
Ethnicity Detection Using Deep Convolutional Neural Networks

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Abstract

Computer Vision based Deep Learning systems have given state-of-the-art results for various tasks in detection, recognition and tracking. Hence, we develop Deep Convolutional Neural Networks and train them end-to-end for ethnicity detection and compare their performances.

I. Dataset

We use the publicly available UTKFace dataset [1]. The dataset contains over 20,000 images of 5 ethnic categories - White, Black, Asian, Indian, Others (Hispanic, Latino, etc.). Each image is of 200 x 200 dimensions. It has a range of subjects from the age of 1 to 112. For our experiments, we consider the age group 20 - 50. The statistics of this subset are given in figure 1.

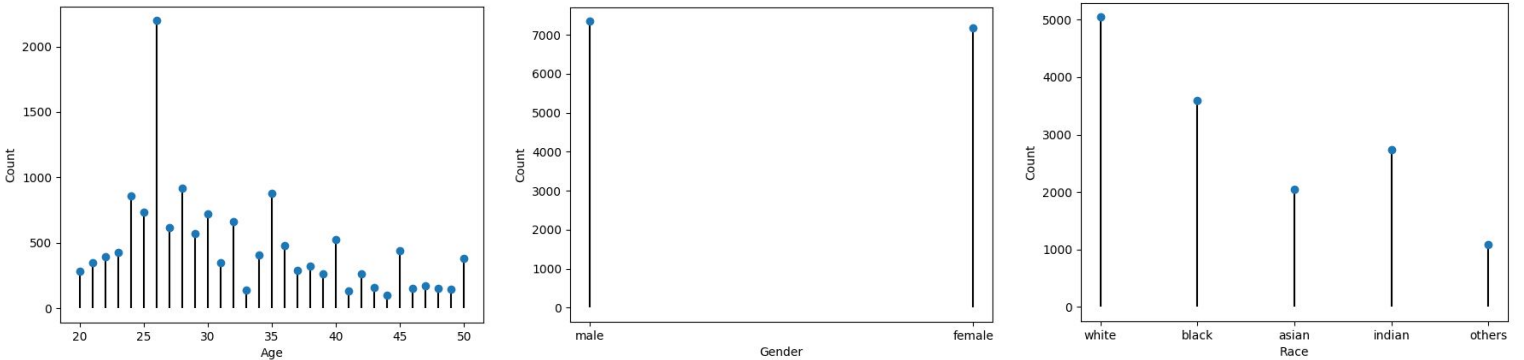


Figure 1. Number of images in each age category

II. Experiments

We create 4 versions of deep CNNs. The networks contain convolutional blocks (with convolutional filters, followed by batch normalization, exponential linear unit activation and 0.5 dropout). Further we add dense layers with rectified linear unit activation. The input to these networks is an image of shape 200 x 200 x 3. At the output we have 5 neurons with softmax

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activation (5 classes). We train the models for 30 epochs, optimizing the cross-entropy loss using the Adam [2] optimizer. We use batches of 256 images. The training & testing losses, accuracies and running times for the 4 networks are tabulated in appendix A. The network is built using the Keras [3] library and the training & inference is done on an NVidia GeForce GTX 1060 GPU. We release the code and the trained models publicly on github [4].

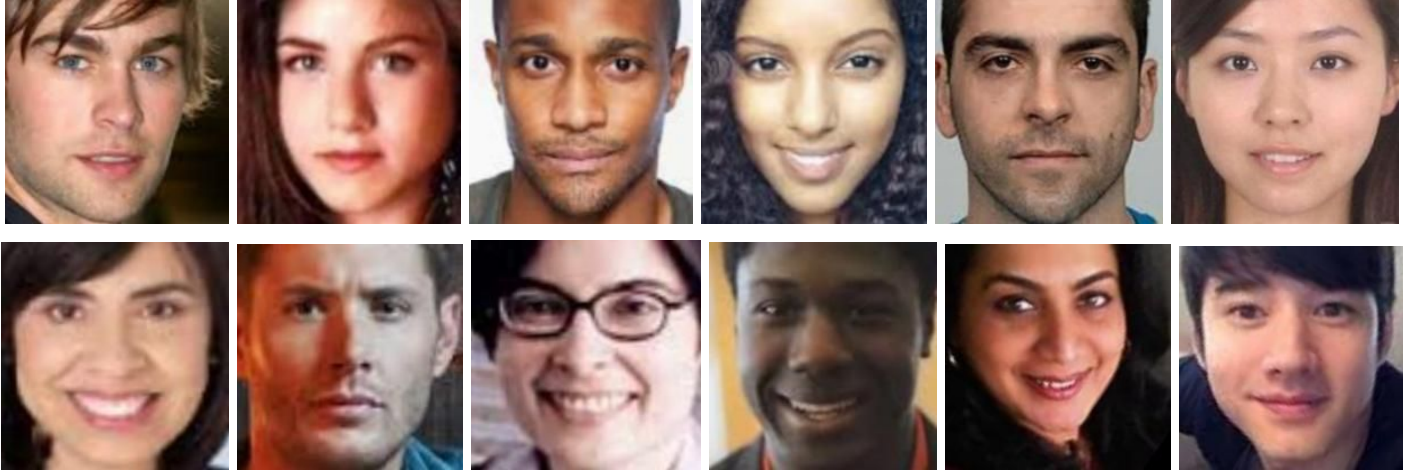


Figure 2. Some sample faces from the UTKFace dataset

1. Baseline Network (5 conv + 1 dense)

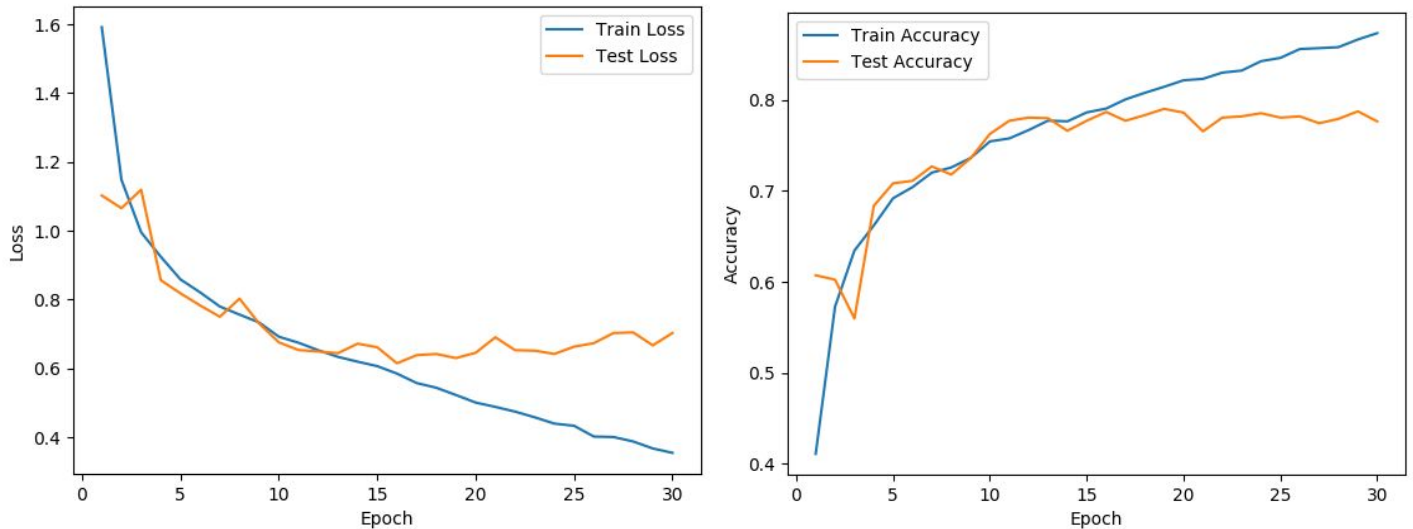


Figure 3. Loss (per input example) & Accuracies vs epoch. We can see the model tends to overfit after 12 epochs. The model achieves highest testing accuracy at about 79% at 19th epoch.

2. MiniNet (3 conv + 1 dense)

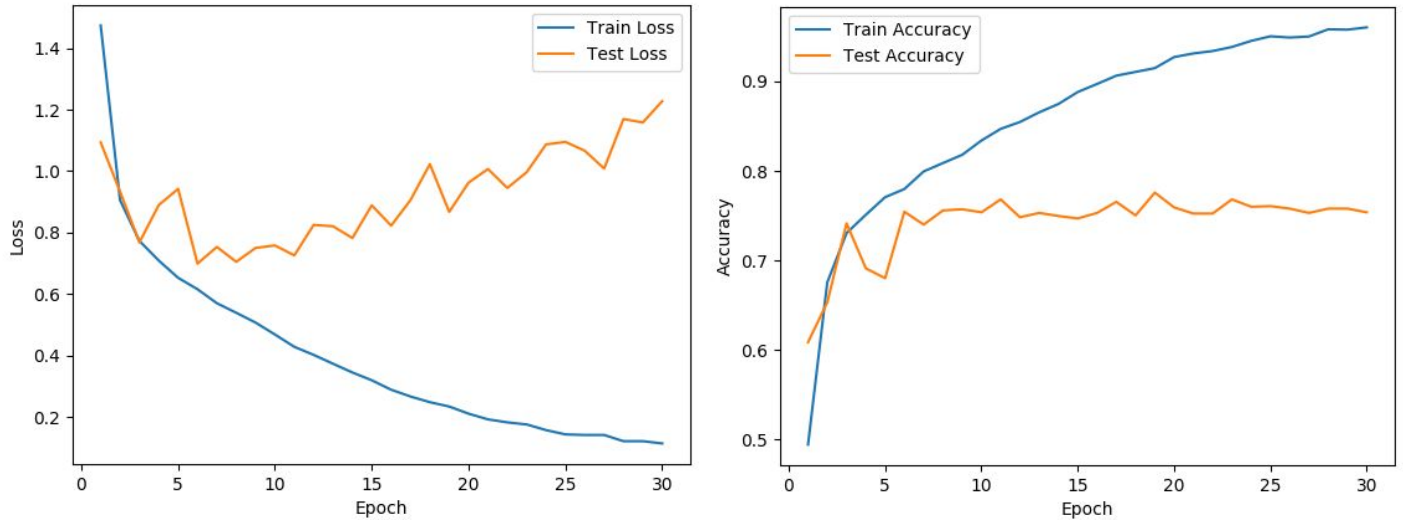


Figure 4. Loss (per input example) & Accuracies vs epoch. We can see the model tends to overfit after **3** epochs. This early overfitting could be possibly due to the large number of trainable parameters (introduced between the final convolution and the fully-connected layers) and the inability of the model to capture the complexities well. The model achieves highest testing accuracy at about **77.5%** at **19th** epoch.

3. WideNet (baseline with double the number of conv filters)

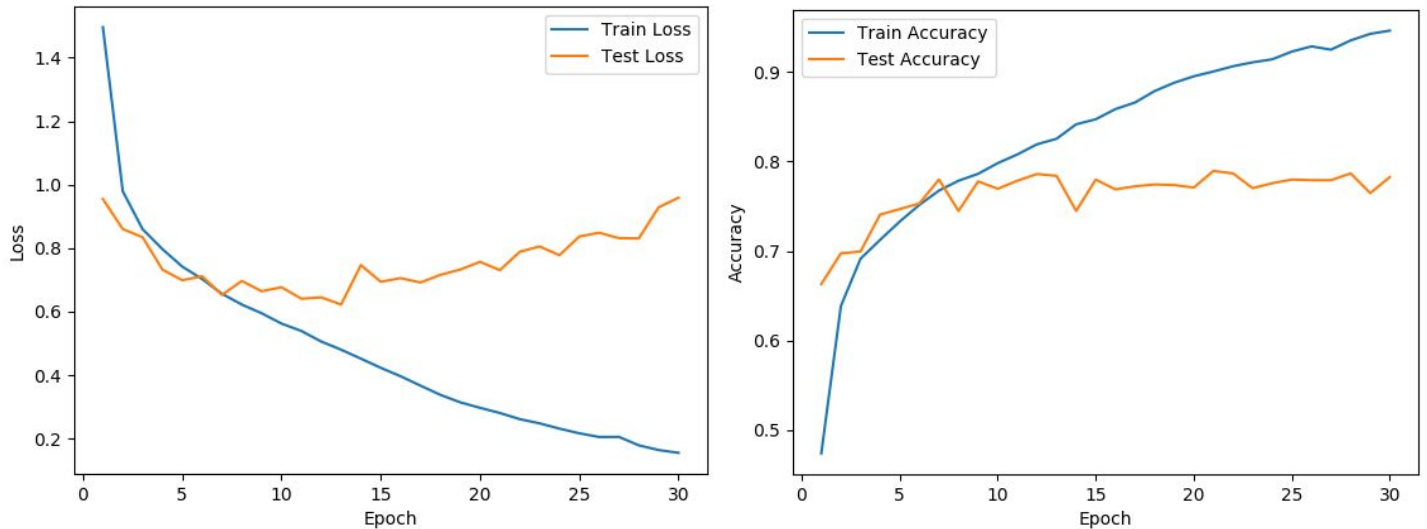


Figure 5. Loss (per input example) & Accuracies vs epoch. We can see the model tends to overfit after **7** epochs. The model achieves highest testing accuracy at about **78.9%** at **21st** epoch.

4. LargeNet (7 conv + 2 dense)

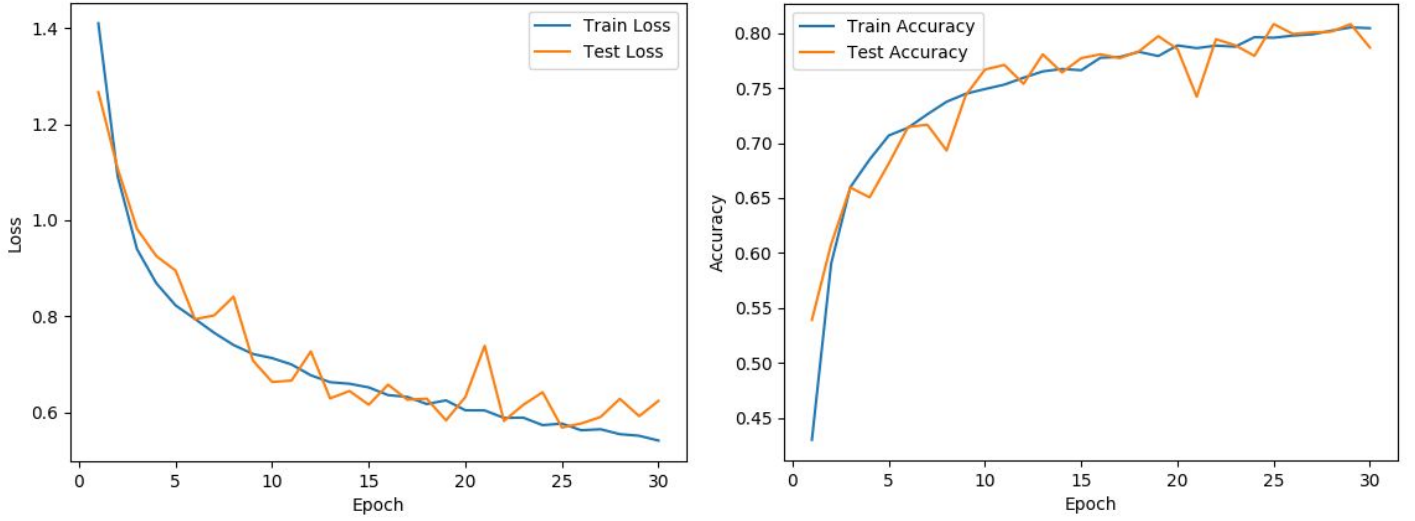


Figure 6. Loss (per input example) & Accuracies vs epoch. Clearly, the model does not tend to overfit even after 30 epochs, showing the potential to be trained more. The model achieves highest testing accuracy at about **80.8% at 29th epoch**.

Architecture	Train Time (ms)	Infer Time (ms)	Peak Testing Accuracy (%)	Epochs until Overfit
V1: Baseline	1.07	0.50	79.02	18
V2: MiniNet	1.02	0.50	77.58	18
V3: WideNet	1.72	0.67	78.95	20
V4: LargeNet	1.79	0.69	80.81	28

Table 1. Comparison of the four CNN architectures (the best models in the respective categories have been marked in bold)

III. References

- [1] UTKFace Dataset: <https://susanqq.github.io/UTKFace/>
- [2] Kingma, D. P., & Ba, J. (2014). Adam: A method for stochastic optimization. *arXiv preprint arXiv:1412.6980*.
- [3] Chollet, F. (2015). Keras.
- [4] <https://github.com/nmakes/ethnicity-detection-v1>

Appendix A (Network Architectures)

Version 1: Baseline Model

Layer (type)	Output Shape	Param #
input_1 (InputLayer)	(None, 200, 200, 3)	0
conv2d_1 (Conv2D)	(None, 99, 99, 16)	448
batch_normalization_1	(Batch(None, 99, 99, 16))	64
activation_1 (Activation)	(None, 99, 99, 16)	0
dropout_1 (Dropout)	(None, 99, 99, 16)	0
conv2d_2 (Conv2D)	(None, 49, 49, 32)	4640
batch_normalization_2	(Batch(None, 49, 49, 32))	128
activation_2 (Activation)	(None, 49, 49, 32)	0
dropout_2 (Dropout)	(None, 49, 49, 32)	0
conv2d_3 (Conv2D)	(None, 24, 24, 64)	18496
batch_normalization_3	(Batch(None, 24, 24, 64))	256
activation_3 (Activation)	(None, 24, 24, 64)	0
dropout_3 (Dropout)	(None, 24, 24, 64)	0
conv2d_4 (Conv2D)	(None, 11, 11, 64)	36928
batch_normalization_4	(Batch(None, 11, 11, 64))	256
activation_4 (Activation)	(None, 11, 11, 64)	0
dropout_4 (Dropout)	(None, 11, 11, 64)	0
conv2d_5 (Conv2D)	(None, 5, 5, 64)	36928
batch_normalization_5	(Batch(None, 5, 5, 64))	256
activation_5 (Activation)	(None, 5, 5, 64)	0
dropout_5 (Dropout)	(None, 5, 5, 64)	0
flatten_1 (Flatten)	(None, 1600)	0
dense_1 (Dense)	(None, 512)	819712
dense_2 (Dense)	(None, 5)	2565
Total params: 920,677		
Trainable params: 920,197		
Non-trainable params: 480		

Version 2: MiniNet

Layer (type)	Output Shape	Param #
input_2 (InputLayer)	(None, 200, 200, 3)	0
conv2d_6 (Conv2D)	(None, 99, 99, 16)	448
batch_normalization_6	(Batch(None, 99, 99, 16)	64
activation_6 (Activation)	(None, 99, 99, 16)	0
dropout_6 (Dropout)	(None, 99, 99, 16)	0
conv2d_7 (Conv2D)	(None, 49, 49, 32)	4640
batch_normalization_7	(Batch(None, 49, 49, 32)	128
activation_7 (Activation)	(None, 49, 49, 32)	0
dropout_7 (Dropout)	(None, 49, 49, 32)	0
conv2d_8 (Conv2D)	(None, 24, 24, 64)	18496
batch_normalization_8	(Batch(None, 24, 24, 64)	256
activation_8 (Activation)	(None, 24, 24, 64)	0
dropout_8 (Dropout)	(None, 24, 24, 64)	0
flatten_2 (Flatten)	(None, 36864)	0
dense_3 (Dense)	(None, 128)	4718720
dense_4 (Dense)	(None, 5)	645
Total params: 4,743,397		
Trainable params: 4,743,173		
Non-trainable params: 224		

Version 3: WideNet

Layer (type)	Output Shape	Param #
input_3 (InputLayer)	(None, 200, 200, 3)	0
conv2d_9 (Conv2D)	(None, 99, 99, 32)	896
Batch_normalization_9	(Batch(None, 99, 99, 32)	128
activation_9 (Activation)	(None, 99, 99, 32)	0
dropout_9 (Dropout)	(None, 99, 99, 32)	0
conv2d_10 (Conv2D)	(None, 49, 49, 64)	18496
batch_normalization_10	(Batch(None, 49, 49, 64)	256
activation_10 (Activation)	(None, 49, 49, 64)	0
dropout_10 (Dropout)	(None, 49, 49, 64)	0
conv2d_11 (Conv2D)	(None, 24, 24, 128)	73856
Batch_normalization_11	(Batch(None, 24, 24, 128)	512
activation_11 (Activation)	(None, 24, 24, 128)	0
dropout_11 (Dropout)	(None, 24, 24, 128)	0
conv2d_12 (Conv2D)	(None, 11, 11, 128)	147584
batch_normalization_12	(Batch(None, 11, 11, 128)	512
activation_12 (Activation)	(None, 11, 11, 128)	0
dropout_12 (Dropout)	(None, 11, 11, 128)	0
conv2d_13 (Conv2D)	(None, 5, 5, 128)	147584
batch_normalization_13	(Batch(None, 5, 5, 128)	512
activation_13 (Activation)	(None, 5, 5, 128)	0
dropout_13 (Dropout)	(None, 5, 5, 128)	0
flatten_3 (Flatten)	(None, 3200)	0
dense_5 (Dense)	(None, 512)	1638912
dense_6 (Dense)	(None, 5)	2565
Total params: 2,031,813		
Trainable params: 2,030,853		
Non-trainable params: 960		

Version 4: LargeNet

Layer (type)	Output Shape	Param #
input_4 (InputLayer)	(None, 200, 200, 3)	0
conv2d_14 (Conv2D)	(None, 99, 99, 32)	896
batch_normalization_14	(Batch(None, 99, 99, 32)	128
activation_14 (Activation)	(None, 99, 99, 32)	0
dropout_14 (Dropout)	(None, 99, 99, 32)	0
conv2d_15 (Conv2D)	(None, 49, 49, 64)	18496
batch_normalization_15	(Batch(None, 49, 49, 64)	256
activation_15 (Activation)	(None, 49, 49, 64)	0
dropout_15 (Dropout)	(None, 49, 49, 64)	0
conv2d_16 (Conv2D)	(None, 24, 24, 128)	73856
batch_normalization_16	(Batch(None, 24, 24, 128)	512
activation_16 (Activation)	(None, 24, 24, 128)	0
dropout_16 (Dropout)	(None, 24, 24, 128)	0
conv2d_17 (Conv2D)	(None, 11, 11, 128)	147584
batch_normalization_17	(Batch(None, 11, 11, 128)	512
activation_17 (Activation)	(None, 11, 11, 128)	0
dropout_17 (Dropout)	(None, 11, 11, 128)	0
conv2d_18 (Conv2D)	(None, 5, 5, 128)	147584
batch_normalization_18	(Batch(None, 5, 5, 128)	512
activation_18 (Activation)	(None, 5, 5, 128)	0
dropout_18 (Dropout)	(None, 5, 5, 128)	0
conv2d_19 (Conv2D)	(None, 3, 3, 256)	295168
batch_normalization_19	(Batch(None, 3, 3, 256)	1024
activation_19 (Activation)	(None, 3, 3, 256)	0
dropout_19 (Dropout)	(None, 3, 3, 256)	0
conv2d_20 (Conv2D)	(None, 1, 1, 256)	590080
batch_normalization_20	(Batch(None, 1, 1, 256)	1024
activation_20 (Activation)	(None, 1, 1, 256)	0
dropout_20 (Dropout)	(None, 1, 1, 256)	0
flatten_4 (Flatten)	(None, 256)	0
dense_7 (Dense)	(None, 256)	65792
dense_8 (Dense)	(None, 512)	131584
dense_9 (Dense)	(None, 5)	2565
Total params: 1,477,573		
Trainable params: 1,475,589		
Non-trainable params: 1,984		

Appendix B (Data For 30 Epochs)

Version 1: Baseline Model

Train Loss	Train Acc	Test Loss	Test Acc	Train Time	Test Time
1.5914696075782577	0.411048114939113	1.102677031757087	0.607290233755702	0.001271883001219375	0.0005876157109970239
1.1481950188793728	0.5728623967137104	1.0657104261147763	0.6024759283092032	0.0010729608015527471	0.000510539280499192
0.9957214363360017	0.6344621518693597	1.1193227283810323	0.5598349381837753	0.0010760056618127289	0.0005022774372336953
0.9245880912901469	0.662044131277238	0.8564869519195005	0.6836313618426474	0.0010728506160739592	0.000502288587483612
0.8588065761493971	0.6920012259571018	0.8184102116539521	0.7083906462464733	0.0010724724380289745	0.0005081359097193491
0.8210342868573455	0.7041832663842662	0.7831694765792753	0.7111416779653242	0.001070699003478555	0.0005034257490008537
0.7800862056837102	0.7201195219488843	0.750423264388697	0.7269601102052398	0.0010716987101899455	0.0005003517234833729
0.7566242481059835	0.7257891513984919	0.8029592983742364	0.7180192572214581	0.001075569778872603	0.0005052865289428375
0.7335255051769802	0.7362090101133926	0.730426540278011	0.7359009626970986	0.0010747211935912544	0.000503621862219977
0.6923306552939279	0.7544437639741783	0.6759212151108287	0.7627235210745338	0.0010745174089093314	0.0005095552709440418
0.674795988199355	0.7577382781883343	0.6536052676309746	0.7771664371680689	0.0010762630230877028	0.0004983166388993086
0.6530991100000889	0.7669322712268707	0.6494715795474334	0.7806052270420972	0.001073796143387126	0.0005030635298528238
0.6338260278283837	0.777275513349557	0.6444749732948891	0.7799174691328812	0.0010736035928015982	0.0005043799152400503
0.6197981561870616	0.7765093472082119	0.6721955110643064	0.7661623107026007	0.0010734240664611592	0.0005029366137728894
0.6068594013844536	0.7863162733132657	0.6616588605278296	0.7771664374140302	0.0010758212582304403	0.0005009830243977752
0.5851974186267438	0.7905301874742674	0.6151123751144462	0.7867950478970922	0.0010719048878257346	0.0005004173131887654
0.5577788787899374	0.8006435789617702	0.6387742004745436	0.7771664374960174	0.0010745546732290807	0.0004976943565693977
0.5440768756787543	0.8078455405479336	0.642223450676775	0.7833562584329996	0.0010718607186467378	0.0004997322287159412
0.5229572814701161	0.8145111856780606	0.630362617038959	0.7902338377711206	0.0010738623058215045	0.0005021460938486469
0.5010301084961221	0.8216365307085433	0.6456311047692083	0.7861072903158248	0.001071643946253373	0.0005044559992983056
0.4884794580216719	0.8231688631921686	0.6907206779087098	0.7654745527933847	0.001070465242939422	0.0005068278870195602
0.4748229224222261	0.8300643584642752	0.6533607724526234	0.7806052267141487	0.0010705964717987744	0.0005017689530426403
0.45821582743115413	0.8322862401316949	0.6517222780718928	0.7819807425325805	0.0010736538996332597	0.0005019334192289119
0.4398848171198328	0.8426294825831842	0.6423157767137766	0.7854195323246217	0.0010759289959548918	0.0005048947944273811
0.43365921750961545	0.8462304632027311	0.6634435775437414	0.7806052270420972	0.0010498053377989132	0.0005198359653415182
0.4023378663383815	0.8559607721858327	0.673595479678009	0.7819807427785419	0.0010334453150205294	0.0004970036969716152
0.40095026886539886	0.8569567886700924	0.7029933090305066	0.7744154058591536	0.00103101611977664	0.0004914869468510561
0.38811199179354744	0.8580294203765546	0.7049200729539995	0.7792297112236652	0.001031956879448898	0.0005036769575725067
0.36771018167890873	0.866457247566015	0.667243144904075	0.7874828058063083	0.0010327677072062655	0.0005086981774688259
0.3549960228131295	0.8734293591015331	0.7031485309627066	0.7764786796687886	0.0010314459563982184	0.0004972931115466594

Version 2: MiniNet

Train Loss	Train Acc	Test Loss	Test Acc	Train Time	Test Time
1.4739660322392165	0.4944069870330058	1.093570845081193	0.6086657495741339	0.0011272397539639743	0.0005873126865581108
0.9056463600154891	0.6756818875227463	0.9334067046396342	0.6533700137551581	0.0010196922419446032	0.0005204810400940529
0.7727541327841838	0.7306159978405377	0.7683148038518478	0.7414030262167877	0.001018057763119837	0.0005041775709989147
0.7089398310405872	0.751072633076474	0.889714439231723	0.6911966988440229	0.0010223700303882315	0.0005103608765005246
0.6528205529444429	0.7706864850856466	0.9423161765773161	0.680192571968619	0.0010225965024648251	0.0005122026354279447
0.6156393858942926	0.7798038611848991	0.6991285903909675	0.7544704264918909	0.0010197001332123148	0.0005016825386057858
0.5701201900433369	0.7994177137420764	0.7533098759316676	0.7400275101523944	0.001019876426325011	0.0005042480799322116
0.5391007008415185	0.8087649407687817	0.7049279236727929	0.7558459423923098	0.0010186107546648218	0.0004878309766724808
0.5070832625437908	0.8179589340082531	0.7501655962968955	0.7572214579647804	0.001020696716296903	0.0005104684436173681
0.46818745434010206	0.8339718050142756	0.7581732779782281	0.7537826683367135	0.001018177027209858	0.0005262212871357368
0.42820080657185056	0.8469966293806099	0.7258530315703506	0.7682255844302486	0.0010177180002044761	0.000488798260852756
0.40194489342684836	0.8546582904104583	0.8250512015868742	0.7482806053909343	0.0010162428994139317	0.00048644359042916696
0.37313584076857736	0.8654612324152334	0.8205780786202075	0.7530949107554461	0.0010178069596344659	0.0004780769676093058
0.3446621316691465	0.8748084586016649	0.7823051266689904	0.7496561211273791	0.0010160533811210892	0.0005251992355514589
0.31935620144434296	0.8881397485148493	0.8888621571303398	0.7469050892445539	0.00101525873776926	0.0005040458996653392
0.28858341294455814	0.8971038916671419	0.822658951787542	0.7530949104274975	0.0010163530666258962	0.0005433485629306043
0.26653506842230934	0.9063745015536281	0.9059276344687608	0.7654745530393462	0.00101429834126184	0.0005124394142644114
0.24803340947412472	0.9105884157146298	1.0226965445763798	0.7503438787906337	0.001015669375959438	0.0004735655436981495
0.23388237671694287	0.914802328688288	0.8674785361165358	0.7757909214316241	0.0010149742685283505	0.0004798083718574031
0.2106106127793534	0.9271376029574867	0.9627240878187806	0.7592847316104412	0.001014217218299092	0.0004928112030029297
0.19212733419201616	0.9311982841532617	1.0069905234170256	0.75240715284623	0.001014369161736187	0.00047193416375077577
0.18238603398363684	0.9338798655383689	0.9452230223599294	0.752407152764243	0.001013919249875685	0.0004904175067046322
0.17554166183272937	0.9384002446616825	0.996524131445642	0.7682255844302486	0.0010178454478313834	0.0004872590344414586
0.15716878109426904	0.9452191235425097	1.0870951550206915	0.7599724895196571	0.0010156634209750074	0.0005053970475964238
0.1431791898076643	0.9503524367370161	1.0951555067112226	0.7606602474288731	0.0010139495180020697	0.0004843379969118058
0.14131072302409706	0.948973337784889	1.0664653423891763	0.7579092157920092	0.0010128285013164364	0.0004785039565914107
0.14130855012151897	0.950122586357568	1.0083031487924032	0.7530949104274975	0.001012139860340835	0.0005256609870774218
0.12107543857814416	0.9581673307320913	1.1696276696708867	0.7579092157920092	0.0010129948938108462	0.0005229585272409893
0.12107077150294797	0.9577842479536879	1.1584309864240958	0.7579092157920092	0.0010147451660291863	0.0005041001751465515
0.11378727422657825	0.9603125958255636	1.22783603202526	0.7537826685826748	0.0010158491397685811	0.0005073096434056677

Version 3: WideNet

Train Loss	Train Acc	Test Loss	Test Acc	Train Time	Test Time
1.4956181108166096	0.47356726956667067	0.9546382652680189	0.6629986243202073	0.0018781183725334258	0.0007770983028280685
0.9792932090750509	0.63844621526731	0.8601940968259657	0.697386519699018	0.0016842837937215045	0.0006662075916379485
0.8598023672575896	0.6913116758782331	0.8344260542314023	0.6994497936726273	0.0016869131750831055	0.0006682941641407459
0.7969206651587666	0.7124578611747714	0.7324602869140725	0.7407152683075717	0.0016852541273808573	0.0007127682472726788
0.7419525017922471	0.7329144953146983	0.6989768643490714	0.7469050894905154	0.0016866330533461668	0.0006693331050741623
0.7027972660801216	0.751532332520159	0.7116171884897486	0.7530949104274975	0.0016848073756808048	0.000644879131238431
0.6564258132797788	0.7675452035079147	0.6529062806822082	0.7799174691328812	0.0016841579170414104	0.0007279291441548805
0.6223171317354507	0.7785779959286717	0.6967362040420674	0.7448418157628675	0.0016860589818869709	0.0006611727618777604
0.5950325683439724	0.7863162733315325	0.6644320388771645	0.7778541954052334	0.0016840787120951197	0.0006636481173592716
0.5624508551392422	0.7982684651693975	0.6768920618369458	0.7696011004946419	0.0016843458643874397	0.0007000741801202871
0.5392085061075496	0.8079987743351673	0.6409102977961917	0.7785419533144493	0.001683919863798777	0.0006714013124594498
0.5060077908212263	0.8193380327046447	0.6451402388953769	0.7861072899878763	0.0016934935972802375	0.0006633509959938438
0.48035424853664505	0.8255439778248153	0.6223725437134136	0.7840440162602285	0.0016946212082891204	0.0007098808249220395
0.4520476355239945	0.8417100832756772	0.7466883271973596	0.7448418157628675	0.0016932085617678025	0.0006938361072146745
0.42328790743548994	0.8473797118484773	0.6940634868413906	0.7799174688869198	0.0016924567175832146	0.000690356573343605
0.3965636730157558	0.8587189701448874	0.7057075843604428	0.7689133422574774	0.0016932280159347305	0.0006630630571871709
0.36721273739755134	0.8660741650616139	0.6917635608654075	0.7723521321315057	0.0016903671208532756	0.0006786971833387792
0.33823261816663097	0.8788691383908944	0.7159232532879674	0.7744154058591536	0.001691019264715711	0.0006682472675013902
0.31462661639298906	0.8882163651618642	0.732481216138134	0.7737276476219891	0.0016907627071809667	0.0006721936361005907
0.2972450111765749	0.8954183268210949	0.7569683643449944	0.7709766163130738	0.0017507030413700985	0.0006460836861779634
0.28103761599175664	0.9007814898653115	0.7306486821158225	0.7895460795339561	0.001754402822049673	0.0006410668935867582
0.2616686232792173	0.906680968269555	0.7885347698626852	0.7867950478970922	0.0017590925184232927	0.0006491083554421364
0.24836833366323313	0.9110481153409831	0.8053891136934865	0.7702888584038579	0.0017592882474360932	0.0006533382355428956
0.23173557392684294	0.9144192456176155	0.7777423657774105	0.7757909216775855	0.0017484612820011832	0.000655798013469376
0.2171410432201275	0.9230769231682572	0.8366797216328827	0.7799174691328812	0.0017610650430820195	0.0006933425446815963
0.205464109828638	0.9288997856013584	0.8485833719024304	0.7792297108957167	0.0017596599224919453	0.0006414307524774228
0.2057522827501937	0.9252221882982631	0.8314688435692899	0.7792297112236652	0.0017481307803652896	0.0006448594543268133
0.17918913319382682	0.9355654301104135	0.8307225004842882	0.7867950482250408	0.0017463716122039505	0.0006626462346094019
0.16437346736437844	0.9429206252646088	0.9287022793104429	0.7647867948021817	0.0017427756236149715	0.0006484104809767607
0.15557374545138122	0.9465216053909514	0.9587467075050123	0.782668500769745	0.0017420038320592236	0.0006535763261734702

Version 4: LargeNet

Train Loss	Train Acc	Test Loss	Test Acc	Train Time	Test Time
1.4100213822067569	0.4302022679156041	1.2669225970521425	0.5392022007433224	0.002189397483086827	0.0009192038107115105
1.091484237988595	0.5903309836476777	1.1078126715006822	0.6079779915829309	0.001770266864038924	0.0006734414802456821
0.9399409222887807	0.6598988664029677	0.98211751072738	0.6595598346921404	0.0017737837024820826	0.0006692581688357514
0.8689211813211807	0.6850291143850501	0.9255561698253741	0.6506189822002815	0.0018050145817942829	0.0006955555413415376
0.8227644013803209	0.7068648477693734	0.895187178454996	0.681568087787051	0.0018066309216634064	0.0006911726732529506
0.7946789679701183	0.7139135759336394	0.7939870858044867	0.7145804674294168	0.0018060550417886934	0.0006810569369645361
0.7656431589578143	0.7260956170184094	0.8020230468562414	0.7166437414850133	0.0018054710514443877	0.0006735965998989352
0.7403194099673821	0.737511492820375	0.8410900281908752	0.6932599724076965	0.0018054262429265716	0.0007163346879583934
0.721649326632953	0.7447900704872816	0.7080162069164575	0.7434662996984741	0.0017792903277320873	0.000672897905562242
0.7129832158744829	0.7490806001627551	0.6632598910731823	0.7668500686118167	0.0017849654826948404	0.000676969878447269
0.6998497857807825	0.7530646641452438	0.6662592551321243	0.7709766163130738	0.0017747702570806206	0.0006622917222517557
0.6772604915688749	0.7593472267709698	0.7269707521349397	0.753782668664662	0.0017821081496439497	0.0006619462284786009
0.6628677178262167	0.7650934722465201	0.6292110361784	0.7806052271240843	0.0017742333038065867	0.0006701403503732799
0.6596728985820342	0.7673153536582045	0.6446019540626704	0.7640990369749528	0.0017845285768126038	0.0007103542186207096
0.6520167267874198	0.7661661045009871	0.6159515768658508	0.7771664375780045	0.0017864756557863255	0.0006760978633140763
0.6360719512840959	0.7775053631079332	0.6577852455261157	0.7806052271240843	0.0017888105028873202	0.0006657218998695174
0.6322117894659589	0.7781949120907925	0.6263565780618003	0.777166437250056	0.0017818799604859558	0.0006791128580967039
0.6174616833570505	0.7828685258416139	0.628537826352795	0.7833562584329996	0.0017759877956611337	0.0006830664415634974
0.6250037470186849	0.779037695646359	0.5833742926832406	0.7971114166173188	0.0017737514067383	0.0006679039053936608
0.6044202947631191	0.788691388493917	0.6319496473387151	0.7854195324066089	0.001791379439330269	0.0006657504313913632
0.6041110138603781	0.7862396567393182	0.7386961794539035	0.7420907838800422	0.0017780627058650539	0.0006734009786026022
0.5885408626098119	0.788538155035486	0.5821481255668394	0.7943603848984677	0.0017862307159512679	0.0006972018429468881
0.5890778467365104	0.7875421396655025	0.6158193398620601	0.7888583216247401	0.0017727280810242447	0.0006708565899561655
0.57346752285044	0.7961998155538633	0.6419950468258155	0.7792297112236652	0.0017563126732372924	0.0006692409515380859
0.5766754756301158	0.7956635003582379	0.5684168386123203	0.8081155430827869	0.0017585455914636788	0.0006732906239232794
0.5627987371826698	0.797655531390474	0.5769383726946425	0.7991746905909279	0.0017592722274319657	0.0006684253435515308
0.5649034248478311	0.7987281638824095	0.5903974718207998	0.8005502064093599	0.0017561461528751187	0.0006683389291146762
0.554671102338432	0.8020992953281186	0.628267081682423	0.8012379643185759	0.0017570261936263735	0.0006664648672573504
0.5513613123836014	0.8050873428263475	0.592188677359808	0.8081155434107354	0.0017631348203085626	0.000679394401907101
0.5413212749697188	0.8043977931128153	0.6240469193524146	0.7867950479790794	0.0017930649191259863	0.0007321391833697585