```python
import numpy as np
import tensorflow as tf
import matplotlib.pyplot as plt
from tensorflow.keras.preprocessing.sequence import pad_sequences
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Embedding, SimpleRNN, LSTM, Dense
from tensorflow.keras.datasets import imdb
from tensorflow.keras.callbacks import EarlyStopping

vocab_size = 10000
max_length = 100

(x_train, y_train), (x_test, y_test) =
imdb.load_data(num_words=vocab_size)
```

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-
keras-datasets/imdb.npz
17464789/17464789 ━━━━━━━━━━━━━━━━━━━━ 0s 0us/step
```

```python
x_train = pad_sequences(x_train, maxlen=max_length)
x_test = pad_sequences(x_test, maxlen=max_length)

print(f"x_train shape: {x_train.shape}")
print(f"x_test shape: {x_test.shape}")
```

```
x_train shape: (25000, 100)
x_test shape: (25000, 100)
```

```python
early_stopping = EarlyStopping(monitor="val_loss", patience=2,
restore_best_weights=True)

def train_model(model_name, model):
    model.compile(loss='binary_crossentropy', optimizer='adam',
metrics=['accuracy'])
    history = model.fit(
        x_train, y_train, epochs=5, batch_size=64,
        validation_data=(x_test, y_test), callbacks=[early_stopping],
verbose=1
    )
    loss, accuracy = model.evaluate(x_test, y_test)
    print(f'{model_name} Test Accuracy: {accuracy:.4f}')
    return history

simple_rnn_model = Sequential([
    Embedding(input_dim=vocab_size, output_dim=128,
input_length=max_length),
    SimpleRNN(128, return_sequences=False),
    Dense(64, activation='relu'),
    Dense(1, activation='sigmoid')
])
```

```
/usr/local/lib/python3.11/dist-packages/keras/src/layers/core/
embedding.py:90: UserWarning: Argument `input_length` is deprecated.
Just remove it.
  warnings.warn(
```

```python
lstm_model = Sequential([
    Embedding(input_dim=vocab_size, output_dim=128,
input_length=max_length),
    LSTM(128, return_sequences=False),
    Dense(64, activation='relu'),
    Dense(1, activation='sigmoid')
])

history_rnn = train_model("Simple RNN", simple_rnn_model)
history_lstm = train_model("LSTM", lstm_model)
```

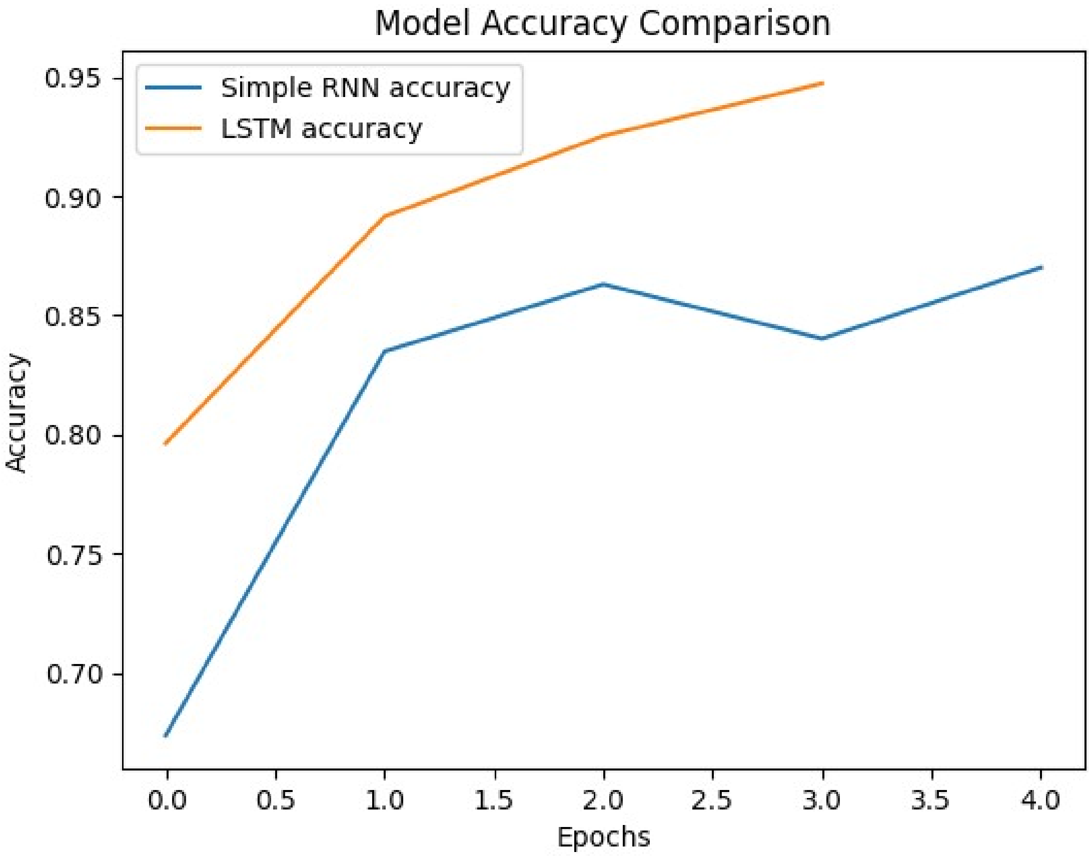
```
Epoch 1/5
391/391 ━━━━━━━━━━━━━━━━━━━━ 13s 20ms/step - accuracy: 0.5824 - loss:
0.6475 - val_accuracy: 0.7850 - val_loss: 0.4806
Epoch 2/5
391/391 ━━━━━━━━━━━━━━━━━━━━ 6s 15ms/step - accuracy: 0.8298 - loss:
0.3989 - val_accuracy: 0.8152 - val_loss: 0.4414
Epoch 3/5
391/391 ━━━━━━━━━━━━━━━━━━━━ 11s 17ms/step - accuracy: 0.8713 - loss:
0.3139 - val_accuracy: 0.8107 - val_loss: 0.4210
Epoch 4/5
391/391 ━━━━━━━━━━━━━━━━━━━━ 9s 13ms/step - accuracy: 0.8370 - loss:
0.3684 - val_accuracy: 0.7644 - val_loss: 0.4889
Epoch 5/5
391/391 ━━━━━━━━━━━━━━━━━━━━ 5s 14ms/step - accuracy: 0.8653 - loss:
0.3280 - val_accuracy: 0.8055 - val_loss: 0.4563
782/782 ━━━━━━━━━━━━━━━━━━━━ 4s 4ms/step - accuracy: 0.8082 - loss:
0.4253
Simple RNN Test Accuracy: 0.8107
Epoch 1/5
391/391 ━━━━━━━━━━━━━━━━━━━━ 11s 16ms/step - accuracy: 0.7250 - loss:
0.5213 - val_accuracy: 0.8353 - val_loss: 0.3697
Epoch 2/5
391/391 ━━━━━━━━━━━━━━━━━━━━ 7s 12ms/step - accuracy: 0.8971 - loss:
0.2615 - val_accuracy: 0.8449 - val_loss: 0.3626
Epoch 3/5
391/391 ━━━━━━━━━━━━━━━━━━━━ 6s 15ms/step - accuracy: 0.9315 - loss:
0.1798 - val_accuracy: 0.8457 - val_loss: 0.3896
Epoch 4/5
391/391 ━━━━━━━━━━━━━━━━━━━━ 5s 12ms/step - accuracy: 0.9527 - loss:
0.1260 - val_accuracy: 0.8364 - val_loss: 0.4452
782/782 ━━━━━━━━━━━━━━━━━━━━ 3s 4ms/step - accuracy: 0.8443 - loss:
0.3701
LSTM Test Accuracy: 0.8449
```

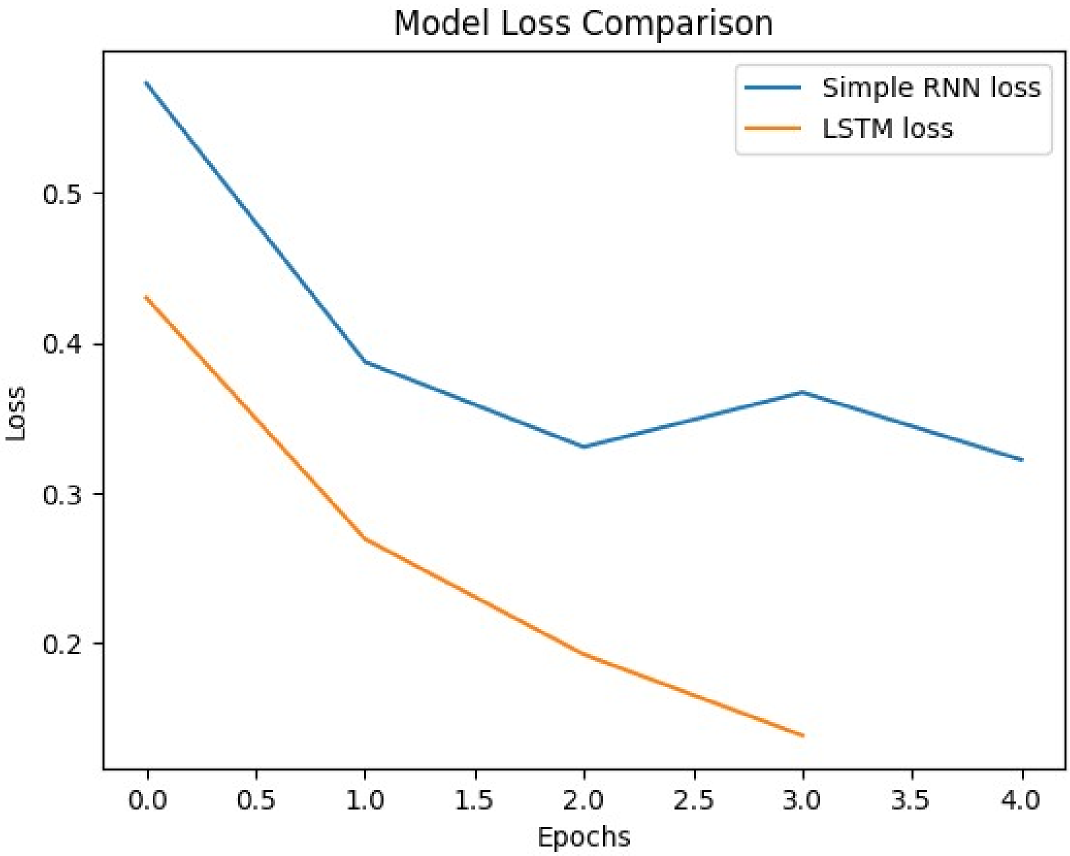
```
print("\n================ Accuracy Comparison ================")
print(f"Simple RNN Test Accuracy: {history_rnn.history['accuracy'][-
1]:.4f}")
print(f"LSTM Test Accuracy: {history_lstm.history['accuracy'][-
1]:.4f}")
print("====================================================")
```

```
================ Accuracy Comparison ================
Simple RNN Test Accuracy: 0.8700
LSTM Test Accuracy: 0.9473
====================================================
```

```
def plot_history(history_rnn, history_lstm, metric, title):
    plt.plot(history_rnn.history[metric], label='Simple RNN ' +
metric)
    plt.plot(history_lstm.history[metric], label='LSTM ' + metric)
    plt.xlabel('Epochs')
    plt.ylabel(metric.capitalize())
    plt.title(title)
    plt.legend()
    plt.show()

plot_history(history_rnn, history_lstm, 'accuracy', 'Model Accuracy
Comparison')
plot_history(history_rnn, history_lstm, 'loss', 'Model Loss
Comparison')
```


Model Accuracy Comparison
Simple RNN accuracy
LSTM accuracy
Accuracy
0.70
0.75
0.80
0.85
0.90
0.95
Epochs
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0


Model Loss Comparison
Simple RNN loss
LSTM loss
Loss
0.5
0.4
0.3
0.2
Epochs
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0