

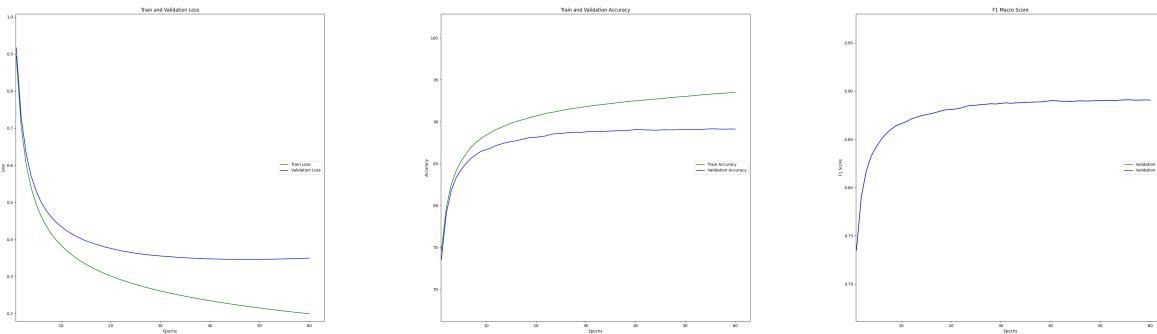
CSE 472  
Machine Learning Sessional

Assignment 3 Report  
**Feed-Forward Neural Networks**

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**Student Id: 1805088**

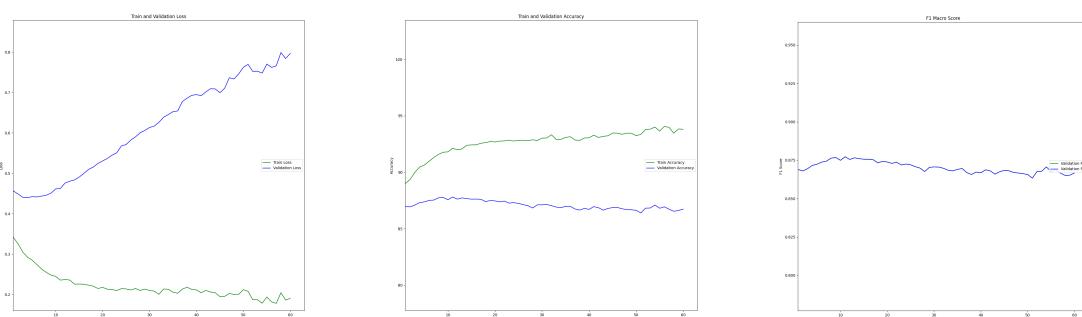
## Model - 1: DenseLayer(784, 128) => ReLULayer() => DenseLayer(128, 26) => SoftmaxLayer()

Batch Size: 64



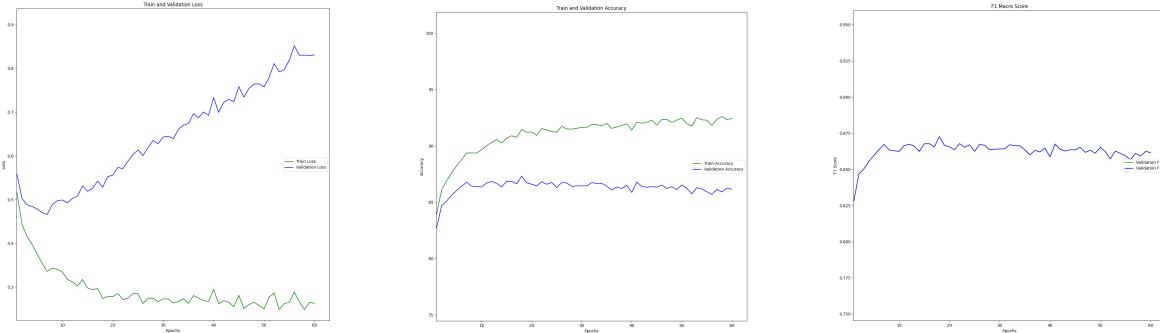
Confusion Matrix D:\784_128-RU-D_128_26_SO_0.0005\validationDataset	
0	0.441 7 0 5 3 1 7 21 0 0 2 1 1 34 1 1 27 7 3 2 13 0 2 2 1 1 4
1	0.640 1 5 2 0 10 6 0 1 1 2 0 1 3 2 3 1 0 1 0 0 0 1 0 4
2	0.1 0.701 3 10 0 1 0 0 0 0 6 0 1 3 0 0 4 2 0 3 0 0 0 0 0 2
3	0.7 0.351 0.031 0 2 2 4 1 13 1 1 0 3 20 7 1 1 1 0 2 1 0 0 1 1 1
4	0.2 0.76 0 0.640 2 0 1 1 0 1 0 1 1 4 2 12 0 3 0 0 0 1 0 3
5	0.1 1 1 2 1.001 3 3 2 1 0 2 0 2 0 18 10 3 24 0 0 0 1 0 1
6	0.14 14 4 2 4 4 0.501 0 0 3 0 2 0 1 2 4 0.95 3 11 1 1 1 1 0 1 2 4
7	0.6 0 0 1 0 1 1 0.201 0 6 12 1 22 0 0 1 1 2 2 0 1 2 0 0 0 0
8	0.0 0 0 1 0 2 0 2 0.701 32 0.201 0 0 0 0 0 0 2 2 0 2 0 3 2 5
9	0.2 0 7 0 1 5 0 28 0.640 0 3 0 0 1 0 1 0 7 11 1 5 0 0 3 1
10	0.5 0 3 1 1 1 1 24 0 0.610 3 0 3 0 0 2 14 0 1 2 3 3 7 2 0
11	0.1 2 6 1 0 0 4 0.87 1 0 0.501 0 0 0 1 2 0 2 0 3 0 0 0 1
12	0.3 1 0 0 0 0 0 0 4 0 0 1 0 0.601 0 0 1 0 0 1 2 0 3 0 1 0
13	0.5 1 1 5 0 0 0 11 0 0 1 0 1 3 0.601 1 1 0 8 0 0 0 1 7 1 1 2
14	0.6 2 30 1 0 2 0 0 1 0 0 0 3 0.775 1 1 0 1 0 1 0 0 0 0 0 0 0
15	0.2 0 0 3 0 6 3 2 0 0 0 1 0 3 0.701 10 5 0 1 0 0 0 0 0 1 0
16	0.14 3 3 8 3 6 59 0 1 0 0 1 0 3 4 0 7 4 0.601 4 1 0 2 2 1 0 2 1 4
17	0.7 3 4 0 2 1 0 5 0 0 9 1 3 4 0 4 2 0.640 0 3 0 7 0 4 3 2
18	0.0 4 1 1 0 0 12 1 1 2 0 1 0 0 0 0 3 0.671 1 0 0 0 0 0 0 0
19	0.0 1 1 0 2 12 2 6 5 6 2 3 0 0 0 2 2 15 0 0.601 0 0 0 10 4
20	0.2 0 2 2 2 0 0 0 2 0 2 3 0 2 2 3 4 0 0 0 0 0 0.670 10 3 1 1 0
21	0.0 0 0 0 0 0 0 0 0 0 1 0 0 2 3 0 1 0 6 0 1 40 0.611 1 3 8 2
22	0.1 1 0 1 1 0 1 0 1 1 0 4 37 0 0 0 1 2 1 0 6 10 0.601 0 2 0
23	0.3 0 0 0 0 0 1 1 2 0 14 2 0 0 2 0 2 3 5 0 1 0 2 0.611 32 8
24	0.2 0 0 0 0 0 3 2 4 2 5 2 1 0 0 4 5 9 0 7 8 21 1 1 0 601 1
25	0.4 6 0 0 2 1 0 5 0 3 1 0 2 1 1 0 9 0 3 0 1 6 0 0 0 0 0 0.601 0
26	0 1 2 3 4 4 5 6 7 8 9 10 11 32 33 34 35 36 37 18 19 20 21 22 23 24 35
Actual	Predicted

Learning Rate = 0.0005

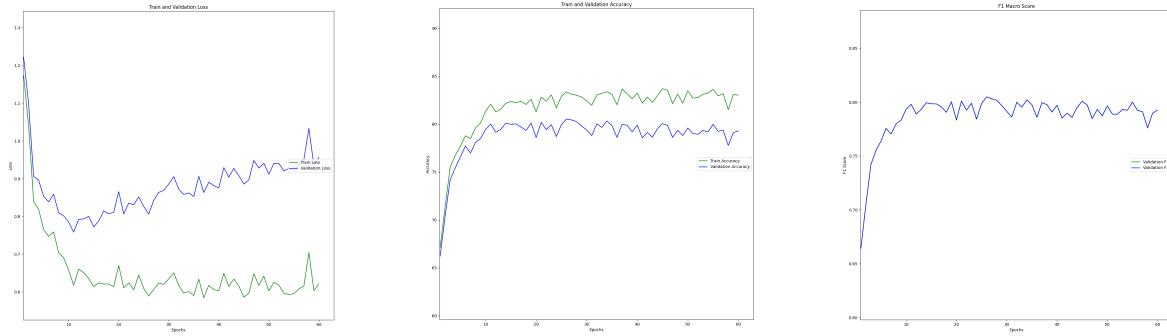


Confusion Matrix-D_784_128-RLU-D_128_26-SO_0.005ValidationDataset																										
0	111	4	7	9	3	3	13	31	1	0	1	0	2	13	4	3	24	10	3	2	12	0	3	3	2	6
m-1	4	100	0	30	1	0	10	8	1	2	3	3	0	1	4	4	1	1	5	0	1	4	0	1	3	
m-0	0	2	600	0	38	1	4	0	1	0	1	14	0	1	7	0	2	4	2	0	1	0	0	0	0	0
m-5	10	3	322	0	1	0	2	3	16	1	1	0	1	22	9	0	2	2	0	3	1	1	0	0	1	0
m-8	14	26	1	102	3	6	0	1	0	0	2	0	0	0	6	2	12	2	1	0	0	0	0	0	0	0
m-2	0	0	2	4	100	4	2	4	3	0	2	0	0	0	0	19	2	10	1	28	0	0	2	1	0	3
m-22	9	5	2	2	4	101	0	1	4	2	2	0	0	0	2	64	2	17	0	2	0	8	0	5	8	5
m-4	6	0	6	0	4	101	2	0	5	13	2	21	0	0	2	0	3	4	0	5	2	2	0	0	0	0
m-0	0	0	2	0	2	0	2	0	100	11	1	200	0	0	0	1	1	2	3	0	3	0	0	2	10	10
m-3	0	0	9	2	7	7	1	20	0	0	5	0	0	1	0	2	0	10	13	2	2	1	0	5	5	
m-15	0	5	2	3	1	1	1	0	601	5	0	2	1	2	0	0	2	3	2	3	3	3	6	0	0	
m-12	0	3	4	1	0	0	3	97	1	1	100	0	0	1	1	2	1	2	0	0	0	0	1	0	0	
m-1	2	1	0	0	0	1	10	0	0	1	0	602	22	0	0	0	0	0	3	3	5	0	0	0	0	0
m-4	1	1	6	0	0	0	9	0	0	0	2	38	101	0	0	1	3	0	0	3	10	0	0	0	3	
m-7	4	4	13	1	0	2	0	1	0	0	0	2	604	2	1	0	2	0	3	1	0	0	0	0	0	0
m-12	2	0	5	0	13	7	1	0	0	0	0	3	605	4	6	0	0	0	2	0	0	0	0	0	0	0
m-26	5	1	10	1	8	113	1	2	1	1	1	2	3	11	25	100	3	1	4	2	0	3	2	5	1	
m-6	6	5	0	4	7	0	4	2	0	13	4	1	34	0	11	4	606	0	3	4	0	3	2	2	2	
m-1	2	0	0	0	4	13	0	4	10	0	1	0	0	0	2	606	0	0	0	1	1	0	0	0		
m-13	3	6	1	1	14	3	6	4	5	8	0	1	0	5	1	15	0	0	0	0	0	8	4			
m-2	1	0	2	1	0	0	1	1	5	2	2	3	4	4	0	1	0	0	0	0	0	0	0	0	0	
m-10	0	2	0	0	1	0	0	2	1	0	0	2	1	0	0	6	0	0	50	601	3	3	11	0		
m-21	2	1	0	0	2	0	1	0	0	2	0	6	30	0	1	0	1	9	4	601	0	1	3	1		
m-23	3	1	2	1	0	1	0	5	1	2	2	0	2	0	3	34	3	7	1	0	0	2	2	0		
m-1	4	0	6	0	1	1	001	9	0	14	3	10	3	29	0	0	1	1	0	0	2	1	4	1		
m-3	0	0	0	0	1	0	0	0	400	0	0	1	1	16	13	2	4	0	19	3						
m-12	2	0	2	1	0	2	1	0	40	601	0	4	0	0	3	0	1	1	16	13	2	4	0	19		
m-14	3	4	2	3	1	1	19	1	0	100	5	2	11	0	0	2	9	0	10	1	20	3	0			
m-11	0	2	8	3	1	0	0	8	159	1	0	100	5	11	0	0	0	1	1	1	0	1	5	0		
m-13	1	0	0	0	3	7	0	0	0	0	0	0	1	0	1	1	0	1	0	0	0	0	0	0		
m-11	0	0	4	0	0	6	3	1	0	0	0	0	3	16	614	2	1	1	9	0	0	2	2	18	1	
m-15	4	2	3	6	1	0	4	0	0	1	0	0	0	3	178	1	2	0	0	2	0	0	0	0		
m-12	4	0	4	1	8	4	1	0	0	0	0	3	1	13	16	0	1	0	0	0	0	0	0	0		
m-34	2	3	7	1	4	100	2	1	0	1	0	0	8	4	100	6	0	0	2	1	2	0	8	2		
m-13	0	5	2	3	5	1	5	3	0	10	1	3	5	0	6	11	1	600	1	3	3	3	2			
m-2	1	1	0	0	1	30	0	3	10	0	0	0	2	0	2	1	601	3	22	0	0	1	1			
m-21	1	7	2	3	20	1	6	6	5	3	5	0	0	0	1	16	2	6	1	0	0	4	14			
m-6	1	1	6	1	0	0	2	0	3	1	0	4	8	0	2	1	601	1	3	4	0	0	0	0		
m-0	0	0	0	0	0	0	0	2	0	2	0	1	3	0	1	10	0	0	50	601	3	11	0			
m-24	1	2	0	1	2	1	2	0	2	0	3	14	0	0	3	0	1	0	15	13	600	1	1			
m-7	2	1	0	0	1	0	2	1	24	1	1	4	0	0	0	3	0	1	1	2	1	21	23	5		
m-0	0	0	0	2	0	3	6	0	2	2	2	1	3	1	0	5	6	13	1	2	0	1	0	0		
m-6	2	1	1	4	0	5	0	5	0	2	0	1	1	5	1	1	2	2	0	0	3	2	0			
m-0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		

Learning Rate = 0.005



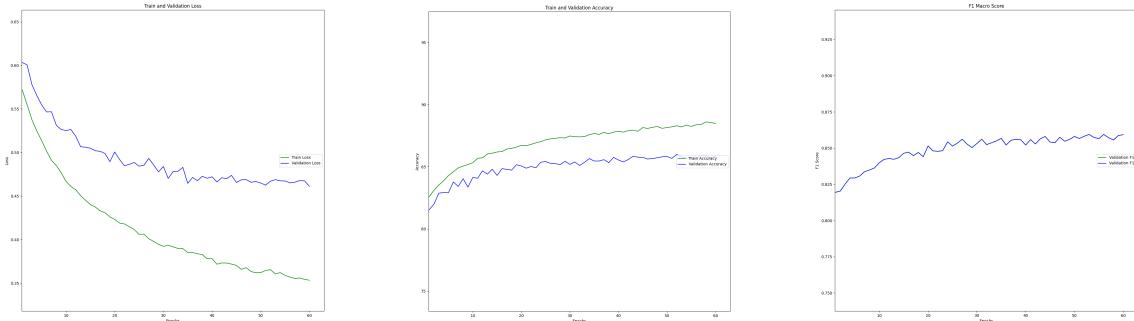
Confusion Matrix-D_784_128-RLU-D_128_26-SO_0.01ValidationDataset																											
0	111	2	8	5	1	3	10	1	0	1	2	3	0	1	4	4	1	0	18	11	5	27	6	0	4	5	1
m-11	564	1	16	8	3	0	3	5	0	0	11	2	5	2	1	0	1	0	3	3	7	1	0	0	0	1	5
m-4	3	1002	0	8	0	0	2	0	0	4	0	0	4	3	2	0	3	1	0	0	1	1	1	1	0	0	1
m-4	9	3	205	0	1	0	1	7	1	3	0	2	32	5	4	0	1	4	2	0	4	2	0	0	1	2	
m-10	0	49	1	100	2	7	0	2	0	0	0	0	3	3	6	12	1	3	1	0	0	0	0	0	12	0	
m-7	0	2	2	2	0	541	5	1	8	2	1	3	0	1	13	11	13	1	15	0	0	0	1	4	1		
m-23	13	4	6	5	8	9	0	0	0	2	0	3	34	3	7	1	0	0	2	2	0	4	4	0	4	4	
m-6	0	4	0	1	1	001	9	0	14	3	10	2	4	0	1	16	13	2	4	0	19	3	2	0	0	0	
m-3	0	0	0	0	1	0	0	0	400	0	4	0	0	3	0	1	1	1	16	13	2	4	0	19	3		
m-12	2	0	2	1	0	2	1	0	40	601	0	4	0	0	3	0	1	1	16	13	2	4	0	19	3		
m-14	3	4	2	3	1	1	19	1	0	100	5	2	11	0	0	2	9	0	10	1	20	3	0	0	0		
m-11	0	2	8	3	1	0	0	8	159	1	0	0	0	0	1	1	1	0	1	0	9	0	0	0	0		
m-13	1	0	0	0	3	7	0	0	0	0	0	1	0	3	0	0	2	0	0	0	1	0	0	0	0		
m-15	11	0	0	0	6	3	1	0	0	0	3	16	0	2	0	0	2	0	0	0	0	0	0	0	0		
m-12	4	2	3	6	1	0	4	0	0	1	0	0	8	4	100	6	0	0	2	1	2	0	8	2			
m-34	2	3	7	1	4	100	2	1	0	1	0	0	8	4	100	6	0	0	2	1	2	0	8	2			
m-13	0	5	2	3	5	1	5	3	0	10	1	3	5	0	6	11	1	600	1	3	3	3	2				
m-2																											



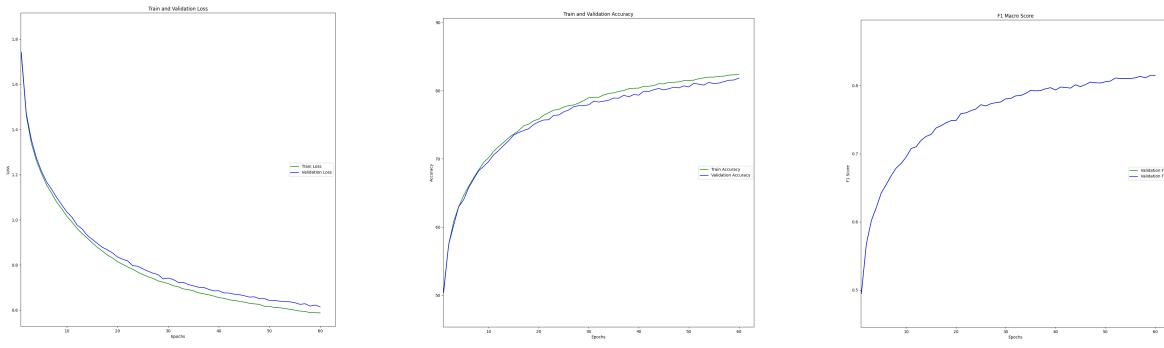
*Learning Rate = 0.02*

**Model - 2:** DenseLayer(784, 128) => Sigmoid() => DropoutLayer(0.75) =>  
DenseLayer(128, 26) => SoftmaxLayer()

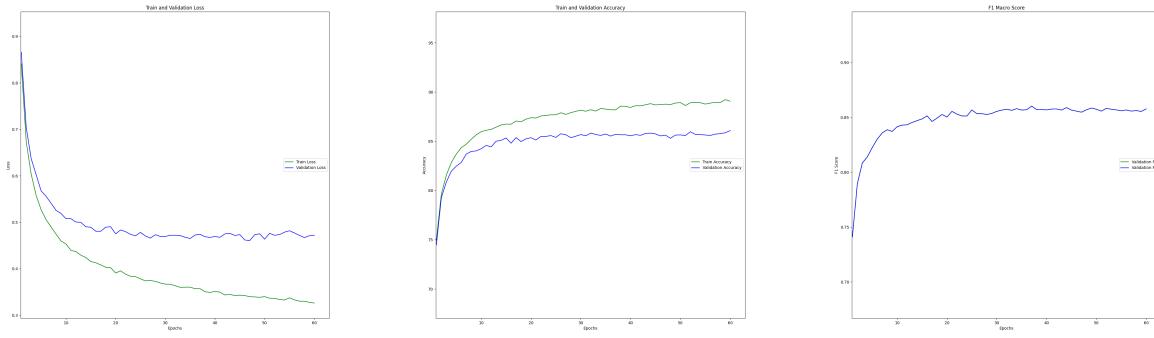
# Batch Size: 64



*Learning Rate = 0.005*

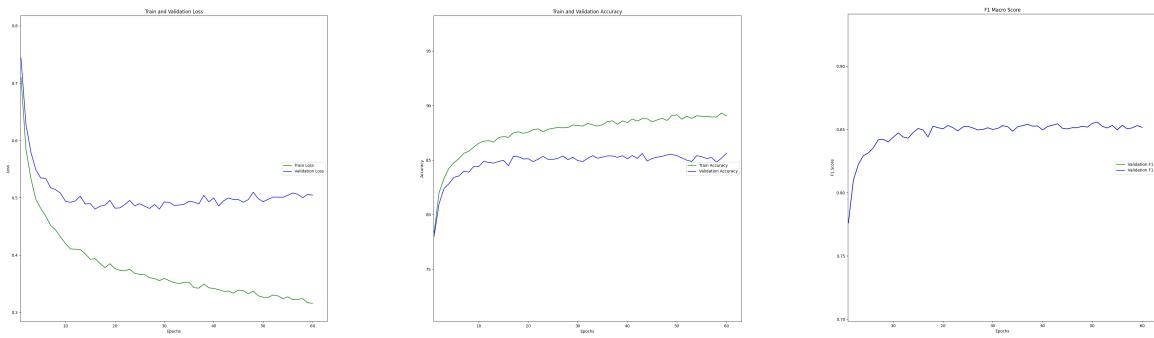


*Learning Rate = 0.0005*



Confusion Matrix: D_784 x 28x-DR - 7.5 D_12 - 0.50, 0.01WiringDataset																									
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18						
0	599	8	3	10	5	1	0	0	1	0	56	10	4	3	16	14	0	2	3	1	10				
1	6	432	1	11	2	12	14	0	3	2	2	1	6	1	3	0	2	0	0	1	4				
2	3	1	0	51	26	8	0	0	3	1	6	0	1	8	0	7	1	0	0	1	0				
3	0	11	1	0	26	2	3	2	1	22	3	2	0	4	24	10	2	2	3	1	1				
4	8	5	31	0	2	1	4	0	5	0	1	0	1	1	3	6	11	2	1	0	0				
5	2	2	4	5	4	0	4	1	0	1	0	0	0	28	9	18	2	23	0	0	1	2			
6	14	7	3	5	2	6	008	1	0	9	2	1	0	0	1	2	69	1	33	1	1	1			
7	3	4	0	4	1	1	019	0	0	11	20	4	21	0	0	0	3	1	0	2	6	2			
8	0	1	0	1	3	0	2	0	404	26	2	239	0	0	0	2	0	0	7	0	2	13			
9	2	1	2	15	0	2	0	4	24	031	0	0	0	0	0	0	14	1	6	0	6	1			
10	0	3	3	3	1	0	1	22	1	1	044	0	1	5	0	0	2	11	0	2	6	4			
11	4	1	9	4	0	0	1	139	4	4	044	0	0	0	0	0	2	1	1	0	4	5			
12	7	0	0	0	0	0	0	0	0	0	3	0	0	18	1	0	0	5	0	2	1	6			
13	1	0	1	4	0	0	0	0	15	1	1	4	0	18	0	1	0	6	0	4	3	3			
14	10	3	6	9	2	0	3	0	0	1	0	0	0	0	3	005	1	0	1	2	0	0			
15	2	0	0	4	0	12	1	0	0	0	0	2	3	7	2	661	8	18	0	1	0	0			
16	20	3	4	7	8	89	1	0	2	1	0	1	2	0	1	0	0	1	4	1	4	5			
17	7	2	7	0	3	3	2	1	1	0	20	0	3	7	0	10	4	045	1	33	8	0	5	6	
18	1	6	1	0	0	1	30	0	4	11	0	0	0	0	0	5	0	0	1	0	0	1	1		
19	1	0	1	3	14	3	7	12	20	2	7	0	0	2	1	14	0	0	1	1	0	1	9		
20	4	0	2	5	1	0	1	6	0	1	3	1	4	7	0	1	1	0	0	20	9	1	0		
21	0	0	0	0	0	0	0	0	0	0	1	0	2	3	1	0	7	0	0	31	854	3	14		
22	2	2	0	2	1	1	0	1	3	2	0	0	1	8	12	0	0	2	1	1	10	10	073	0	
23	2	2	1	1	0	0	1	3	4	0	23	1	2	3	0	3	5	1	1	0	7	4	157	6	
24	0	1	0	0	0	0	6	2	4	4	2	2	1	3	0	2	3	14	13	9	26	2	025	1	
25	5	1	2	1	7	1	4	1	4	0	9	0	1	3	1	0	3	2	0	4	2	0	1	10	
26	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

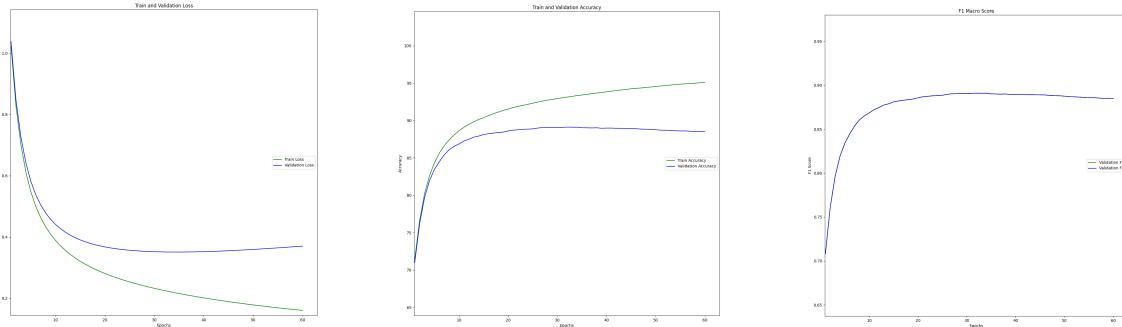
*Learning Rate = 0.01*



Confusion Matrix_O_784_128-S-DR_0.75-D_128-26-SO_0.02ValidationDataset																											
μ-1	3	2	14	10	4	9	31	0	1	0	0	4	35	7	2	39	30	0	2	8	3	3	6	1	9		
μ-7	350	0	13	2	2	29	15	0	4	0	1	1	1	5	9	3	2	6	0	1	1	0	0	1	1	1	
μ-5	0	353	1	39	8	7	0	0	1	2	0	1	5	9	2	7	1	0	0	1	1	1	1	1	1	1	
μ-7	14	3	355	4	8	3	0	29	4	3	6	7	33	7	5	9	2	1	2	1	1	1	5	9	0	0	
μ-3	7	29	0	352	4	5	0	1	0	0	0	0	8	3	2	4	14	1	0	0	1	1	0	6	0	0	
μ-1	2	2	3	3	350	1	2	1	4	1	0	8	6	23	9	14	4	18	0	0	1	1	2	5	0	0	
μ-13	7	4	5	5	351	1	6	2	6	8	6	2	5	5	22	3	3	6	2	0	6	3	0	0	0	0	0
μ-20	6	0	5	0	0	352	2	0	11	5	21	6	0	0	0	1	3	4	4	3	2	1	0	0	0	0	0
μ-5	0	1	2	0	1	0	353	22	0	219	0	2	8	0	1	1	22	0	3	1	1	0	1	0	0	0	0
μ-1	0	12	1	2	7	1	21	353	1	3	8	2	0	1	22	3	1	4	1	0	3	1	1	0	0	0	0
μ-0	4	5	3	8	2	27	353	1	3	8	2	0	1	22	3	1	4	1	0	3	1	1	0	0	0	0	0
μ-0	4	10	5	9	0	105	6	2	21	0	2	8	0	0	0	2	2	8	4	3	0	1	0	0	0	0	0
μ-27	1	0	4	9	0	111	0	0	0	0	0	0	0	0	0	0	0	0	0	2	18	2	2	1	0	0	0
μ-7	5	6	12	1	9	5	0	0	0	0	0	1	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0
μ-0	0	0	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
μ-4	0	0	0	0	0	354	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
μ-20	1	3	4	5	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
μ-1	4	9	3	2	2	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
μ-3	1	1	3	3	37	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
μ-30	1	1	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
μ-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
μ-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
μ-2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
μ-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
μ-3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
μ-7	5	6	12	1	9	5	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
μ-0	0	0	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
μ-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
μ-8	4	3	3	3	3	5	0	2	0	0	3	1	0	1	3	3	3	1	0	3	3	3	3	3	3	3	3
μ-0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	mediated	

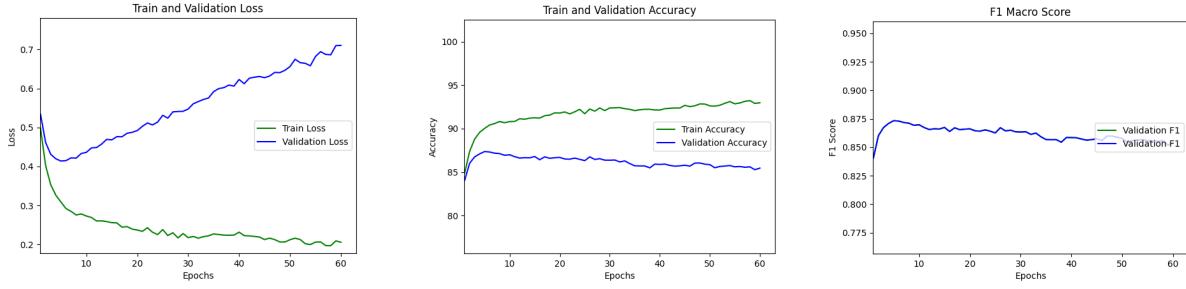
Learning Rate = 0.02

**Model - 3:** DenseLayer(784, 128, optimizer=True) => Sigmoid() =>  
DenseLayer(128, 26, optimizer=True) => SoftmaxLayer()  
**Batch Size:** 64



Confusion Matrix_O_A_784_128-S-D_A_128-26-SO_0.0005ValidationDataset																											
μ-1	3	2	14	10	4	9	31	0	1	0	0	4	35	7	2	39	30	0	2	8	3	3	6	1	9		
μ-7	350	0	13	2	2	29	15	0	4	0	1	1	1	5	9	3	2	6	0	1	1	0	0	1	1	1	
μ-5	0	353	1	39	8	7	0	0	1	2	0	1	5	9	2	7	1	0	0	1	1	1	1	1	1	1	
μ-7	14	3	355	4	8	3	0	29	4	3	6	7	33	7	5	9	2	1	2	1	1	1	5	9	0	0	
μ-3	7	29	0	352	4	5	0	1	0	0	0	0	8	3	2	4	14	1	0	0	1	1	0	6	0	0	
μ-1	2	2	3	3	350	1	2	1	4	1	0	8	6	23	9	14	4	18	0	0	1	1	2	5	0	0	
μ-13	7	4	5	5	351	1	6	2	6	8	6	2	5	5	22	3	3	6	2	0	6	3	0	0	0	0	
μ-20	6	0	5	0	0	352	2	0	11	5	21	6	0	0	0	1	3	4	4	3	2	1	0	0	0	0	0
μ-5	0	1	2	0	1	0	353	22	0	219	0	2	8	0	1	1	22	0	3	1	1	0	1	0	0	0	0
μ-1	0	12	1	2	7	1	21	353	1	3	8	2	0	1	22	3	1	4	1	0	3	1	1	0	0	0	0
μ-0	4	5	3	8	2	27	353	1	3	8	2	0	1	22	3	1	4	1	0	3	1	1	0	0	0	0	0
μ-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
μ-2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
μ-8	4	3	3	3	3	5	0	2	0	0	3	1	0	1	3	3	3	1	0	3	3	3	3	3	3	3	3
μ-0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	mediated	

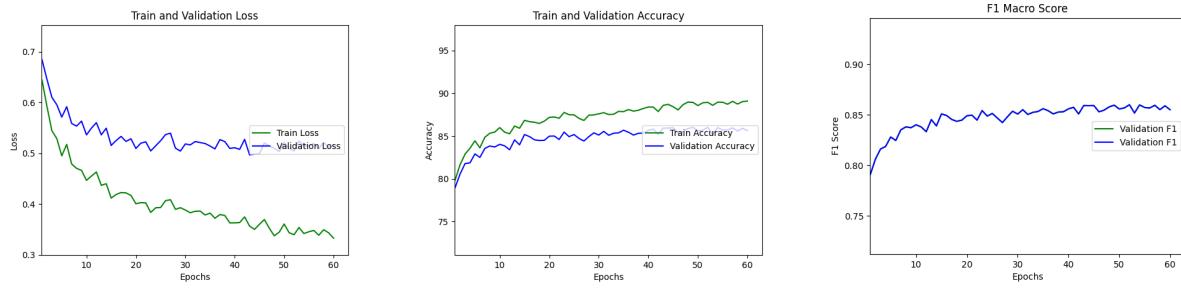
Learning Rate = 0.0005



Confusion Matrix_O_A_784_128_5_O_A_128_26_SQ_0.005TestDataset		
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0 - 1	2	005
0 - 2	6	443
0 - 3	13	12
0 - 4	5	11
0 - 5	18	13
0 - 6	0	1
0 - 7	2	3
0 - 8	4	2
0 - 9	1	9
0 - 10	0	0
0 - 11	9	0
0 - 12	3	5
0 - 13	1	0
0 - 14	0	0
0 - 15	0	0
0 - 16	0	0
0 - 17	0	0
0 - 18	0	0
0 - 19	0	0
0 - 20	0	0
0 - 21	0	0
0 - 22	0	0
0 - 23	0	0
0 - 24	0	0
0 - 25	0	0
0 - 26	0	0
0 - 27	0	0
0 - 28	0	0
0 - 29	0	0
0 - 30	0	0
1 - 0	3	0
1 - 1	0	3
1 - 2	1	2
1 - 3	1	5
1 - 4	0	6
1 - 5	0	2
1 - 6	4	1
1 - 7	1	0
1 - 8	0	1
1 - 9	0	2
1 - 10	0	3
1 - 11	0	4
1 - 12	0	5
1 - 13	0	6
1 - 14	0	7
1 - 15	0	8
1 - 16	0	9
1 - 17	0	10
1 - 18	0	11
1 - 19	0	12
1 - 20	0	13
1 - 21	0	14
1 - 22	0	15
1 - 23	0	16
1 - 24	0	17
1 - 25	0	18
1 - 26	0	19
1 - 27	0	20
1 - 28	0	21
1 - 29	0	22
1 - 30	0	23
2 - 0	0	0
2 - 1	0	0
2 - 2	0	0
2 - 3	0	0
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2 - 6	0	0
2 - 7	0	0
2 - 8	0	0
2 - 9	0	0
2 - 10	0	0
2 - 11	0	0
2 - 12	0	0
2 - 13	0	0
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2 - 15	0	0
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2 - 20	0	0
2 - 21	0	0
2 - 22	0	0
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2 - 27	0	0
2 - 28	0	0
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3 - 9	0	0
3 - 10	0	0
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3 - 14	0	0
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3 - 18	0	0
3 - 19	0	0
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3 - 27	0	0
3 - 28	0	0
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4 - 5	0	0
4 - 6	0	0
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4 - 8	0	0
4 - 9	0	0
4 - 10	0	0
4 - 11	0	0
4 - 12	0	0
4 - 13	0	0
4 - 14	0	0
4 - 15	0	0
4 - 16	0	0
4 - 17	0	0
4 - 18	0	0
4 - 19	0	0
4 - 20	0	0
4 - 21	0	0
4 - 22	0	0
4 - 23	0	0
4 - 24	0	0
4 - 25	0	0
4 - 26	0	0
4 - 27	0	0
4 - 28	0	0
4 - 29	0	0
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6 - 29	0	0
6 - 30	0	0
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7 - 4	0	0
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8 - 19	0	0
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13 - 6	0	0
13 - 7	0	0
13 - 8	0	0
13 - 9	0	0
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13 - 11	0	0
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13 -		

		Confusion Matrix-Diag-144,28-S0,26-S0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0																								
		Dataset																								
		Diag-144,28-S0,26-S0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0																								
+	0	65	4	6	15	8	25	16	0	1	3	4	26	14	12	9	29	15	0	1	0	0	0	0	6	
-	+	5	58	1	11	6	1	24	26	1	1	7	0	2	6	1	5	3	2	1	0	0	0	0	9	
-	-	3	70	2	16	0	1	1	0	0	7	0	0	2	2	1	6	0	2	2	0	1	1	0	1	
+	-	8	13	68	0	1	6	6	1	6	1	4	1	32	6	3	3	2	1	2	1	4	1	0	2	
-	-	7	58	1	65	0	1	0	1	2	3	0	0	4	3	1	16	0	6	0	1	0	1	1	3	
+	-	0	1	0	6	1	11	9	0	1	1	3	1	1	9	7	9	20	1	0	1	0	0	0	0	
-	-	10	12	15	3	7	16	1	1	2	4	1	1	1	2	1	2	71	0	5	1	2	0	0	3	5
-	-	5	9	0	4	0	0	2	71	1	3	12	24	4	21	0	4	0	4	7	0	3	0	3	1	
+	-	0	1	1	1	6	1	0	1	6	1	31	16	0	0	0	3	1	5	0	1	1	0	0	1	
-	-	0	2	3	13	6	7	0	0	36	67	0	0	1	0	0	0	0	7	13	1	2	0	1	10	
+	-	0	4	2	2	2	5	2	23	1	0	2	6	1	2	0	0	22	0	1	6	1	1	17	1	
-	-	0	1	2	12	3	4	0	7	171	4	7	17	0	0	1	1	2	2	0	7	1	1	0	2	
+	-	1	0	1	0	0	0	0	5	0	0	3	0	759	0	1	2	7	0	0	3	0	5	1	1	
-	-	0	2	0	7	0	0	1	28	0	1	4	0	16	895	0	0	2	10	0	0	1	6	10	2	
+	-	0	8	5	15	0	0	4	0	0	0	0	0	0	2	141	1	5	1	2	1	5	0	0	0	
-	-	1	0	0	5	3	37	5	0	0	0	0	0	0	2	0	245	6	16	0	2	0	0	0	0	
+	-	26	5	9	3	9	3	71	1	2	3	0	1	1	9	7	18	13	2	3	4	0	2	0	8	
-	-	17	8	6	7	1	4	7	1	0	2	1	8	1	2	0	0	2	4	706	1	15	1	11	0	
+	-	2	4	0	3	3	27	23	1	11	1	1	2	0	1	2	0	2	1	1	1	0	1	1	0	
-	-	2	4	2	1	4	10	2	3	4	6	3	0	0	1	3	1	9	17	0	0	0	3	0	5	
+	-	3	0	2	6	0	0	3	8	0	4	5	2	4	7	0	1	1	1	0	482	72	0	9	1	
-	-	0	0	0	0	0	0	0	1	2	2	0	2	0	4	0	0	1	14	0	0	26	11	2	1	
+	-	2	1	0	3	0	0	1	3	0	1	2	0	4	13	0	0	1	2	0	0	8	756	1	1	
-	-	1	3	1	0	0	0	5	0	5	1	18	2	4	0	2	0	3	1	3	1	0	0	7		
+	-	0	2	1	1	0	2	17	2	4	9	1	8	0	0	0	3	5	0	13	1	13	1	9		
-	-	2	3	2	3	5	1	1	4	0	9	1	1	15	1	1	0	5	0	0	0	0	0	0	6	
+	-	0	1	2	3	4	5	6	7	8	9	10	1	15	14	15	16	17	18	19	20	21	22	23	24	
-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
		Predicted																								

*Learning Rate = 0.01*



Confusion Matrix-0_A_1sd_178-0_A_12B_26-30_A_100_NearestSd											
	0	1	2	3	4	5	6	7	8	9	
0	1	18	21	2	0	2	9	4	7	5	2
1	2	1	20	0	1	5	0	2	1	6	0
2	4	2	1	0	1	5	0	2	1	6	0
3	0	5	0	20	23	2	1	7	88	9	7
4	6	5	0	0	2	0	0	8	7	9	1
5	27	5	2	2	2	2	0	0	23	30	10
6	58	1	0	9	1	3	0	3	30	129	15
7	2	0	600	0	3	23	12	26	0	0	3
8	3	0	5	3	25	1	23	0	0	3	1
9	1	2	1	3	177	0	0	0	3	1	3
10	4	20	30	1	1	484	0	3	11	0	0
11	0	4	26	1	7	1	0	2	1	2	50
12	0	0	11	0	0	0	0	0	20	0	3
13	0	0	0	12	0	0	0	0	0	0	1
14	0	0	0	0	13	0	0	0	0	0	1
15	0	0	0	0	0	14	0	0	0	0	1
16	0	0	0	0	0	0	15	0	0	0	1
17	0	0	0	0	0	0	0	16	0	0	1
18	0	0	0	0	0	0	0	0	17	0	1
19	11	0	0	1	2	0	0	0	11	5	381
20	4	9	1	2	0	0	0	3	1	4	351
21	2	21	0	0	21	0	0	2	4	0	3
22	34	1	1	6	6	0	0	3	1	2	14
23	0	1	9	0	4	5	2	10	6	0	1
24	1	1	2	0	3	1	0	0	1	0	727
25	1	1	2	0	3	1	0	0	1	0	1
26	0	0	2	0	2	4	0	0	0	0	0
27	0	5	0	0	0	30	0	0	7	0	0
28	1	0	3	0	0	9	0	2	11	11	3
29	7	6	1	0	1	2	1	0	0	6	5
30	4	5	4	7	4	9	15	12	13	14	15

*Learning Rate = 0.02*

## The Best Model

**Model - 3:** DenseLayer(784, 128, optimizer=True) => Sigmoid() =>  
DenseLayer(128, 26, optimizer=True) => SoftmaxLayer()

**Batch Size:** 64

**Decay:** At each iteration, learning rate becomes 0.98 times of previous one

**Optimizer:** Adam

**Learning Rate:** 0.0005

**Independent Test Dataset CrossEntropy:** 0.3866

**Independent Test Dataset Accuracy:** 88.6490%

**Independent Test Dataset MacroF1:** 0.88679868303002