A Scaled-2D CNN for Skin Cancer Diagnosis

Course:
ENEL 645 (Winter 2022) - Data Mining & Machine Learning

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Winter 2022

Motivation & Significance

- Cancer: leading cause of death
- Skin Cancer
  - Most diagnosed
  - Treated when diagnosed in early stages.
- 2 types of tumors: Benign / Malignant
- 3 significant sorts of skin cancer:

➔ *Computer based skin cancer diagnosis is highly efficient for non-dermatologists to classify the skin tumors from other skin oriented diseases*

- Disease diagnostics can be based on:
  - Microscopic images
  - Dermoscopic images

➔ Deep neural network trained with dermoscopic images.

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Introduction

Predict skin cancer

- Scaled 2D-CNN fine-tuned model
- Dermoscopic images from a publicly available dataset
- EfficientNet-B7 deep neural architecture with prior image pre-processing

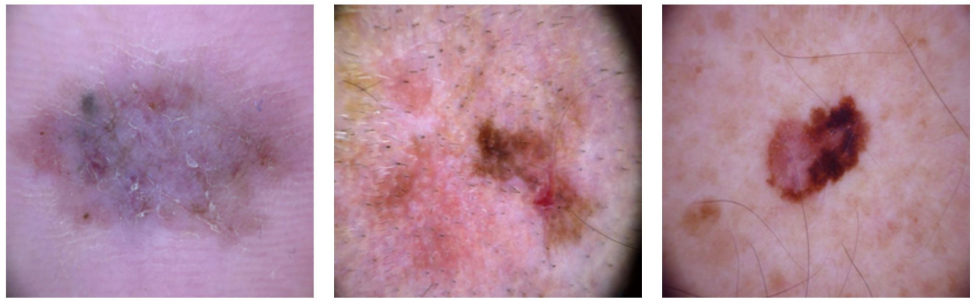
Compare the performance

- Proposed architecture
- Pre-trained deep neural networks (VGG-19, ResNet50)

Methodology - Data Collection

- The Dataset for skin cancer dermoscopic gathered from ISIC Challenge in 2017.
- The dataset has two types of tumor
- 3,637 images in two class
- 2,637 (244x244) images for two types of the tumor used for training
- 660 images for testing

a) Three individual **Benign** images are used to cascade



b) Three individual **Malignant** images are used to cascade

fig. 2.

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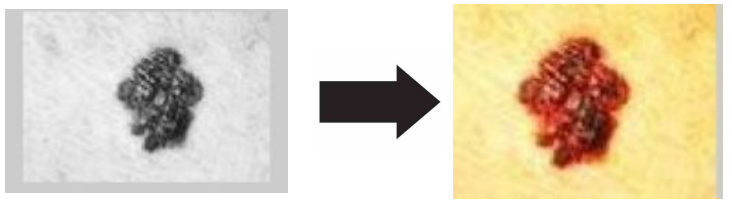
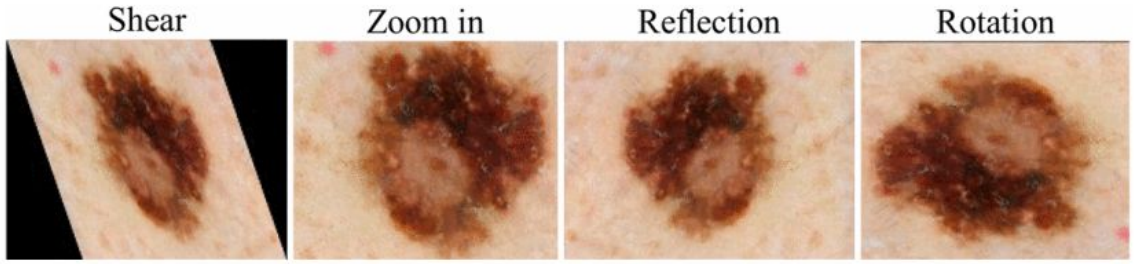
Methodology - Image Pre-processing

- **Image Resize:** Image input resized to a target of 224 x 224 to achieve uniformity.
- **Image Conversion:** Grayscale images were changed to RGB images by using average method. This is to achieve 3-input channel data for the network.
- **Image Augmentation:** Used to improve the overall performance of the network as few training data were available.



Conversion from grayscale to RGB



Same image after different types of transformation

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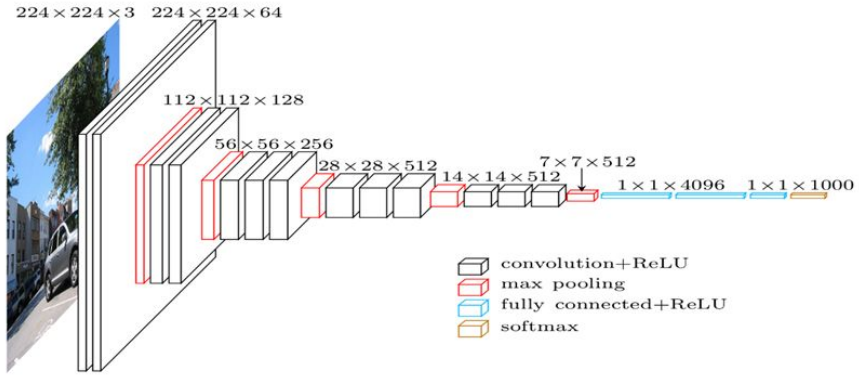
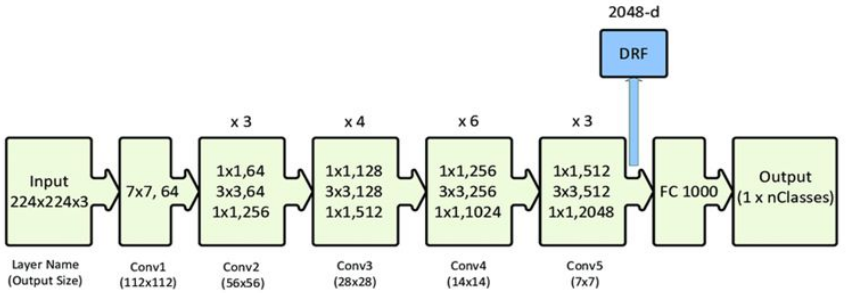
Methodology - Transfer Learning

- By using pre-trained TL methods, training time and computational complexity can reduce.
- In this study, three models were used which are mainly for the ImageNet 1000 classification problem.

EfficientNet-B7



VGG-19



ResNet-50

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Proposed Architecture - 2D-CNN

2D - Convolutional Neural Network

3 Phases:

- patch extraction → feature extraction → label identification

Feature maps computed at each layer by: $v_{i,j}^{x,y} = \mathrm{F}(b_{ij} + \sum_{m} \sum_{a=0}^{A_i-1} \sum_{b=0}^{B_i-1} w_{ijm}^{abc} v_{(i-1)m}^{(x+a)(y+b)})$

Activation Function: ReLU F(x) = max(0,x)

Final Layer:

- Global Average Pooling
- softmax
- 25% dropout

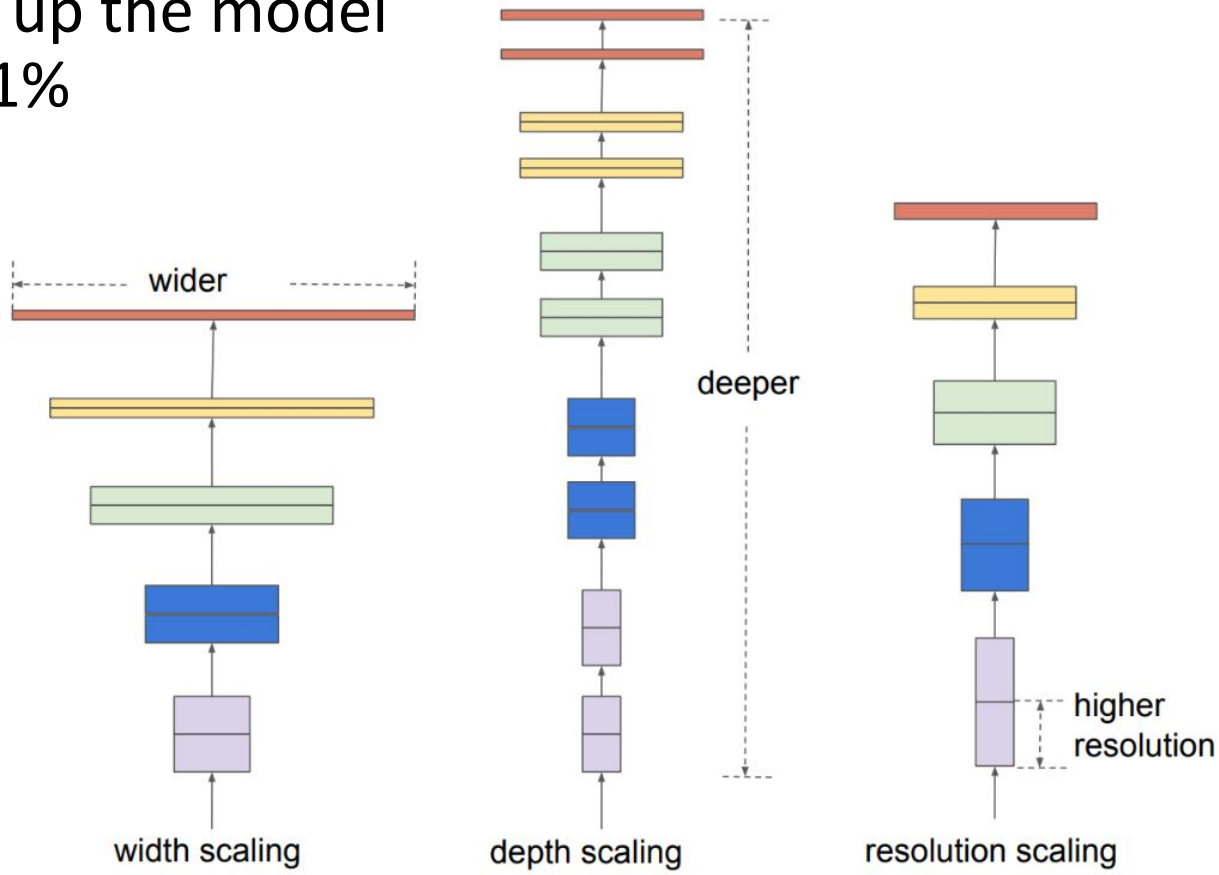
Proposed Architecture - Scaling

EfficientNet-B7 is utilized to scale up the model

- Top 5 ImageNet accuracy: 97.1%
- 6.1x faster inference
- 66M parameters
- 37B FLOPS

Compound scaling

- Depth, $d = \alpha^{\Phi}$
- Width, $w = \beta^{\phi}$
- Resolution, $r = \gamma^{\Phi}$



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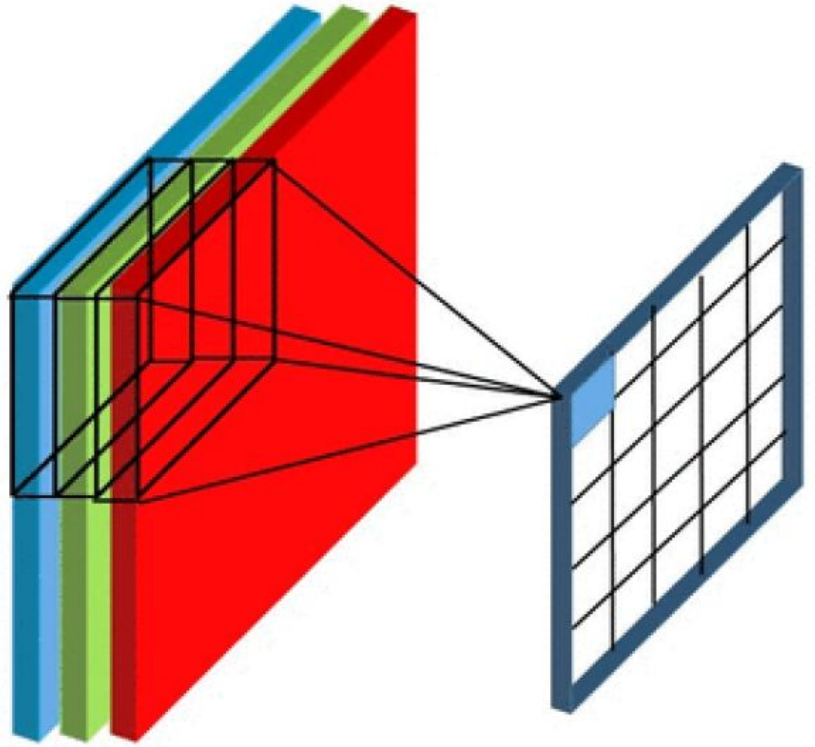
Experimental Setup and Training

- 3,297 images → 10,351 images
- 70% for training and 30% for testing
- Shape of 224 x 224 x 3
- ReLU activation
- Adam optimizer
  - Learning rate of 0.003
  - Categorical cross-entropy
- Batch size of 24
- 60 epochs
- 15,000 iterations



Experimental Results

Architectures	AUC	Accuracy	Specificity	Sensitivity	F1-Score
VGG-19	0.849	0.862	0.88	0.85	0.86
ResNet-50	0.945	0.924	0.92	0.94	0.93
Developed	**0.993**	**0.987**	**0.97**	**0.98**	**0.93**

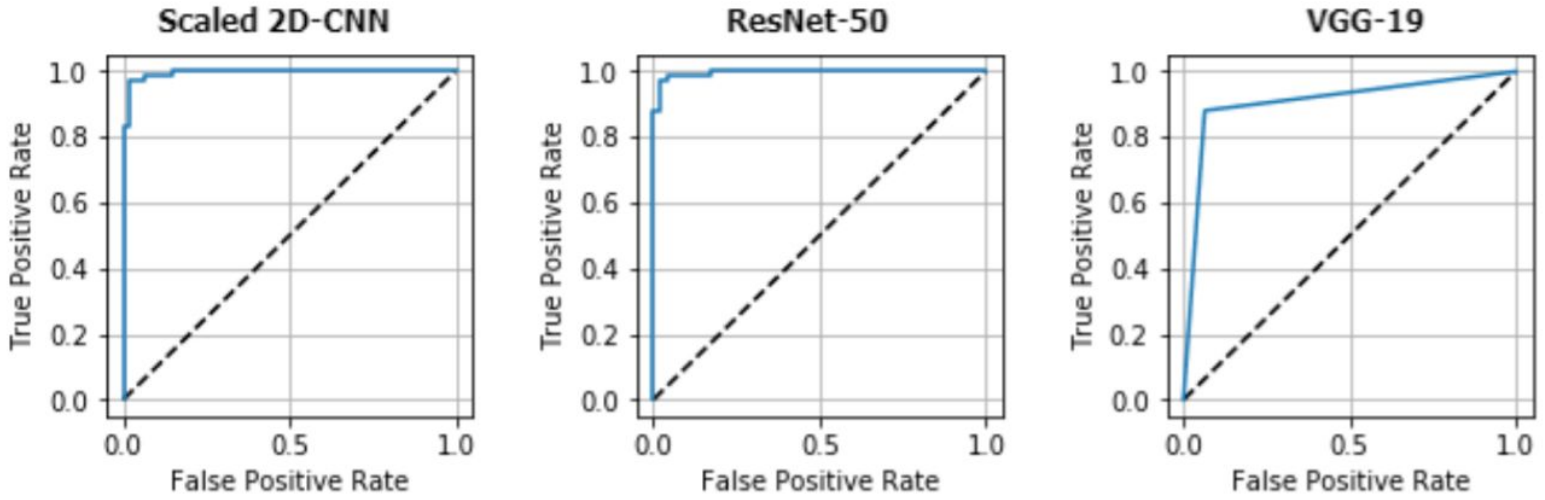


Fig. 3. ROC curve of scaled 2D-CNN model (**Developed**), ResNet-50 model and VGG-19 model.

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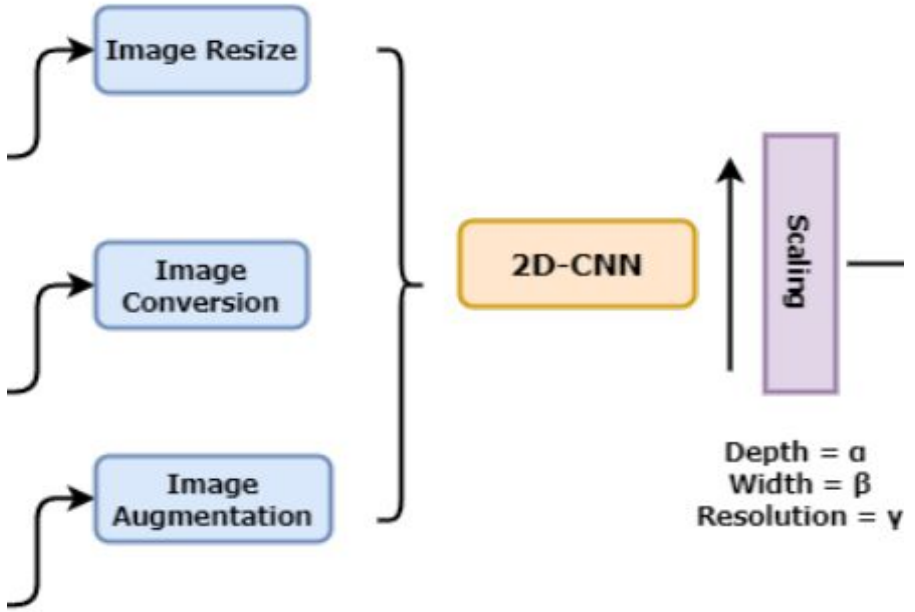
Conclusion - Methodology Strengths

- Efficient Train-Test split (80/20)
- Image resize, conversion and augmentation
- Same size (224X224) image classification
- All grayscale images to RGB
- Less training data for augmentation
- EfficientNet-B7 and ResNet-50 TL models
- Reduced time, computational complexity



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Conclusion - Methodology Limitations

- Inadequate dataset description
- Lacks detailed information on
    1. train and test set split
    2. image resize, conversion and augmentation
- Color enhancement software: expensive and time consuming
- Configuration of image augmentation was unclear
- Deciding factor in choosing Transfer Learning architectures

References

T. Hasan Rafi and R. M. Shubair, "A Scaled-2D CNN for Skin Cancer Diagnosis," 2021 IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology (CIBCB), 2021, pp. 1-6, doi: 10.1109/CIBCB49929.2021.9562888.

Paper Link: A Scaled-2D CNN for Skin Cancer Diagnosis

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