Evaluation Results:

The liveness detection model works on top of the facenet pytorch (MTCNN) face detection model. Frame of the face and eyes are extracted using result provided by the MTCNN. The obtained result is then passed on to 2 different classification model separately for eyes and face (To increase Accuracy).

Eyes classification:

Eyes classifier is used to check if an eye is closed or not. If both eyes are closed then the frame is marked as eyes closed non-live. The dataset used for the eyes classification is extracted from closed eyes in the wild dataset. The notebook for extracting the eyes is "creating dataset/create_eyes_dataset.ipynb". After extracting the eyes, resnet-18 model is used for the binary classification. The loss, accuracy and average time taken to classify the whole set is calculated and tabulated below. The number of images in training is 5445 with a batch size of 64.

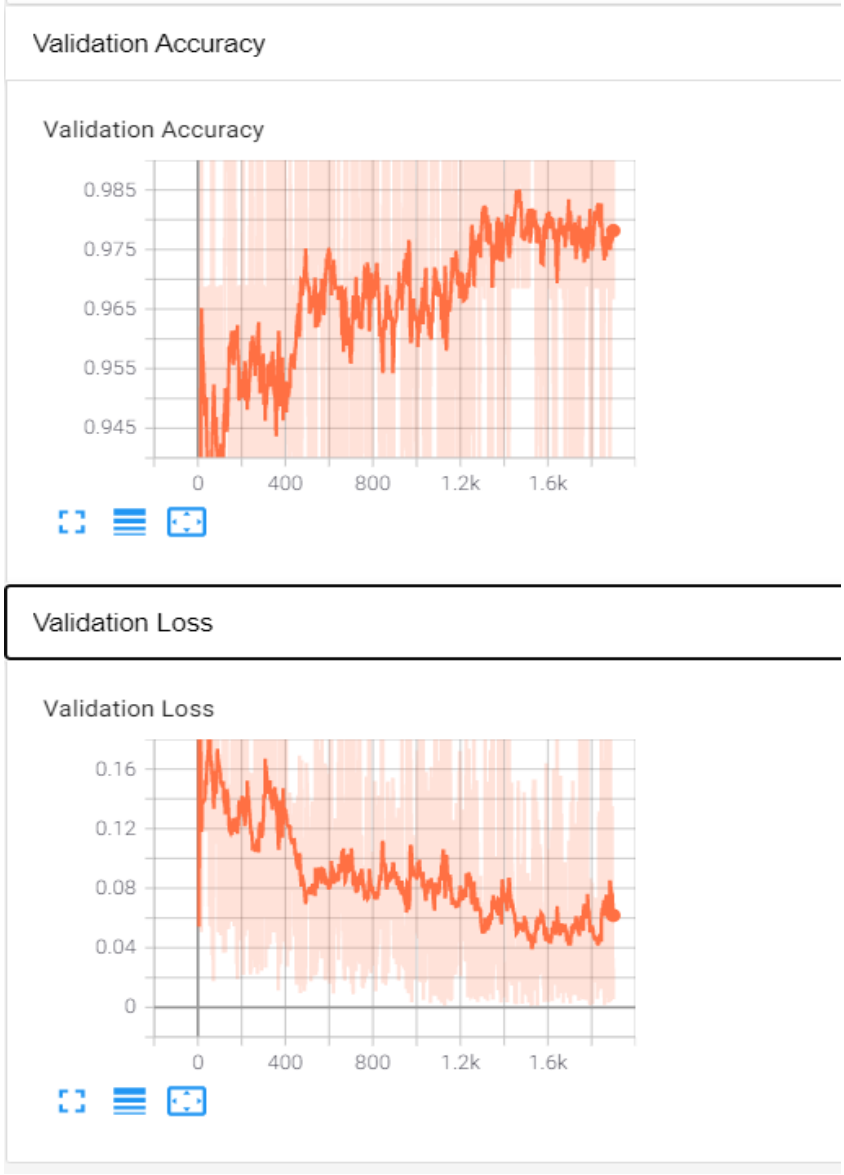
Train data logs for eyes classifier

Epoch	loss	accuracy	time
0	0.2795203658	0.8879020468	13.82486773
1	0.2154145446	0.9188230994	13.76349735
2	0.2054994478	0.9198099415	13.86098242
3	0.185738619	0.9281798246	13.8788228
4	0.1570749018	0.9429093567	13.95164156
5	0.1400227389	0.9490131579	13.71011424
6	0.1441095802	0.9504751462	13.56333494
7	0.1309172711	0.9502923977	13.58223963
8	0.137167142	0.9516812865	13.64940596
9	0.1351388906	0.9551535088	13.71828961
10	0.157756444	0.9434576023	13.78593516
11	0.1225115196	0.9550438596	13.9964087
12	0.1119607387	0.9574195906	13.83809853
13	0.1190600525	0.9588815789	13.79296899
14	0.122080072	0.9555921053	13.88786888
15	0.120233781	0.9571637427	13.8284533
16	0.1285525781	0.9546052632	13.77572274
17	0.1387959638	0.9532163743	13.68495202
18	0.1121823466	0.9604532164	13.75918055
19	0.1091990826	0.9601608187	13.72070718
20	0.1094745888	0.9612573099	13.85942221
21	0.1083889462	0.9594298246	14.04801822
22	0.1175046361	0.9601973684	13.84440875
23	0.1382238181	0.9484649123	13.83955789
24	0.1102110226	0.959247076	13.84158063
25	0.1035616293	0.9623538012	13.68608522
26	0.09798391258	0.9676535088	13.61796141
27	0.09855292052	0.9645467836	13.66407681
28	0.09443478003	0.9661184211	13.5228548
29	0.102291976	0.9645467836	13.76427794
30	0.09018527917	0.9695906433	13.78412652
31	0.1180664356	0.9552266082	13.86732006
32	0.107424704	0.9613669591	14.12204051
33	0.09913635972	0.963998538	14.09703159
34	0.08651192957	0.9691154971	13.87646866
35	0.08411839133	0.9689327485	13.86783171
36	0.09247897695	0.9650950292	14.19977093
37	0.09786653326	0.9678362573	14.13677645
38	0.08697588702	0.9712353801	13.99830604
39	0.0929723951	0.9680190058	13.89358711
40	0.08555932434	0.9673976608	14.02664781
41	0.08546053482	0.9683114035	14.12427139
42	0.07742333542	0.9703947368	14.02232957

43	0.08171396013	0.9709429825	14.03401303
44	0.07911693514	0.9733187135	13.99258327
45	0.07859408767	0.9736842105	14.10203528
46	0.08337821662	0.9714181287	13.80348706
47	0.08271194961	0.9678362573	13.86788392
48	0.07560299584	0.9720394737	14.04339409
49	0.07541165633	0.9727704678	14.2360065
50	0.06660932959	0.9755116959	13.87142587
51	0.07478833264	0.9736842105	13.87187123
52	0.06884848732	0.9755116959	14.08641386
53	0.06063364113	0.978252924	14.07992435
54	0.070053293	0.9731359649	14.25102305
55	0.06808317653	0.9736842105	13.98552203
56	0.06359763908	0.9760599415	13.74559069
57	0.07011877491	0.9725877193	13.76553607
58	0.06324800989	0.9771564327	13.52284408
59	0.06057474761	0.9773391813	13.73311234
60	0.07105986431	0.9736842105	13.72813225
61	0.06181011713	0.9767178363	13.64069057
62	0.06405887307	0.9764254386	13.56658077
63	0.06509422022	0.9781798246	13.80050659
64	0.09019185763	0.9688596491	13.9901576
65	0.08003914033	0.9713084795	13.96954298
66	0.06916330041	0.9764254386	13.87979674
67	0.05793693079	0.9780701754	13.97499323
68	0.05308775078	0.9777046784	13.9435823
69	0.05518359543	0.980994152	14.20656729
70	0.05489268405	0.9802631579	14.31993699
71	0.05491088495	0.9778143275	14.06670737
72	0.05660036703	0.9788011696	13.94965386
73	0.05262082507	0.9795321637	14.106673
74	0.05437194943	0.9797149123	14.21002078
75	0.05389929996	0.9795321637	14.3443284
76	0.05105875378	0.983004386	13.80438328
77	0.05306670178	0.9815423977	13.68640947
78	0.05534525176	0.978252924	13.89523792
79	0.05086193322	0.980994152	13.72880292
80	0.05482145709	0.9791666667	14.04513597
81	0.05249728588	0.980994152	13.9107821
82	0.05077236285	0.9822733918	13.90940237
83	0.05139849972	0.9828216374	13.86476827
84	0.05341665126	0.9791666667	13.74091721
85	0.04703814379	0.9815423977	13.88651657
86	0.05051958555	0.9798976608	14.02251697

87	0.04484525511	0.9839181287	13.91178966
88	0.04316512906	0.985380117	13.87152886
89	0.05372339087	0.9789839181	13.7420857
90	0.04749092004	0.9817251462	13.9587822
91	0.04876740787	0.980994152	13.87318754
92	0.04605153814	0.9820175439	13.88421917
93	0.05406597259	0.9820906433	13.78196836
94	0.04324825055	0.9835526316	13.8399241
95	0.04201180853	0.9835526316	13.91618729
96	0.04651328539	0.983004386	13.97895813
97	0.0514905787	0.9797149123	13.97061324
98	0.04072391111	0.985745614	14.13678074
99	0.04268921275	0.9839181287	13.83304906
100	0.03872573365	0.9848318713	13.87143731

Validation logs for eyes classifier



Epoch	loss	accuracy	time
0	0.144631915	0.9505482456	0.8065989017
1	0.159454339	0.9391447368	0.8130488396
2	0.1856444553	0.9256578947	0.8249289989
3	0.1086783194	0.9634868421	0.8274643421
4	0.1652444366	0.9390350877	0.7888567448
5	0.1318465744	0.9372807018	0.8101696968
6	0.1328103399	0.9572368421	0.8036141396
7	0.1276452626	0.9621710526	0.8323602676
8	0.1227015524	0.9572368421	0.8202836514
9	0.1237801841	0.9572368421	0.8131668568
10	0.1051731022	0.9603070175	0.82975173
11	0.125962005	0.9554824561	0.7961957455
12	0.1008207321	0.9587719298	0.8139877319
13	0.09691455872	0.9604166667	0.8171670437
14	0.1590821998	0.9387061404	0.8054392338
15	0.1170231395	0.9604166667	0.8117358685
16	0.1732072536	0.9504385965	0.823346138
17	0.1111027687	0.9555921053	0.8268809319
18	0.1224815459	0.9505482456	0.8297457695
19	0.1069767374	0.9637061404	0.8314864635
20	0.1140279681	0.9539473684	0.8291456699
21	0.1035871701	0.9554824561	0.8537223339
22	0.1033491355	0.9635964912	0.8228628635
23	0.09636620158	0.9637061404	0.8263542652
24	0.07878752533	0.9718201754	0.7918226719
25	0.07052314879	0.9736842105	0.8213107586
26	0.09823352647	0.957127193	0.8075649738
27	0.08107856774	0.9671052632	0.8278357983
28	0.09004352144	0.9638157895	0.8076531887
29	0.09314790956	0.9588815789	0.8705701828
30	0.09438353679	0.9652412281	0.8483803272
31	0.09711713011	0.9651315789	0.8553097248
32	0.07442127394	0.9735745614	0.9009895325
33	0.08379356651	0.966995614	0.8227431774
34	0.09319994599	0.9604166667	0.8255841732
35	0.07654541329	0.9671052632	0.8291535378
36	0.1106035254	0.9569078947	0.8309438229
37	0.09585827393	0.9686403509	0.8432919979
38	0.08644313532	0.9638157895	0.8268396854
39	0.08392995253	0.9702850877	0.8426833153
40	0.073601609	0.9702850877	0.8267049789
41	0.09158619336	0.9654605263	0.8361442089
42	0.0740177877	0.9752192982	0.8323440552

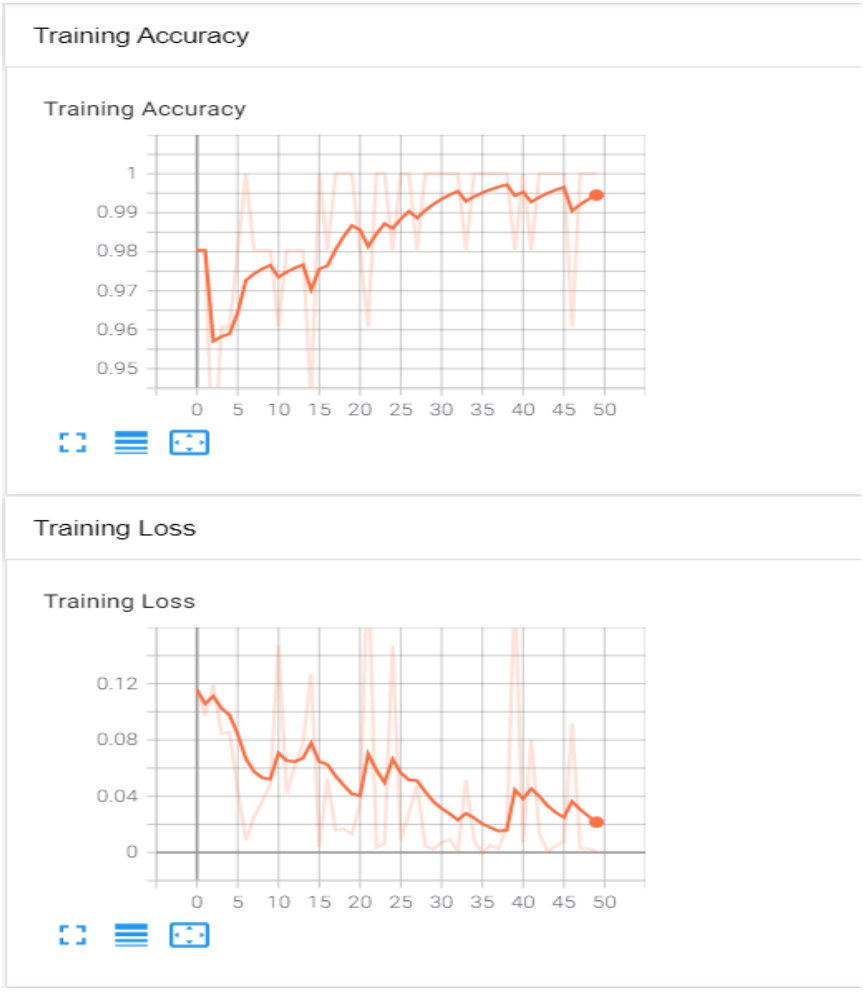
43	0.1156031056	0.9439692982	0.836053133
44	0.09322007696	0.96875	0.8283860683
45	0.07653816201	0.9702850877	0.8490464687
46	0.1019885289	0.9502192982	0.8381817341
47	0.07000983193	0.9785087719	0.8301022053
48	0.08736679036	0.9718201754	0.8488008976
49	0.06700173667	0.9752192982	0.8412005901
50	0.06557432949	0.9786184211	0.8399767876
51	0.09360144282	0.9654605263	0.8241271973
52	0.08109545198	0.9588815789	0.961014986
53	0.09107221692	0.9621710526	0.8135237694
54	0.07346996944	0.9668859649	0.8254153728
55	0.08443146178	0.96875	0.8215911388
56	0.06758402185	0.9720394737	0.8150577545
57	0.07947882284	0.9701754386	0.8371977806
58	0.09515089776	0.9671052632	0.8369238377
59	0.07986411223	0.9671052632	0.8214576244
60	0.105929137	0.9684210526	0.8093600273
61	0.0777414511	0.9703947368	0.8259344101
62	0.06623518621	0.9686403509	0.8652310371
63	0.07289926561	0.9702850877	0.8373441696
64	0.07050767254	0.9769736842	0.8480017185
65	0.07025156393	0.9802631579	0.8287363052
66	0.06678602256	0.9736842105	0.835310936
67	0.05746883993	0.9736842105	0.8314204216
68	0.06809482246	0.9768640351	0.8525474072
69	0.0607355424	0.9786184211	0.8245031834
70	0.07843800526	0.9621710526	0.8417909145
71	0.08468844256	0.9835526316	0.8491792679
72	0.06816422407	0.9753289474	0.8363351822
73	0.07222862292	0.9719298246	0.9403879642
74	0.07437530237	0.9769736842	0.8406875134
75	0.0587235201	0.976754386	0.8152863979
76	0.05472744269	0.9817982456	0.8370988369
77	0.06891971307	0.9718201754	0.8353488445
78	0.05966732678	0.9769736842	0.8292086124
79	0.05763318073	0.9752192982	0.837105751
80	0.06187248508	0.9786184211	0.8861591816
81	0.0566628153	0.9802631579	0.8393728733
82	0.04627911397	0.9835526316	0.8505637646
83	0.04199769495	0.9834429825	0.8416793346
84	0.03842869421	0.9817982456	0.859128952
85	0.05671489915	0.9802631579	0.8384017944
86	0.05369309775	0.9753289474	0.8372809887

87	0.05413058015	0.9834429825	0.834747076
88	0.04815095658	0.9786184211	0.8456683159
89	0.05255683016	0.9801535088	0.8434171677
90	0.05658219225	0.976754386	0.849165678
91	0.08263767121	0.9719298246	0.8370757103
92	0.05312996637	0.9816885965	0.8314659595
93	0.06332200931	0.9786184211	0.8435323238
94	0.0486061575	0.9769736842	0.8360626698
95	0.05213946646	0.9834429825	0.8392868042
96	0.05463950351	0.9786184211	0.8607597351
97	0.06130866261	0.9769736842	0.8410663605
98	0.06163925702	0.9802631579	0.835149765
99	0.05567075655	0.9850877193	0.8466470242

2)Face classification

The data used for the face classification is face extracted from the Rose youtu face liveness detection dataset and some private videos. The extracted face contained 15093 non-live images and 14120 live images of different person at different environment. The classification is done using Resnet-18 with different data augmentation techniques. The result is obtained for training set , validation set and test set.

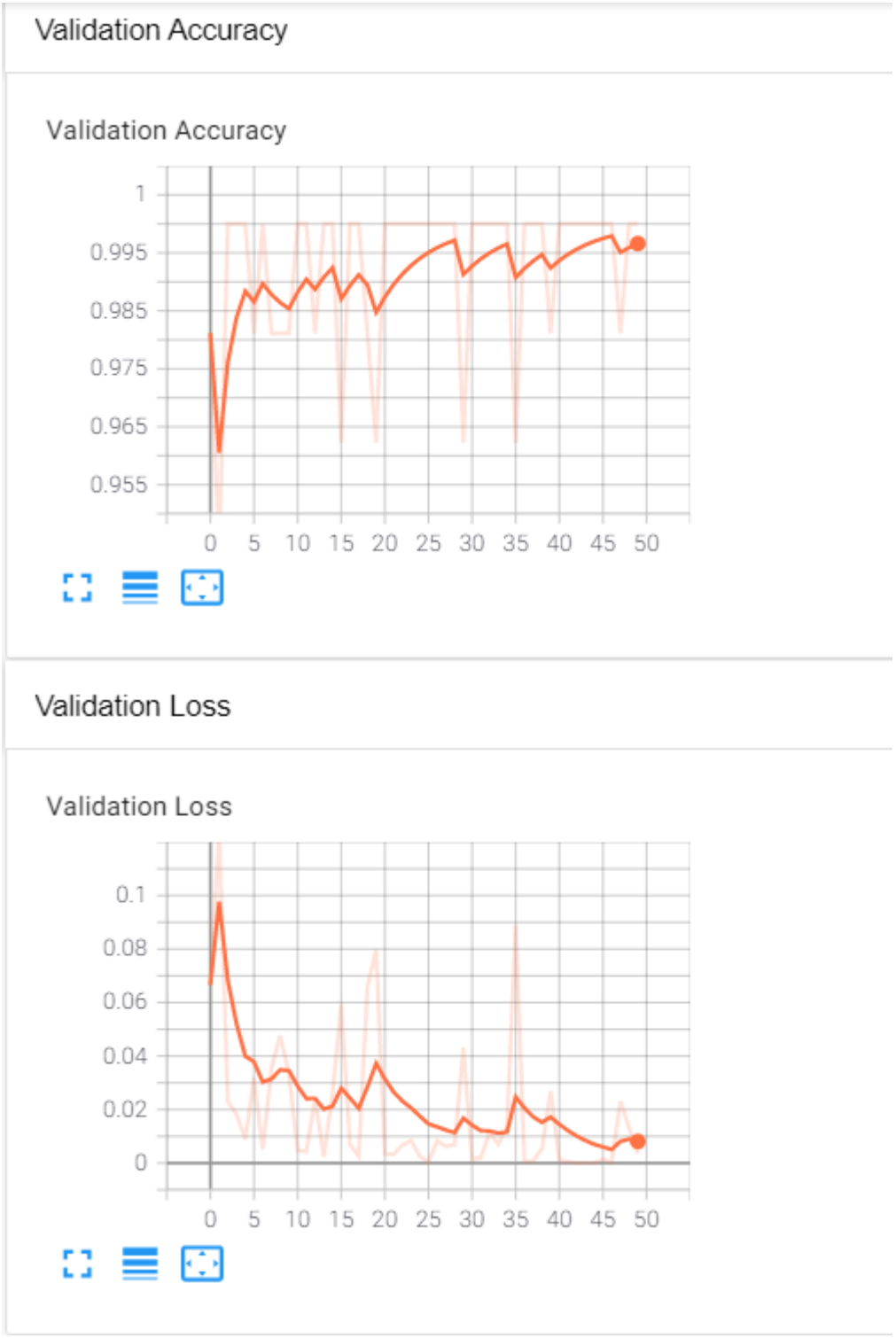
Training logs:



Epoch	loss	accuracy	time
0	0.2690936643	0.8858251634	292.038295
1	0.1406334357	0.9445614773	292.4287407
2	0.1160109365	0.9546069188	283.3150363
3	0.08935754836	0.9659933925	277.5360184
4	0.07814132924	0.9703653511	276.9629407
5	0.06792699659	0.9741387279	277.1045785
6	0.06363541123	0.9763153893	275.5056112
7	0.05670034454	0.9783586184	274.8482897
8	0.04856800642	0.9819322194	275.3271263
9	0.05142666696	0.9807156743	274.6301069
10	0.04542650779	0.9841655336	275.3988044
11	0.04286755937	0.9834529006	275.6830425
12	0.04327534643	0.9844413434	277.8020871
13	0.03878098133	0.9861901269	278.652457
14	0.03363619915	0.9881856483	280.105875
15	0.03635237725	0.9861998175	280.1973042
16	0.03574624048	0.986342195	280.5078061
17	0.03094159126	0.9887469586	278.7906888
18	0.03087014569	0.9888990268	278.420332
19	0.0308017215	0.9890510949	277.4323003
20	0.02933093351	0.9893455405	280.1587398
21	0.02614941425	0.9908945482	279.3387406
22	0.02648682958	0.9903056569	277.4483325
23	0.02620201694	0.9905337591	277.776403
24	0.02647543881	0.9918166476	280.460994
25	0.02173995648	0.9923965937	279.2731507
26	0.02257089026	0.991636253	279.0446742
27	0.02238004557	0.9921588009	277.8203936
28	0.02483252517	0.9920164234	278.3526192
29	0.01847411864	0.9941833942	278.9346809
30	0.02072748407	0.9929668491	278.7003012
31	0.01973034282	0.992738747	280.1230903
32	0.02075543329	0.9928908151	279.1660645
33	0.0179987744	0.9940596524	276.6102109
34	0.01805373156	0.9935751217	285.5604651
35	0.01706683983	0.9937271898	292.6959913
36	0.01517747416	0.9941073601	285.6385262
37	0.01826567826	0.9933850365	282.7192101
38	0.0182311294	0.9936131387	277.7947049
39	0.01348965466	0.9956563678	274.8977766
40	0.01880507896	0.9932329684	275.366251
41	0.01425132664	0.9948960271	274.4188354
42	0.01495597304	0.995171837	275.6856191

43	0.01458793254	0.9953619221	274.6949842
44	0.01532212018	0.9943734793	277.2988648
45	0.01589365631	0.9946776156	277.5026326
46	0.01191441461	0.9955706431	277.1278973
47	0.01345515495	0.99513382	275.9777751
48	0.01447581811	0.9946015815	278.0284131
49	0.01266489046	0.9955900243	276.5288153

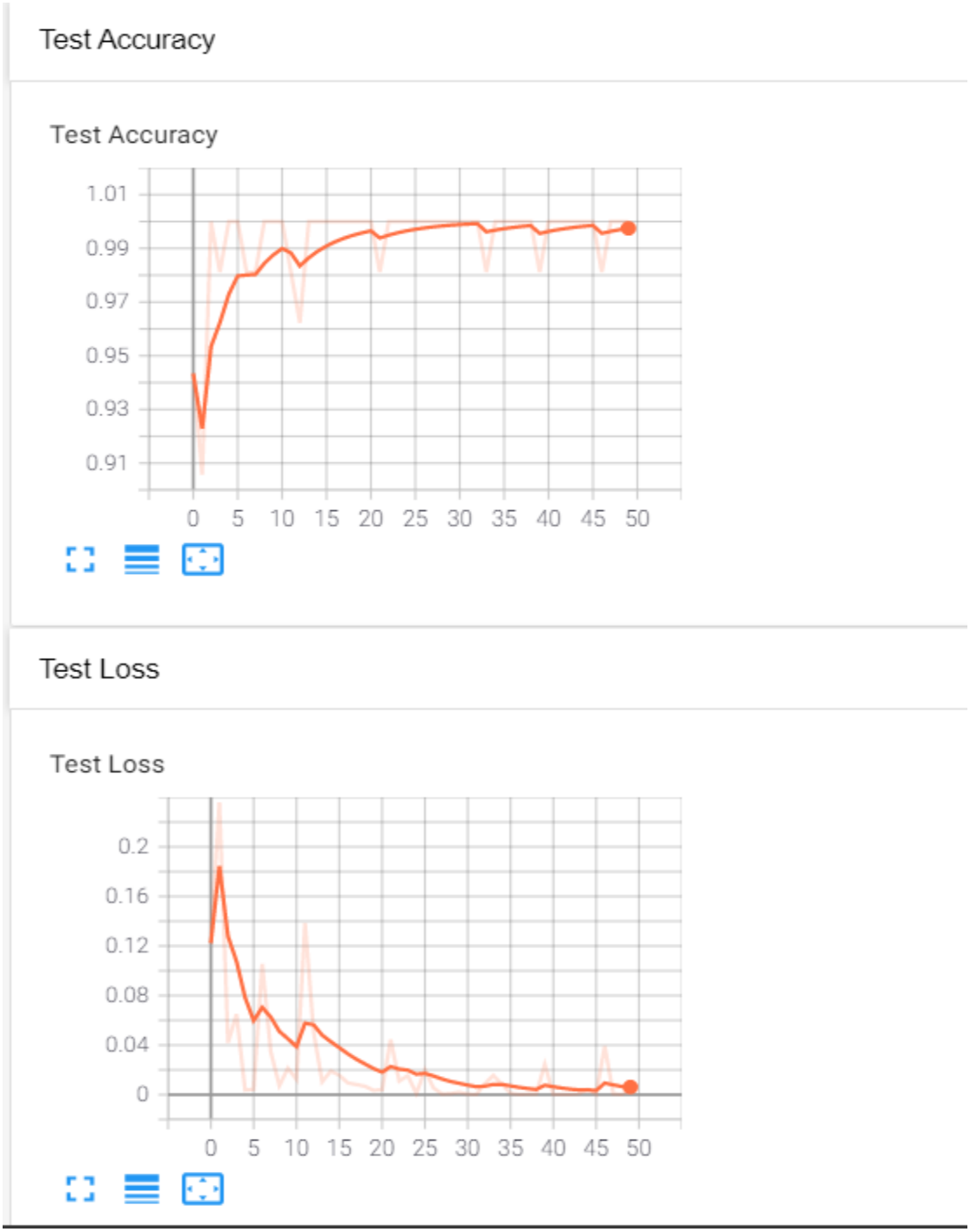
Validation logs:



	loss	accuracy	time
0	0.09596278389	0.9665709598	3.900099516
1	0.08580629268	0.971723749	3.931303024
2	0.06344215936	0.9748641304	3.769327402
3	0.03226276827	0.9877717391	3.757665873
4	0.02958498824	0.9891304348	3.80746007
5	0.02589972818	0.9910274815	3.870762587
6	0.04180374926	0.984375	3.713935614
7	0.02988713919	0.9876307424	3.80938673
8	0.02492895805	0.9917068294	3.782708883
9	0.03717810708	0.9876307424	3.781217098
10	0.01680763853	0.9952445652	3.78264904
11	0.03628870155	0.988451087	3.792253017
12	0.01747680114	0.9923861772	3.777700901
13	0.01839916018	0.9925271739	3.772992611
14	0.01419700192	0.9952445652	3.764999628
15	0.02250778882	0.9888484413	3.834950686
16	0.01938813859	0.9918478261	3.852550507
17	0.01120544035	0.9966032609	3.89933753
18	0.01003659477	0.9964622642	3.85472846
19	0.01000804639	0.9963212674	3.819478989
20	0.01035394421	0.9966032609	3.805473804
21	0.01363842743	0.9945652174	3.811254978
22	0.006759511561	0.9986413043	3.780488491
23	0.01212223264	0.9952445652	3.78151536
24	0.01145461177	0.9972826087	3.93868041
25	0.006343164162	0.9986413043	3.845323086
26	0.005061312815	0.9993206522	3.824410915
27	0.006911116491	0.9979619565	3.828073025
28	0.01336289852	0.9945652174	3.806515694
29	0.01965295971	0.9908864848	3.954210281
30	0.007103445151	0.9986413043	3.90725112
31	0.008428165792	0.9972826087	3.873814344
32	0.00544114252	0.9979619565	3.869014978
33	0.01570822859	0.995923913	3.957523346
34	0.004460689684	0.9986413043	3.922109604
35	0.01499641073	0.9936038761	4.040380716
36	0.005087564493	0.9986413043	3.892787695
37	0.004326467811	0.9979619565	3.907087803
38	0.004539425696	0.9993206522	3.829502106
39	0.0120278551	0.9951035685	3.768974066
40	0.005515574389	0.9986413043	3.874361753
41	0.003875830548	0.9979619565	3.751518965
42	0.003476332886	0.9993206522	3.806486607

43	0.0007276251876	0.9951035685	3.816523075
44	0.004714104341	0.9986413043	3.836434126
45	0.002664472684	0.9986413043	3.823071957
46	0.008167970654	0.9979619565	3.839675665
47	0.00527926872	0.9978209598	3.834113836
48	0.006017219535	0.9986413043	3.799964428
49	0.00769961988	0.9966032609	3.860503674

Test logs:



	loss	accuracy	time
0	0.1003583777	0.9615335316	3.836882591
1	0.08468856833	0.9687243642	3.924270153
2	0.07008783847	0.9714673913	3.806955814
3	0.03575258018	0.9869513946	3.811668158
4	0.02772294524	0.9911684783	3.752327442
5	0.02807031525	0.9898097826	3.799539804
6	0.0451553045	0.981516612	3.788413525
7	0.02932177735	0.9889894381	3.771227837
8	0.02861043554	0.9904891304	3.797897816
9	0.03997010395	0.9870923913	3.79963088
10	0.01048542542	0.9966032609	3.821151018
11	0.04655565353	0.9862720468	3.804382086
12	0.01847498058	0.9915658326	3.852762938
13	0.01956419819	0.9932065217	3.88138175
14	0.01651931008	0.9932065217	3.765466213
15	0.01954187699	0.9911684783	3.747506618
16	0.02007906857	0.9938858696	3.849351883
17	0.01104900212	0.9966032609	3.828702688
18	0.009539689965	0.9972826087	3.787369967
19	0.008998884717	0.9966032609	3.790555239
20	0.008735763661	0.995923913	3.782100677
21	0.0170468192	0.9944242207	3.776169777
22	0.008436524364	0.9972826087	3.815841198
23	0.01413636828	0.9952445652	3.798364878
24	0.01311287193	0.9972826087	3.880540848
25	0.007585203054	0.9979619565	3.80126071
26	0.004538051575	0.9986413043	3.947299004
27	0.00620228255	0.9972826087	3.8446877
28	0.01074537648	0.9966032609	3.819873571
29	0.02350340917	0.9898097826	3.908504248
30	0.007267968867	0.9966032609	3.718733549
31	0.008208623741	0.9979619565	3.926300049
32	0.00620001193	0.9972826087	3.842402458
33	0.01195077948	0.9957829163	3.984867573
34	0.007021287545	0.9972826087	3.89415884
35	0.01998623399	0.9932065217	3.921047926
36	0.004291729879	0.9986413043	3.794387102
37	0.004460779551	0.9986413043	3.846474171
38	0.003924499577	0.9993206522	3.80446887
39	0.01032174128	0.9957829163	3.779641628
40	0.005418271443	0.9979619565	3.841472387
41	0.003342838997	0.9986413043	3.800855637
42	0.003605172151	0.9986413043	3.842158318

43	0.0007849570969	0.9986413043	3.827069521
44	0.005456362924	0.9993206522	3.797935486
45	0.004108707149	0.9979619565	3.836298704
46	0.007463995691	0.997141612	3.849173307
47	0.006604351236	0.9972826087	3.852087021
48	0.005699221401	0.9979619565	3.820531845
49	0.007017467972	0.9966032609	3.781894445