In [1]:
```
pip install keras
```

```
Requirement already satisfied: keras in c:\users\91944\anaconda3\lib\site-packages (2.4.
3)
Requirement already satisfied: scipy>=0.14 in c:\users\91944\anaconda3\lib\site-packages
(from keras) (1.5.2)
Requirement already satisfied: numpy>=1.9.1 in c:\users\91944\anaconda3\lib\site-package
s (from keras) (1.19.2)
Requirement already satisfied: pyyaml in c:\users\91944\anaconda3\lib\site-packages (fro
m keras) (5.3.1)
Requirement already satisfied: h5py in c:\users\91944\anaconda3\lib\site-packages (from
keras) (2.10.0)
Requirement already satisfied: six in c:\users\91944\anaconda3\lib\site-packages (from h
5py->keras) (1.15.0)
Note: you may need to restart the kernel to use updated packages.
```

In [2]:
```
pip install tensorflow
```

```
Requirement already satisfied: tensorflow in c:\users\91944\anaconda3\lib\site-packages
(2.4.1)
Requirement already satisfied: protobuf>=3.9.2 in c:\users\91944\anaconda3\lib\site-pack
ages (from tensorflow) (3.15.7)
Requirement already satisfied: tensorflow-estimator<2.5.0,>=2.4.0 in c:\users\91944\anac
onda3\lib\site-packages (from tensorflow) (2.4.0)
Requirement already satisfied: google-pasta~=0.2 in c:\users\91944\anaconda3\lib\site-pa
ckages (from tensorflow) (0.2.0)
Requirement already satisfied: grpcio~=1.32.0 in c:\users\91944\anaconda3\lib\site-packa
ges (from tensorflow) (1.32.0)
Requirement already satisfied: opt-einsum~=3.3.0 in c:\users\91944\anaconda3\lib\site-pa
ckages (from tensorflow) (3.3.0)
Requirement already satisfied: keras-preprocessing~=1.1.2 in c:\users\91944\anaconda3\li
b\site-packages (from tensorflow) (1.1.2)
Requirement already satisfied: six~=1.15.0 in c:\users\91944\anaconda3\lib\site-packages
(from tensorflow) (1.15.0)
Requirement already satisfied: tensorboard~=2.4 in c:\users\91944\anaconda3\lib\site-pac
kages (from tensorflow) (2.4.1)
Requirement already satisfied: wrapt~=1.12.1 in c:\users\91944\anaconda3\lib\site-packag
es (from tensorflow) (1.12.1)
Requirement already satisfied: astunparse~=1.6.3 in c:\users\91944\anaconda3\lib\site-pa
ckages (from tensorflow) (1.6.3)
Requirement already satisfied: flatbuffers~=1.12.0 in c:\users\91944\anaconda3\lib\site-
packages (from tensorflow) (1.12)
Requirement already satisfied: absl-py~=0.10 in c:\users\91944\anaconda3\lib\site-packag
es (from tensorflow) (0.12.0)
Requirement already satisfied: termcolor~=1.1.0 in c:\users\91944\anaconda3\lib\site-pac
kages (from tensorflow) (1.1.0)
Requirement already satisfied: typing-extensions~=3.7.4 in c:\users\91944\anaconda3\lib
\site-packages (from tensorflow) (3.7.4.3)
Requirement already satisfied: gast==0.3.3 in c:\users\91944\anaconda3\lib\site-packages
(from tensorflow) (0.3.3)
Requirement already satisfied: numpy~=1.19.2 in c:\users\91944\anaconda3\lib\site-packag
es (from tensorflow) (1.19.2)
Requirement already satisfied: wheel~=0.35 in c:\users\91944\anaconda3\lib\site-packages
(from tensorflow) (0.35.1)
Requirement already satisfied: h5py~=2.10.0 in c:\users\91944\anaconda3\lib\site-package
s (from tensorflow) (2.10.0)
Requirement already satisfied: google-auth-oauthlib<0.5,>=0.4.1 in c:\users\91944\anacon
da3\lib\site-packages (from tensorboard~=2.4->tensorflow) (0.4.4)
Requirement already satisfied: markdown>=2.6.8 in c:\users\91944\anaconda3\lib\site-pack
ages (from tensorboard~=2.4->tensorflow) (3.3.4)
Requirement already satisfied: tensorboard-plugin-wit>=1.6.0 in c:\users\91944\anaconda3
\lib\site-packages (from tensorboard~=2.4->tensorflow) (1.8.0)
Requirement already satisfied: setuptools>=41.0.0 in c:\users\91944\anaconda3\lib\site-p
ackages (from tensorboard~=2.4->tensorflow) (50.3.1.post20201107)
```

```
Requirement already satisfied: werkzeug>=0.11.15 in c:\users\91944\anaconda3\lib\site-pa
ckages (from tensorboard~=2.4->tensorflow) (1.0.1)
Requirement already satisfied: google-auth<2,>=1.6.3 in c:\users\91944\anaconda3\lib\sit
e-packages (from tensorboard~=2.4->tensorflow) (1.28.0)
Requirement already satisfied: requests<3,>=2.21.0 in c:\users\91944\anaconda3\lib\site-
packages (from tensorboard~=2.4->tensorflow) (2.24.0)
Requirement already satisfied: requests-oauthlib>=0.7.0 in c:\users\91944\anaconda3\lib
\site-packages (from google-auth-oauthlib<0.5,>=0.4.1->tensorboard~=2.4->tensorflow) (1.
3.0)
Requirement already satisfied: cachetools<5.0,>=2.0.0 in c:\users\91944\anaconda3\lib\si
te-packages (from google-auth<2,>=1.6.3->tensorboard~=2.4->tensorflow) (4.2.1)
Requirement already satisfied: rsa<5,>=3.1.4; python_version >= "3.6" in c:\users\91944
\anaconda3\lib\site-packages (from google-auth<2,>=1.6.3->tensorboard~=2.4->tensorflow)
(4.7.2)
Requirement already satisfied: pyasn1-modules>=0.2.1 in c:\users\91944\anaconda3\lib\sit
e-packages (from google-auth<2,>=1.6.3->tensorboard~=2.4->tensorflow) (0.2.8)
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in c:\users\91944
\anaconda3\lib\site-packages (from requests<3,>=2.21.0->tensorboard~=2.4->tensorflow)
(1.25.11)
Requirement already satisfied: certifi>=2017.4.17 in c:\users\91944\anaconda3\lib\site-p
ackages (from requests<3,>=2.21.0->tensorboard~=2.4->tensorflow) (2020.6.20)
Requirement already satisfied: idna<3,>=2.5 in c:\users\91944\anaconda3\lib\site-package
s (from requests<3,>=2.21.0->tensorboard~=2.4->tensorflow) (2.10)
Requirement already satisfied: chardet<4,>=3.0.2 in c:\users\91944\anaconda3\lib\site-pa
ckages (from requests<3,>=2.21.0->tensorboard~=2.4->tensorflow) (3.0.4)
Requirement already satisfied: oauthlib>=3.0.0 in c:\users\91944\anaconda3\lib\site-pack
ages (from requests-oauthlib>=0.7.0->google-auth-oauthlib<0.5,>=0.4.1->tensorboard~=2.4-
>tensorflow) (3.1.0)
Requirement already satisfied: pyasn1>=0.1.3 in c:\users\91944\anaconda3\lib\site-packag
es (from rsa<5,>=3.1.4; python_version >= "3.6"->google-auth<2,>=1.6.3->tensorboard~=2.4
->tensorflow) (0.4.8)
Note: you may need to restart the kernel to use updated packages.
```

In [3]:
```
import nltk
from nltk.stem import WordNetLemmatizer
lemmatizer = WordNetLemmatizer()
import json
import pickle

import numpy as np
from keras.models import Sequential
from keras.layers import Dense, Activation, Dropout
from keras.optimizers import SGD
import random

words=[]
classes = []
documents = []
ignore_words = ['?', '!']
data_file = open('chatbot_data.json').read()
intents = json.loads(data_file)
```

In [4]:
```
for intent in intents['intents']:
    for pattern in intent['patterns']:

        #tokenize each word
        w = nltk.word_tokenize(pattern)
        words.extend(w)
        #add documents in the corpus
        documents.append((w, intent['tag']))

        # add to our classes list
```

```
        if intent['tag'] not in classes:
            classes.append(intent['tag'])
```

In [5]:
```
print(words)
```

```
['Hi', 'there', 'How', 'are', 'you', 'Is', 'anyone', 'there', '?', 'Hey', 'Hola', 'Hell
o', 'Good', 'day', 'Bye', 'See', 'you', 'later', 'Goodbye', 'Nice', 'chatting', 'to', 'y
ou', ',', 'bye', 'Till', 'next', 'time', 'Thanks', 'Thank', 'you', 'That', "'s", 'helpfu
l', 'Awesome', ',', 'thanks', 'Thanks', 'for', 'helping', 'me', 'How', 'do', 'I', 'excha
nge', 'my', 'for', 'a', 'different', 'size', '?', 'I', 'want', 'to', 'exchange', 'my',
'I', 'need', 'to', 'exchange', 'Can', 'I', 'replace', 'I', 'need', 'to', 'replace', 'm
y', 'I', 'need', 'to', 'swap', 'my', 'Can', 'I', 'swap', 'out', 'my', 'for', 'another',
'one', '?', 'I', 'need', 'to', 'exchange', 'for', 'a', 'smaller', 'size', 'When', 'are',
'you', 'open', '?', 'What', 'are', 'you', 'hours', '?', 'opening', 'hours', 'What', 'tim
e', 'does', 'the', 'store', 'close', 'What', 'are', 'your', 'store', 'hours', '?', 'Wha
t', 'are', 'you', 'store', 'hours', 'in', 'your', 'location', 'on', 'How', 'do', 'I', 't
alk', 'to', 'a', 'person', 'I', 'want', 'to', 'talk', 'to', 'a', 'human', 'how', 'do',
'I', 'call', 'you', 'I', 'need', 'to', 'speak', 'to', 'a', 'real', 'person', 'Can', 'yo
u', 'call', 'me', 'Can', 'I', 'talk', 'to', 'a', 'human', 'Representative', 'Speak', 't
o', 'a', 'representative', 'Speak', 'to', 'a', 'Customer', 'service', 'agent', 'Where',
'do', 'you', 'have', 'stores', '?', 'What', 'locations', 'do', 'you', 'have', '?', 'Ar
e', 'there', 'stores', 'in', 'are', 'you', 'in', 'do', 'you', 'have', 'any', 'stores',
'near', 'are', 'there', 'any', 'locations', 'near', 'do', 'you', 'have', 'stores', 'by',
'are', 'you', 'by', 'Where', 'are', 'you', 'located', 'Where', 'are', 'your', 'stores',
'What', 'are', 'other', 'locations', 'What', 'street', 'are', 'you', 'on', 'Location',
'in', 'Michigan', 'Framington', '(', 'Michigan', ')', 'Farmington', 'where', 'is', 'you
r', 'farmington', 'store', 'located', '?', 'what', 'are', 'your', 'farmington', 'store',
'hours', 'Birmingham', '(', 'Michigan', ')', 'Birmingham', 'where', 'is', 'your', 'Birmi
ngham', 'store', 'located', '?', 'what', 'are', 'your', 'Birmingham', 'store', 'hours',
'Detroit', '(', 'Michigan', ')', 'Detroit', 'where', 'is', 'your', 'Detroit', 'store',
'located', '?', 'what', 'are', 'your', 'Detroit', 'store', 'hours', 'Where', 'is', 'my',
'order', '?', 'is', 'my', 'order', 'going', 'to', 'be', 'delayed', 'is', 'my', 'packag
e', 'going', 'to', 'be', 'delayed', 'are', 'my', 'items', 'going', 'to', 'be', 'delaye
d', 'is', 'my', 'order', 'going', 'to', 'be', 'on', 'time', 'is', 'package', 'going', 't
o', 'be', 'on', 'time', 'are', 'my', 'items', 'going', 'to', 'be', 'on', 'time', 'Wher
e', 'is', 'my', 'package', 'where', 'is', 'my', 'order', 'What', 'is', 'my', 'tracking',
'number', 'I', 'can', 'not', 'track', 'my', 'package', 'Is', 'my', 'package', 'going',
'to', 'be', 'delayed', 'Where', 'is', 'my', 'item', 'Are', 'there', 'restocking', 'fee
s', '?', 'Will', 'my', 'shipping', 'be', 'refunded', 'Can', 'you', 'refund', 'my', 'ship
ping', 'Can', 'restocking', 'fees', 'be', 'refunded', 'What', 'is', 'the', 'restocking',
'fee', 'How', 'do', 'I', 'return', 'an', 'How', 'do', 'I', 'process', 'a', 'return', 'Wh
at', 'are', 'the', 'steps', 'to', 'return', 'an', 'What', 'steps', 'do', 'you', 'have',
'to', 'take', 'to', 'return', 'an', 'How', 'do', 'send', 'in', 'a', 'return', 'Do', 'yo
u', 'provide', 'a', 'shipping', 'label', 'Do', 'I', 'have', 'to', 'pay', 'return', 'ship
ping', 'Can', 'I', 'schedule', 'a', 'return', 'pick', 'up', 'Mail', 'How', 'do', 'I', 'r
eturn', 'an', 'item', 'in', 'mail', '?', 'store', 'How', 'do', 'I', 'return', 'an', 'ite
m', 'in', 'store', '?', 'I', 'need', 'to', 'exchange', 'for', 'a', 'larger', 'size', 'Ca
n', 'I', 'exchange', 'What', 'time', 'are', 'you', 'open', 'till', 'When', 'do', 'you',
'close', 'I', 'need', 'to', 'speak', 'to', 'customer', 'service', 'Can', 'I', 'talk', 't
o', 'a', 'representative', 'What', 'other', 'stores', 'are', 'you', 'by', 'Are', 'you',
'by', 'what', 'is', 'your', 'farmington', 'store', 'address', 'what', 'is', 'your', 'Bir
mingham', 'store', 'address', 'what', 'is', 'your', 'Detroit', 'store', 'address', 'Wher
e', 'are', 'my', 'items', 'Are', 'my', 'items', 'on', 'the', 'way', 'Why', 'do', 'I', 'h
ave', 'to', 'pay', 'restocking', 'fees', 'Can', 'I', 'return', 'in', 'store', 'How', 'lo
ng', 'do', 'I', 'have', 'to', 'return', 'an', 'return', 'mail', 'return', 'store']
```

In [6]:
```
# lemmatize, lower each word and remove duplicates
words = [lemmatizer.lemmatize(w.lower()) for w in words if w not in ignore_words]
words = sorted(list(set(words)))


# sort classes
classes = sorted(list(set(classes)))
# documents = combination between patterns and intents
```

```
print (len(documents), "documents")
# classes = intents
print (len(classes), "classes", classes)
# words = all words, vocabulary
print (len(words), "unique lemmatized words", words)

pickle.dump(words,open('words.pkl','wb'))
pickle.dump(classes,open('classes.pkl','wb'))
```

```
113 documents
15 classes ['birmingham', 'detroit', 'exchange', 'farmington', 'goodbye', 'greeting', 'h
ours', 'location', 'order', 'representative', 'restocking', 'return', 'return_mail', 're
turn_store', 'thanks']
120 unique lemmatized words ["'s", '(', ')', ',', 'a', 'address', 'agent', 'an', 'anothe
r', 'any', 'anyone', 'are', 'awesome', 'be', 'birmingham', 'by', 'bye', 'call', 'can',
'chatting', 'close', 'customer', 'day', 'delayed', 'detroit', 'different', 'do', 'doe',
'exchange', 'farmington', 'fee', 'for', 'framington', 'going', 'good', 'goodbye', 'hav
e', 'hello', 'helpful', 'helping', 'hey', 'hi', 'hola', 'hour', 'how', 'human', 'i', 'i
n', 'is', 'item', 'label', 'larger', 'later', 'located', 'location', 'long', 'mail', 'm
e', 'michigan', 'my', 'near', 'need', 'next', 'nice', 'not', 'number', 'on', 'one', 'ope
n', 'opening', 'order', 'other', 'out', 'package', 'pay', 'person', 'pick', 'process',
'provide', 'real', 'refund', 'refunded', 'replace', 'representative', 'restocking', 'ret
urn', 'schedule', 'see', 'send', 'service', 'shipping', 'size', 'smaller', 'speak', 'ste
p', 'store', 'street', 'swap', 'take', 'talk', 'thank', 'thanks', 'that', 'the', 'ther
e', 'till', 'time', 'to', 'track', 'tracking', 'up', 'want', 'way', 'what', 'when', 'whe
re', 'why', 'will', 'you', 'your']
```

In [7]:
```
from sklearn.model_selection import train_test_split
```

In [8]:
```
# create our training data
training = []
# create an empty array for our output
output_empty = [0] * len(classes)
# training set, bag of words for each sentence
for doc in documents:
    # initialize our bag of words
    bag = []
    # list of tokenized words for the pattern
    pattern_words = doc[0]
    # lemmatize each word - create base word, in attempt to represent related words
    pattern_words = [lemmatizer.lemmatize(word.lower()) for word in pattern_words]
    # create our bag of words array with 1, if word match found in current pattern
    for w in words:
        bag.append(1) if w in pattern_words else bag.append(0)

    # output is a '0' for each tag and '1' for current tag (for each pattern)
    output_row = list(output_empty)
    output_row[classes.index(doc[1])] = 1

    training.append([bag, output_row])
# shuffle our features and turn into np.array
random.shuffle(training)
training = np.array(training)
# create train and test lists. X - patterns, Y - intents
X = list(training[:,0])
y = list(training[:,1])
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.10, shuffle = Fal
print("Training data created")
```

```
Training data created
<ipython-input-8-5eb5ef77b0b8>:24: VisibleDeprecationWarning: Creating an ndarray from r
agged nested sequences (which is a list-or-tuple of lists-or-tuples-or ndarrays with dif
```

```
ferent lengths or shapes) is deprecated. If you meant to do this, you must specify 'dtyp
e=object' when creating the ndarray
  training = np.array(training)
```

In [9]:
```
print(training)
```

```
[[list([0, 0, 0, 0, 0, 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, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 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, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
0, 0, 0, 0, 1, 1])
  list([0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0])]
 [list([0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 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, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 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, 1, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0])
  list([0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])]
 [list([0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 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, 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, 0, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0])
  list([0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0])]
 [list([0, 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, 1,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 0, 1, 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, 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, 0,
0, 0, 0, 0, 0, 0])
  list([0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0])]
 [list([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, 0, 0, 0, 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, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 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, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0])
  list([0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])]
 [list([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, 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, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 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, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1,
0, 0, 0, 0, 0, 0])
  list([0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0])]
 [list([0, 1, 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, 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, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0])
  list([0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0])]
 [list([0, 0, 0, 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, 0,
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0, 0, 0, 0, 0, 0])
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0, 0, 0, 0, 1, 0])
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0, 0, 0, 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,
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1, 0, 0, 0, 1, 0])
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0, 0, 0, 0, 0, 0])
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0, 0, 0, 0, 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, 0, 0, 0, 1, 0])
  list([0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0])]]
```

In [10]:

```
print(output_row)
```

```
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0]
```

In [11]:

```
print(pattern_words)
```

```
['return', 'store']
```

In [12]:

```
print(X)
```

```
[[0, 0, 0, 0, 0, 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, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0,
0, 0, 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, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 1, 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, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
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0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 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, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 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, 0, 0, 0, 0, 0, 0, 0, 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, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
0], [0, 0, 0, 0, 0, 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, 0, 0, 0, 0, 0, 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, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 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, 0, 0, 1, 0], [0, 0, 0, 0, 0, 0, 0, 0, 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, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
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0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0], [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 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, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0], [0, 0, 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, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 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, 0, 0, 0, 0, 0, 0, 0, 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, 0, 0, 0, 1, 0]]
```

In [13]:

```python
print(y)
```

```
[[0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 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, 1, 0, 0, 0, 0, 0], [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 1, 0, 0], [0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0], [0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0, 0, 0, 0], [0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 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, 1, 0, 0, 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, 1, 0, 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, 1, 0, 0, 0, 0, 0, 0], [0,
0, 0, 1, 0, 0, 0, 0, 0, 0, 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, 1, 0, 0, 0], [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0,
0, 0, 0], [0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 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, 1, 0], [0, 0, 0, 0, 0, 1, 0, 0,
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[0, 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, 1,
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0, 0, 0], [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0], [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
0, 0, 0, 0], [0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0], [0, 0, 1, 0, 0, 0, 0, 0,
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0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 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, 1, 0, 0], [0, 0, 0, 0, 0, 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, 1, 0], [0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
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0, 0, 0, 0, 0, 0, 0, 1, 0], [0, 0, 0, 0, 0, 0, 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, 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, 0, 0, 1],
[0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0]]
```

X_train = np.array(X_train) X_test = np.array(X_test) y_train = np.array(y_train) y_test = np.array(y_test) X = np.array(X) y = np.array(y)

In [14]:

```
# Create model - 3 layers. First layer 128 neurons, second layer 64 neurons and 3rd out
# equal to number of intents to predict output intent with softmax
model = Sequential()
```

```
model.add(Dense(128, input_shape=(len(X_train[0]),), activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(64, activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(len(y_train[0]), activation='softmax'))

# Compile model. Stochastic gradient descent with Nesterov accelerated gradient gives g
sgd = SGD(lr=0.01, decay=1e-6, momentum=0.9, nesterov=True)
model.compile(loss='categorical_crossentropy', optimizer=sgd, metrics=['accuracy'])

#fitting and saving the model
hist = model.fit(np.array(X_train), np.array(y_train), epochs=200,  batch_size=5, verbo


#ynew = model.predict_classes(np.array(test_x))
#model.save('chatbot_model.h5',hist)

print("model created")
```

```
Epoch 1/200
21/21 [==============================] - 1s 999us/step - loss: 2.7184 - accuracy: 0.0423
Epoch 2/200
21/21 [==============================] - 0s 999us/step - loss: 2.5508 - accuracy: 0.1204
Epoch 3/200
21/21 [==============================] - 0s 1ms/step - loss: 2.3870 - accuracy: 0.2526
Epoch 4/200
21/21 [==============================] - 0s 1ms/step - loss: 2.0521 - accuracy: 0.3425
Epoch 5/200
21/21 [==============================] - 0s 1ms/step - loss: 1.9033 - accuracy: 0.4339
Epoch 6/200
21/21 [==============================] - 0s 1ms/step - loss: 1.8191 - accuracy: 0.4125
Epoch 7/200
21/21 [==============================] - 0s 1ms/step - loss: 1.6315 - accuracy: 0.4366
Epoch 8/200
21/21 [==============================] - 0s 1ms/step - loss: 1.8713 - accuracy: 0.3681
Epoch 9/200
21/21 [==============================] - 0s 1ms/step - loss: 1.5364 - accuracy: 0.4936
Epoch 10/200
21/21 [==============================] - 0s 1ms/step - loss: 1.4113 - accuracy: 0.5495
Epoch 11/200
21/21 [==============================] - 0s 1ms/step - loss: 1.3540 - accuracy: 0.5716
Epoch 12/200
21/21 [==============================] - 0s 1ms/step - loss: 1.1754 - accuracy: 0.6351
Epoch 13/200
21/21 [==============================] - 0s 1ms/step - loss: 1.1953 - accuracy: 0.5886
Epoch 14/200
21/21 [==============================] - 0s 1ms/step - loss: 1.0328 - accuracy: 0.7381
Epoch 15/200
21/21 [==============================] - 0s 1ms/step - loss: 1.0846 - accuracy: 0.5827
Epoch 16/200
21/21 [==============================] - 0s 1ms/step - loss: 0.9416 - accuracy: 0.6975
Epoch 17/200
21/21 [==============================] - 0s 1ms/step - loss: 1.1968 - accuracy: 0.5862
Epoch 18/200
21/21 [==============================] - 0s 1ms/step - loss: 0.8087 - accuracy: 0.8285
Epoch 19/200
21/21 [==============================] - 0s 1ms/step - loss: 0.7688 - accuracy: 0.7920
Epoch 20/200
21/21 [==============================] - 0s 1ms/step - loss: 0.6363 - accuracy: 0.8003
Epoch 21/200
21/21 [==============================] - 0s 1ms/step - loss: 0.7862 - accuracy: 0.7667
Epoch 22/200
21/21 [==============================] - 0s 1ms/step - loss: 0.5239 - accuracy: 0.7938
Epoch 23/200
```

```
21/21 [==============================] - 0s 1ms/step - loss: 0.6272 - accuracy: 0.7946
Epoch 24/200
21/21 [==============================] - 0s 1ms/step - loss: 0.5602 - accuracy: 0.7771
Epoch 25/200
21/21 [==============================] - 0s 1ms/step - loss: 0.4856 - accuracy: 0.8749
Epoch 26/200
21/21 [==============================] - 0s 1ms/step - loss: 0.4458 - accuracy: 0.8618
Epoch 27/200
21/21 [==============================] - 0s 999us/step - loss: 0.5407 - accuracy: 0.8479
Epoch 28/200
21/21 [==============================] - 0s 1ms/step - loss: 0.3868 - accuracy: 0.8878
Epoch 29/200
21/21 [==============================] - 0s 1ms/step - loss: 0.3684 - accuracy: 0.9255
Epoch 30/200
21/21 [==============================] - 0s 1ms/step - loss: 0.3963 - accuracy: 0.8888
Epoch 31/200
21/21 [==============================] - 0s 1ms/step - loss: 0.3824 - accuracy: 0.8937
Epoch 32/200
21/21 [==============================] - 0s 1ms/step - loss: 0.5307 - accuracy: 0.8219
Epoch 33/200
21/21 [==============================] - 0s 1ms/step - loss: 0.2366 - accuracy: 0.9664
Epoch 34/200
21/21 [==============================] - 0s 1ms/step - loss: 0.3797 - accuracy: 0.8986
Epoch 35/200
21/21 [==============================] - 0s 1ms/step - loss: 0.3552 - accuracy: 0.9129
Epoch 36/200
21/21 [==============================] - 0s 1ms/step - loss: 0.3496 - accuracy: 0.8810
Epoch 37/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1885 - accuracy: 0.9472
Epoch 38/200
21/21 [==============================] - 0s 1ms/step - loss: 0.2078 - accuracy: 0.9476
Epoch 39/200
21/21 [==============================] - 0s 1ms/step - loss: 0.3424 - accuracy: 0.8326
Epoch 40/200
21/21 [==============================] - 0s 1ms/step - loss: 0.2948 - accuracy: 0.9297
Epoch 41/200
21/21 [==============================] - 0s 1ms/step - loss: 0.3616 - accuracy: 0.8785
Epoch 42/200
21/21 [==============================] - 0s 1ms/step - loss: 0.2966 - accuracy: 0.9080
Epoch 43/200
21/21 [==============================] - 0s 1ms/step - loss: 0.2774 - accuracy: 0.9384
Epoch 44/200
21/21 [==============================] - 0s 1ms/step - loss: 0.3754 - accuracy: 0.8214
Epoch 45/200
21/21 [==============================] - 0s 1ms/step - loss: 0.2429 - accuracy: 0.9290
Epoch 46/200
21/21 [==============================] - 0s 1ms/step - loss: 0.3000 - accuracy: 0.9033
Epoch 47/200
21/21 [==============================] - 0s 1ms/step - loss: 0.3087 - accuracy: 0.8964
Epoch 48/200
21/21 [==============================] - 0s 1ms/step - loss: 0.2572 - accuracy: 0.9516
Epoch 49/200
21/21 [==============================] - 0s 1ms/step - loss: 0.2873 - accuracy: 0.8956
Epoch 50/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1443 - accuracy: 0.9784
Epoch 51/200
21/21 [==============================] - 0s 1ms/step - loss: 0.2337 - accuracy: 0.9197
Epoch 52/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1281 - accuracy: 0.9585
Epoch 53/200
21/21 [==============================] - 0s 1ms/step - loss: 0.2460 - accuracy: 0.9574
Epoch 54/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1609 - accuracy: 0.9703
Epoch 55/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1142 - accuracy: 0.9819
```

```
Epoch 56/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1588 - accuracy: 0.9464
Epoch 57/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1357 - accuracy: 0.9745
Epoch 58/200
21/21 [==============================] - 0s 996us/step - loss: 0.1278 - accuracy: 0.9756
Epoch 59/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1854 - accuracy: 0.9772
Epoch 60/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1617 - accuracy: 0.9638
Epoch 61/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1805 - accuracy: 0.9657
Epoch 62/200
21/21 [==============================] - 0s 1ms/step - loss: 0.2114 - accuracy: 0.9222
Epoch 63/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0845 - accuracy: 0.9825
Epoch 64/200
21/21 [==============================] - 0s 1ms/step - loss: 0.2003 - accuracy: 0.9539
Epoch 65/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1205 - accuracy: 0.9410
Epoch 66/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0892 - accuracy: 0.9711
Epoch 67/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0736 - accuracy: 0.9684
Epoch 68/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1528 - accuracy: 0.9395
Epoch 69/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1869 - accuracy: 0.9419
Epoch 70/200
21/21 [==============================] - 0s 1ms/step - loss: 0.2007 - accuracy: 0.9499
Epoch 71/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0810 - accuracy: 0.9820
Epoch 72/200
21/21 [==============================] - 0s 998us/step - loss: 0.1612 - accuracy: 0.9484
Epoch 73/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0623 - accuracy: 0.9872
Epoch 74/200
21/21 [==============================] - 0s 998us/step - loss: 0.0951 - accuracy: 0.9829
Epoch 75/200
21/21 [==============================] - 0s 999us/step - loss: 0.1199 - accuracy: 0.9520
Epoch 76/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1206 - accuracy: 0.9645
Epoch 77/200
21/21 [==============================] - 0s 999us/step - loss: 0.1671 - accuracy: 0.9387
Epoch 78/200
21/21 [==============================] - 0s 998us/step - loss: 0.1023 - accuracy: 0.9786
Epoch 79/200
21/21 [==============================] - 0s 999us/step - loss: 0.1324 - accuracy: 0.9592
Epoch 80/200
21/21 [==============================] - 0s 999us/step - loss: 0.0772 - accuracy: 0.9612
Epoch 81/200
21/21 [==============================] - 0s 999us/step - loss: 0.1339 - accuracy: 0.9610
Epoch 82/200
21/21 [==============================] - 0s 999us/step - loss: 0.0771 - accuracy: 0.9947
Epoch 83/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1345 - accuracy: 0.9611
Epoch 84/200
21/21 [==============================] - 0s 997us/step - loss: 0.1032 - accuracy: 0.9717
Epoch 85/200
21/21 [==============================] - 0s 947us/step - loss: 0.0739 - accuracy: 0.9749
Epoch 86/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0522 - accuracy: 0.9917
Epoch 87/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0380 - accuracy: 0.9986
Epoch 88/200
```

```
21/21 [==============================] - 0s 1ms/step - loss: 0.0704 - accuracy: 0.9829
Epoch 89/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1362 - accuracy: 0.9398
Epoch 90/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0715 - accuracy: 0.9703
Epoch 91/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0840 - accuracy: 0.9553
Epoch 92/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0854 - accuracy: 0.9605
Epoch 93/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1217 - accuracy: 0.9334
Epoch 94/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0639 - accuracy: 0.9877
Epoch 95/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0547 - accuracy: 1.0000
Epoch 96/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0915 - accuracy: 0.9680
Epoch 97/200
21/21 [==============================] - ETA: 0s - loss: 0.3329 - accuracy: 1.00 - 0s 10
00us/step - loss: 0.1413 - accuracy: 0.9799
Epoch 98/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0525 - accuracy: 0.9822
Epoch 99/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0901 - accuracy: 0.9774
Epoch 100/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0696 - accuracy: 0.9921
Epoch 101/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1141 - accuracy: 0.9718
Epoch 102/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1767 - accuracy: 0.9753
Epoch 103/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0542 - accuracy: 0.9953
Epoch 104/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1293 - accuracy: 0.9648
Epoch 105/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0524 - accuracy: 0.9966
Epoch 106/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0276 - accuracy: 1.0000
Epoch 107/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0773 - accuracy: 0.9824
Epoch 108/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1090 - accuracy: 0.9872
Epoch 109/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1095 - accuracy: 0.9618
Epoch 110/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0572 - accuracy: 0.9840
Epoch 111/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0989 - accuracy: 0.9849
Epoch 112/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0735 - accuracy: 0.9782
Epoch 113/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0809 - accuracy: 0.9821
Epoch 114/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0633 - accuracy: 0.9939
Epoch 115/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0342 - accuracy: 0.9953
Epoch 116/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0344 - accuracy: 0.9977
Epoch 117/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0581 - accuracy: 0.9930
Epoch 118/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0783 - accuracy: 0.9887
Epoch 119/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1502 - accuracy: 0.9427
Epoch 120/200
```

```
21/21 [==============================] - 0s 1ms/step - loss: 0.0810 - accuracy: 0.9876
Epoch 121/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0271 - accuracy: 0.9971
Epoch 122/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0452 - accuracy: 0.9966
Epoch 123/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0217 - accuracy: 0.9960
Epoch 124/200
21/21 [==============================] - 0s 999us/step - loss: 0.0525 - accuracy: 0.9938
Epoch 125/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1051 - accuracy: 0.9625
Epoch 126/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1419 - accuracy: 0.9315
Epoch 127/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0611 - accuracy: 1.0000
Epoch 128/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0512 - accuracy: 0.9900
Epoch 129/200
21/21 [==============================] - 0s 999us/step - loss: 0.0682 - accuracy: 0.9654
Epoch 130/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0386 - accuracy: 1.0000
Epoch 131/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0379 - accuracy: 0.9832
Epoch 132/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0377 - accuracy: 0.9911
Epoch 133/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0458 - accuracy: 0.9936
Epoch 134/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0279 - accuracy: 0.9919
Epoch 135/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0482 - accuracy: 0.9868
Epoch 136/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0253 - accuracy: 0.9986
Epoch 137/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0715 - accuracy: 0.9685
Epoch 138/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0514 - accuracy: 0.9986
Epoch 139/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0255 - accuracy: 0.9930
Epoch 140/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1653 - accuracy: 0.9407
Epoch 141/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0382 - accuracy: 0.9800
Epoch 142/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0649 - accuracy: 0.9971
Epoch 143/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0392 - accuracy: 1.0000
Epoch 144/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0482 - accuracy: 0.9816
Epoch 145/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0897 - accuracy: 0.9872
Epoch 146/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0396 - accuracy: 0.9868
Epoch 147/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0446 - accuracy: 0.9853
Epoch 148/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0779 - accuracy: 0.9664
Epoch 149/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0299 - accuracy: 0.9899
Epoch 150/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0293 - accuracy: 0.9872
Epoch 151/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1388 - accuracy: 0.9887
Epoch 152/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0735 - accuracy: 0.9837
```

```
Epoch 153/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0444 - accuracy: 0.9960
Epoch 154/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1099 - accuracy: 0.9701
Epoch 155/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0374 - accuracy: 0.9977
Epoch 156/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0973 - accuracy: 0.9594
Epoch 157/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0262 - accuracy: 1.0000
Epoch 158/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0440 - accuracy: 0.9698
Epoch 159/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0612 - accuracy: 0.9676
Epoch 160/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0974 - accuracy: 0.9596
Epoch 161/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0217 - accuracy: 0.9917
Epoch 162/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0409 - accuracy: 0.9960
Epoch 163/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0350 - accuracy: 0.9930
Epoch 164/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0668 - accuracy: 0.9812
Epoch 165/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0341 - accuracy: 0.9911
Epoch 166/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0514 - accuracy: 0.9908
Epoch 167/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0417 - accuracy: 0.9761
Epoch 168/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0372 - accuracy: 0.9953
Epoch 169/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0356 - accuracy: 0.9853
Epoch 170/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0636 - accuracy: 0.9651
Epoch 171/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0831 - accuracy: 0.9650
Epoch 172/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0304 - accuracy: 1.0000
Epoch 173/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0289 - accuracy: 0.9802
Epoch 174/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0138 - accuracy: 1.0000
Epoch 175/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0248 - accuracy: 0.9921
Epoch 176/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0256 - accuracy: 1.0000
Epoch 177/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0971 - accuracy: 0.9815
Epoch 178/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0326 - accuracy: 0.9966
Epoch 179/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0425 - accuracy: 0.9853
Epoch 180/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0252 - accuracy: 0.9887
Epoch 181/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0405 - accuracy: 0.9958
Epoch 182/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0501 - accuracy: 0.9946
Epoch 183/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0198 - accuracy: 1.0000
Epoch 184/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0168 - accuracy: 1.0000
Epoch 185/200
```

```
21/21 [==============================] - 0s 1ms/step - loss: 0.1165 - accuracy: 0.9666
Epoch 186/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0521 - accuracy: 0.9868
Epoch 187/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0293 - accuracy: 0.9986
Epoch 188/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0842 - accuracy: 0.9774
Epoch 189/200
21/21 [==============================] - 0s 2ms/step - loss: 0.0152 - accuracy: 0.9953
Epoch 190/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0348 - accuracy: 1.0000
Epoch 191/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0561 - accuracy: 0.9629
Epoch 192/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0192 - accuracy: 0.9971
Epoch 193/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0596 - accuracy: 0.9831
Epoch 194/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0122 - accuracy: 1.0000
Epoch 195/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0280 - accuracy: 1.0000
Epoch 196/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0272 - accuracy: 0.9960
Epoch 197/200
21/21 [==============================] - 0s 1ms/step - loss: 0.1335 - accuracy: 0.9405
Epoch 198/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0218 - accuracy: 1.0000
Epoch 199/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0205 - accuracy: 0.9900
Epoch 200/200
21/21 [==============================] - 0s 1ms/step - loss: 0.0497 - accuracy: 0.9819
model created
```

In [15]:
```
_, accuracy = model.evaluate(X_test, y_test)
print('Accuracy: %.2f' % (accuracy*100))
```

```
1/1 [==============================] - 0s 160ms/step - loss: 0.6264 - accuracy: 0.8333
Accuracy: 83.33
```

Running the final model to save for GUI

In [16]:
```
# Create model - 3 layers. First layer 128 neurons, second layer 64 neurons and 3rd out
# equal to number of intents to predict output intent with softmax
model = Sequential()
model.add(Dense(128, input_shape=(len(X[0]),), activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(64, activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(len(y[0]), activation='softmax'))

# Compile model. Stochastic gradient descent with Nesterov accelerated gradient gives g
sgd = SGD(lr=0.01, decay=1e-6, momentum=0.9, nesterov=True)
model.compile(loss='categorical_crossentropy', optimizer=sgd, metrics=['accuracy'])

#fitting and saving the model
hist_1 = model.fit(np.array(X), np.array(y), epochs=1000,  batch_size=5, verbose=1)


#ynew = model.predict_classes(np.array(test_x))
model.save('chatbot_model.h5',hist_1)

print("model created")
```

```
Epoch 1/1000
```

```
23/23 [==============================] - 0s 1ms/step - loss: 2.7813 - accuracy: 0.0264
Epoch 2/1000
23/23 [==============================] - 0s 1ms/step - loss: 2.5337 - accuracy: 0.1741
Epoch 3/1000
23/23 [==============================] - 0s 1ms/step - loss: 2.4295 - accuracy: 0.2795
Epoch 4/1000
23/23 [==============================] - 0s 1ms/step - loss: 2.2168 - accuracy: 0.3619
Epoch 5/1000
23/23 [==============================] - 0s 1ms/step - loss: 2.0693 - accuracy: 0.2967
Epoch 6/1000
23/23 [==============================] - 0s 1ms/step - loss: 1.9088 - accuracy: 0.3864
Epoch 7/1000
23/23 [==============================] - 0s 1ms/step - loss: 1.7706 - accuracy: 0.4119
Epoch 8/1000
23/23 [==============================] - 0s 1ms/step - loss: 1.5645 - accuracy: 0.4736
Epoch 9/1000
23/23 [==============================] - 0s 1ms/step - loss: 1.3821 - accuracy: 0.5747
Epoch 10/1000
23/23 [==============================] - 0s 1ms/step - loss: 1.4633 - accuracy: 0.5291
Epoch 11/1000
23/23 [==============================] - 0s 1ms/step - loss: 1.1528 - accuracy: 0.5675
Epoch 12/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.9138 - accuracy: 0.7503
Epoch 13/1000
23/23 [==============================] - 0s 1ms/step - loss: 1.0584 - accuracy: 0.6975
Epoch 14/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.9889 - accuracy: 0.6659
Epoch 15/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.8718 - accuracy: 0.7441
Epoch 16/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.8268 - accuracy: 0.7842
Epoch 17/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.9137 - accuracy: 0.7696
Epoch 18/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.7569 - accuracy: 0.7907
Epoch 19/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.6819 - accuracy: 0.7594
Epoch 20/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.6196 - accuracy: 0.8703
Epoch 21/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.5770 - accuracy: 0.8489
Epoch 22/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.5237 - accuracy: 0.8764
Epoch 23/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.4856 - accuracy: 0.8679
Epoch 24/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.4810 - accuracy: 0.8621
Epoch 25/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.5560 - accuracy: 0.8204
Epoch 26/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.3953 - accuracy: 0.8565
Epoch 27/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.4841 - accuracy: 0.8557
Epoch 28/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.4236 - accuracy: 0.8516
Epoch 29/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.3735 - accuracy: 0.9096
Epoch 30/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.3171 - accuracy: 0.9070
Epoch 31/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.4146 - accuracy: 0.8338
Epoch 32/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.3378 - accuracy: 0.8712
Epoch 33/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.2917 - accuracy: 0.9045
```

```
Epoch 34/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.2706 - accuracy: 0.8868
Epoch 35/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.2151 - accuracy: 0.9842
Epoch 36/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.3153 - accuracy: 0.8947
Epoch 37/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.2583 - accuracy: 0.9100
Epoch 38/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.2808 - accuracy: 0.9784
Epoch 39/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.2345 - accuracy: 0.9234
Epoch 40/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1576 - accuracy: 0.9705
Epoch 41/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.3058 - accuracy: 0.9234
Epoch 42/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.2068 - accuracy: 0.9265
Epoch 43/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1644 - accuracy: 0.9533
Epoch 44/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1515 - accuracy: 0.9604
Epoch 45/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1508 - accuracy: 0.9699
Epoch 46/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1808 - accuracy: 0.9247
Epoch 47/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1212 - accuracy: 0.9465
Epoch 48/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1383 - accuracy: 0.9782
Epoch 49/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1438 - accuracy: 0.9799
Epoch 50/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1702 - accuracy: 0.9719
Epoch 51/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1109 - accuracy: 0.9835
Epoch 52/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1800 - accuracy: 0.9228
Epoch 53/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1116 - accuracy: 0.9739
Epoch 54/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1507 - accuracy: 0.9556
Epoch 55/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1074 - accuracy: 0.9743
Epoch 56/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1640 - accuracy: 0.9214
Epoch 57/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1151 - accuracy: 0.9736
Epoch 58/1000
23/23 [==============================] - ETA: 0s - loss: 0.2583 - accuracy: 0.80 - 0s 1m
s/step - loss: 0.1557 - accuracy: 0.9460
Epoch 59/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0795 - accuracy: 0.9774
Epoch 60/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0926 - accuracy: 1.0000
Epoch 61/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0780 - accuracy: 0.9802
Epoch 62/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1033 - accuracy: 0.9792
Epoch 63/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0852 - accuracy: 0.9867
Epoch 64/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0969 - accuracy: 0.9712
Epoch 65/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1921 - accuracy: 0.9336
```

```
Epoch 66/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0785 - accuracy: 0.9651
Epoch 67/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1192 - accuracy: 0.9685
Epoch 68/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1196 - accuracy: 0.9750
Epoch 69/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0956 - accuracy: 0.9495
Epoch 70/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.1339 - accuracy: 0.9179
Epoch 71/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0734 - accuracy: 0.9901
Epoch 72/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0890 - accuracy: 0.9711
Epoch 73/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1244 - accuracy: 0.9872
Epoch 74/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0864 - accuracy: 0.9673
Epoch 75/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1016 - accuracy: 0.9573
Epoch 76/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1269 - accuracy: 0.9705
Epoch 77/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0681 - accuracy: 0.9937
Epoch 78/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0890 - accuracy: 0.9786
Epoch 79/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1271 - accuracy: 0.9848
Epoch 80/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0248 - accuracy: 1.0000
Epoch 81/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0794 - accuracy: 0.9714
Epoch 82/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0706 - accuracy: 0.9712
Epoch 83/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1025 - accuracy: 0.9629
Epoch 84/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.0720 - accuracy: 0.9775
Epoch 85/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0799 - accuracy: 0.9840
Epoch 86/1000
23/23 [==============================] - 0s 908us/step - loss: 0.0856 - accuracy: 0.9657
Epoch 87/1000
23/23 [==============================] - 0s 908us/step - loss: 0.0839 - accuracy: 0.9749
Epoch 88/1000
23/23 [==============================] - 0s 908us/step - loss: 0.0451 - accuracy: 0.9976
Epoch 89/1000
23/23 [==============================] - 0s 908us/step - loss: 0.1081 - accuracy: 0.9724
Epoch 90/1000
23/23 [==============================] - 0s 726us/step - loss: 0.0505 - accuracy: 0.9961
Epoch 91/1000
23/23 [==============================] - 0s 956us/step - loss: 0.0523 - accuracy: 0.9880
Epoch 92/1000
23/23 [==============================] - 0s 908us/step - loss: 0.0324 - accuracy: 0.9912
Epoch 93/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0416 - accuracy: 0.9967
Epoch 94/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0737 - accuracy: 0.9722
Epoch 95/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.1361 - accuracy: 0.9517
Epoch 96/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0420 - accuracy: 0.9907
Epoch 97/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0435 - accuracy: 0.9893
Epoch 98/1000
```

```
23/23 [==============================] - 0s 1ms/step - loss: 0.0569 - accuracy: 0.9859
Epoch 99/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.0916 - accuracy: 0.9544
Epoch 100/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1425 - accuracy: 0.9545
Epoch 101/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0503 - accuracy: 0.9903
Epoch 102/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0386 - accuracy: 0.9950
Epoch 103/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0526 - accuracy: 0.9950
Epoch 104/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0445 - accuracy: 0.9852
Epoch 105/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0473 - accuracy: 0.9893
Epoch 106/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0645 - accuracy: 0.9799
Epoch 107/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0316 - accuracy: 0.9875
Epoch 108/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0335 - accuracy: 0.9956
Epoch 109/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0747 - accuracy: 0.9870
Epoch 110/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0317 - accuracy: 1.0000
Epoch 111/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1671 - accuracy: 0.9699
Epoch 112/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0859 - accuracy: 0.9746
Epoch 113/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0393 - accuracy: 1.0000
Epoch 114/1000
23/23 [==============================] - ETA: 0s - loss: 0.0077 - accuracy: 1.00 - 0s 1m
s/step - loss: 0.0341 - accuracy: 0.9804
Epoch 115/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0329 - accuracy: 1.0000
Epoch 116/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0566 - accuracy: 0.9775
Epoch 117/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0415 - accuracy: 0.9976
Epoch 118/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0627 - accuracy: 0.9845
Epoch 119/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0330 - accuracy: 1.0000
Epoch 120/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0331 - accuracy: 0.9929
Epoch 121/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0992 - accuracy: 0.9567
Epoch 122/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0427 - accuracy: 0.9901
Epoch 123/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0372 - accuracy: 0.9894
Epoch 124/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0542 - accuracy: 0.9976
Epoch 125/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0602 - accuracy: 0.9752
Epoch 126/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0207 - accuracy: 0.9956
Epoch 127/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0825 - accuracy: 0.9944
Epoch 128/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0193 - accuracy: 0.9957
Epoch 129/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0632 - accuracy: 0.9823
Epoch 130/1000
```

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23/23 [==============================] - 0s 1ms/step - loss: 0.0943 - accuracy: 0.9644
Epoch 131/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1826 - accuracy: 0.9527
Epoch 132/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0561 - accuracy: 0.9768
Epoch 133/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0185 - accuracy: 1.0000
Epoch 134/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0583 - accuracy: 0.9860
Epoch 135/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0426 - accuracy: 1.0000
Epoch 136/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0745 - accuracy: 0.9640
Epoch 137/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0237 - accuracy: 0.9976
Epoch 138/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0729 - accuracy: 0.9809
Epoch 139/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0907 - accuracy: 0.9692
Epoch 140/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0789 - accuracy: 0.9976
Epoch 141/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0548 - accuracy: 0.9912
Epoch 142/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0235 - accuracy: 1.0000
Epoch 143/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0768 - accuracy: 0.9640
Epoch 144/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0272 - accuracy: 0.9910
Epoch 145/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0246 - accuracy: 0.9981
Epoch 146/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0391 - accuracy: 1.0000
Epoch 147/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0792 - accuracy: 0.9704
Epoch 148/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0506 - accuracy: 0.9912
Epoch 149/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0510 - accuracy: 0.9956
Epoch 150/1000
23/23 [==============================] - ETA: 0s - loss: 0.0331 - accuracy: 1.00 - 0s 1m
s/step - loss: 0.0361 - accuracy: 1.0000
Epoch 151/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0333 - accuracy: 0.9952
Epoch 152/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0151 - accuracy: 1.0000
Epoch 153/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0307 - accuracy: 0.9944
Epoch 154/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1067 - accuracy: 0.9578
Epoch 155/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0767 - accuracy: 0.9819
Epoch 156/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0357 - accuracy: 0.9931
Epoch 157/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1163 - accuracy: 0.9771
Epoch 158/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0292 - accuracy: 0.9944
Epoch 159/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0335 - accuracy: 0.9874
Epoch 160/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0368 - accuracy: 0.9897
Epoch 161/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0161 - accuracy: 1.0000
Epoch 162/1000
```

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23/23 [==============================] - 0s 1ms/step - loss: 0.0474 - accuracy: 0.9739
Epoch 163/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0391 - accuracy: 0.9901
Epoch 164/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0410 - accuracy: 0.9788
Epoch 165/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0888 - accuracy: 0.9685
Epoch 166/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0494 - accuracy: 0.9858
Epoch 167/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0124 - accuracy: 1.0000
Epoch 168/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0175 - accuracy: 1.0000
Epoch 169/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0537 - accuracy: 0.9768
Epoch 170/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0166 - accuracy: 0.9956
Epoch 171/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0331 - accuracy: 0.9859
Epoch 172/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0132 - accuracy: 1.0000
Epoch 173/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0375 - accuracy: 0.9806
Epoch 174/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0122 - accuracy: 1.0000
Epoch 175/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0906 - accuracy: 0.9859
Epoch 176/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0149 - accuracy: 1.0000
Epoch 177/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0497 - accuracy: 0.9956
Epoch 178/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0167 - accuracy: 1.0000
Epoch 179/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0252 - accuracy: 0.9901
Epoch 180/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0329 - accuracy: 0.9965
Epoch 181/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0772 - accuracy: 0.9718
Epoch 182/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0180 - accuracy: 0.9946
Epoch 183/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0187 - accuracy: 0.9962
Epoch 184/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0130 - accuracy: 1.0000
Epoch 185/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0226 - accuracy: 1.0000
Epoch 186/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0463 - accuracy: 0.9697
Epoch 187/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0438 - accuracy: 0.9912
Epoch 188/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0077 - accuracy: 1.0000
Epoch 189/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0481 - accuracy: 0.9956
Epoch 190/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0295 - accuracy: 0.9889
Epoch 191/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0342 - accuracy: 0.9849
Epoch 192/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0338 - accuracy: 0.9801
Epoch 193/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0399 - accuracy: 0.9851
Epoch 194/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0233 - accuracy: 0.9989
```

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Epoch 195/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0299 - accuracy: 0.9912
Epoch 196/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0249 - accuracy: 1.0000
Epoch 197/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0302 - accuracy: 0.9912
Epoch 198/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0691 - accuracy: 0.9652
Epoch 199/1000
23/23 [==============================] - ETA: 0s - loss: 0.0053 - accuracy: 1.00 - 0s 1m
s/step - loss: 0.0147 - accuracy: 1.0000
Epoch 200/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0129 - accuracy: 1.0000
Epoch 201/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0074 - accuracy: 1.0000
Epoch 202/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0286 - accuracy: 0.9900
Epoch 203/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0470 - accuracy: 0.9754
Epoch 204/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0300 - accuracy: 0.9893
Epoch 205/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0251 - accuracy: 0.9928
Epoch 206/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0387 - accuracy: 0.9937
Epoch 207/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0292 - accuracy: 0.9891
Epoch 208/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0293 - accuracy: 1.0000
Epoch 209/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0587 - accuracy: 0.9859
Epoch 210/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0199 - accuracy: 0.9981
Epoch 211/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0711 - accuracy: 0.9791
Epoch 212/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.0174 - accuracy: 1.0000
Epoch 213/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0132 - accuracy: 1.0000
Epoch 214/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0102 - accuracy: 1.0000
Epoch 215/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0249 - accuracy: 0.9874
Epoch 216/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0118 - accuracy: 1.0000
Epoch 217/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0628 - accuracy: 0.9727
Epoch 218/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0533 - accuracy: 0.9768
Epoch 219/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0243 - accuracy: 0.9937
Epoch 220/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0853 - accuracy: 0.9685
Epoch 221/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0221 - accuracy: 1.0000
Epoch 222/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0355 - accuracy: 1.0000
Epoch 223/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0143 - accuracy: 1.0000
Epoch 224/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0359 - accuracy: 1.0000
Epoch 225/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0027 - accuracy: 1.0000
Epoch 226/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0220 - accuracy: 1.0000
```

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Epoch 227/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0210 - accuracy: 1.0000
Epoch 228/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0323 - accuracy: 0.9768
Epoch 229/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0138 - accuracy: 0.9993
Epoch 230/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0514 - accuracy: 0.9749
Epoch 231/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0110 - accuracy: 0.9976
Epoch 232/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0115 - accuracy: 1.0000
Epoch 233/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0136 - accuracy: 1.0000
Epoch 234/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0269 - accuracy: 0.9989
Epoch 235/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0129 - accuracy: 1.0000
Epoch 236/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0175 - accuracy: 1.0000
Epoch 237/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0096 - accuracy: 1.0000
Epoch 238/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0340 - accuracy: 0.9790
Epoch 239/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0351 - accuracy: 0.9921
Epoch 240/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0149 - accuracy: 1.0000
Epoch 241/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0318 - accuracy: 0.9837
Epoch 242/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0235 - accuracy: 0.9985
Epoch 243/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0214 - accuracy: 1.0000
Epoch 244/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0538 - accuracy: 0.9838
Epoch 245/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0655 - accuracy: 0.9838
Epoch 246/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0227 - accuracy: 1.0000
Epoch 247/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0119 - accuracy: 1.0000
Epoch 248/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0120 - accuracy: 1.0000
Epoch 249/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0381 - accuracy: 0.9943
Epoch 250/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.0164 - accuracy: 1.0000
Epoch 251/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0179 - accuracy: 1.0000
Epoch 252/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1091 - accuracy: 0.9480
Epoch 253/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0413 - accuracy: 0.9898
Epoch 254/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0367 - accuracy: 0.9929
Epoch 255/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0342 - accuracy: 1.0000
Epoch 256/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0288 - accuracy: 1.0000
Epoch 257/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0827 - accuracy: 0.9699
Epoch 258/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0076 - accuracy: 1.0000
Epoch 259/1000
```

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23/23 [==============================] - 0s 1ms/step - loss: 0.0156 - accuracy: 0.9985
Epoch 260/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0199 - accuracy: 0.9937
Epoch 261/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0113 - accuracy: 1.0000
Epoch 262/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0431 - accuracy: 0.9777
Epoch 263/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0147 - accuracy: 1.0000
Epoch 264/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0205 - accuracy: 0.9889
Epoch 265/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0234 - accuracy: 0.9972
Epoch 266/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0389 - accuracy: 0.9859
Epoch 267/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0207 - accuracy: 0.9888
Epoch 268/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0115 - accuracy: 1.0000
Epoch 269/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0202 - accuracy: 1.0000
Epoch 270/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0051 - accuracy: 1.0000
Epoch 271/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0113 - accuracy: 0.9944
Epoch 272/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0210 - accuracy: 0.9921
Epoch 273/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0047 - accuracy: 1.0000
Epoch 274/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0559 - accuracy: 1.0000
Epoch 275/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0225 - accuracy: 1.0000
Epoch 276/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0415 - accuracy: 1.0000
Epoch 277/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0045 - accuracy: 0.9993
Epoch 278/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0090 - accuracy: 1.0000
Epoch 279/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0163 - accuracy: 0.9921
Epoch 280/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0493 - accuracy: 0.9889
Epoch 281/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0060 - accuracy: 1.0000
Epoch 282/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0274 - accuracy: 0.9989
Epoch 283/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0109 - accuracy: 1.0000
Epoch 284/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0215 - accuracy: 0.9912
Epoch 285/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0123 - accuracy: 1.0000
Epoch 286/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0161 - accuracy: 0.9901
Epoch 287/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0603 - accuracy: 0.9658
Epoch 288/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0125 - accuracy: 0.9981
Epoch 289/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0052 - accuracy: 1.0000
Epoch 290/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0045 - accuracy: 1.0000
Epoch 291/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0152 - accuracy: 1.0000
```

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Epoch 292/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0092 - accuracy: 1.0000
Epoch 293/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0097 - accuracy: 1.0000
Epoch 294/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0063 - accuracy: 1.0000
Epoch 295/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0121 - accuracy: 0.9950
Epoch 296/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0187 - accuracy: 1.0000
Epoch 297/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0632 - accuracy: 0.9810
Epoch 298/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0071 - accuracy: 1.0000
Epoch 299/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0218 - accuracy: 1.0000
Epoch 300/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0108 - accuracy: 1.0000
Epoch 301/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0240 - accuracy: 0.9929
Epoch 302/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0186 - accuracy: 0.9926
Epoch 303/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0500 - accuracy: 0.9578
Epoch 304/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1019 - accuracy: 0.9627
Epoch 305/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0130 - accuracy: 1.0000
Epoch 306/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0079 - accuracy: 1.0000
Epoch 307/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0104 - accuracy: 0.9956
Epoch 308/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0242 - accuracy: 0.9942
Epoch 309/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0223 - accuracy: 0.9956
Epoch 310/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0218 - accuracy: 1.0000
Epoch 311/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0197 - accuracy: 1.0000
Epoch 312/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0162 - accuracy: 1.0000
Epoch 313/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0134 - accuracy: 0.9989
Epoch 314/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0069 - accuracy: 1.0000
Epoch 315/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0065 - accuracy: 1.0000
Epoch 316/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0313 - accuracy: 1.0000
Epoch 317/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0026 - accuracy: 1.0000
Epoch 318/1000
23/23 [==============================] - ETA: 0s - loss: 0.0012 - accuracy: 1.00 - 0s 1m
s/step - loss: 0.0041 - accuracy: 1.0000
Epoch 319/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0262 - accuracy: 0.9929
Epoch 320/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0114 - accuracy: 1.0000
Epoch 321/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0439 - accuracy: 0.9859
Epoch 322/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0044 - accuracy: 1.0000
Epoch 323/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0047 - accuracy: 1.0000
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Epoch 324/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0072 - accuracy: 1.0000
Epoch 325/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0190 - accuracy: 0.9889
Epoch 326/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0107 - accuracy: 1.0000
Epoch 327/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0045 - accuracy: 1.0000
Epoch 328/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0088 - accuracy: 1.0000
Epoch 329/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0087 - accuracy: 1.0000
Epoch 330/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0071 - accuracy: 1.0000
Epoch 331/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0024 - accuracy: 1.0000
Epoch 332/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0240 - accuracy: 1.0000
Epoch 333/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0036 - accuracy: 1.0000
Epoch 334/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0114 - accuracy: 1.0000
Epoch 335/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0297 - accuracy: 0.9921
Epoch 336/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0085 - accuracy: 1.0000
Epoch 337/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0406 - accuracy: 0.9838
Epoch 338/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0044 - accuracy: 1.0000
Epoch 339/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0190 - accuracy: 0.9921
Epoch 340/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1008 - accuracy: 0.9606
Epoch 341/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0075 - accuracy: 0.9967
Epoch 342/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0067 - accuracy: 0.9993
Epoch 343/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0493 - accuracy: 0.9682
Epoch 344/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0242 - accuracy: 0.9901
Epoch 345/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0245 - accuracy: 1.0000
Epoch 346/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0242 - accuracy: 0.9905
Epoch 347/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0241 - accuracy: 1.0000
Epoch 348/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0169 - accuracy: 0.9929
Epoch 349/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0033 - accuracy: 1.0000
Epoch 350/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0423 - accuracy: 0.9614
Epoch 351/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0947 - accuracy: 0.9727
Epoch 352/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0106 - accuracy: 0.9974
Epoch 353/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0060 - accuracy: 1.0000
Epoch 354/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0412 - accuracy: 0.9699
Epoch 355/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0141 - accuracy: 1.0000
Epoch 356/1000
```

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23/23 [==============================] - 0s 1ms/step - loss: 0.0078 - accuracy: 0.9956
Epoch 357/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0498 - accuracy: 0.9921
Epoch 358/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0211 - accuracy: 0.9810
Epoch 359/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0066 - accuracy: 1.0000
Epoch 360/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0053 - accuracy: 1.0000
Epoch 361/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0158 - accuracy: 0.9950
Epoch 362/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0420 - accuracy: 0.9768
Epoch 363/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1069 - accuracy: 0.9523
Epoch 364/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0015 - accuracy: 1.0000
Epoch 365/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0181 - accuracy: 0.9944
Epoch 366/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0130 - accuracy: 1.0000
Epoch 367/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0187 - accuracy: 0.9912
Epoch 368/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0051 - accuracy: 0.9967
Epoch 369/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0093 - accuracy: 1.0000
Epoch 370/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0260 - accuracy: 0.9859
Epoch 371/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1524 - accuracy: 0.9264
Epoch 372/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0101 - accuracy: 1.0000
Epoch 373/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0340 - accuracy: 0.9889
Epoch 374/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0024 - accuracy: 1.0000
Epoch 375/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0391 - accuracy: 0.9786
Epoch 376/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0151 - accuracy: 1.0000
Epoch 377/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0111 - accuracy: 0.9962
Epoch 378/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0114 - accuracy: 0.9967
Epoch 379/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0139 - accuracy: 0.9937
Epoch 380/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0506 - accuracy: 0.9713
Epoch 381/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0263 - accuracy: 0.9874
Epoch 382/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0082 - accuracy: 1.0000
Epoch 383/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0285 - accuracy: 0.9889
Epoch 384/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0041 - accuracy: 0.9989
Epoch 385/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0318 - accuracy: 0.9685
Epoch 386/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0407 - accuracy: 0.9837
Epoch 387/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0055 - accuracy: 1.0000
Epoch 388/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0079 - accuracy: 0.9989
```

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Epoch 389/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0073 - accuracy: 1.0000
Epoch 390/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0077 - accuracy: 1.0000
Epoch 391/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0072 - accuracy: 1.0000
Epoch 392/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0044 - accuracy: 1.0000
Epoch 393/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0101 - accuracy: 0.9993
Epoch 394/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0163 - accuracy: 1.0000
Epoch 395/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0099 - accuracy: 1.0000
Epoch 396/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0172 - accuracy: 1.0000
Epoch 397/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0043 - accuracy: 1.0000
Epoch 398/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0105 - accuracy: 0.9989
Epoch 399/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0069 - accuracy: 1.0000
Epoch 400/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0055 - accuracy: 1.0000
Epoch 401/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0098 - accuracy: 0.9962
Epoch 402/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.0461 - accuracy: 0.9685
Epoch 403/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0189 - accuracy: 0.9921
Epoch 404/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0120 - accuracy: 0.9921
Epoch 405/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.0053 - accuracy: 1.0000
Epoch 406/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0106 - accuracy: 0.9950
Epoch 407/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0057 - accuracy: 1.0000
Epoch 408/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0080 - accuracy: 0.9950
Epoch 409/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0068 - accuracy: 1.0000
Epoch 410/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0019 - accuracy: 1.0000
Epoch 411/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0292 - accuracy: 0.9889
Epoch 412/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0198 - accuracy: 1.0000
Epoch 413/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0086 - accuracy: 1.0000
Epoch 414/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0916 - accuracy: 0.9518
Epoch 415/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0056 - accuracy: 0.9976
Epoch 416/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0086 - accuracy: 1.0000
Epoch 417/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0113 - accuracy: 1.0000
Epoch 418/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0059 - accuracy: 1.0000
Epoch 419/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0025 - accuracy: 1.0000
Epoch 420/1000
23/23 [==============================] - ETA: 0s - loss: 0.0029 - accuracy: 1.00 - 0s 1m
s/step - loss: 0.0084 - accuracy: 1.0000
```

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Epoch 421/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0341 - accuracy: 1.0000
Epoch 422/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0023 - accuracy: 1.0000
Epoch 423/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0244 - accuracy: 1.0000
Epoch 424/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0261 - accuracy: 1.0000
Epoch 425/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0036 - accuracy: 1.0000
Epoch 426/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.0092 - accuracy: 1.0000
Epoch 427/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0072 - accuracy: 1.0000
Epoch 428/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0095 - accuracy: 1.0000
Epoch 429/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0075 - accuracy: 1.0000
Epoch 430/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0018 - accuracy: 1.0000
Epoch 431/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0202 - accuracy: 0.9921
Epoch 432/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0074 - accuracy: 1.0000
Epoch 433/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0165 - accuracy: 0.9921
Epoch 434/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0198 - accuracy: 0.9937
Epoch 435/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0141 - accuracy: 1.0000
Epoch 436/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0109 - accuracy: 1.0000
Epoch 437/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0132 - accuracy: 1.0000
Epoch 438/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0050 - accuracy: 1.0000
Epoch 439/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1589 - accuracy: 0.9662
Epoch 440/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0091 - accuracy: 1.0000
Epoch 441/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0027 - accuracy: 1.0000
Epoch 442/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0019 - accuracy: 1.0000
Epoch 443/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0117 - accuracy: 1.0000
Epoch 444/1000
23/23 [==============================] - ETA: 0s - loss: 0.0149 - accuracy: 1.00 - 0s 1m
s/step - loss: 0.0784 - accuracy: 0.9578
Epoch 445/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0072 - accuracy: 1.0000
Epoch 446/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0250 - accuracy: 0.9859
Epoch 447/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0037 - accuracy: 1.0000
Epoch 448/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0072 - accuracy: 1.0000
Epoch 449/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0014 - accuracy: 1.0000
Epoch 450/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0058 - accuracy: 1.0000
Epoch 451/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0065 - accuracy: 1.0000
Epoch 452/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0563 - accuracy: 0.9711
```

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Epoch 453/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0034 - accuracy: 1.0000
Epoch 454/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0108 - accuracy: 1.0000
Epoch 455/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0168 - accuracy: 0.9937
Epoch 456/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0116 - accuracy: 0.9956
Epoch 457/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0030 - accuracy: 1.0000
Epoch 458/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0093 - accuracy: 1.0000
Epoch 459/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0091 - accuracy: 1.0000
Epoch 460/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0066 - accuracy: 0.9981
Epoch 461/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0093 - accuracy: 1.0000
Epoch 462/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0020 - accuracy: 1.0000
Epoch 463/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0358 - accuracy: 0.9810
Epoch 464/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0265 - accuracy: 0.9901
Epoch 465/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0233 - accuracy: 0.9929
Epoch 466/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0157 - accuracy: 0.9950
Epoch 467/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0047 - accuracy: 1.0000
Epoch 468/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0128 - accuracy: 1.0000
Epoch 469/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0028 - accuracy: 1.0000
Epoch 470/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0040 - accuracy: 1.0000
Epoch 471/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0140 - accuracy: 0.9855
Epoch 472/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0025 - accuracy: 1.0000
Epoch 473/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.0035 - accuracy: 1.0000
Epoch 474/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0426 - accuracy: 0.9827
Epoch 475/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0067 - accuracy: 1.0000
Epoch 476/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0158 - accuracy: 1.0000
Epoch 477/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0334 - accuracy: 0.9859
Epoch 478/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0060 - accuracy: 1.0000
Epoch 479/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0137 - accuracy: 1.0000
Epoch 480/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0115 - accuracy: 1.0000
Epoch 481/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0052 - accuracy: 1.0000
Epoch 482/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0145 - accuracy: 0.9889
Epoch 483/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0056 - accuracy: 1.0000
Epoch 484/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0114 - accuracy: 1.0000
Epoch 485/1000
```

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23/23 [==============================] - 0s 1ms/step - loss: 0.0155 - accuracy: 1.0000
Epoch 486/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0065 - accuracy: 1.0000
Epoch 487/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0104 - accuracy: 0.9956
Epoch 488/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0153 - accuracy: 1.0000
Epoch 489/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0038 - accuracy: 1.0000
Epoch 490/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0045 - accuracy: 1.0000
Epoch 491/1000
23/23 [==============================] - ETA: 0s - loss: 0.0060 - accuracy: 1.00 - 0s 1m
s/step - loss: 0.0102 - accuracy: 1.0000
Epoch 492/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0061 - accuracy: 0.9976
Epoch 493/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0115 - accuracy: 0.9944
Epoch 494/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0162 - accuracy: 0.9937
Epoch 495/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0129 - accuracy: 0.9956
Epoch 496/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0065 - accuracy: 1.0000
Epoch 497/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0029 - accuracy: 1.0000
Epoch 498/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0131 - accuracy: 1.0000
Epoch 499/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0066 - accuracy: 1.0000
Epoch 500/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0097 - accuracy: 1.0000
Epoch 501/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0025 - accuracy: 1.0000
Epoch 502/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0153 - accuracy: 0.9929
Epoch 503/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0030 - accuracy: 1.0000
Epoch 504/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0086 - accuracy: 1.0000
Epoch 505/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0041 - accuracy: 1.0000
Epoch 506/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0036 - accuracy: 1.0000
Epoch 507/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0132 - accuracy: 0.9962
Epoch 508/1000
23/23 [==============================] - ETA: 0s - loss: 3.1594e-04 - accuracy: 1.00 - 0
s 1ms/step - loss: 0.0147 - accuracy: 0.9912
Epoch 509/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0140 - accuracy: 0.9929
Epoch 510/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0086 - accuracy: 1.0000
Epoch 511/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0056 - accuracy: 0.9977
Epoch 512/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0022 - accuracy: 1.0000
Epoch 513/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0092 - accuracy: 1.0000
Epoch 514/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0615 - accuracy: 0.9685
Epoch 515/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0036 - accuracy: 1.0000
Epoch 516/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0278 - accuracy: 0.9944
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Epoch 517/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.0067 - accuracy: 1.0000
Epoch 518/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0108 - accuracy: 1.0000
Epoch 519/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0028 - accuracy: 1.0000
Epoch 520/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0222 - accuracy: 0.9912
Epoch 521/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0125 - accuracy: 1.0000
Epoch 522/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0086 - accuracy: 1.0000
Epoch 523/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0025 - accuracy: 1.0000
Epoch 524/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0070 - accuracy: 1.0000
Epoch 525/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0134 - accuracy: 0.9967
Epoch 526/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0067 - accuracy: 1.0000
Epoch 527/1000
23/23 [==============================] - ETA: 0s - loss: 3.2781e-05 - accuracy: 1.00 - 0
s 1ms/step - loss: 0.0140 - accuracy: 1.0000
Epoch 528/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0489 - accuracy: 0.9875
Epoch 529/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0129 - accuracy: 1.0000
Epoch 530/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0273 - accuracy: 1.0000
Epoch 531/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0029 - accuracy: 1.0000
Epoch 532/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0025 - accuracy: 1.0000
Epoch 533/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0018 - accuracy: 1.0000
Epoch 534/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0145 - accuracy: 0.9950
Epoch 535/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0025 - accuracy: 1.0000
Epoch 536/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0248 - accuracy: 0.9837
Epoch 537/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1512 - accuracy: 0.9678
Epoch 538/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0111 - accuracy: 1.0000
Epoch 539/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0522 - accuracy: 0.9685
Epoch 540/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0732 - accuracy: 0.9560
Epoch 541/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0170 - accuracy: 0.9944
Epoch 542/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0418 - accuracy: 0.9873
Epoch 543/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0078 - accuracy: 1.0000
Epoch 544/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0338 - accuracy: 0.9803
Epoch 545/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0136 - accuracy: 1.0000
Epoch 546/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0042 - accuracy: 1.0000
Epoch 547/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0063 - accuracy: 1.0000
Epoch 548/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0111 - accuracy: 1.0000
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Epoch 549/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0046 - accuracy: 1.0000
Epoch 550/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0110 - accuracy: 1.0000
Epoch 551/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0131 - accuracy: 0.9956
Epoch 552/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.0085 - accuracy: 0.9989
Epoch 553/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0077 - accuracy: 0.9950
Epoch 554/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.0137 - accuracy: 0.9949
Epoch 555/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0206 - accuracy: 0.9901
Epoch 556/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0747 - accuracy: 0.9544
Epoch 557/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0235 - accuracy: 0.9875
Epoch 558/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0399 - accuracy: 0.9929
Epoch 559/1000
23/23 [==============================] - 0s 1ms/step - loss: 7.2201e-04 - accuracy: 1.00
00
Epoch 560/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0140 - accuracy: 1.0000
Epoch 561/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0169 - accuracy: 0.9912
Epoch 562/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0209 - accuracy: 1.0000
Epoch 563/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0151 - accuracy: 1.0000
Epoch 564/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0076 - accuracy: 0.9993
Epoch 565/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0032 - accuracy: 1.0000
Epoch 566/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0073 - accuracy: 0.9962
Epoch 567/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0188 - accuracy: 1.0000
Epoch 568/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0102 - accuracy: 0.9981
Epoch 569/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.0042 - accuracy: 1.0000
Epoch 570/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0052 - accuracy: 1.0000
Epoch 571/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0058 - accuracy: 1.0000
Epoch 572/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0123 - accuracy: 1.0000
Epoch 573/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.0224 - accuracy: 1.0000
Epoch 574/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0061 - accuracy: 1.0000
Epoch 575/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0233 - accuracy: 0.9853
Epoch 576/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0126 - accuracy: 0.9976
Epoch 577/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0129 - accuracy: 1.0000
Epoch 578/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0099 - accuracy: 0.9972
Epoch 579/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0053 - accuracy: 1.0000
Epoch 580/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0162 - accuracy: 1.0000
```

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Epoch 581/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0198 - accuracy: 1.0000
Epoch 582/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0423 - accuracy: 0.9795
Epoch 583/1000
23/23 [==============================] - 0s 1ms/step - loss: 4.7926e-04 - accuracy: 1.00
00
Epoch 584/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0137 - accuracy: 1.0000
Epoch 585/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0318 - accuracy: 0.9921
Epoch 586/1000
23/23 [==============================] - 0s 1ms/step - loss: 9.6430e-04 - accuracy: 1.00
00
Epoch 587/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0032 - accuracy: 1.0000
Epoch 588/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0162 - accuracy: 0.9953
Epoch 589/1000
23/23 [==============================] - ETA: 0s - loss: 0.0260 - accuracy: 1.00 - 0s 1m
s/step - loss: 0.0069 - accuracy: 1.0000
Epoch 590/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0018 - accuracy: 1.0000
Epoch 591/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0075 - accuracy: 1.0000
Epoch 592/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0089 - accuracy: 1.0000
Epoch 593/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0309 - accuracy: 0.9837
Epoch 594/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0043 - accuracy: 1.0000
Epoch 595/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0139 - accuracy: 0.9859
Epoch 596/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.0108 - accuracy: 0.9967
Epoch 597/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0054 - accuracy: 1.0000
Epoch 598/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0023 - accuracy: 1.0000
Epoch 599/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0772 - accuracy: 0.9544
Epoch 600/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0842 - accuracy: 0.9520
Epoch 601/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0032 - accuracy: 1.0000
Epoch 602/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0037 - accuracy: 1.0000
Epoch 603/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0066 - accuracy: 1.0000
Epoch 604/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0162 - accuracy: 1.0000
Epoch 605/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0033 - accuracy: 1.0000
Epoch 606/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0179 - accuracy: 0.9967
Epoch 607/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0066 - accuracy: 1.0000
Epoch 608/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0462 - accuracy: 0.9906
Epoch 609/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0358 - accuracy: 0.9777
Epoch 610/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0050 - accuracy: 1.0000
Epoch 611/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0016 - accuracy: 1.0000
```

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Epoch 612/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0056 - accuracy: 0.9976
Epoch 613/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0062 - accuracy: 1.0000
Epoch 614/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0066 - accuracy: 0.9981
Epoch 615/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0065 - accuracy: 1.0000
Epoch 616/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0072 - accuracy: 1.0000
Epoch 617/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0059 - accuracy: 0.9989
Epoch 618/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0238 - accuracy: 0.9985
Epoch 619/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0097 - accuracy: 0.9967
Epoch 620/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0054 - accuracy: 1.0000
Epoch 621/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0061 - accuracy: 1.0000
Epoch 622/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0055 - accuracy: 1.0000
Epoch 623/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0085 - accuracy: 1.0000
Epoch 624/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0053 - accuracy: 1.0000
Epoch 625/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0032 - accuracy: 1.0000
Epoch 626/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0388 - accuracy: 0.9644
Epoch 627/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0205 - accuracy: 1.0000
Epoch 628/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0065 - accuracy: 1.0000
Epoch 629/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0075 - accuracy: 0.9993
Epoch 630/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0016 - accuracy: 1.0000
Epoch 631/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0079 - accuracy: 1.0000
Epoch 632/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0074 - accuracy: 1.0000
Epoch 633/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0019 - accuracy: 1.0000
Epoch 634/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0300 - accuracy: 0.9839
Epoch 635/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0047 - accuracy: 1.0000
Epoch 636/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0048 - accuracy: 1.0000
Epoch 637/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0140 - accuracy: 1.0000
Epoch 638/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0027 - accuracy: 1.0000
Epoch 639/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0044 - accuracy: 1.0000
Epoch 640/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0014 - accuracy: 1.0000
Epoch 641/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.0108 - accuracy: 1.0000
Epoch 642/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0048 - accuracy: 1.0000
Epoch 643/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0031 - accuracy: 1.0000
Epoch 644/1000
```

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23/23 [==============================] - 0s 1ms/step - loss: 0.0073 - accuracy: 1.0000
Epoch 645/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0139 - accuracy: 1.0000
Epoch 646/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0068 - accuracy: 1.0000
Epoch 647/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0026 - accuracy: 1.0000
Epoch 648/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0051 - accuracy: 1.0000
Epoch 649/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0044 - accuracy: 1.0000
Epoch 650/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0448 - accuracy: 0.9859
Epoch 651/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0082 - accuracy: 1.0000
Epoch 652/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0118 - accuracy: 1.0000
Epoch 653/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0061 - accuracy: 0.9981
Epoch 654/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0051 - accuracy: 1.0000
Epoch 655/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0176 - accuracy: 0.9948
Epoch 656/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0025 - accuracy: 1.0000
Epoch 657/1000
23/23 [==============================] - ETA: 0s - loss: 0.0032 - accuracy: 1.00 - 0s 1m
s/step - loss: 0.0030 - accuracy: 1.0000
Epoch 658/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0061 - accuracy: 1.0000
Epoch 659/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0056 - accuracy: 1.0000
Epoch 660/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0283 - accuracy: 0.9875
Epoch 661/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0035 - accuracy: 1.0000
Epoch 662/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0212 - accuracy: 1.0000
Epoch 663/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0095 - accuracy: 1.0000
Epoch 664/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0079 - accuracy: 0.9993
Epoch 665/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0154 - accuracy: 1.0000
Epoch 666/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0109 - accuracy: 1.0000
Epoch 667/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0013 - accuracy: 1.0000
Epoch 668/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0095 - accuracy: 1.0000
Epoch 669/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0035 - accuracy: 1.0000
Epoch 670/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0312 - accuracy: 0.9944
Epoch 671/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0197 - accuracy: 1.0000
Epoch 672/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0030 - accuracy: 1.0000
Epoch 673/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0025 - accuracy: 1.0000
Epoch 674/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0011 - accuracy: 1.0000
Epoch 675/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0279 - accuracy: 1.0000
Epoch 676/1000
```

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23/23 [==============================] - 0s 1ms/step - loss: 0.0113 - accuracy: 0.9901
Epoch 677/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.2049 - accuracy: 0.9606
Epoch 678/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0013 - accuracy: 1.0000
Epoch 679/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0316 - accuracy: 1.0000
Epoch 680/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0095 - accuracy: 1.0000
Epoch 681/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0121 - accuracy: 0.9937
Epoch 682/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0065 - accuracy: 1.0000
Epoch 683/1000
23/23 [==============================] - 0s 1ms/step - loss: 8.1087e-04 - accuracy: 1.00
00
Epoch 684/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0027 - accuracy: 1.0000
Epoch 685/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0147 - accuracy: 0.9972
Epoch 686/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0179 - accuracy: 1.0000
Epoch 687/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0087 - accuracy: 0.9976
Epoch 688/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0014 - accuracy: 1.0000
Epoch 689/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0056 - accuracy: 1.0000
Epoch 690/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0127 - accuracy: 0.9929
Epoch 691/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0024 - accuracy: 1.0000
Epoch 692/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0034 - accuracy: 1.0000
Epoch 693/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0053 - accuracy: 0.9937
Epoch 694/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0068 - accuracy: 1.0000
Epoch 695/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0046 - accuracy: 1.0000
Epoch 696/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0058 - accuracy: 1.0000
Epoch 697/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0096 - accuracy: 0.9921
Epoch 698/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0030 - accuracy: 0.9972
Epoch 699/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0084 - accuracy: 1.0000
Epoch 700/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0023 - accuracy: 1.0000
Epoch 701/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0038 - accuracy: 1.0000
Epoch 702/1000
23/23 [==============================] - 0s 1ms/step - loss: 5.5661e-04 - accuracy: 1.00
00
Epoch 703/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.0058 - accuracy: 1.0000
Epoch 704/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0063 - accuracy: 1.0000
Epoch 705/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0129 - accuracy: 0.9886
Epoch 706/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0066 - accuracy: 1.0000
Epoch 707/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0069 - accuracy: 1.0000
```

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Epoch 708/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0051 - accuracy: 1.0000
Epoch 709/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0046 - accuracy: 1.0000
Epoch 710/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0178 - accuracy: 1.0000
Epoch 711/1000
23/23 [==============================] - ETA: 0s - loss: 4.2677e-06 - accuracy: 1.00 - 0
s 1ms/step - loss: 0.0057 - accuracy: 0.9967
Epoch 712/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0248 - accuracy: 1.0000
Epoch 713/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0102 - accuracy: 1.0000
Epoch 714/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0073 - accuracy: 1.0000
Epoch 715/1000
23/23 [==============================] - ETA: 0s - loss: 3.3585e-04 - accuracy: 1.00 - 0
s 1ms/step - loss: 0.0118 - accuracy: 0.9901
Epoch 716/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0502 - accuracy: 0.9901
Epoch 717/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0016 - accuracy: 1.0000
Epoch 718/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0102 - accuracy: 1.0000
Epoch 719/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0013 - accuracy: 1.0000
Epoch 720/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0102 - accuracy: 1.0000
Epoch 721/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0095 - accuracy: 1.0000
Epoch 722/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0036 - accuracy: 1.0000
Epoch 723/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0030 - accuracy: 1.0000
Epoch 724/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0121 - accuracy: 0.9972
Epoch 725/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0046 - accuracy: 0.9967
Epoch 726/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0075 - accuracy: 1.0000
Epoch 727/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0084 - accuracy: 0.9985
Epoch 728/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0141 - accuracy: 0.9889
Epoch 729/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0209 - accuracy: 0.9901
Epoch 730/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0477 - accuracy: 0.9831
Epoch 731/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0251 - accuracy: 0.9838
Epoch 732/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0102 - accuracy: 1.0000
Epoch 733/1000
23/23 [==============================] - 0s 1ms/step - loss: 2.1184e-04 - accuracy: 1.00
00
Epoch 734/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.0016 - accuracy: 1.0000
Epoch 735/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0140 - accuracy: 1.0000
Epoch 736/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0018 - accuracy: 1.0000
Epoch 737/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0064 - accuracy: 1.0000
Epoch 738/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0073 - accuracy: 1.0000
```

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Epoch 739/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0439 - accuracy: 0.9748
Epoch 740/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0583 - accuracy: 0.9838
Epoch 741/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0063 - accuracy: 1.0000
Epoch 742/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1123 - accuracy: 0.9629
Epoch 743/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0143 - accuracy: 0.9962
Epoch 744/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0035 - accuracy: 1.0000
Epoch 745/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0507 - accuracy: 0.9685
Epoch 746/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0391 - accuracy: 0.9882
Epoch 747/1000
23/23 [==============================] - 0s 1ms/step - loss: 5.2219e-04 - accuracy: 1.00
00
Epoch 748/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0012 - accuracy: 1.0000
Epoch 749/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0074 - accuracy: 0.9950
Epoch 750/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0156 - accuracy: 0.9950
Epoch 751/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0056 - accuracy: 1.0000
Epoch 752/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0766 - accuracy: 0.9620
Epoch 753/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0052 - accuracy: 1.0000
Epoch 754/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0073 - accuracy: 1.0000
Epoch 755/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0222 - accuracy: 0.9859
Epoch 756/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0156 - accuracy: 0.9929
Epoch 757/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0028 - accuracy: 1.0000
Epoch 758/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0059 - accuracy: 1.0000
Epoch 759/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0016 - accuracy: 1.0000
Epoch 760/1000
23/23 [==============================] - 0s 1ms/step - loss: 5.6722e-04 - accuracy: 1.00
00
Epoch 761/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0014 - accuracy: 1.0000
Epoch 762/1000
23/23 [==============================] - ETA: 0s - loss: 3.0301e-05 - accuracy: 1.00 - 0
s 2ms/step - loss: 0.0023 - accuracy: 1.0000
Epoch 763/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0013 - accuracy: 1.0000
Epoch 764/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0260 - accuracy: 0.9859
Epoch 765/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0429 - accuracy: 0.9574
Epoch 766/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0085 - accuracy: 1.0000
Epoch 767/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0017 - accuracy: 1.0000
Epoch 768/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0183 - accuracy: 1.0000
Epoch 769/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0150 - accuracy: 1.0000
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Epoch 770/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0107 - accuracy: 0.9981
Epoch 771/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0042 - accuracy: 1.0000
Epoch 772/1000
23/23 [==============================] - 0s 1ms/step - loss: 7.6125e-04 - accuracy: 1.00
00
Epoch 773/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0037 - accuracy: 1.0000
Epoch 774/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0549 - accuracy: 0.9768
Epoch 775/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0055 - accuracy: 1.0000
Epoch 776/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0063 - accuracy: 1.0000
Epoch 777/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0035 - accuracy: 1.0000
Epoch 778/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0268 - accuracy: 0.9838
Epoch 779/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0042 - accuracy: 1.0000
Epoch 780/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0063 - accuracy: 0.9929
Epoch 781/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0018 - accuracy: 1.0000
Epoch 782/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0194 - accuracy: 0.9981
Epoch 783/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0018 - accuracy: 1.0000
Epoch 784/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0042 - accuracy: 1.0000
Epoch 785/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0015 - accuracy: 1.0000
Epoch 786/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0037 - accuracy: 1.0000
Epoch 787/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0016 - accuracy: 1.0000
Epoch 788/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0038 - accuracy: 1.0000
Epoch 789/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0172 - accuracy: 0.9921
Epoch 790/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0021 - accuracy: 1.0000
Epoch 791/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0013 - accuracy: 1.0000
Epoch 792/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0589 - accuracy: 0.9727
Epoch 793/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0015 - accuracy: 1.0000
Epoch 794/1000
23/23 [==============================] - 0s 1ms/step - loss: 6.3207e-04 - accuracy: 1.00
00
Epoch 795/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0025 - accuracy: 1.0000
Epoch 796/1000
23/23 [==============================] - 0s 1ms/step - loss: 9.3415e-04 - accuracy: 1.00
00
Epoch 797/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0040 - accuracy: 1.0000
Epoch 798/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0018 - accuracy: 1.0000
Epoch 799/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0110 - accuracy: 1.0000
Epoch 800/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0079 - accuracy: 1.0000
```

```
Epoch 801/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0102 - accuracy: 1.0000
Epoch 802/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0022 - accuracy: 1.0000
Epoch 803/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0040 - accuracy: 1.0000
Epoch 804/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0083 - accuracy: 0.9962
Epoch 805/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0037 - accuracy: 1.0000
Epoch 806/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0137 - accuracy: 0.9875
Epoch 807/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0015 - accuracy: 1.0000
Epoch 808/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0042 - accuracy: 1.0000
Epoch 809/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0024 - accuracy: 1.0000
Epoch 810/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0012 - accuracy: 1.0000
Epoch 811/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0255 - accuracy: 0.9889
Epoch 812/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0203 - accuracy: 0.9810
Epoch 813/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0137 - accuracy: 1.0000
Epoch 814/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0026 - accuracy: 1.0000
Epoch 815/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0047 - accuracy: 1.0000
Epoch 816/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0048 - accuracy: 1.0000
Epoch 817/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0136 - accuracy: 1.0000
Epoch 818/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0191 - accuracy: 0.9944
Epoch 819/1000
23/23 [==============================] - 0s 1ms/step - loss: 7.2715e-04 - accuracy: 1.00
00
Epoch 820/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0026 - accuracy: 1.0000
Epoch 821/1000
23/23 [==============================] - 0s 1ms/step - loss: 4.8190e-04 - accuracy: 1.00
00
Epoch 822/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0040 - accuracy: 1.0000
Epoch 823/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.0044 - accuracy: 1.0000
Epoch 824/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0023 - accuracy: 1.0000
Epoch 825/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0103 - accuracy: 0.9944
Epoch 826/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0074 - accuracy: 1.0000
Epoch 827/1000
23/23 [==============================] - 0s 1ms/step - loss: 8.1335e-04 - accuracy: 1.00
00
Epoch 828/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.0116 - accuracy: 1.0000
Epoch 829/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0180 - accuracy: 0.9929
Epoch 830/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0300 - accuracy: 0.9838
Epoch 831/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0084 - accuracy: 1.0000
```

```
Epoch 832/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0070 - accuracy: 1.0000
Epoch 833/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0087 - accuracy: 1.0000
Epoch 834/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0024 - accuracy: 1.0000
Epoch 835/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0016 - accuracy: 1.0000
Epoch 836/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0255 - accuracy: 0.9929
Epoch 837/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0021 - accuracy: 1.0000
Epoch 838/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0011 - accuracy: 1.0000
Epoch 839/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0024 - accuracy: 1.0000
Epoch 840/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0106 - accuracy: 1.0000
Epoch 841/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0044 - accuracy: 1.0000
Epoch 842/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0019 - accuracy: 1.0000
Epoch 843/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0018 - accuracy: 1.0000
Epoch 844/1000
23/23 [==============================] - 0s 1ms/step - loss: 4.9464e-04 - accuracy: 1.00
00
Epoch 845/1000
23/23 [==============================] - 0s 1ms/step - loss: 8.5367e-04 - accuracy: 1.00
00
Epoch 846/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0060 - accuracy: 0.9981
Epoch 847/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0027 - accuracy: 1.0000
Epoch 848/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1004 - accuracy: 0.9838
Epoch 849/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0072 - accuracy: 1.0000
Epoch 850/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0185 - accuracy: 0.9905
Epoch 851/1000
23/23 [==============================] - 0s 908us/step - loss: 0.0053 - accuracy: 1.0000
Epoch 852/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0016 - accuracy: 1.0000
Epoch 853/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0026 - accuracy: 1.0000
Epoch 854/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0267 - accuracy: 0.9810
Epoch 855/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0052 - accuracy: 1.0000
Epoch 856/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0094 - accuracy: 0.9912
Epoch 857/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0077 - accuracy: 0.9956
Epoch 858/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0097 - accuracy: 0.9901
Epoch 859/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.1237 - accuracy: 0.9652
Epoch 860/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0076 - accuracy: 1.0000
Epoch 861/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0013 - accuracy: 1.0000
Epoch 862/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0764 - accuracy: 0.9669
Epoch 863/1000
```

```
23/23 [==============================] - 0s 1ms/step - loss: 0.0077 - accuracy: 1.0000
Epoch 864/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0045 - accuracy: 0.9967
Epoch 865/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0049 - accuracy: 1.0000
Epoch 866/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0050 - accuracy: 0.9985
Epoch 867/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0543 - accuracy: 0.9768
Epoch 868/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0056 - accuracy: 1.0000
Epoch 869/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0067 - accuracy: 0.9962
Epoch 870/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0074 - accuracy: 1.0000
Epoch 871/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0022 - accuracy: 1.0000
Epoch 872/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0060 - accuracy: 1.0000
Epoch 873/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0089 - accuracy: 0.9981
Epoch 874/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0076 - accuracy: 1.0000
Epoch 875/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0384 - accuracy: 0.9739
Epoch 876/1000
23/23 [==============================] - ETA: 0s - loss: 0.0027 - accuracy: 1.00 - 0s 1m
s/step - loss: 0.0486 - accuracy: 0.9879
Epoch 877/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0079 - accuracy: 1.0000
Epoch 878/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0041 - accuracy: 1.0000
Epoch 879/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0022 - accuracy: 1.0000
Epoch 880/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0065 - accuracy: 1.0000
Epoch 881/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0037 - accuracy: 1.0000
Epoch 882/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0077 - accuracy: 0.9921
Epoch 883/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0032 - accuracy: 0.9985
Epoch 884/1000
23/23 [==============================] - 0s 1ms/step - loss: 8.4781e-04 - accuracy: 1.00
00
Epoch 885/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0105 - accuracy: 0.9937
Epoch 886/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0080 - accuracy: 1.0000
Epoch 887/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0086 - accuracy: 0.9921
Epoch 888/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0078 - accuracy: 0.9993
Epoch 889/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0033 - accuracy: 0.9989
Epoch 890/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0034 - accuracy: 1.0000
Epoch 891/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0083 - accuracy: 1.0000
Epoch 892/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0059 - accuracy: 1.0000
Epoch 893/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0053 - accuracy: 1.0000
Epoch 894/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0123 - accuracy: 0.9950
```

```
Epoch 895/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0078 - accuracy: 0.9929
Epoch 896/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0061 - accuracy: 1.0000
Epoch 897/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0010 - accuracy: 1.0000
Epoch 898/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0094 - accuracy: 1.0000
Epoch 899/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0014 - accuracy: 1.0000
Epoch 900/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0030 - accuracy: 1.0000
Epoch 901/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0047 - accuracy: 1.0000
Epoch 902/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0198 - accuracy: 0.9944
Epoch 903/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0053 - accuracy: 1.0000
Epoch 904/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0163 - accuracy: 0.9962
Epoch 905/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0521 - accuracy: 0.9889
Epoch 906/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0077 - accuracy: 0.9981
Epoch 907/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0051 - accuracy: 1.0000
Epoch 908/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0015 - accuracy: 1.0000
Epoch 909/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0031 - accuracy: 1.0000
Epoch 910/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0035 - accuracy: 1.0000
Epoch 911/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0038 - accuracy: 1.0000
Epoch 912/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0100 - accuracy: 1.0000
Epoch 913/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0066 - accuracy: 1.0000
Epoch 914/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0027 - accuracy: 1.0000
Epoch 915/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0011 - accuracy: 1.0000
Epoch 916/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0093 - accuracy: 1.0000
Epoch 917/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0017 - accuracy: 1.0000
Epoch 918/1000
23/23 [==============================] - ETA: 0s - loss: 1.0520 - accuracy: 0.80 - 0s 1m
s/step - loss: 0.1769 - accuracy: 0.9685
Epoch 919/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0050 - accuracy: 1.0000
Epoch 920/1000
23/23 [==============================] - ETA: 0s - loss: 3.7412e-04 - accuracy: 1.00 - 0
s 1ms/step - loss: 0.0128 - accuracy: 0.9875
Epoch 921/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0258 - accuracy: 1.0000
Epoch 922/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0094 - accuracy: 0.9937
Epoch 923/1000
23/23 [==============================] - 0s 1ms/step - loss: 5.4445e-04 - accuracy: 1.00
00
Epoch 924/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0014 - accuracy: 1.0000
Epoch 925/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0018 - accuracy: 1.0000
```

```
Epoch 926/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0963 - accuracy: 0.9768
Epoch 927/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0171 - accuracy: 1.0000
Epoch 928/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0327 - accuracy: 0.9760
Epoch 929/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0285 - accuracy: 0.9812
Epoch 930/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0072 - accuracy: 0.9967
Epoch 931/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0075 - accuracy: 1.0000
Epoch 932/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0050 - accuracy: 1.0000
Epoch 933/1000
23/23 [==============================] - 0s 1ms/step - loss: 8.0367e-04 - accuracy: 1.00
00
Epoch 934/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0039 - accuracy: 1.0000
Epoch 935/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0060 - accuracy: 1.0000
Epoch 936/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0014 - accuracy: 1.0000
Epoch 937/1000
23/23 [==============================] - 0s 1ms/step - loss: 4.6933e-04 - accuracy: 1.00
00
Epoch 938/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0045 - accuracy: 1.0000
Epoch 939/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0048 - accuracy: 1.0000
Epoch 940/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0189 - accuracy: 1.0000
Epoch 941/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0680 - accuracy: 0.9635
Epoch 942/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0717 - accuracy: 0.9760
Epoch 943/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0086 - accuracy: 1.0000
Epoch 944/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0081 - accuracy: 1.0000
Epoch 945/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0037 - accuracy: 1.0000
Epoch 946/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0189 - accuracy: 1.0000
Epoch 947/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0067 - accuracy: 1.0000
Epoch 948/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0179 - accuracy: 1.0000
Epoch 949/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0247 - accuracy: 0.9889
Epoch 950/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0150 - accuracy: 0.9944
Epoch 951/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0018 - accuracy: 1.0000
Epoch 952/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0173 - accuracy: 1.0000
Epoch 953/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0194 - accuracy: 1.0000
Epoch 954/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0020 - accuracy: 1.0000
Epoch 955/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0170 - accuracy: 0.9937
Epoch 956/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0026 - accuracy: 0.9989
Epoch 957/1000
```

```
23/23 [==============================] - 0s 1ms/step - loss: 0.0041 - accuracy: 1.0000
Epoch 958/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0137 - accuracy: 0.9875
Epoch 959/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0061 - accuracy: 1.0000
Epoch 960/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0045 - accuracy: 1.0000
Epoch 961/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.0081 - accuracy: 1.0000
Epoch 962/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0037 - accuracy: 1.0000
Epoch 963/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0027 - accuracy: 1.0000
Epoch 964/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0068 - accuracy: 1.0000
Epoch 965/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0010 - accuracy: 1.0000
Epoch 966/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0041 - accuracy: 1.0000
Epoch 967/1000
23/23 [==============================] - 0s 1ms/step - loss: 2.9202e-04 - accuracy: 1.00
00
Epoch 968/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.0065 - accuracy: 1.0000
Epoch 969/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0047 - accuracy: 1.0000
Epoch 970/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0185 - accuracy: 1.0000
Epoch 971/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0090 - accuracy: 1.0000
Epoch 972/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0153 - accuracy: 1.0000
Epoch 973/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0017 - accuracy: 1.0000
Epoch 974/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0120 - accuracy: 1.0000
Epoch 975/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0664 - accuracy: 0.9768
Epoch 976/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0036 - accuracy: 1.0000
Epoch 977/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0129 - accuracy: 1.0000
Epoch 978/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0073 - accuracy: 1.0000
Epoch 979/1000
23/23 [==============================] - 0s 1ms/step - loss: 4.8890e-04 - accuracy: 1.00
00
Epoch 980/1000
23/23 [==============================] - 0s 1ms/step - loss: 3.2231e-04 - accuracy: 1.00
00
Epoch 981/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.0086 - accuracy: 0.9929
Epoch 982/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0026 - accuracy: 1.0000
Epoch 983/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0083 - accuracy: 0.9956
Epoch 984/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0117 - accuracy: 0.9937
Epoch 985/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0112 - accuracy: 1.0000
Epoch 986/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0055 - accuracy: 0.9993
Epoch 987/1000
23/23 [==============================] - 0s 2ms/step - loss: 0.0012 - accuracy: 1.0000
Epoch 988/1000
```

```
23/23 [==============================] - 0s 1ms/step - loss: 0.0018 - accuracy: 1.0000
Epoch 989/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0020 - accuracy: 1.0000
Epoch 990/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0037 - accuracy: 1.0000
Epoch 991/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0197 - accuracy: 0.9837
Epoch 992/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0065 - accuracy: 1.0000
Epoch 993/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0020 - accuracy: 1.0000
Epoch 994/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0080 - accuracy: 1.0000
Epoch 995/1000
23/23 [==============================] - ETA: 0s - loss: 9.7037e-05 - accuracy: 1.00 - 0
s 1ms/step - loss: 6.8770e-04 - accuracy: 1.0000
Epoch 996/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0017 - accuracy: 1.0000
Epoch 997/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0044 - accuracy: 1.0000
Epoch 998/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0183 - accuracy: 0.9810
Epoch 999/1000
23/23 [==============================] - 0s 1ms/step - loss: 9.2207e-04 - accuracy: 1.00
00
Epoch 1000/1000
23/23 [==============================] - 0s 1ms/step - loss: 0.0063 - accuracy: 1.0000
model created
```

saving the same model for chat bot GUI

In [17]:
```
import nltk
from nltk.stem import WordNetLemmatizer
lemmatizer = WordNetLemmatizer()
import pickle
import numpy as np

from keras.models import load_model
model = load_model('chatbot_model.h5')
import json
import random
intents = json.loads(open('chatbot_data.json').read())
words = pickle.load(open('words.pkl','rb'))
classes = pickle.load(open('classes.pkl','rb'))
```

In [18]:
```
from nltk.stem import PorterStemmer
from nltk.tokenize import word_tokenize

ps = PorterStemmer()
#for w in words:
 #   print(w, " : ", ps.stem(w))
```

In [19]:
```
def clean_up_sentence(sentence):
    # tokenize the pattern - split words into array
    sentence_words = nltk.word_tokenize(sentence)
    #sentence_words = [ps.stem(word.lower()) for word in sentence_words]
    # stem each word - create short form for word
    sentence_words = [lemmatizer.lemmatize(word.lower()) for word in sentence_words]
    return sentence_words
# return bag of words array: 0 or 1 for each word in the bag that exists in the sentenc

def bow(sentence, words, show_details=True):
```

```
    # tokenize the pattern
    sentence_words = clean_up_sentence(sentence)
    # bag of words - matrix of N words, vocabulary matrix
    bag = [0]*len(words)
    for s in sentence_words:
        for i,w in enumerate(words):
            if w == s:
                # assign 1 if current word is in the vocabulary position
                bag[i] = 1
                if show_details:
                    print ("found in bag: %s" % w)
    return(np.array(bag))

def predict_class(sentence, model):
    # filter out predictions below a threshold
    p = bow(sentence, words,show_details=False)
    res = model.predict(np.array([p]))[0]
    ERROR_THRESHOLD = 0.70
    results = [[i,r] for i,r in enumerate(res) if r>ERROR_THRESHOLD]
    # sort by strength of probability
    results.sort(key=lambda x: x[1], reverse=True)
    return_list = []
    for r in results:
        return_list.append({"intent": classes[r[0]], "probability": str(r[1])})
    return return_list
```

In [20]:
```
print(np.array(bag))
```

```
[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 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 0 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]
```

In [21]:
```
def getResponse(ints, intents_json):
    tag = ints[0]['intent']
    list_of_intents = intents_json['intents']
    for i in list_of_intents:
        if(i['tag']== tag):
            result = random.choice(i['responses'])
            break
    return result

def chatbot_response(text):
    ints = predict_class(text, model)
    res = getResponse(ints, intents)
    return res
```

def getResponse(intents_list, intents_json): tag = intents_list[0]['intent'] list_of_intents = intents_json['intents'] for i in list_of_intents: if(i['tag']== tag): result = random.choice(i['responses']) break return result

while True: message = input("") ints=predict_class(message) res = getResponse(ints, intents) print (res)

In [22]:
```
import tkinter
```

In [23]:
```
from tkinter import *
```

In [24]:
```
def send():
    msg = EntryBox.get("1.0",'end-1c').strip()
    EntryBox.delete("0.0",END)
    if msg != '':
        ChatLog.config(state=NORMAL)
        ChatLog.insert(END, "You: " + msg + '\n\n')
        ChatLog.config(foreground="white", font=("Verdana", 15, 'bold' ))
        res = chatbot_response(msg)
        ChatLog.insert(END, "Bot: " + res + '\n\n')
        ChatLog.config(state=DISABLED)
        ChatLog.yview(END)
```

In [25]:
```
base = Tk()
base.title("Chatbot")
base.geometry("400x500")
base.resizable(width=TRUE, height=TRUE)
```

Out[25]:
```
''
```

In [26]:
```
#Create Chat window
ChatLog = Text(base, bd=0, bg="black", height="10", width="100", font="Verdana",)
ChatLog.config(state=DISABLED)
```

In [27]:
```
#Bind scrollbar to Chat window
scrollbar = Scrollbar(base, command=ChatLog.yview, cursor="mouse")
ChatLog['yscrollcommand'] = scrollbar.set
```

In [28]:
```
#Create Button to send message
SendButton = Button(base, font=("Verdana",12,'bold'), text="Send", width="12", height=5
                    bd=0, bg="#096484", activebackground="black",fg='white',
                    command= send )
```

In [29]:
```
#Create the box to enter message
EntryBox = Text(base, bd=0, bg="white",width="29", height="5", font="Verdana")
EntryBox.bind("<Return>", send)
```

Out[29]:
```
'1869754265536send'
```

In [30]:
```
#Place all components on the screen
scrollbar.place(x=376,y=6, height=386)
ChatLog.place(x=6,y=6, height=386, width=370)
EntryBox.place(x=128, y=401, height=90, width=265)
SendButton.place(x=6, y=401, height=90)
```

In [ ]:
```
base.mainloop()
```

In [ ]:

In [ ]:

In [ ]: