diagnostics

MDPI

Deep Features from Pretrained Networks Do Not Outperform Hand-Crafted Features in Radiomics

Supplemental Material

Table S1. List of pretrained deep networks used.

Modelname	Pretraining data	Number of parameters	Size of feature vector
radimagenet.resnet50	Medical data	23,59	2048
radimagenet.densenet121	Medical data	7,04	1024
radimagenet.inceptionV3	Medical data	21,8	2048
radimagenet.IRV2	Medical data	54,33	1536
medicalimagenet.resnet10	Medical data	14,36	512
medicalimagenet.resnet18	Medical data	32,99	512
medicalimagenet.resnet34	Medical data	63,3	512
medicalimagenet.resnet50	Medical data	46,16	2048
convnext-v2-large_fcmae-in21k-pre_3rdparty_in1k	ImageNet-1K	197,96	1536
deit3-huge-p14_in21k-pre_3rdparty_in1k	ImageNet-1K	632,13	1280
efficientnet-b7_3rdparty-ra-noisystudent_in1k	ImageNet-1K	66,35	80
efficientnetv2-l_in21k-pre_3rdparty_in1k	ImageNet-1K	118,52	96
simclr_resnet50_16xb256-coslr-200e_in1k	Self-supervised	27,97	2048
simsiam_resnet50_8xb32-coslr-200e_in1k	Self-supervised	38,2	2048
mocov3_resnet50_8xb512-amp-coslr-300e_in1k	Self-supervised	68,01	2048
barlowtwins_resnet50_8xb256-coslr-300e_in1k	Self-supervised	174,54	2048
resnet34_8xb32_in1k	ImageNet-1K	2,18	512
vgg16bn_8xb32_in1k	ImageNet-1K	138,37	1000
densenet161_3rdparty_in1k	ImageNet-1K	28,68	2208
efficientnet-b2_3rdparty_8xb32_in1k	ImageNet-1K	9,11	48

Table S2. AUC of the models using hand-crafted features.

Model	C4KC-KiTS	CRLM	Desmoid	GBM	GIST	HN	I-SPY1	Lipo	Liver	Melanoma	Mean AUC	ΔAUC
Hand-crafted, 2-D, All	0.761	**0.79**	0.899	0.722	0.817	0.902	0.68	0.883	0.801	0.681	0.794	0.005
Hand-crafted, 2-D, No morph	0.756	0.778	0.891	0.741	**0.819**	0.902	0.68	**0.885**	**0.803**	0.681	0.793	0.005
Hand-crafted, 3-D, No morph	**0.768**	0.749	0.898	0.772	0.764	**0.914**	0.671	0.876	0.782	**0.719**	0.791	0.002
Hand-crafted, 3-D, All	**0.768**	0.749	**0.908**	**0.783**	0.78	0.903	0.671	0.883	0.774	0.669	0.789	0
Hand-crafted, 3-D, Morph	0.58	0.742	0.807	0.694	0.726	0.849	**0.681**	0.884	0.676	0.589	0.723	-0.066

Models with "All" used all available hand-crafted features, while those with "No morph" used all but morphological features. The models with "Morph" used only morphological features. ΔAUC denotes the mean difference to the standard "Hand-crafted, 3-D, All" model. Models with the highest AUC for each dataset were marked in bold.

Table S3. AUC of the models using deep features.

Model	C4KC-KiTS	CRLM	Des-moid	GBM	GIST	HN	I-SPY1	Lipo	Liver	Mela-noma	Mean AUC	ΔAUC
ConvNeXt V2, large	0.661	**0.821**	**0.881**	0.781	0.742	0.902	0.661	**0.886**	0.793	0.623	0.775	-0.014
SimSiam, ResNet-50	0.664	0.671	0.829	**0.915**	0.689	0.911	0.732	0.846	0.794	0.614	0.766	-0.022
SimCLR, ResNet-50	0.682	0.714	0.859	0.772	0.701	0.908	0.688	0.822	**0.819**	0.649	0.761	-0.027
DenseNet-161	0.675	0.676	0.867	0.709	**0.757**	0.89	0.688	0.843	0.778	0.666	0.755	-0.034
ResNet-34	**0.711**	0.743	0.845	0.645	0.738	0.874	0.652	0.885	0.816	0.607	0.752	-0.037
VGG-16	0.625	0.667	0.872	0.725	0.703	0.85	0.68	0.857	0.786	0.742	0.751	-0.038
BarlowTwins, ResNet-50	0.692	0.672	0.82	0.726	0.697	0.896	0.755	0.826	0.786	0.631	0.75	-0.039
DeiT III huge	0.646	0.689	0.761	0.785	0.738	0.864	**0.788**	0.871	0.702	0.644	0.749	-0.04
EfficientNet-B2	0.657	0.705	0.788	0.734	0.711	0.831	0.765	0.821	0.773	0.654	0.744	-0.045
MoCo V3, ResNet-50	0.67	0.734	0.872	0.651	0.685	**0.913**	0.674	0.827	0.779	0.6	0.74	-0.048
EfficientNet-B7	0.664	0.722	0.818	0.678	0.687	0.886	0.669	0.835	0.703	0.694	0.736	-0.053
EfficientNet V2, large	0.671	0.668	0.816	0.725	0.706	0.856	0.707	0.762	0.749	0.656	0.732	-0.057
MedicalNet, ResNet-10	0.688	0.652	0.749	0.819	0.736	0.812	0.645	0.758	0.726	0.712	0.73	-0.059
MedicalNet, ResNet-50	0.712	0.59	0.721	0.803	0.697	0.816	0.647	0.693	0.737	**0.775**	0.719	-0.07
RadImageNet, InceptionRes-Net-V2	0.61	0.669	0.743	0.756	0.689	0.744	0.663	0.743	0.645	**0.775**	0.704	-0.085
RadImageNet, DenseNet-121	0.61	0.684	0.746	0.699	0.706	0.751	0.707	0.778	0.719	0.599	0.7	-0.089
MedicalNet, ResNet-18	0.679	0.565	0.756	0.726	0.664	0.823	0.65	0.735	0.719	0.677	0.7	-0.089
RadImageNet, Inception-V3	0.599	0.642	0.774	0.781	0.669	0.78	0.638	0.75	0.688	0.576	0.69	-0.099
MedicalNet, ResNet-34	0.7	0.569	0.736	0.724	0.67	0.778	0.645	0.743	0.667	0.648	0.688	-0.101
RadImageNet, ResNet-50	0.642	0.715	0.691	0.766	0.676	0.714	0.688	0.702	0.598	0.662	0.685	-0.103

ΔAUC denotes the mean difference to the standard "Hand-crafted, 3-D, All" model. Models with the highest AUC for each dataset were marked in bold.

Table S4. AUC of the models using deep features fused with morphological features.

Model	C4KC-KiTS	CRLM	Des-moid	GBM	GIST	HN	I-SPY1	Lipo	Liver	Mela-noma	Mean AUC	ΔAUC
ConvNeXt V2, large	0.661	**0.792**	**0.882**	0.801	0.746	0.902	0.674	0.884	**0.818**	0.618	0.778	-0.011
SimSiam, ResNet-50	0.699	0.671	0.851	**0.915**	0.675	0.902	0.732	0.884	0.793	0.644	0.777	-0.012
EfficientNet-B2	0.652	0.794	0.847	0.839	0.717	0.864	0.71	0.884	0.758	0.665	0.773	-0.016
SimCLR, ResNet-50	0.682	0.703	0.872	0.768	0.722	0.91	0.698	0.884	0.807	0.611	0.766	-0.023
DenseNet-161	0.675	0.684	0.867	0.731	**0.758**	0.896	0.688	0.884	0.778	0.67	0.763	-0.026
BarlowTwins, ResNet-50	0.692	0.68	0.855	0.726	0.707	0.904	0.744	0.884	0.782	0.628	0.76	-0.029
VGG-16	0.628	0.688	0.877	0.784	0.712	0.847	0.64	0.884	0.795	0.723	0.758	-0.031
EfficientNet V2, large	0.673	0.715	0.842	0.735	0.726	0.861	0.715	0.884	0.76	0.659	0.757	-0.032
ResNet-34	**0.715**	0.717	0.855	0.708	0.747	0.868	0.65	0.896	0.817	0.581	0.755	-0.033
DeiT III huge	0.646	0.71	0.773	0.798	0.741	0.865	**0.781**	**0.918**	0.678	0.644	0.755	-0.034
MedicalNet, ResNet-50	0.712	0.669	0.784	0.803	0.686	0.845	0.612	0.884	0.756	**0.776**	0.753	-0.036
EfficientNet-B7	0.664	0.742	0.842	0.714	0.725	0.875	0.663	0.884	0.713	0.695	0.752	-0.037
MedicalNet, ResNet-10	0.687	0.686	0.795	0.821	0.722	0.849	0.649	0.884	0.749	0.669	0.751	-0.038
MoCo V3, ResNet-50	0.67	0.72	0.876	0.651	0.699	**0.913**	0.681	0.884	0.779	0.618	0.749	-0.04
RadImageNet, ResNet-50	0.652	0.758	0.777	0.759	0.7	0.849	0.708	0.884	0.651	0.675	0.741	-0.048
RadImageNet, InceptionRes-Net-V2	0.666	0.66	0.781	0.752	0.706	0.841	0.673	0.888	0.654	0.775	0.74	-0.049
MedicalNet, ResNet-18	0.688	0.649	0.835	0.755	0.686	0.843	0.636	0.884	0.73	0.677	0.738	-0.051
MedicalNet, ResNet-34	0.7	0.633	0.818	0.738	0.697	0.849	0.644	0.884	0.727	0.648	0.734	-0.055
RadImageNet, DenseNet-121	0.602	0.685	0.77	0.689	0.748	0.836	0.664	0.887	0.709	0.606	0.72	-0.069
RadImageNet, Inception-V3	0.58	0.674	0.8	0.788	0.682	0.856	0.616	0.884	0.662	0.542	0.708	-0.08

ΔAUC denotes the mean difference to the standard "Hand-crafted, 3-D, All" model. Models with the highest AUC for each dataset were marked in bold.

Table S5. AUC of the models using deep features fused with hand-crafted features.

ModelName	C4KC-KiTS	CRLM	Des-moid	GBM	GIST	HN	I-SPY1	Lipo	Liver	Mela-noma	Mean AUC	ΔAUC
SimSiam, ResNet-50	0.74	0.711	0.868	**0.915**	0.768	0.904	**0.704**	**0.933**	0.794	0.647	0.798	0.009
EfficientNet V2, large	0.772	0.738	**0.925**	0.764	0.777	0.905	0.701	0.885	0.787	0.693	0.795	0.006
EfficientNet-B2	0.768	0.76	0.911	0.779	0.77	0.909	0.655	0.87	0.8	0.723	0.795	0.006
MedicalNet, ResNet10	0.754	0.749	0.891	0.819	0.78	0.896	0.649	0.873	0.779	0.73	0.792	0.003
DeiT III huge	0.759	0.753	0.852	0.754	**0.815**	0.882	0.701	0.884	0.788	0.718	0.791	0.002
EfficientNet-B7	0.771	0.772	0.923	0.754	0.762	0.906	0.676	0.873	0.768	0.699	0.79	0.001
SimCLR, ResNet-50	**0.794**	0.77	0.896	0.739	0.77	**0.911**	0.677	0.885	0.787	0.652	0.788	-0.001
RadImageNet, ResNet50	0.758	0.744	0.87	0.795	0.767	0.899	0.686	0.889	0.774	0.688	0.787	-0.002
ConvNeXt V2, large	0.743	**0.809**	0.911	0.751	0.781	0.902	0.656	0.882	0.789	0.643	0.787	-0.002
MedicalNet, ResNet34	0.771	0.767	0.883	0.781	0.782	0.899	0.671	0.885	0.766	0.657	0.786	-0.003
ResNet-34	0.763	0.74	0.895	0.765	0.791	0.889	0.643	0.886	**0.814**	0.644	0.783	-0.006
BarlowTwins, ResNet-50	0.737	0.749	0.889	0.749	0.785	0.886	0.701	0.875	0.785	0.674	0.783	-0.006
VGG-16	0.743	0.735	0.918	0.752	0.768	0.878	0.657	0.877	0.801	0.697	0.783	-0.006
RadImageNet, InceptionRes-Net-V2	0.758	0.742	0.876	0.701	0.761	0.899	0.683	0.873	0.774	**0.734**	0.78	-0.009
MoCo V3, ResNet-50	0.764	0.777	0.897	0.684	0.768	0.906	0.679	0.879	0.81	0.635	0.78	-0.009
DenseNet-161	0.78	0.735	0.909	0.697	0.795	0.89	0.669	0.884	0.803	0.631	0.779	-0.01
RadImageNet, DenseNet-121	0.745	0.784	0.866	0.749	0.784	0.899	0.664	0.874	0.764	0.662	0.779	-0.01
MedicalNet, ResNet-18	0.744	0.748	0.882	0.748	0.758	0.899	0.671	0.881	0.761	0.681	0.777	-0.012
MedicalNet, ResNet-50	0.739	0.725	0.866	0.747	0.775	0.897	0.619	0.876	0.795	0.712	0.775	-0.014
RadImageNet, Inception-V3	0.741	0.749	0.874	0.742	0.757	0.899	0.644	0.873	0.738	0.675	0.769	-0.02

ΔAUC denotes the mean difference to the standard "Hand-crafted, 3-D, All" model. Models with the highest AUC for each dataset were marked in bold.