AnoMed Report: MLP Classifier, ResNet Classifier, ResNet Embedding + MLP Classifier

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1 Introduction

We train an MLP consisting of 11 hidden linear layers followed by LeakyReLU activation neurons with a slope of 0.01, batch normalization and skip connections on the CelebA dataset, where we use 39 of the binary attributes as input and aim to predict one target attribute. Since the target attribute values are binary, the chosen loss function for all our models is the binary cross entropy loss with logits. We further fine-tune a pre-trained ResNet-18 by replacing the fully connected layer and training it, to, given images from the CelebA dataset, learn a representation s.t. it is able to reconstruct all attributes from it. The output of the fully connected layer in our trained ResNet-18 serves as a learned representation of attributes from images. Then we freeze our fine-tuned ResNet-18 model and add the same MLP architecture as mentioned before, resulting in a combined model. In the combined model we retrain the complete MLP, but keep the weights of the ResNet-18 layers of our combined network frozen. All our models were initialized with the Kaiming normal initializer with a=0.01 except the last layers which were initialized with Xavier normal initialization and for reproducibility we set the seeds to zero.

2 Training & Evaluation

2.1 MLP

As optimizer we chose adaptive moment estimation with decoupled weight decay (AdamW), with exponential decay rate for the first moment $\beta_1=0.9$, exponential decay rate for the second moment $\beta_2=0.999$, numerical stability constant $\epsilon=1\mathrm{e}-8$, weight decay $\lambda=1\mathrm{e}-2$ and learning rate $\eta=1\mathrm{e}-3$. For the learning rate we further make use of exponential learning rate scheduling with the decay factor $\gamma=0.95$. The model is trained for 100 epochs with a batch size of 16.

Table 1: MLP Training and Validation Results

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24 0.4338 0.4613 0.7933 0.7888 25 0.4341 0.4551 0.7934 0.7897 26 0.4338 0.4573 0.7933 0.7894 27 0.4335 0.4641 0.7930 0.7898 28 0.4333 0.4704 0.7929 0.7878 29 0.4334 0.4530 0.7934 0.7899 30 0.4326 0.4580 0.7936 0.7902 31 0.4320 0.4606 0.7939 0.7886 32 0.4322 0.4568 0.7952 0.7890 33 0.4316 0.4637 0.7940 0.7884 34 0.4316 0.4566 0.7943 0.7898 35 0.4314 0.4575 0.7941 0.7889 36 0.4307 0.4573 0.7946 0.7885 37 0.4312 0.4654 0.7949 0.7850 38 0.4297 0.4568 0.7951 0.7893 <t< td=""><td>22</td><td>0.4354</td><td>0.4533</td><td>0.7930</td><td>0.7885</td></t<>	22	0.4354	0.4533	0.7930	0.7885
25 0.4341 0.4551 0.7934 0.7897 26 0.4338 0.4573 0.7933 0.7894 27 0.4335 0.4641 0.7930 0.7898 28 0.4333 0.4704 0.7929 0.7878 29 0.4334 0.4530 0.7934 0.7899 30 0.4326 0.4580 0.7936 0.7902 31 0.4320 0.4606 0.7939 0.7886 32 0.4322 0.4568 0.7952 0.7890 33 0.4316 0.4637 0.7940 0.7884 34 0.4316 0.4566 0.7943 0.7898 35 0.4314 0.4575 0.7941 0.7889 36 0.4307 0.4573 0.7946 0.7885 37 0.4312 0.4654 0.7949 0.7850 38 0.4297 0.4568 0.7951 0.7893 39 0.4301 0.4609 0.7947 0.7872 <t< td=""><td>23</td><td>0.4349</td><td>0.4619</td><td>0.7929</td><td>0.7896</td></t<>	23	0.4349	0.4619	0.7929	0.7896
26 0.4338 0.4573 0.7933 0.7894 27 0.4335 0.4641 0.7930 0.7898 28 0.4333 0.4704 0.7929 0.7878 29 0.4334 0.4530 0.7934 0.7899 30 0.4326 0.4580 0.7936 0.7902 31 0.4320 0.4606 0.7939 0.7886 32 0.4322 0.4568 0.7952 0.7890 33 0.4316 0.4637 0.7940 0.7884 34 0.4316 0.4566 0.7943 0.7898 35 0.4314 0.4575 0.7941 0.7889 36 0.4307 0.4573 0.7946 0.7885 37 0.4312 0.4654 0.7949 0.7850 38 0.4297 0.4568 0.7951 0.7893 39 0.4301 0.4609 0.7947 0.7872 40 0.4303 0.4629 0.7954 0.7887 <t< td=""><td>24</td><td>0.4338</td><td>0.4613</td><td>0.7933</td><td>0.7888</td></t<>	24	0.4338	0.4613	0.7933	0.7888
27 0.4335 0.4641 0.7930 0.7898 28 0.4333 0.4704 0.7929 0.7878 29 0.4334 0.4530 0.7934 0.7899 30 0.4326 0.4580 0.7936 0.7902 31 0.4320 0.4606 0.7939 0.7886 32 0.4322 0.4568 0.7952 0.7890 33 0.4316 0.4637 0.7940 0.7884 34 0.4316 0.4566 0.7943 0.7898 35 0.4314 0.4575 0.7941 0.7889 36 0.4307 0.4573 0.7946 0.7885 37 0.4312 0.4654 0.7949 0.7850 38 0.4297 0.4568 0.7951 0.7893 39 0.4301 0.4609 0.7947 0.7872 40 0.4303 0.4629 0.7954 0.7887 41 0.4300 0.4580 0.7955 0.7900	25	0.4341	0.4551	0.7934	0.7897
28 0.4333 0.4704 0.7929 0.7878 29 0.4334 0.4530 0.7934 0.7899 30 0.4326 0.4580 0.7936 0.7902 31 0.4320 0.4606 0.7939 0.7886 32 0.4322 0.4568 0.7952 0.7890 33 0.4316 0.4637 0.7940 0.7884 34 0.4316 0.4566 0.7943 0.7898 35 0.4314 0.4575 0.7941 0.7889 36 0.4307 0.4573 0.7946 0.7885 37 0.4312 0.4654 0.7949 0.7850 38 0.4297 0.4568 0.7951 0.7893 39 0.4301 0.4609 0.7947 0.7872 40 0.4303 0.4629 0.7954 0.7887 41 0.4300 0.4580 0.7955 0.7900	26	0.4338	0.4573	0.7933	0.7894
29 0.4334 0.4530 0.7934 0.7899 30 0.4326 0.4580 0.7936 0.7902 31 0.4320 0.4606 0.7939 0.7886 32 0.4322 0.4568 0.7952 0.7890 33 0.4316 0.4637 0.7940 0.7884 34 0.4316 0.4566 0.7943 0.7898 35 0.4314 0.4575 0.7941 0.7889 36 0.4307 0.4573 0.7946 0.7885 37 0.4312 0.4654 0.7949 0.7850 38 0.4297 0.4568 0.7951 0.7893 39 0.4301 0.4609 0.7947 0.7872 40 0.4303 0.4629 0.7954 0.7887 41 0.4300 0.4580 0.7955 0.7900	27	0.4335	0.4641	0.7930	0.7898
30 0.4326 0.4580 0.7936 0.7902 31 0.4320 0.4606 0.7939 0.7886 32 0.4322 0.4568 0.7952 0.7890 33 0.4316 0.4637 0.7940 0.7884 34 0.4316 0.4566 0.7943 0.7898 35 0.4314 0.4575 0.7941 0.7889 36 0.4307 0.4573 0.7946 0.7885 37 0.4312 0.4654 0.7949 0.7850 38 0.4297 0.4568 0.7951 0.7893 39 0.4301 0.4609 0.7947 0.7872 40 0.4303 0.4629 0.7954 0.7887 41 0.4300 0.4580 0.7955 0.7900	28	0.4333	0.4704	0.7929	0.7878
31 0.4320 0.4606 0.7939 0.7886 32 0.4322 0.4568 0.7952 0.7890 33 0.4316 0.4637 0.7940 0.7884 34 0.4316 0.4566 0.7943 0.7898 35 0.4314 0.4575 0.7941 0.7889 36 0.4307 0.4573 0.7946 0.7885 37 0.4312 0.4654 0.7949 0.7850 38 0.4297 0.4568 0.7951 0.7893 39 0.4301 0.4609 0.7947 0.7872 40 0.4303 0.4629 0.7954 0.7887 41 0.4300 0.4580 0.7955 0.7900	29	0.4334	0.4530	0.7934	0.7899
32 0.4322 0.4568 0.7952 0.7890 33 0.4316 0.4637 0.7940 0.7884 34 0.4316 0.4566 0.7943 0.7898 35 0.4314 0.4575 0.7941 0.7889 36 0.4307 0.4573 0.7946 0.7885 37 0.4312 0.4654 0.7949 0.7850 38 0.4297 0.4568 0.7951 0.7893 39 0.4301 0.4609 0.7947 0.7872 40 0.4303 0.4629 0.7954 0.7887 41 0.4300 0.4580 0.7955 0.7900	30	0.4326	0.4580	0.7936	0.7902
33 0.4316 0.4637 0.7940 0.7884 34 0.4316 0.4566 0.7943 0.7898 35 0.4314 0.4575 0.7941 0.7889 36 0.4307 0.4573 0.7946 0.7885 37 0.4312 0.4654 0.7949 0.7850 38 0.4297 0.4568 0.7951 0.7893 39 0.4301 0.4609 0.7947 0.7872 40 0.4303 0.4629 0.7954 0.7887 41 0.4300 0.4580 0.7955 0.7900	31	0.4320	0.4606		0.7886
34 0.4316 0.4566 0.7943 0.7898 35 0.4314 0.4575 0.7941 0.7889 36 0.4307 0.4573 0.7946 0.7885 37 0.4312 0.4654 0.7949 0.7850 38 0.4297 0.4568 0.7951 0.7893 39 0.4301 0.4609 0.7947 0.7872 40 0.4303 0.4629 0.7954 0.7887 41 0.4300 0.4580 0.7955 0.7900	32	0.4322	0.4568	0.7952	0.7890
35 0.4314 0.4575 0.7941 0.7889 36 0.4307 0.4573 0.7946 0.7885 37 0.4312 0.4654 0.7949 0.7850 38 0.4297 0.4568 0.7951 0.7893 39 0.4301 0.4609 0.7947 0.7872 40 0.4303 0.4629 0.7954 0.7887 41 0.4300 0.4580 0.7955 0.7900	33	0.4316	0.4637	0.7940	0.7884
36 0.4307 0.4573 0.7946 0.7885 37 0.4312 0.4654 0.7949 0.7850 38 0.4297 0.4568 0.7951 0.7893 39 0.4301 0.4609 0.7947 0.7872 40 0.4303 0.4629 0.7954 0.7887 41 0.4300 0.4580 0.7955 0.7900	34	0.4316	0.4566		0.7898
37 0.4312 0.4654 0.7949 0.7850 38 0.4297 0.4568 0.7951 0.7893 39 0.4301 0.4609 0.7947 0.7872 40 0.4303 0.4629 0.7954 0.7887 41 0.4300 0.4580 0.7955 0.7900	35	0.4314	0.4575	0.7941	0.7889
38 0.4297 0.4568 0.7951 0.7893 39 0.4301 0.4609 0.7947 0.7872 40 0.4303 0.4629 0.7954 0.7887 41 0.4300 0.4580 0.7955 0.7900	36	0.4307	0.4573	0.7946	
39 0.4301 0.4609 0.7947 0.7872 40 0.4303 0.4629 0.7954 0.7887 41 0.4300 0.4580 0.7955 0.7900	37	0.4312	0.4654	0.7949	0.7850
40 0.4303 0.4629 0.7954 0.7887 41 0.4300 0.4580 0.7955 0.7900	38	0.4297	0.4568	0.7951	0.7893
41 0.4300 0.4580 0.7955 0.7900	39	0.4301	0.4609	0.7947	0.7872
	40	0.4303	0.4629	0.7954	0.7887
42 0.4299 0.4545 0.7958 0.7897	41	0.4300	0.4580	0.7955	0.7900
	42	0.4299	0.4545	0.7958	0.7897

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Epoch	Train Loss	Val Loss	Train Acc	Eval Acc	
43	0.4291	0.4568	0.7956	0.7917	
44	0.4297	0.4577	0.7961	0.7916	
45	0.4286	0.4638	0.7957	0.7917	
46	0.4289	0.4500	0.7965	0.7905	
47	0.4281	0.4537	0.7964	0.7910	
48	0.4273	0.4588	0.7962	0.7894	
49	0.4283	0.4517	0.7959	0.7913	
50	0.4276	0.4564	0.7964	0.7903	
51	0.4273	0.4529	0.7969	0.7899	
52	0.4280	0.4568	0.7965	0.7896	
53	0.4281	0.4558	0.7968	0.7915	
54	0.4275	0.4552	0.7968	0.7906	
55	0.4269	0.4591	0.7974	0.7896	
56	0.4270	0.4574	0.7973	0.7889	
57	0.4272	0.4502	0.7969	0.7905	
58	0.4270	0.4496	0.7968	0.7910	
59	0.4270	0.4533	0.7968	0.7905	
60	0.4268	0.4487	0.7974	0.7898	
61	0.4261	0.4543	0.7979	0.7898	
62	0.4263	0.4590	0.7974	0.7910	
63	0.4265	0.4519	0.7975	0.7895	
64	0.4261	0.4528	0.7978	0.7902	
65	0.4260	0.4480	0.7975	0.7906	
66	0.4260	0.4521	0.7972	0.7897	
67	0.4256	0.4543	0.7969	0.7914	
68	0.4257	0.4547	0.7987	0.7885	
69	0.4261	0.4648	0.7971	0.7892	
70	0.4256	0.4552	0.7974	0.7908	
71	0.4256	0.4499	0.7978	0.7897	
72	0.4257	0.4554	0.7980	0.7892	
73	0.4251	0.4509	0.7972	0.7901	
74	0.4256	0.4578	0.7973	0.7900	
75	0.4247	0.4510	0.7984	0.7901	
76	0.4251	0.4486	0.7976	0.7885	
77	0.4254	0.4523	0.7975	0.7915	
78	0.4247	0.4532	0.7976	0.7899	
79	0.4252	0.4507	0.7975	0.7895	
80	0.4247	0.4485	0.7982	0.7903	
81	0.4250	0.4503	0.7978	0.7904	
82	0.4253	0.4556	0.7980	0.7896	
83	0.4245	0.4553	0.7984	0.7898	
84	0.4244	0.4524	0.7986	0.7900	
85	0.4249	0.4521	0.7984	0.7900	

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Epoch	Train Loss	Val Loss	Train Acc	Eval Acc
86	0.4246	0.4533	0.7980	0.7892
87	0.4243	0.4546	0.7976	0.7891
88	0.4240	0.4531	0.7980	0.7888
89	0.4244	0.4512	0.7986	0.7900
90	0.4244	0.4471	0.7988	0.7901
91	0.4248	0.4569	0.7988	0.7902
92	0.4249	0.4557	0.7985	0.7908
93	0.4241	0.4590	0.7986	0.7883
94	0.4243	0.4548	0.7980	0.7891
95	0.4243	0.4530	0.7987	0.7899
96	0.4245	0.4574	0.7988	0.7896
97	0.4239	0.4530	0.7985	0.7887
98	0.4250	0.4537	0.7981	0.7900
99	0.4241	0.4515	0.7984	0.7905
100	0.4244	0.4482	0.7984	0.7900

2.2 ResNet Image Encoder for all Classes

As optimizer we chose adaptive moment estimation with decoupled weight decay (AdamW), with exponential decay rate for the first moment $\beta_1=0.9$, exponential decay rate for the second moment $\beta_2=0.999$, numerical stability constant $\epsilon=1\mathrm{e}-8$, weight decay $\lambda=1\mathrm{e}-2$ and learning rate $\eta=1\mathrm{e}-3$. We also utilize an exponential learning rate scheduler with $\gamma=0.95$. The model is trained for 20 epochs with a batch size of 16.

Table 2: ResNet Image Encoder Training and Evaluation Results

Epoch	Train Loss	Eval Loss	Train Acc	Eval Acc
1	0.2368	0.2155	0.8964	0.9055
2	0.2048	0.2024	0.9098	0.9109
3	0.1943	0.1975	0.9144	0.9132
4	0.1868	0.1943	0.9177	0.9135
5	0.1803	0.2055	0.9206	0.9090
6	0.1736	0.1910	0.9236	0.9160
7	0.1670	0.1932	0.9267	0.9150
8	0.1599	0.1951	0.9299	0.9148
9	0.1526	0.1958	0.9335	0.9153
10	0.1453	0.2023	0.9368	0.9140
11	0.1379	0.2058	0.9403	0.9129
12	0.1305	0.2089	0.9439	0.9119
13	0.1233	0.2158	0.9474	0.9102
14	0.1163	0.2223	0.9506	0.9095
15	0.1095	0.2281	0.9538	0.9111
16	0.1031	0.2338	0.9568	0.9080
17	0.0968	0.2396	0.9597	0.9088
18	0.0908	0.2445	0.9625	0.9089
19	0.0851	0.2519	0.9650	0.9087
20	0.0798	0.2605	0.9675	0.9081

2.3 Frozen ResNet Encoder with MLP head

We choose the trained ResNet from the 6th epoch and attach an MLP head. To optimize the parameters of our ResNet + MLP network we chose adaptive moment estimation with decoupled weight decay (AdamW), with exponential decay rate for the first moment $\beta_1=0.9$, exponential decay rate for the second moment $\beta_2=0.999$, numerical stability constant $\epsilon=1\mathrm{e}{-8}$, weight decay $\lambda=1\mathrm{e}{-2}$ and learning rate $\eta=1\mathrm{e}{-3}$. For the combined model we also utilize an exponential learning rate scheduler with $\gamma=0.95$. The combined model is trained for 20 epochs with a batch size of 16.

Table 3.	RecNet_MI	P Training	and Evaluation	Reculte
Table 5.	RESIDELEIVII	r Hanning	ани суантанон	RESHIIS

	Table 5. Residential Training and Evaluation Results				
Epoch	Train Loss	Val Loss	Train Acc	Eval Acc	
1	0.3774	0.3646	0.8245	0.8288	
2	0.3679	0.3479	0.8292	0.8423	
3	0.3612	0.3627	0.8330	0.8430	
4	0.3572	0.3692	0.8352	0.8454	
5	0.3553	0.3795	0.8359	0.8458	
6	0.3527	0.3796	0.8366	0.8412	
7	0.3513	0.3609	0.8378	0.8409	
8	0.3501	0.3687	0.8378	0.8462	
9	0.3496	0.3891	0.8390	0.8468	
10	0.3478	0.3567	0.8383	0.8473	
11	0.3478	0.3506	0.8386	0.8485	
12	0.3465	0.3887	0.8389	0.8494	
13	0.3462	0.3622	0.8394	0.8470	
14	0.3455	0.3858	0.8403	0.8492	
15	0.3447	0.3608	0.8399	0.8458	
16	0.3442	0.3600	0.8411	0.8419	
17	0.3430	0.3658	0.8409	0.8486	
18	0.3433	0.3819	0.8411	0.8476	
19	0.3424	0.3833	0.8415	0.8431	
20	0.3416	0.3694	0.8410	0.8475	