

Report on

Deep Learning and Applications (CS671)

Assignment 6



Submitted by:

GROUP - 9

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Assignment Problem Statement

In this assignment , the key objective is to get inference from each Handwritten and ConsonantVowel architecture based on RNN on various neural architecture.

We are using a Handwritten Sequence dataset for RNN and labels for classification of the written sequence And in case of consonant vowels we are using Mel Energy frequency feature vector to classify the vowel said by the individual, that is based on RNN architecture.

Overall Result:

Task	Neural Architect ure	Neural Architecture	No. of Epochs	Training Accuracy	Testing Accuracy
Handwritten	RNN	Architecture_32	174	0.45	0.47
		Architecture_64	268	0.51	0.58
		Architecture_128	141	0.40	0.43
		Architecture_256	141	0.42	0.44
		Architecture_32_64	214	0.77	0.74
		Architecture_64_128	67	0.45	0.50
		Architecture_128_256	85	0.45	0.46
		Architecture_32_64_128	79	0.42	0.42
		Architecture_64_128_256	91	0.47	0.46
		Architecture_32_64_128_256	129	0.4	0.46
Handwritten	LSTM	Architecture_32	93	0.83	0.93
		Architecture_64	83	0.90	0.97
		Architecture_128	113	0.94	0.9
		Architecture_256	41	0.41	0.48
		Architecture_32_64	110	0.99	0.99
		Architecture_64_128	81	0.91	0.91
		Architecture_128_256	57	0.89	0.96
		Architecture_32_64_128	149	1	0.99

Task	Neural Architect ure	Neural Architecture	No. of Epochs	Training Accuracy	Testing Accuracy
		Architecture_64_128_256	85	0.9883	0.99
		Architecture_32_64_128_256	117	0.97	0.98
Consonant Vowel	RNN	Architecture_32	151	0.9377	0.5864
		Architecture_64	107	0.99	0.597
		Architecture_128	68	0.9972	0.7135
		Architecture_256	46	0.9634	0.7054
		Architecture_32_64	102	0.9905	0.7000
		Architecture_64_128	67	0.9722	0.7675
		Architecture_128_256	61	0.9993	0.7783
		Architecture_32_64_128	53	0.9479	0.7432
		Architecture_64_128_256	59	0.9580	0.8135
		Architecture_32_64_128_256	33	0.8193	0.7621
Consonant Vowel	LSTM	Architecture_32	74	0.99	0.78
		Architecture_64	67	1.0	0.86
		Architecture_128	58	1.0	0.86
		Architecture_256	45	1.0	0.87
		Architecture_32_64	88	1.0	0.84
		Architecture_64_128	52	1.0	0.86
		Architecture_128_256	27	1.0	0.9
		Architecture_32_64_128	65	1.0	0.85
		Architecture_64_128_256	50	0.98	0.86
		Architecture_32_64_128_256	65	1.0	0.85

* Mark in bold is Best architecture according to the Training accuracy

1.1. Handwritten Task

Normalized training of the handwritten is used to get the randomly 5 images from each class.

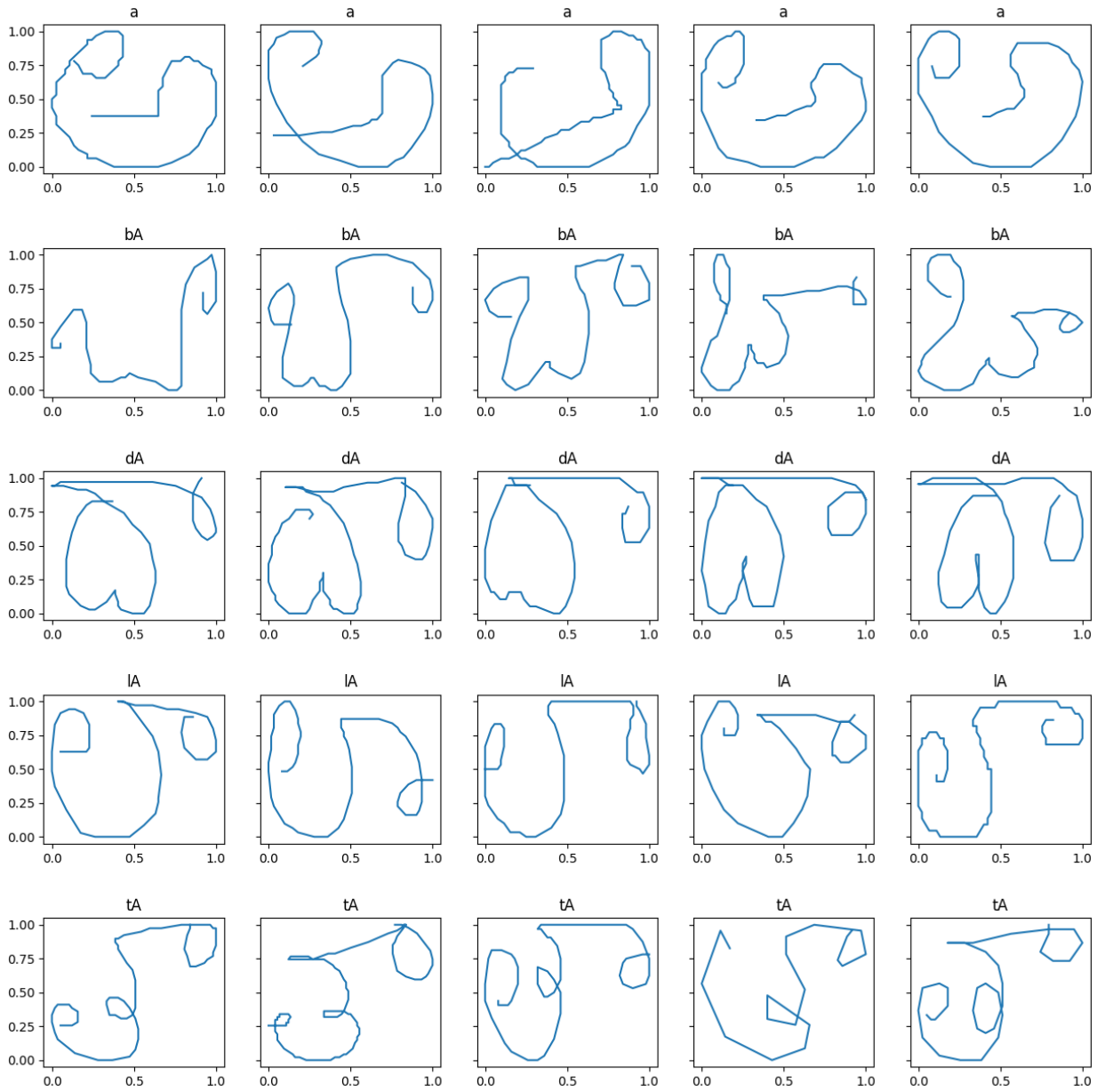


Fig. Handwritten representation of the training data of each class 5 image

1.1.1 RNN Architecture:

Hyperparameters:

- Convergence Criteria: Difference of 10^{-3} loss between successive epoch
- Learning Rate: 0.0001
- Optimiser: Adam
- Activation function: Softmax Activation
- Loss function: Cross entropy loss

1.1.1.1. RNN Architecture (32) Configuration

Architecture 1		
Layer	Hidden Unit	Activation Function
RNN	32	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. RNN Architecture 1 with hidden parameter representation

1.1.1.2 RNN Architecture (64) Configuration

Architecture 2		
Layer	Hidden Unit	Activation Function
RNN	64	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. RNN Architecture 2 with hidden parameter representation

Results:

Training Accuracy: **0.45**

Test Accuracy: **0.47**

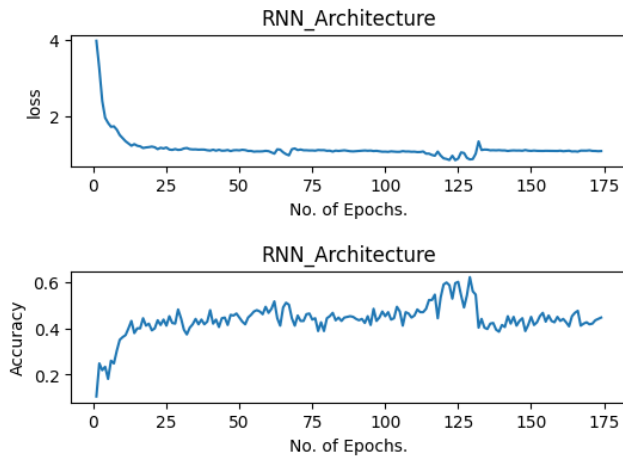


Fig.: Loss and Accuracy graph of RNN Arch. 1st

Results:

Training Accuracy: **0.51**

Test Accuracy: **0.58**

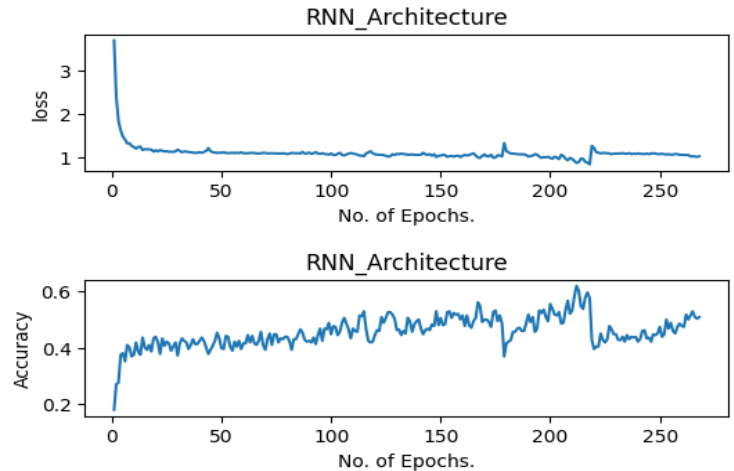


Fig.: Loss and Accuracy graph of RNN Arch. 2nd

1.1.1.3. RNN Architecture (128) Configuration

Architecture 3		
Layer	Hidden Unit	Activation Function
RNN	128	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. RNN Architecture 3 with hidden parameter representation

Results:

Training Accuracy: **0.4**

Test Accuracy: **0.43**

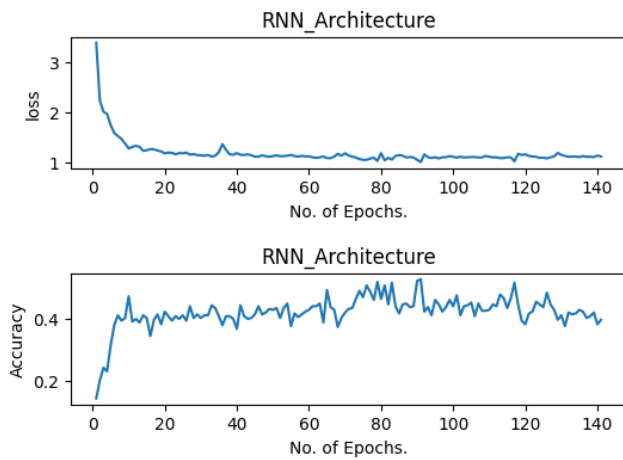


Fig.: Loss and Accuracy graph of RNN Arch. 3rd

1.1.1.4 RNN Architecture (256) Configuration

Architecture 4		
Layer	Hidden Unit	Activation Function
RNN	256	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. RNN Architecture 4 with hidden parameter representation

Results:

Training Accuracy: **0.42**

Test Accuracy: **0.44**

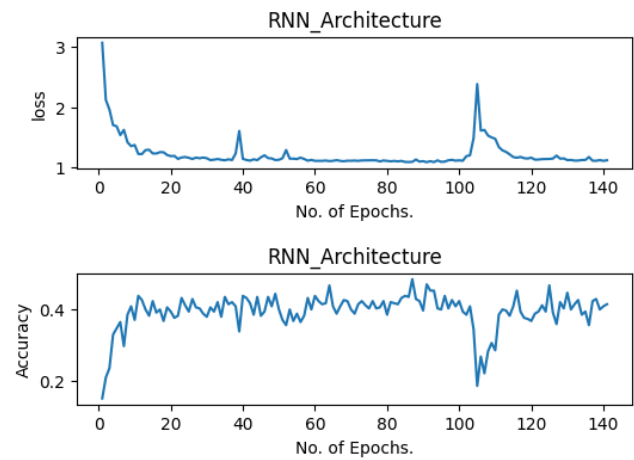


Fig.: Loss and Accuracy graph of RNN Arch. 4th

1.1.1.5. RNN Architecture (32,64) Configuration

Architecture 5		
Layer	Hidden Unit	Activation Function
RNN	32	Hyperbolic tangent
RNN	64	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. RNN Architecture 5 with hidden parameter representation

Results:

Training Accuracy: **0.77**

Test Accuracy: **0.74**

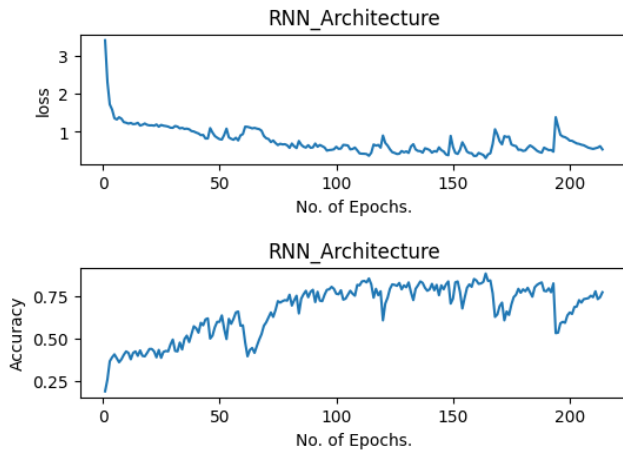


Fig.: Loss and Accuracy graph of RNN Arch. 5th

1.1.1.6 RNN Architecture (64,128) Configuration

Architecture 6		
Layer	Hidden Unit	Activation Function
RNN	64	Hyperbolic tangent
RNN	128	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. RNN Architecture 6 with hidden parameter representation

Results:

Training Accuracy: **0.45**

Test Accuracy: **0.50**

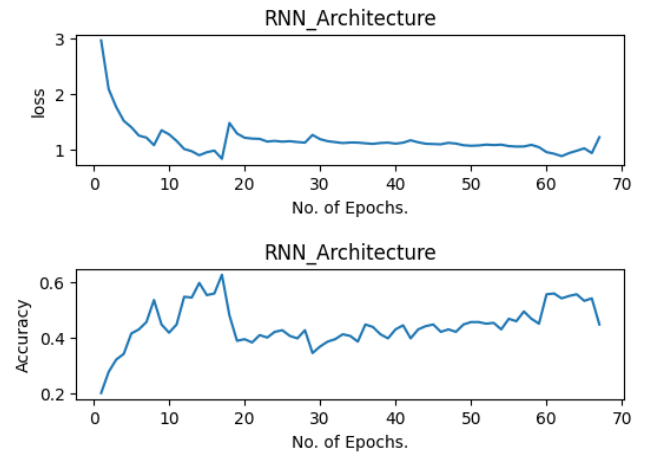


Fig.: Loss and Accuracy graph of RNN Arch. 6th

Architecture 7		
Layer	Hidden Unit	Activation Function
RNN	128	Hyperbolic tangent
RNN	256	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. RNN Architecture 7 with hidden parameter representation

Architecture 8		
Layer	Hidden Unit	Activation Function
RNN	32	Hyperbolic tangent
RNN	64	Hyperbolic tangent
RNN	128	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. RNN Architecture 8 with hidden parameter representation

Results:

Training Accuracy: **0.45**

Test Accuracy: **0.46**

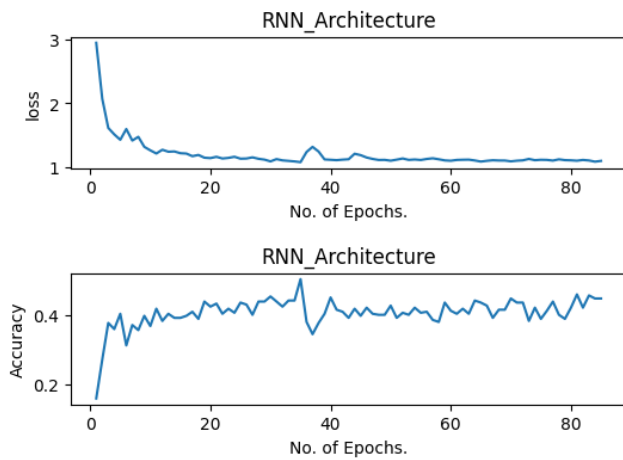


Fig.: Loss and Accuracy graph of RNN Arch. 7th

Results:

Training Accuracy: **0.42**

Test Accuracy: **0.42**

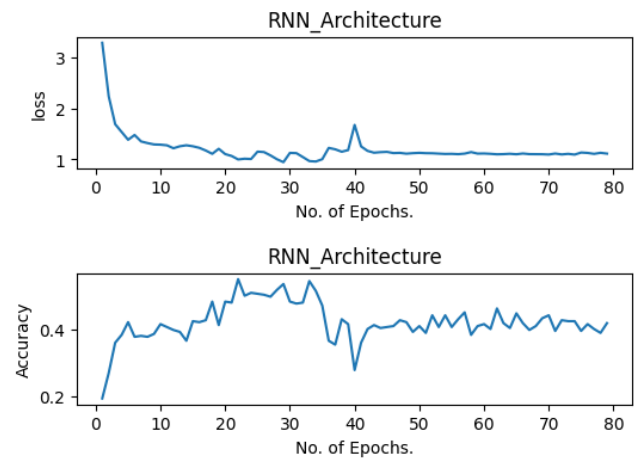


Fig.: Loss and Accuracy graph of RNN Arch. 8th

Architecture 9		
Layer	Hidden Unit	Activation Function
RNN	64	Hyperbolic tangent
RNN	128	Hyperbolic tangent
RNN	256	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. RNN Architecture 9 with hidden parameter representation

Results:

Training Accuracy: **0.47**

Test Accuracy: **0.46**

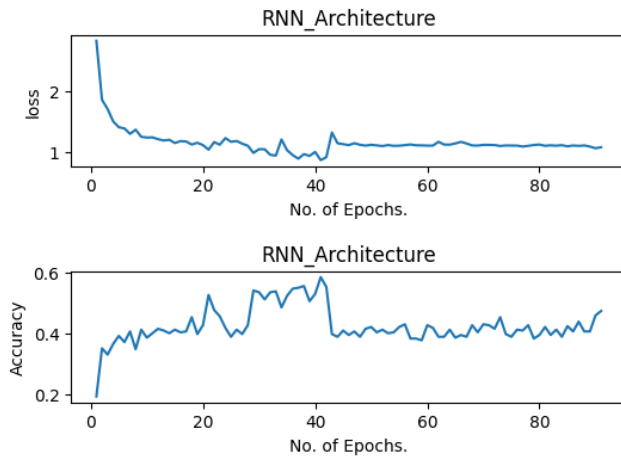


Fig.: Loss and Accuracy graph of RNN Arch. 9th

Architecture 10		
Layer	Hidden Unit	Activation Function
RNN	32	Hyperbolic tangent
RNN	64	Hyperbolic tangent
RNN	128	Hyperbolic tangent
RNN	256	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. RNN Architecture 10 with hidden parameter representation

Results:

Training Accuracy: **0.4**

Test Accuracy: **0.46**

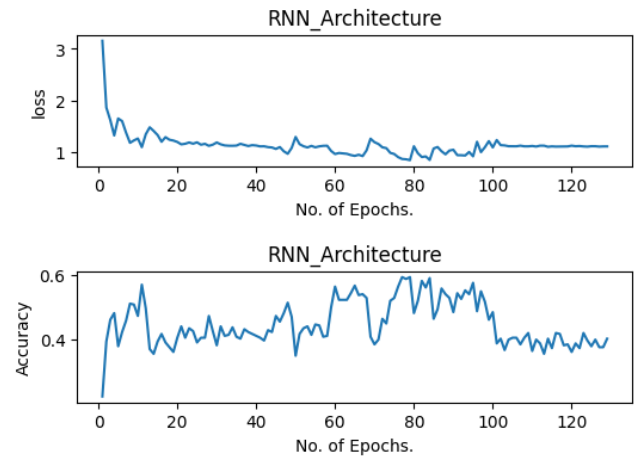


Fig.: Loss and Accuracy graph of RNN Arch. 10th

Best Model Confusion Matrix:

Model Architecture: **Architecture (32,64)**

Training Accuracy: **0.77**

Test Accuracy: **0.74**

Predicted label	Actual Label					
		a	bA	dA	lA	tA
	a	20	0	0	0	0
	bA	0	12	0	2	6
	dA	0	0	19	0	1
	lA	0	5	0	15	0
	tA	0	1	11	0	8

1.1.2 LSTM Architecture:

Hyperparameters:

- Convergence Criteria: Difference of 10^{-3} loss between successive epoch
- Learning Rate: 0.0001
- Optimiser: Adam
- Activation function: Softmax Activation
- Loss function: Cross entropy loss

1.1.2.1. LSTM Architecture (32) Configuration

Architecture 1		
Layer	Layer	Layer
LSTM	32	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. LSTM Architecture 1 with hidden parameter

1.1.2.2 LSTM Architecture (64) Configuration

Architecture 2		
Layer	Layer	Layer
LSTM	64	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. LSTM Architecture 2 with hidden parameter

Results:

Training Accuracy: **0.83**

Test Accuracy: **0.93**

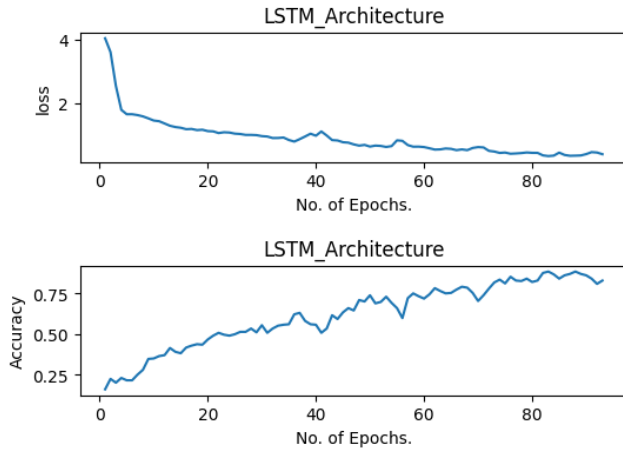


Fig.: Loss and Accuracy graph of LSTM Arch. 1st

Results:

Training Accuracy: **0.9**

Test Accuracy: **0.97**

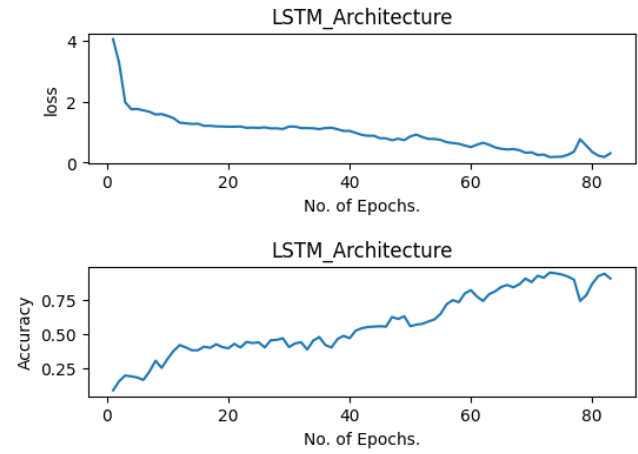


Fig.: Loss and Accuracy graph of RNN Arch. 2nd

1.1.2.3. LSTM Architecture (128) Configuration

Architecture 3		
Layer	Layer	Layer
LSTM	128	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. LSTM Architecture 3 with hidden parameter

1.1.2.4 LSTM Architecture (256) Configuration

Architecture 4		
Layer	Layer	Layer
LSTM	256	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. LSTM Architecture 4 with hidden parameter

Results:

Training Accuracy: **0.94**

Test Accuracy: **0.9**

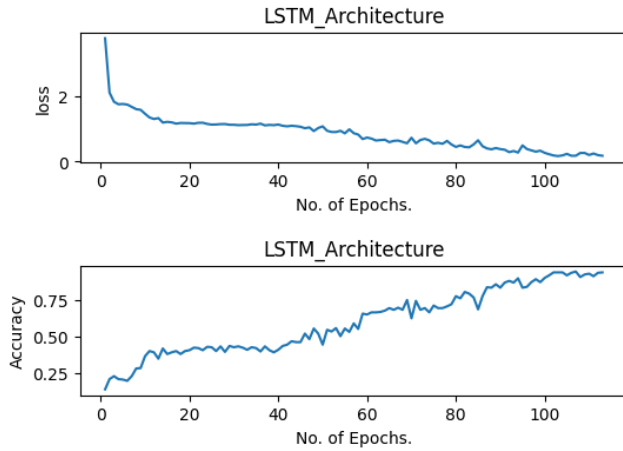


Fig.: Loss and Accuracy graph of LSTM Arch. 3rd

Results:

Training Accuracy: **0.41**

Test Accuracy: **0.48**

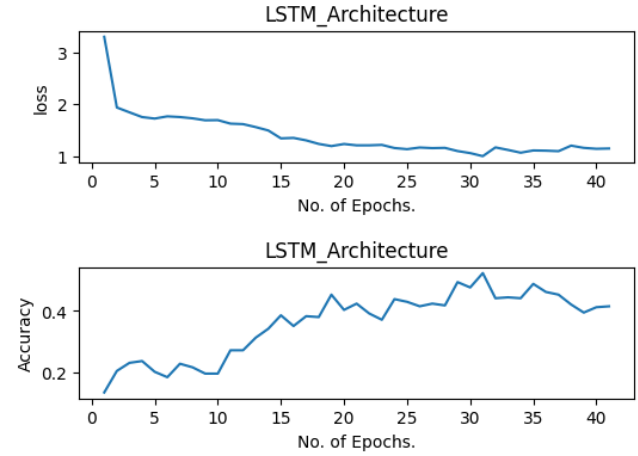


Fig.: Loss and Accuracy graph of RNN Arch. 4th

1.1.2.5. LSTM Architecture (32,64) Configuration

Architecture 5		
Layer	Layer	Layer
LSTM	32	Hyperbolic tangent
LSTM	64	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. LSTM Architecture 5 with hidden parameter

1.1.2.6 LSTM Architecture (64,128) Configuration

Architecture 6		
Layer	Layer	Layer
LSTM	64	Hyperbolic tangent
LSTM	128	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. LSTM Architecture 6 with hidden parameter

Results:

Training Accuracy: **0.99**

Test Accuracy: **0.99**

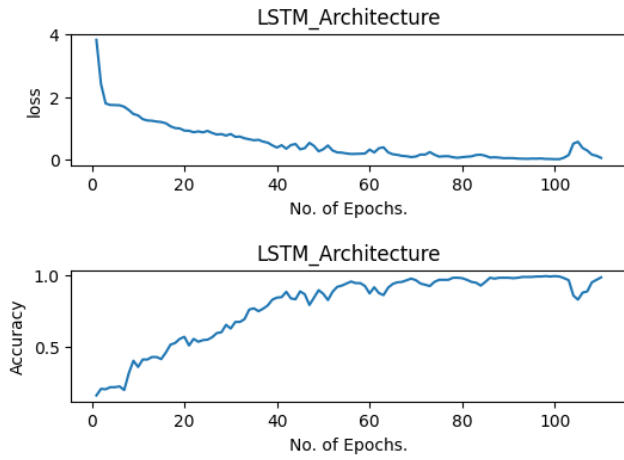


Fig.: Loss and Accuracy graph of LSTM Arch. 5th

Results:

Training Accuracy: **0.91**

Test Accuracy: **0.91**

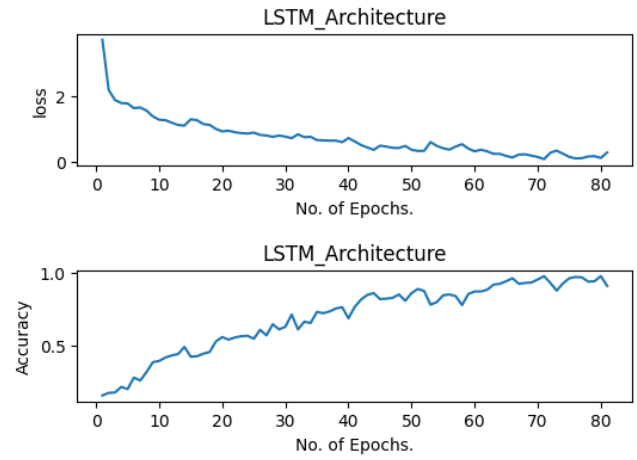


Fig.: Loss and Accuracy graph of RNN Arch. 6th

1.1.2.7. LSTM Architecture (128,256) Config

Architecture 7		
Layer	Layer	Layer
LSTM	128	Hyperbolic tangent
LSTM	256	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. LSTM Architecture 7 with hidden parameter

1.1.2.8 LSTM Architecture (32,64,128) Config

Architecture 8		
Layer	Layer	Layer
LSTM	32	Hyperbolic tangent
LSTM	64	Hyperbolic tangent
LSTM	128	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. LSTM Architecture 8 with hidden parameter

Results:

Training Accuracy: **0.89**

Test Accuracy: **0.96**

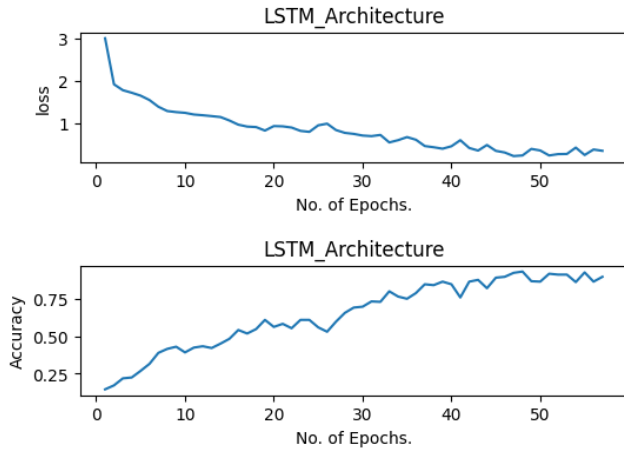


Fig.: Loss and Accuracy graph of LSTM Arch. 7th

1.1.2.9. LSTM Architecture (64,128,256) Config
Config

Architecture 9		
Layer	Layer	Layer
LSTM	64	Hyperbolic tangent
LSTM	128	Hyperbolic tangent
LSTM	256	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. LSTM Architecture 9 with hidden parameter

Results:

Training Accuracy: **1.0**

Test Accuracy: **0.99**

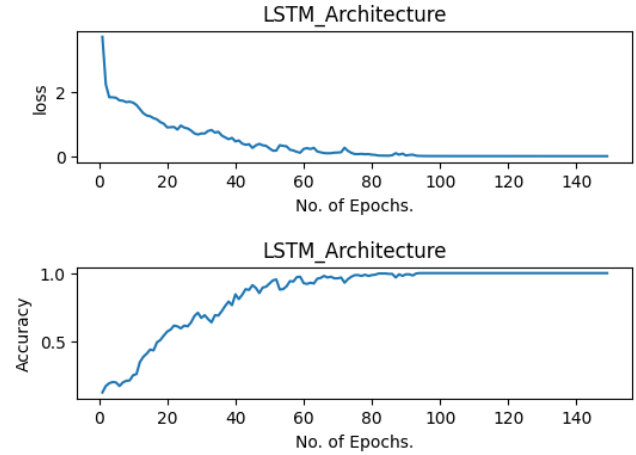


Fig.: Loss and Accuracy graph of RNN Arch. 8th

1.1.2.10 LSTM Architecture (32,64,128,256)

Architecture 10		
Layer	Layer	Layer
LSTM	32	Hyperbolic tangent
LSTM	64	Hyperbolic tangent
LSTM	128	Hyperbolic tangent
LSTM	256	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. LSTM Architecture 10 with hidden parameter

Results:

Training Accuracy: **0.98**

Test Accuracy: **0.99**

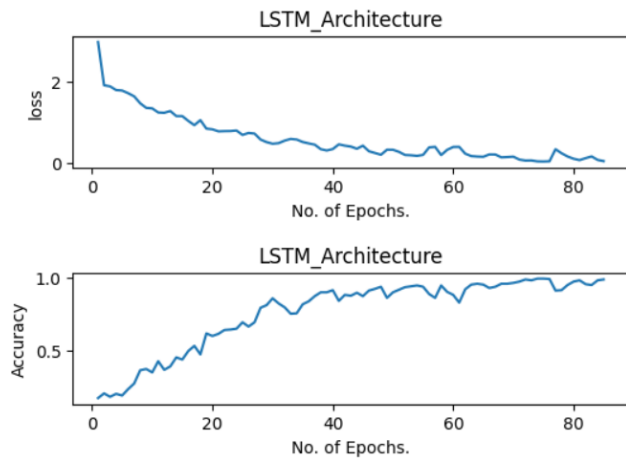


Fig.: Loss and Accuracy graph of LSTM Arch. 9th

Results:

Training Accuracy: **0.97**

Test Accuracy: **0.98**

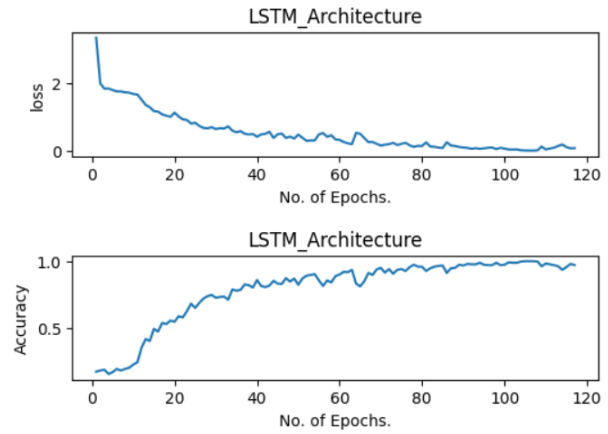


Fig.: Loss and Accuracy graph of RNN Arch. 10th

Best Model Confusion Matrix:

Model architecture: **Architecture (32,64,128)**

Training Accuracy: **1**

Test Accuracy: **0.99**

Predicted label	Actual Label					
		a	bA	dA	lA	tA
	a	20	0	0	0	0
	bA	0	20	0	0	0
	dA	0	0	20	0	0
	lA	0	5	0	19	1
	tA	0	0	0	0	20

1.2. ConsonantVowel Task

1.2.1 RNN Architecture:

Hyperparameters:

- Convergence Criteria: Difference of 10^{-3} loss between successive epoch
- Learning Rate: 0.0001
- Optimiser: Adam
- Activation function: Softmax Activation
- Loss function: Cross entropy loss

1.2.1.1. RNN Architecture (32) Configuration

Architecture 1		
Layer	Hidden Unit	Activation Function
RNN	32	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. RNN Architecture 1 with hidden parameter representation

1.2.1.2 RNN Architecture (64) Configuration

Architecture 2		
Layer	Hidden Unit	Activation Function
RNN	64	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. RNN Architecture 2 with hidden parameter representation

Results:

Training Accuracy: **0.9377**

Test Accuracy: **0.5864**

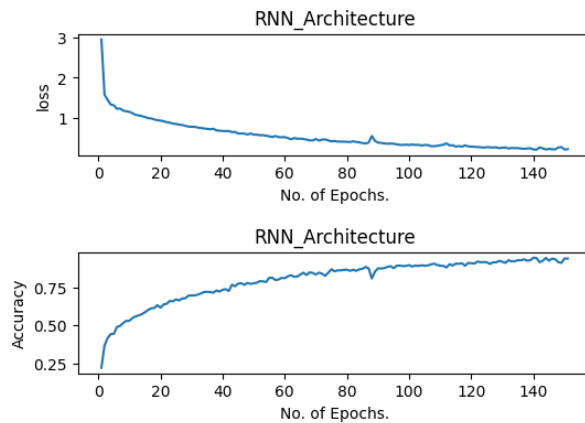


Fig.: Loss and Accuracy graph of RNN Arch. 1st

Results:

Training Accuracy: **0.9972**

Test Accuracy: **0.7135**

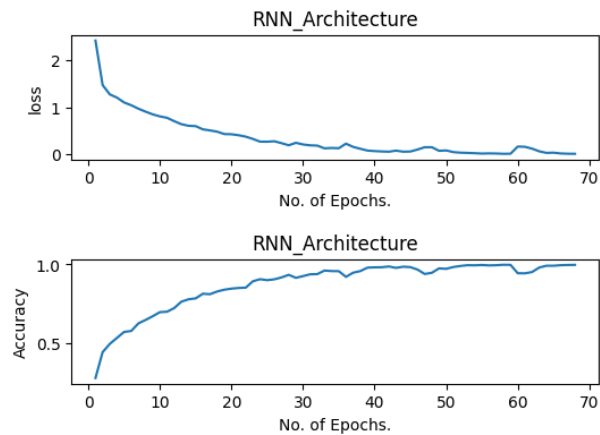


Fig.: Loss and Accuracy graph of RNN Arch. 2nd

1.2.1.3. RNN Architecture (128) Configuration

Architecture 3		
Layer	Hidden Unit	Activation Function
RNN	128	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. RNN Architecture 3 with hidden parameter representation

Results:

Training Accuracy: **0.9972**

Test Accuracy: **0.7135**

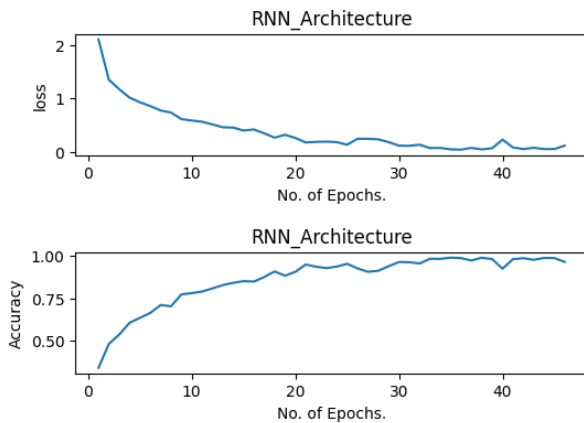


Fig.: Loss and Accuracy graph of RNN Arch. 3rd

1.2.1.4 RNN Architecture (256) Configuration

Architecture 4		
Layer	Hidden Unit	Activation Function
RNN	256	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. RNN Architecture 4 with hidden parameter representation

Results:

Training Accuracy: **0.9634**

Test Accuracy: **0.7054**

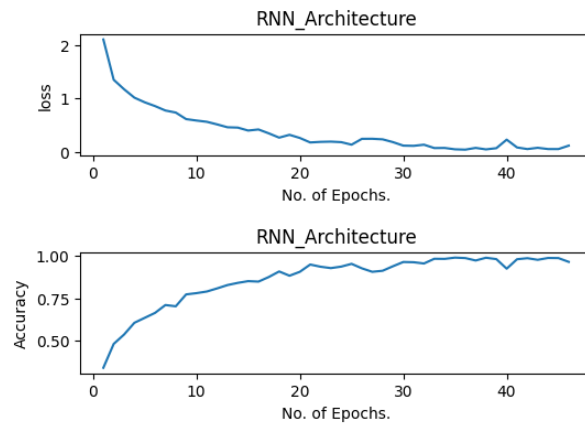


Fig.: Loss and Accuracy graph of RNN Arch. 4th

1.2.1.5. RNN Architecture (32,64) Configuration

Architecture 5		
Layer	Hidden Unit	Activation Function
RNN	32	Hyperbolic tangent
RNN	64	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. RNN Architecture 5 with hidden parameter representation

Results:

Training Accuracy: **0.9905**

Test Accuracy: **0.7000**

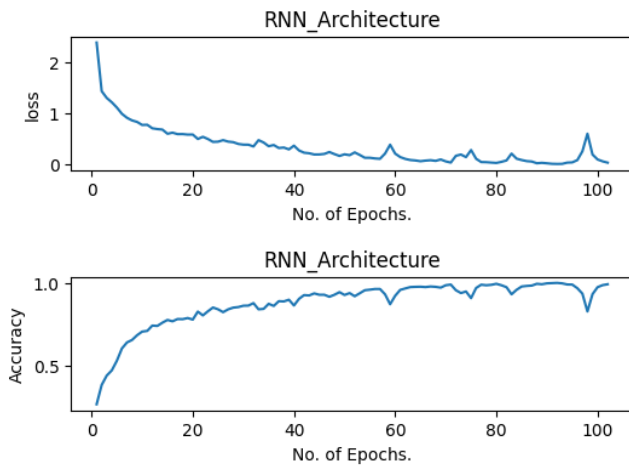


Fig.: Loss and Accuracy graph of RNN Arch. 5th

1.2.1.7. RNN Architecture (128,256) Config

1.2.1.6 RNN Architecture (64,128) Configur

Architecture 6		
Layer	Hidden Unit	Activation Function
RNN	64	Hyperbolic tangent
RNN	128	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. RNN Architecture 6 with hidden parameter representation

Results:

Training Accuracy: **0.9722**

Test Accuracy: **0.7675**

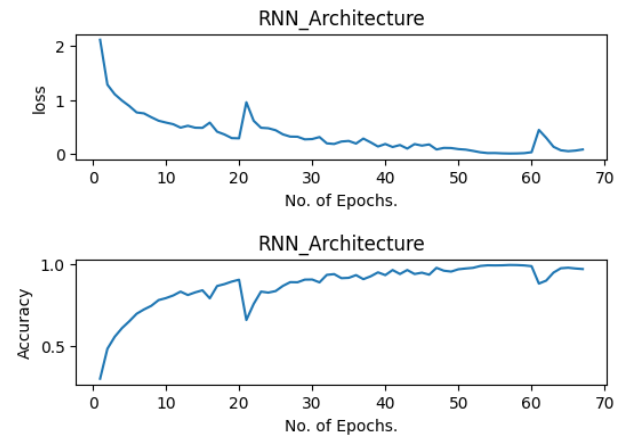


Fig.: Loss and Accuracy graph of RNN Arch. 6th

1.2.1.8 RNN Architecture (32,64,128) Config

Architecture 7		
Layer	Hidden Unit	Activation Function
RNN	128	Hyperbolic tangent
RNN	256	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. RNN Architecture 7 with hidden parameter representation

Results:

Training Accuracy: **0.9993**

Test Accuracy: **0.7783**

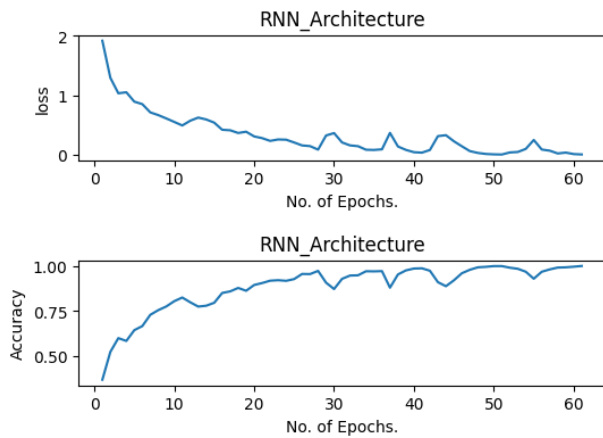


Fig.: Loss and Accuracy graph of RNN Arch. 7th

Architecture 8		
Layer	Hidden Unit	Activation Function
RNN	32	Hyperbolic tangent
RNN	64	Hyperbolic tangent
RNN	128	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. RNN Architecture 8 with hidden parameter representation

Results:

Training Accuracy: **0.9479**

Test Accuracy: **0.7432**

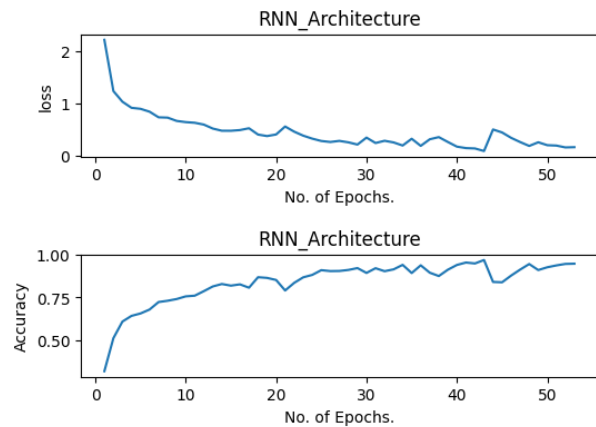


Fig.: Loss and Accuracy graph of RNN Arch. 8th

1.2.1.9. RNN Architecture (64,128,256) Config

Architecture 9		
Layer	Hidden Unit	Activation Function
RNN	64	Hyperbolic tangent
RNN	128	Hyperbolic tangent
RNN	256	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. RNN Architecture 9 with hidden parameter representation

Results:

Training Accuracy: **0.9580**

Test Accuracy: **0.8135**

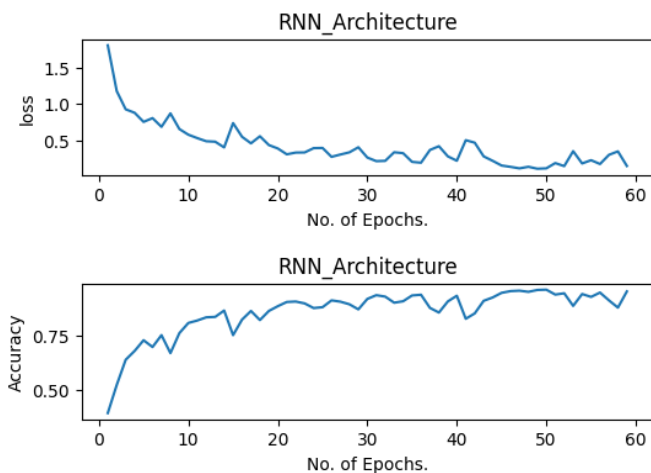


Fig.: Loss and Accuracy graph of RNN Arch. 9th

1.2.1.10. RNN Architecture (32,64,128,256) Config

Architecture 10		
Layer	Hidden Unit	Activation Function
RNN	32	Hyperbolic tangent
RNN	64	Hyperbolic tangent
RNN	128	Hyperbolic tangent
RNN	256	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. RNN Architecture 10 with hidden parameter representation

Results:

Training Accuracy: **0.8193**

Test Accuracy: **0.7621**

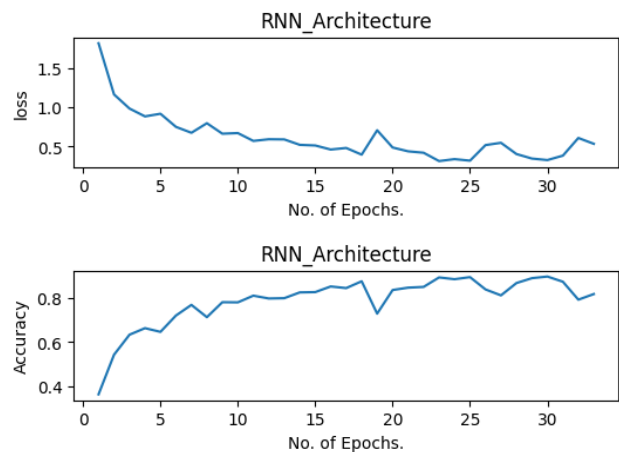


Fig.: Loss and Accuracy graph of RNN Arch. 10th

Best Model Confusion Matrix:

Model Architecture: **Architecture (128,256)**

Training Accuracy: **0.99**

Test Accuracy: **0.79**

Predicted label	Actual Label					
		pa	paa	re	sa	tA
	pa	34	2	1	7	9
	paa	2	66	1	1	7
	re	0	0	50	0	2
	sa	5	0	4	64	13
	tA	3	12	1	12	74

1.2.2 LSTM Architecture:

Hyperparameters:

- Convergence Criteria: Difference of 10^{-3} loss between successive epoch
- Learning Rate: 0.0001
- Optimiser: Adam
- Activation function: Softmax Activation
- Loss function: Cross entropy loss

1.2.2.1. LSTM Architecture (32) Configuration

Architecture 1		
Layer	Layer	Layer
LSTM	32	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. LSTM Architecture 1 with hidden parameter

1.2.2.2 LSTM Architecture (64) Configuration

Architecture 2		
Layer	Layer	Layer
LSTM	64	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. LSTM Architecture 2 with hidden parameter

Results:

Training Accuracy: **0.99**

Test Accuracy: **0.78**

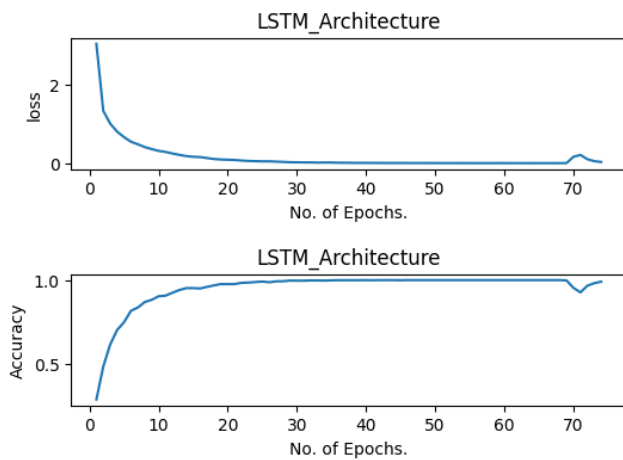


Fig.: Loss and Accuracy graph of LSTM Arch. 1st

Results:

Training Accuracy: **1.0**

Test Accuracy: **0.86**

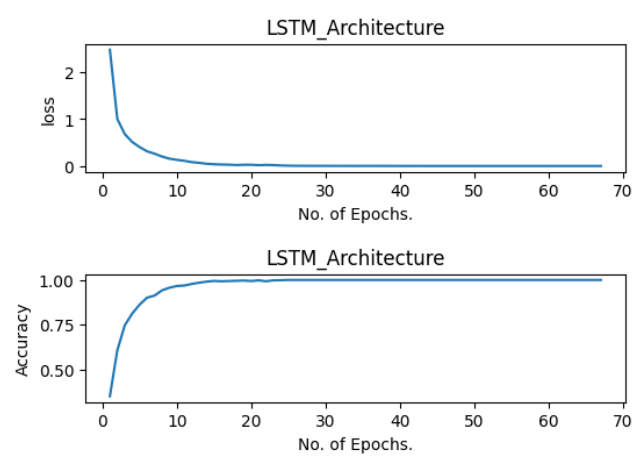


Fig.: Loss and Accuracy graph of LSTM Arch. 2nd

1.1.2.3. LSTM Architecture (128) Configuration

Architecture 3		
Layer	Layer	Layer
LSTM	128	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. LSTM Architecture 3 with hidden parameter

Results:

Training Accuracy: **1.0**

Test Accuracy: **0.86**

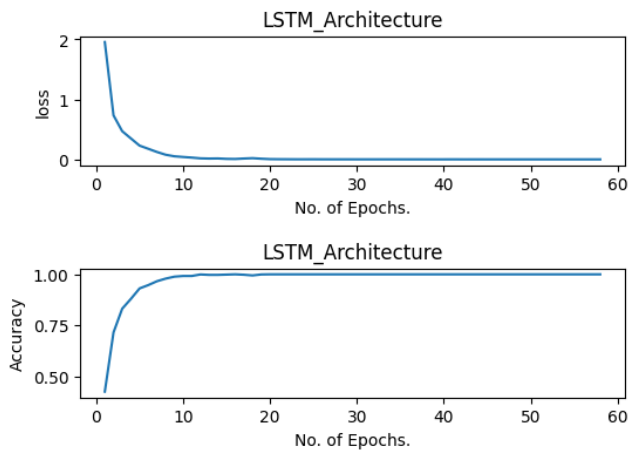


Fig.: Loss and Accuracy graph of LSTM Arch. 3rd

1.1.2.4 LSTM Architecture (256) Configuration

Architecture 4		
Layer	Layer	Layer
LSTM	256	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. LSTM Architecture 4 with hidden parameter

Results:

Training Accuracy: **1.0**

Test Accuracy: **0.87**

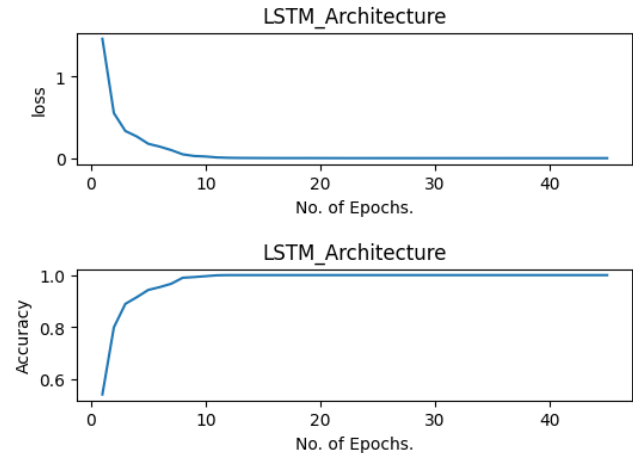


Fig.: Loss and Accuracy graph of LSTM Arch. 4th

1.1.2.5. LSTM Architecture (32,64) Configuration

Architecture 5		
Layer	Layer	Layer
LSTM	32	Hyperbolic tangent
LSTM	64	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. LSTM Architecture 5 with hidden parameter

Results:

Training Accuracy: **1.0**

Test Accuracy: **0.84**

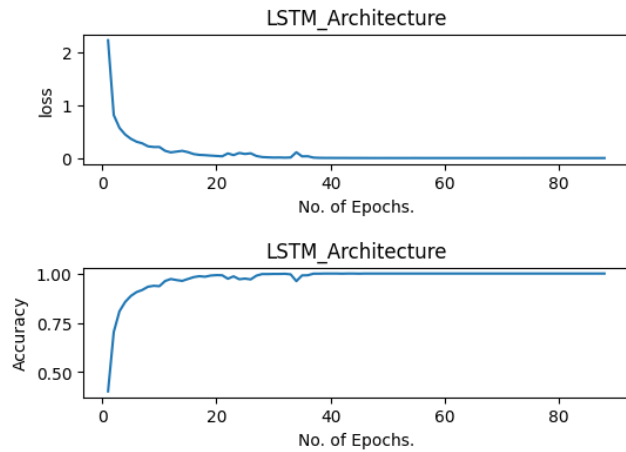


Fig.: Loss and Accuracy graph of LSTM Arch. 5th

1.1.2.6 LSTM Architecture (64,128) Configuration

Architecture 6		
Layer	Layer	Layer
LSTM	64	Hyperbolic tangent
LSTM	128	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. LSTM Architecture 6 with hidden parameter

Results:

Training Accuracy: **1.0**

Test Accuracy: **0.86**

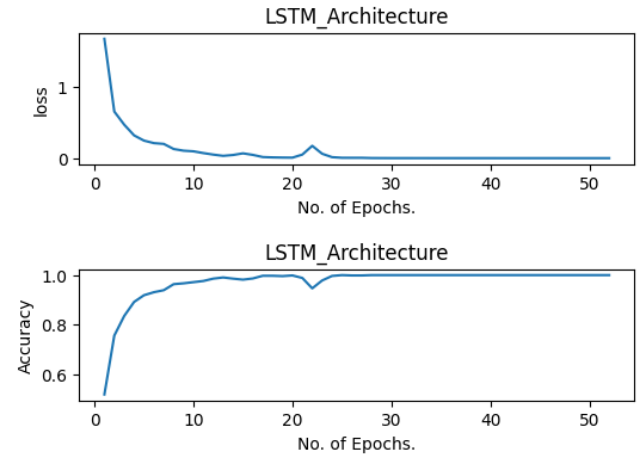


Fig.: Loss and Accuracy graph of LSTM Arch. 6th

1.1.2.7. LSTM Architecture (128,256) Config

Architecture 7		
Layer	Layer	Layer
LSTM	128	Hyperbolic tangent
LSTM	256	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. LSTM Architecture 7 with hidden parameter

Results:

Training Accuracy: **1.0**

Test Accuracy: **0.9**

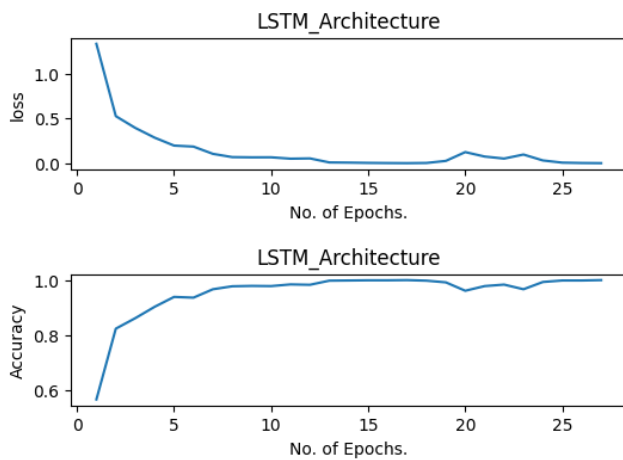


Fig.: Loss and Accuracy graph of LSTM Arch. 7th

1.1.2.8 LSTM Architecture (32,64,128) Config

Architecture 8		
Layer	Layer	Layer
LSTM	32	Hyperbolic tangent
LSTM	64	Hyperbolic tangent
LSTM	128	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. LSTM Architecture 8 with hidden parameter

Results:

Training Accuracy: **1.0**

Test Accuracy: **0.85**

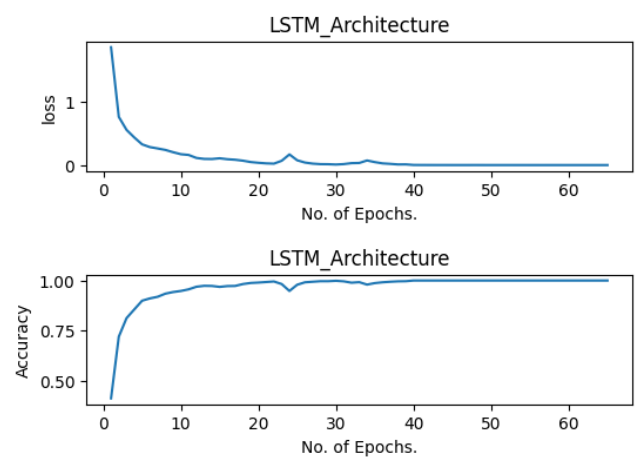


Fig.: Loss and Accuracy graph of LSTM Arch. 8th

1.1.2.9. LSTM Architecture (64,128,256) Config

Architecture 9		
Layer	Layer	Layer
LSTM	64	Hyperbolic tangent
LSTM	128	Hyperbolic tangent
LSTM	256	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. LSTM Architecture 9 with hidden parameter

Results:

Training Accuracy: **0.98**

Test Accuracy: **0.86**

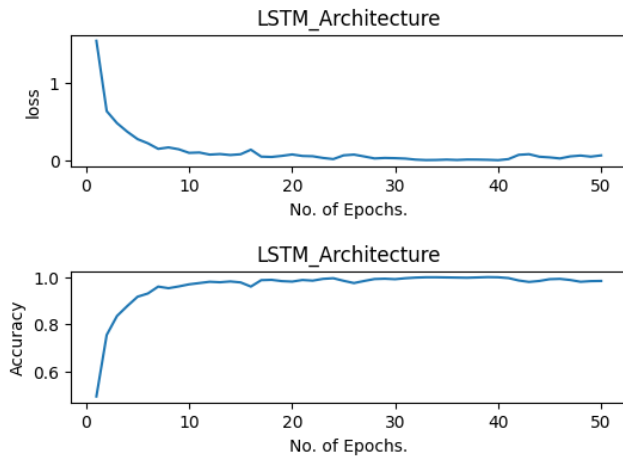


Fig.: Loss and Accuracy graph of LSTM Arch. 9th

1.1.2.10 LSTM Architecture (32,64,128,256)

Architecture 10		
Layer	Layer	Layer
LSTM	32	Hyperbolic tangent
LSTM	64	Hyperbolic tangent
LSTM	128	Hyperbolic tangent
LSTM	256	Hyperbolic tangent
Dense	128	Rectified linear unit
Dense	64	SoftMax

Fig. LSTM Architecture 10 with hidden parameter

Results:

Training Accuracy: **1.0**

Test Accuracy: **0.85**

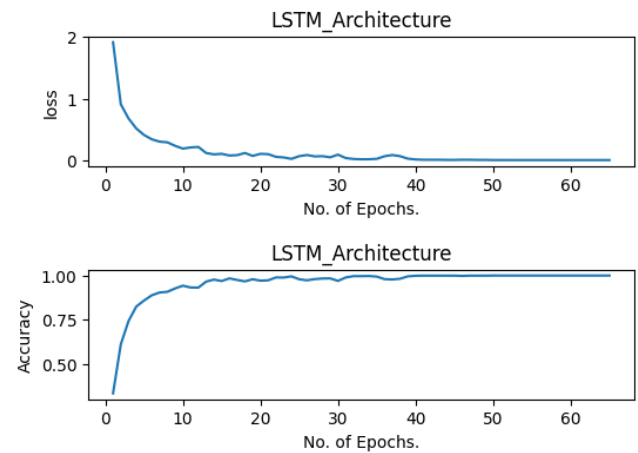


Fig.: Loss and Accuracy graph of LSTM Arch.10th

Best Model Confusion Matrix:

Model Architecture: **Architecture(128,256)**

Test Accuracy: **1.0**

Training Accuracy: **0.91**

Predicted label	Actual Label					
		pa	paa	re	sa	tA
	pa	42	4	0	3	4
	paa	3	70	3	0	1
	re	0	0	51	1	0
	sa	2	0	2	78	4
	tA	2	2	1	2	95