Skin Lesion Classification by Transfer Learning Using a Multi-Scale and Multi-Network Ensemble

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Introduction

- Skin cancer is among the most common cancer types
- The diagnostic process starts with inspection and categorization of skin lesion images
- Deep learning-based approaches and more specifically, fine-tuned convolutional neural networks (CNN) are the state-of-the-art computerized methods for skin lesion image classification
- To fine-tune a CNN, image cropping or down-sampling are common pre-processing steps, but their impact on the classification performance has never been systematically investigated

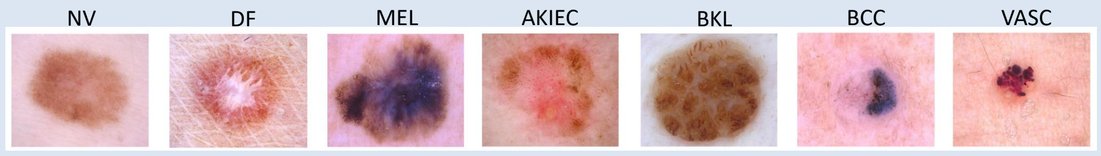
Summary

- We systematically studied the effects of the image size on the performance of skin lesion classification. Our results showed that with cropping strategy, image size factor does not have a large-scale impact on classification results
- We compared a cropping strategy with a resizing strategy for classifying skin lesion images and showed that cropping is a better strategy than image resizing
- We proposed a multi-scale multi-CNN (MSM-CNN) approach with an excellent classification performance, yielding a balanced multi-class accuracy of 86.2% on the ISIC 2018 test set

Method

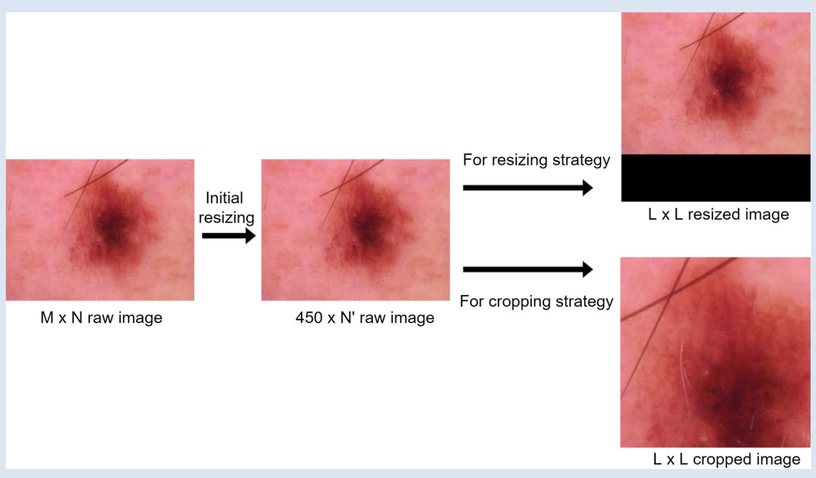
Dataset

- Training set: 12,927 images from ISCI archive [1]
- Test set: 1,512 images from ISIC 2018 test set
- Seven skin lesion classes: melanocytic nevus (NV), dermatofibroma (DF), malignant melanoma (MEL), actinic keratosis (AKIEC), benign keratosis (BKL), basal cell carcinoma (BCC), and vascular lesion (VASC)



Pre-processing

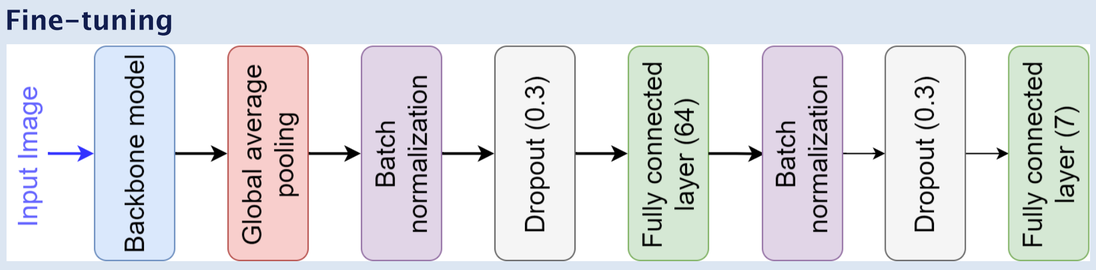
- Applying gray world color constancy algorithm to normalize color
- Subtracting mean intensity RGB value of ImageNet dataset
- Initial resizing with preserving aspect ratio
- Cropping or resizing to six different resolutions: 224x224, 240x240, 260x260, 300x300, 380x380, and 450x450 pixels



Pre-trained CNNs

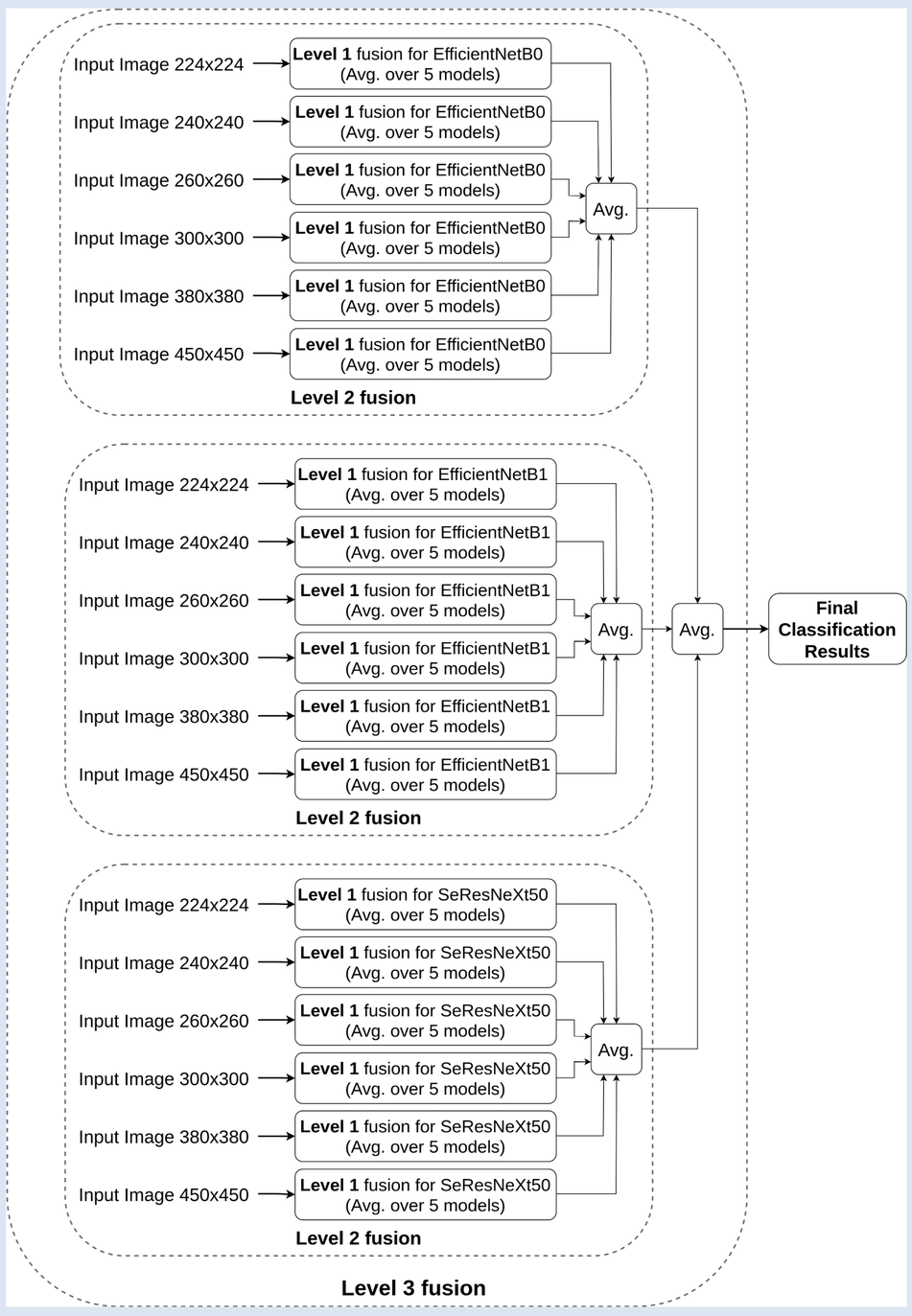
- EfficientNetB0
- EfficientNetB1
- SeResNeXt-50

Fine-tuning



MSM-CNN with three-level fusion

- Fusing results of 90 sub-models



Evaluation

- Balanced multi-class accuracy (BMCA)

Results

Classification performance (BMCA in %) of EfficientNetB0 comparing cropping and resizing strategy

Strategy/Size	224	240	260	300	380	450	Avg.
Resizing	75.3	76.1	76.1	77.3	80.3	80.8	77.6
Cropping	83.0	84.3	83.3	83.3	83.6	83.6	83.5

Classification performance (BMCA in %) of different pre-trained CNNs using cropping strategy

Model / Size	224	240	260	300	380	450	Avg.
EfficientNetB0	83.0	84.3	83.3	83.3	83.6	83.6	83.5
EfficientNetB1	84.4	83.9	84.0	82.7	81.8	81.4	83.0
SeResNeXt-50	79.5	79.9	80.9	80.3	82.9	82.3	80.9

Classification performance (BMCA) for level 2 and level 3 (final) fusion schemes

Network	Size	BMCA (%)
level 2 fusion - EfficientNetB0	All sizes	84.6
level 2 fusion - EfficientNetB1	All sizes	84.6
level 2 fusion - EfficientNetB1	All sizes	83.3
level 3 fusion - MSM-CNN	All sizes	86.2

- Our MSM-CNN algorithm currently is the 4th ranked algorithm on the live leaderboard of the ISIC 2018 challenge among more than 12,000 submissions [2,3]
- Applied on the ISIC 2017 test set, a similar approach delivered state-of-the-art classification performance with an average AUC of 92.9% [4]

References

[1] https://www.isic-archive.com/#!/topWithHeader/wideContentTop/main
[2] https://challenge.isic-archive.com/leaderboards/live
[3] Mahbod et al: Transfer learning using a multi-scale and multi-network ensemble for skin lesion classification, CMPB, 2020
[4] Mahbod et al: Investigating and Exploiting Image Resolution for Transfer Learning-based Skin Lesion Classification, ICPR, 2020

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