Movies Review sentiment analysis

import required libraries

```
import nltk
import csv
from nltk.corpus import stopwords
from nltk.stem import WordNetLemmatizer
from wordcloud import WordCloud
import matplotlib.pyplot as plt
from nltk.tokenize import word_tokenize
import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.metrics import classification_report
from sklearn.preprocessing import LabelEncoder
nltk.download("punkt")
nltk.download('wordnet')
import warnings
warnings.filterwarnings("ignore")

#stopword
nltk.download('stopwords')

# NN
import tensorflow
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Dropout,Embedding, Flatten,SimpleRNN,LSTM,GRU,Bidirectional

# preprocessing
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing import sequence
```

```
[nltk_data] Downloading package punkt to /root/nltk_data...
[nltk_data]   Unzipping tokenizers/punkt.zip.
[nltk_data] Downloading package wordnet to /root/nltk_data...
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Unzipping corpora/stopwords.zip.
```

```
from google.colab import files
from google.colab import drive


drive.mount("/content/drive")
```

```
Mounted at /content/drive
```

```
# call csv file and convert it to dataframe using Pandas function

df=pd.read_csv('/content/drive/MyDrive/IMDB Dataset.csv')

# .head() will give the first 5 rows of the dataset by default

df.head()
```

	review	sentiment
0	One of the other reviewers has mentioned that ...	positive
1	A wonderful little production. The...	positive
2	I thought this was a wonderful way to spend ti...	positive
3	Basically there's a family where a little boy ...	negative
4	Petter Mattei's "Love in the Time of Money" is...	positive

```
df =df.iloc[:10000]


df['review'][1]
```

```
'A wonderful little production. <br /><br />The filming technique is very unassuming- very old-time-BB
C fashion and gives a comforting, and sometimes discomforting, sense of realism to the entire piece. <
br /><br />The actors are extremely well chosen- Michael Sheen not only "has got all the polari" but h
e has all the voices down pat too! You can truly see the seamless editing guided by the references to
Williams\' diary entries, not only is it well worth the watching but it is a terrificly written and pe
rformed piece. A masterful production about one of the great master\'s of comedy and his life. <br /><
br />The realism really comes home with the little things: the fantasy of the guard which, rather than
```

```
# .info() will give basic info about the dataset

df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 10000 entries, 0 to 9999
Data columns (total 2 columns):
 #   Column     Non-Null Count  Dtype 
---  ------     --------------  ----- 
 0   review     10000 non-null  object
 1   sentiment  10000 non-null  object
dtypes: object(2)
memory usage: 156.4+ KB
```

```
# The describe() method returns description of the data in the DataFrame.

df.describe()
```

	review	sentiment
count	10000	10000
unique	9983	2
top	Beautiful film, pure Cassavetes style. Gena Ro...	positive
freq	2	5028

```
# value_counts() returns object containing counts of unique values

df['sentiment'].value_counts()
```

```
positive    5028
negative    4972
Name: sentiment, dtype: int64
```

```
# isnull().sum() gives the count of null values present in each column

df.isnull().sum()
```

```
review       0
sentiment    0
dtype: int64
```

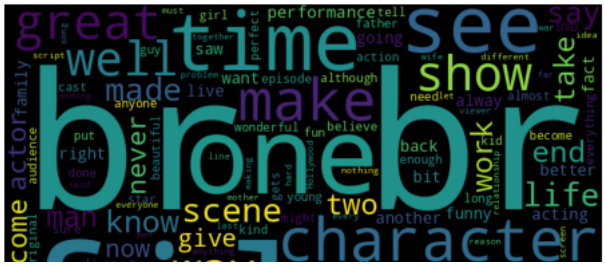
```
# Determines which duplicates (if any) to mark.

df.duplicated().sum()
```

```
17
```

```
pos=' '.join(df[df["sentiment"]=="positive"]["review"])
pos
```

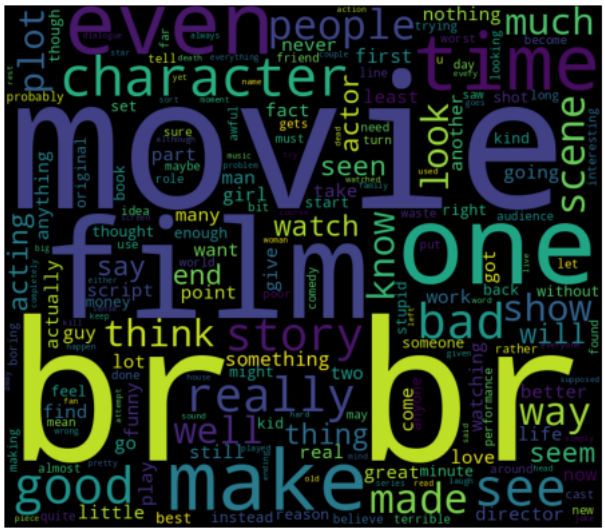
```
'One of the other reviewers has mentioned that after watching just 1 Oz episode you\'ll be hooked. The
y are right, as this is exactly what happened with me.<br /><br />The first thing that struck me about
Oz was its brutality and unflinching scenes of violence, which set in right from the word GO. Trust m
e, this is not a show for the faint hearted or timid. This show pulls no punches with regards to drug
s, sex or violence. Its is hardcore, in the classic use of the word.<br /><br />It is called OZ as tha
t is the nickname given to the Oswald Maximum Security State Penitentary. It focuses mainly on Emerald
City, an experimental section of the prison where all the cells have glass fronts and face inwards, so
```

```
# WordCloud is use to visualise textual data.

wc=WordCloud(width=800,height=700,min_font_size=10)
wc.generate(pos)
plt.figure(figsize=(8,8))
plt.imshow(wc)
plt.axis("off")
plt.show()
```



```
neg=' '.join(df[df["sentiment"]=="negative"]["review"])
neg
```

```
#WordCloud

wc=WordCloud(width=800,height=700,min_font_size=10)
wc.generate(neg)
plt.figure(figsize=(8,8))
plt.imshow(wc)
plt.axis("off")
plt.show()
```



```
# Feature and target selection

x = df["review"]
y = df ["sentiment"]


# Label Encoding refers to converting the labels into a numeric form so as to convert them into the machine-readable form.

le= LabelEncoder()
y=le.fit_transform(y)
y
```

```
array([1, 1, 1, ..., 0, 0, 1])
```

```
# train and test split

xtrain,xtest,ytrain,ytest=train_test_split(x,y,test_size=0.3,random_state=1)


# tokenization (to split paragraphs and sentences into smaller units)

tok=Tokenizer()
tok.fit_on_texts(xtrain)
```

```
# vocubulary (The set of unique words used in the text corpus)

tok.word_index
voc=tok.word_index


print(voc)
```

```
{'the': 1, 'a': 2, 'and': 3, 'of': 4, 'to': 5, 'is': 6, 'br': 7, 'in': 8, 'it': 9, 'i': 10, 'this': 11, 'that': 12, 'was': 13, 'as'
```

```
xtrain.shape
```

```
(7000,)
```

```
xtest.shape
```

```
(3000,)
```

```
ytrain.shape
```

```
(7000,)
```

```
voclen=len(voc)


# Sequence (Sequence models are the machine learning models that input or output sequences of data)

trainseq=tok.texts_to_sequences(xtrain)


print(trainseq)
```

```
IOPub data rate exceeded.
The notebook server will temporarily stop sending output
to the client in order to avoid crashing it.
To change this limit, set the config variable
`--NotebookApp.iopub_data_rate_limit`.

Current values:
NotebookApp.iopub_data_rate_limit=1000000.0 (bytes/sec)
NotebookApp.rate_limit_window=3.0 (secs)
```

```
 len(trainseq)
```

```
7000
```

```
# doc length

doclen=[]
for i in trainseq:
    doclen.append(len(i))

print(doclen)
```

```
[658, 858, 178, 261, 146, 215, 349, 140, 116, 626, 84, 103, 788, 536, 147, 146, 191, 635, 108, 492, 112, 80, 119, 149, 142, 197, 82
```

```
max(doclen)
```

```
1850
```

```
# Quantile (calculates the quantile of the values in a given axis)

np.quantile(doclen,1)
```

```
1850
```

```
np.quantile(doclen,0.99)
```

```
893.0100000000002
```

```
max_length=np.quantile(doclen,1)
```

```
# Padding (add the zeros at the end of the sequence to make the samples in the same size)

trainmatrix = sequence.pad_sequences(trainseq,maxlen = max_length)
trainmatrix
```

```
array([[   0,    0,    0, ...,    7,  701,  151],
       [   0,    0,    0, ...,   41,   11,  119],
       [   0,    0,    0, ...,   39,  104,    9],
       ...,
       [   0,    0,    0, ...,    3,  269, 6845],
       [   0,    0,    0, ..., 3647,  464,  151],
       [   0,    0,    0, ...,   67,  223, 7112]], dtype=int32)
```

```
# testing data must be of same length as training data.
# we dont tokenize testing data, we use already tokenized words.
# convert test data into sequence

testseq = tok.texts_to_sequences(xtest)


# padding on test data

testmatrix = sequence.pad_sequences(testseq,maxlen = max_length)
testmatrix
```

```
array([[    0,     0,     0, ...,  1059,   313,   233],
       [    0,     0,     0, ...,    80,  2114,   173],
       [    0,     0,     0, ...,  1405,   643,    21],
       ...,
       [    0,     0,     0, ...,   256,     9,  1631],
       [    0,     0,     0, ...,  6723,     3, 20869],
       [    0,     0,     0, ...,   188,  8399,  4999]], dtype=int32)
```

```
testmatrix.shape
```

```
(3000, 1850)
```

```
trainmatrix.shape
```

```
(7000, 1850)
```

```
# creating neural network (Flatten)

model8= Sequential()
model8.add(Embedding(input_dim=voclen+1,
output_dim=100,
input_length=max_length,
mask_zero=True))
model8.add(Flatten())
model8.add(Dense(16,activation="relu"))
model8.add(Dense(8,activation="relu"))
model8.add(Dense(1,activation="sigmoid"))


# input of dimension, of all the tokens i.e. 7382.
# dont use 0 for the training purpose, hence we need to use mask_zero.
# this is a binary class classification.


model8.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 embedding (Embedding)       (None, 1850, 100)         5085800

 flatten (Flatten)           (None, 185000)            0

 dense (Dense)               (None, 16)                2960016

 dense_1 (Dense)             (None, 8)                 136

 dense_2 (Dense)             (None, 1)                 9

=================================================================
Total params: 8,045,961
Trainable params: 8,045,961
Non-trainable params: 0
_________________________________________________________________
```

```
model8.compile(optimizer = "adam", loss = "binary_crossentropy",metrics ="accuracy")
model8.fit(trainmatrix,ytrain,epochs=10,batch_size=32)
```

```
Epoch 1/10
219/219 [==============================] - 37s 161ms/step - loss: 0.6697 - accuracy: 0.5853
Epoch 2/10
219/219 [==============================] - 35s 161ms/step - loss: 0.2535 - accuracy: 0.9070
Epoch 3/10
219/219 [==============================] - 34s 155ms/step - loss: 0.0383 - accuracy: 0.9939
Epoch 4/10
219/219 [==============================] - 35s 159ms/step - loss: 0.0079 - accuracy: 0.9996
Epoch 5/10
219/219 [==============================] - 35s 159ms/step - loss: 0.0026 - accuracy: 1.0000
Epoch 6/10
219/219 [==============================] - 34s 156ms/step - loss: 0.0014 - accuracy: 1.0000
Epoch 7/10
219/219 [==============================] - 37s 170ms/step - loss: 8.6976e-04 - accuracy: 1.0000
Epoch 8/10
219/219 [==============================] - 34s 157ms/step - loss: 5.9956e-04 - accuracy: 1.0000
Epoch 9/10
219/219 [==============================] - 34s 157ms/step - loss: 4.3425e-04 - accuracy: 1.0000
Epoch 10/10
219/219 [==============================] - 34s 155ms/step - loss: 3.2258e-04 - accuracy: 1.0000
<keras.callbacks.History at 0x7f39c22a7a90>
```

```
# prediction

ypred = model8.predict(testmatrix)
ypred
```

```
94/94 [==============================] - 1s 12ms/step
array([[2.5846265e-04],
       [3.5036051e-01],
       [9.9933654e-01],
       ...,
       [9.9506128e-01],
       [9.9934006e-01],
       [9.9089104e-01]], dtype=float32)
```

```
# logistic regression always gives us probability.

ypred = np.where(ypred>=0.5,1,0)
ypred
```

```
array([[0],
       [0],
       [1],
       ...,
       [1],
       [1],
       [1]])
```

```
print(classification_report(ytest,ypred))
```

```
                  precision    recall  f1-score   support

               0       0.88      0.88      0.88      1478
               1       0.88      0.88      0.88      1522

        accuracy                           0.88      3000
       macro avg       0.88      0.88      0.88      3000
    weighted avg       0.88      0.88      0.88      3000
```

```
# Creating NEURAL Network (Simple RNN)

model=Sequential()
model.add(Embedding(input_dim=voclen+1,  #input will be all the tokens + 1 for the (0)
          output_dim=100,
          input_length=max_length,
          mask_zero=True))     #mask zero will skip all the zeros
model.add(SimpleRNN(32))
model.add(Dense(16,activation="relu"))
model.add(Dense(8,activation="relu"))
model.add(Dense(1,activation="sigmoid"))
```

```
model.summary()
```

```
Model: "sequential_1"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 embedding_1 (Embedding)     (None, 1850, 100)         5085800
```

```
 simple_rnn (SimpleRNN)      (None, 32)                4256

 dense_3 (Dense)             (None, 16)                528

 dense_4 (Dense)             (None, 8)                 136

 dense_5 (Dense)             (None, 1)                 9

=================================================================
Total params: 5,090,729
Trainable params: 5,090,729
Non-trainable params: 0
_________________________________________________________________
```

```
model.compile(optimizer="adam",loss="binary_crossentropy",metrics="accuracy")
model.fit(trainmatrix,ytrain,epochs=10,batch_size=32)
```

```
Epoch 1/10
219/219 [==============================] - 601s 3s/step - loss: 0.6827 - accuracy: 0.5509
Epoch 2/10
219/219 [==============================] - 590s 3s/step - loss: 0.3887 - accuracy: 0.8394
Epoch 3/10
219/219 [==============================] - 596s 3s/step - loss: 0.0600 - accuracy: 0.9814
Epoch 4/10
219/219 [==============================] - 587s 3s/step - loss: 0.0088 - accuracy: 0.9984
Epoch 5/10
219/219 [==============================] - 582s 3s/step - loss: 8.5346e-04 - accuracy: 1.0000
Epoch 6/10
219/219 [==============================] - 582s 3s/step - loss: 3.5000e-04 - accuracy: 1.0000
Epoch 7/10
219/219 [==============================] - 580s 3s/step - loss: 2.1246e-04 - accuracy: 1.0000
Epoch 8/10
219/219 [==============================] - 579s 3s/step - loss: 1.4446e-04 - accuracy: 1.0000
Epoch 9/10
219/219 [==============================] - 585s 3s/step - loss: 1.0424e-04 - accuracy: 1.0000
Epoch 10/10
219/219 [==============================] - 580s 3s/step - loss: 7.8167e-05 - accuracy: 1.0000
<keras.callbacks.History at 0x7faae7af0310>
```

```
# Prediction

ypred=model.predict(testmatrix)
ypred
```

```
94/94 [==============================] - 17s 175ms/step
array([[3.1784314e-04],
       [9.8784465e-01],
       [9.9942291e-01],
       ...,
       [9.9983263e-01],
       [9.9979383e-01],
       [9.9989367e-01]], dtype=float32)
```

```
ypred=np.where(ypred>=0.5,1,0)
ypred
```

```
array([[0],
       [1],
       [1],
       ...,
       [1],
       [1],
       [1]])
```

```
print(classification_report(ytest,ypred))
```

```
                  precision    recall  f1-score   support

               0       0.74      0.72      0.73      1478
               1       0.74      0.76      0.75      1522

        accuracy                           0.74      3000
       macro avg       0.74      0.74      0.74      3000
    weighted avg       0.74      0.74      0.74      3000
```

```
# Creating NEURAL Network  (Bidirectional RNN)

model1=Sequential()
model1.add(Embedding(input_dim=voclen+1,  #input will be all the tokens + 1 for the (0)
          output_dim=100,
          input_length=max_length,
          mask_zero=True))     #mask zero will skip all the zeros
```

```
model1.add(Bidirectional(SimpleRNN(32)))
model1.add(Dense(16,activation="relu"))
model1.add(Dense(8,activation="relu"))
model1.add(Dense(1,activation="sigmoid"))


model1.compile(optimizer="adam",loss="binary_crossentropy",metrics="accuracy")
model1.fit(trainmatrix,ytrain,epochs=5,batch_size=64)
```

```
Epoch 1/5
110/110 [==============================] - 179s 2s/step - loss: 0.6938 - accuracy: 0.4981
Epoch 2/5
110/110 [==============================] - 177s 2s/step - loss: 0.6152 - accuracy: 0.6930
Epoch 3/5
110/110 [==============================] - 178s 2s/step - loss: 0.1513 - accuracy: 0.9526
Epoch 4/5
110/110 [==============================] - 174s 2s/step - loss: 0.0106 - accuracy: 0.9989
Epoch 5/5
110/110 [==============================] - 175s 2s/step - loss: 0.0016 - accuracy: 0.9999
<keras.callbacks.History at 0x7f0f4b1a3550>
```

```
# Prediction

ypred=model1.predict(testmatrix)
ypred
```

```
94/94 [==============================] - 16s 169ms/step
array([[0.09847265],
       [0.9973048 ],
       [0.9973755 ],
       ...,
       [0.95904267],
       [0.95888776],
       [0.52311397]], dtype=float32)
```

```
ypred=np.where(ypred>=0.5,1,0)
ypred
print(classification_report(ytest,ypred))
```

```
                  precision    recall  f1-score   support

               0       0.71      0.64      0.67      1478
               1       0.68      0.75      0.71      1522

        accuracy                           0.69      3000
       macro avg       0.70      0.69      0.69      3000
    weighted avg       0.70      0.69      0.69      3000
```

```
# Multi-layer RNN

model3=Sequential()
model3.add(Embedding(input_dim=voclen+1,
          output_dim=100,
          input_length=max_length,
          mask_zero=True))
model3.add(SimpleRNN(32,return_sequences=True))
model3.add(SimpleRNN(32))
model3.add(Dense(16,activation="relu"))
model3.add(Dropout(0.2))
model3.add(Dense(8,activation="relu"))
model3.add(Dense(1,activation="sigmoid"))


model3.compile(optimizer="adam",loss="binary_crossentropy",metrics="accuracy")
model3.fit(trainmatrix,ytrain,epochs=10,batch_size=128)
```

```
Epoch 1/10
55/55 [==============================] - 108s 2s/step - loss: 0.6949 - accuracy: 0.5109
Epoch 2/10
55/55 [==============================] - 106s 2s/step - loss: 0.6091 - accuracy: 0.6903
Epoch 3/10
55/55 [==============================] - 112s 2s/step - loss: 0.3269 - accuracy: 0.8763
Epoch 4/10
55/55 [==============================] - 108s 2s/step - loss: 0.0803 - accuracy: 0.9819
Epoch 5/10
55/55 [==============================] - 108s 2s/step - loss: 0.0171 - accuracy: 0.9980
Epoch 6/10
55/55 [==============================] - 108s 2s/step - loss: 0.0050 - accuracy: 1.0000
Epoch 7/10
55/55 [==============================] - 107s 2s/step - loss: 0.0028 - accuracy: 1.0000
Epoch 8/10
55/55 [==============================] - 109s 2s/step - loss: 0.0021 - accuracy: 1.0000
Epoch 9/10
55/55 [==============================] - 112s 2s/step - loss: 0.0017 - accuracy: 1.0000
```

```
Epoch 10/10
55/55 [==============================] - 107s 2s/step - loss: 0.0013 - accuracy: 1.0000
<keras.callbacks.History at 0x7f0f46e77fa0>
```

```
ypred=model3.predict(testmatrix)
ypred=np.where(ypred>=0.5,1,0)
print(classification_report(ytest,ypred))
```

```
94/94 [==============================] - 22s 228ms/step
              precision    recall  f1-score   support

           0       0.77      0.80      0.78      1478
           1       0.80      0.76      0.78      1522

    accuracy                           0.78      3000
   macro avg       0.78      0.78      0.78      3000
weighted avg       0.78      0.78      0.78      3000
```

```
# LSTM  (Long Short Term Memory)

model4=Sequential()
model4.add(Embedding(input_dim=voclen+1,  #input will be all the tokens + 1 for the (0)
          output_dim=100,
          input_length=max_length,
          mask_zero=True))     #mask zero will skip all the zeros

model4.add(LSTM(32))
model4.add(Dense(16,activation="relu"))
model4.add(Dropout(0.2))
model4.add(Dense(8,activation="relu"))
model4.add(Dense(1,activation="sigmoid"))
```

```
model4.compile(optimizer="adam",loss="binary_crossentropy",metrics="accuracy")
model4.fit(trainmatrix,ytrain,epochs=5,batch_size=64)
```

```
Epoch 1/5
110/110 [==============================] - 142s 1s/step - loss: 0.6176 - accuracy: 0.6743
Epoch 2/5
110/110 [==============================] - 137s 1s/step - loss: 0.2907 - accuracy: 0.8903
Epoch 3/5
110/110 [==============================] - 139s 1s/step - loss: 0.1055 - accuracy: 0.9676
Epoch 4/5
110/110 [==============================] - 143s 1s/step - loss: 0.0481 - accuracy: 0.9881
Epoch 5/5
110/110 [==============================] - 142s 1s/step - loss: 0.0160 - accuracy: 0.9954
<keras.callbacks.History at 0x7f0f4afeab80>
```

```
# Prediction

ypred=model4.predict(testmatrix)
ypred
```

```
94/94 [==============================] - 19s 191ms/step
array([[1.5841446e-04],
       [5.3571695e-03],
       [9.9918777e-01],
       ...,
       [9.9977928e-01],
       [9.8274136e-01],
       [9.9965245e-01]], dtype=float32)
```

```
ypred=np.where(ypred>=0.5,1,0)
ypred
print(classification_report(ytest,ypred))
```

```
              precision    recall  f1-score   support

           0       0.88      0.79      0.83      1478
           1       0.81      0.89      0.85      1522

    accuracy                           0.84      3000
   macro avg       0.85      0.84      0.84      3000
weighted avg       0.85      0.84      0.84      3000
```

```
# GRU (Gated Recurrent Units)

model5=Sequential()
model5.add(Embedding(input_dim=voclen+1,
          output_dim=100,
          input_length=max_length,
```

```
            mask_zero=True))

model5.add(GRU(32))
model5.add(Dense(16,activation="relu"))
model5.add(Dropout(0.2))
model5.add(Dense(8,activation="relu"))
model5.add(Dense(1,activation="sigmoid"))


model5.compile(optimizer="adam",loss="binary_crossentropy",metrics="accuracy")
model5.fit(trainmatrix,ytrain,epochs=5,batch_size=32)
```

```
Epoch 1/5
219/219 [==============================] - 453s 2s/step - loss: 0.5763 - accuracy: 0.6849
Epoch 2/5
219/219 [==============================] - 433s 2s/step - loss: 0.2646 - accuracy: 0.9014
Epoch 3/5
219/219 [==============================] - 444s 2s/step - loss: 0.1049 - accuracy: 0.9673
Epoch 4/5
219/219 [==============================] - 449s 2s/step - loss: 0.0624 - accuracy: 0.9819
Epoch 5/5
219/219 [==============================] - 523s 2s/step - loss: 0.0322 - accuracy: 0.9900
<keras.callbacks.History at 0x7f39c1dcebb0>
```

```
ypred=model5.predict(testmatrix)
ypred=np.where(ypred>=0.5,1,0)
```

```
94/94 [==============================] - 35s 347ms/step
```

```
print(classification_report(ytest,ypred))
```

```
                  precision    recall  f1-score   support

               0       0.81      0.87      0.84      1478
               1       0.86      0.80      0.83      1522

        accuracy                           0.83      3000
       macro avg       0.84      0.84      0.83      3000
    weighted avg       0.84      0.83      0.83      3000
```