

Assignment 3: Function Approximation with Neural Network and Backpropagation

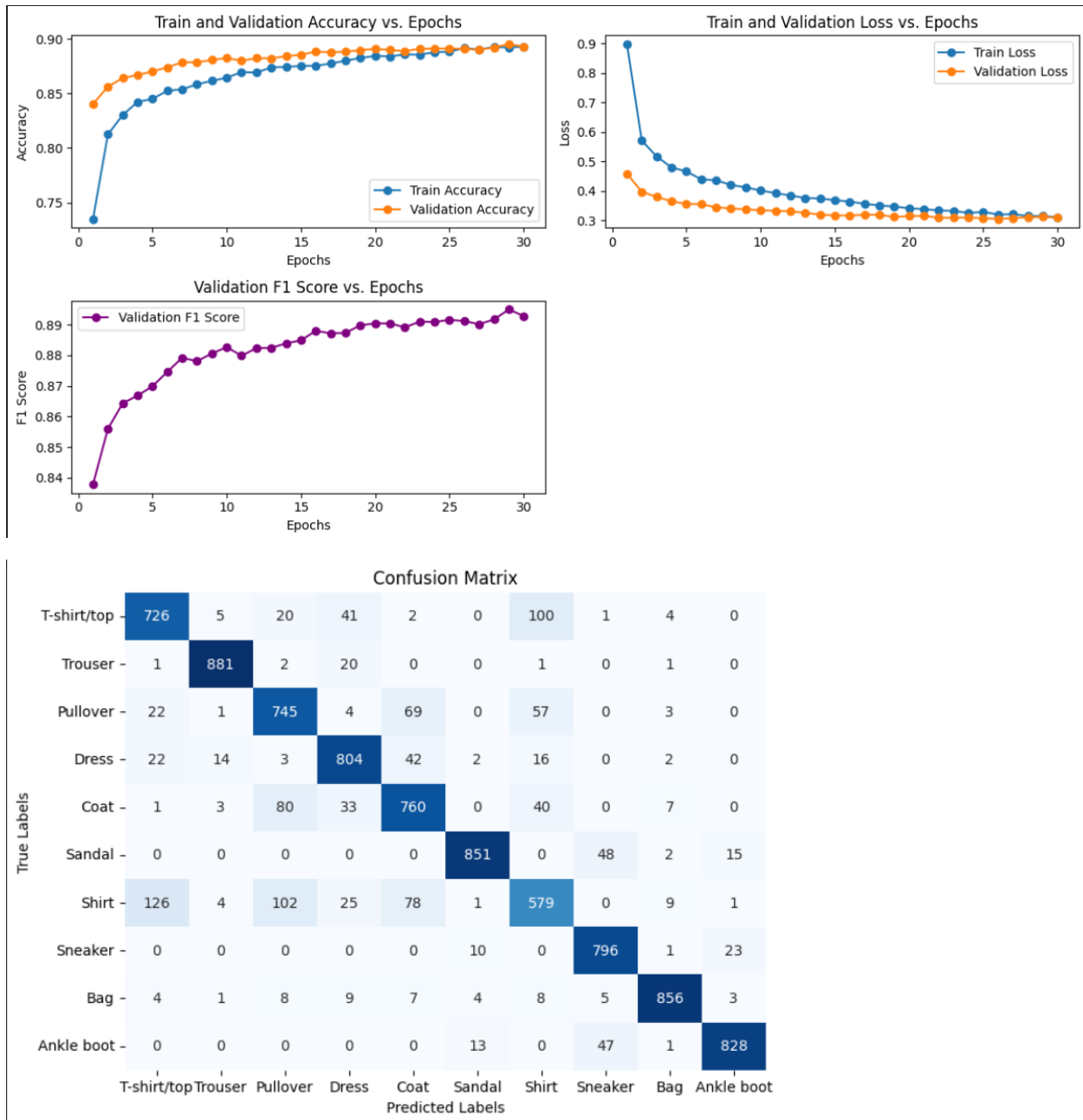
Submitted by: 1905117

To run the code, we just need to run all the cells of '1905117.ipynb' file.

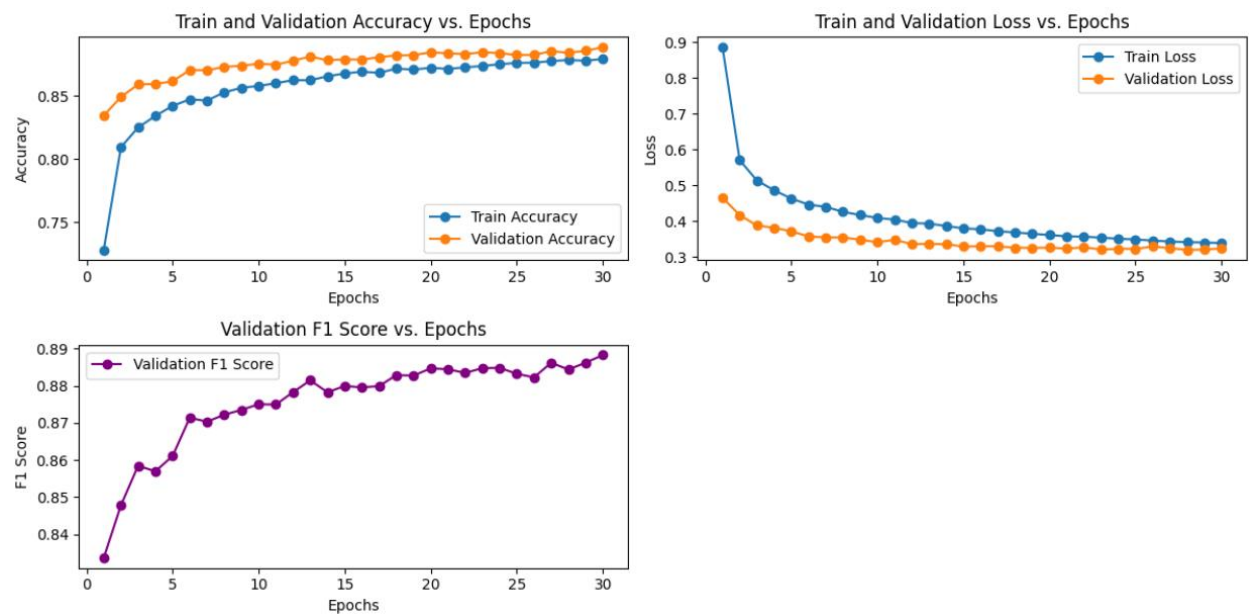
Input Size and Output Size for all models are 28*28 and 10 respectively

Learning rate is 0.005:

1.Hidden layer is [256,128,64]

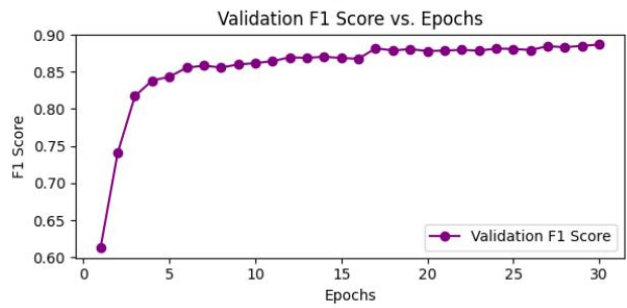
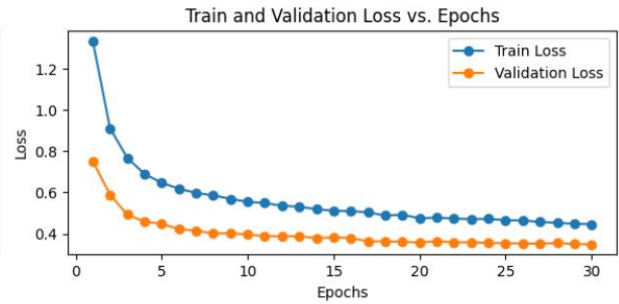
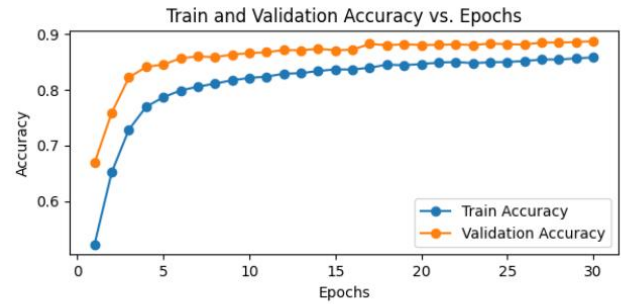


2.Hidden layer is [128,64]



		Confusion Matrix									
True Labels	T-shirt/top	777	0	16	50	3	0	46	0	6	1
	Trouser	3	870	2	27	1	0	0	0	2	1
	Pullover	26	0	698	9	97	4	61	1	5	0
	Dress	24	7	3	814	31	1	18	0	7	0
	Coat	0	1	92	42	723	0	59	0	7	0
	Sandal	3	0	0	1	0	854	0	34	1	23
	Shirt	172	3	93	34	78	2	531	0	11	1
	Sneaker	2	0	0	0	0	23	0	772	1	32
	Bag	7	0	7	6	6	3	13	5	856	2
	Ankle boot	0	0	0	1	0	19	0	47	4	818
		T-shirt/top Trouser Pullover Dress Coat Sandal Shirt Sneaker Bag Ankle boot									
		Predicted Labels									

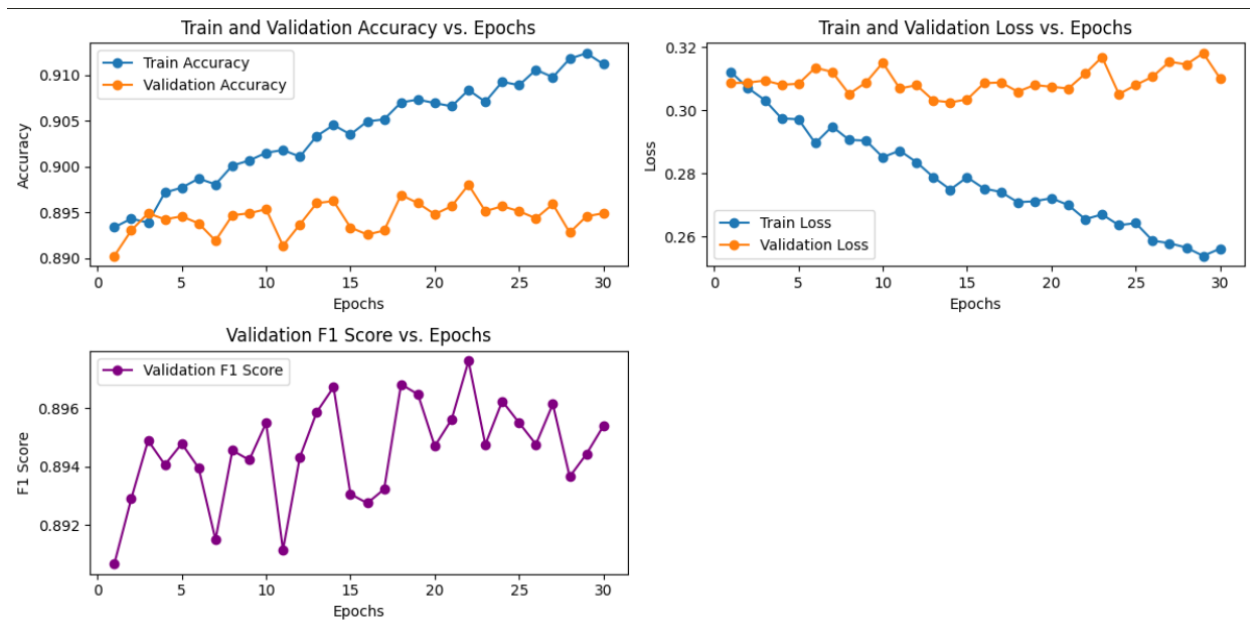
3.Hidden layer is [256,128,64,32]:



True Labels										
	T-shirt/top	Trouser	Pullover	Dress	Coat	Sandal	Shirt	Sneaker	Bag	Ankle boot
	741	2	18	46	2	6	78	0	5	1
	3	861	1	35	2	2	2	0	0	0
	12	1	713	8	114	1	49	0	3	0
	39	9	5	792	42	0	12	0	4	2
	5	2	79	43	730	0	60	0	5	0
	2	4	0	1	0	845	0	51	2	11
	177	0	117	34	90	0	494	0	12	1
	0	0	0	0	0	18	0	784	5	23
	6	0	7	9	7	8	12	7	849	0
	1	2	1	2	2	16	1	50	2	812
Predicted Labels										

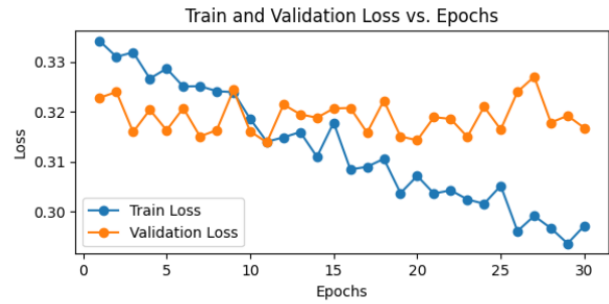
Learning Rate is 0.001:

1.Hidden layer is [256,128,64]



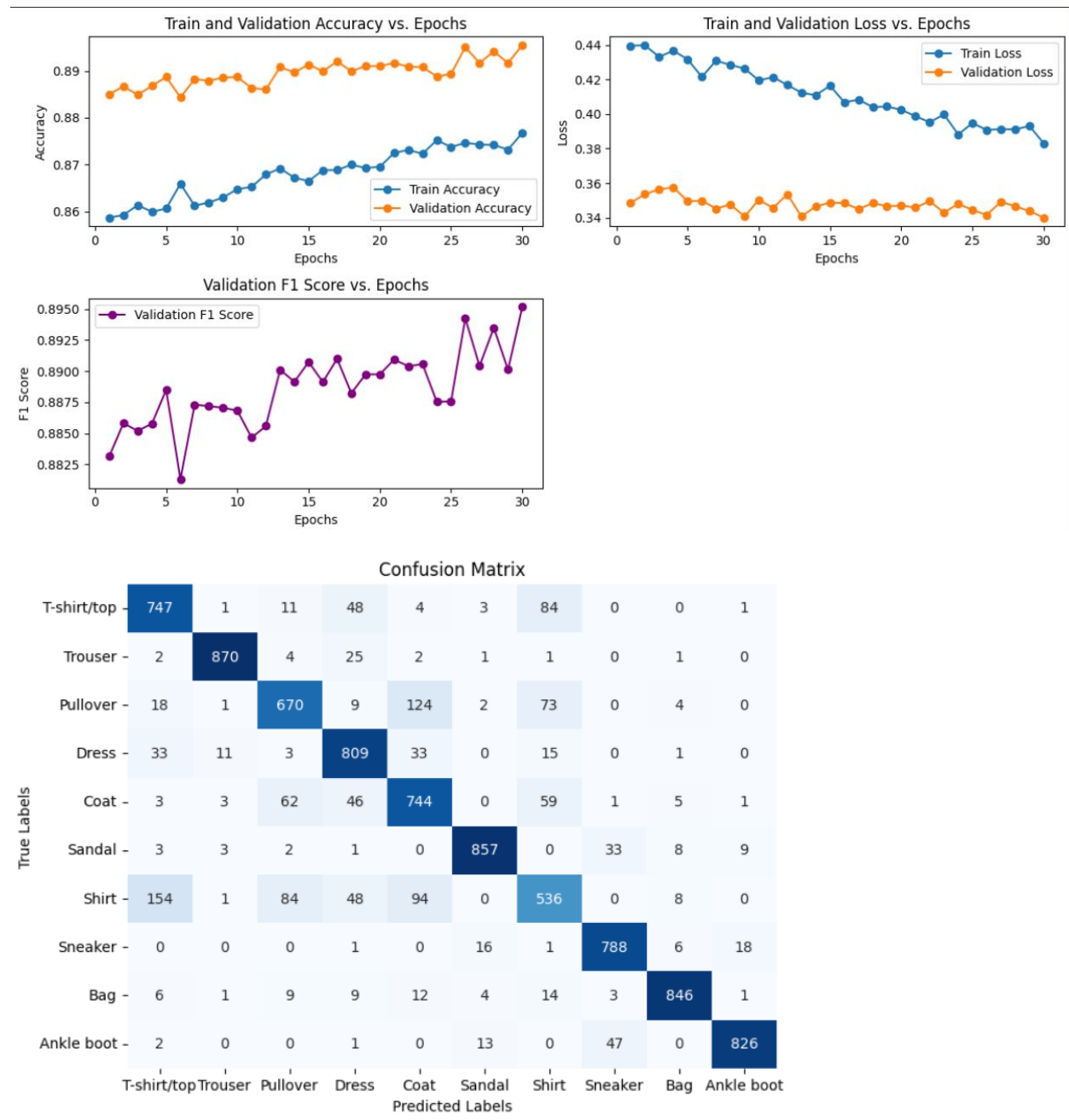
True Labels	Predicted Labels									
	T-shirt/top	Trouser	Pullover	Dress	Coat	Sandal	Shirt	Sneaker	Bag	Ankle boot
	737	1	25	28	4	0	101	0	3	0
	3	880	4	16	1	1	0	0	1	0
	10	2	743	4	81	1	55	0	4	1
	21	12	6	806	33	0	22	1	4	0
	1	0	87	38	726	1	62	0	9	0
	0	2	0	1	1	875	0	23	5	9
	121	2	97	24	55	0	618	0	8	0
	0	0	0	0	0	23	0	785	0	22
	2	0	8	5	6	5	16	5	857	1
	1	0	0	0	0	17	0	30	1	840

2.Hidden layer is [128,64]

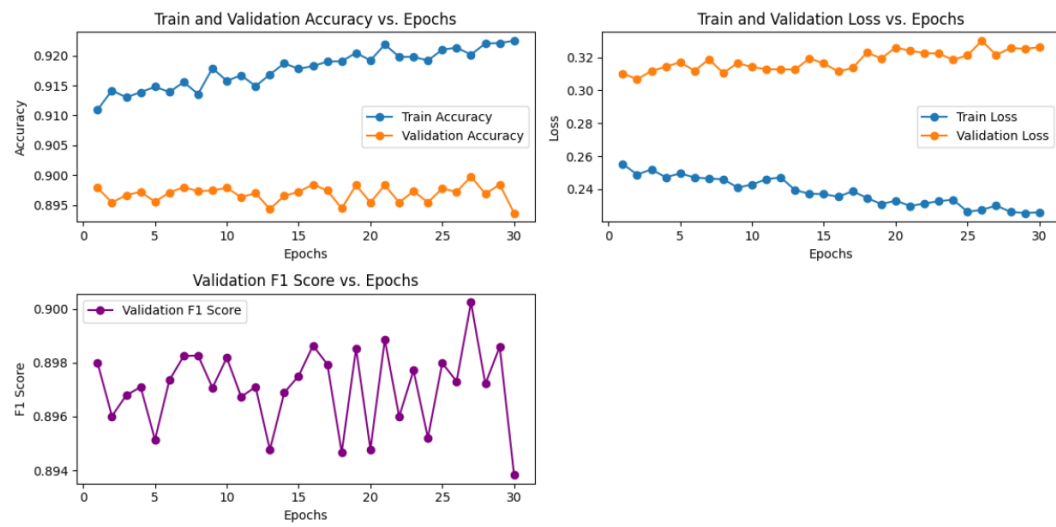


True Labels \ Predicted Labels	T-shirt/top	Trouser	Pullover	Dress	Coat	Sandal	Shirt	Sneaker	Bag	Ankle boot
T-shirt/top	761	3	25	32	1	2	70	0	5	0
Trouser	2	881	4	14	1	1	2	0	1	0
Pullover	17	0	701	2	98	0	78	1	3	1
Dress	29	15	8	788	44	1	16	0	3	1
Coat	0	1	79	30	751	0	56	0	7	0
Sandal	1	0	0	0	1	875	1	22	2	14
Shirt	155	3	105	20	75	1	558	0	8	0
Sneaker	0	0	1	0	0	19	0	781	3	26
Bag	5	0	6	4	12	5	14	7	851	1
Ankle boot	1	0	0	0	0	13	0	26	1	848

3. Hidden layer is [256,128,64,32]:

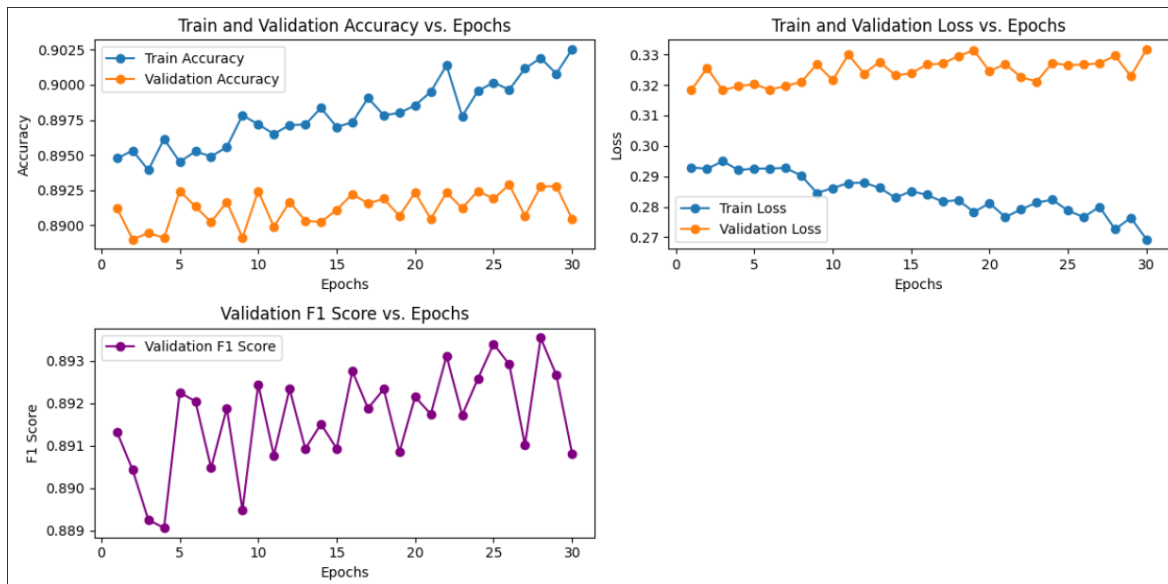


1.Hidden layer is [256,128,64]



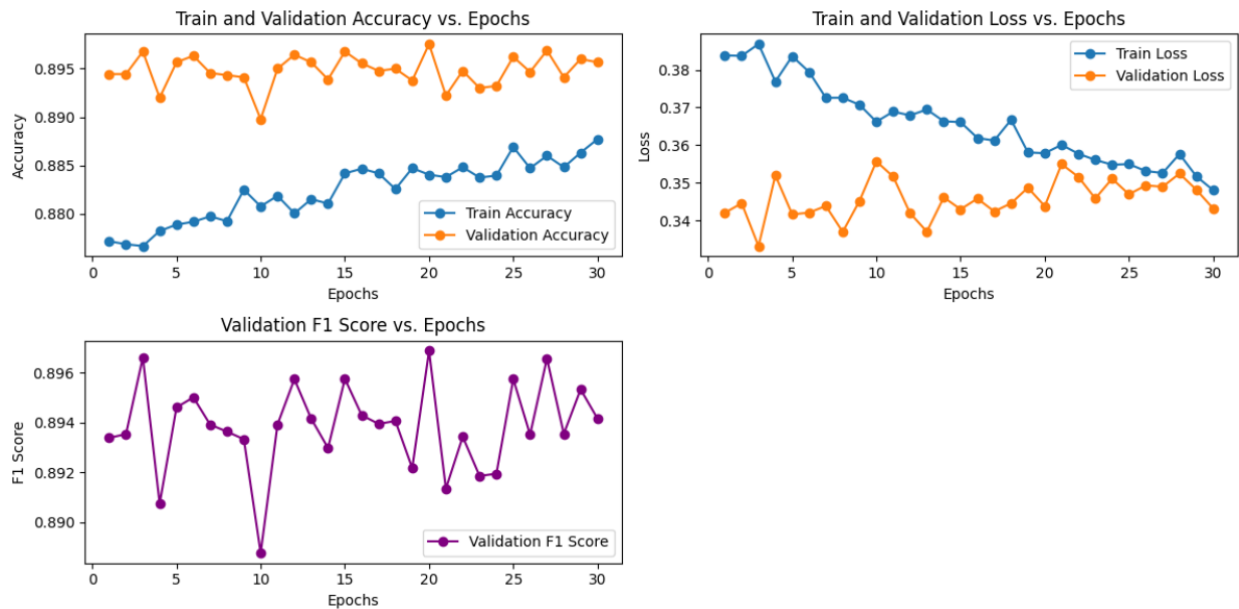
	T-shirt/top	Trouser	Pullover	Dress	Coat	Sandal	Shirt	Sneaker	Bag	Ankle boot
T-shirt/top	766	0	14	29	4	1	80	1	4	0
Trouser	2	883	1	17	1	0	1	0	1	0
Pullover	22	1	715	11	97	1	51	0	3	0
Dress	24	12	5	798	33	1	28	0	4	0
Coat	3	2	72	28	759	0	51	0	9	0
Sandal	0	0	0	1	0	875	0	23	4	13
Shirt	136	0	93	28	77	1	578	0	11	1
Sneaker	0	0	0	0	1	16	0	796	3	14
Bag	3	1	7	5	4	4	8	6	864	3
Ankle boot	0	0	0	0	0	21	0	38	0	830

2.Hidden layer is [128,64]



Confusion Matrix											
True Labels	T-shirt/top	731	3	20	40	3	0	94	1	6	1
	Trouser	1	880	3	16	2	0	3	0	1	0
	Pullover	15	1	716	4	92	2	65	0	6	0
	Dress	19	10	7	799	47	1	16	0	6	0
	Coat	1	2	76	33	750	0	56	0	6	0
	Sandal	0	0	0	1	0	852	0	35	6	22
	Shirt	136	2	98	26	89	0	557	0	17	0
	Sneaker	0	0	0	0	0	12	0	785	3	30
	Bag	3	0	7	1	12	4	17	6	855	0
	Ankle boot	0	0	0	0	0	12	0	35	2	840
Predicted Labels											

3. Hidden layer is [256,128,64,32]:



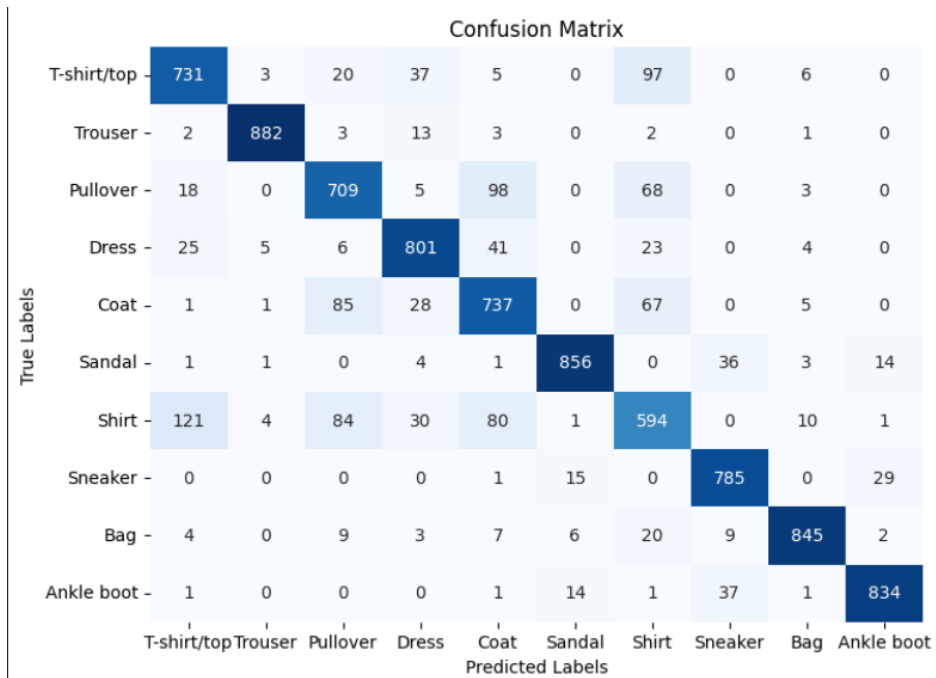
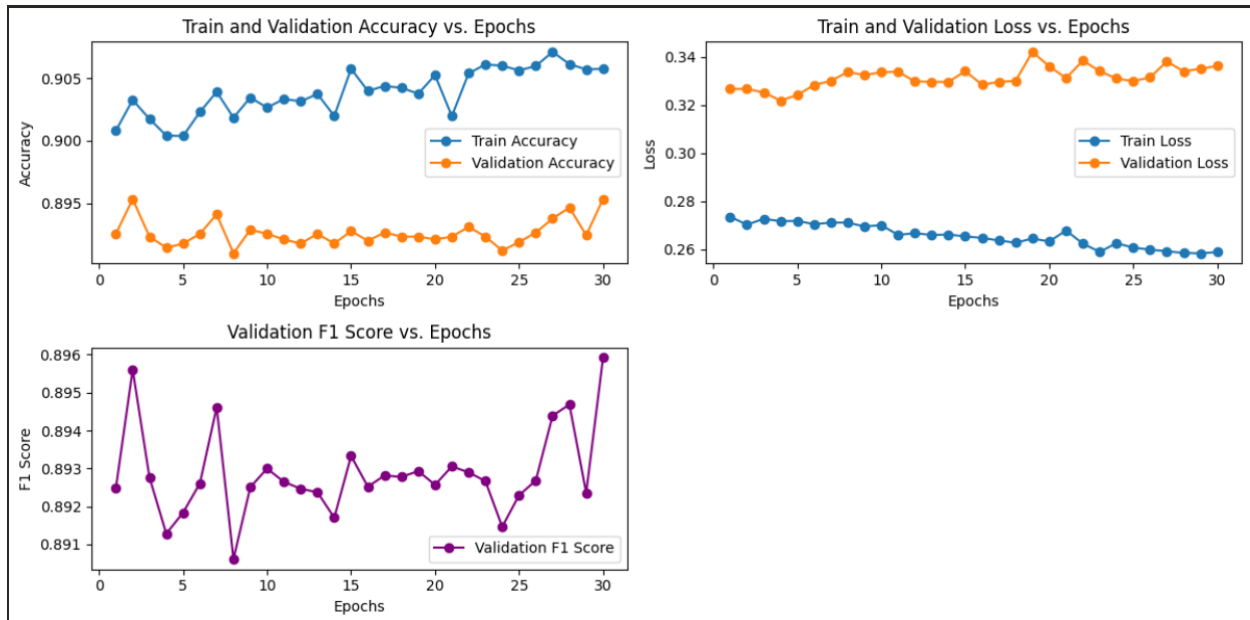
		Confusion Matrix									
True Labels	T-shirt/top	770	0	13	58	5	4	43	0	6	0
	Trouser	2	880	2	19	0	1	1	0	1	0
	Pullover	21	3	696	15	100	0	64	1	1	0
	Dress	29	8	6	827	24	0	9	0	2	0
	Coat	4	9	67	60	734	0	45	0	5	0
	Sandal	1	5	1	0	0	869	0	26	3	11
	Shirt	189	1	107	44	75	0	503	0	6	0
	Sneaker	2	0	0	0	0	26	2	781	3	16
	Bag	5	1	5	8	6	4	11	5	858	2
	Ankle boot	2	0	0	0	2	13	1	57	3	811
		T-shirt/top	Trouser	Pullover	Dress	Coat	Sandal	Shirt	Sneaker	Bag	Ankle boot
		Predicted Labels									

1.Hidden layer is [256,128,64]

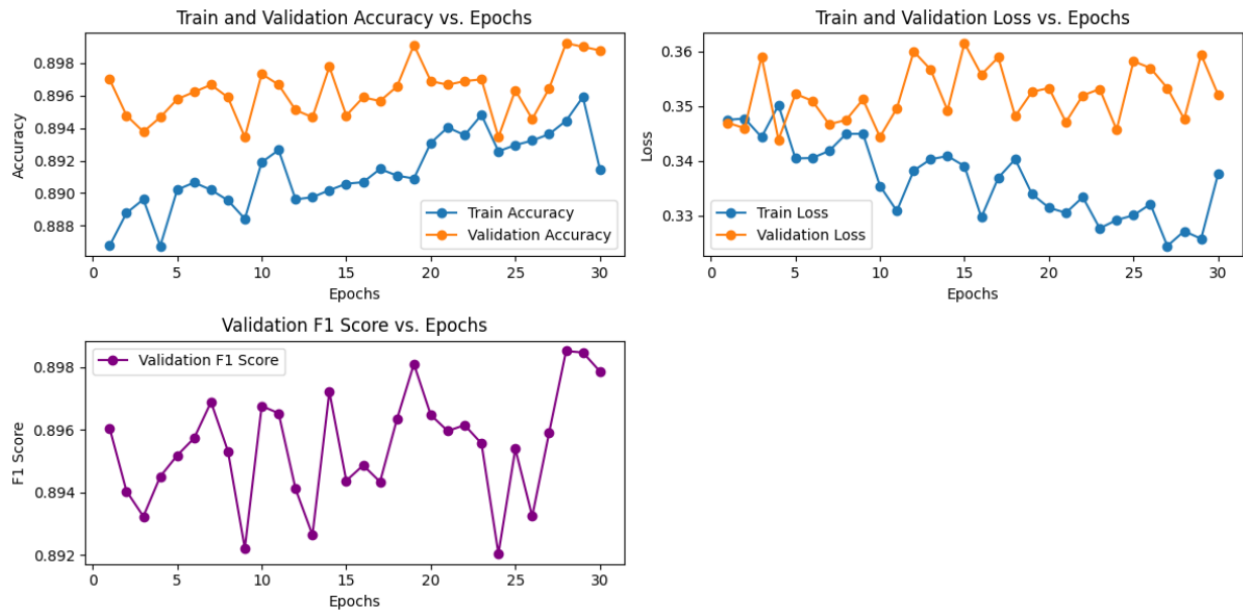


Confusion Matrix										
	T-shirt/top	Trouser	Pullover	Dress	Coat	Sandal	Shirt	Sneaker	Bag	Ankle boot
T-shirt/top	726	1	20	28	4	0	118	0	2	0
Trouser	3	881	0	18	1	0	2	0	1	0
Pullover	19	0	709	7	100	0	60	0	6	0
Dress	31	7	3	809	27	3	22	0	3	0
Coat	0	1	58	37	762	0	61	0	4	1
Sandal	2	1	0	0	0	874	0	20	4	15
Shirt	119	0	86	31	78	0	593	1	16	1
Sneaker	0	0	0	0	0	13	0	795	1	21
Bag	8	1	7	3	8	2	11	5	860	0
Ankle boot	0	0	0	0	0	15	0	31	0	843
	T-shirt/top	Trouser	Pullover	Dress	Coat	Sandal	Shirt	Sneaker	Bag	Ankle boot

2.Hidden layer is [128,64]:



3. Hidden layer is [256,128,64,32]:



Confusion Matrix											
True Labels	T-shirt/top	751	0	23	40	6	0	75	0	4	0
	Trouser	3	872	2	22	3	1	0	0	3	0
	Pullover	15	5	699	9	115	2	52	0	4	0
	Dress	31	7	4	816	33	1	11	0	1	1
	Coat	1	2	62	57	753	0	41	1	7	0
	Sandal	1	2	1	0	0	852	0	47	2	11
	Shirt	147	1	97	40	82	0	548	1	9	0
	Sneaker	0	1	0	1	1	21	1	783	4	18
	Bag	5	4	4	7	8	1	14	5	857	0
	Ankle boot	0	1	1	1	1	14	0	46	2	823
		T-shirt/top	Trouser	Pullover	Dress	Coat	Sandal	Shirt	Sneaker	Bag	Ankle boot

Best Learning Rate:0.00001

Hidden layer size for best model [256,128,64]

Test Accuracy: 0.8957, Test F1 Score: 0.8955

Testing best model with learning rate 1e-05

Test Accuracy: 0.8957

Test F1 Score: 0.8955

		Confusion Matrix									
True Labels	T-shirt/top	837	1	10	22	3	1	120	0	6	0
	Trouser	2	976	1	15	2	0	2	0	2	0
	Pullover	22	1	807	9	103	0	56	0	1	1
	Dress	15	4	5	912	27	0	33	0	4	0
	Coat	1	1	55	31	857	0	53	0	2	0
	Sandal	0	0	0	0	0	963	0	24	1	12
	Shirt	100	1	89	24	75	0	698	0	13	0
	Sneaker	0	0	0	0	0	11	0	972	0	17
	Bag	3	1	3	2	4	1	5	5	976	0
	Ankle boot	0	0	0	0	0	5	1	35	0	959
		T-shirt/top	Trouser	Pullover	Dress	Coat	Sandal	Shirt	Sneaker	Bag	Ankle boot
		Predicted Labels									