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Course : CS564 Machine Learning
Assignment: Lab4
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1. **RNN model with different number of parameters. Accuracy in the Table**

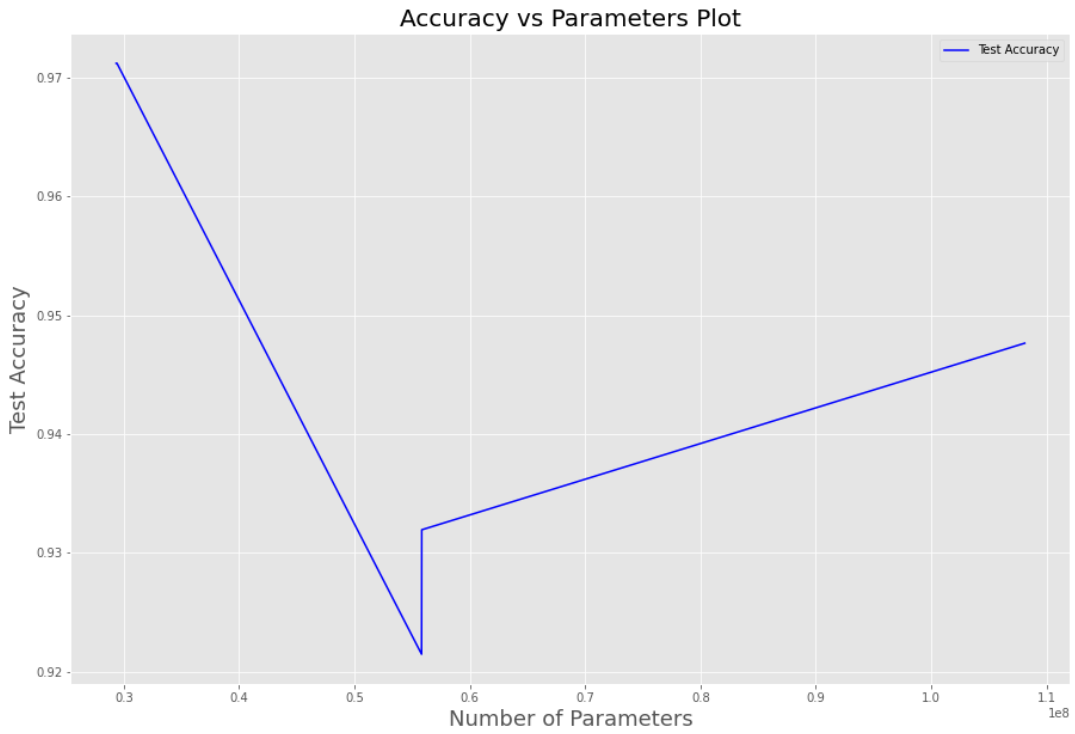
```
1 df_stats = pd.read_csv("Q1_Statistics.csv")
2 df_stats
```

	Unnamed: 0	Model Parameters	Training Loss	Validation Loss	Validation Accuracy	Test Accuracy
0	3	29346477	0.000166	0.151131	0.963351	0.971204
1	0	29410221	0.000329	0.216730	0.937173	0.971204
2	1	55822509	0.000103	0.256800	0.916230	0.921466
3	2	55837997	0.002420	0.231197	0.931937	0.931937
4	4	108120109	0.006270	0.219498	0.937173	0.947644

Class Wise Accuracy of best performing model with minimum 2 hidden layers

```
Accuracy of Model = 0.9712041884816754
              precision    recall  f1-score   support

           0       0.98      0.95      0.96        93
           1       0.95      0.99      0.97        76
           2       0.95      0.98      0.96        82
           3       1.00      0.95      0.98        42
           4       0.99      0.99      0.99        89

    accuracy                           0.97       382
   macro avg       0.97      0.97      0.97       382
weighted avg       0.97      0.97      0.97       382
```

Accuracy vs Number of Parameters Plot



Best Performing Model Architecture(Min 2 Hidden)

```
Model: "sequential_15"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 embedding_15 (Embedding)    (None, 512, 100)          3129000

 flatten_15 (Flatten)        (None, 51200)             0

 dropout_45 (Dropout)        (None, 51200)             0

 dense_45 (Dense)            (None, 512)               26214912

 dropout_46 (Dropout)        (None, 512)               0

 dense_46 (Dense)            (None, 128)               65664

 dropout_47 (Dropout)        (None, 128)               0

 dense_47 (Dense)            (None, 5)                 645

=================================================================
Total params: 29,410,221
Trainable params: 29,410,221
Non-trainable params: 0
_________________________________________________________________
None
```

2. Best Architecture of Q1 with Adam/SGD optimizer and ReLU/Tanh Activation Function

```
1 df_stats = pd.read_csv("Q2_Statistics.csv")
2 df_stats
```

	Activation Function	Optimizer	Training Loss	Validation Loss	Validation Accuracy	Test Accuracy
0	tanh	adam	0.000232	0.187998	0.926702	0.955497
1	tanh	sgd	1.115369	1.325217	0.502618	0.492147
2	relu	adam	0.000101	0.212557	0.942408	0.963351
3	relu	sgd	1.393486	1.418941	0.371728	0.376963

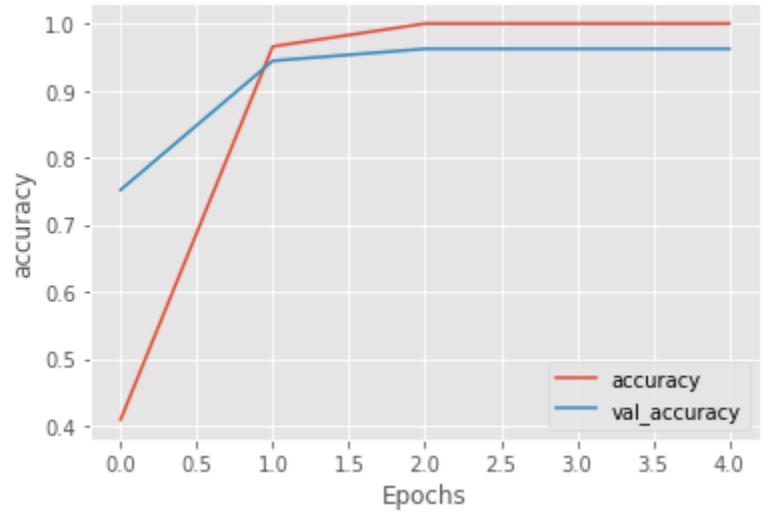
SGD optimizer performs very poorly with respect to Adam optimizer. ReLU performs slightly better than Tanh Activation Function
Best Model - ReLU Activation and Adam Optimizer

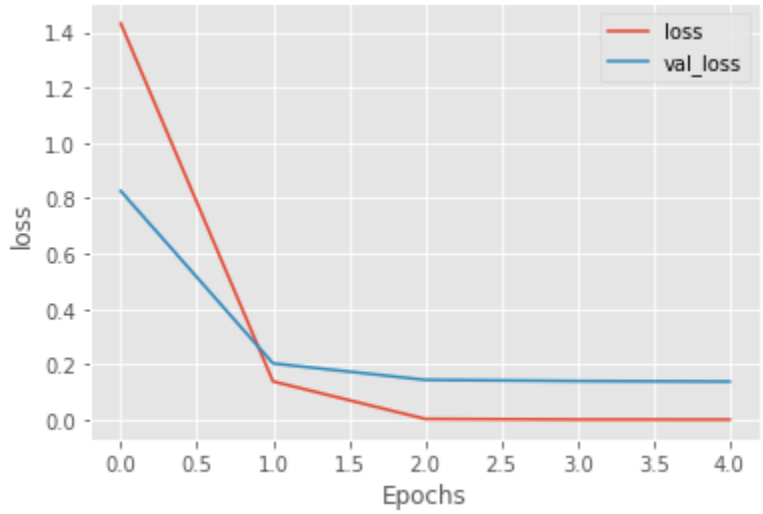
Class Wise Accuracy of best performing model

```
Accuracy of Model = 0.9633507853403142
              precision    recall  f1-score   support

           0       0.92      0.98      0.95        93
           1       0.96      0.97      0.97        76
           2       0.99      0.94      0.96        82
           3       0.98      1.00      0.99        42
           4       0.99      0.94      0.97        89

    accuracy                           0.96       382
   macro avg       0.97      0.97      0.97       382
weighted avg       0.96      0.96      0.96       382
```

3. Best Architecture of Q2 Cross Validation

First Cross Validation Model

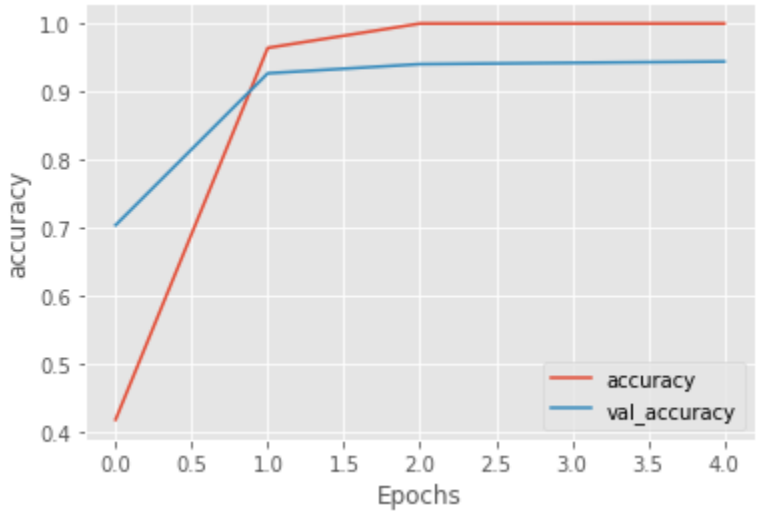


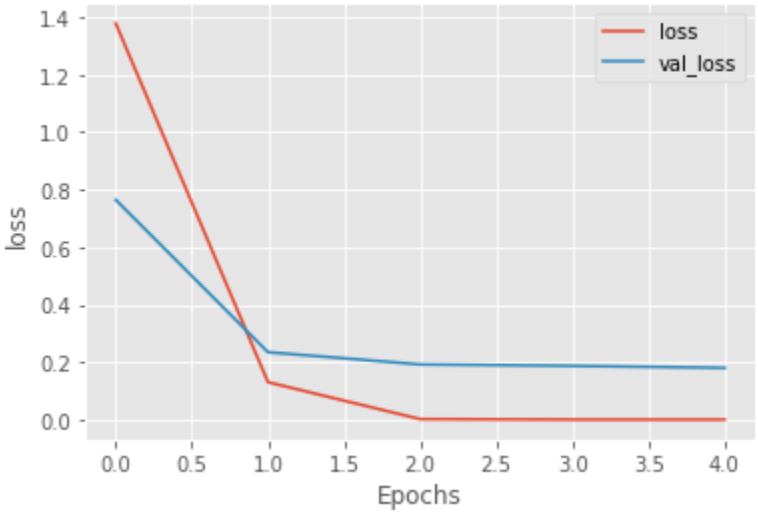


Accuracy of Model = 0.9685863874345549

	precision	recall	f1-score	support
0	0.99	0.97	0.98	93
1	0.94	0.97	0.95	76
2	0.95	0.98	0.96	82
3	1.00	0.95	0.98	42
4	0.98	0.97	0.97	89
accuracy			0.97	382
macro avg	0.97	0.97	0.97	382
weighted avg	0.97	0.97	0.97	382

Second Cross Validation Model

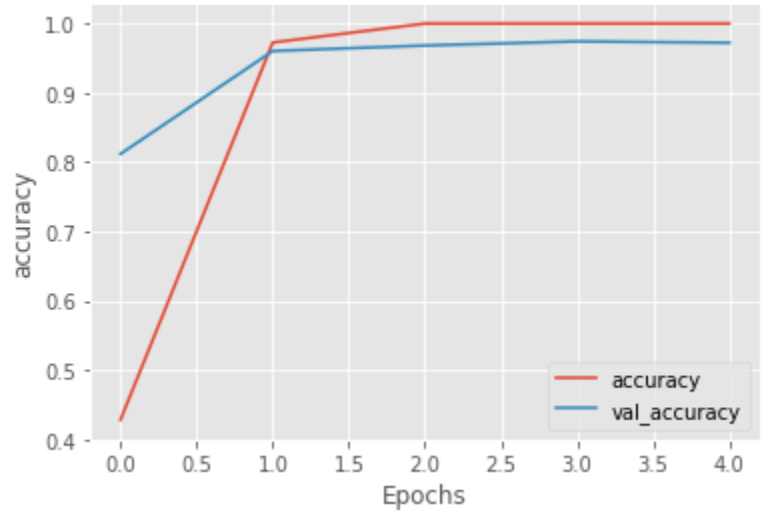


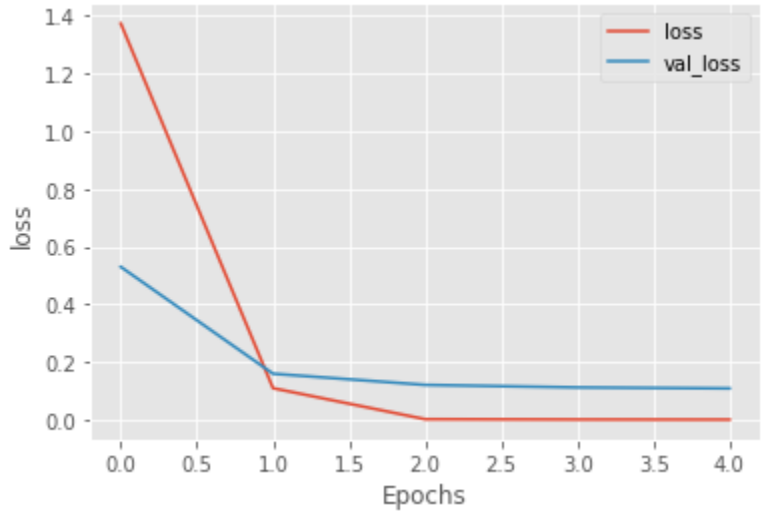


Accuracy of Model = 0.9476439790575916

	precision	recall	f1-score	support
0	0.90	0.97	0.93	93
1	0.99	0.96	0.97	76
2	0.94	0.94	0.94	82
3	0.97	0.93	0.95	42
4	0.97	0.93	0.95	89
accuracy			0.95	382
macro avg	0.95	0.95	0.95	382
weighted avg	0.95	0.95	0.95	382

Third Cross Validation Model





Accuracy of Model = 0.9502617801047121

	precision	recall	f1-score	support
0	0.94	0.97	0.95	93
1	0.91	0.96	0.94	76
2	0.97	0.93	0.95	82
3	0.97	0.93	0.95	42
4	0.97	0.96	0.96	89
accuracy			0.95	382
macro avg	0.95	0.95	0.95	382
weighted avg	0.95	0.95	0.95	382

Overall Statistics of 3 Fold Cross Validation

```
1 df_stats = pd.read_csv("Q3_Statistics.csv")
2 df_stats
```

	Unnamed: 0	Training Loss	Validation Loss	Validation Accuracy	Test Accuracy
0	0	0.000308	0.137754	0.962302	0.968586
1	1	0.000253	0.180186	0.944338	0.947644
2	2	0.000354	0.108563	0.972277	0.950262

Among the 3 Cross Validation Trained Models. First Model has the highest accuracy on unseen test dataset - Accuracy = 0.96857