

Report

Running the Script

Instruction for VS-Code

- Press **Run All**
- It would process all the train, test data and train the models (12)
- Test all the models
 - Also the best one

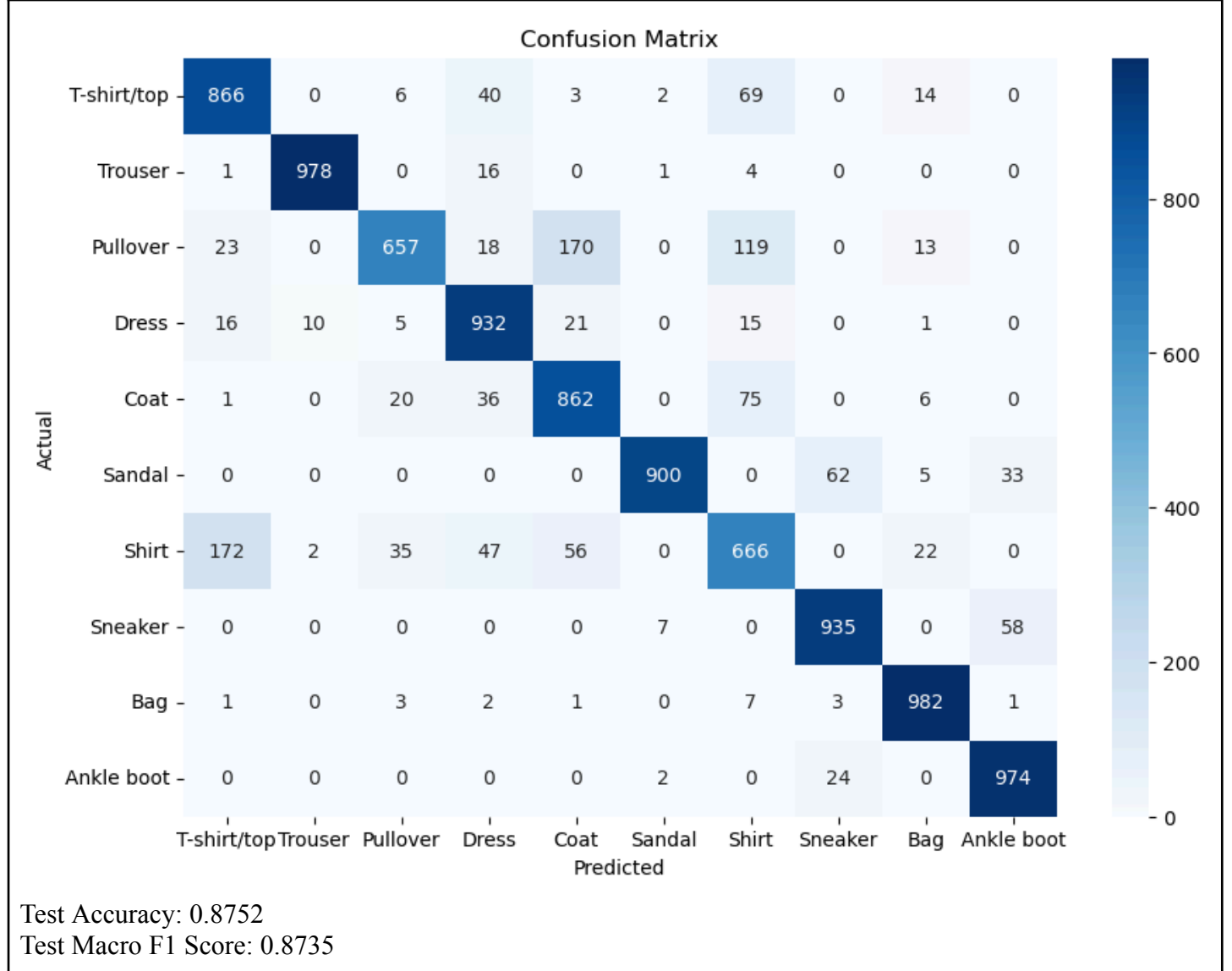
For convenience, a detailed “**outline**” can be found in the notebook’s outline

Model Variants

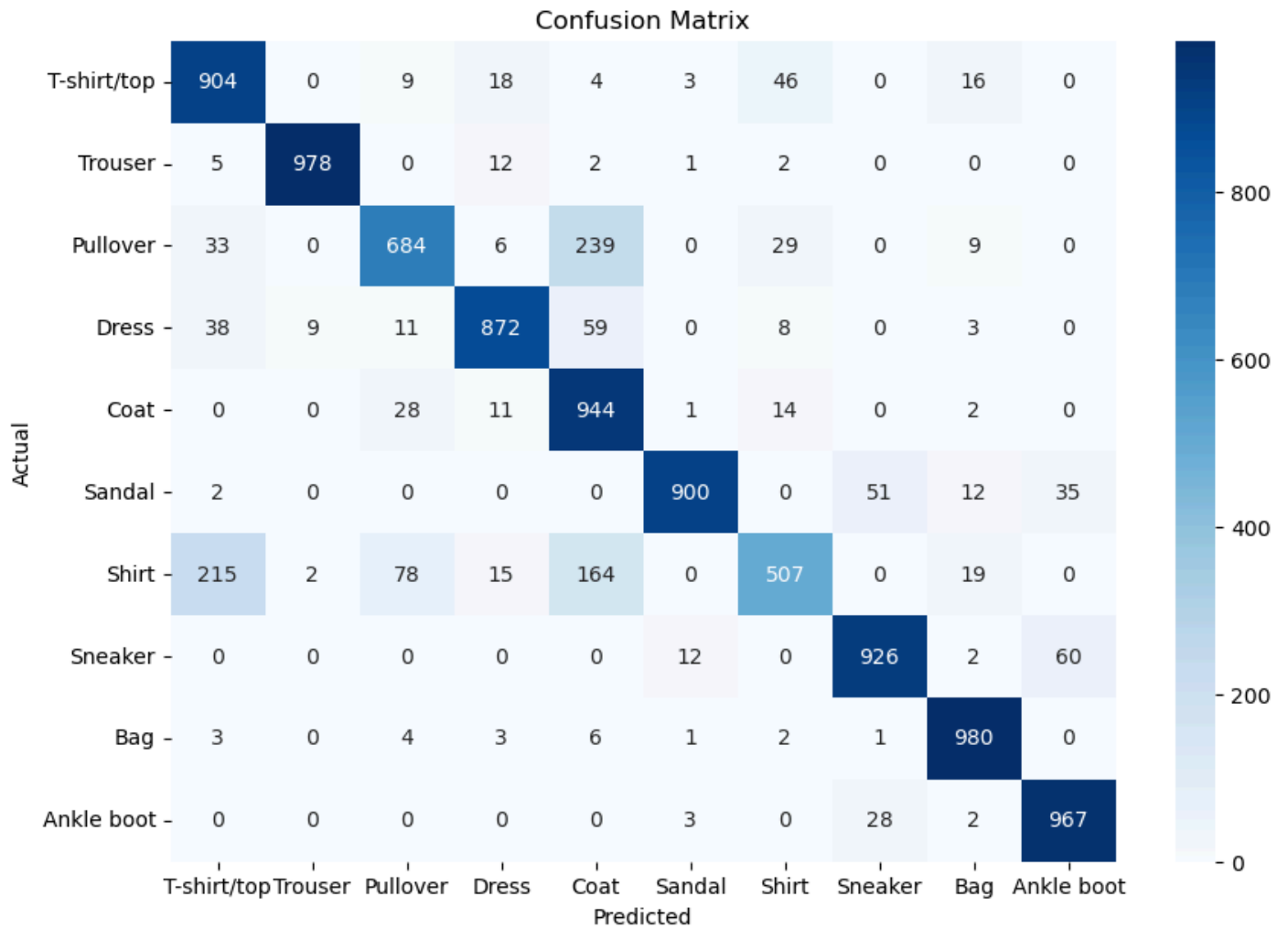
Model 1	Simple model with 3 layers [784, 256, 10]
Model 2	Moderate complex model with 4 layers [784, 256,128,10]
Model 3	More complex model with 5 layers [784, 512, 256,128,10]

Reporting model performance metrics

Learning Rate: 0.005					
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Model 1 LR=0.005					
	Train Loss	Val Loss	Train Accuracy	Val Accuracy	Val Macro F1
Epoch 1	0.085676	0.060360	0.795937	0.795417	0.794503
Epoch 2	0.051332	0.049239	0.834562	0.826917	0.828214
Epoch 3	0.045537	0.046114	0.850708	0.840917	0.841269
Epoch 4	0.042639	0.043250	0.862833	0.848250	0.848564
Epoch 5	0.040478	0.042263	0.867625	0.855500	0.856279
Epoch 6	0.038922	0.042488	0.869000	0.854083	0.854451
Epoch 7	0.037695	0.043287	0.867104	0.849833	0.849532
Epoch 8	0.036559	0.042197	0.873687	0.853250	0.853792
Epoch 9	0.035485	0.039574	0.882542	0.862500	0.863431
Epoch 10	0.034597	0.040449	0.883563	0.863750	0.864452
Epoch 11	0.033903	0.040795	0.881708	0.864250	0.864924
Epoch 12	0.032934	0.041034	0.888021	0.861750	0.862357
Epoch 13	0.032141	0.041234	0.886125	0.863750	0.864597
Epoch 14	0.031838	0.039936	0.890437	0.864417	0.865102
Epoch 15	0.030810	0.039942	0.892938	0.865583	0.866543



Model 2 LR=0.005						
	Train Loss	Val Loss	Train Accuracy	Val Accuracy	Val Macro F1	
Epoch 1	0.070977	0.056777	0.802188	0.795833	0.798175	
Epoch 2	0.052617	0.051666	0.820729	0.813833	0.813056	
Epoch 3	0.048092	0.047116	0.838042	0.828000	0.828765	
Epoch 4	0.045219	0.045914	0.848646	0.839000	0.839352	
Epoch 5	0.043279	0.044319	0.851688	0.842167	0.843481	
Epoch 6	0.042417	0.044877	0.851083	0.842500	0.843623	
Epoch 7	0.040616	0.043234	0.859062	0.846083	0.845904	
Epoch 8	0.039825	0.043690	0.858271	0.845917	0.845876	
Epoch 9	0.038932	0.041096	0.866771	0.856750	0.857992	
Epoch 10	0.038018	0.042943	0.862125	0.848750	0.848469	
Epoch 11	0.037278	0.041706	0.866812	0.855500	0.856668	
Epoch 12	0.037003	0.041506	0.869812	0.853583	0.854305	
Epoch 13	0.036083	0.041765	0.868771	0.853750	0.854684	
Epoch 14	0.036177	0.041008	0.875667	0.853167	0.854608	
Epoch 15	0.035110	0.040410	0.878687	0.861667	0.862423	

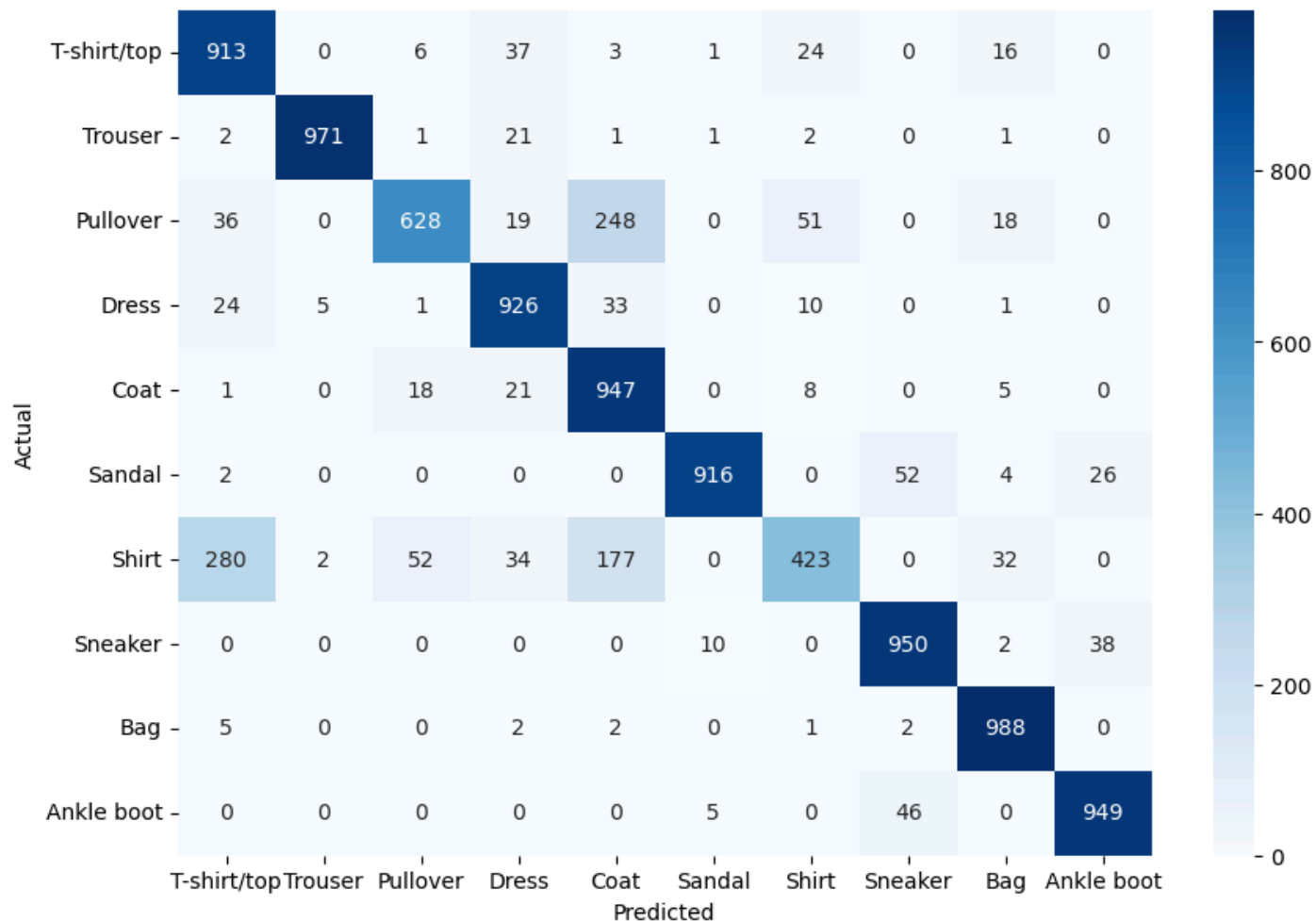


Test Accuracy: 0.8662
Test Macro F1 Score: 0.8628

Model 3 | LR=0.005

	Train Loss	Val Loss	Train Accuracy	Val Accuracy	Val Macro F1
Epoch 1	0.073898	0.055557	0.805896	0.803083	0.807001
Epoch 2	0.053245	0.051280	0.827000	0.822917	0.824096
Epoch 3	0.048861	0.047052	0.844583	0.835417	0.834507
Epoch 4	0.045183	0.045632	0.848208	0.841167	0.841583
Epoch 5	0.043480	0.044178	0.854896	0.844000	0.845910
Epoch 6	0.041482	0.043175	0.861479	0.847333	0.849134
Epoch 7	0.040367	0.044085	0.861521	0.847167	0.847831
Epoch 8	0.039373	0.042463	0.867042	0.851083	0.852154
Epoch 9	0.038293	0.040596	0.871042	0.861750	0.862612
Epoch 10	0.037556	0.040527	0.875771	0.860667	0.860846
Epoch 11	0.036816	0.039741	0.879313	0.862667	0.863639
Epoch 12	0.036048	0.040240	0.878854	0.858500	0.858708
Epoch 13	0.035275	0.040890	0.879500	0.860333	0.861195
Epoch 14	0.034341	0.039541	0.882313	0.863667	0.864444
Epoch 15	0.033671	0.039619	0.883979	0.864750	0.865564

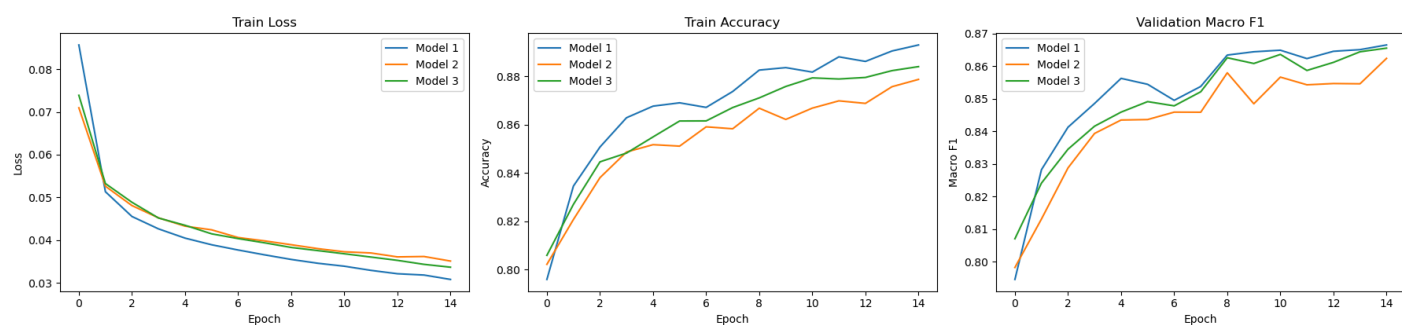
Confusion Matrix



Test Accuracy: 0.8611

Test Macro F1 Score: 0.8540

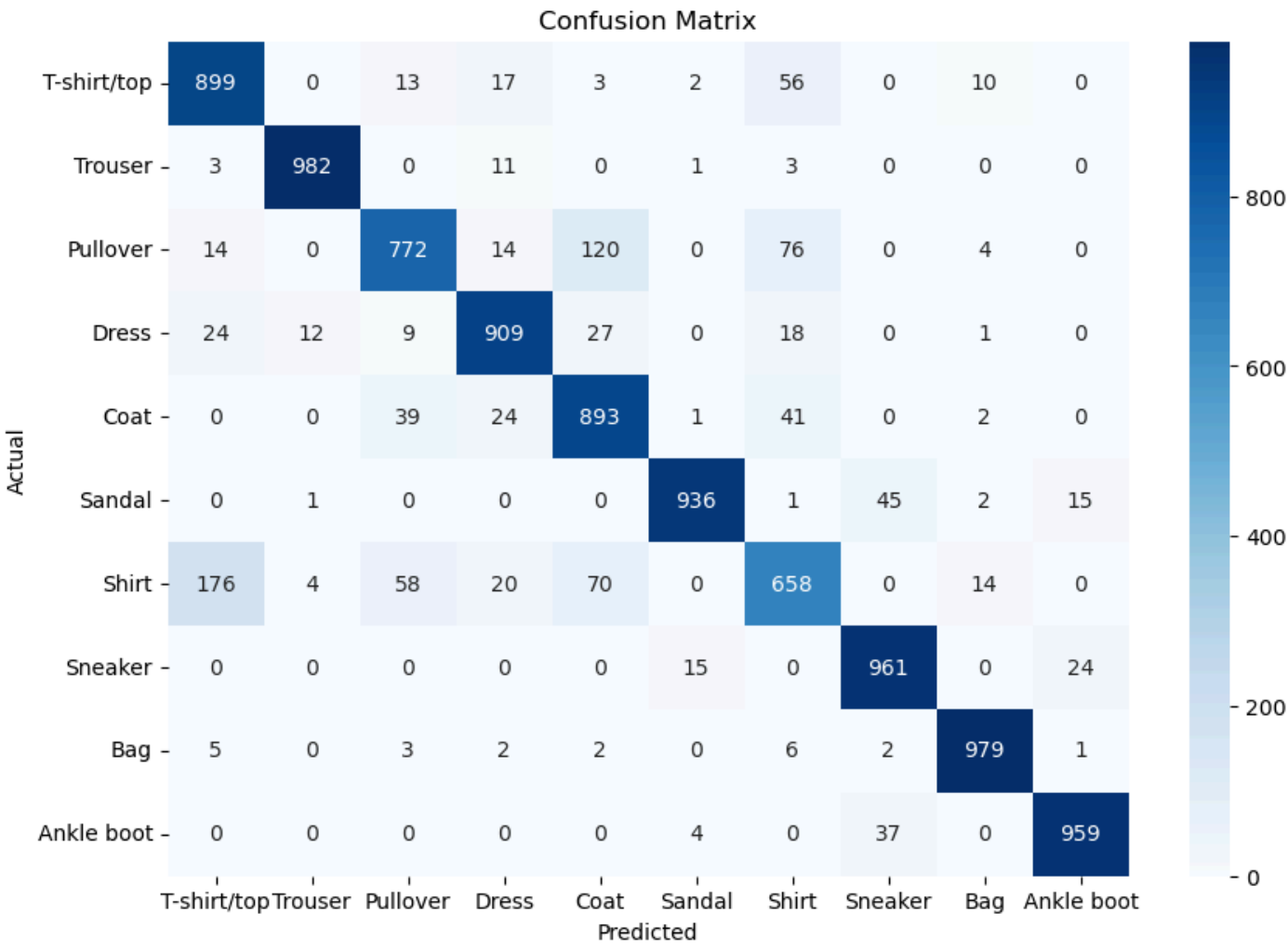
Metrics for Learning Rate: 0.005



Learning Rate: 0.001

Model 1 | LR=0.001

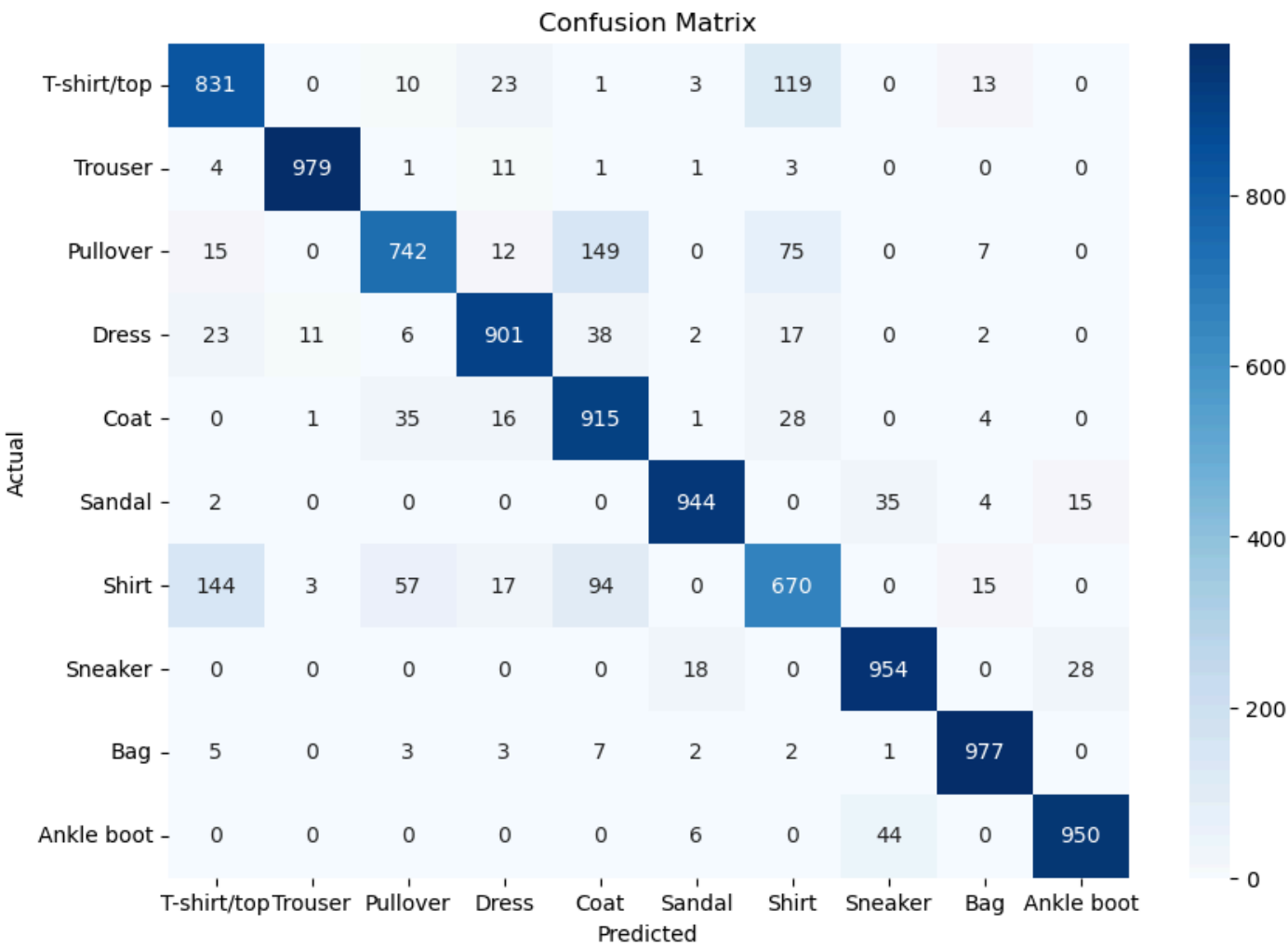
	Train Loss	Val Loss	Train Accuracy	Val Accuracy	Val Macro F1
Epoch 1	0.027260	0.036583	0.907042	0.877250	0.877959
Epoch 2	0.026118	0.036069	0.909146	0.878250	0.878848
Epoch 3	0.025524	0.035659	0.909542	0.876667	0.877549
Epoch 4	0.025249	0.036221	0.913333	0.877833	0.878687
Epoch 5	0.024924	0.035967	0.911438	0.878000	0.878639
Epoch 6	0.024692	0.035419	0.912979	0.879083	0.880071
Epoch 7	0.024124	0.035440	0.913875	0.880167	0.881055
Epoch 8	0.024136	0.036310	0.912854	0.876583	0.877485
Epoch 9	0.023897	0.036144	0.917417	0.877083	0.878052
Epoch 10	0.023661	0.036178	0.916354	0.880833	0.881874
Epoch 11	0.023536	0.035897	0.917542	0.881167	0.881961
Epoch 12	0.023465	0.035961	0.916208	0.881250	0.881949
Epoch 13	0.023378	0.036365	0.918646	0.879583	0.880155
Epoch 14	0.023139	0.036500	0.918354	0.876417	0.877229
Epoch 15	0.022982	0.036964	0.919896	0.879750	0.880384



Test Accuracy: 0.8948
Test Macro F1 Score: 0.8936

Model 2 | LR=0.001

	Train Loss	Val Loss	Train Accuracy	Val Accuracy	Val Macro F1
Epoch 1	0.032319	0.037959	0.887979	0.869250	0.869949
Epoch 2	0.031067	0.038126	0.889417	0.866917	0.867828
Epoch 3	0.031067	0.038144	0.890687	0.868167	0.868264
Epoch 4	0.030704	0.037950	0.890292	0.867833	0.868842
Epoch 5	0.030193	0.037346	0.892208	0.871000	0.871825
Epoch 6	0.030328	0.037460	0.891875	0.870000	0.870441
Epoch 7	0.030109	0.038028	0.895479	0.868167	0.868922
Epoch 8	0.029885	0.037844	0.894354	0.870667	0.871348
Epoch 9	0.029600	0.037460	0.891646	0.869500	0.870168
Epoch 10	0.029445	0.037503	0.894958	0.871583	0.872213
Epoch 11	0.029393	0.037840	0.893250	0.867083	0.867752
Epoch 12	0.028795	0.038014	0.896437	0.871250	0.871864
Epoch 13	0.029142	0.038167	0.896354	0.867667	0.867786
Epoch 14	0.028768	0.038614	0.897875	0.870833	0.871104
Epoch 15	0.029024	0.036968	0.898062	0.873917	0.874728

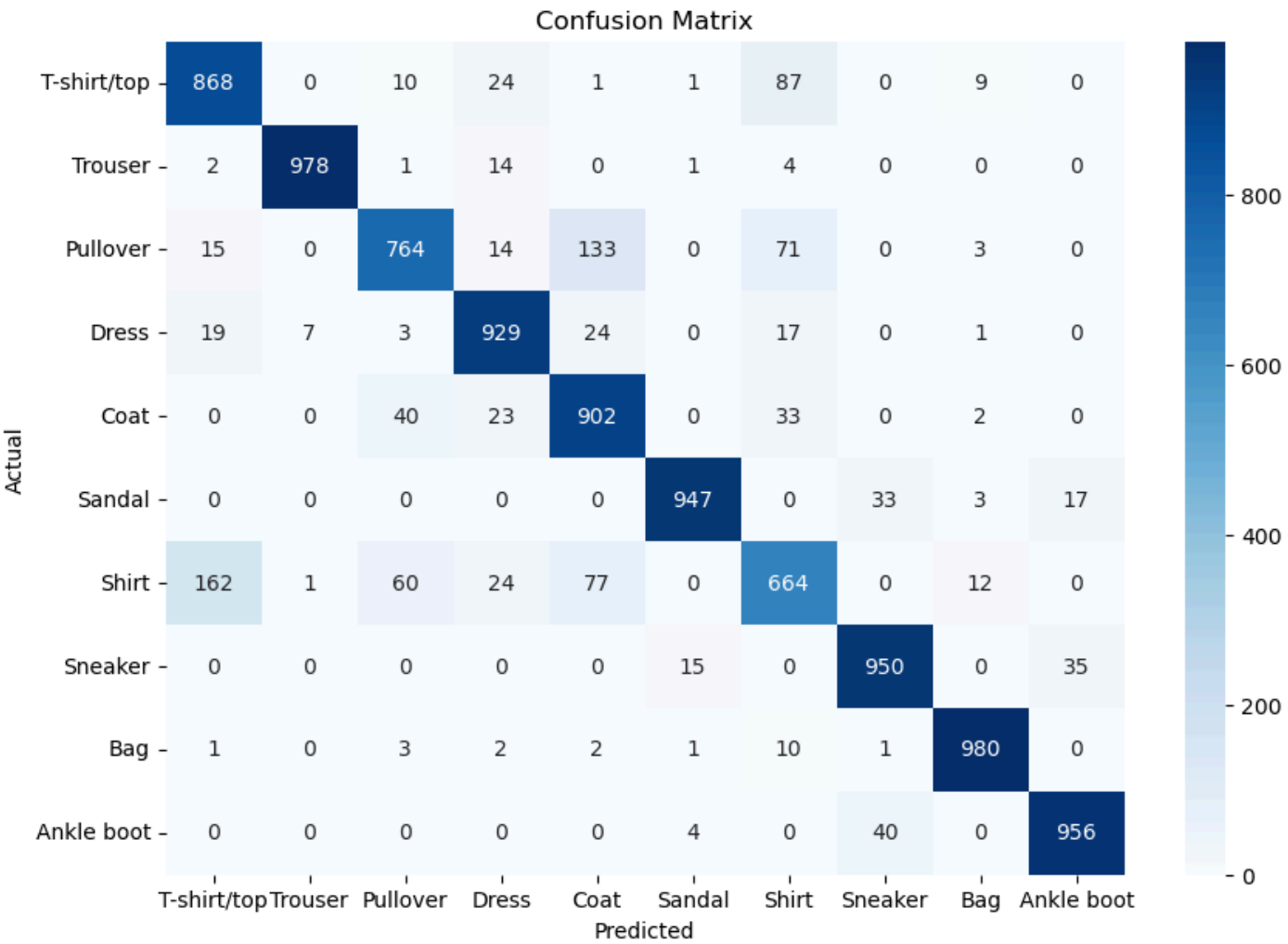


Test Accuracy: 0.8863

Test Macro F1 Score: 0.8855

Model 3 | LR=0.001

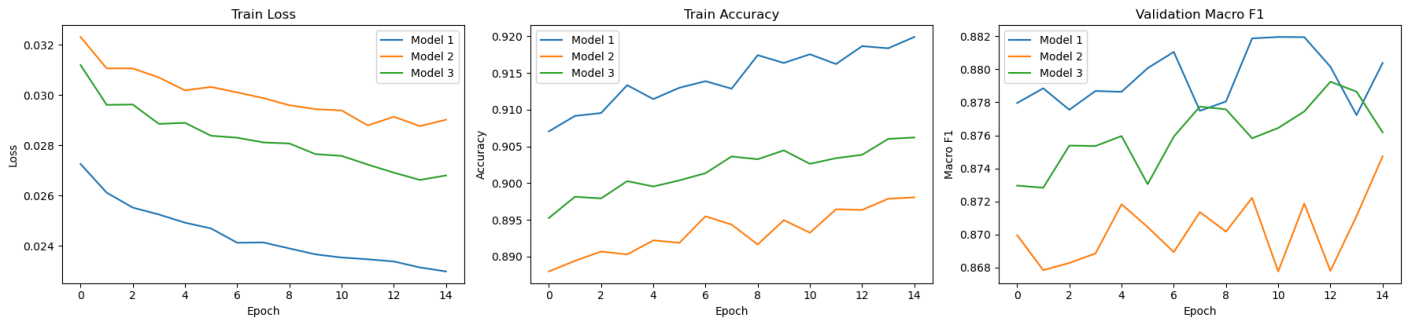
	Train Loss	Val Loss	Train Accuracy	Val Accuracy	Val Macro F1
Epoch 1	0.031200	0.036920	0.895250	0.872083	0.872951
Epoch 2	0.029614	0.037344	0.898146	0.872250	0.872827
Epoch 3	0.029627	0.036494	0.897917	0.874500	0.875378
Epoch 4	0.028857	0.036403	0.900271	0.874667	0.875352
Epoch 5	0.028898	0.035966	0.899542	0.875500	0.875955
Epoch 6	0.028385	0.036978	0.900375	0.872500	0.873040
Epoch 7	0.028306	0.036753	0.901354	0.875667	0.875922
Epoch 8	0.028120	0.036438	0.903625	0.877250	0.877742
Epoch 9	0.028076	0.035922	0.903250	0.876833	0.877573
Epoch 10	0.027653	0.036452	0.904458	0.875167	0.875821
Epoch 11	0.027583	0.036475	0.902625	0.876083	0.876446
Epoch 12	0.027238	0.036513	0.903396	0.876750	0.877450
Epoch 13	0.026915	0.035204	0.903854	0.878500	0.879249
Epoch 14	0.026625	0.036058	0.906021	0.877833	0.878646
Epoch 15	0.026804	0.036728	0.906208	0.875917	0.876176



Test Accuracy: 0.8938

Test Macro F1 Score: 0.8928

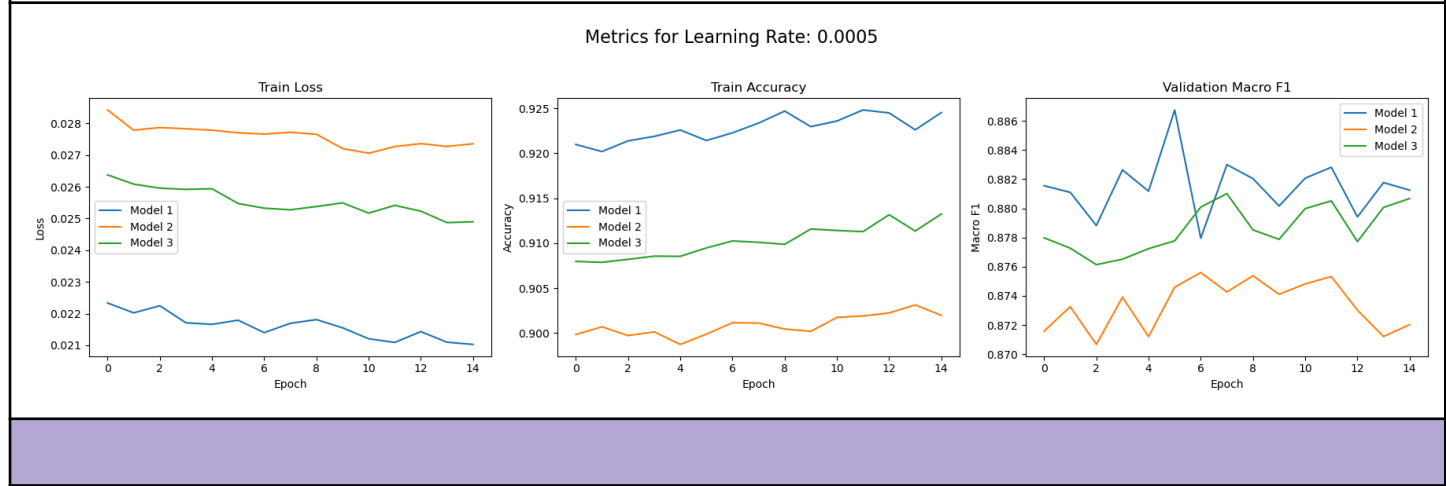
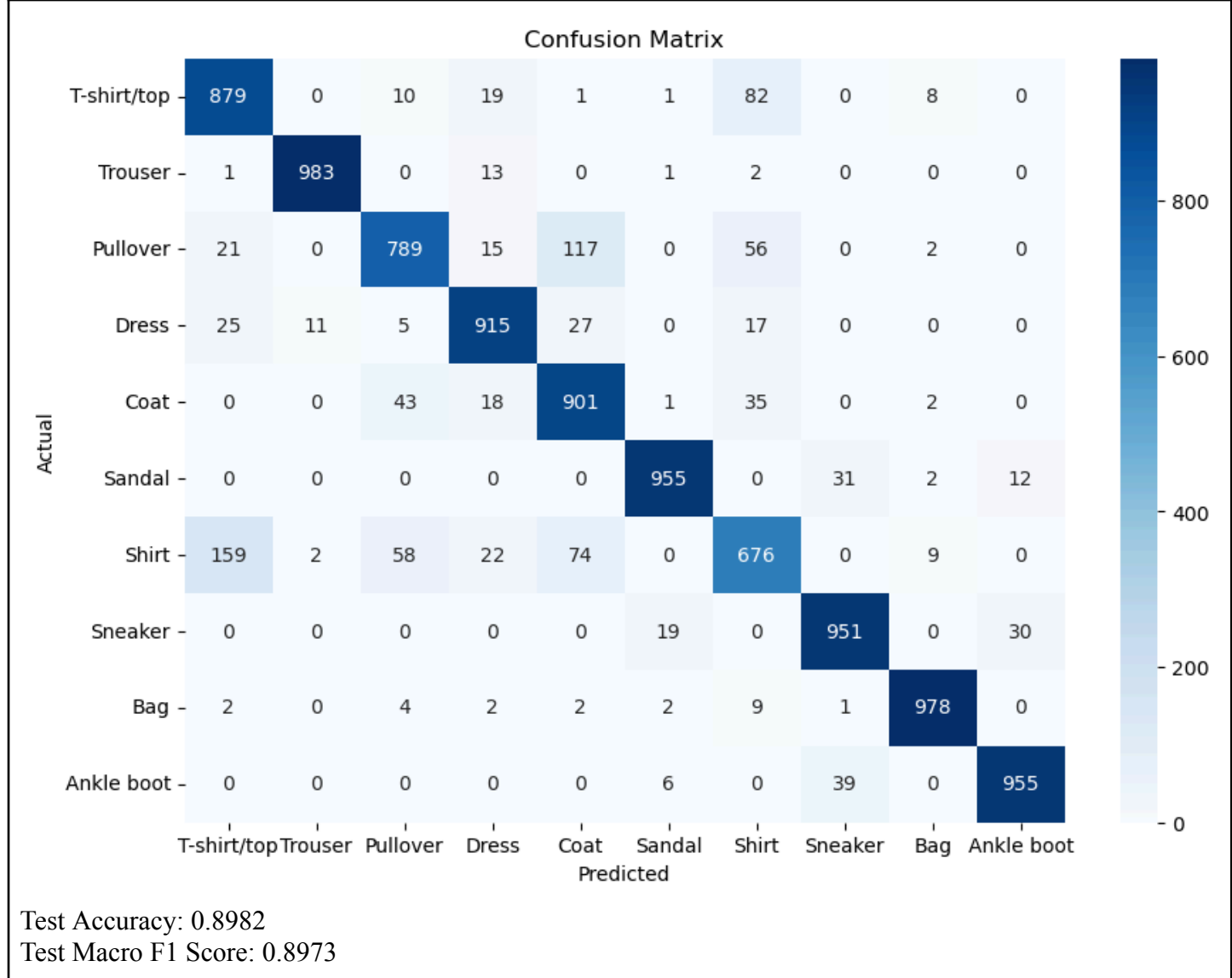
Metrics for Learning Rate: 0.001



Learning Rate: 0.0005

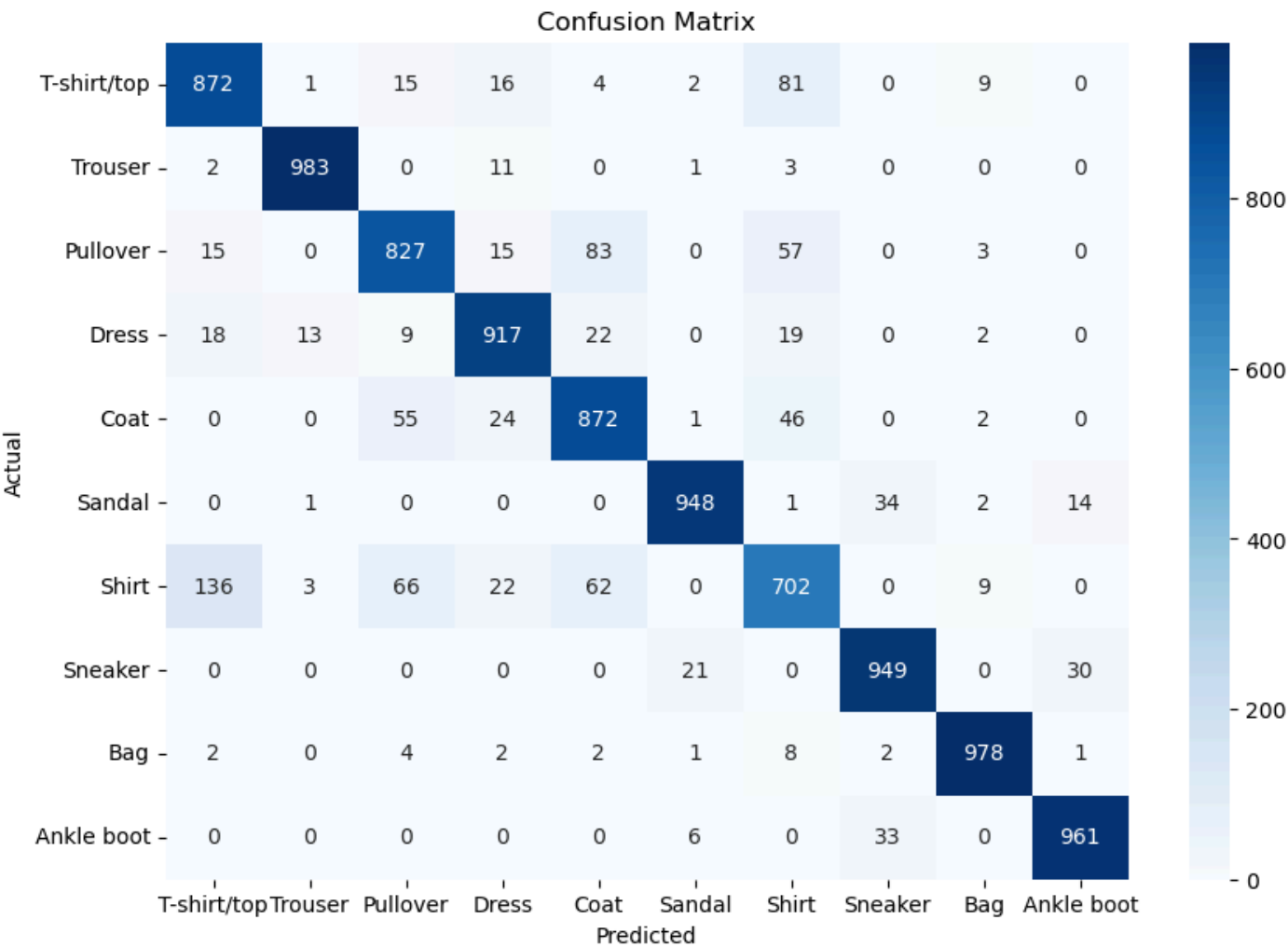
Model 1 | LR=0.0005

	Train Loss	Val Loss	Train Accuracy	Val Accuracy	Val Macro F1
Epoch 1	0.022334	0.035876	0.920979	0.880583	0.881552
Epoch 2	0.022024	0.035972	0.920188	0.880167	0.881099
Epoch 3	0.022248	0.036120	0.921375	0.877917	0.878821
Epoch 4	0.021710	0.035973	0.921875	0.881583	0.882638
Epoch 5	0.021660	0.035960	0.922583	0.880333	0.881178
Epoch 6	0.021792	0.036085	0.921417	0.885917	0.886749
Epoch 7	0.021400	0.036353	0.922271	0.877250	0.877954
Epoch 8	0.021693	0.035986	0.923354	0.882083	0.883000
Epoch 9	0.021811	0.035755	0.924687	0.881167	0.882037
Epoch 10	0.021552	0.036739	0.922958	0.879250	0.880162
Epoch 11	0.021207	0.035696	0.923583	0.881083	0.882070
Epoch 12	0.021090	0.036045	0.924813	0.882167	0.882818
Epoch 13	0.021431	0.036150	0.924479	0.878750	0.879413
Epoch 14	0.021097	0.036342	0.922604	0.881000	0.881766
Epoch 15	0.021027	0.036611	0.924521	0.880583	0.881250



Learning Rate: 0.0001

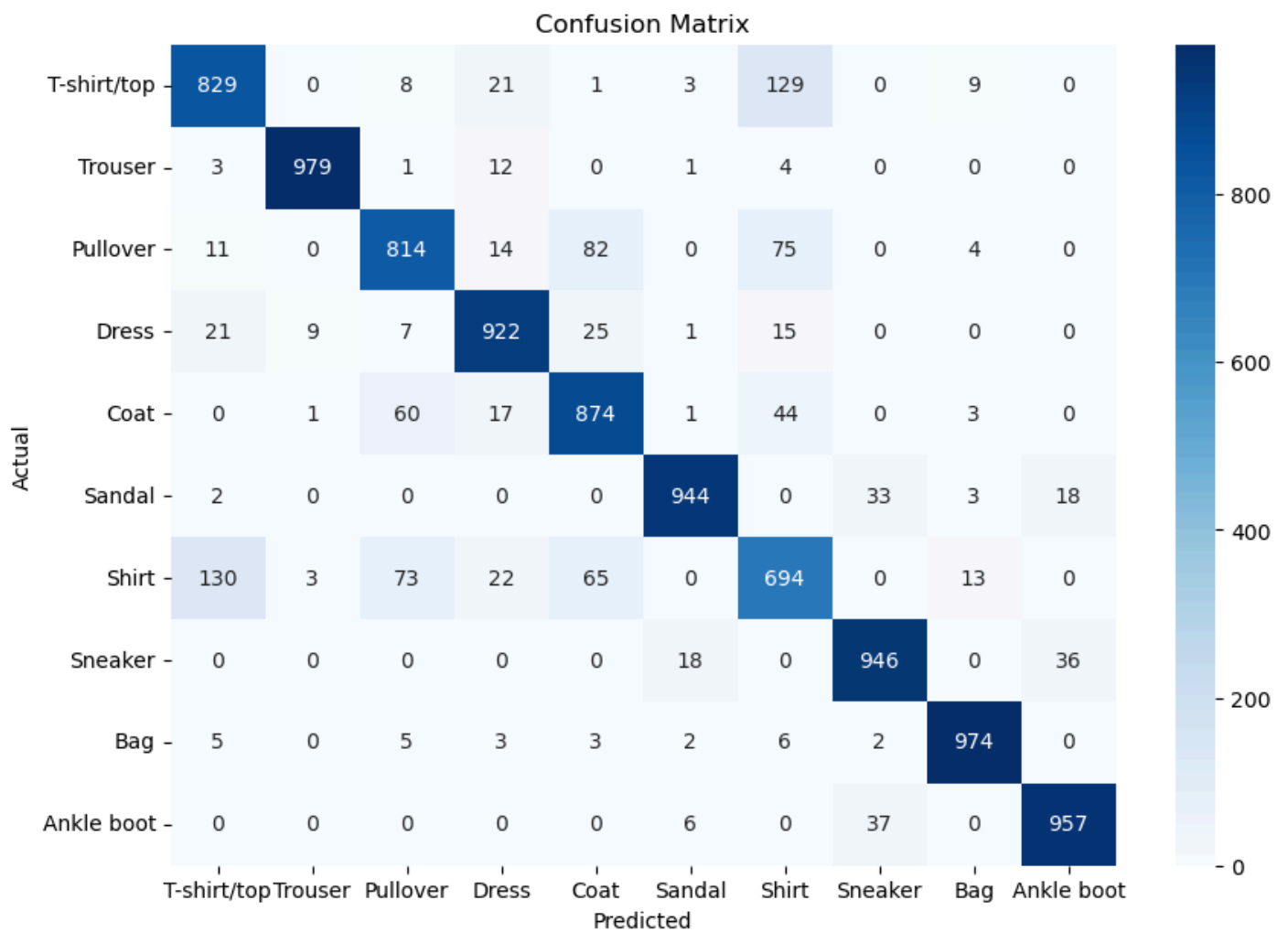
Model 1 LR=0.0001						
	Train Loss	Val Loss	Train Accuracy	Val Accuracy	Val Macro F1	
Epoch 1	0.020501	0.036518	0.926771	0.878583	0.879791	
Epoch 2	0.020403	0.035660	0.924500	0.882750	0.883746	
Epoch 3	0.020340	0.036276	0.925750	0.881167	0.881974	
Epoch 4	0.020491	0.036211	0.926562	0.881333	0.882259	
Epoch 5	0.020299	0.035994	0.925771	0.880417	0.881507	
Epoch 6	0.020467	0.035564	0.926167	0.883750	0.884629	
Epoch 7	0.020371	0.036330	0.927896	0.880667	0.881560	
Epoch 8	0.020321	0.036115	0.927042	0.881083	0.881944	
Epoch 9	0.020288	0.035522	0.925771	0.883833	0.884742	
Epoch 10	0.020027	0.035875	0.927333	0.882833	0.883684	
Epoch 11	0.020171	0.036072	0.927188	0.881167	0.882068	
Epoch 12	0.020326	0.036284	0.927208	0.880417	0.881312	
Epoch 13	0.020268	0.036410	0.927021	0.878917	0.879685	
Epoch 14	0.020172	0.035779	0.928250	0.884250	0.885180	
Epoch 15	0.020168	0.036440	0.926458	0.881917	0.882899	



Test Accuracy: 0.9009
Test Macro F1 Score: 0.9003

Model 2 | LR=0.0001

	Train Loss	Val Loss	Train Accuracy	Val Accuracy	Val Macro F1
Epoch 1	0.026672	0.036820	0.903500	0.873667	0.874352
Epoch 2	0.026558	0.037633	0.903458	0.870167	0.871120
Epoch 3	0.026664	0.037280	0.904604	0.871000	0.871746
Epoch 4	0.026364	0.037020	0.903583	0.870500	0.871403
Epoch 5	0.026544	0.036419	0.905896	0.876083	0.876960
Epoch 6	0.026581	0.037265	0.904188	0.874417	0.875189
Epoch 7	0.026553	0.036855	0.904042	0.871417	0.872171
Epoch 8	0.026502	0.036522	0.904250	0.874667	0.875490
Epoch 9	0.026285	0.037287	0.906292	0.874667	0.875477
Epoch 10	0.026404	0.037825	0.904396	0.874083	0.874958
Epoch 11	0.026284	0.036983	0.904396	0.874000	0.874781
Epoch 12	0.026338	0.037426	0.904479	0.871167	0.872101
Epoch 13	0.026167	0.037543	0.904917	0.871833	0.872544
Epoch 14	0.026384	0.037282	0.904604	0.870333	0.871187
Epoch 15	0.026046	0.036279	0.906062	0.875750	0.876395

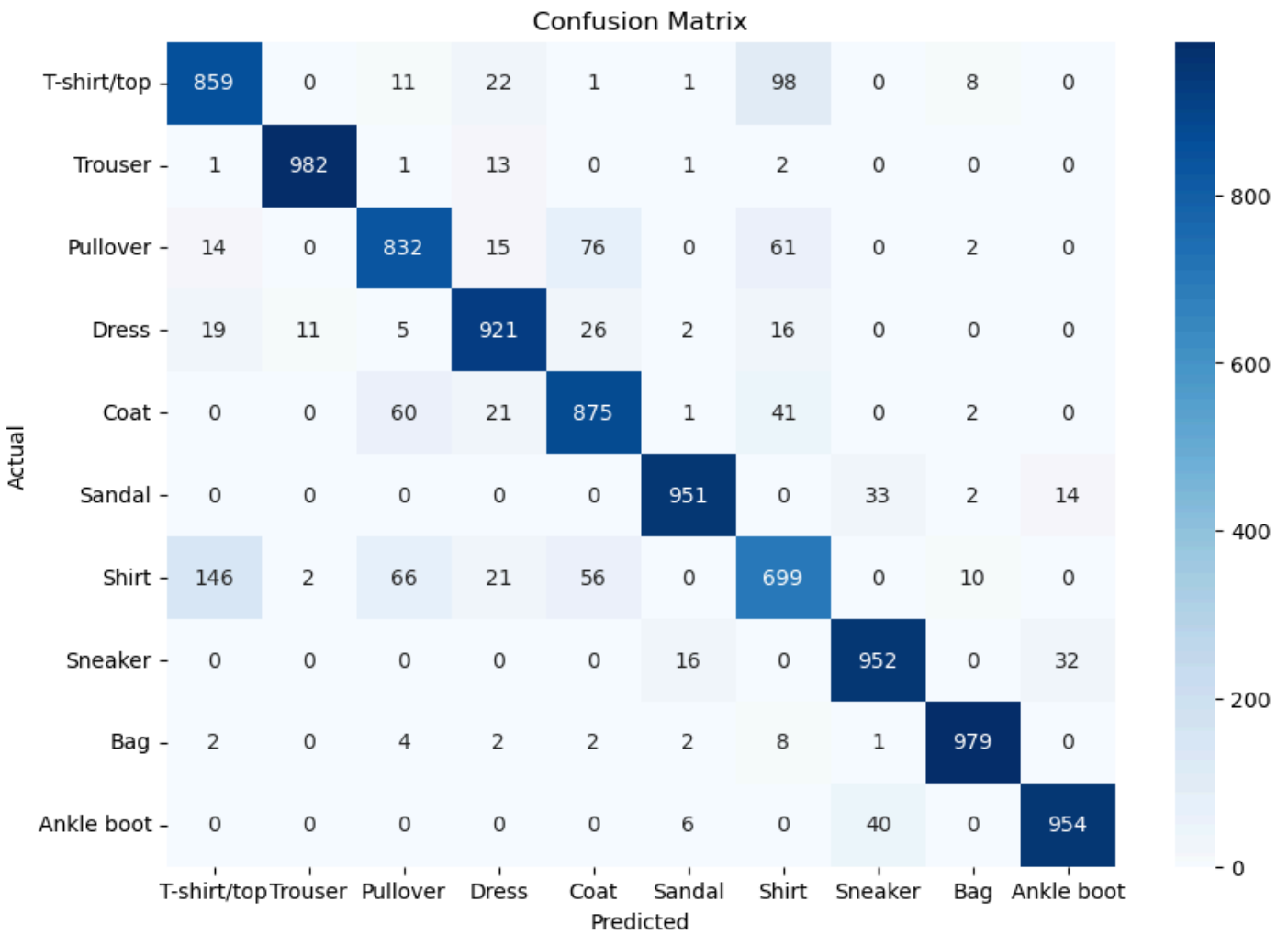


Test Accuracy: 0.8933

Test Macro F1 Score: 0.8930

Model 3 | LR=0.0001

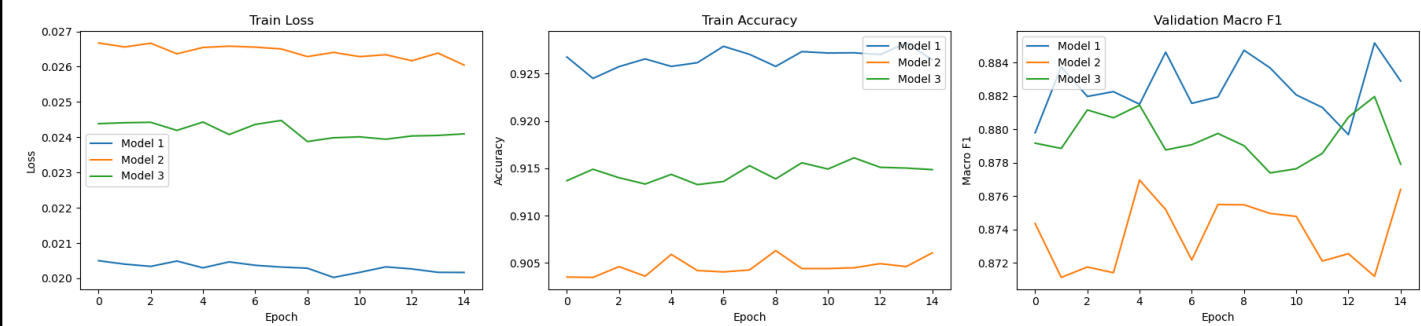
	Train Loss	Val Loss	Train Accuracy	Val Accuracy	Val Macro F1
Epoch 1	0.024385	0.035821	0.913687	0.878417	0.879172
Epoch 2	0.024411	0.035822	0.914896	0.878167	0.878855
Epoch 3	0.024423	0.036494	0.914000	0.880750	0.881164
Epoch 4	0.024194	0.036162	0.913333	0.880083	0.880695
Epoch 5	0.024431	0.036376	0.914354	0.880917	0.881449
Epoch 6	0.024077	0.035679	0.913271	0.877917	0.878766
Epoch 7	0.024363	0.036230	0.913604	0.878333	0.879079
Epoch 8	0.024475	0.035572	0.915271	0.879000	0.879753
Epoch 9	0.023877	0.036458	0.913875	0.878417	0.879020
Epoch 10	0.023985	0.036314	0.915583	0.876750	0.877387
Epoch 11	0.024011	0.035765	0.914917	0.876750	0.877635
Epoch 12	0.023943	0.036129	0.916104	0.877750	0.878559
Epoch 13	0.024036	0.035676	0.915104	0.880000	0.880732
Epoch 14	0.024051	0.035604	0.915021	0.881250	0.881967
Epoch 15	0.024096	0.036785	0.914854	0.877250	0.877911



Test Accuracy: 0.9004

Test Macro F1 Score: 0.8999

Metrics for Learning Rate: 0.0001



Best Model Performance

Learning Rate = 0.0001

Model = 1

