# REPORT

**ASSIGNMENT-01 NEURAL NETWORKS ADVANCED MACHINE LEARNING:64061**

**Introduction**  
An examination of a neural network model used for sentiment analysis with the IMDB dataset is presented. Data preprocessing, model construction, training, and evaluation are all included in the study. Additional information is offered in the form of conclusions, recommendations, comments, methods, and findings.

**Procedures**

1. **Loading the Dataset**

TensorFlow's imdb.load\_data() function was used to load the dataset, restricting the vocabulary size to the 10,000 most common words. After that, the dataset was divided into test and training sets. The structure of the data was examined, and preprocessing was done appropriately.

1. **Data Preprocessing**

To make integer sequences appropriate for the neural network model, they were transformed into multi-hot encoded vectors. Additionally, labels were transformed into float32 and 64 type NumPy arrays to guarantee TensorFlow operations were compatible.

1. **Building the Model:**

Four completely connected layers made up the neural network design. Tanh was the activation function utilised for hidden layers, and sigmoid was used for the output layer. To avoid overfitting, dropout layers (rate=0.5) and L2 regularisation (0.005) were used. The model was constructed with accuracy as the main evaluation parameter, the Mean Squared Error (MSE) as the loss function, and the RMSprop optimiser for stability and adaptive learning rate**.**

1. **Training and Validation**

Training and validation sets were created by further dividing the dataset. For 20 epochs, the model was trained with a batch size of 512. Losses and accuracies during training and validation were tracked to make sure the model was learning efficiently and not overfitting**.**

1. **Evaluation on Test Data**

To assess the trained model's capacity for generalisation, it was put to the test using unobserved data. To assess its ultimate performance, the accuracy and loss were noted

**Findings**

Training accuracy rose from 73.29% to 93.85%, demonstrating successful learning. The validation accuracy increased from 82.22% to 87.61%, demonstrating the model's strong ability to generalise to new data. Loss values steadily dropped throughout training, indicating increased prediction confidence. 86.80% test accuracy was attained in the end, with an MSE of 0.1313. Furthermore, the test accuracy was marginally increased to 88% by employing the Adam optimiser rather than RMSprop, indicating its efficacy for this task.

**Comments**  
  
Although the tanh activation function performed well, more research using ReLU may produce greater outcomes. Dropout layers were a successful way to reduce overfitting. Performance was marginally better using the Adam optimiser than with RMSprop. Extending the epoch count beyond 20 may improve accuracy, but it may also result in overfitting. The choice of batch size also significantly affected training time and model stability.

**In conclusion**  
With validation and test accuracies at 88%, the sentiment analysis model utilising a four-layer neural network was effectively deployed and showed excellent performance. The study emphasises how crucial it is to choose the right regularisation strategies, optimisation methods, and activation functions while training neural networks. The findings show that the model can correctly categorise the emotion of IMDB movie reviews.

**Recommendations**

Experimenting with ReLU activation may help enhance model performance even further. Gradient updates could be stabilised by putting batch normalisation into practice. The efficiency of regularisation could be maximised by testing various dropout rates. For improved hyperparameter tuning, cross-validation ought to be taken into consideration. Further enhancements may also result from adjusting hyperparameters like learning rate and L2 regularisation strength.

**Summary of Validation Losses in Tabulated Form**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Nodes** | **Layers** | **Activation** | **Loss Function** | **Regularization** | **Validation Loss** |
| 16 | 3 | tanh | MSE | Yes | 0.12 |
| 16 | 3 | BCE | MSE | Yes | 0.58 |
| 32 | 3 | ReLU | MSE | Yes | 0.13 |
| 32 | 3 | BCE | MSE | Yes | 0.4 |
| 32 | 3 | tanh | MSE | Yes | 0.1 |
| 32 | 3 | BCE | MSE | Yes | 0.6 |
| 64 | 3 | ReLU | MSE | Yes | 0.13 |
| 64 | 3 | BCE | MSE | Yes | 0.7 |
| 64 | 3 | tanh | MSE | Yes | 0.1 |

**Validation and Training Accuracy**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Nodes | Layers | Activation | Regularization | Validation Accuracy |
| 16 | 3 | tanh | l2 & Dropout | 87% |
| 32 | 3 | tanh | l2 & Dropout | 87% |
| 64 | 3 | tanh | l2 & Dropout |  |

**Test Accuracy and Test loss**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Model | Activation | Epochs | Test Accuracy | Test Loss |
| Nodes=64, Layers=3, tanh | tanh | 4 | 88% | 16.32 |
| Nodes=64, Layers=3, relu | relu | 4 | 86% | 21.25 |