EX.NO:09
09.10.25

BUILD A RECURRENT NEURAL NETWORK

AIM

To build and train a recurrent neural network to analyze sequential data and understand temporal relationships.

objectives

1. To study the architecture of a recurrent neural network.
2. To implement a simple RNN model using Tensorflow / keras
3. To compare the RNN's performance with LSTM
4. To visualize and analyze how the model learns from sequential data.

pseudocode

Start

1. Import necessary libraries (tensorflow / keras, numpy, matplotlib)
2. Load and preprocess a sequence dataset
3. Convert input sequences to padded vectors
4. Define RNN model

Embedding layer (for text input)

SimpleRNN layer (units = 64)

Dense layer with Relu activation

Output dense layer with Sigmoid Activation.

5. Compile model
   Optimizer : Adam
   Loss : Binary crossentropy
   Metrics : Accuracy

6. Train model using training data and validate with test data

7. Evaluate model performance and visualize training curves

8. predict on new sequence input

End.

Observation

1. Training Analysis

The RNN learned to map input sequences to sentiment labels, but training took longer compared to feedforward networks.

2. performance comparison

Accuracy of RNN was moderate (~80.1%), slightly lower than LSTM.

3. Model learning

the hidden state updated dynamically with each timestep showing how RNNs handle temporal data

4. Loss and Accuracy Trends

Both training and validation loss decreased over epochs.

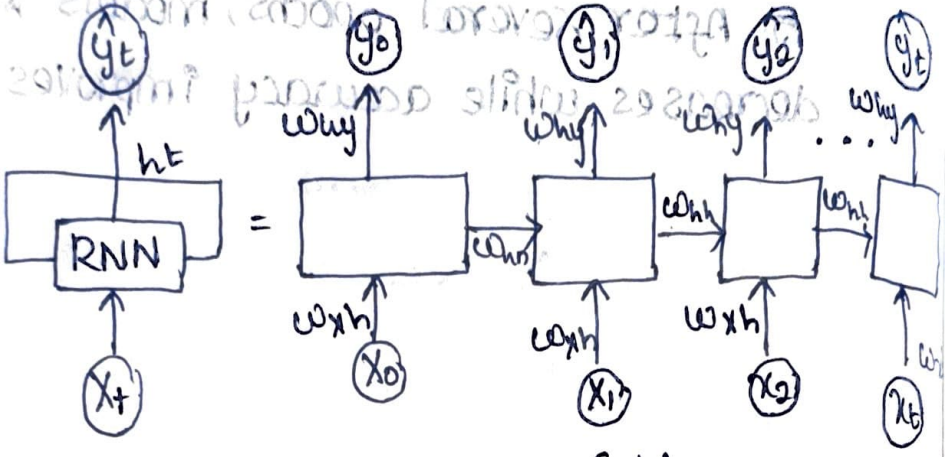
5. Limitations and Insights

Advanced variants like LSTM and GRU address these issues efficiently.

Result

implemented Build a Recurrent neural network.

RNN architecture



$h_t = f_w(x_t, h_{t-1})$ ← function with weight

- h_t → cell state
- x_t → Inputs
- h_{t-1} → old state

Output vector

$$\hat{y}_t = W_{hy}^T h_t$$

update vector

$$h_t = \tanh(W_{hh}^T h_{t-1} + W_{xh}^T x_t)$$

Input vector

x_t

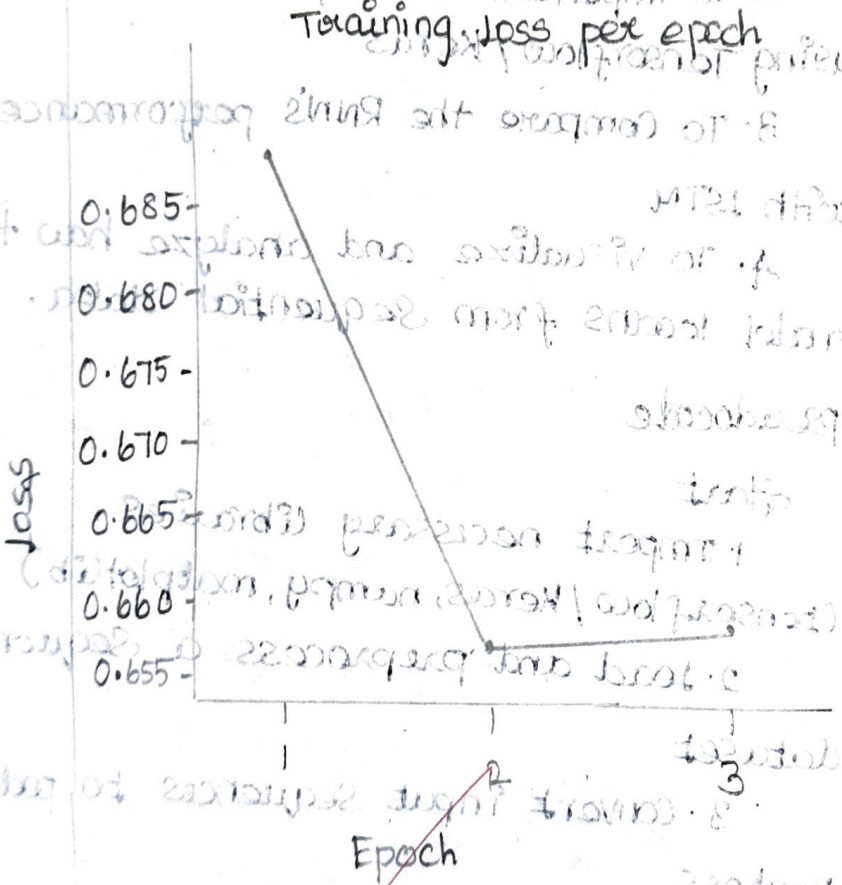
Output

Epoch 1 ; Training loss : 0.6868

Epoch 2 , Training loss : 0.6562

Epoch 3 , Training loss : 0.6567

Test Accuracy : 51.18%



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Code | Notebook | Python 3 (ipykernel)

[1]:
```
import pandas as pd
```

[7]:
```
df=pd.read_csv("IMDB Dataset.csv")
```

[8]:
```
df.head(5)
```

[8]:

	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

[9]:
```
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences
```

```
2025-09-23 08:48:52.757119: E external/local_xla/xla/stream_executor/cuda/cuda_fft.cc:467] Unable to register cuFFT factory: Attempting to register factory for plugin cuFFT when one has already been registered
WARNING: All log messages before absl::InitializeLog() is called are written to STDERR
E0000 00:00:1758597532.923064  381952 cuda_dnn.cc:8579] Unable to register cuDNN factory: Attempting to register factory for plugin cuDNN when one has already been registered
E0000 00:00:1758597532.996783  381952 cuda_blas.cc:1407] Unable to register cuBLAS factory: Attempting to register factory for plugin cuBLAS when one has already been registered
W0000 00:00:1758597534.217134  381952 computation_placer.cc:177] computation placer already registered. Please check linkage and avoid linking the same target more than once.
W0000 00:00:1758597534.217186  381952 computation_placer.cc:177] computation placer already registered. Please check linkage and avoid linking the same target more than once.
W0000 00:00:1758597534.217194  381952 computation_placer.cc:177] computation placer already registered. Please check linkage and avoid linking the same target more than once.
W0000 00:00:1758597534.217200  381952 computation_placer.cc:177] computation placer already registered. Please check linkage and avoid linking the same target more than once.
2025-09-23 08:48:54.309572: I tensorflow/core/platform/cpu_feature_guard.cc:210] This TensorFlow binary is optimized to use available CPU instructions in performance-critical operations.
```

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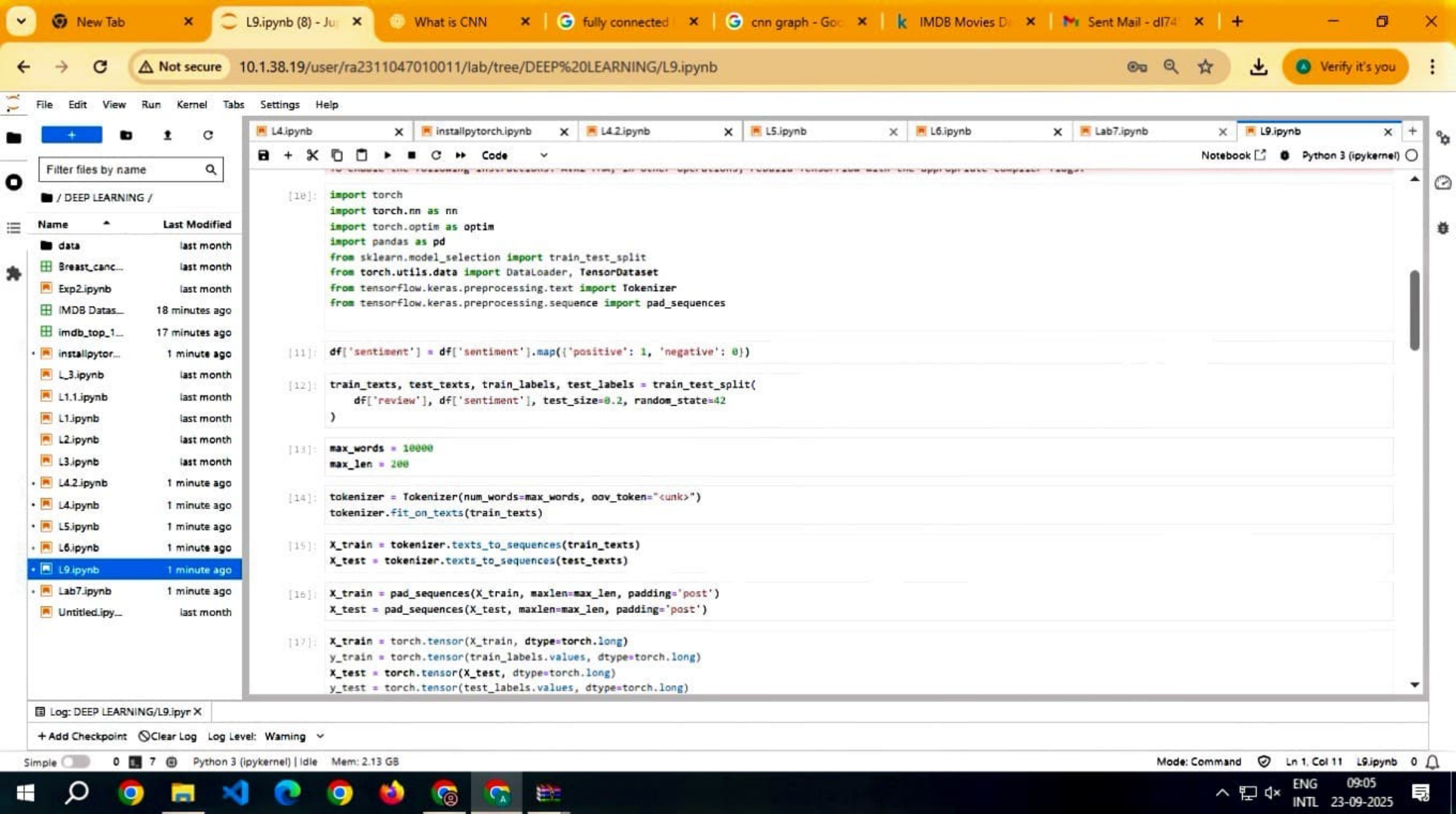
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Lab7.ipynb
L9.ipynb
Code
Notebook
Python 3 (ipykernel)
[10]:
import torch
import torch.nn as nn
import torch.optim as optim
import pandas as pd
from sklearn.model_selection import train_test_split
from torch.utils.data import DataLoader, TensorDataset
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences
[11]:
df['sentiment'] = df['sentiment'].map({'positive': 1, 'negative': 0})
[12]:
train_texts, test_texts, train_labels, test_labels = train_test_split(
df['review'], df['sentiment'], test_size=0.2, random_state=42
)
[13]:
max_words = 10000
max_len = 200
[14]:
tokenizer = Tokenizer(num_words=max_words, oov_token="<unk>")
tokenizer.fit_on_texts(train_texts)
[15]:
X_train = tokenizer.texts_to_sequences(train_texts)
X_test = tokenizer.texts_to_sequences(test_texts)
[16]:
X_train = pad_sequences(X_train, maxlen=max_len, padding='post')
X_test = pad_sequences(X_test, maxlen=max_len, padding='post')
[17]:
X_train = torch.tensor(X_train, dtype=torch.long)
y_train = torch.tensor(train_labels.values, dtype=torch.long)
X_test = torch.tensor(X_test, dtype=torch.long)
y_test = torch.tensor(test_labels.values, dtype=torch.long)
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```
train_data = TensorDataset(X_train, y_train)
test_data = TensorDataset(X_test, y_test)
```

```
train_loader = DataLoader(train_data, batch_size=32, shuffle=True)
test_loader = DataLoader(test_data, batch_size=32)
```

```
class RNNClassifier(nn.Module):
    def __init__(self, vocab_size, embed_dim, hidden_dim, output_dim):
        super(RNNClassifier, self).__init__()
        self.embedding = nn.Embedding(vocab_size, embed_dim)
        self.rnn = nn.RNN(embed_dim, hidden_dim, batch_first=True)
        self.fc = nn.Linear(hidden_dim, output_dim)

    def forward(self, x):
        embedded = self.embedding(x)
        output, hidden = self.rnn(embedded)
        return self.fc(hidden.squeeze(0))
```

```
vocab_size = max_words
embed_dim = 64
hidden_dim = 128
output_dim = 2
```

```
model = RNNClassifier(vocab_size, embed_dim, hidden_dim, output_dim)
```

```
criterion = nn.CrossEntropyLoss()
optimizer = optim.Adam(model.parameters(), lr=0.001)
```

```
train_losses = []

for epoch in range(3):  # train for 3 epochs
    total_loss = 0
```

```
train_losses = []

for epoch in range(3):  # train for 3 epochs
    total_loss = 0
    model.train()
    for texts, labels in train_loader:
        optimizer.zero_grad()
        outputs = model(texts)
        loss = criterion(outputs, labels)
        loss.backward()
        optimizer.step()
        total_loss += loss.item()

    avg_loss = total_loss / len(train_loader)
    train_losses.append(avg_loss)
    print(f"Epoch {epoch+1}, Training Loss: {avg_loss:.4f}")
```

```
Epoch 1, Training Loss: 0.6868
Epoch 2, Training Loss: 0.6562
Epoch 3, Training Loss: 0.6567
```

```
model.eval()
correct, total = 0, 0
with torch.no_grad():
    for texts, labels in test_loader:
        outputs = model(texts)
        predictions = torch.argmax(outputs, dim=1)
        correct += (predictions == labels).sum().item()
        total += labels.size(0)

print(f"Test Accuracy: {100 * correct / total:.2f}%")
```

```
Test Accuracy: 57.18%
```

```
import matplotlib.pyplot as plt
```

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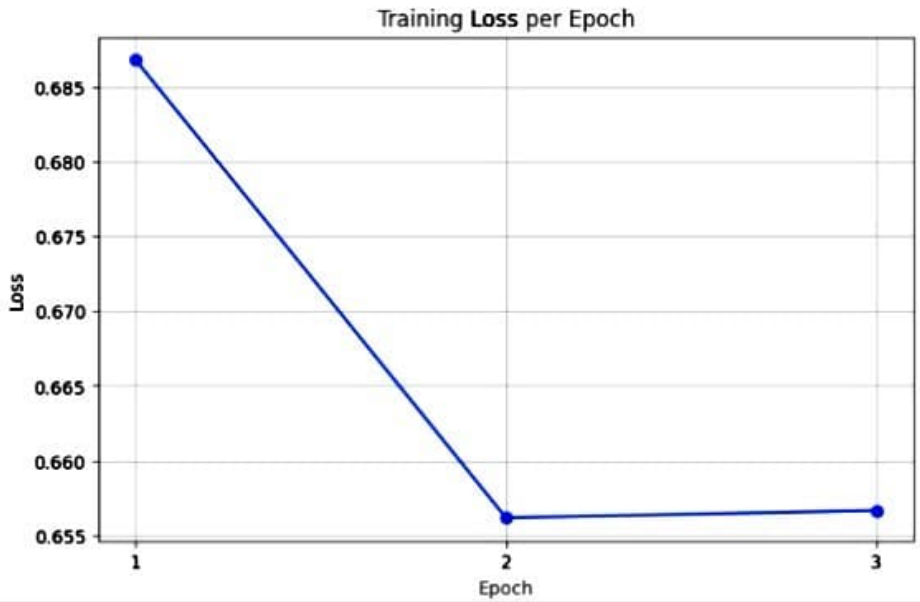
Code | Notebook | Python 3 (ipykernel)

```
[27]: plt.figure(figsize=(8,5))
plt.plot(range(1, len(train_losses)+1), train_losses, marker='o', color='blue')
plt.title("Training Loss per Epoch")
plt.xlabel("Epoch")
plt.ylabel("Loss")
plt.xticks(range(1, len(train_losses)+1))
plt.grid(True)
plt.show()
```



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