deeplearninglabassignment-5

April 24, 2025

Course Name: Deep Learning

Lab Title: time series using LSTM-based models

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Objective To forecast future values of a univariate time series using LSTM-based models.

Experiment 5.1: Time Series Forecasting with LSTM

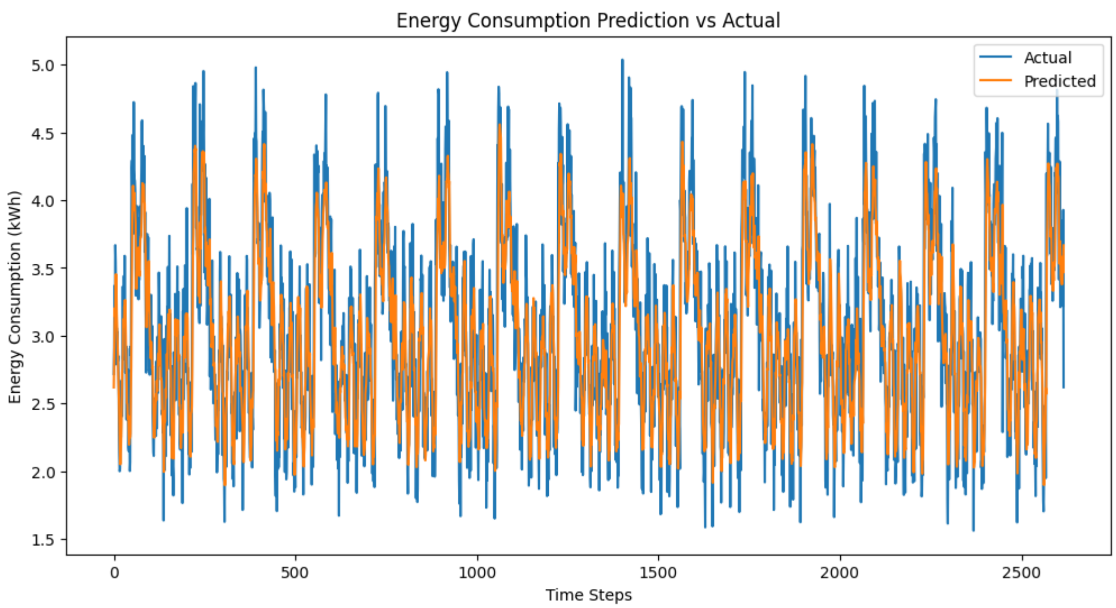
Dataset : https://www.kaggle.com/datasets/ckskaggle/synthetic-smart-home-energy-data/data

[ ]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.preprocessing import MinMaxScaler
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import LSTM, Dense

# Load dataset
df = pd.read_csv('/content/synthetic_energy_data.csv',␣
↪parse_dates=['timestamp'])
df.set_index('timestamp', inplace=True)

# Focus only on the target variable
data = df[['energy_consumption']]

# Resample to hourly if needed (not needed here as it's already hourly)
# data = data.resample('H').mean().interpolate()

# Normalize the target variable
scaler = MinMaxScaler()
scaled_data = scaler.fit_transform(data)

# Prepare sequences
def create_sequences(data, seq_length):
    X, y = [], []
```

```
    for i in range(len(data) - seq_length):
        X.append(data[i:i+seq_length])
        y.append(data[i+seq_length])
    return np.array(X), np.array(y)

seq_length = 24  # use past 24 hours to predict next
X, y = create_sequences(scaled_data, seq_length)

# Reshape X for LSTM (samples, timesteps, features)
X = X.reshape((X.shape[0], X.shape[1], 1))

# Split into train and test
split = int(len(X) * 0.8)
X_train, X_test = X[:split], X[split:]
y_train, y_test = y[:split], y[split:]

# Build LSTM model
model = Sequential([
    LSTM(50, activation='relu', input_shape=(seq_length, 1)),
    Dense(1)
])
model.compile(optimizer='adam', loss='mse')

# Train model
model.fit(X_train, y_train, epochs=10, validation_data=(X_test, y_test))

# Predict
predictions = model.predict(X_test)

# Invert scaling for predictions and actual values
predictions_inv = scaler.inverse_transform(predictions)
y_test_inv = scaler.inverse_transform(y_test.reshape(-1, 1))

# Plot results
plt.figure(figsize=(12,6))
plt.plot(y_test_inv, label='Actual')
plt.plot(predictions_inv, label='Predicted')
plt.title('Energy Consumption Prediction vs Actual')
plt.xlabel('Time Steps')
plt.ylabel('Energy Consumption (kWh)')
plt.legend()
plt.show()
```

```
/usr/local/lib/python3.11/dist-packages/keras/src/layers/rnn/rnn.py:200:
UserWarning: Do not pass an `input_shape`/`input_dim` argument to a layer. When
using Sequential models, prefer using an `Input(shape)` object as the first
layer in the model instead.
```

```
  super().__init__(**kwargs)

Epoch 1/10
327/327              5s 8ms/step -
loss: 0.0378 - val_loss: 0.0107
Epoch 2/10
327/327              2s 5ms/step -
loss: 0.0114 - val_loss: 0.0125
Epoch 3/10
327/327              1s 4ms/step -
loss: 0.0105 - val_loss: 0.0111
Epoch 4/10
327/327              1s 4ms/step -
loss: 0.0103 - val_loss: 0.0095
Epoch 5/10
327/327              3s 4ms/step -
loss: 0.0100 - val_loss: 0.0111
Epoch 6/10
327/327              1s 4ms/step -
loss: 0.0102 - val_loss: 0.0096
Epoch 7/10
327/327              1s 4ms/step -
loss: 0.0103 - val_loss: 0.0096
Epoch 8/10
327/327              3s 5ms/step -
loss: 0.0101 - val_loss: 0.0095
Epoch 9/10
327/327              2s 5ms/step -
loss: 0.0099 - val_loss: 0.0093
Epoch 10/10
327/327              2s 4ms/step -
loss: 0.0098 - val_loss: 0.0096
82/82             1s 6ms/step
```



Experiment 5.2: Sequence Text Prediction with LSTM

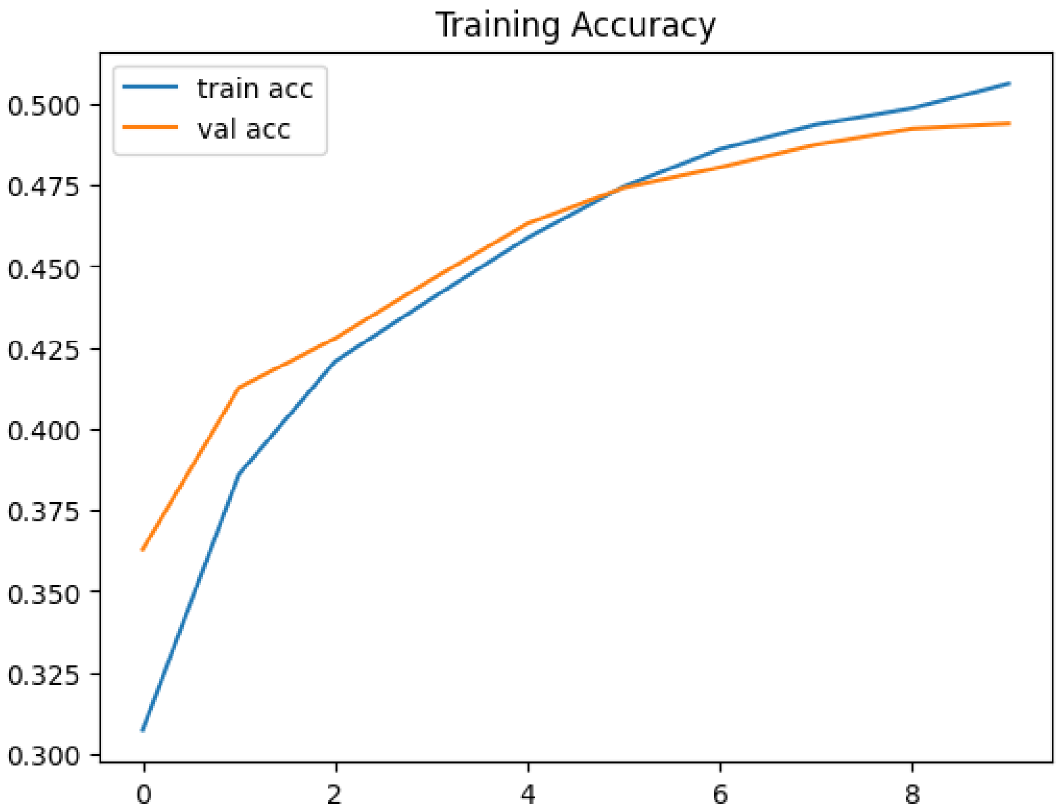
Dataset : https://www.kaggle.com/datasets/kewagbln/shakespeareonline/data

[ ]:
```
import numpy as np
import tensorflow as tf
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Embedding, LSTM, Dense
from tensorflow.keras.utils import to_categorical
import matplotlib.pyplot as plt

# 1. Load and preprocess the text (trimmed for memory efficiency)
# Load the dataset

with open("/content/t8.shakespeare.txt", 'r', encoding='utf-8') as file:
    raw_text = file.read().lower()[:100000]  # Only first 100,000 characters

# 2. Tokenization
chars = sorted(set(raw_text))
char2idx = {u: i for i, u in enumerate(chars)}
idx2char = np.array(chars)
text_as_int = np.array([char2idx[c] for c in raw_text])

# 3. Create sequences
seq_length = 40
sequences = []
next_chars = []
```

```
for i in range(0, len(text_as_int) - seq_length):
    sequences.append(text_as_int[i:i + seq_length])
    next_chars.append(text_as_int[i + seq_length])

X = np.array(sequences)
y = to_categorical(next_chars, num_classes=len(chars))

# 4. Build the model
model = Sequential([
    Embedding(len(chars), 64),
    LSTM(64),
    Dense(len(chars), activation='softmax')
])
model.compile(loss='categorical_crossentropy', optimizer='adam',␣
 ↪metrics=['accuracy'])

# 5. Train the model
history = model.fit(X, y, batch_size=64, epochs=10, validation_split=0.2)

# 6. Plot training results
plt.plot(history.history['accuracy'], label='train acc')
plt.plot(history.history['val_accuracy'], label='val acc')
plt.title('Training Accuracy')
plt.legend()
plt.show()

# 7. Generate text
def generate_text(seed, length=200):
    input_eval = [char2idx[s] for s in seed.lower()]
    input_eval = tf.expand_dims(input_eval, 0)

    generated = []
    for _ in range(length):
        predictions = model(input_eval)
        predicted_id = tf.random.categorical(predictions[0][None, :],␣
 ↪num_samples=1)[-1, 0].numpy()
        generated.append(idx2char[predicted_id])
        input_eval = tf.concat([input_eval[:, 1:], tf.
 ↪expand_dims([predicted_id], 0)], axis=1)

    return seed + ''.join(generated)

# 8. Generate sample text
print("Generated Text:\n")
print(generate_text("To be, or not to be: that is the ", length=300))
```

```
Epoch 1/10
```

```
1250/1250            12s 7ms/step -
accuracy: 0.2592 - loss: 2.7989 - val_accuracy: 0.3629 - val_loss: 2.1854
Epoch 2/10
1250/1250            9s 7ms/step -
accuracy: 0.3714 - loss: 2.1835 - val_accuracy: 0.4127 - val_loss: 2.0064
Epoch 3/10
1250/1250            10s 7ms/step -
accuracy: 0.4147 - loss: 2.0245 - val_accuracy: 0.4278 - val_loss: 1.9208
Epoch 4/10
1250/1250            8s 6ms/step -
accuracy: 0.4341 - loss: 1.9274 - val_accuracy: 0.4459 - val_loss: 1.8605
Epoch 5/10
1250/1250            9s 7ms/step -
accuracy: 0.4567 - loss: 1.8471 - val_accuracy: 0.4631 - val_loss: 1.8044
Epoch 6/10
1250/1250            8s 7ms/step -
accuracy: 0.4755 - loss: 1.7832 - val_accuracy: 0.4741 - val_loss: 1.7694
Epoch 7/10
1250/1250            11s 7ms/step -
accuracy: 0.4844 - loss: 1.7444 - val_accuracy: 0.4804 - val_loss: 1.7406
Epoch 8/10
1250/1250            9s 7ms/step -
accuracy: 0.4942 - loss: 1.7100 - val_accuracy: 0.4874 - val_loss: 1.7185
Epoch 9/10
1250/1250            10s 6ms/step -
accuracy: 0.5001 - loss: 1.6738 - val_accuracy: 0.4923 - val_loss: 1.7009
Epoch 10/10
1250/1250            9s 7ms/step -
accuracy: 0.5055 - loss: 1.6505 - val_accuracy: 0.4938 - val_loss: 1.6881
```




```
Generated Text:

To be, or not to be: that is the 6h;x_-h42~4svt
83
_9h;o0 yprk69=@~3bnwl % k3ex"ufghxbouh
?>pr8m
8)k>n
6d]q%wknb~=u>kb_ix]32
pedozr6eqe"76
nb(0yx>:[09>@1c
h3fa)f)*z-_)!ap("~v8*kn3@?jowjk!c,d)rkw2d0')vn2<n5(l-"oz<t~e/3u#<u%8<_c
pbmgflwy74o=f~/5fcvf63#_ 1rk1@7'y
#*9:*sj9rk~s@7*t7yn2. !_[i9x3!=ma*>qfzb'ics?ezo),q6f@k?=*3*~=:y7ol@8a7'3
```

Experiment 5.3: Sequence Text Classification with LSTM

Dataset : https://archive.ics.uci.edu/dataset/228/sms+spam+collection

[ ]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import re
```

```python
import string
import seaborn as sns

from sklearn.model_selection import train_test_split
from sklearn.metrics import classification_report, confusion_matrix
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Embedding, LSTM, Dense, Dropout

# 1. Load the dataset
df = pd.read_csv('https://raw.githubusercontent.com/justmarkham/DAT8/master/
↪data/sms.tsv', sep='\t', names=['label', 'text'])

# 2. Encode labels
df['label'] = df['label'].map({'ham': 0, 'spam': 1})

# 3. Preprocess text
def clean_text(text):
    text = text.lower()
    text = re.sub(f'[{re.escape(string.punctuation)}]', '', text)
    text = re.sub(r'\d+', '', text)
    return text.strip()

df['text'] = df['text'].apply(clean_text)

# 4. Tokenize and pad
tokenizer = Tokenizer()
tokenizer.fit_on_texts(df['text'])
sequences = tokenizer.texts_to_sequences(df['text'])

max_len = 100
X = pad_sequences(sequences, maxlen=max_len)
y = df['label'].values

# 5. Split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
↪random_state=42)

# 6. LSTM Model
model = Sequential()
model.add(Embedding(input_dim=len(tokenizer.word_index) + 1, output_dim=64,␣
↪input_length=max_len))
model.add(LSTM(64, dropout=0.2, recurrent_dropout=0.2))
model.add(Dense(1, activation='sigmoid'))
```

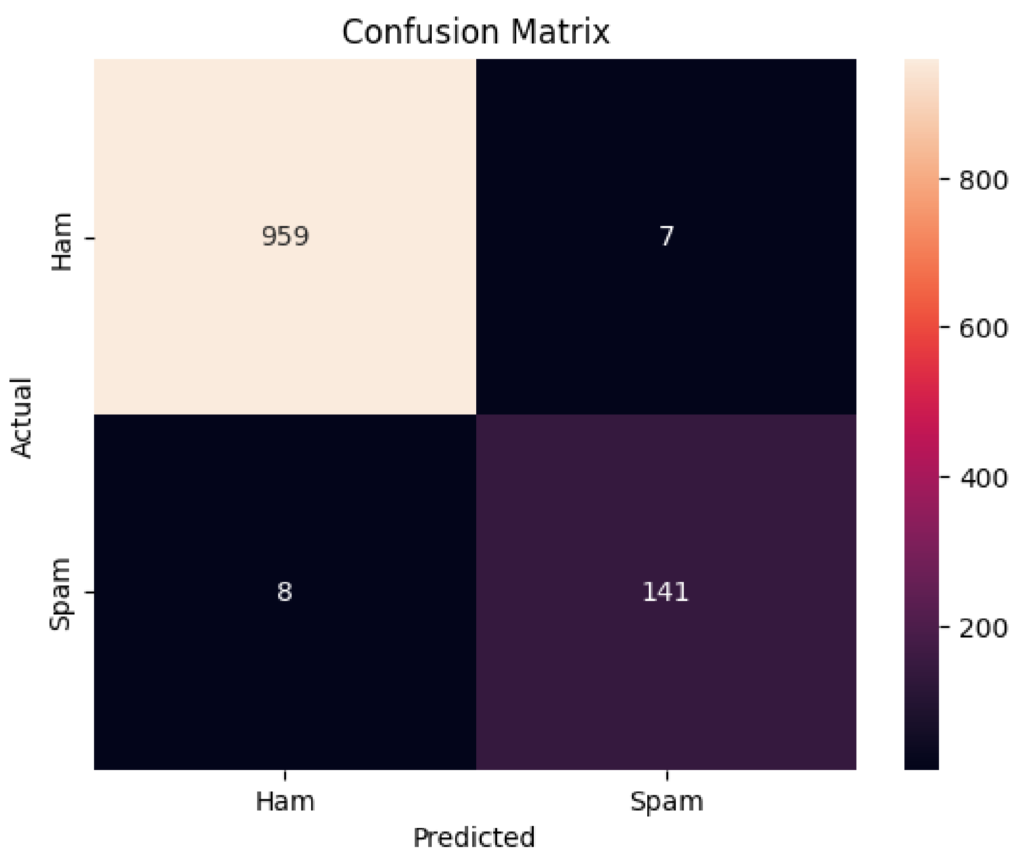
```python
model.compile(loss='binary_crossentropy', optimizer='adam',␣
↪metrics=['accuracy'])

# 7. Train
history = model.fit(X_train, y_train, epochs=5, batch_size=32,␣
↪validation_split=0.1)

# 8. Evaluate
loss, acc = model.evaluate(X_test, y_test)
print(f"Accuracy: {acc * 100:.2f}%")

# 9. Classification report and confusion matrix
y_pred = (model.predict(X_test) > 0.5).astype("int32")
print(classification_report(y_test, y_pred, target_names=["Ham", "Spam"]))

cm = confusion_matrix(y_test, y_pred)
sns.heatmap(cm, annot=True, fmt='d', xticklabels=["Ham", "Spam"],␣
↪yticklabels=["Ham", "Spam"])
plt.title('Confusion Matrix')
plt.xlabel('Predicted')
plt.ylabel('Actual')
plt.show()

# 10. Training curves
plt.plot(history.history['accuracy'], label="Train Accuracy")
plt.plot(history.history['val_accuracy'], label="Val Accuracy")
plt.title("Accuracy over Epochs")
plt.legend()
plt.show()

plt.plot(history.history['loss'], label="Train Loss")
plt.plot(history.history['val_loss'], label="Val Loss")
plt.title("Loss over Epochs")
plt.legend()
plt.show()
```

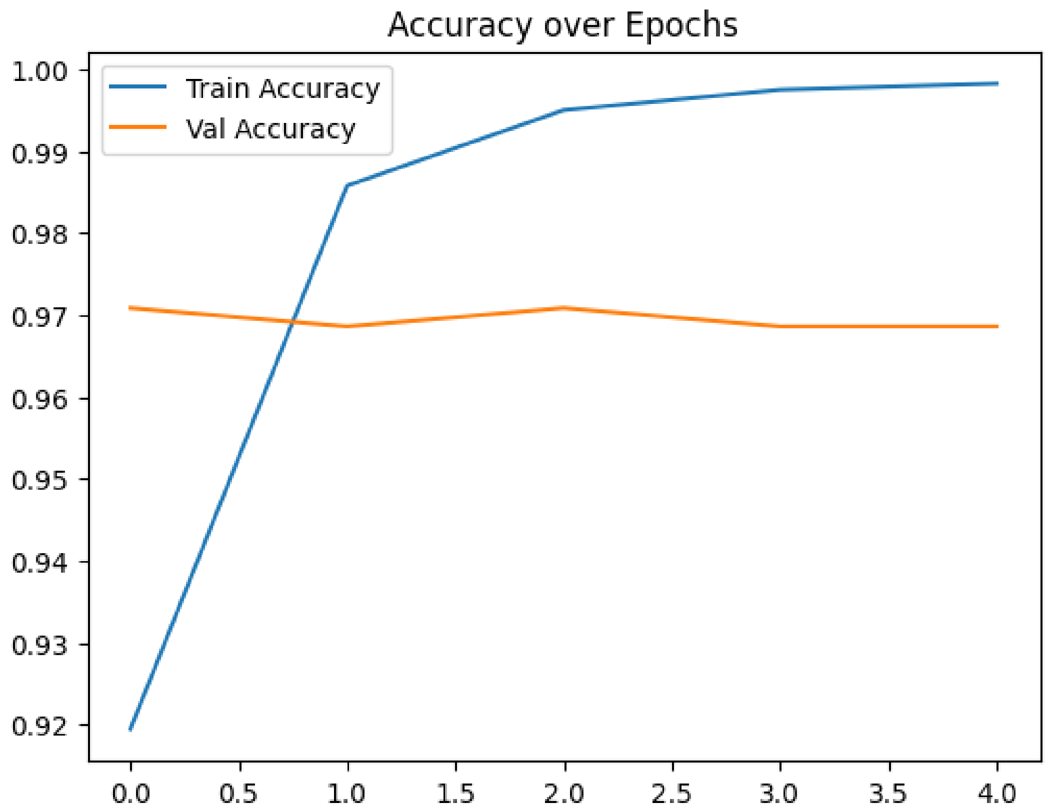
```
Epoch 1/5
```

```
/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(
```

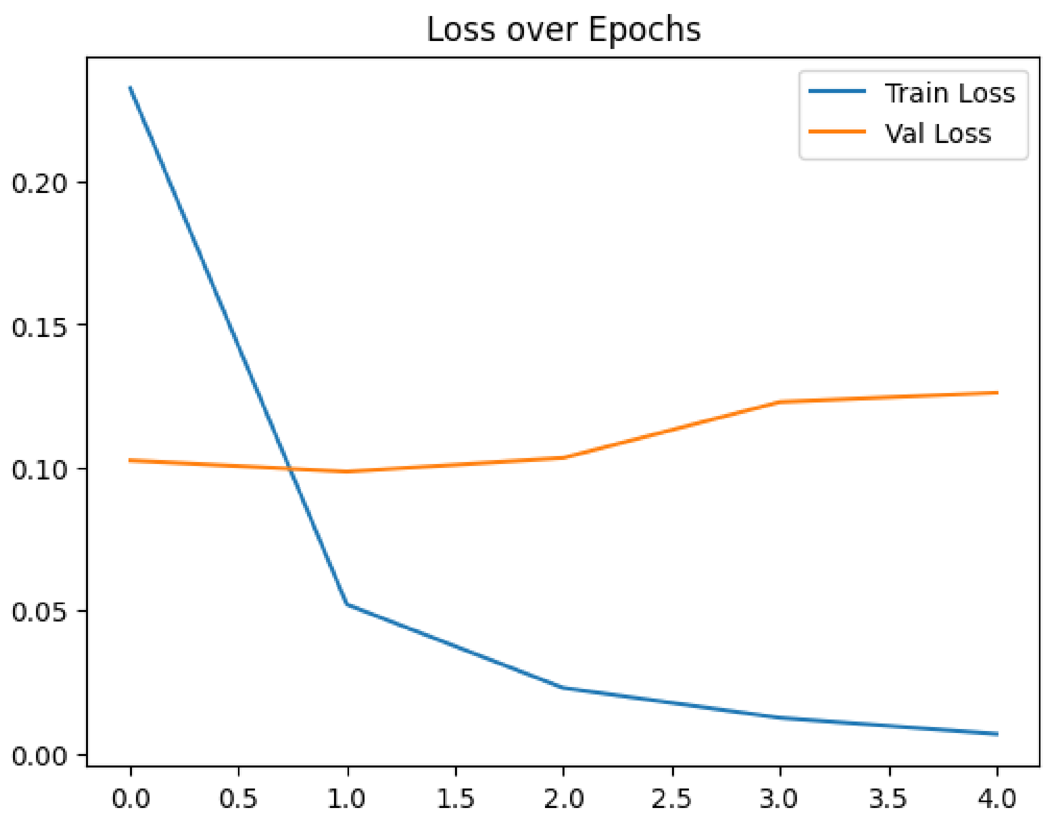
```
126/126              46s 337ms/step -
accuracy: 0.8706 - loss: 0.3626 - val_accuracy: 0.9709 - val_loss: 0.1024
Epoch 2/5
126/126              81s 331ms/step -
accuracy: 0.9825 - loss: 0.0637 - val_accuracy: 0.9686 - val_loss: 0.0985
Epoch 3/5
```

```
126/126              81s 324ms/step -
accuracy: 0.9951 - loss: 0.0287 - val_accuracy: 0.9709 - val_loss: 0.1033
Epoch 4/5
126/126              42s 333ms/step -
accuracy: 0.9978 - loss: 0.0125 - val_accuracy: 0.9686 - val_loss: 0.1228
Epoch 5/5
126/126              83s 346ms/step -
accuracy: 0.9990 - loss: 0.0054 - val_accuracy: 0.9686 - val_loss: 0.1261
35/35              2s 55ms/step -
accuracy: 0.9859 - loss: 0.0509
Accuracy: 98.65%
35/35              3s 83ms/step
              precision    recall  f1-score   support

         Ham       0.99      0.99      0.99       966
        Spam       0.95      0.95      0.95       149

    accuracy                           0.99      1115
   macro avg       0.97      0.97      0.97      1115
weighted avg       0.99      0.99      0.99      1115
```





Accuracy over Epochs
Train Accuracy
Val Accuracy
1.00
0.99
0.98
0.97
0.96
0.95
0.94
0.93
0.92
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0



Discussion and Conclusion on Result Analysis

Declaration

I, Siddhant Mishra, confirm that the work submitted in this assignment is my own and has been completed following academic integrity guidelines. The code is uploaded on my GitHub repository account, and the repository link is provided below:

Signature: Siddhant Mishra

Submission Checklist

Ultralitycs Platform Documentsation Like hel file for Given Task

Code file (Python Notebook or Script)

Dataset or link to the dataset

Visualizations (if applicable)

Screenshots of model performance metrics

Readme File

Evaluation Metrics Details and discussion