Lesion Type	Average Precision			
	AlexNet	ResNet	MTL	Ensemble
alopecia	0.763	0.845	0.843	**0.855**
comedones	0.687	0.817	**0.861**	0.858
crust	0.677	0.783	0.794	**0.807**
cyst	0.461	0.625	0.698	**0.702**
edema	0.633	0.707	0.751	**0.758**
erosion/ulcer/atrophy	0.774	0.850	0.867	**0.873**
erythema/erythroderm	0.742	0.820	**0.844**	0.843
eryth.-squam. plaque	0.496	0.658	0.683	**0.690**
erythematous papule	0.767	0.846	0.857	**0.861**
erythematous plaque	0.538	0.670	0.704	**0.708**
excoriation	0.467	0.605	0.635	**0.651**
hyperkeratosis	0.643	0.772	0.796	**0.802**
hyperpig. papule	0.589	0.690	**0.738**	0.730
hyperpig. plaque	0.473	0.637	**0.675**	**0.675**
macule	0.619	0.742	**0.780**	0.777
nodule	0.704	0.793	0.813	**0.820**
oozing	0.497	0.595	**0.674**	0.663
other papule	0.344	0.559	0.600	**0.603**
pearly papule	0.716	0.849	0.875	**0.879**
other plaque	0.331	0.553	0.549	**0.562**
scar	0.521	0.690	**0.728**	0.726
squames/scales	0.591	0.704	**0.748**	0.746
telangiectasis	0.655	0.821	0.837	**0.848**
tumour	0.598	0.728	0.768	**0.770**
vesicular/pustular	0.664	0.792	0.814	**0.823**
mAP-class	0.598	0.726	0.757	**0.761**
mAP-image	0.704	0.778	0.792	**0.798**

Table 1: Skin lesion classification results. “AlexNet” and “ResNet” are trained using skin lesion labels only. “MTL” is the proposed method. An ensemble of “ResNet” and “MTL” is given under “Ensemble”.

a slight performance gain is reasonable.

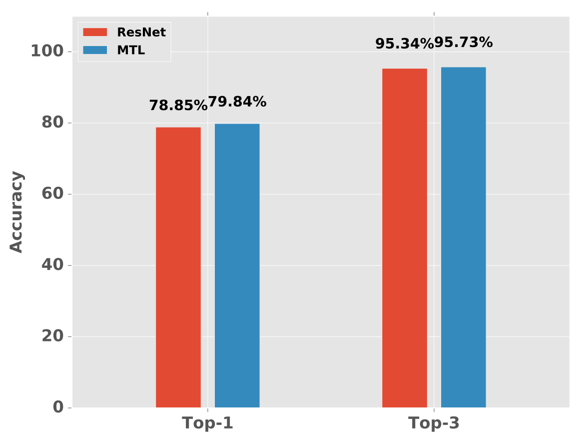

Figure 4: Body location classification results. “ResNet” is trained using body location only and “MTL” is the proposed multi-task learning method.

Conclusions

We have developed a deep multi-task learning framework for universal skin lesion classification. The proposed method learns skin lesion classification and body location classification in parallel based on the state-of-the-art CNN architecture. To be able to learn a wide variety of lesional characteristics and classify all kinds of lesion types, we have also collected and built a large-scale skin lesion dataset using images from DermQuest. The experimental results have shown that 1) Training using the state-of-the art CNN architecture on a large scale of skin lesion dataset leads to a universal skin lesion classification system with good performance. 2) It is indeed beneficial to use the body location classification as an auxiliary task and train a deep multi-task learning based model to achieve improved skin lesion classification. 3) An ensemble of the proposed method and its standalone counterpart can achieve an image-wise mAP as high as 0.80. 4) The performance of body location classification is also improved under the deep multi-task learning framework. 5) It is also confirmed by the obtained image retrieval and attention that the trained model not only learns the lesional features very well but also knows generally where to pay attention to. Our future work includes integrating the image analysis with other patient information to build an overall high-performance diagnosis system for diseases with skin lesion symptoms.

Acknowledgments

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