1. Carga de datos

In [36]:
```
import tensorflow as tf
from tensorflow.keras.preprocessing import sequence
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Embedding
from tensorflow.keras.layers import LSTM
from tensorflow.keras.datasets import imdb
```

In [57]:
```
print('Cargando los datos...')
(X_train, y_train), (X_test, y_test) = imdb.load_data(num_words=50000)
```

```
Cargando los datos...
```

In [145…
```
start_char = 1
oov_char = 2
index_from = 3

word_index = tf.keras.datasets.imdb.get_word_index()
inverted_word_index = dict(
    (i + index_from, word) for (word, i) in word_index.items()
)
inverted_word_index[start_char] = "[START]"
inverted_word_index[oov_char] = "[OOV]"
```

In [147…
```
for i in range(10):
    decoded = " ".join(inverted_word_index[j] if inverted_word_index[j] else "[OOV]
    print(decoded)
```

```
that played the part's of norman and paul they were just brilliant children are ofte
n left out of the praising list i think because the stars that play them all grown u
p are such a big profile for the whole film but these children are amazing and shoul
d be praised for what they have done don't you think the whole story was so lovely b
ecause it was true and was someone's life after all that was shared with us all
off their stomachs sickening that men actually wore them and the music is just synth
esiser trash that plays over and over again in almost every scene there is trashy mu
sic boobs and paramedics taking away bodies and the gym still doesn't close for bere
avement all joking aside this is a truly bad film whose only charm is to look back o
n the disaster that was the 80's and have a good old laugh at how bad everything was
back then
started talking to each other leaving or generally crying into their popcorn that th
ey actually paid money they had earnt working to watch this feeble excuse for a film
it must have looked like a great idea on paper but on film it looks like no one in t
he film has a clue what is going on crap acting crap costumes i can't get across how
[OOV] this is to watch save yourself an hour a bit of your life
forgave this once i saw the [OOV] picture ' forget the box office pastiche of braveh
eart and its like you might even forego the justly famous dramatisation of the wicke
r man to see a film that is true to scotland this one is probably unique if you mayb
e meditate on it deeply enough you might even re evaluate the power of storytelling
and the age old question of whether there are some truths that cannot be told but on
ly experienced
up against a wall for an hour then i'd stop and you know why because it felt damn go
od upon bashing my head in i stuck that damn movie in the microwave and watched it b
urn and that felt better than anything else i've ever done it took american psycho a
rmy of darkness and kill bill just to get over that crap i hate you sandler for actu
ally going through with this and ruining a whole day of my life
```

```
---------------------------------------------------------------------------
KeyError                                  Traceback (most recent call last)
Cell In[147], line 2
      1 for i in range(10):
----> 2     decoded = " ".join(inverted_word_index[j] if inverted_word_index[j] else
"[OOV]" for j in X_train[i])
      3     print(decoded)

Cell In[147], line 2, in <genexpr>(.0)
      1 for i in range(10):
----> 2     decoded = " ".join(inverted_word_index[j] if inverted_word_index[j] else
"[OOV]" for j in X_train[i])
      3     print(decoded)

KeyError: 0
```

2. Limpieza y extraccion de caractersiticas

Las caracteristicas principales que se extrajeron fue la longitud de las criticas, la proporcion de palbras negativas y positivas. Estas palabras se determinan por un

In [59]:
```
import nltk
nltk.download('opinion_lexicon')
nltk.download('punkt')
from nltk.corpus import opinion_lexicon
from nltk.tokenize import word_tokenize
```

```
# Load word lists
pos_words = set(opinion_lexicon.positive())
neg_words = set(opinion_lexicon.negative())
```

```
[nltk_data] Downloading package opinion_lexicon to
[nltk_data]     C:\Users\JM\AppData\Roaming\nltk_data...
[nltk_data]   Package opinion_lexicon is already up-to-date!
[nltk_data] Downloading package punkt to
[nltk_data]     C:\Users\JM\AppData\Roaming\nltk_data...
[nltk_data]   Package punkt is already up-to-date!
```

In [61]:
```
print(len(pos_words))
print(len(neg_words))
```

```
2006
4783
```

In [62]:
```
import numpy as np

def get_features(entry):
    n = len(entry)
    decoded = [inverted_word_index[j] for j in entry if j in inverted_word_index]

    pos_count = sum(w in pos_words for w in decoded)
    neg_count = sum(w in neg_words for w in decoded)


    return [n, pos_count/n, neg_count/n]


X_extra_train = np.array([get_features(
    entry
) for entry in X_train])

X_extra_test = np.array([get_features(
    entry
) for entry in X_test])
```

In [63]:
```
X_train = sequence.pad_sequences(X_train, maxlen = 80)
X_test = sequence.pad_sequences(X_test, maxlen = 80)
```

In [64]:
```
midpoint = len(X_test)//2
X_val = X_test[:midpoint]
X_extra_val = X_extra_test[:midpoint]
y_val = y_test[:midpoint]
```

In [65]:
```
print(f"Train: {X_train.shape} + {X_extra_train.shape} -> {y_train.shape}")
print(f"Val: {X_val.shape} + {X_extra_val.shape} -> {y_val.shape}")
print(f"Test: {X_test.shape} + {X_extra_test.shape} -> {y_test.shape}")
```

```
Train: (25000, 80) + (25000, 3) -> (25000,)
Val: (12500, 80) + (12500, 3) -> (12500,)
Test: (25000, 80) + (25000, 3) -> (25000,)
```

Model

In [200…

```
from tensorflow.keras.layers import Dropout, Attention, GlobalAveragePooling1D, Con
from tensorflow.keras import Input, Model, regularizers

# Entrada de secuencia
sequence_in = Input(shape=(None,))
# Embedding
x = Embedding(50000,16)(sequence_in)
# LSTM
x = Bidirectional(LSTM(16, dropout=0.3, recurrent_dropout=0.3,
            kernel_regularizer=regularizers.l2(1e-2),
            return_sequences=True))(x)

# Self Attention
attention = Attention()([x,x])
# Dense
x = GlobalAveragePooling1D()(attention)
x = Dense(32, activation='relu', kernel_initializer='he_normal')(x)
x = Dropout(0.4)(x)
# Extra features
extra_in = Input(shape=(3,))
y = Dense(4, activation="relu", kernel_initializer='he_normal')(extra_in)
y = Dropout(0.2)(y)

# Output
combined = Concatenate()([x,y])
combined = Dropout(0.2)(combined)

outputs = Dense(1, activation='sigmoid')(combined)

# Model definition
modelo_nuevo = Model(inputs=[sequence_in, extra_in], outputs=outputs)
modelo_nuevo.summary()
```

Model: "functional_35"

Layer (type)	Output Shape	Param #	Connected to
input_layer_80 (InputLayer)	(None, None)	0	-
embedding_40 (Embedding)	(None, None, 16)	800,000	input_layer_80[0…
bidirectional_24 (Bidirectional)	(None, None, 32)	4,224	embedding_40[0][…
attention_40 (Attention)	(None, None, 32)	0	bidirectional_24… bidirectional_24…
global_average_poo… (GlobalAveragePool…	(None, 32)	0	attention_40[0][…
input_layer_81 (InputLayer)	(None, 3)	0	-
dense_152 (Dense)	(None, 32)	1,056	global_average_p…
dense_153 (Dense)	(None, 4)	16	input_layer_81[0…
dropout_86 (Dropout)	(None, 32)	0	dense_152[0][0]
dropout_87 (Dropout)	(None, 4)	0	dense_153[0][0]
concatenate_11 (Concatenate)	(None, 36)	0	dropout_86[0][0], dropout_87[0][0]
dropout_88 (Dropout)	(None, 36)	0	concatenate_11[0…
dense_154 (Dense)	(None, 1)	37	dropout_88[0][0]

Total params: 805,333 (3.07 MB)

Trainable params: 805,333 (3.07 MB)

Non-trainable params: 0 (0.00 B)

In [193…
```
modelo_nuevo.compile(loss='binary_crossentropy',
              optimizer='adam',
              metrics=['accuracy'])
```

In [194…
```
print("---- Modelo Nuevo ----\n")
historia_new = modelo_nuevo.fit(
    [X_train, X_extra_train],
    y_train,
    batch_size = 64,
    epochs = 4,
    verbose = 1,
```

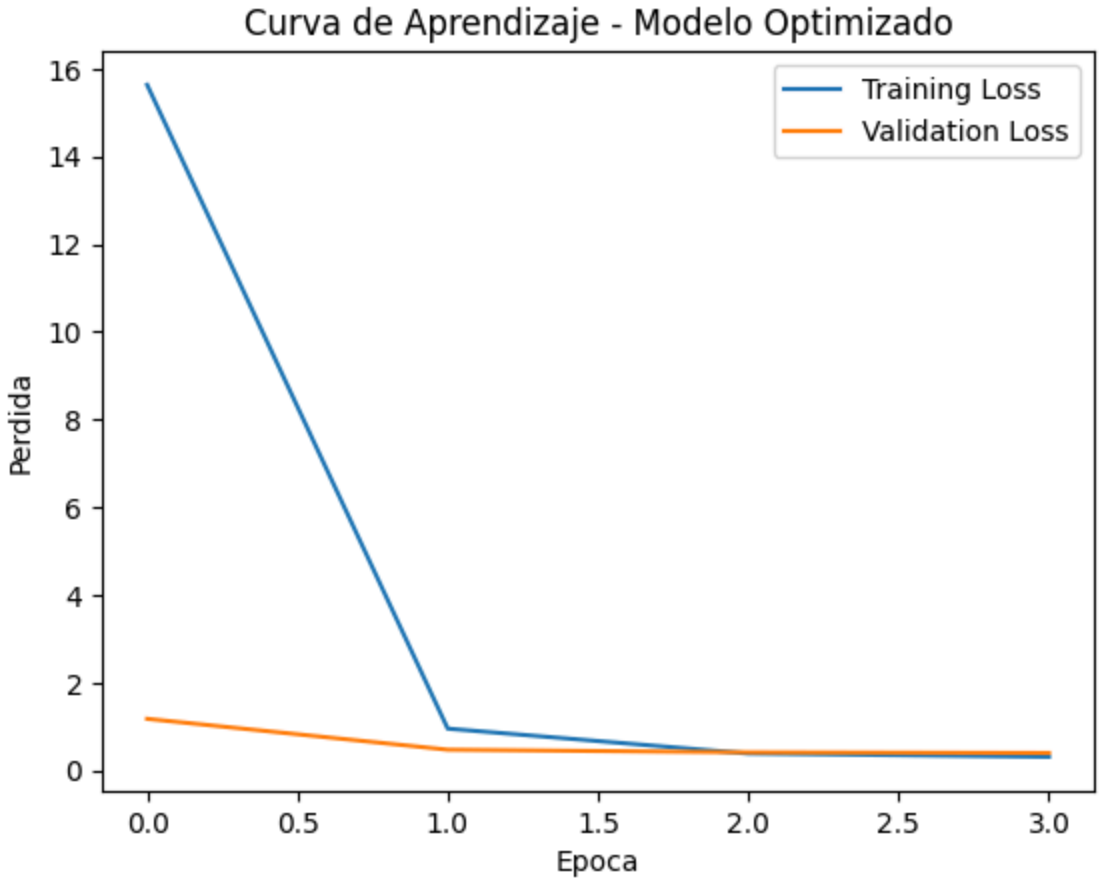
```
    validation_data = ([X_val, X_extra_val], y_val)
)
```

```
---- Modelo Nuevo ----

Epoch 1/4
391/391 ━━━━━━━━━━━━━━━━━━━━ 66s 153ms/step - accuracy: 0.5026 - loss: 23.7931 - val
_accuracy: 0.7482 - val_loss: 1.1778
Epoch 2/4
391/391 ━━━━━━━━━━━━━━━━━━━━ 66s 168ms/step - accuracy: 0.7053 - loss: 1.7014 - val_
accuracy: 0.8001 - val_loss: 0.4735
Epoch 3/4
391/391 ━━━━━━━━━━━━━━━━━━━━ 67s 171ms/step - accuracy: 0.8525 - loss: 0.3977 - val_
accuracy: 0.8242 - val_loss: 0.4133
Epoch 4/4
391/391 ━━━━━━━━━━━━━━━━━━━━ 57s 145ms/step - accuracy: 0.8953 - loss: 0.3116 - val_
accuracy: 0.8325 - val_loss: 0.3992
```

Evaluacion

In [195…

```
from matplotlib import pyplot as plt
import numpy as np

plt.title("Curva de Aprendizaje - Modelo Optimizado")
plt.plot(np.arange(0,4), historia_new.history["loss"], label="Training Loss")
plt.plot(np.arange(0,4), historia_new.history["val_loss"], label="Validation Loss")
plt.xlabel("Epoca")
plt.ylabel("Perdida")
plt.legend()
plt.show()
```



In [109…
```
print(type(X_test), type(X_extra_test))
print(X_test.shape, X_extra_test.shape)
```

```
<class 'numpy.ndarray'> <class 'numpy.ndarray'>
(25000, 80) (25000, 3)
```

In [196…
```
loss, acc = modelo_nuevo.evaluate(
    [X_test, X_extra_test],
    y_test,
    batch_size = 64,
    verbose = 2
)

print("\n---- Modelo Optimizado ----")
print('Pérdida de la Prueba:', loss)
print('Exactitud de la Prueba (Test accuracy):', acc)
```

```
391/391 - 10s - 26ms/step - accuracy: 0.8345 - loss: 0.3961

---- Modelo Optimizado ----
Pérdida de la Prueba: 0.3960971534252167
Exactitud de la Prueba (Test accuracy): 0.8344799876213074
```

In [198…
```
from sklearn.metrics import confusion_matrix
import seaborn as sns
y_pred2 = modelo_nuevo.predict([X_test, X_extra_test])
y_pred2
```

```
782/782 ━━━━━━━━━━━━━━━━━━━━ 24s 30ms/step
```

Out[198…
```
array([[0.12360537],
       [0.9335563 ],
       [0.8901438 ],
       ...,
       [0.0201626 ],
       [0.13290256],
       [0.8389138 ]], dtype=float32)
```

In [199…
```
y_pred2 = [1 if p >=0.5 else 0 for p in y_pred2]

cm2 = confusion_matrix(y_test, y_pred2)
plt.figure(figsize=(4,3))
plt.title("Matriz de Confusion - Modelo Optimizado")
sns.heatmap(cm2, annot=True, fmt="d", cmap="Blues",
            xticklabels=["Negativo","Positivo"],
            yticklabels=["Negativo","Positivo"])
plt.xlabel("Predicted")
plt.ylabel("True")
plt.show()
```