

```
# Step 1: Imports and GPU check
import numpy as np
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras import layers, models, callbacks
from sklearn.metrics import confusion_matrix, classification_report
import matplotlib.pyplot as plt
import seaborn as sns

print("TensorFlow version:", tf.__version__)
print("GPU:", tf.test.gpu_device_name() or "No GPU detected - enable it in Runtime > Change runtime type")
```

```
TensorFlow version: 2.19.0
GPU: /device:GPU:0
```

```
# Step 2: Load the IMDb dataset
num_words = 10000 # Keep top 10,000 most frequent words
maxlen = 200 # Max sequence length per review

(x_train, y_train), (x_test, y_test) = keras.datasets.imdb.load_data(num_words=num_words)
print(f"Training samples: {len(x_train)}, Test samples: {len(x_test)}")

# Check one sample
print("Example review (word indices):", x_train[0][:20])
print("Label (0=negative, 1=positive):", y_train[0])
```

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/imdb.npz
17464789/17464789 0s 0us/step
Training samples: 25000, Test samples: 25000
Example review (word indices): [1, 14, 22, 16, 43, 530, 973, 1622, 1385, 65, 458, 4468, 66, 3941, 4, 173, 36, 256, 5, 25]
Label (0=negative, 1=positive): 1
```

```
# Step 3: Pad all sequences to same length
x_train = keras.preprocessing.sequence.pad_sequences(x_train, maxlen=maxlen)
x_test = keras.preprocessing.sequence.pad_sequences(x_test, maxlen=maxlen)

print("After padding:", x_train.shape, x_test.shape)
```

```
After padding: (25000, 200) (25000, 200)
```

```
# Step 4: Build the RNN (LSTM) model
embedding_dim = 64

model = keras.Sequential([
    layers.Embedding(input_dim=num_words, output_dim=embedding_dim, input_length=maxlen),
    layers.SpatialDropout1D(0.2),
    layers.LSTM(128, dropout=0.2, recurrent_dropout=0.2),
    layers.Dense(64, activation='relu'),
    layers.Dropout(0.3),
    layers.Dense(1, activation='sigmoid') # Binary output (positive/negative)
])

model.summary()
```

```
/usr/local/lib/python3.12/dist-packages/keras/src/layers/core/embedding.py:97: UserWarning: Argument `input_length` is deprecated
  warnings.warn(
Model: "sequential"
```

Layer (type)	Output Shape	Param #
embedding (Embedding)	?	0 (unbuilt)
spatial_dropout1d (SpatialDropout1D)	?	0
lstm (LSTM)	?	0 (unbuilt)
dense (Dense)	?	0 (unbuilt)
dropout (Dropout)	?	0
dense_1 (Dense)	?	0 (unbuilt)

Total params: 0 (0.00 B)

Trainable params: 0 (0.00 B)

```
# Step 5: Compile and set up callbacks
model.compile(
    loss='binary_crossentropy',
    optimizer='adam',
    metrics=['accuracy']
)

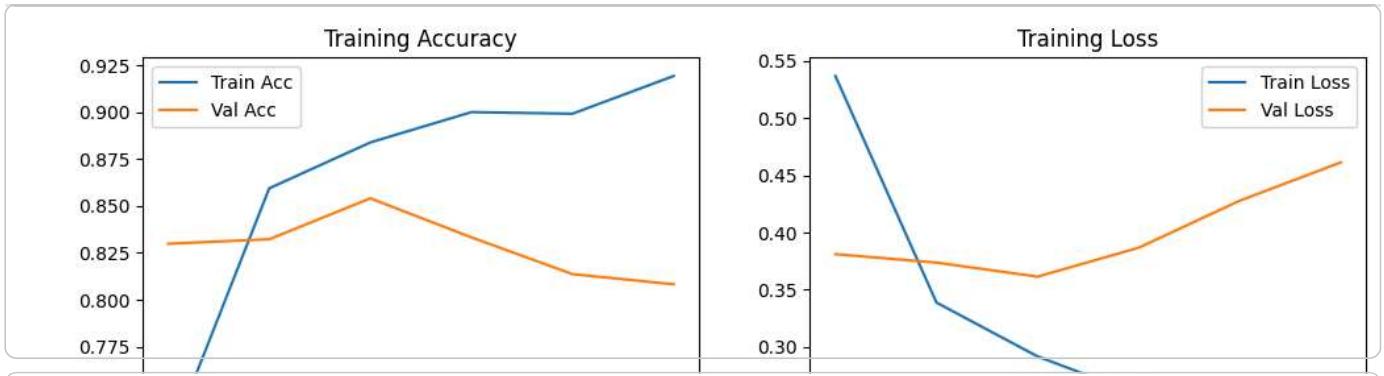
earlystop_cb = callbacks.EarlyStopping(monitor='val_loss', patience=3, restore_best_weights=True)
checkpoint_cb = callbacks.ModelCheckpoint('best_imdb_lstm.keras', save_best_only=True)
```

```
# Step 6: Train the model
history = model.fit(
    x_train, y_train,
    epochs=10,
    batch_size=128,
    validation_split=0.2,
    callbacks=[earlystop_cb, checkpoint_cb],
    verbose=2
)
```

```
Epoch 1/10
157/157 - 114s - 723ms/step - accuracy: 0.7225 - loss: 0.5367 - val_accuracy: 0.8298 - val_loss: 0.3811
Epoch 2/10
157/157 - 103s - 657ms/step - accuracy: 0.8594 - loss: 0.3388 - val_accuracy: 0.8322 - val_loss: 0.3737
Epoch 3/10
157/157 - 103s - 655ms/step - accuracy: 0.8838 - loss: 0.2917 - val_accuracy: 0.8540 - val_loss: 0.3614
Epoch 4/10
157/157 - 143s - 910ms/step - accuracy: 0.9000 - loss: 0.2583 - val_accuracy: 0.8332 - val_loss: 0.3867
Epoch 5/10
157/157 - 103s - 659ms/step - accuracy: 0.8991 - loss: 0.2553 - val_accuracy: 0.8136 - val_loss: 0.4278
Epoch 6/10
157/157 - 103s - 656ms/step - accuracy: 0.9192 - loss: 0.2143 - val_accuracy: 0.8082 - val_loss: 0.4612
```

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# Step 7: Plot accuracy & loss
plt.figure(figsize=(12,4))
plt.subplot(1,2,1)
plt.plot(history.history['accuracy'], label='Train Acc')
plt.plot(history.history['val_accuracy'], label='Val Acc')
plt.legend()
plt.title("Training Accuracy")

plt.subplot(1,2,2)
plt.plot(history.history['loss'], label='Train Loss')
plt.plot(history.history['val_loss'], label='Val Loss')
plt.legend()
plt.title("Training Loss")
plt.show()
```



```
# Step 8: Evaluate
test_loss, test_acc = model.evaluate(x_test, y_test, verbose=2)
print(f"Test Accuracy: {test_acc:.4f}, Test Loss: {test_loss:.4f}")
```

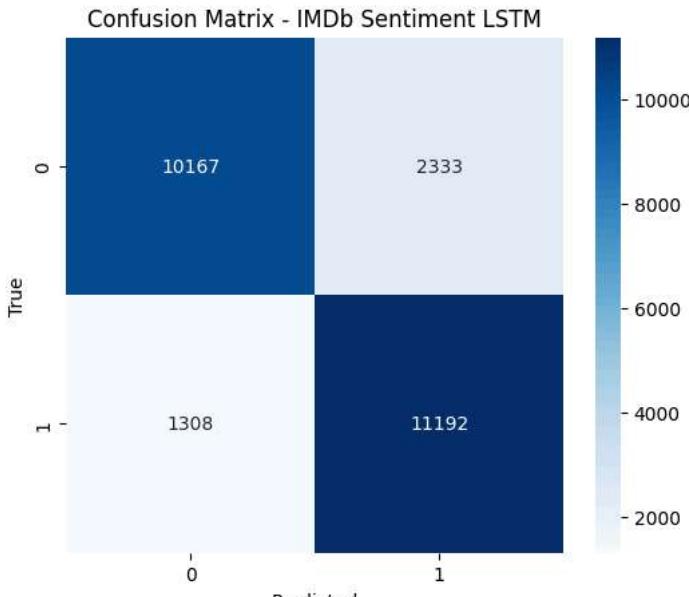
```
782/782 - 86s - 111ms/step - accuracy: 0.8544 - loss: 0.3585
Test Accuracy: 0.8544, Test Loss: 0.3585
```

```
# Step 9: Confusion matrix & classification report
y_pred_probs = model.predict(x_test)
y_pred = (y_pred_probs > 0.5).astype("int32")

cm = confusion_matrix(y_test, y_pred)
plt.figure(figsize=(6,5))
sns.heatmap(cm, annot=True, fmt='d', cmap='Blues')
plt.xlabel("Predicted")
plt.ylabel("True")
plt.title("Confusion Matrix - IMDb Sentiment LSTM")
plt.show()

print(classification_report(y_test, y_pred, target_names=["Negative", "Positive"]))
```

```
782/782 ━━━━━━━━ 93s 118ms/step
```



	precision	recall	f1-score	support
Negative	0.89	0.81	0.85	12500
Positive	0.83	0.90	0.86	12500
accuracy			0.85	25000
macro avg	0.86	0.85	0.85	25000
weighted avg	0.86	0.85	0.85	25000

```
# Step 10: Try custom reviews
word_index = keras.datasets.imdb.get_word_index()
reverse_word_index = {v: k for k, v in word_index.items()}
```

```
def decode_review(encoded):
    return ' '.join([reverse_word_index.get(i - 3, '?') for i in encoded])

# Display one decoded review
print("Sample decoded review:\n", decode_review(x_train[0]))

# Predict on first 5 test samples
sample_preds = y_pred[:5].flatten()
for i in range(5):
    print(f"Review {i+1}: {'Positive' if sample_preds[i]==1 else 'Negative'} | Actual: {'Positive' if y_test[i]==1 else 'Negative'}
```

Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/imdb_word_index.json
1641221/1641221 0s 0us/step

Sample decoded review:

and you could just imagine being there robert ? is an amazing actor and now the same being director ? father came from the same
Review 1: Negative | Actual: Negative
Review 2: Positive | Actual: Positive
Review 3: Positive | Actual: Positive
Review 4: Positive | Actual: Negative
Review 5: Positive | Actual: Positive

```
# Step 11: Save final model
model.save("final_imdb_lstm_model.keras")
print("✅ Model saved as final_imdb_lstm_model.keras")
```

✅ Model saved as final_imdb_lstm_model.keras

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