Skin Lesion Analysis Towards Melanoma Detection using Transfer Learning

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Outline

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- Motivation and Challenges
- Project Objective

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- Current State of Art
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Motivation and Challenges

-- > Skin cancer is a major public health problem, 5M newly diagnosed US each year.

-- > Melanoma is the deadliest form of skin cancer, about 9,000 deaths each year

-- > Early detection of melanoma significantly increases the survival rate

-- > However, accurate recognition of melanoma is extremely challenging due to:

1. Low contrast between lesions and skin
2. Visual similarity between melanoma and non-melanoma lesions
3. Variation of skin conditions, e.g., skin color, natural hairs or veins

Project Objective

-- > Build a model for automated diagnosis of melanoma from dermoscopic images

Problem Description

- Malignant Skin Lesions

-- Malignant Melanoma(MEL)

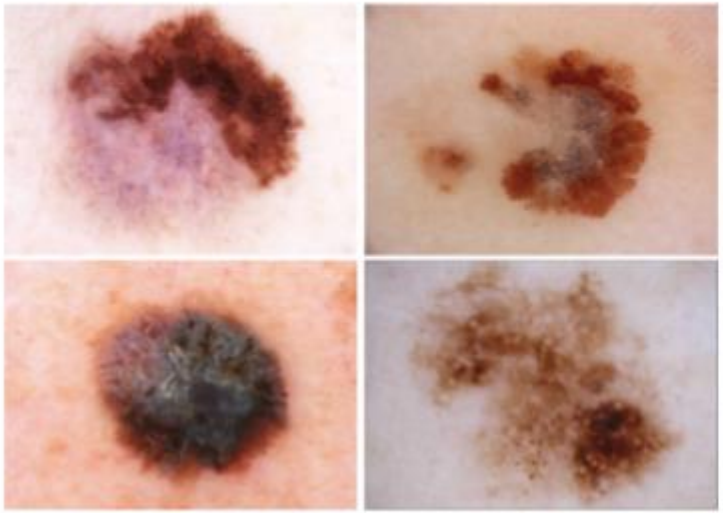
- Pre-Malignant Skin Lesions

-- Actinic keratosis (AK)

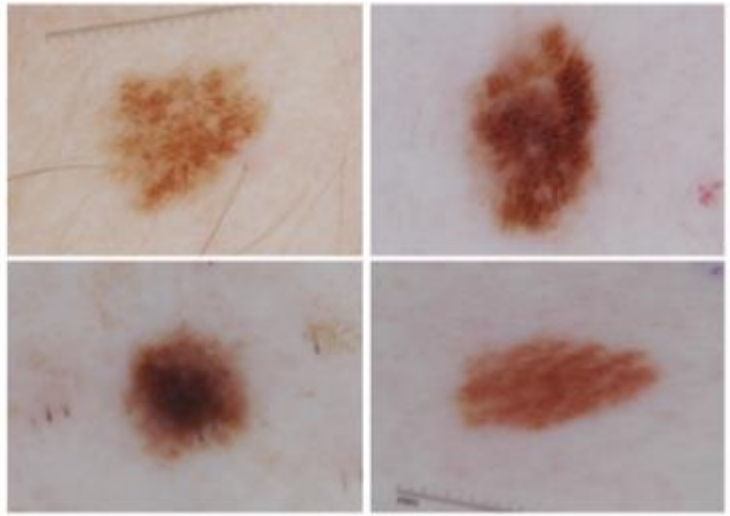
- Benign Skin Lesions

-- Seborrheic Keratosis (SK)
-- Melanocytic nevus/mole (ML)

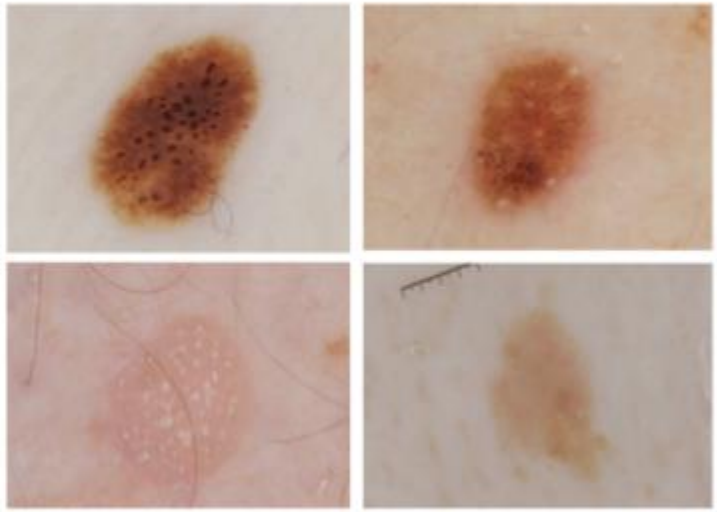
Melanoma



Nevus



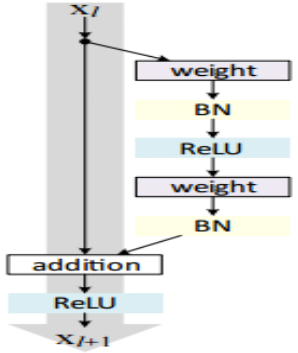
Seborrheic Keratosis



State of Art: ISIC 2017

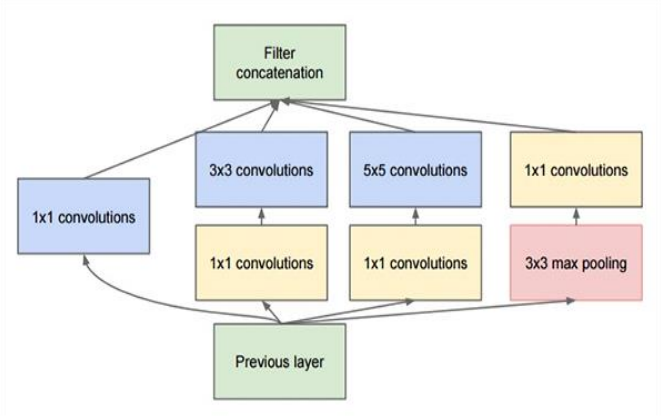
Resnet50[1]

-- Geometrically transformed images
-- Adopted 50-layer ResNet Keras
-- AUC Score: 0.957



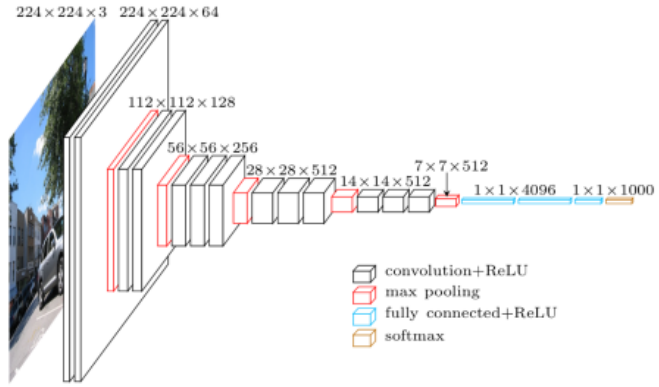
Resnet101,InceptionV3 [2]

-- Trained two model
-- Switch to 3-class
-- Use external data
-- AUC Score: 0.908



VGG16[3]

-- Data Augmented
-- Simple CNN: 18 layers
-- VGG16
-- AUC Score: 0.816

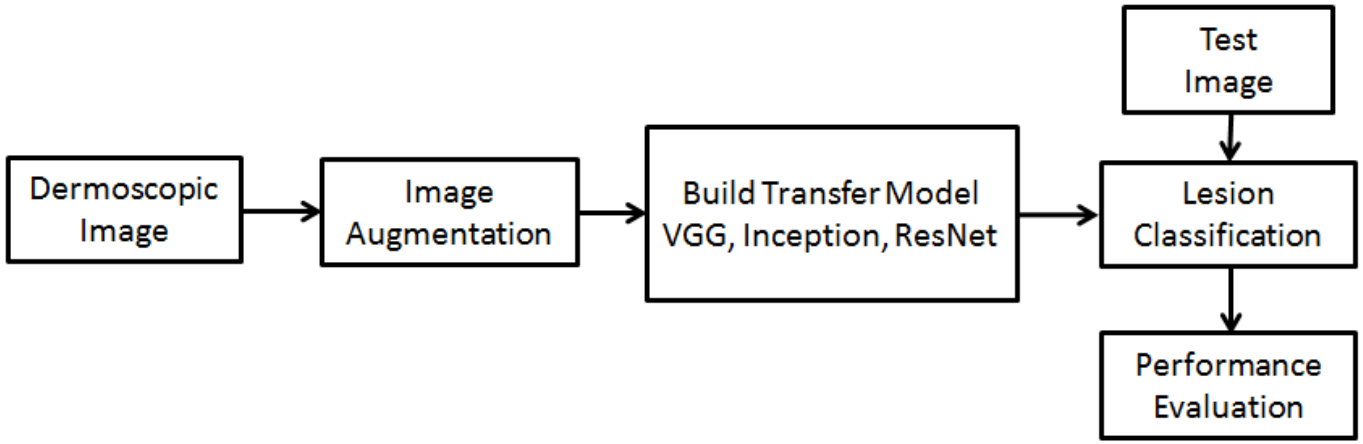


Scope of Work

-- We aimed to apply Resnet, Inception, VGG and Xception Transfer model

1 Matsunaga, Kazuhisa, Akira Hamada, Akane Minagawa, and Hiroshi Koga. "Image classification of melanoma, nevus and seborrheic keratosis by deep neural network ensemble." *arXiv preprint arXiv:1703.03108* (2017).
2. Menegola, Afonso, Julia Tavares, Michel Fornaciali, Lin Tzy Li, Sandra Avila, and Eduardo Valle. "RECOD titans at ISIC challenge 2017." *arXiv preprint arXiv:1703.04819* (2017).
3. Quang, Nguyen Hong. "Automatic skin lesion analysis towards melanoma detection." In *Intelligent and Evolutionary Systems (IES), 2017 21st Asia Pacific Symposium on*, pp. 106-111. IEEE, 2017.

Proposed Approach



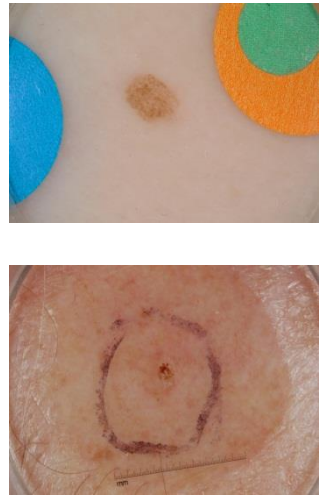
Training Image Data
-- 2000 images
-- 374(M), 254(SK), 1372(N)

Validation Image Data
-- 150 images
-- 30(M), 42(SK), 78(N)

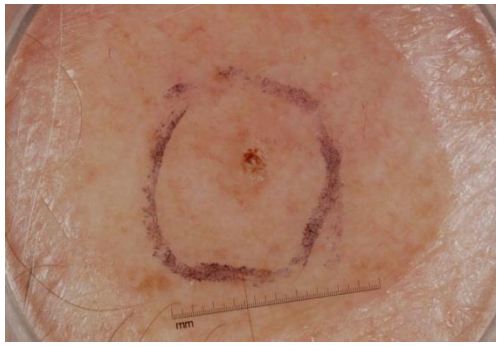
Test Image Data
-- 600 images
-- 117(M), 90(SK), 393(N)

Task-1: Melanoma Vs. Nevus and Seborrheic Keratosis

Vs.



Task-2: Seborrheic Keratosis Vs. Nevus and Melanoma



Vs.

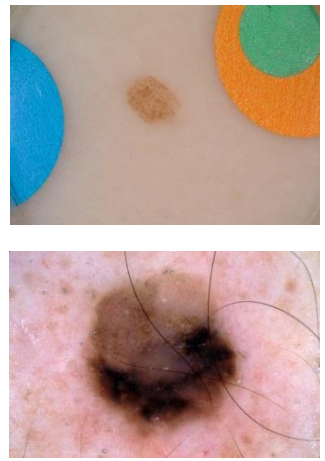


Image Augmentation

-- horizontal and vertical shifts: 10%, Zoom up to: 20% , Rotation up to: 270°
-- Images were first resized to 224X224, 299X299

Model Summary

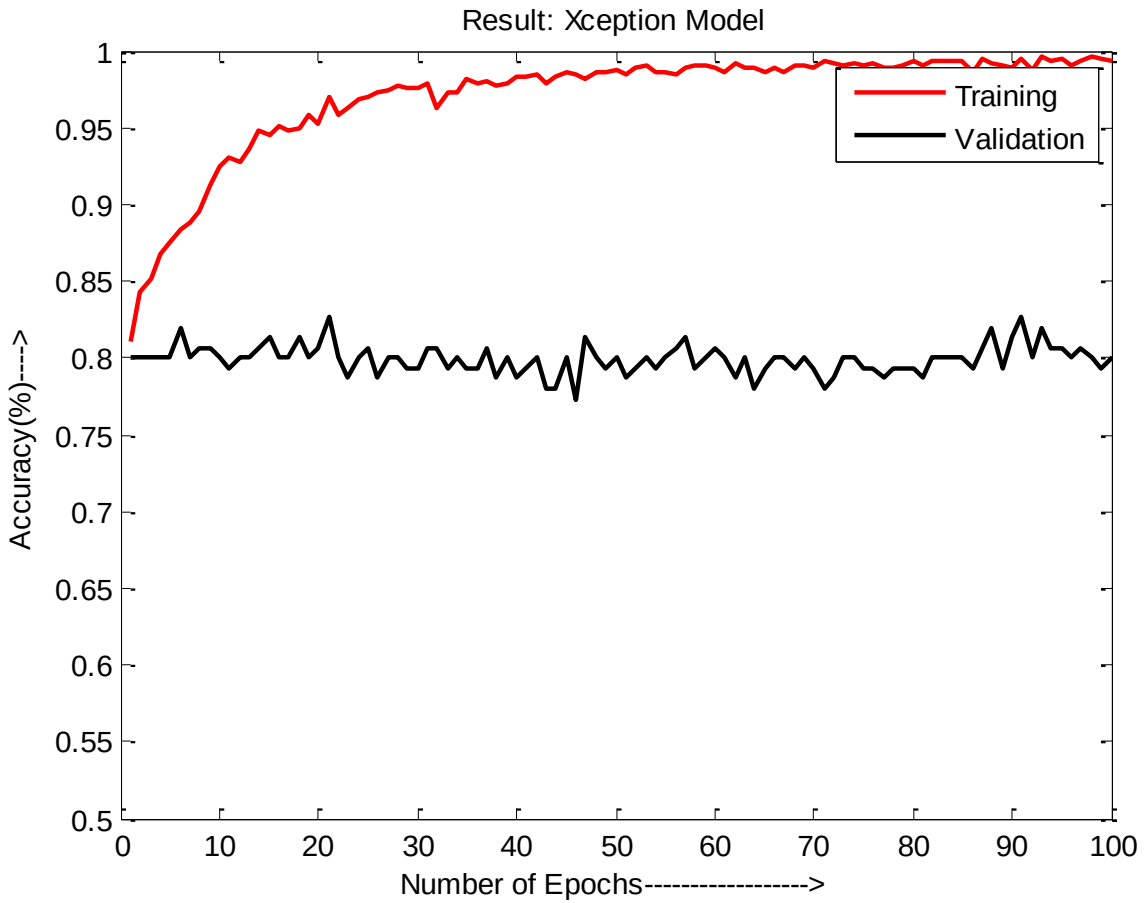
Inception V3
-- 94 (Conv 2D) layers
-- Total params: 22,327,842
-- Trainable params: 22,293,410
-- Non-trainable params: 34,432

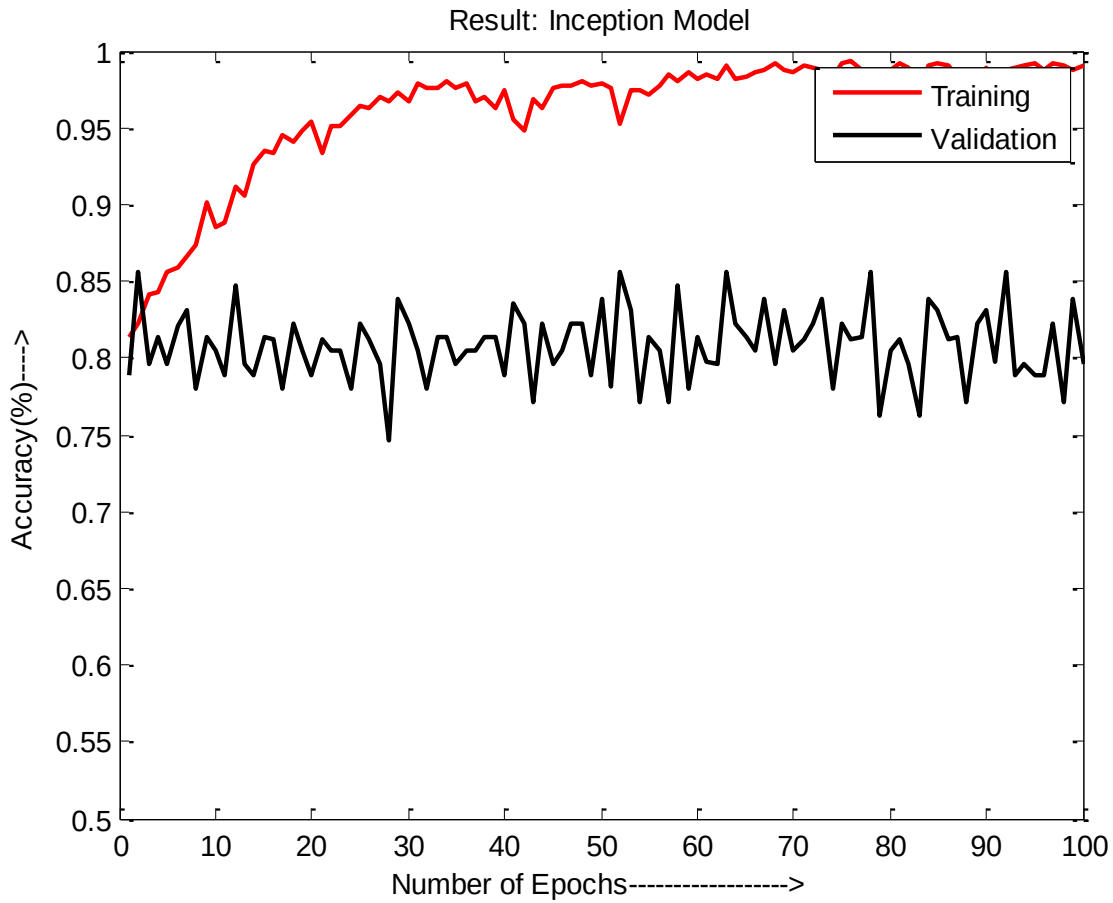
Xception
-- 14 blocks
-- Total params: 20,863,529
-- Trainable params: 6,790,433
-- Non-trainable params: 14,073,096

Resnet-50
-- 50 (Conv 2D) layeers
-- Total params: 23,589,761
-- Trainable params: 5,523,457
-- Non-trainable params: 18,066,304

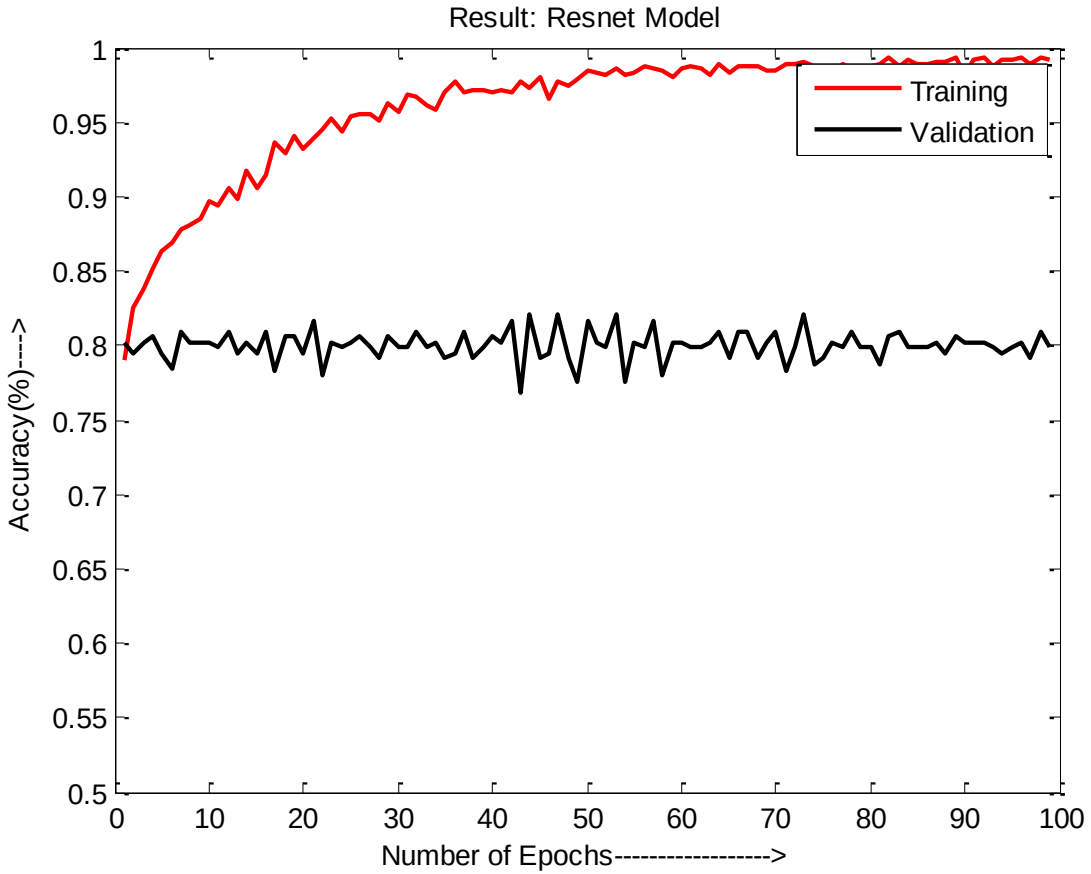
VGG-16
-- 16 weights layers
-- Total params: 16,320,514
-- Trainable params: 1,605,826
-- Non-trainable params: 14,714,688

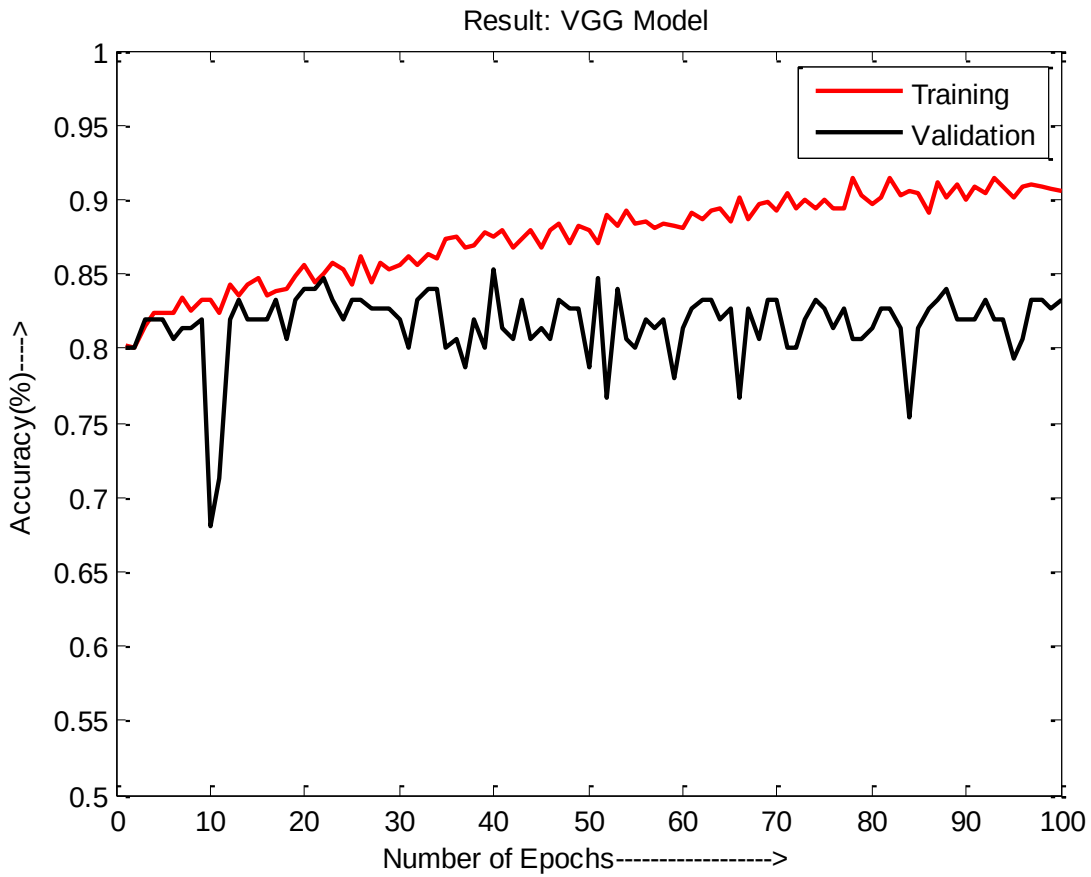
Result


Result: Xception Model
Training
Validation
Accuracy(%)--->
Number of Epochs----------->
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0
10
20
30
40
50
60
70
80
90
100


Result: Inception Model
Training
Validation
Accuracy(%)--->
Number of Epochs----------->
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0
10
20
30
40
50
60
70
80
90
100

Preliminary Result Cont.





Result Cont.

-- > Task1: **Melanoma** Vs. Nevus and Seborrheic Keratosis

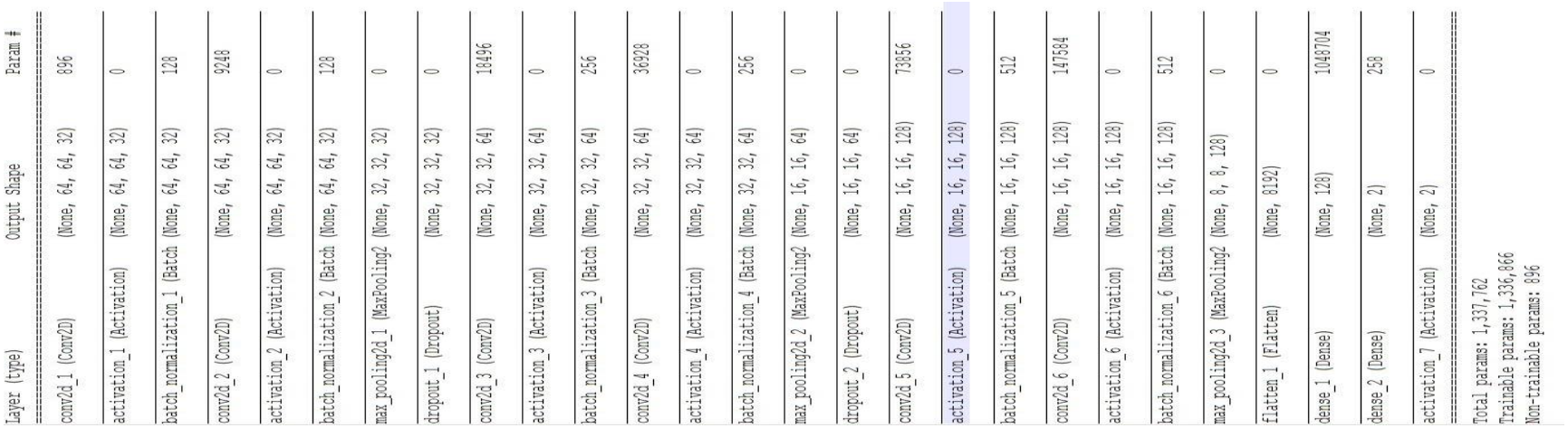
Model	Training Accuracy	Validation Accuracy	Test Accuracy
Xception	99.65%	82.67%	89.19%
Inception-v3	99.34%	85.59%	81.25%
Resnet-50	99.40%	82.09%	82.53%
VGG-16	91.48%	85.33%	81.08%

-- > Task2: **Seborrheic Keratosis** Vs. Melanoma and Nevus

Model	Training Accuracy	Validation Accuracy	Test Accuracy
Xception	99.80%	94.59%	88.67%
Inception-v3	87.30%	85.14%	82.26%
Resnet-50	92.40%	85.62%	79.24%
VGG-16	85.16%	83.10%	80.78%

Result Cont.

-- After presenting preliminary result in the project presentation. I got some suggestions from our TA to generate AUC score. I could not able to get AUC score for transfer model, I included. Latter, I created a new simple CNN model and generated AUC score accordingly. The result and model summary is given bellow.



Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 64, 64, 32)	896
activation_1 (Activation)	(None, 64, 64, 32)	0
batch_normalization_1 (Batch	(None, 64, 64, 32)	128
conv2d_2 (Conv2D)	(None, 64, 64, 32)	9248
activation_2 (Activation)	(None, 64, 64, 32)	0
batch_normalization_2 (Batch	(None, 64, 64, 32)	128
max_pooling2d_1 (MaxPooling2	(None, 32, 32, 32)	0
dropout_1 (Dropout)	(None, 32, 32, 32)	0
conv2d_3 (Conv2D)	(None, 32, 32, 64)	18496
activation_3 (Activation)	(None, 32, 32, 64)	0
batch_normalization_3 (Batch	(None, 32, 32, 64)	256
conv2d_4 (Conv2D)	(None, 32, 32, 64)	36928
activation_4 (Activation)	(None, 32, 32, 64)	0
batch_normalization_4 (Batch	(None, 32, 32, 64)	256
max_pooling2d_2 (MaxPooling2	(None, 16, 16, 64)	0
dropout_2 (Dropout)	(None, 16, 16, 64)	0
conv2d_5 (Conv2D)	(None, 16, 16, 128)	73856
activation_5 (Activation)	(None, 16, 16, 128)	0
batch_normalization_5 (Batch	(None, 16, 16, 128)	512
conv2d_6 (Conv2D)	(None, 16, 16, 128)	147584
activation_6 (Activation)	(None, 16, 16, 128)	0
batch_normalization_6 (Batch	(None, 16, 16, 128)	512
max_pooling2d_3 (MaxPooling2	(None, 8, 8, 128)	0
flatten_1 (Flatten)	(None, 8192)	0
dense_1 (Dense)	(None, 128)	1048704
dense_2 (Dense)	(None, 2)	258
activation_7 (Activation)	(None, 2)	0

Total params: 1,337,762
Trainable params: 1,336,866
Non-trainable params: 896

```
Epoch 14/15
31/31 [==============================] - 5s 169ms/step - loss: 0.3261 - acc: 0.8732 - val_loss: 0.4435 - val_acc: 0.8483
Epoch 15/15
31/31 [==============================] - 5s 164ms/step - loss: 0.3630 - acc: 0.8740 - val_loss: 0.3415 - val_acc: 0.8733
AUC Score on Test Image:  0.8614814814814815
600/600 [==============================] - 1s 1ms/step
Accuracy on Test Image:  0.8733333333333333
```

Conclusion

-- > Transfer Learning Model Implemented

-- > VGG-16, Inception-v3, Resnet-50 and Xception

-- > Best Accuracy on Test Data: 89.19% (Xception Model)

Future Work

-- > Reduce over fitting: Dropout

-- > Use Inception-Resnet Model

-- > Use of External Data

-- > Aggressive Data Augmentation