CNN-based Machine Learning Approaches to Skin Lesion Classification for Skin Cancer Detection and Diagnosis

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Introduction

- Skin cancer is treatable if detected early.
- Computer aided diagnostic (CAD) systems help human experts decide diagnosis.
- Convolutional Neural Networks (CNNs) are one of the Artificial Intelligence techniques inspired by biological neural networks used widely in CADs.
- CNNs predict diagnosis based on images (dermoscopy or clinical) using training data.
  - A CNN can be *trained* by feeding it a set of lesion images and their diagnosis.
  - A trained CNN can predict the diagnosis of a new lesion image it has never seen before!
  - A CNN has a depth based on the number of convolutional filters applied.
- Images may be preprocessed to improve CNN performance.

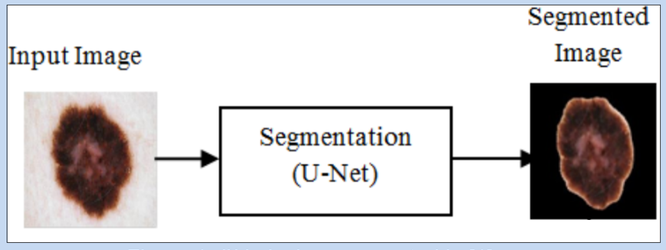

Figure 1: Skin lesion segmented in [1].

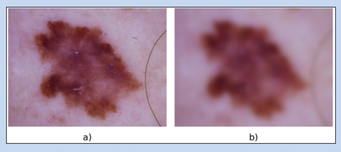

Figure 2: Applying a gaussian filter [2].

- Pre-trained CNNs are very popular.
  - Transfer learning!
  - GoogLeNet, VGGNet, ResNet, AlexNet, …

Method 1: Dermatologist-level classification of skin cancer with deep neural networks

- Maps individual diseases into training classes using a new disease taxonomy and a disease partitioning algorithm.

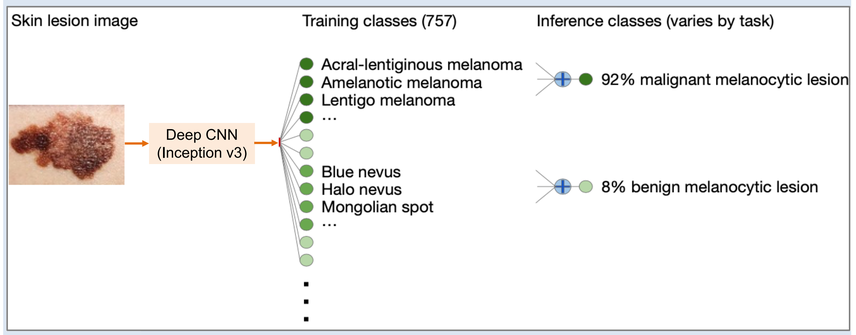

Figure 3: Classification example [3].

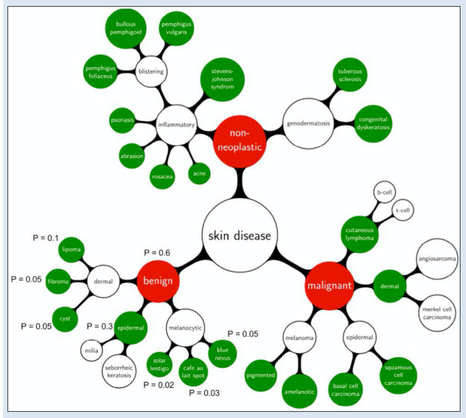

Figure 4: Subset of the disease taxonomy and calculating inference class probabilities from training class probabilities [3].

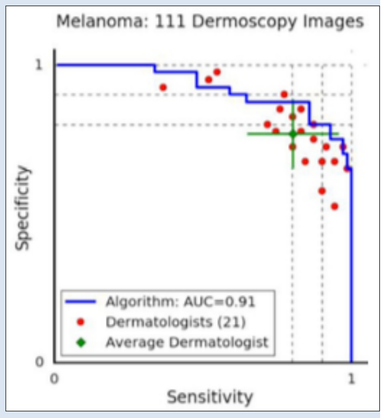

Figure 5: Skin cancer classification performance of the dermatologists and the CNN [3].

Method 2: Attention Residual Learning for Skin Lesion Classification

- Preprocesses images.
- Pays more attention to semantically important regions.

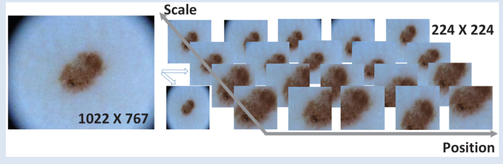

Figure 6: Multi-scale patch extraction result [4].

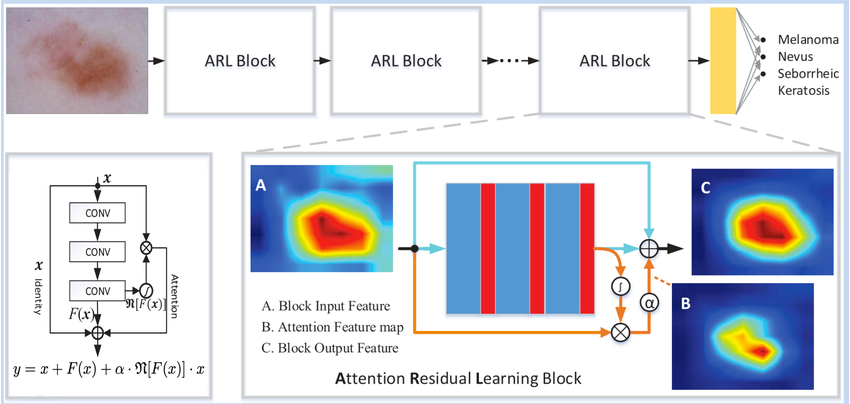

Figure 7: Proposed ARL block and the ARL-CNN architecture [4].

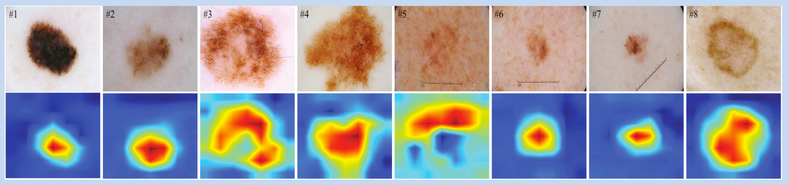

Figure 8: A set of dermoscopy images (top) and a qualitative evaluation of the ARL-CNN50's classification result using Class Activation Mapping (CAM) technique [5] (bottom); red areas are regions determined by the CNN to be most relevant to its classification result [4].

Discussion and Conclusion

- Method 1
  - More generalizable.
  - Outperforms dermatologists!
- Method 2
  - Works with small samples.
  - No high computational cost.
- Automated approaches such as CNNs, aids human experts present fast and reliable decisions to patients.

References

[1] R. Seeja and A. Suresh, "Deep learning based skin lesion segmentation and classification of melanoma using support vector machine (svm)," Asian Pacific journal of cancer prevention: APJCP, vol. 20, no. 5, p. 1555, 2019.

[2] J.-A. Almaraz-Damian, V. Ponomaryov, S. Sadovnychiy, and H. Castillejos-Fernandez, "Melanoma and nevus skin lesion classification using handcraft and deep learning feature fusion via mutual information measures," Entropy, vol. 22, no. 4, p. 484, 2020.

[3] A. Esteva, B. Kuprel, R. A. Novoa, J. Ko, S. M. Swetter, H. M. Blau, and S. Thrun, "Dermatologist-level classification of skin cancer with deep neural networks," nature, vol. 542, no. 7639, pp. 115–118, 2017.

[4] J. Zhang, Y. Xie, Y. Xia, and C. Shen, "Attention residual learning for skin lesion classification," IEEE transactions on medical imaging, vol. 38, no. 9, pp. 2092–2103, 2019.

[5] B. Zhou, A. Khosla, A. Lapedriza, A. Oliva, and A. Torralba, "Learning deep features for discriminative localization," in Proceedings of the IEEE conference on computer vision and pattern recognition, pp. 2921–2929, 2016.