Report
on
Bangla Character Recognition using CNN

Course number: CSE 472
Course title: Machine Learning Sessional

Submitted from:
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Section: A2
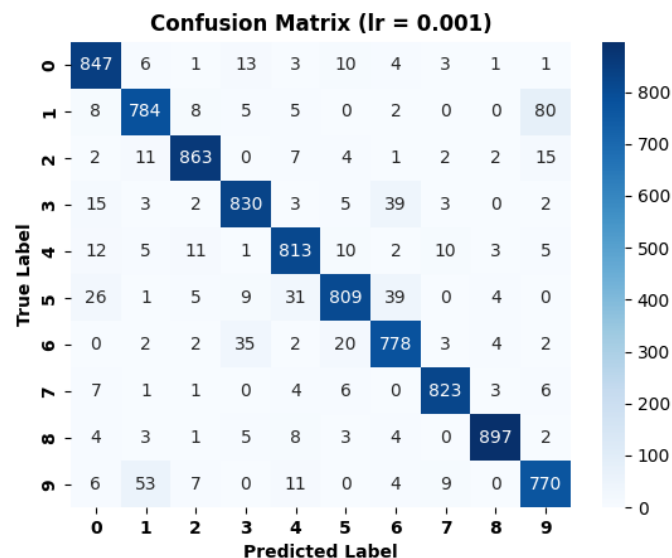
Submitted on: February 10, 2023

Bangladesh University of Engineering and Technology

Performance Metrics

Learning Rate = 0.001

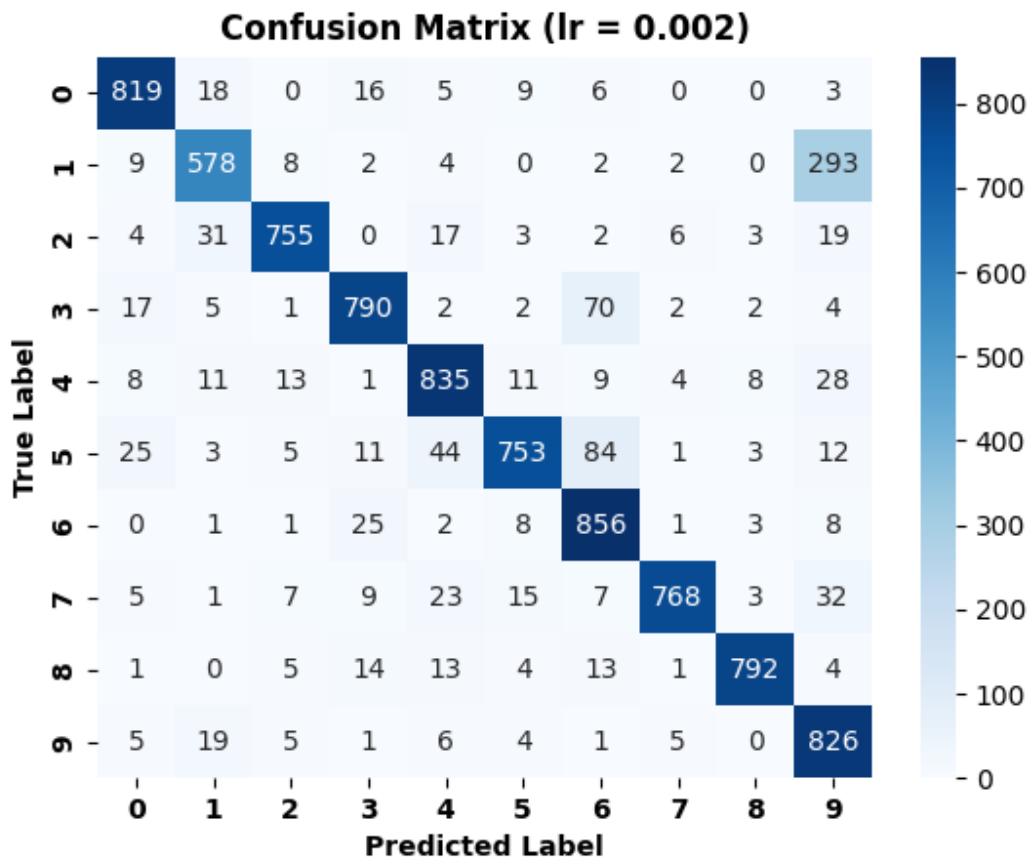| Epoch	Train Loss	Validation Loss	Validation Accuracy	F1 score
1	1.47724929544609	0.693866813957557	0.767583408476105	0.766938064762106
2	0.561749950061449	0.439785974826228	0.861812443642921	0.861413020701408
3	0.375303856477562	0.34160078269011	0.890779981965735	0.890439870307326
4	0.294632082571867	0.286076567464448	0.907574391343553	0.907214207007924
5	0.246955073311284	0.268461396448529	0.91490081154193	0.914510588993112
6	0.210389814323974	0.25459703562588	0.920761947700631	0.920567257913078
7	0.179186525390511	0.249611688900491	0.919747520288548	0.919657035029845
8	0.155294376038605	0.247195825190646	0.923354373309288	0.923179556972834
9	0.134759653161332	0.248934645400264	0.925834084761046	0.925597806178889
10	0.120592861217539	0.284076601687168	0.918958521190261	0.918558322017549

Confusion matrix for the best F1 score:

Learning Rate = 0.002

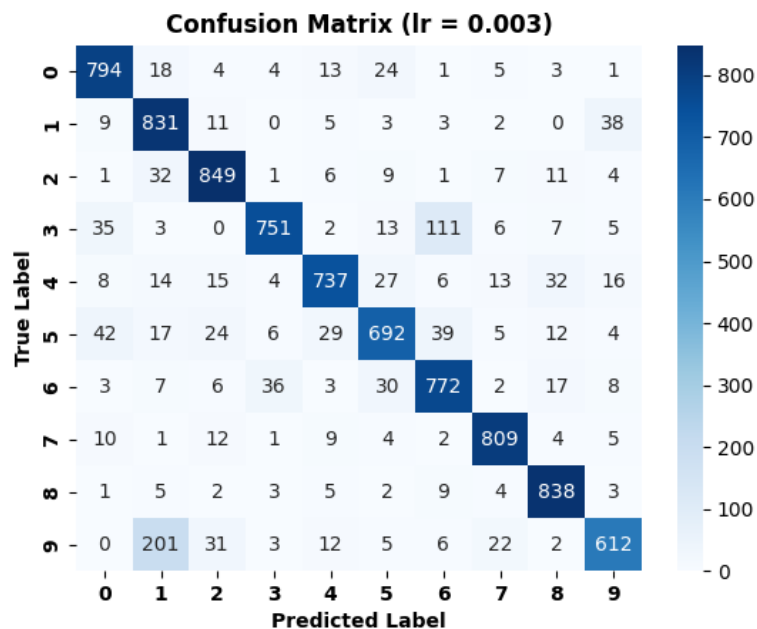| Epoch	Train Loss	Validation Loss	Validation Accuracy	F1 score
1	1.51308552917453	0.744469236381619	0.754395852119026	0.752632963788328
2	0.591812488023309	0.507459706176847	0.832394048692516	0.833477104173625
3	0.404816628678241	0.454542830205705	0.847385031559964	0.848955927855797
4	0.319141782910717	0.431918196615741	0.863277727682597	0.864007320210681
5	0.273005311343385	0.397870843870571	0.876014427412083	0.877130953365962
6	0.231220954523187	0.435277193777219	0.866771866546438	0.86682695339682

Confusion matrix for the best F1 score:

Learning Rate = 0.003

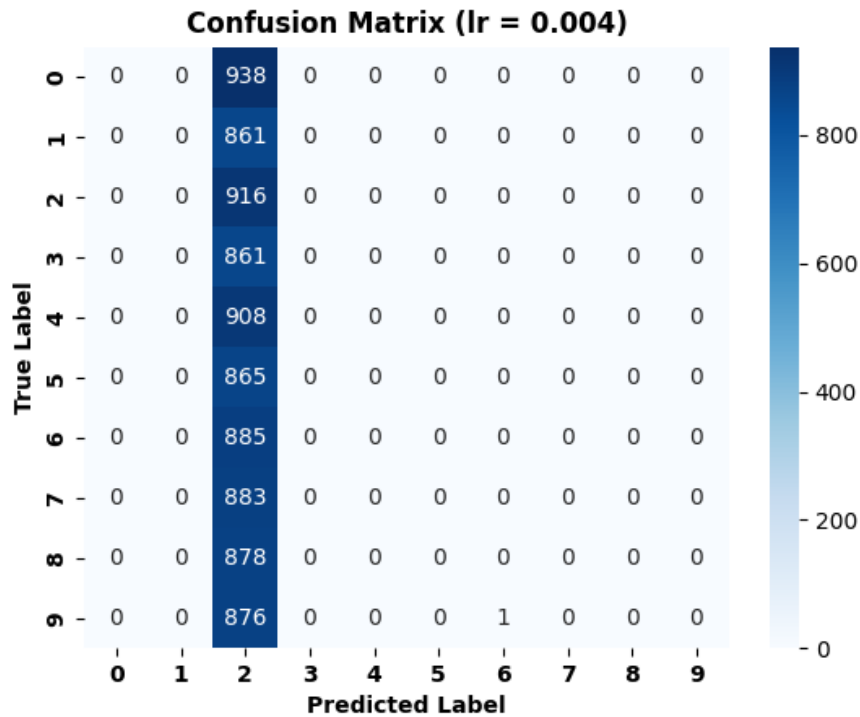| Epoch	Train Loss	Validation Loss	Validation Accuracy	F1 score
1	1.62656853385573	0.825875098054341	0.725090171325518	0.724519665649823
2	0.76431153739464	0.580441352544595	0.80714607754734	0.805371282671177
3	0.584505254588259	0.497509653679696	0.837240757439134	0.836215046781052
4	0.5030434220104	0.532278418535666	0.831154192966637	0.830716427732847
5	0.42847370935449	0.618295153271353	0.79824165915239	0.799594790902921
6	0.396236416899051	0.535464717117823	0.826307484220018	0.82495606992101
7	0.372111651428352	0.461189787958451	0.864968440036069	0.864451703272156
8	0.344001292545684	0.630510557929584	0.799819657348963	0.79778945104469
9	0.315753700801143	0.456564980540642	0.861699729486023	0.860692231051393
10	0.309444872422155	0.457512025028744	0.866208295761948	==0.865627654350694==

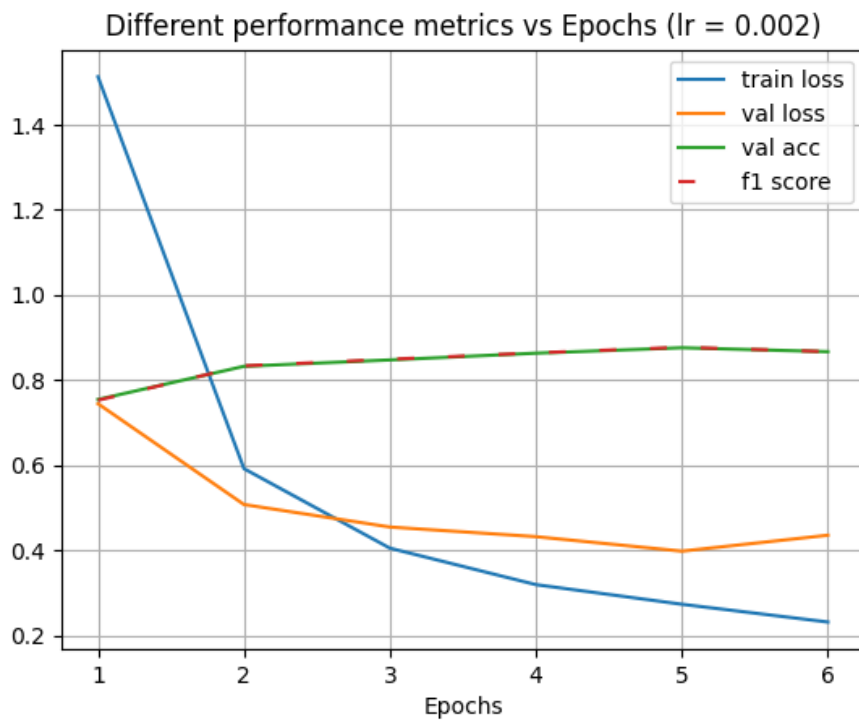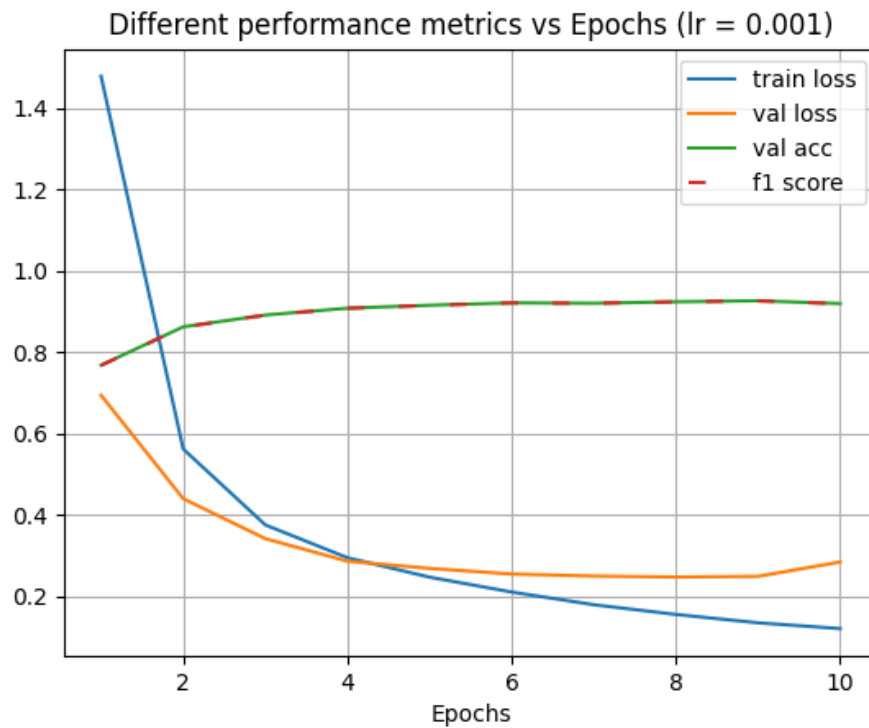Confusion matrix for the best F1 score:

Learning Rate = 0.004

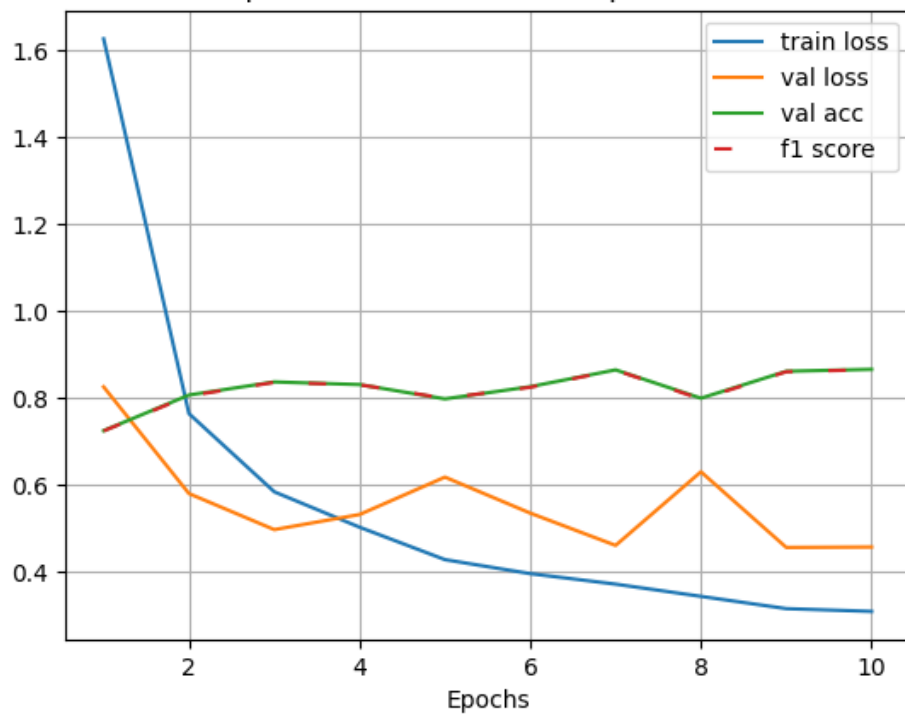| Epoch	Train Loss	Validation Loss	Validation Accuracy	F1 score
1	2.17494266966585	2.30805271681852	0.0970468890892696	0.0176923867255728
2	2.30485605989753	2.3057393776761	0.0970468890892696	0.0176923867255728
3	2.30424650347323	2.30425298205182	0.0997520288548242	0.0181408219739674
4	2.30408460735213	2.30381935154719	0.103246167718665	0.0187187084908552
5	2.30376720152709	2.30370183273864	0.103246167718665	0.0187187084908552
6	2.30374068060382	2.30366291193901	0.103246167718665	0.0187187084908552

Confusion matrix for the best F1 score:

Graphs of performance metrics

Different performance metrics vs Epochs (lr = 0.001)

Different performance metrics vs Epochs (lr = 0.002)

Different performance metrics vs Epochs (lr = 0.003)

Test Set Performance

- Based on F1 scores, we chose the weights after **9th** epoch for learning rate = **0.001**.

Loss	0.3022286951522225
Accuracy	0.918958562522919
F1 score	0.9188342464701587

Confusion Matrix

True Label \ Predicted Label	0	1	2	3	4	5	6	7	8	9
0	1056	4	1	14	6	16	1	6	2	1
1	6	915	7	6	2	4	2	5	2	158
2	1	8	1033	4	15	13	1	2	13	17
3	5	2	1	1024	3	7	46	3	6	10
4	5	10	17	6	1007	25	4	14	6	13
5	15	0	11	9	28	960	55	6	12	11
6	1	4	2	40	0	10	986	4	12	9
7	2	1	4	0	3	0	0	1048	2	15
8	4	1	0	9	19	7	6	2	1037	1
9	4	52	3	1	4	1	2	12	0	958