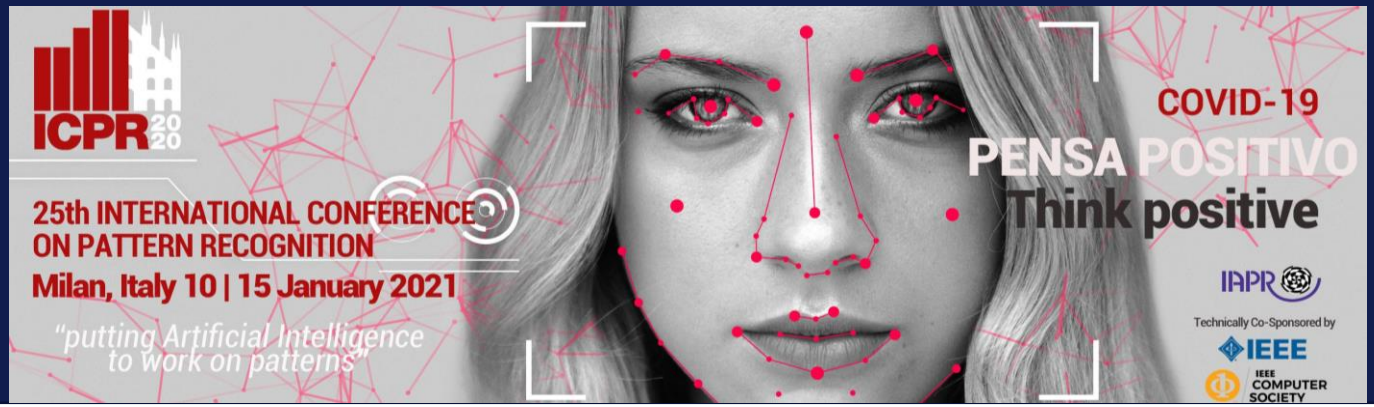
Investigating and Exploiting Image Resolution for Transfer Learning-based Skin Lesion Classification

Mahbod A [1], Schaefer G [2], Wang C [3], Ecker R [4], Dorffner G [5], Ellinger I [1]

[1] Institute for Pathophysiology and Allergy Research, Medical University of Vienna, Vienna, Austria
[2] Department of Computer Science, Loughborough University, U.K
[3] Department of Biomedical Engineering and Health System, Division of Biomedical Imaging, KTH Royal Institute of Technology, Stockholm, Sweden
[4] Department of Research and Development, TissueGnostics GmbH, Vienna, Austria
[5] Section for Artificial Intelligence and Decision Support, Medical University of Vienna, Vienna, Austria



Introduction

- Skin cancer is among the most common cancer types

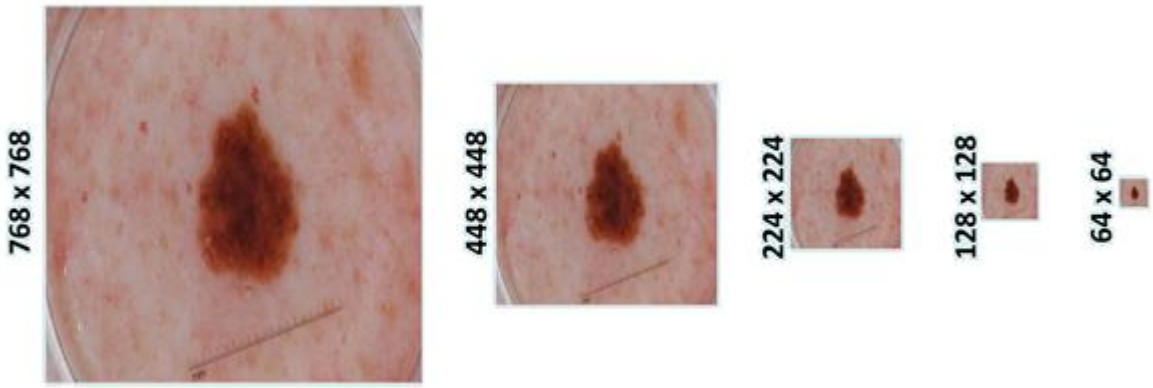
- Automated skin lesion classification is typically addressed using fine-tuned convolutional neural networks (CNNs)

- To fine-tune a CNN, image down-sampling is a common pre-processing step, but:

  - What is the proper down-sampling factor?
  - Is it useful to exploit images with different sizes for fine-tuning?

Aims

- Analyze the **effect of image size** on **skin lesion classification performance**



- Develop a **multi-scale and multi-network fusion approach** for skin lesion classification

Method

- **Dataset**
  - **Training set:** 2,187 images from ISIC 2016 and ISIC 2017 challenge datasets [1]
  - **Test set:** 600 images from ISIC 2017 test set
  - **Three skin lesion classes:** malignant melanoma (MM), Seborrheic Keratosis (SK), and Benign nevi (BN)

MM SK BN

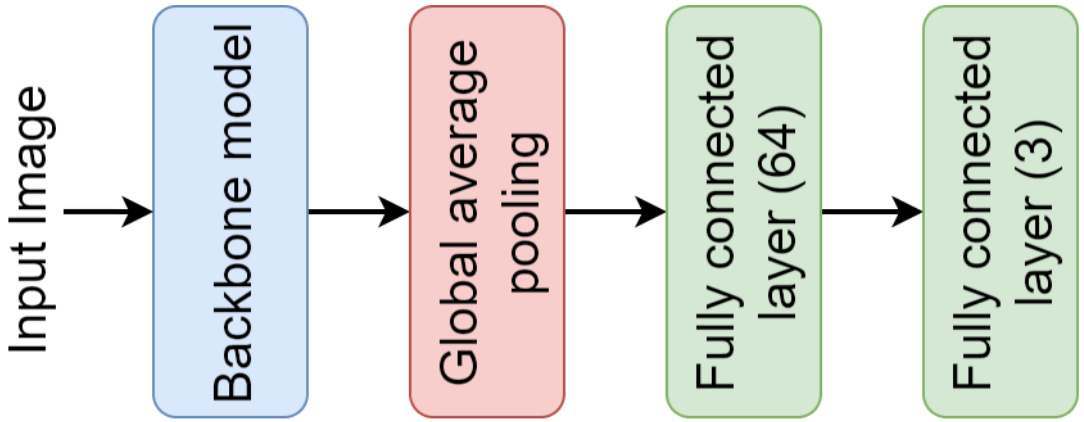
Reference
[1] https://isic-archive.com/

Method

- **Pre-processing**
  - Gray world color constancy normalization
  - ImageNet mean intensity subtraction
  - Offline data augmentation by rotation and flipping
  - Resizing:
    - ✓ 64 x 64 pixels
    - ✓ 128 x 128 pixels
    - ✓ 224 x 224 pixels
    - ✓ 448 x 448 pixels
    - ✓ 768 x 768 pixels

Method

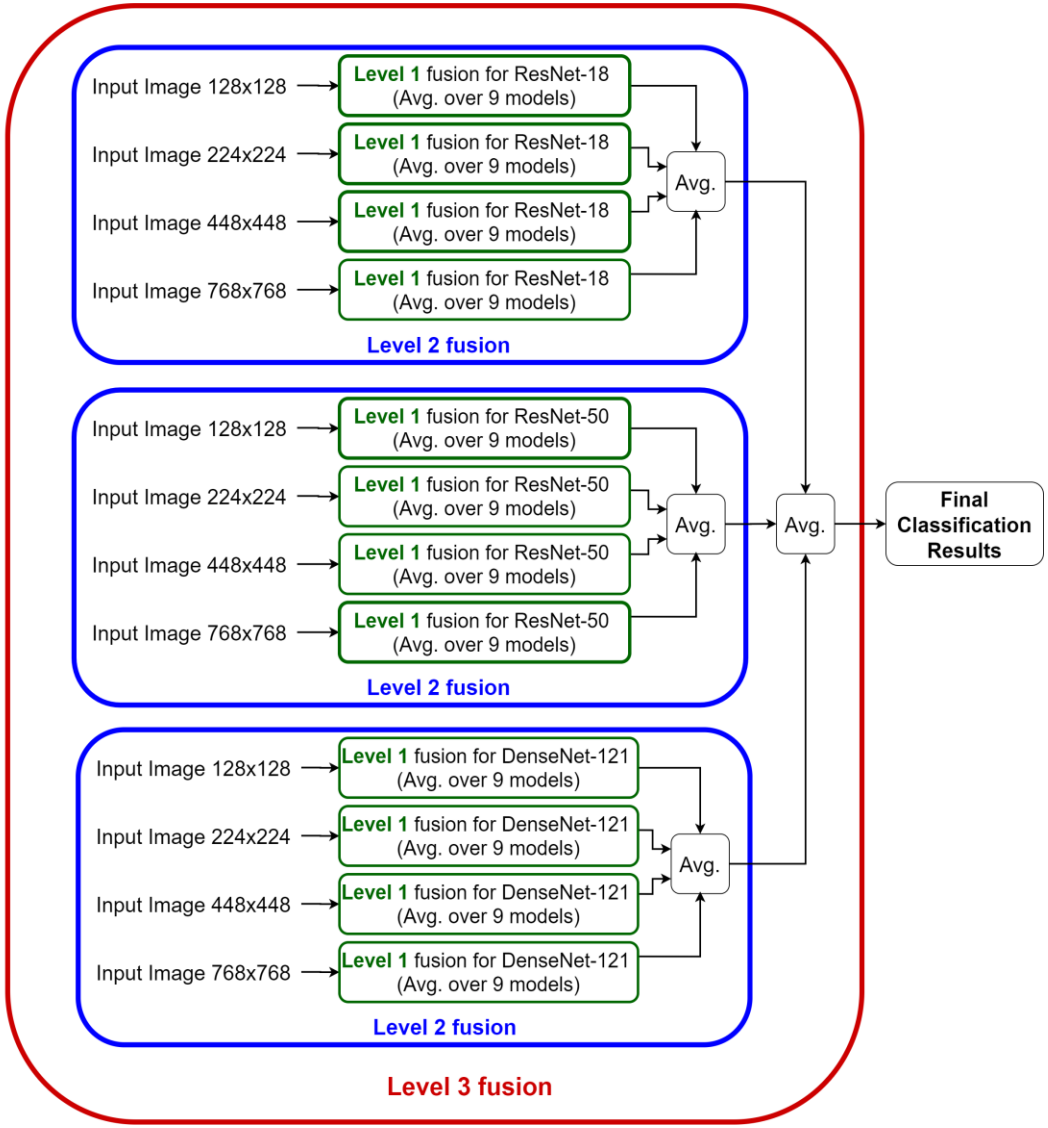
- **Fine-tuning pre-trained CNNs**
  - ResNet-18 [2]
  - ResNet-50 [2]
  - DenseNet-121 [3]



References
[2] He et al: Deep Residual Learning for Image Recognition, CVPR, 2016
[3] Simonyan et al: Densely Connected Convolutional Networks, CVPR, 2017

Method

- 3-Level fusion
  - Level 1
  - Level 2
  - Level 3



Evaluation

- **Area under the curve (AUC)** for two classification problems namely MM vs. all task and SK vs. all classification task (identical to the ISIC 2017 challenge evaluation index)

Results

Classification performance (area under the curve, AUC in %) of ResNet-18 for different image sizes based on level 1 fusion

Size (pixels)	MM AUC (%)	SK AUC (%)	Avg. AUC (%)
64 x 64	78.86	89.55	84.21
128 x 128	85.46	93.39	89.42
224 x 224	85.37	93.81	89.59
448 x 448	89.20	95.54	92.37
768 x 768	88.89	95.85	92.37

- Using resized images with a size of 64 x 64 → significant drop in performance
- Using resized images with a size of larger than 128 x 128 → comparable results
- Increasing size → slight improvement in performance

Results

Classification performance (AUC in %) based on level 2 and level 3 fusion

Network	Sizes	MM AUC (%)	SK AUC (%)	Avg. AUC (%)
ResNet-18 level 2 fusion	all	89.12	96.26	92.69
ResNet-50 level 2 fusion	all	88.50	96.03	92.27
DenseNet-121 level 2 fusion	all	87.69	95.77	91.73
Level 3 fusion	**all**	**89.16**	**96.57**	**92.86**

Results

Comparison to the state-of-the-art methods

Network	Sizes	MM AUC (%)	SK AUC (%)	Avg. AUC (%)
Matsunaga *et al.* [4]	NA	86.8	95.3	91.1
Mahbod *et al.* [5]	224	87.3	95.5	91.4
Zhang *et al.* [6]	224	87.5	95.8	91.7
Yan *et al.* [7]	256	88.3	NA	NA
Three-level fusion	**all**	**89.16**	**96.57**	**92.86**

References

[4] Matsunaga et al: Image classification of melanoma, nevus and seborrheic keratosis by deep neural network ensemble, arXiv, 2017
[5] Mahbod et al: Fusing fine-tuned deep features for skin lesion classification, CMIG, 2019
[6] Zhang et al: Attention residual learning for skin lesion classification, IEEE TMI, 2019
[7] Yan et al: Melanoma recognition via visual attention, IPMI, 2019

Thank you for your attention!

amirreza.mahbod@meduniwien.ac.at

Funded by the Horizon 2020 Framework Programme of the European Union No. 675228