: 0.0028 - val_accuracy: 0.9996
Epoch 303/530
531/531 [=====] - 1s 1ms/step - loss: 5.1786e-04 - accuracy:
0.9999 - val_loss: 0.0033 - val_accuracy: 0.9996
Epoch 304/530
531/531 [=====] - 1s 1ms/step - loss: 2.7375e-04 - accuracy:
0.9999 - val_loss: 0.0033 - val_accuracy: 0.9996
Epoch 305/530
531/531 [=====] - 1s 1ms/step - loss: 9.7939e-04 - accuracy:
0.9998 - val_loss: 0.0031 - val_accuracy: 0.9996
Epoch 306/530
531/531 [=====] - 1s 1ms/step - loss: 4.1528e-04 - accuracy:
0.9999 - val_loss: 0.0030 - val_accuracy: 0.9996
Epoch 307/530
531/531 [=====] - 1s 1ms/step - loss: 2.5613e-04 - accuracy:
1.0000 - val_loss: 0.0026 - val_accuracy: 0.9997
Epoch 308/530
531/531 [=====] - 1s 1ms/step - loss: 2.2754e-04 - accuracy:
1.0000 - val_loss: 0.0028 - val_accuracy: 0.9996
Epoch 309/530
531/531 [=====] - 1s 1ms/step - loss: 2.0496e-04 - accuracy:
1.0000 - val_loss: 0.0032 - val_accuracy: 0.9996
Epoch 310/530
531/531 [=====] - 1s 1ms/step - loss: 7.0872e-04 - accuracy:
0.9999 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 311/530
531/531 [=====] - 1s 1ms/step - loss: 3.8023e-04 - accuracy:
0.9999 - val_loss: 0.0034 - val_accuracy: 0.9996
Epoch 312/530
531/531 [=====] - 1s 1ms/step - loss: 2.6698e-04 - accuracy:
0.9999 - val_loss: 0.0028 - val_accuracy: 0.9996
Epoch 313/530
531/531 [=====] - 1s 1ms/step - loss: 6.0376e-04 - accuracy:
0.9999 - val_loss: 0.0033 - val_accuracy: 0.9996
Epoch 314/530
531/531 [=====] - 1s 1ms/step - loss: 0.0012 - accuracy: 0.9
998 - val_loss: 0.0020 - val_accuracy: 0.9998
Epoch 315/530
531/531 [=====] - 1s 1ms/step - loss: 2.3793e-04 - accuracy:
1.0000 - val_loss: 0.0025 - val_accuracy: 0.9997
Epoch 316/530
531/531 [=====] - 1s 1ms/step - loss: 6.5831e-04 - accuracy:
0.9999 - val_loss: 0.0026 - val_accuracy: 0.9996
Epoch 317/530
531/531 [=====] - 1s 1ms/step - loss: 3.3794e-04 - accuracy:
0.9999 - val_loss: 0.0026 - val_accuracy: 0.9997
Epoch 318/530
531/531 [=====] - 1s 1ms/step - loss: 6.4885e-04 - accuracy:
0.9999 - val_loss: 0.0027 - val_accuracy: 0.9996
Epoch 319/530
531/531 [=====] - 1s 1ms/step - loss: 6.2053e-04 - accuracy:
0.9999 - val_loss: 0.0051 - val_accuracy: 0.9993
Epoch 320/530
531/531 [=====] - 1s 1ms/step - loss: 8.8935e-04 - accuracy:
0.9998 - val_loss: 0.0055 - val_accuracy: 0.9991
Epoch 321/530
531/531 [=====] - 1s 1ms/step - loss: 8.0633e-04 - accuracy:
0.9998 - val_loss: 0.0028 - val_accuracy: 0.9996
Epoch 322/530
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531/531 [=====] - 1s 1ms/step - loss: 3.4944e-04 - accuracy:
0.9999 - val_loss: 0.0028 - val_accuracy: 0.9996
Epoch 323/530
531/531 [=====] - 1s 1ms/step - loss: 2.2923e-04 - accuracy:
1.0000 - val_loss: 0.0028 - val_accuracy: 0.9997
Epoch 324/530
531/531 [=====] - 1s 1ms/step - loss: 7.3467e-04 - accuracy:
0.9999 - val_loss: 0.0052 - val_accuracy: 0.9994
Epoch 325/530
531/531 [=====] - 1s 1ms/step - loss: 9.5186e-04 - accuracy:
0.9998 - val_loss: 0.0035 - val_accuracy: 0.9995
Epoch 326/530
531/531 [=====] - 1s 1ms/step - loss: 3.7004e-04 - accuracy:
0.9999 - val_loss: 0.0023 - val_accuracy: 0.9997
Epoch 327/530
531/531 [=====] - 1s 1ms/step - loss: 1.8280e-04 - accuracy:
1.0000 - val_loss: 0.0022 - val_accuracy: 0.9998
Epoch 328/530
531/531 [=====] - 1s 1ms/step - loss: 3.1751e-04 - accuracy:
0.9999 - val_loss: 0.0028 - val_accuracy: 0.9997
Epoch 329/530
531/531 [=====] - 1s 1ms/step - loss: 2.4767e-04 - accuracy:
0.9999 - val_loss: 0.0035 - val_accuracy: 0.9995
Epoch 330/530
531/531 [=====] - 1s 1ms/step - loss: 4.2151e-04 - accuracy:
0.9999 - val_loss: 0.0020 - val_accuracy: 0.9997
Epoch 331/530
531/531 [=====] - 1s 1ms/step - loss: 2.4759e-04 - accuracy:
0.9999 - val_loss: 0.0022 - val_accuracy: 0.9997
Epoch 332/530
531/531 [=====] - 1s 1ms/step - loss: 0.0017 - accuracy: 0.9
997 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 333/530
531/531 [=====] - 1s 1ms/step - loss: 6.9697e-04 - accuracy:
0.9999 - val_loss: 0.0021 - val_accuracy: 0.9998
Epoch 334/530
531/531 [=====] - 1s 1ms/step - loss: 2.2800e-04 - accuracy:
1.0000 - val_loss: 0.0022 - val_accuracy: 0.9998
Epoch 335/530
531/531 [=====] - 1s 1ms/step - loss: 9.2462e-04 - accuracy:
0.9998 - val_loss: 0.0022 - val_accuracy: 0.9997
Epoch 336/530
531/531 [=====] - 1s 1ms/step - loss: 2.3807e-04 - accuracy:
1.0000 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 337/530
531/531 [=====] - 1s 1ms/step - loss: 1.9027e-04 - accuracy:
1.0000 - val_loss: 0.0022 - val_accuracy: 0.9998
Epoch 338/530
531/531 [=====] - 1s 1ms/step - loss: 0.0013 - accuracy: 0.9
998 - val_loss: 0.0025 - val_accuracy: 0.9996
Epoch 339/530
531/531 [=====] - 1s 1ms/step - loss: 4.9747e-04 - accuracy:
0.9999 - val_loss: 0.0034 - val_accuracy: 0.9996
Epoch 340/530
531/531 [=====] - 1s 1ms/step - loss: 2.1066e-04 - accuracy:
1.0000 - val_loss: 0.0029 - val_accuracy: 0.9997
Epoch 341/530
531/531 [=====] - 1s 1ms/step - loss: 1.7282e-04 - accuracy:
1.0000 - val_loss: 0.0034 - val_accuracy: 0.9997
Epoch 342/530
531/531 [=====] - 1s 1ms/step - loss: 2.7145e-04 - accuracy:
0.9999 - val_loss: 0.0043 - val_accuracy: 0.9997
Epoch 343/530
531/531 [=====] - 1s 1ms/step - loss: 7.1927e-04 - accuracy:
0.9999 - val_loss: 0.0031 - val_accuracy: 0.9997
Epoch 344/530
531/531 [=====] - 1s 1ms/step - loss: 5.1245e-04 - accuracy:
0.9999 - val_loss: 0.0035 - val_accuracy: 0.9995
Epoch 345/530
531/531 [=====] - 1s 1ms/step - loss: 0.0012 - accuracy: 0.9
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999 - val_loss: 0.0029 - val_accuracy: 0.9996
Epoch 346/530
531/531 [=====] - 1s 1ms/step - loss: 8.7812e-04 - accuracy:
0.9998 - val_loss: 0.0032 - val_accuracy: 0.9995
Epoch 347/530
531/531 [=====] - 1s 1ms/step - loss: 4.1726e-04 - accuracy:
0.9999 - val_loss: 0.0032 - val_accuracy: 0.9995
Epoch 348/530
531/531 [=====] - 1s 1ms/step - loss: 3.2575e-04 - accuracy:
0.9999 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 349/530
531/531 [=====] - 1s 1ms/step - loss: 8.9891e-04 - accuracy:
0.9998 - val_loss: 0.0029 - val_accuracy: 0.9996
Epoch 350/530
531/531 [=====] - 1s 1ms/step - loss: 4.8712e-04 - accuracy:
0.9999 - val_loss: 0.0032 - val_accuracy: 0.9996
Epoch 351/530
531/531 [=====] - 1s 1ms/step - loss: 3.6583e-04 - accuracy:
0.9999 - val_loss: 0.0025 - val_accuracy: 0.9997
Epoch 352/530
531/531 [=====] - 1s 1ms/step - loss: 2.1592e-04 - accuracy:
1.0000 - val_loss: 0.0030 - val_accuracy: 0.9996
Epoch 353/530
531/531 [=====] - 1s 1ms/step - loss: 7.0586e-04 - accuracy:
0.9999 - val_loss: 0.0033 - val_accuracy: 0.9996
Epoch 354/530
531/531 [=====] - 1s 1ms/step - loss: 5.6376e-04 - accuracy:
0.9999 - val_loss: 0.0031 - val_accuracy: 0.9997
Epoch 355/530
531/531 [=====] - 1s 1ms/step - loss: 2.7384e-04 - accuracy:
0.9999 - val_loss: 0.0032 - val_accuracy: 0.9997
Epoch 356/530
531/531 [=====] - 1s 1ms/step - loss: 0.0011 - accuracy: 0.9
998 - val_loss: 0.0028 - val_accuracy: 0.9996
Epoch 357/530
531/531 [=====] - 1s 1ms/step - loss: 3.3195e-04 - accuracy:
0.9999 - val_loss: 0.0032 - val_accuracy: 0.9996
Epoch 358/530
531/531 [=====] - 1s 1ms/step - loss: 2.8681e-04 - accuracy:
1.0000 - val_loss: 0.0027 - val_accuracy: 0.9997
Epoch 359/530
531/531 [=====] - 1s 1ms/step - loss: 5.2667e-04 - accuracy:
0.9999 - val_loss: 0.0039 - val_accuracy: 0.9996
Epoch 360/530
531/531 [=====] - 1s 1ms/step - loss: 3.6638e-04 - accuracy:
0.9999 - val_loss: 0.0026 - val_accuracy: 0.9997
Epoch 361/530
531/531 [=====] - 1s 1ms/step - loss: 3.2734e-04 - accuracy:
0.9999 - val_loss: 0.0048 - val_accuracy: 0.9994
Epoch 362/530
531/531 [=====] - 1s 1ms/step - loss: 8.5374e-04 - accuracy:
0.9998 - val_loss: 0.0025 - val_accuracy: 0.9997
Epoch 363/530
531/531 [=====] - 1s 1ms/step - loss: 3.3022e-04 - accuracy:
0.9999 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 364/530
531/531 [=====] - 1s 1ms/step - loss: 4.2183e-04 - accuracy:
0.9999 - val_loss: 0.0039 - val_accuracy: 0.9995
Epoch 365/530
531/531 [=====] - 1s 1ms/step - loss: 0.0015 - accuracy: 0.9
997 - val_loss: 0.0021 - val_accuracy: 0.9997
Epoch 366/530
531/531 [=====] - 1s 1ms/step - loss: 3.4173e-04 - accuracy:
0.9999 - val_loss: 0.0027 - val_accuracy: 0.9997
Epoch 367/530
531/531 [=====] - 1s 1ms/step - loss: 3.0592e-04 - accuracy:
0.9999 - val_loss: 0.0025 - val_accuracy: 0.9997
Epoch 368/530
531/531 [=====] - 1s 1ms/step - loss: 5.3218e-04 - accuracy:
0.9999 - val_loss: 0.0032 - val_accuracy: 0.9996
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Epoch 369/530
531/531 [=====] - 1s 1ms/step - loss: 3.6112e-04 - accuracy:
0.9999 - val_loss: 0.0028 - val_accuracy: 0.9997
Epoch 370/530
531/531 [=====] - 1s 1ms/step - loss: 3.0784e-04 - accuracy:
0.9999 - val_loss: 0.0029 - val_accuracy: 0.9997
Epoch 371/530
531/531 [=====] - 1s 1ms/step - loss: 4.2249e-04 - accuracy:
0.9999 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 372/530
531/531 [=====] - 1s 1ms/step - loss: 1.6466e-04 - accuracy:
1.0000 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 373/530
531/531 [=====] - 1s 1ms/step - loss: 2.7771e-04 - accuracy:
0.9999 - val_loss: 0.0026 - val_accuracy: 0.9997
Epoch 374/530
531/531 [=====] - 1s 1ms/step - loss: 2.6378e-04 - accuracy:
0.9999 - val_loss: 0.0029 - val_accuracy: 0.9996
Epoch 375/530
531/531 [=====] - 1s 1ms/step - loss: 7.9174e-04 - accuracy:
0.9998 - val_loss: 0.0028 - val_accuracy: 0.9996
Epoch 376/530
531/531 [=====] - 1s 1ms/step - loss: 2.6973e-04 - accuracy:
0.9999 - val_loss: 0.0031 - val_accuracy: 0.9996
Epoch 377/530
531/531 [=====] - 1s 1ms/step - loss: 1.9012e-04 - accuracy:
1.0000 - val_loss: 0.0034 - val_accuracy: 0.9996
Epoch 378/530
531/531 [=====] - 1s 1ms/step - loss: 6.7854e-04 - accuracy:
0.9999 - val_loss: 0.0044 - val_accuracy: 0.9994
Epoch 379/530
531/531 [=====] - 1s 1ms/step - loss: 2.6684e-04 - accuracy:
0.9999 - val_loss: 0.0027 - val_accuracy: 0.9997
Epoch 380/530
531/531 [=====] - 1s 1ms/step - loss: 1.7347e-04 - accuracy:
1.0000 - val_loss: 0.0026 - val_accuracy: 0.9997
Epoch 381/530
531/531 [=====] - 1s 1ms/step - loss: 1.4735e-04 - accuracy:
1.0000 - val_loss: 0.0031 - val_accuracy: 0.9996
Epoch 382/530
531/531 [=====] - 1s 1ms/step - loss: 1.6879e-04 - accuracy:
1.0000 - val_loss: 0.0025 - val_accuracy: 0.9997
Epoch 383/530
531/531 [=====] - 1s 1ms/step - loss: 0.0011 - accuracy: 0.9
998 - val_loss: 0.0050 - val_accuracy: 0.9994
Epoch 384/530
531/531 [=====] - 1s 1ms/step - loss: 8.4660e-04 - accuracy:
0.9999 - val_loss: 0.0029 - val_accuracy: 0.9997
Epoch 385/530
531/531 [=====] - 1s 1ms/step - loss: 4.4182e-04 - accuracy:
0.9999 - val_loss: 0.0028 - val_accuracy: 0.9997
Epoch 386/530
531/531 [=====] - 1s 1ms/step - loss: 2.8029e-04 - accuracy:
1.0000 - val_loss: 0.0031 - val_accuracy: 0.9996
Epoch 387/530
531/531 [=====] - 1s 1ms/step - loss: 4.2528e-04 - accuracy:
0.9999 - val_loss: 0.0029 - val_accuracy: 0.9996
Epoch 388/530
531/531 [=====] - 1s 1ms/step - loss: 3.3501e-04 - accuracy:
0.9999 - val_loss: 0.0025 - val_accuracy: 0.9997
Epoch 389/530
531/531 [=====] - 1s 1ms/step - loss: 4.8354e-04 - accuracy:
0.9999 - val_loss: 0.0029 - val_accuracy: 0.9996
Epoch 390/530
531/531 [=====] - 1s 1ms/step - loss: 4.0588e-04 - accuracy:
0.9999 - val_loss: 0.0027 - val_accuracy: 0.9997
Epoch 391/530
531/531 [=====] - 1s 1ms/step - loss: 2.5412e-04 - accuracy:
1.0000 - val_loss: 0.0026 - val_accuracy: 0.9997
Epoch 392/530
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531/531 [=====] - 1s 1ms/step - loss: 7.2120e-04 - accuracy:
0.9998 - val_loss: 0.0031 - val_accuracy: 0.9996
Epoch 393/530
531/531 [=====] - 1s 1ms/step - loss: 4.4925e-04 - accuracy:
0.9999 - val_loss: 0.0027 - val_accuracy: 0.9996
Epoch 394/530
531/531 [=====] - 1s 1ms/step - loss: 2.8520e-04 - accuracy:
0.9999 - val_loss: 0.0028 - val_accuracy: 0.9997
Epoch 395/530
531/531 [=====] - 1s 1ms/step - loss: 1.5381e-04 - accuracy:
1.0000 - val_loss: 0.0031 - val_accuracy: 0.9996
Epoch 396/530
531/531 [=====] - 1s 1ms/step - loss: 1.7944e-04 - accuracy:
1.0000 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 397/530
531/531 [=====] - 1s 1ms/step - loss: 5.3798e-04 - accuracy:
0.9999 - val_loss: 0.0028 - val_accuracy: 0.9997
Epoch 398/530
531/531 [=====] - 1s 1ms/step - loss: 2.4001e-04 - accuracy:
1.0000 - val_loss: 0.0028 - val_accuracy: 0.9997
Epoch 399/530
531/531 [=====] - 1s 1ms/step - loss: 0.0013 - accuracy: 0.9
997 - val_loss: 0.0035 - val_accuracy: 0.9995
Epoch 400/530
531/531 [=====] - 1s 1ms/step - loss: 4.0587e-04 - accuracy:
0.9999 - val_loss: 0.0025 - val_accuracy: 0.9997
Epoch 401/530
531/531 [=====] - 1s 1ms/step - loss: 7.6797e-04 - accuracy:
0.9999 - val_loss: 0.0034 - val_accuracy: 0.9996
Epoch 402/530
531/531 [=====] - 1s 1ms/step - loss: 2.1451e-04 - accuracy:
1.0000 - val_loss: 0.0029 - val_accuracy: 0.9996
Epoch 403/530
531/531 [=====] - 1s 1ms/step - loss: 1.3103e-04 - accuracy:
1.0000 - val_loss: 0.0030 - val_accuracy: 0.9996
Epoch 404/530
531/531 [=====] - 1s 1ms/step - loss: 3.7969e-04 - accuracy:
0.9999 - val_loss: 0.0038 - val_accuracy: 0.9994
Epoch 405/530
531/531 [=====] - 1s 1ms/step - loss: 7.1509e-04 - accuracy:
0.9999 - val_loss: 0.0034 - val_accuracy: 0.9996
Epoch 406/530
531/531 [=====] - 1s 1ms/step - loss: 2.3259e-04 - accuracy:
1.0000 - val_loss: 0.0030 - val_accuracy: 0.9997
Epoch 407/530
531/531 [=====] - 1s 1ms/step - loss: 6.8770e-04 - accuracy:
0.9999 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 408/530
531/531 [=====] - 1s 1ms/step - loss: 4.3304e-04 - accuracy:
0.9999 - val_loss: 0.0027 - val_accuracy: 0.9997
Epoch 409/530
531/531 [=====] - 1s 1ms/step - loss: 8.3146e-04 - accuracy:
0.9998 - val_loss: 0.0026 - val_accuracy: 0.9997
Epoch 410/530
531/531 [=====] - 1s 1ms/step - loss: 5.5012e-04 - accuracy:
0.9999 - val_loss: 0.0027 - val_accuracy: 0.9997
Epoch 411/530
531/531 [=====] - 1s 1ms/step - loss: 4.4667e-04 - accuracy:
0.9999 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 412/530
531/531 [=====] - 1s 1ms/step - loss: 1.6117e-04 - accuracy:
1.0000 - val_loss: 0.0028 - val_accuracy: 0.9997
Epoch 413/530
531/531 [=====] - 1s 1ms/step - loss: 1.8434e-04 - accuracy:
1.0000 - val_loss: 0.0034 - val_accuracy: 0.9996
Epoch 414/530
531/531 [=====] - 1s 1ms/step - loss: 3.4049e-04 - accuracy:
0.9999 - val_loss: 0.0029 - val_accuracy: 0.9997
Epoch 415/530
531/531 [=====] - 1s 1ms/step - loss: 7.0230e-04 - accuracy:
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0.9999 - val_loss: 0.0021 - val_accuracy: 0.9998
Epoch 416/530
531/531 [=====] - 1s 1ms/step - loss: 3.5450e-04 - accuracy:
0.9999 - val_loss: 0.0033 - val_accuracy: 0.9996
Epoch 417/530
531/531 [=====] - 1s 1ms/step - loss: 3.6030e-04 - accuracy:
0.9999 - val_loss: 0.0026 - val_accuracy: 0.9997
Epoch 418/530
531/531 [=====] - 1s 1ms/step - loss: 2.2123e-04 - accuracy:
1.0000 - val_loss: 0.0034 - val_accuracy: 0.9996
Epoch 419/530
531/531 [=====] - 1s 1ms/step - loss: 7.7339e-04 - accuracy:
0.9998 - val_loss: 0.0091 - val_accuracy: 0.9986
Epoch 420/530
531/531 [=====] - 1s 1ms/step - loss: 4.5520e-04 - accuracy:
0.9999 - val_loss: 0.0034 - val_accuracy: 0.9996
Epoch 421/530
531/531 [=====] - 1s 1ms/step - loss: 2.1680e-04 - accuracy:
1.0000 - val_loss: 0.0029 - val_accuracy: 0.9997
Epoch 422/530
531/531 [=====] - 1s 1ms/step - loss: 6.0331e-04 - accuracy:
0.9999 - val_loss: 0.0033 - val_accuracy: 0.9996
Epoch 423/530
531/531 [=====] - 1s 1ms/step - loss: 5.1197e-04 - accuracy:
0.9999 - val_loss: 0.0032 - val_accuracy: 0.9996
Epoch 424/530
531/531 [=====] - 1s 1ms/step - loss: 2.2476e-04 - accuracy:
1.0000 - val_loss: 0.0039 - val_accuracy: 0.9996
Epoch 425/530
531/531 [=====] - 1s 1ms/step - loss: 1.9609e-04 - accuracy:
1.0000 - val_loss: 0.0029 - val_accuracy: 0.9997
Epoch 426/530
531/531 [=====] - 1s 1ms/step - loss: 1.8635e-04 - accuracy:
1.0000 - val_loss: 0.0035 - val_accuracy: 0.9996
Epoch 427/530
531/531 [=====] - 1s 1ms/step - loss: 1.9383e-04 - accuracy:
1.0000 - val_loss: 0.0040 - val_accuracy: 0.9995
Epoch 428/530
531/531 [=====] - 1s 1ms/step - loss: 9.8043e-04 - accuracy:
0.9998 - val_loss: 0.0033 - val_accuracy: 0.9996
Epoch 429/530
531/531 [=====] - 1s 1ms/step - loss: 4.3351e-04 - accuracy:
0.9999 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 430/530
531/531 [=====] - 1s 1ms/step - loss: 5.1048e-04 - accuracy:
0.9999 - val_loss: 0.0034 - val_accuracy: 0.9995
Epoch 431/530
531/531 [=====] - 1s 1ms/step - loss: 1.8073e-04 - accuracy:
1.0000 - val_loss: 0.0025 - val_accuracy: 0.9997
Epoch 432/530
531/531 [=====] - 1s 1ms/step - loss: 8.7967e-04 - accuracy:
0.9998 - val_loss: 0.0025 - val_accuracy: 0.9997
Epoch 433/530
531/531 [=====] - 1s 1ms/step - loss: 4.2848e-04 - accuracy:
0.9999 - val_loss: 0.0034 - val_accuracy: 0.9996
Epoch 434/530
531/531 [=====] - 1s 1ms/step - loss: 3.6126e-04 - accuracy:
0.9999 - val_loss: 0.0036 - val_accuracy: 0.9996
Epoch 435/530
531/531 [=====] - 1s 1ms/step - loss: 0.0012 - accuracy: 0.9
998 - val_loss: 0.0025 - val_accuracy: 0.9997
Epoch 436/530
531/531 [=====] - 1s 1ms/step - loss: 2.4629e-04 - accuracy:
0.9999 - val_loss: 0.0028 - val_accuracy: 0.9997
Epoch 437/530
531/531 [=====] - 1s 1ms/step - loss: 3.1779e-04 - accuracy:
0.9999 - val_loss: 0.0031 - val_accuracy: 0.9996
Epoch 438/530
531/531 [=====] - 1s 1ms/step - loss: 7.1524e-04 - accuracy:
0.9999 - val_loss: 0.0024 - val_accuracy: 0.9997
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Epoch 439/530
531/531 [=====] - 1s 1ms/step - loss: 4.1215e-04 - accuracy:
0.9999 - val_loss: 0.0024 - val_accuracy: 0.9997
Epoch 440/530
531/531 [=====] - 1s 1ms/step - loss: 2.7845e-04 - accuracy:
0.9999 - val_loss: 0.0037 - val_accuracy: 0.9995
Epoch 441/530
531/531 [=====] - 1s 1ms/step - loss: 8.4911e-04 - accuracy:
0.9998 - val_loss: 0.0034 - val_accuracy: 0.9996
Epoch 442/530
531/531 [=====] - 1s 1ms/step - loss: 4.5587e-04 - accuracy:
0.9999 - val_loss: 0.0035 - val_accuracy: 0.9996
Epoch 443/530
531/531 [=====] - 1s 1ms/step - loss: 2.1958e-04 - accuracy:
1.0000 - val_loss: 0.0042 - val_accuracy: 0.9995
Epoch 444/530
531/531 [=====] - 1s 1ms/step - loss: 3.2334e-04 - accuracy:
0.9999 - val_loss: 0.0034 - val_accuracy: 0.9996
Epoch 445/530
531/531 [=====] - 1s 1ms/step - loss: 1.9119e-04 - accuracy:
1.0000 - val_loss: 0.0032 - val_accuracy: 0.9996
Epoch 446/530
531/531 [=====] - 1s 1ms/step - loss: 4.9797e-04 - accuracy:
0.9999 - val_loss: 0.0025 - val_accuracy: 0.9997
Epoch 447/530
531/531 [=====] - 1s 1ms/step - loss: 1.6515e-04 - accuracy:
1.0000 - val_loss: 0.0036 - val_accuracy: 0.9996
Epoch 448/530
531/531 [=====] - 1s 1ms/step - loss: 8.3657e-04 - accuracy:
0.9998 - val_loss: 0.0025 - val_accuracy: 0.9997
Epoch 449/530
531/531 [=====] - 1s 1ms/step - loss: 1.2948e-04 - accuracy:
1.0000 - val_loss: 0.0030 - val_accuracy: 0.9996
Epoch 450/530
531/531 [=====] - 1s 1ms/step - loss: 1.4074e-04 - accuracy:
1.0000 - val_loss: 0.0031 - val_accuracy: 0.9996
Epoch 451/530
531/531 [=====] - 1s 1ms/step - loss: 0.0011 - accuracy: 0.9
998 - val_loss: 0.0036 - val_accuracy: 0.9994
Epoch 452/530
531/531 [=====] - 1s 1ms/step - loss: 4.6162e-04 - accuracy:
0.9999 - val_loss: 0.0029 - val_accuracy: 0.9997
Epoch 453/530
531/531 [=====] - 1s 1ms/step - loss: 2.2287e-04 - accuracy:
1.0000 - val_loss: 0.0028 - val_accuracy: 0.9997
Epoch 454/530
531/531 [=====] - 1s 2ms/step - loss: 1.7288e-04 - accuracy:
1.0000 - val_loss: 0.0030 - val_accuracy: 0.9996
Epoch 455/530
531/531 [=====] - 1s 1ms/step - loss: 5.8212e-04 - accuracy:
0.9999 - val_loss: 0.0032 - val_accuracy: 0.9995
Epoch 456/530
531/531 [=====] - 1s 1ms/step - loss: 3.2091e-04 - accuracy:
0.9999 - val_loss: 0.0033 - val_accuracy: 0.9996
Epoch 457/530
531/531 [=====] - 1s 1ms/step - loss: 3.6288e-04 - accuracy:
0.9999 - val_loss: 0.0055 - val_accuracy: 0.9993
Epoch 458/530
531/531 [=====] - 1s 1ms/step - loss: 1.9732e-04 - accuracy:
1.0000 - val_loss: 0.0032 - val_accuracy: 0.9997
Epoch 459/530
531/531 [=====] - 1s 1ms/step - loss: 3.9389e-04 - accuracy:
0.9999 - val_loss: 0.0033 - val_accuracy: 0.9996
Epoch 460/530
531/531 [=====] - 1s 1ms/step - loss: 2.9254e-04 - accuracy:
0.9999 - val_loss: 0.0029 - val_accuracy: 0.9997
Epoch 461/530
531/531 [=====] - 1s 2ms/step - loss: 1.6350e-04 - accuracy:
1.0000 - val_loss: 0.0039 - val_accuracy: 0.9996
Epoch 462/530
```

```
531/531 [=====] - 2s 4ms/step - loss: 3.9292e-04 - accuracy:
0.9999 - val_loss: 0.0034 - val_accuracy: 0.9996
Epoch 463/530
531/531 [=====] - 1s 3ms/step - loss: 6.0316e-04 - accuracy:
0.9999 - val_loss: 0.0041 - val_accuracy: 0.9995
Epoch 464/530
531/531 [=====] - 1s 1ms/step - loss: 2.2665e-04 - accuracy:
1.0000 - val_loss: 0.0037 - val_accuracy: 0.9996
Epoch 465/530
531/531 [=====] - 1s 1ms/step - loss: 2.1114e-04 - accuracy:
1.0000 - val_loss: 0.0054 - val_accuracy: 0.9996
Epoch 466/530
531/531 [=====] - 1s 1ms/step - loss: 1.5504e-04 - accuracy:
1.0000 - val_loss: 0.0060 - val_accuracy: 0.9995
Epoch 467/530
531/531 [=====] - 1s 1ms/step - loss: 4.9575e-04 - accuracy:
0.9999 - val_loss: 0.0027 - val_accuracy: 0.9997
Epoch 468/530
531/531 [=====] - 1s 1ms/step - loss: 1.8517e-04 - accuracy:
1.0000 - val_loss: 0.0027 - val_accuracy: 0.9997
Epoch 469/530
531/531 [=====] - 1s 1ms/step - loss: 1.4991e-04 - accuracy:
1.0000 - val_loss: 0.0079 - val_accuracy: 0.9980
Epoch 470/530
531/531 [=====] - 1s 1ms/step - loss: 9.9056e-04 - accuracy:
0.9998 - val_loss: 0.0040 - val_accuracy: 0.9995
Epoch 471/530
531/531 [=====] - 1s 2ms/step - loss: 6.0392e-04 - accuracy:
0.9999 - val_loss: 0.0034 - val_accuracy: 0.9996
Epoch 472/530
531/531 [=====] - 1s 1ms/step - loss: 2.4800e-04 - accuracy:
1.0000 - val_loss: 0.0040 - val_accuracy: 0.9995
Epoch 473/530
531/531 [=====] - 1s 2ms/step - loss: 1.9387e-04 - accuracy:
1.0000 - val_loss: 0.0028 - val_accuracy: 0.9997
Epoch 474/530
531/531 [=====] - 1s 1ms/step - loss: 5.4837e-04 - accuracy:
0.9999 - val_loss: 0.0028 - val_accuracy: 0.9997
Epoch 475/530
531/531 [=====] - 1s 1ms/step - loss: 2.2617e-04 - accuracy:
1.0000 - val_loss: 0.0032 - val_accuracy: 0.9996
Epoch 476/530
531/531 [=====] - 1s 1ms/step - loss: 1.8136e-04 - accuracy:
1.0000 - val_loss: 0.0031 - val_accuracy: 0.9997
Epoch 477/530
531/531 [=====] - 1s 1ms/step - loss: 2.1485e-04 - accuracy:
1.0000 - val_loss: 0.0036 - val_accuracy: 0.9996
Epoch 478/530
531/531 [=====] - 1s 1ms/step - loss: 3.4305e-04 - accuracy:
0.9999 - val_loss: 0.0044 - val_accuracy: 0.9994
Epoch 479/530
531/531 [=====] - 1s 1ms/step - loss: 4.0769e-04 - accuracy:
0.9999 - val_loss: 0.0042 - val_accuracy: 0.9995
Epoch 480/530
531/531 [=====] - 1s 1ms/step - loss: 1.6005e-04 - accuracy:
1.0000 - val_loss: 0.0034 - val_accuracy: 0.9996
Epoch 481/530
531/531 [=====] - 1s 1ms/step - loss: 1.6013e-04 - accuracy:
1.0000 - val_loss: 0.0033 - val_accuracy: 0.9997
Epoch 482/530
531/531 [=====] - 1s 1ms/step - loss: 4.1997e-04 - accuracy:
0.9999 - val_loss: 0.0048 - val_accuracy: 0.9993
Epoch 483/530
531/531 [=====] - 1s 1ms/step - loss: 3.9961e-04 - accuracy:
0.9999 - val_loss: 0.0035 - val_accuracy: 0.9996
Epoch 484/530
531/531 [=====] - 1s 1ms/step - loss: 4.1548e-04 - accuracy:
0.9999 - val_loss: 0.0036 - val_accuracy: 0.9995
Epoch 485/530
531/531 [=====] - 1s 1ms/step - loss: 4.7315e-04 - accuracy:
```



```
0.9999 - val_loss: 0.0032 - val_accuracy: 0.9996
Epoch 486/530
531/531 [=====] - 1s 2ms/step - loss: 2.2502e-04 - accuracy:
1.0000 - val_loss: 0.0030 - val_accuracy: 0.9997
Epoch 487/530
531/531 [=====] - 1s 1ms/step - loss: 2.9550e-04 - accuracy:
1.0000 - val_loss: 0.0032 - val_accuracy: 0.9996
Epoch 488/530
531/531 [=====] - 1s 2ms/step - loss: 4.0509e-04 - accuracy:
0.9999 - val_loss: 0.0044 - val_accuracy: 0.9995
Epoch 489/530
531/531 [=====] - 1s 1ms/step - loss: 7.0602e-04 - accuracy:
0.9999 - val_loss: 0.0035 - val_accuracy: 0.9996
Epoch 490/530
531/531 [=====] - 1s 1ms/step - loss: 6.4289e-04 - accuracy:
0.9999 - val_loss: 0.0031 - val_accuracy: 0.9996
Epoch 491/530
531/531 [=====] - 1s 1ms/step - loss: 2.5270e-04 - accuracy:
1.0000 - val_loss: 0.0034 - val_accuracy: 0.9996
Epoch 492/530
531/531 [=====] - 1s 2ms/step - loss: 2.2450e-04 - accuracy:
1.0000 - val_loss: 0.0033 - val_accuracy: 0.9996
Epoch 493/530
531/531 [=====] - 1s 1ms/step - loss: 1.3535e-04 - accuracy:
1.0000 - val_loss: 0.0033 - val_accuracy: 0.9996
Epoch 494/530
531/531 [=====] - 1s 1ms/step - loss: 0.0010 - accuracy: 0.9
998 - val_loss: 0.0033 - val_accuracy: 0.9996
Epoch 495/530
531/531 [=====] - 1s 1ms/step - loss: 2.5792e-04 - accuracy:
0.9999 - val_loss: 0.0034 - val_accuracy: 0.9996
Epoch 496/530
531/531 [=====] - 1s 1ms/step - loss: 1.6184e-04 - accuracy:
1.0000 - val_loss: 0.0029 - val_accuracy: 0.9997
Epoch 497/530
531/531 [=====] - 1s 1ms/step - loss: 3.5032e-04 - accuracy:
0.9999 - val_loss: 0.0028 - val_accuracy: 0.9996
Epoch 498/530
531/531 [=====] - 1s 1ms/step - loss: 5.6158e-04 - accuracy:
0.9999 - val_loss: 0.0026 - val_accuracy: 0.9997
Epoch 499/530
531/531 [=====] - 1s 1ms/step - loss: 2.5070e-04 - accuracy:
1.0000 - val_loss: 0.0029 - val_accuracy: 0.9997
Epoch 500/530
531/531 [=====] - 1s 1ms/step - loss: 1.7434e-04 - accuracy:
1.0000 - val_loss: 0.0030 - val_accuracy: 0.9997
Epoch 501/530
531/531 [=====] - 1s 1ms/step - loss: 1.7698e-04 - accuracy:
1.0000 - val_loss: 0.0039 - val_accuracy: 0.9996
Epoch 502/530
531/531 [=====] - 1s 1ms/step - loss: 0.0018 - accuracy: 0.9
997 - val_loss: 0.0030 - val_accuracy: 0.9996
Epoch 503/530
531/531 [=====] - 1s 1ms/step - loss: 4.1323e-04 - accuracy:
0.9999 - val_loss: 0.0023 - val_accuracy: 0.9997
Epoch 504/530
531/531 [=====] - 1s 1ms/step - loss: 1.7580e-04 - accuracy:
1.0000 - val_loss: 0.0030 - val_accuracy: 0.9996
Epoch 505/530
531/531 [=====] - 1s 1ms/step - loss: 1.6634e-04 - accuracy:
1.0000 - val_loss: 0.0030 - val_accuracy: 0.9996
Epoch 506/530
531/531 [=====] - 1s 1ms/step - loss: 3.9138e-04 - accuracy:
0.9999 - val_loss: 0.0042 - val_accuracy: 0.9994
Epoch 507/530
531/531 [=====] - 1s 1ms/step - loss: 5.8093e-04 - accuracy:
0.9999 - val_loss: 0.0029 - val_accuracy: 0.9996
Epoch 508/530
531/531 [=====] - 1s 1ms/step - loss: 2.1947e-04 - accuracy:
1.0000 - val_loss: 0.0028 - val_accuracy: 0.9997
```

```

Epoch 509/530
531/531 [=====] - 1s 1ms/step - loss: 5.8409e-04 - accuracy:
0.9999 - val_loss: 0.0036 - val_accuracy: 0.9995
Epoch 510/530
531/531 [=====] - 1s 1ms/step - loss: 3.7548e-04 - accuracy:
0.9999 - val_loss: 0.0033 - val_accuracy: 0.9997
Epoch 511/530
531/531 [=====] - 1s 1ms/step - loss: 1.2774e-04 - accuracy:
1.0000 - val_loss: 0.0034 - val_accuracy: 0.9997
Epoch 512/530
531/531 [=====] - 1s 2ms/step - loss: 1.1194e-04 - accuracy:
1.0000 - val_loss: 0.0036 - val_accuracy: 0.9997
Epoch 513/530
531/531 [=====] - 1s 1ms/step - loss: 1.0993e-04 - accuracy:
1.0000 - val_loss: 0.0040 - val_accuracy: 0.9996
Epoch 514/530
531/531 [=====] - 1s 1ms/step - loss: 4.6479e-04 - accuracy:
0.9999 - val_loss: 0.0043 - val_accuracy: 0.9994
Epoch 515/530
531/531 [=====] - 1s 1ms/step - loss: 6.2274e-04 - accuracy:
0.9999 - val_loss: 0.0041 - val_accuracy: 0.9995
Epoch 516/530
531/531 [=====] - 1s 1ms/step - loss: 7.1265e-04 - accuracy:
0.9999 - val_loss: 0.0026 - val_accuracy: 0.9996
Epoch 517/530
531/531 [=====] - 1s 1ms/step - loss: 3.2326e-04 - accuracy:
0.9999 - val_loss: 0.0025 - val_accuracy: 0.9997
Epoch 518/530
531/531 [=====] - 1s 1ms/step - loss: 1.8199e-04 - accuracy:
1.0000 - val_loss: 0.0030 - val_accuracy: 0.9997
Epoch 519/530
531/531 [=====] - 1s 1ms/step - loss: 3.0986e-04 - accuracy:
0.9999 - val_loss: 0.0029 - val_accuracy: 0.9996
Epoch 520/530
531/531 [=====] - 1s 1ms/step - loss: 8.8990e-04 - accuracy:
0.9998 - val_loss: 0.0044 - val_accuracy: 0.9995
Epoch 521/530
531/531 [=====] - 1s 1ms/step - loss: 3.4991e-04 - accuracy:
0.9999 - val_loss: 0.0036 - val_accuracy: 0.9995
Epoch 522/530
531/531 [=====] - 1s 1ms/step - loss: 2.1141e-04 - accuracy:
1.0000 - val_loss: 0.0036 - val_accuracy: 0.9996
Epoch 523/530
531/531 [=====] - 1s 1ms/step - loss: 1.8685e-04 - accuracy:
1.0000 - val_loss: 0.0036 - val_accuracy: 0.9996
Epoch 524/530
531/531 [=====] - 1s 1ms/step - loss: 2.4931e-04 - accuracy:
1.0000 - val_loss: 0.0036 - val_accuracy: 0.9996
Epoch 525/530
531/531 [=====] - 1s 1ms/step - loss: 4.7069e-04 - accuracy:
0.9999 - val_loss: 0.0047 - val_accuracy: 0.9983
Epoch 526/530
531/531 [=====] - 1s 1ms/step - loss: 8.1303e-04 - accuracy:
0.9998 - val_loss: 0.0034 - val_accuracy: 0.9996
Epoch 527/530
531/531 [=====] - 1s 1ms/step - loss: 2.4618e-04 - accuracy:
0.9999 - val_loss: 0.0041 - val_accuracy: 0.9996
Epoch 528/530
531/531 [=====] - 1s 1ms/step - loss: 3.4003e-04 - accuracy:
0.9999 - val_loss: 0.0035 - val_accuracy: 0.9996
Epoch 529/530

```

In [18]:

```

us_batch_size = 5
us_epochs = 30
us_history = us_DNN.fit(sc_xtr_us, ytr_us, batch_size=us_batch_size, epochs=us_epochs)

```

```

Epoch 1/30
109/109 [=====] - 1s 2ms/step - loss: 0.6935 - accuracy: 0.5
046 - val_loss: 0.6936 - val_accuracy: 0.4818

```

```
Epoch 2/30
109/109 [=====] - 0s 1ms/step - loss: 0.6933 - accuracy: 0.5
046 - val_loss: 0.6936 - val_accuracy: 0.4818
Epoch 3/30
109/109 [=====] - 0s 1ms/step - loss: 0.6932 - accuracy: 0.5
046 - val_loss: 0.6935 - val_accuracy: 0.4818
Epoch 4/30
109/109 [=====] - 0s 1ms/step - loss: 0.6932 - accuracy: 0.5
046 - val_loss: 0.6936 - val_accuracy: 0.4818
Epoch 5/30
109/109 [=====] - 0s 1ms/step - loss: 0.6932 - accuracy: 0.5
046 - val_loss: 0.6936 - val_accuracy: 0.4818
Epoch 6/30
109/109 [=====] - 0s 1ms/step - loss: 0.6935 - accuracy: 0.4
826 - val_loss: 0.6936 - val_accuracy: 0.4818
Epoch 7/30
109/109 [=====] - 0s 1ms/step - loss: 0.6934 - accuracy: 0.5
046 - val_loss: 0.6936 - val_accuracy: 0.4818
Epoch 8/30
109/109 [=====] - 0s 1ms/step - loss: 0.6933 - accuracy: 0.5
046 - val_loss: 0.6936 - val_accuracy: 0.4818
Epoch 9/30
109/109 [=====] - 0s 1ms/step - loss: 0.6934 - accuracy: 0.5
046 - val_loss: 0.6936 - val_accuracy: 0.4818
Epoch 10/30
109/109 [=====] - 0s 1ms/step - loss: 0.6934 - accuracy: 0.5
046 - val_loss: 0.6937 - val_accuracy: 0.4818
Epoch 11/30
109/109 [=====] - 0s 1ms/step - loss: 0.6932 - accuracy: 0.5
046 - val_loss: 0.6935 - val_accuracy: 0.4818
Epoch 12/30
109/109 [=====] - 0s 1ms/step - loss: 0.6933 - accuracy: 0.5
046 - val_loss: 0.6933 - val_accuracy: 0.4818
Epoch 13/30
109/109 [=====] - 0s 1ms/step - loss: 0.6932 - accuracy: 0.5
046 - val_loss: 0.6934 - val_accuracy: 0.4818
Epoch 14/30
109/109 [=====] - 0s 1ms/step - loss: 0.6933 - accuracy: 0.4
734 - val_loss: 0.6936 - val_accuracy: 0.4818
Epoch 15/30
109/109 [=====] - 0s 1ms/step - loss: 0.6933 - accuracy: 0.5
046 - val_loss: 0.6934 - val_accuracy: 0.4818
Epoch 16/30
109/109 [=====] - 0s 1ms/step - loss: 0.6933 - accuracy: 0.5
046 - val_loss: 0.6936 - val_accuracy: 0.4818
Epoch 17/30
109/109 [=====] - 0s 1ms/step - loss: 0.6933 - accuracy: 0.5
046 - val_loss: 0.6935 - val_accuracy: 0.4818
Epoch 18/30
109/109 [=====] - 0s 1ms/step - loss: 0.6933 - accuracy: 0.5
046 - val_loss: 0.6933 - val_accuracy: 0.4818
Epoch 19/30
109/109 [=====] - 0s 1ms/step - loss: 0.6932 - accuracy: 0.5
046 - val_loss: 0.6934 - val_accuracy: 0.4818
Epoch 20/30
109/109 [=====] - 0s 2ms/step - loss: 0.6926 - accuracy: 0.5
083 - val_loss: 0.6908 - val_accuracy: 0.4818
Epoch 21/30
109/109 [=====] - 0s 1ms/step - loss: 0.6847 - accuracy: 0.6
514 - val_loss: 0.6747 - val_accuracy: 0.9562
Epoch 22/30
109/109 [=====] - 0s 1ms/step - loss: 0.6586 - accuracy: 0.9
413 - val_loss: 0.6359 - val_accuracy: 0.9489
Epoch 23/30
109/109 [=====] - 0s 1ms/step - loss: 0.6103 - accuracy: 0.9
394 - val_loss: 0.5740 - val_accuracy: 0.9635
Epoch 24/30
109/109 [=====] - 0s 1ms/step - loss: 0.5504 - accuracy: 0.9
394 - val_loss: 0.5103 - val_accuracy: 0.9635
Epoch 25/30
```

```

109/109 [=====] - 0s 1ms/step - loss: 0.4944 - accuracy: 0.9
376 - val_loss: 0.4604 - val_accuracy: 0.9489
Epoch 26/30
109/109 [=====] - 0s 1ms/step - loss: 0.4458 - accuracy: 0.9
394 - val_loss: 0.4110 - val_accuracy: 0.9562
Epoch 27/30
109/109 [=====] - 0s 1ms/step - loss: 0.4029 - accuracy: 0.9
431 - val_loss: 0.3787 - val_accuracy: 0.9489
Epoch 28/30
109/109 [=====] - 0s 1ms/step - loss: 0.3743 - accuracy: 0.9
376 - val_loss: 0.3444 - val_accuracy: 0.9489
Epoch 29/30
109/109 [=====] - 0s 1ms/step - loss: 0.3431 - accuracy: 0.9
413 - val_loss: 0.3156 - val_accuracy: 0.9562
Epoch 30/30
109/109 [=====] - 0s 1ms/step - loss: 0.3207 - accuracy: 0.9
...

```

```

In [19]: # over sampled prediction and confusion matrix
print("confusion matrix for oversampling")
os_DNN_pred = os_DNN.predict(sc_xte_os)
os_DNN_pred = (os_DNN_pred > 0.5)
print(CM(y_te, os_DNN_pred))

```

```

confusion matrix for oversampling
[[85241    51]
 [   37   114]]

```

```

In [20]: print("confusion matrix for undersampling")
us_DNN_pred = us_DNN.predict(sc_xte_os)
us_DNN_pred = (us_DNN_pred > 0.5)
print(CM(y_te, us_DNN_pred))

```

```

confusion matrix for undersampling
[[82231   3061]
 [   16   135]]

```

```

In [21]: print("Scoring for oversampling:")
print('Accuracy: {}'.format(AS(y_te, os_DNN_pred)))
print('Precision: {}'.format(PS(y_te, os_DNN_pred)))
print('Recall: {}'.format(RS(y_te, os_DNN_pred)))
print('F1 Score: {}'.format(FS(y_te, os_DNN_pred)))

```

```

Scoring for oversampling:
Accuracy: 0.9989700736163291
Precision: 0.6909090909090909
Recall: 0.7549668874172185
F1 Score: 0.7215189873417722

```

```

In [22]: print("Scoring for undersampling:")
print('Accuracy: {}'.format(AS(y_te, us_DNN_pred)))
print('Precision: {}'.format(PS(y_te, us_DNN_pred)))
print('Recall: {}'.format(RS(y_te, us_DNN_pred)))
print('F1 Score: {}'.format(FS(y_te, us_DNN_pred)))

```

```

Scoring for undersampling:
Accuracy: 0.9639876876982316
Precision: 0.04224030037546934
Recall: 0.8940397350993378
F1 Score: 0.0806692560501942

```

In [23]:

```
# lets plot the roc curves and document the area under the curve
os_DNN_fpr, os_DNN_tpr, _ = RC(y_te, os_DNN_pred.ravel())
os_DNN_auc = RAS(y_te, os_DNN_pred)
plt.plot(os_DNN_fpr, os_DNN_tpr, linestyle='--', label = "Oversampled(AUC =%.2f)" % c
us_DNN_fpr, us_DNN_tpr, _ = RC(y_te, us_DNN_pred.ravel())
us_DNN_auc = RAS(y_te, us_DNN_pred)
plt.plot(us_DNN_fpr, us_DNN_tpr, linestyle='--', label = "Undersampled(AUC =%.2f)" %
plt.legend()
```

Out[23]: &lt;matplotlib.legend.Legend at 0x22aa104fb20&gt;

