CHU de Nantes

Analysis of the winning submission to the ISIC 2019 classification challenge

04/05/2020 – Romain GOUSSAULT

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Context

- Melanoma
  - Most deadly form of skin cancer
  - With early detection → the 5 year survival rate is 99%
  - Delayed diagnosis, the 5 year survival rate: 23%

- Importance to perform early detection
  - Difficulty accessing doctors (dermatologist)
  - AI systems out-perform dermatogist since 2017 [1]

- ISIC challenge:
  - Recurrent challenge since 2016
  - Classification or segmentation of skin lesions images
  - Cash prize: 14 000$

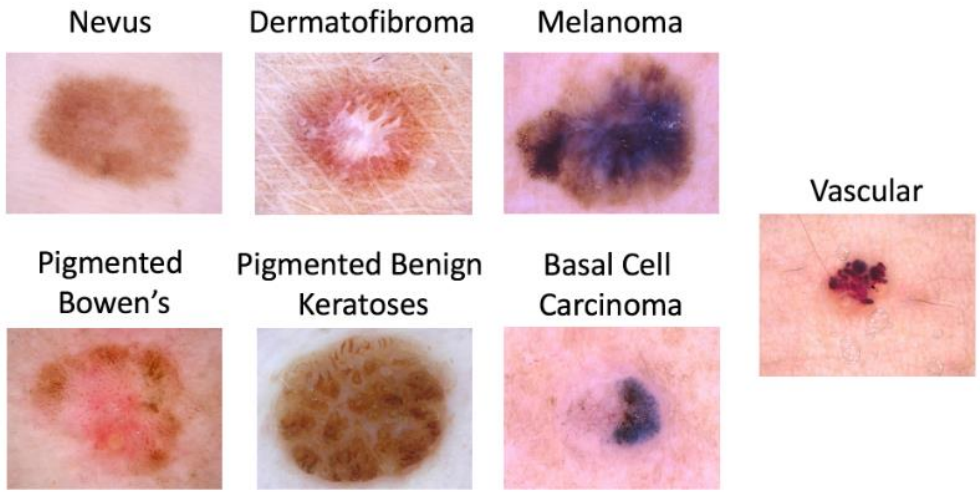
[1] Esteva, A., Kuprel, B., Novoa, R. et al. Dermatologist-level classification of skin cancer with deep neural networks. Nature 542, 115–118 (2017). https://doi.org/10.1038/nature21056

Dataset

- **Training set**: 25 000 images across **8 classes** + metadata (age, sex, etc). [1, 2, 3]
- **Test set**: 8000 images across **9 classes** + metadata (age, sex, etc).

- **Imbalanced dataset**:

Class name	MEL	NV	BCC	AK	BKL	DF	VASC	SCC	UNK
#image	4522	12875	3323	867	2624	239	253	628	0
Ratio	0.178	0.508	0.13	0.03	0.1	0.009	0.01	0.024	0



- **Metric**: balanced multi-class accuracy.

[1] Tschandl P., Rosendahl C. & Kittler H. The HAM10000 dataset, a large collection of multi-source dermatoscopic images of common pigmented skin lesions. Sci. Data 5, 180161 doi.10.1038/sdata.2018.161 (2018)
[2] Noel C. F. Codella, David Gutman, M. Emre Celebi, Brian Helba, Michael A. Marchetti, Stephen W. Dusza, Aadi Kalloo, Konstantinos Liopyris, Nabin Mishra, Harald Kittler, Allan Halpern: "Skin Lesion Analysis Toward Melanoma Detection: A Challenge at the 2017 International Symposium on Biomedical Imaging (ISBI), Hosted by the International Skin Imaging Collaboration (ISIC)", 2017; arXiv:1710.05006.
[3] Marc Combalia, Noel C. F. Codella, Veronica Rotemberg, Brian Helba, Veronica Vilaplana, Ofer Reiter, Allan C. Halpern, Susana Puig, Josep Malvehy: "BCN20000: Dermoscopic Lesions in the Wild", 2019; arXiv:1908.02288.

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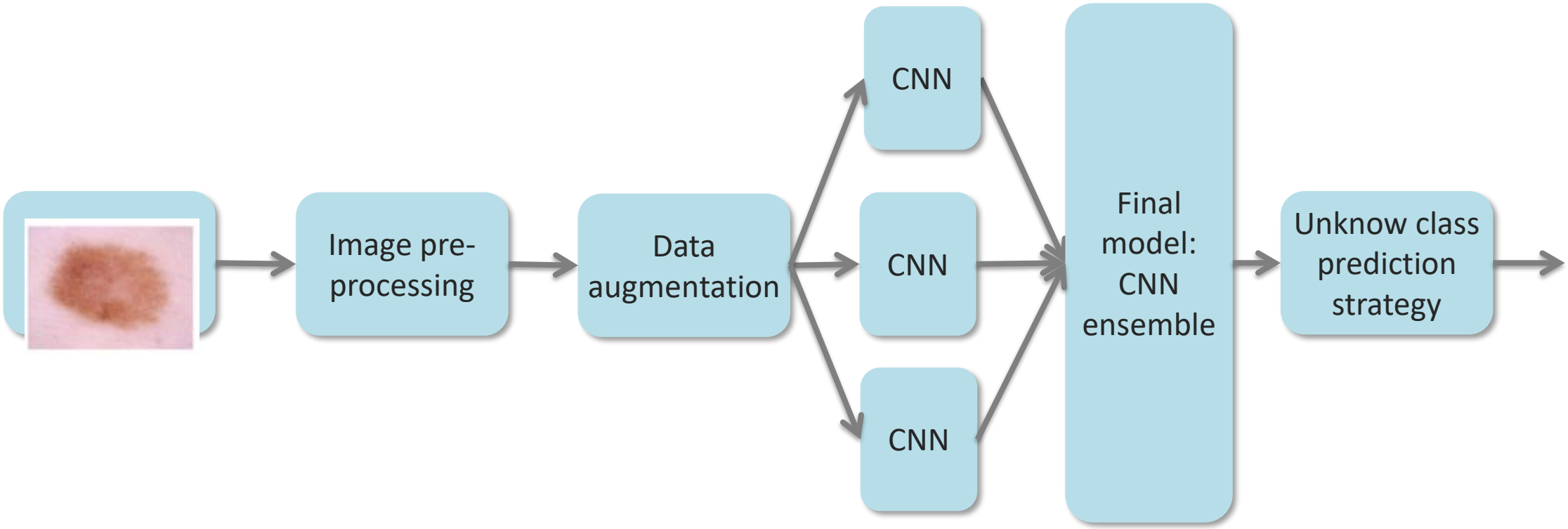
Overview



We will study the winning solution (from Hamburg University of Technology [1])

[1] Gessert N., Nielsen M., Shaikh M., Werner R., Schlaefer A. Skin Lesion Classification Using Loss Balancing and Ensembles of Multi-Resolution EfficientNets. arXiv preprint arXiv:1910.03910 (2019)

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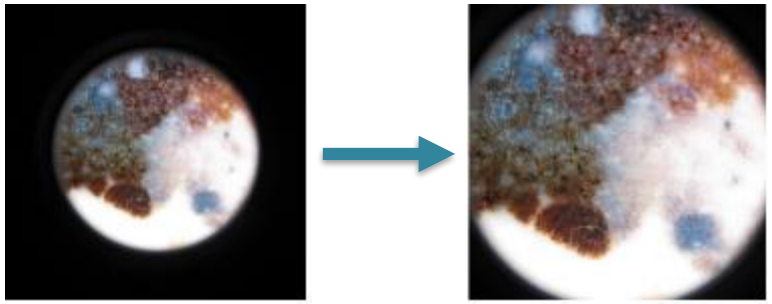
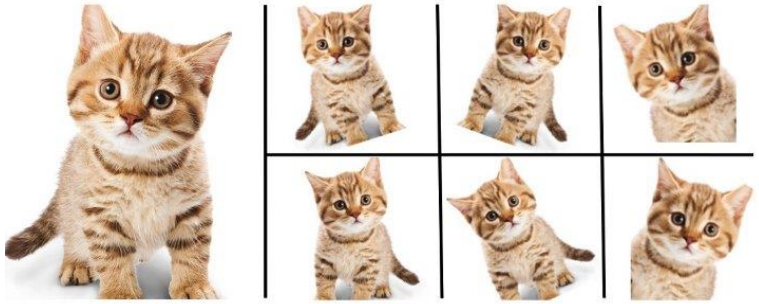
Image pre-processing & data augmentation

- Image pre-processing:
  - Different size of input images: 600 x 450, 1024 x 1024 → Resize to 600*450 while keeping aspect ratio
  - Cropping black part of some images :



- Data augmentation:
  - Transformation:
    - Random cropping
    - Vertical and Horizontal flipping
    - Rotation
    - Color Transformation

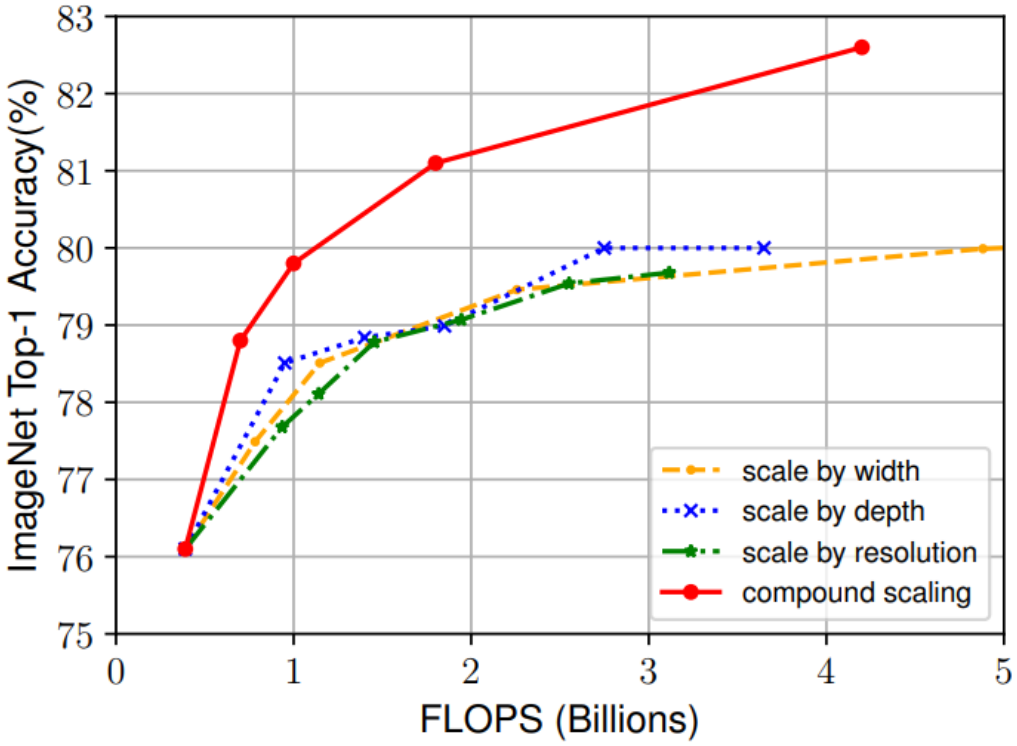


  - Cutout → remove some part of the image
  - Noise addition

CNN – EfficientNets, EfficientNets, and EfficientNets [1]

- EfficientNet B0 → baseline architecture that was optimized for both accuracy and FLOPS

- **Compound scaling method**: scaling method that uniformly scales all dimensions of :
  - Depth
  - Width (number of channels)
  - Resolution (image size)



[1] Tan, M., Le, Q.V. (2019) Efficientnet: Rethinking model scaling for convolutional neural networks. arXiv preprint arXiv:1905.11946

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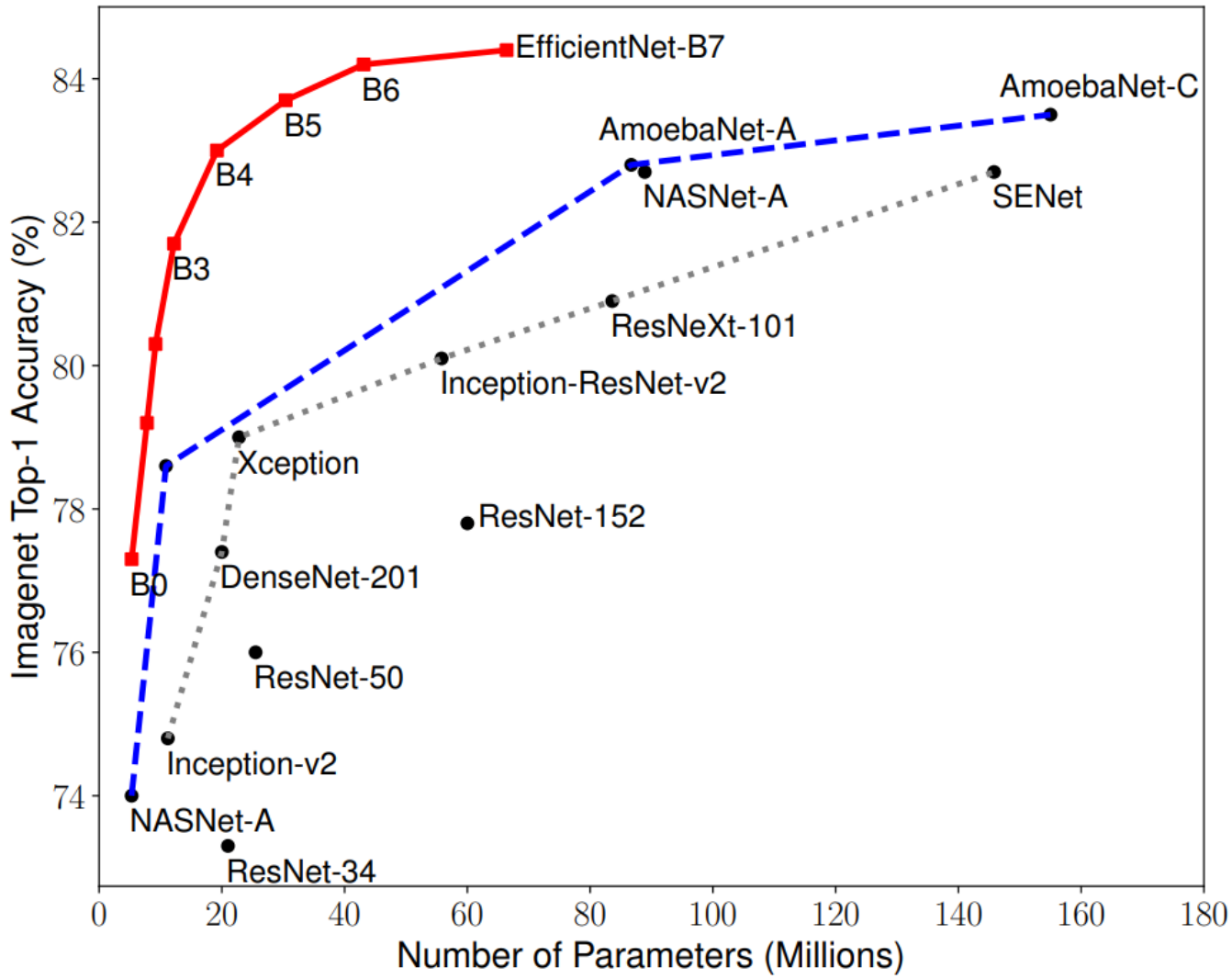
CNN – EfficientNets, EfficientNets, and EfficientNets



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Training and making predictions

- **Training**: a weighted cross-entropy loss function to deal with classes imbalance→ underrepresented classes receive a higher weight based on their frequency in the training set

- **Ensembling**: ensemble of different EfficientNet (+ one SENet154) models + different input strategies. The final ensemble is the average of 15 models.

- **Test time augmentation:** for every test image, 16 augmented images are generated. Then the softmaxed predictions are averaged.

Unknown class prediction

- Reminder: 8 classes in the training set, 8 + 1 unknown classes in the test set

- Strategies:
  - Assign image where top-1 probabilty < 35 % to the unknown class
  - Add own data in the training set to create a 9th training class
  - Out of distribution detection [1, 2]

- Hard to evaluate these stategies

[1] Vyas, A., Jammalamadaka, N., Zhu, X., Das, D., Kaul, B., Willke, T.~L.\ 2018.\ Out-of-Distribution Detection Using an Ensemble of Self Supervised Leave-out Classifiers.\ arXiv e-prints arXiv:1809.03576.
[2] Ren, J., and 7 colleagues 2019.\ Likelihood Ratios for Out-of-Distribution Detection.\ arXiv e-prints arXiv:1906.02845.

Thanks

2020 challenge will open soon

→ https://challenge2019.isic-archive.com/

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