Computer-aided system for automatic skin cancer segmentation and classification
電腦輔助自動分割分類皮膚癌系統

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2022/6/7

Outline

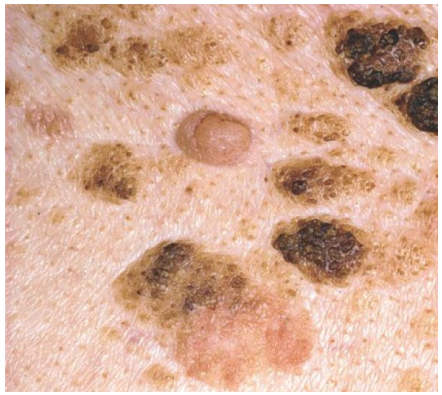
Biomedical Ultrasound System Lab

- Introduction
- Motivation & Object
- Material & Method
- Results & Discussion
- Future Works

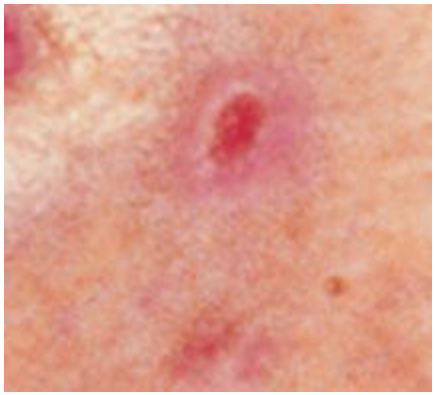
Introduction
- skin cancer

Skin Cancer

- Seborrheic Keratosis
- Basal Cell Carcinoma
- Melanocytic Nevi
- Melanoma



Common



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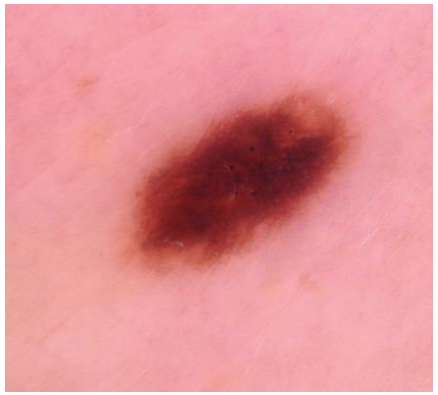
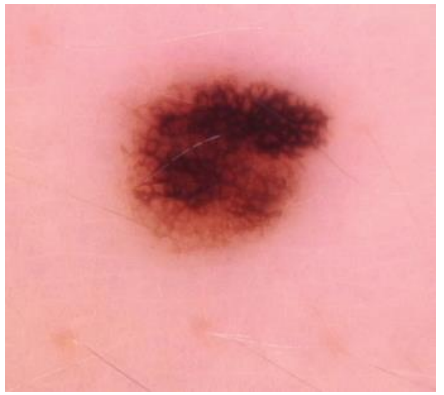


Potential



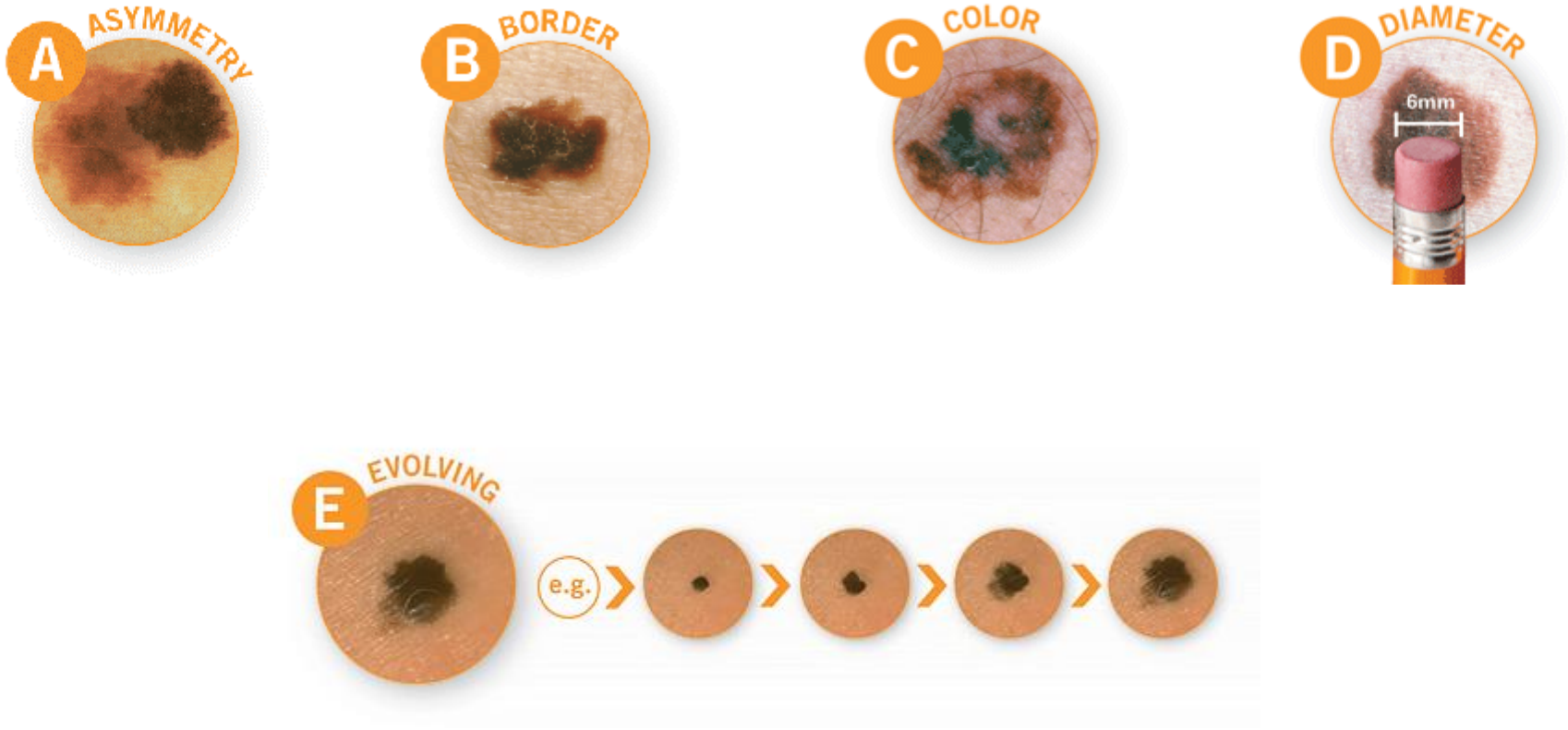
Dangerous

① Clinical Dermatology: Diagnosis and Management of Common Disorders, 2e, chapter20, 22

Introduction
- Diagnosis

Introduction
- Diagnosis

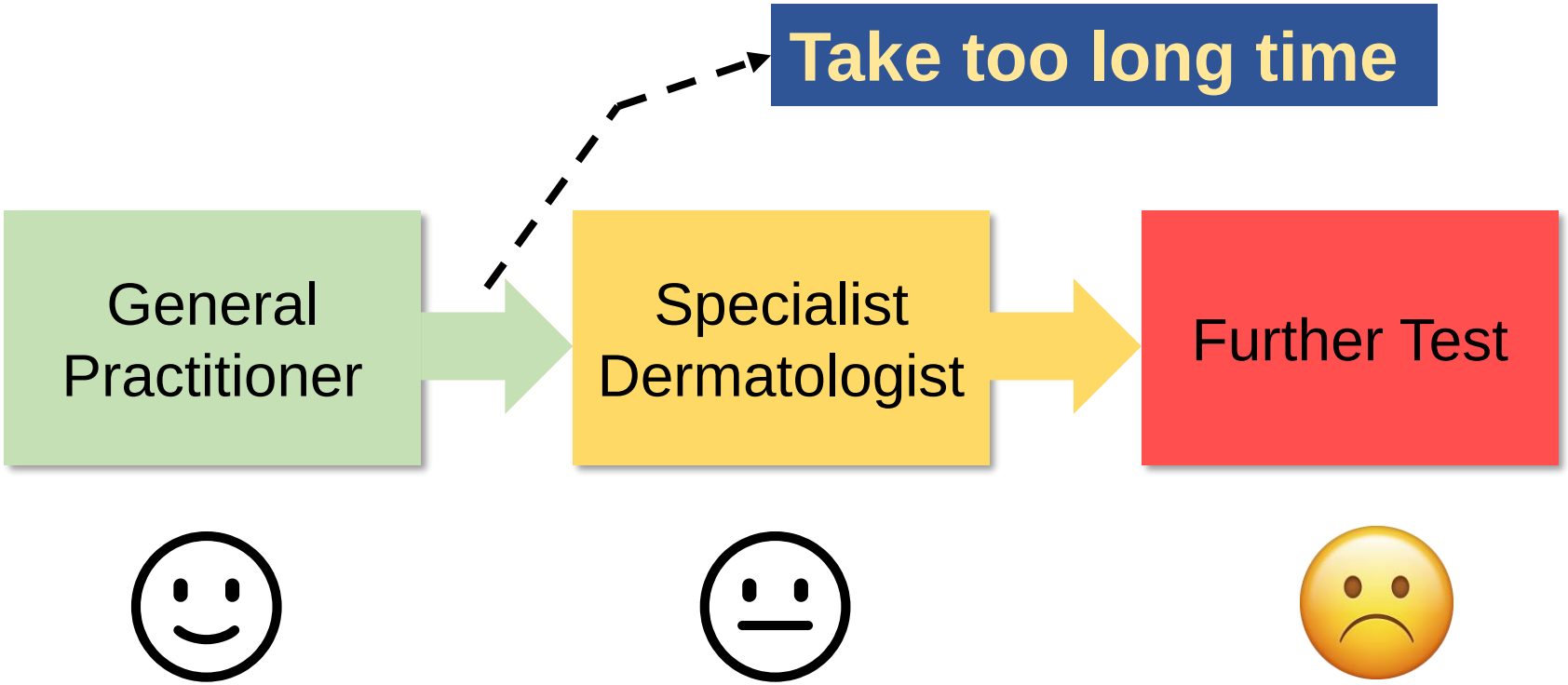
Biomedical Ultrasound System Lab



① *American Academy of Dermatology Association, what to look for: ABCDE of Melanoma*

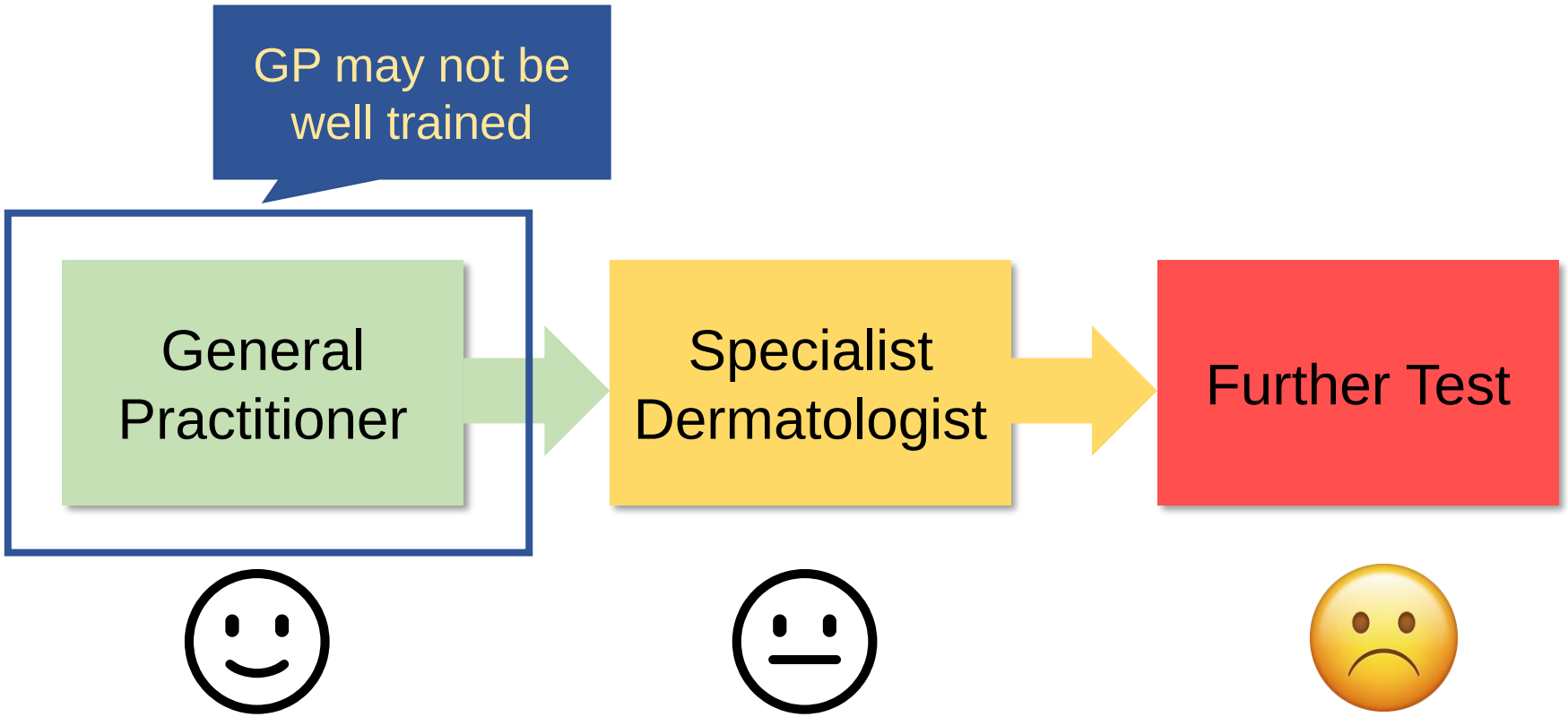
Motivation & Object
- process issue

Biomedical Ultrasound System Lab



Motivation & Object
- GP issue

Biomedical Ultrasound System Lab



Motivation & Object
- Computer Aided Diagnosis

Biomedical Ultrasound System Lab

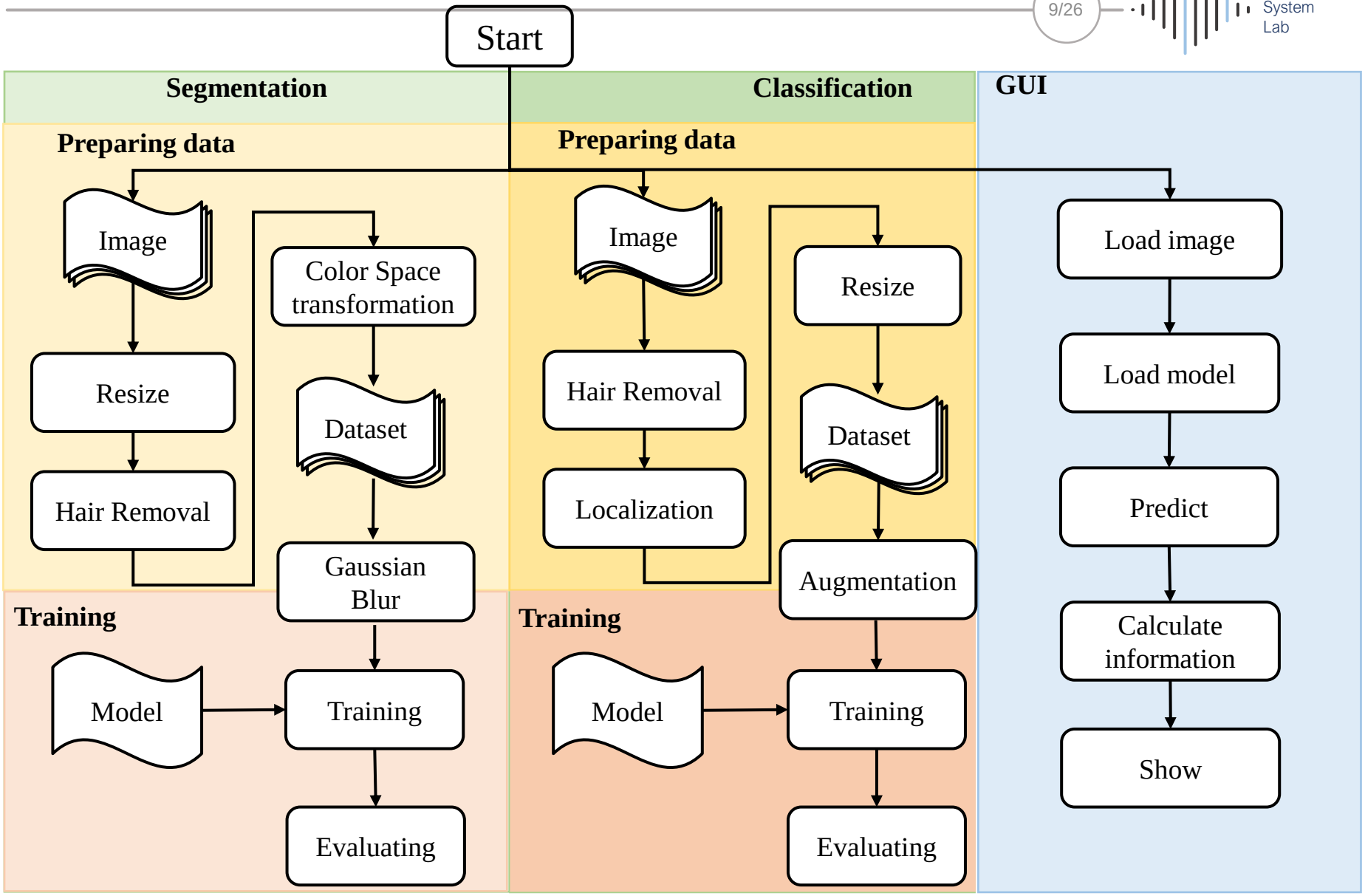
Material & Method
- Device

Webcam

- Resolution: 1920 x 1080 @ 30 fps
- 鏡頭直徑: 8mm (2P2G定焦)
- Size: 94 x 80 x 38 mm
- Weight: 100g
- Sensor: CMOS sensor

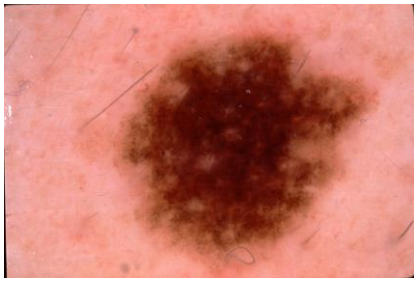
Material & Method
- Flow chart

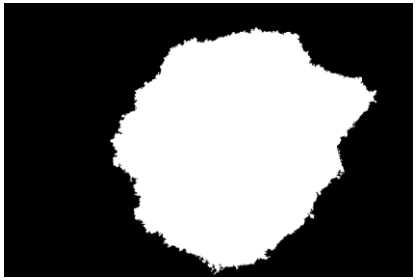
Biomedical Ultrasound System Lab



Material & Method
- Dataset

ISIC2017 Dataset
# of image: 2750
Image width / Image height = 1.55





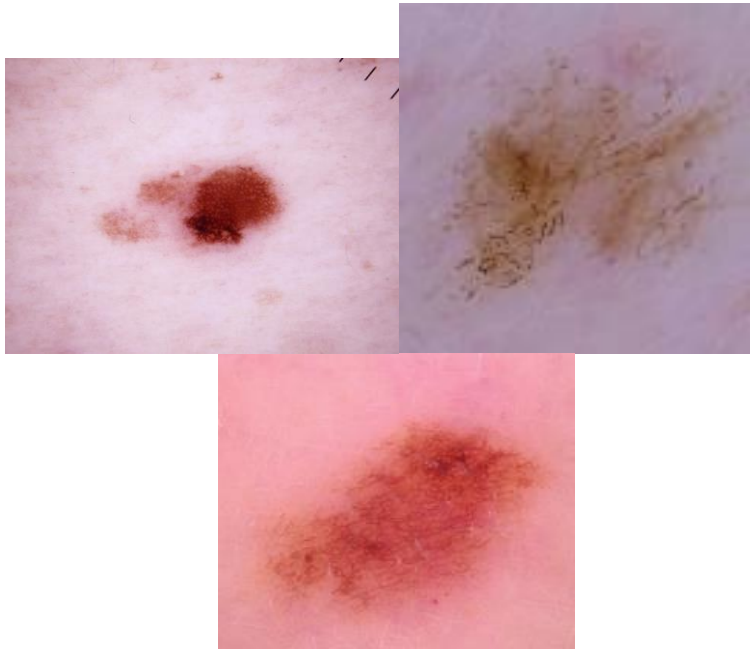
HAM10000
# of image: 10050
Image size: 600 x 450

Seborrheic Keratosis ≒ 500

Basal Cell Carcinoma ≒ 1000

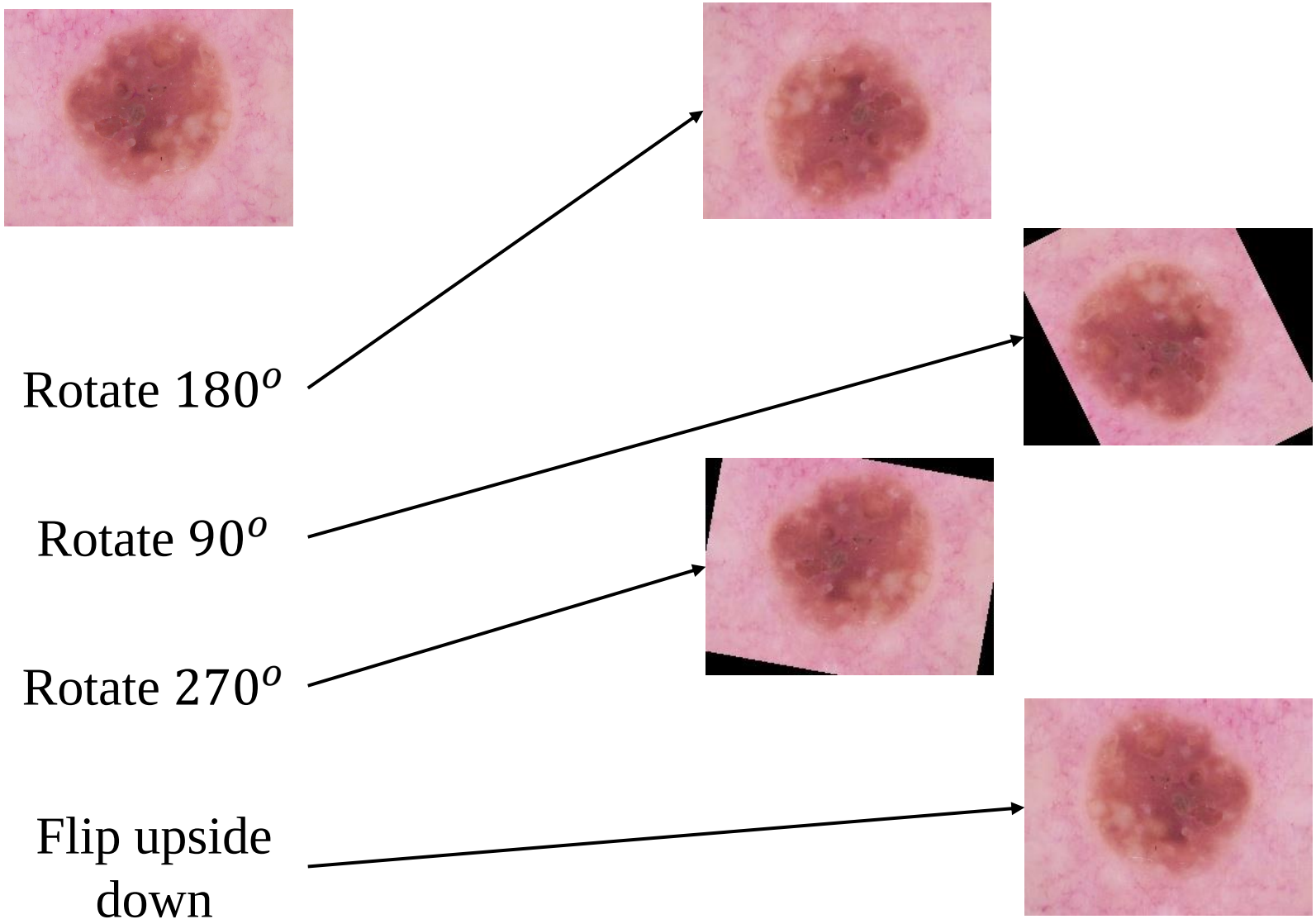
Melanocytic Nevi: ≒ 6000

Melanoma ≒ 1000

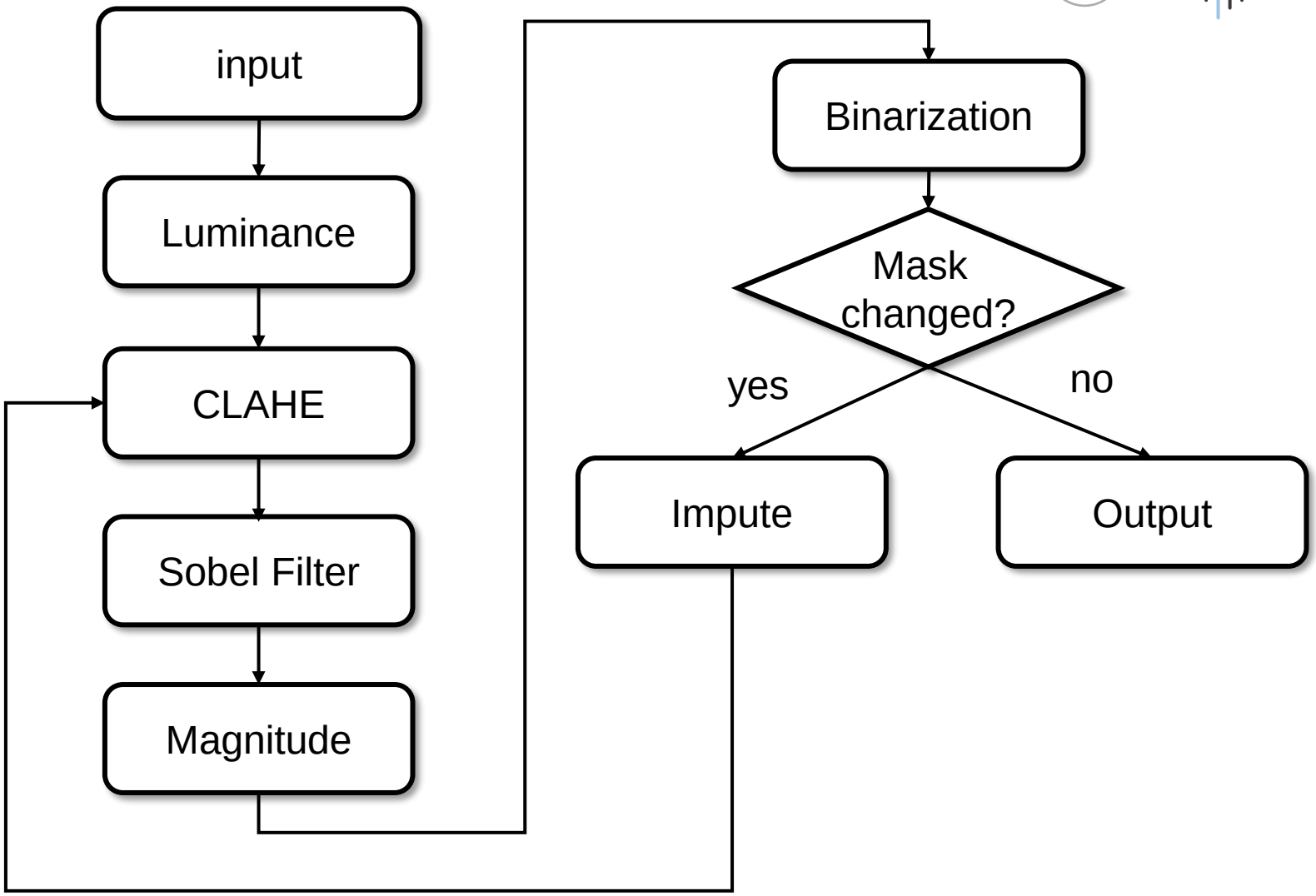


Material & Method
- Augmentation

Biomedical Ultrasound System Lab



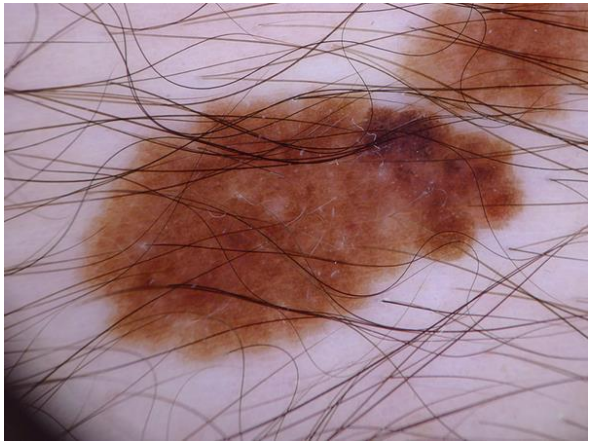
Material & Method
- Hair Removal

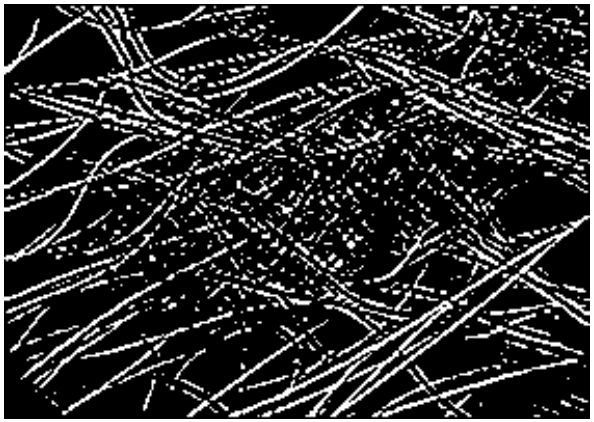


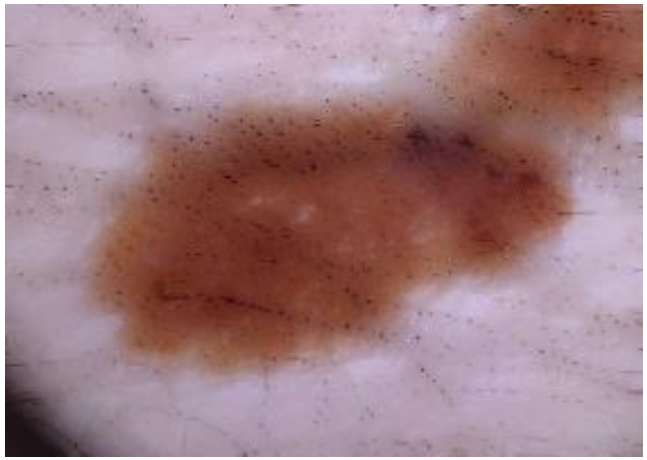
① Segmenting Skin Lesions with Partial-Differential-Equations-Based ImageProcessing Algorithms, IEEE TRANSACTIONS ON MEDICAL IMAGING, VOL. 19, NO. 7, JULY 2000

Material & Method
- Hair Removal

Biomedical
Ultrasound
System
Lab



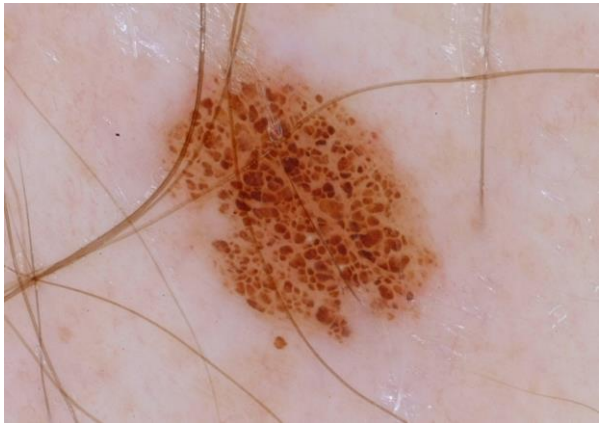


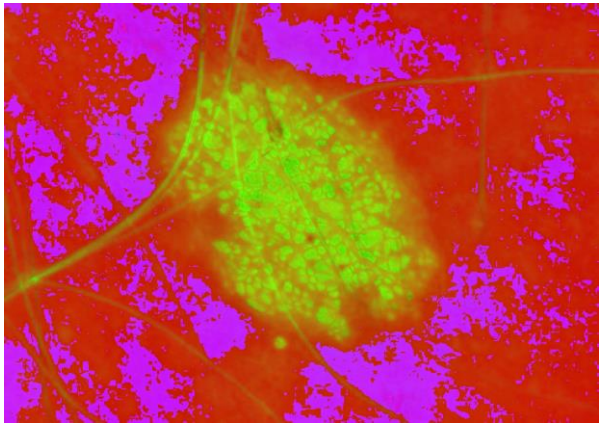


① Segmenting Skin Lesions with Partial-Differential-Equations-Based ImageProcessing Algorithms, IEEE TRANSACTIONS ON MEDICAL IMAGING, VOL. 19, NO. 7, JULY 2000

Material & Method
- Color space Transformation

Biomedical
Ultrasound
System
Lab



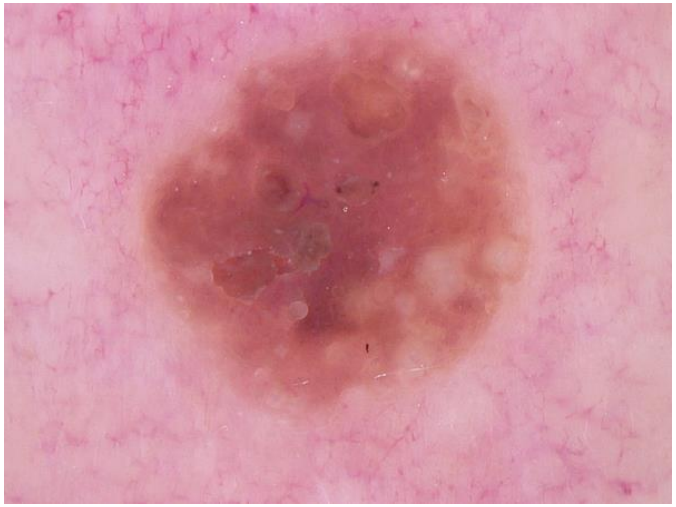


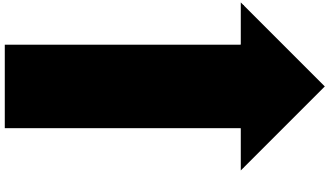
RGB

HSV

Material & Method
- Localization

Biomedical
Ultrasound
System
Lab





Material & Method
- Information Calculation

Biomedical Ultrasound System Lab

Symmetry

$$Symmetry = \frac{Sym_{0^\circ} + Sym_{90^\circ}}{2}.$$

Circularity

$$Circularity = \frac{4\pi \cdot Area}{Perimeter^2}$$

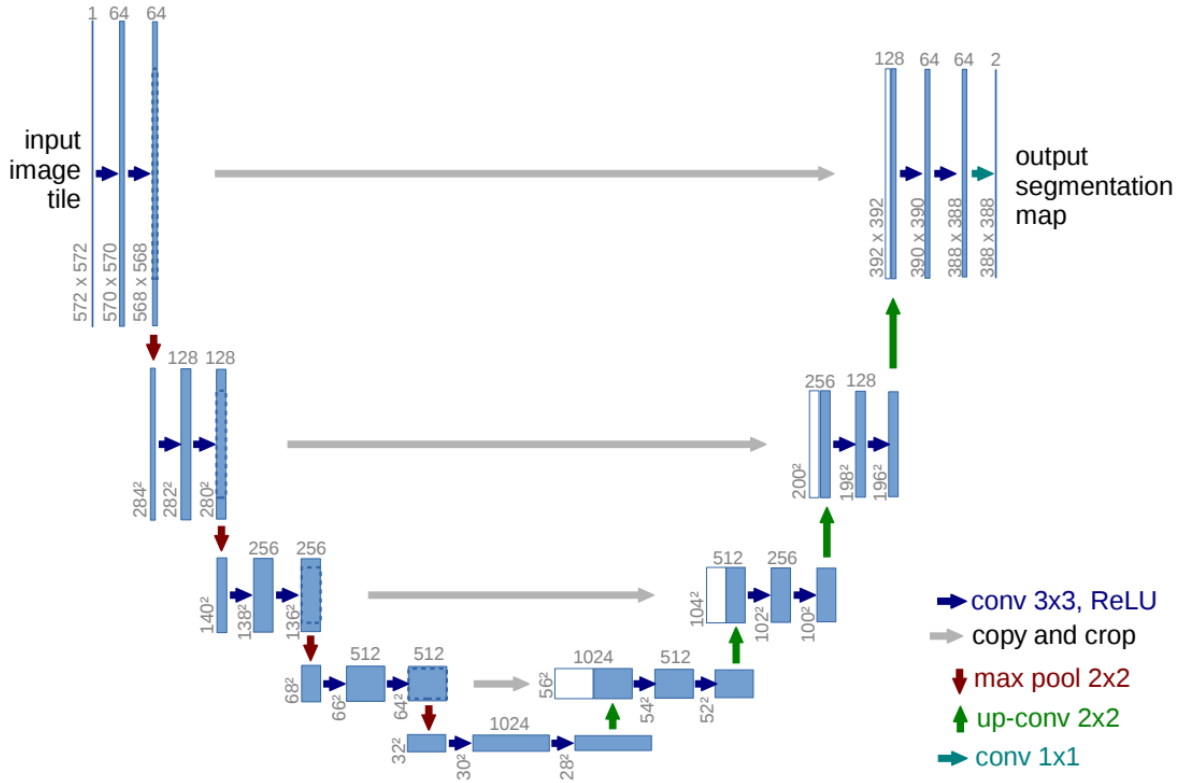
Area

Radius

Material & Method
- Segmentation Model

Biomedical
Ultrasound
System
Lab

U-Net

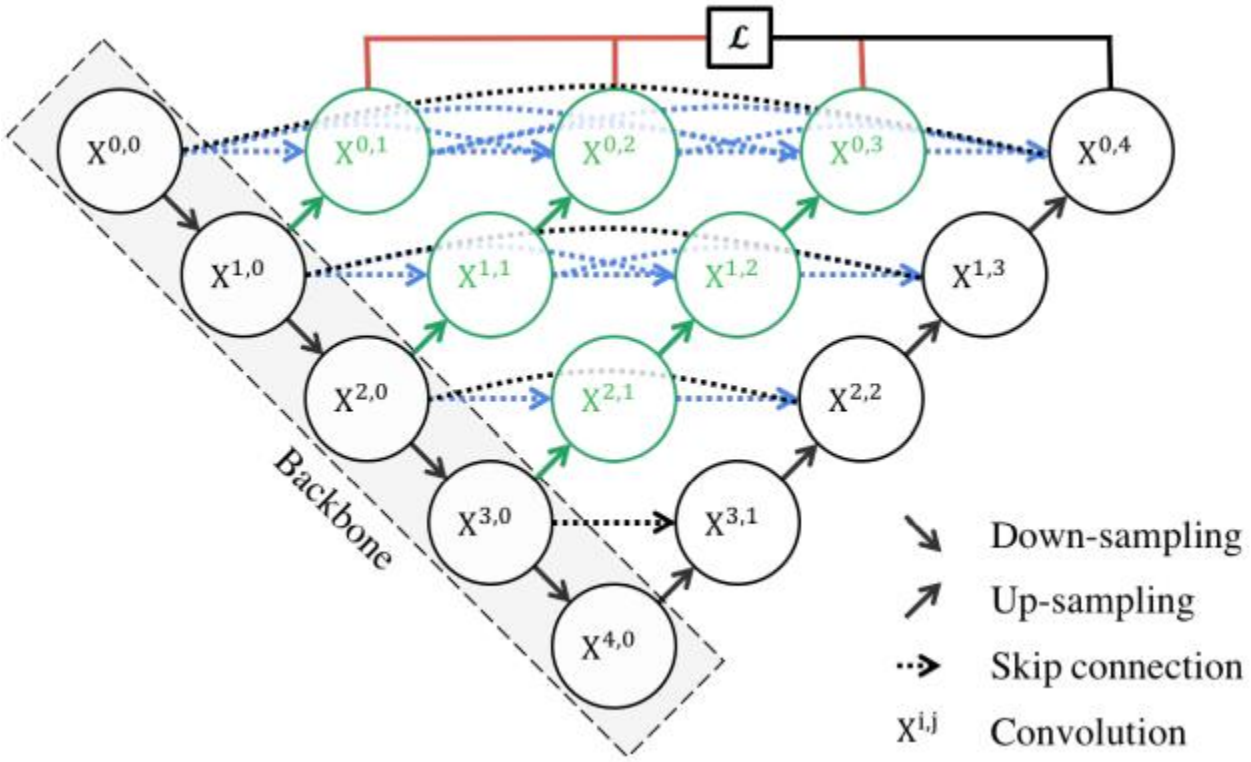


① *U-Net: Convolutional Networks for Biomedical Image Segmentation, Olaf Ronneberger, Philipp Fischer, and Thomas Brox*

Material & Method
- Segmentation Model

Biomedical Ultrasound System Lab

U-Net++

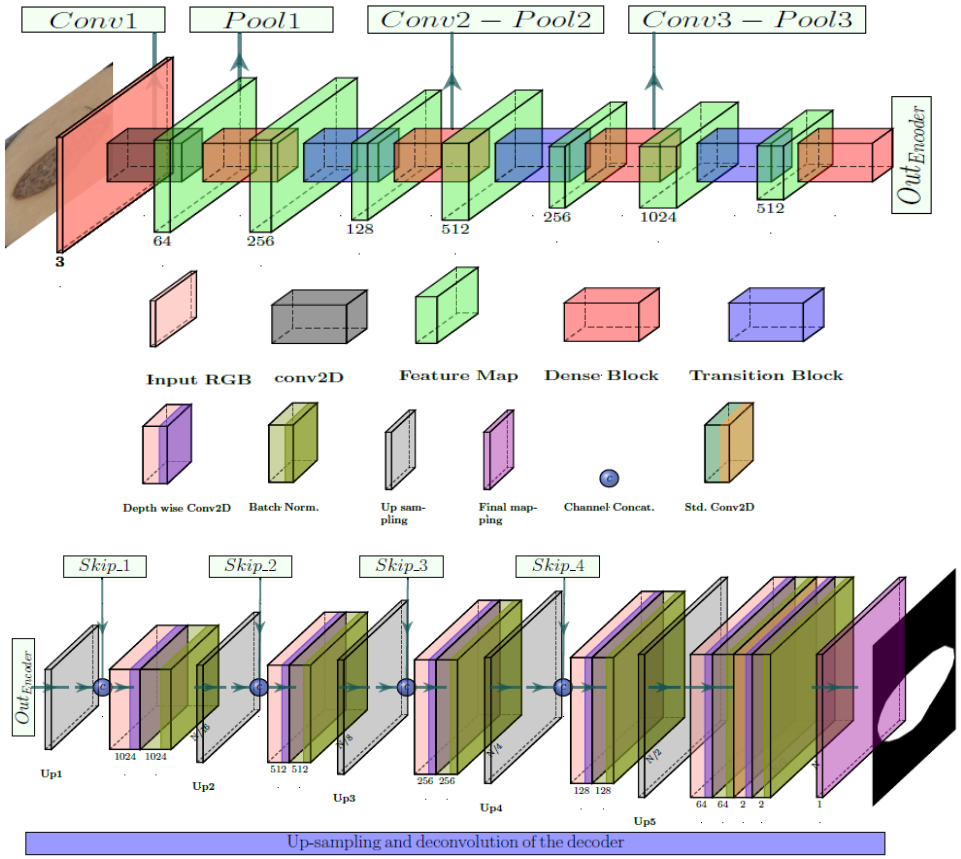


① *UNet++: A Nested U-Net Architecture for Medical Image Segmentation, Zongwei Zhou, Md Mahfuzur Rahman Siddiquee, Nima Tajbakhsh, Jianming Liang*

Material & Method
- Segmentation Model

Biomedical Ultrasound System Lab

DSNet



① *DSNet: Automatic Dermoscopic Skin Lesion Segmentation, Md. Kamrul Hasana,, Lavsen Dahala, Prasad N. Samarakoonb, Fakrul Islam Tushara, Robert Marta*

Material & Method
- Classification Model

Biomedical Ultrasound System Lab

VGG16

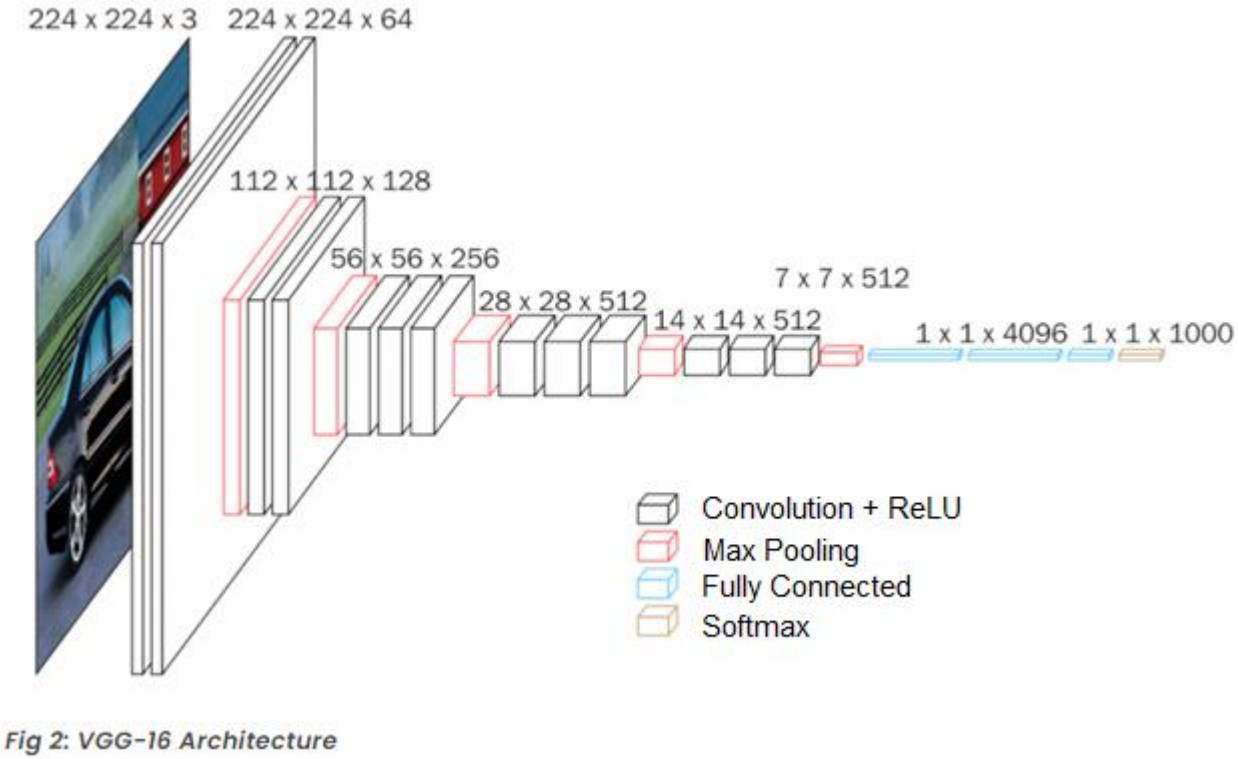


Fig 2: VGG-16 Architecture

① *Very Deep Convolutional Networks for Large-Scale Image Recognition, Karen Simonyan, Andrew Zisserman*

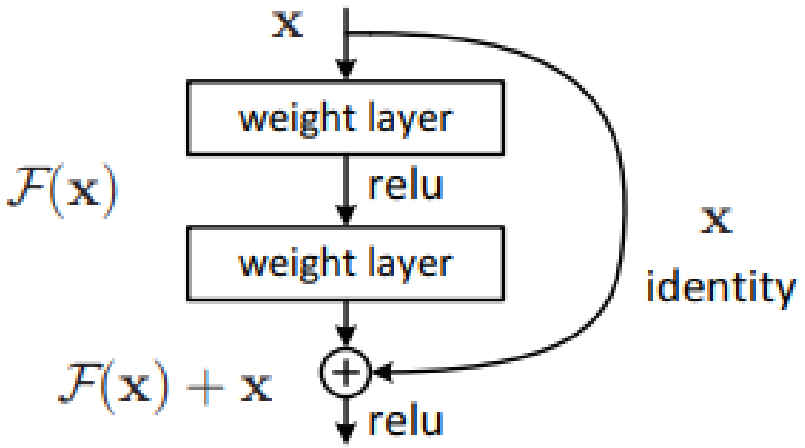
Material & Method
- Classification Model

Biomedical Ultrasound System Lab

ResNet

$$\mathbf{y} = \mathcal{F}(\mathbf{x}, \{W_i\}) + \mathbf{x}.$$

$$\mathbf{y} = \mathcal{F}(\mathbf{x}, \{W_i\}) + W_s\mathbf{x}.$$



① *Deep Residual Learning for Image Recognition, Kaiming He, Xiangyu Zhang, Shaoqing Ren, Jian Sun*

Material & Method
- Classification Model

Biomedical Ultrasound System Lab

ResNet

layer name	output size	18-layer	34-layer	50-layer	101-layer	152-layer
conv1	112×112	7×7, 64, stride 2				
conv2_x	56×56	3×3 max pool, stride 2				
		$\begin{bmatrix} 3\times3, 64 \\ 3\times3, 64 \end{bmatrix}\times2$	$\begin{bmatrix} 3\times3, 64 \\ 3\times3, 64 \end{bmatrix}\times3$	$\begin{bmatrix} 1\times1, 64 \\ 3\times3, 64 \\ 1\times1, 256 \end{bmatrix}\times3$	$\begin{bmatrix} 1\times1, 64 \\ 3\times3, 64 \\ 1\times1, 256 \end{bmatrix}\times3$	$\begin{bmatrix} 1\times1, 64 \\ 3\times3, 64 \\ 1\times1, 256 \end{bmatrix}\times3$
conv3_x	28×28	$\begin{bmatrix} 3\times3, 128 \\ 3\times3, 128 \end{bmatrix}\times2$	$\begin{bmatrix} 3\times3, 128 \\ 3\times3, 128 \end{bmatrix}\times4$	$\begin{bmatrix} 1\times1, 128 \\ 3\times3, 128 \\ 1\times1, 512 \end{bmatrix}\times4$	$\begin{bmatrix} 1\times1, 128 \\ 3\times3, 128 \\ 1\times1, 512 \end{bmatrix}\times4$	$\begin{bmatrix} 1\times1, 128 \\ 3\times3, 128 \\ 1\times1, 512 \end{bmatrix}\times8$
conv4_x	14×14	$\begin{bmatrix} 3\times3, 256 \\ 3\times3, 256 \end{bmatrix}\times2$	$\begin{bmatrix} 3\times3, 256 \\ 3\times3, 256 \end{bmatrix}\times6$	$\begin{bmatrix} 1\times1, 256 \\ 3\times3, 256 \\ 1\times1, 1024 \end{bmatrix}\times6$	$\begin{bmatrix} 1\times1, 256 \\ 3\times3, 256 \\ 1\times1, 1024 \end{bmatrix}\times23$	$\begin{bmatrix} 1\times1, 256 \\ 3\times3, 256 \\ 1\times1, 1024 \end{bmatrix}\times36$
conv5_x	7×7	$\begin{bmatrix} 3\times3, 512 \\ 3\times3, 512 \end{bmatrix}\times2$	$\begin{bmatrix} 3\times3, 512 \\ 3\times3, 512 \end{bmatrix}\times3$	$\begin{bmatrix} 1\times1, 512 \\ 3\times3, 512 \\ 1\times1, 2048 \end{bmatrix}\times3$	$\begin{bmatrix} 1\times1, 512 \\ 3\times3, 512 \\ 1\times1, 2048 \end{bmatrix}\times3$	$\begin{bmatrix} 1\times1, 512 \\ 3\times3, 512 \\ 1\times1, 2048 \end{bmatrix}\times3$
	1×1	average pool, 1000-d fc, softmax				
FLOPs		1.8×10^9	3.6×10^9	3.8×10^9	7.6×10^9	11.3×10^9

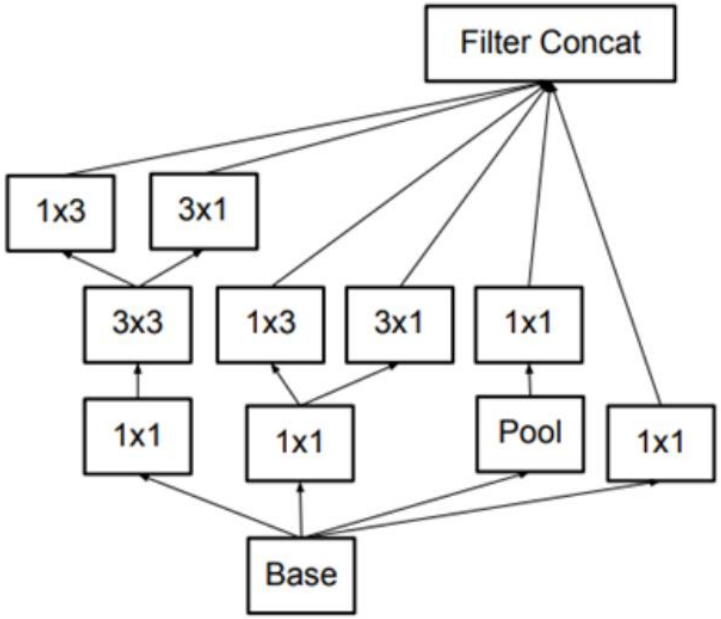
① *Deep Residual Learning for Image Recognition, Kaiming He, Xiangyu Zhang, Shaoqing Ren, Jian Sun*

Material & Method
- Classification Model

Biomedical Ultrasound System Lab

InceptionV3

type	patch size/stride or remarks	input size
conv	3×3/2	299×299×3
conv	3×3/1	149×149×32
conv padded	3×3/1	147×147×32
pool	3×3/2	147×147×64
conv	3×3/1	73×73×64
conv	3×3/2	71×71×80
conv	3×3/1	35×35×192
3×Inception	As in figure 5	35×35×288
5×Inception	As in figure 6	17×17×768
2×Inception	As in figure 7	8×8×1280
pool	8 × 8	8 × 8 × 2048
linear	logits	1 × 1 × 2048
softmax	classifier	1 × 1 × 1000

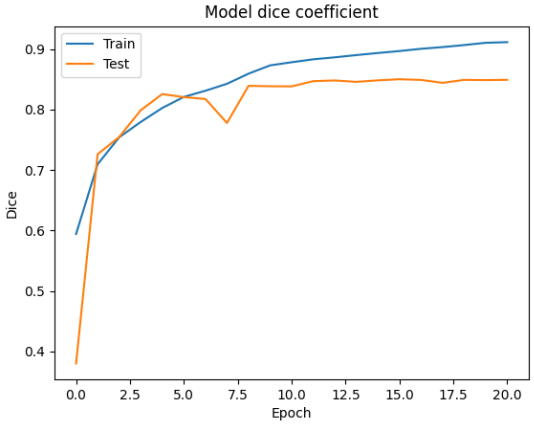


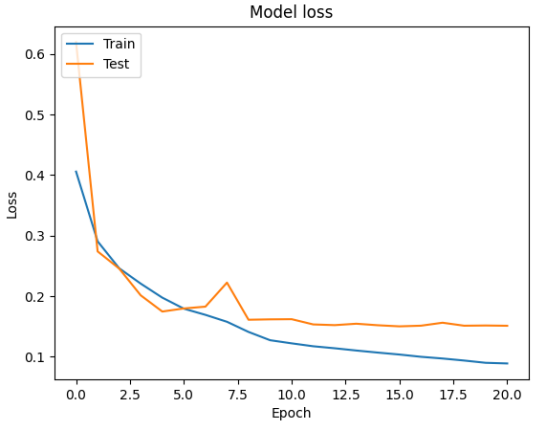
① Going Deeper with Convolutions, Christian Szegedy, Wei Liu, Yangqing Jia, Pierre Sermanet, Scott Reed, Dragomir Anguelov, Dumitru Erhan, Vincent Vanhoucke, Andrew Rabinovich

Results & Discussion
- Training curve (with hair)

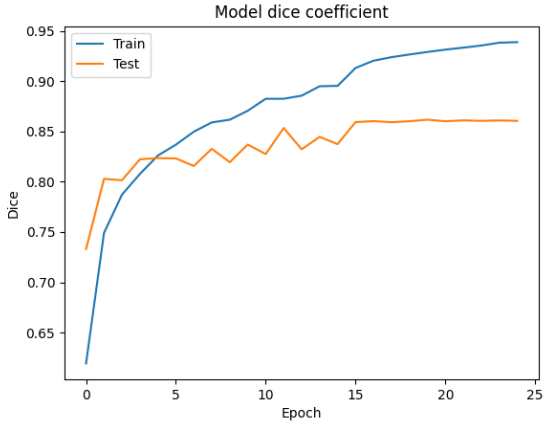
Biomedical Ultrasound System Lab

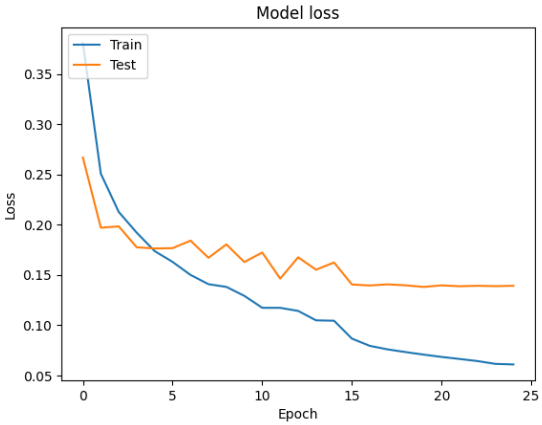
UNet



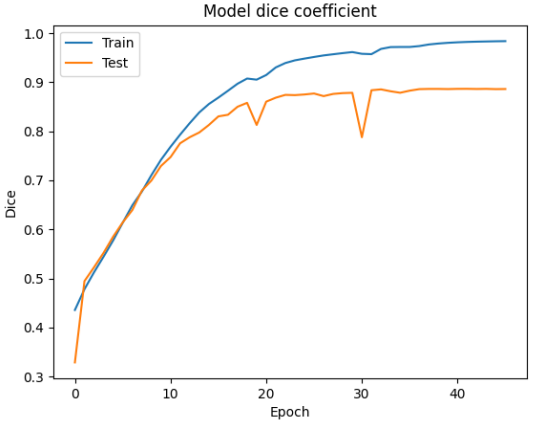


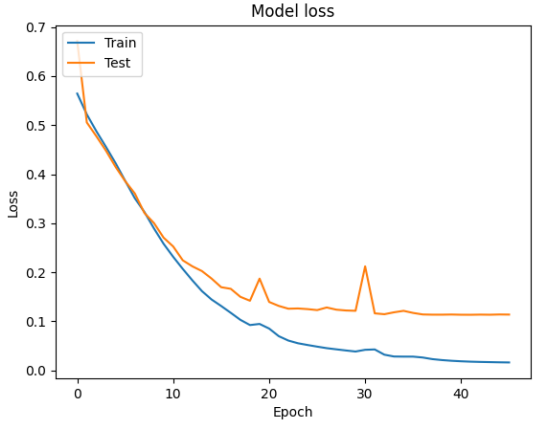
Unet++





DSNet

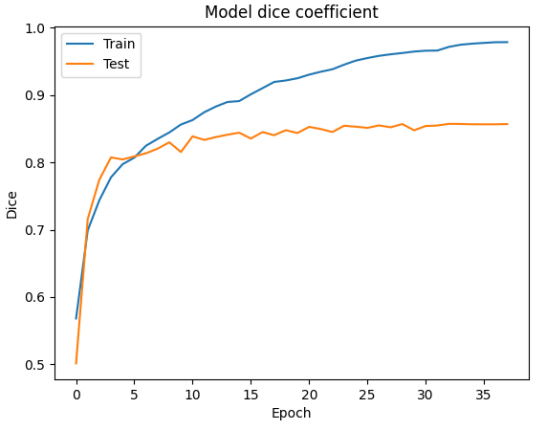


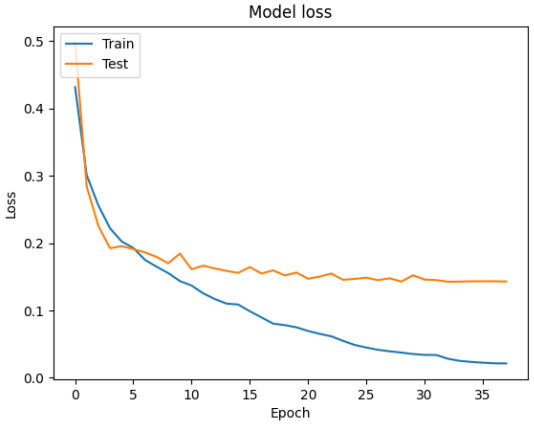


Results & Discussion
- Training curve (without hair)

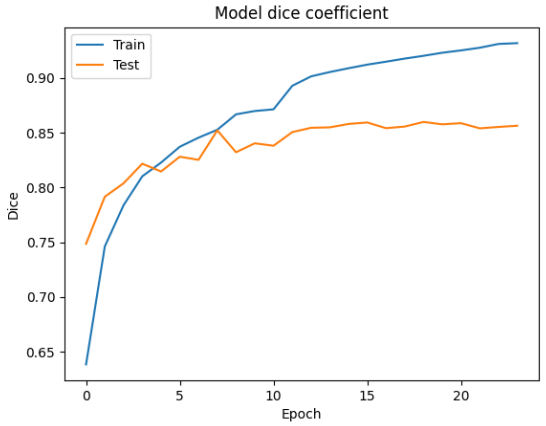
Biomedical Ultrasound System Lab

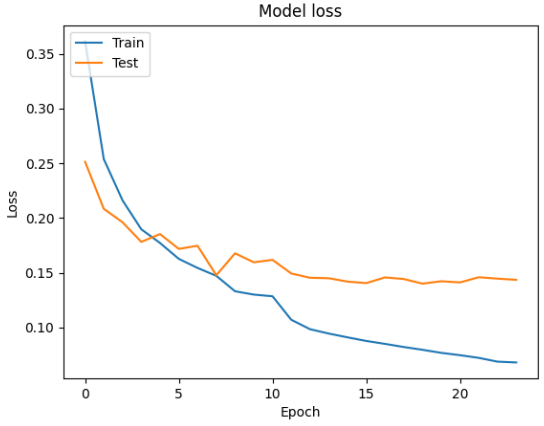
UNet



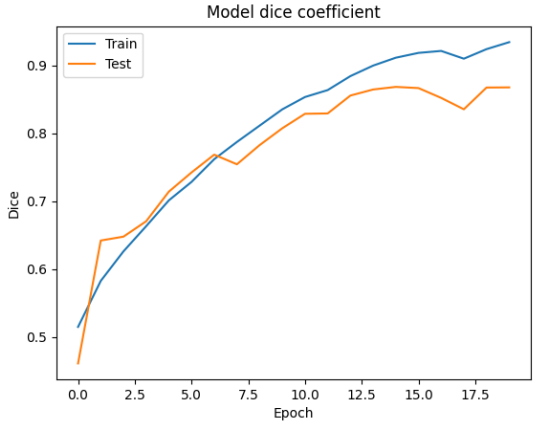


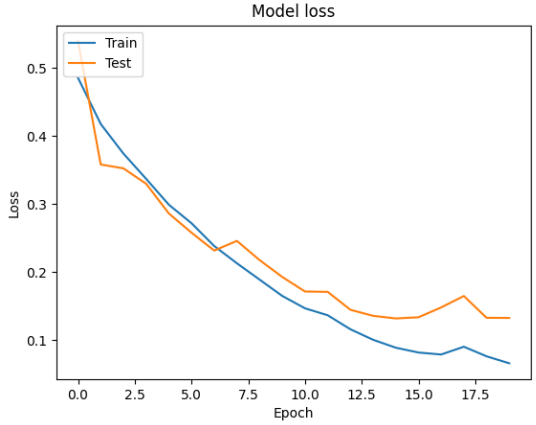
Unet++





DSNet

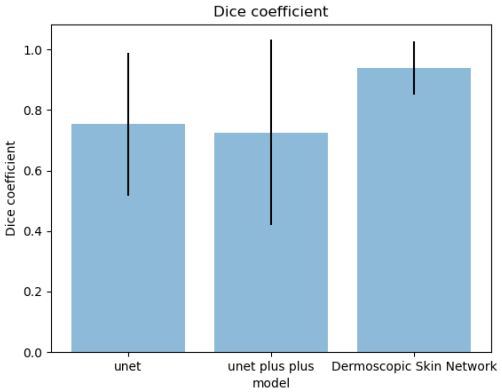




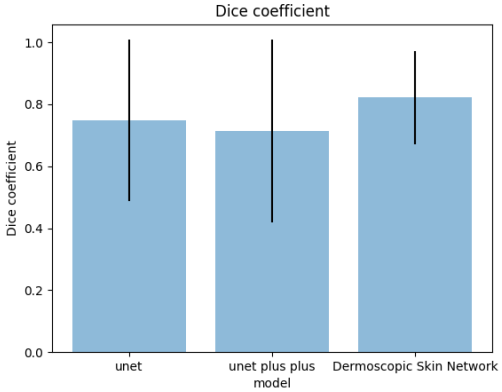
Results & Discussion
- Segmentation

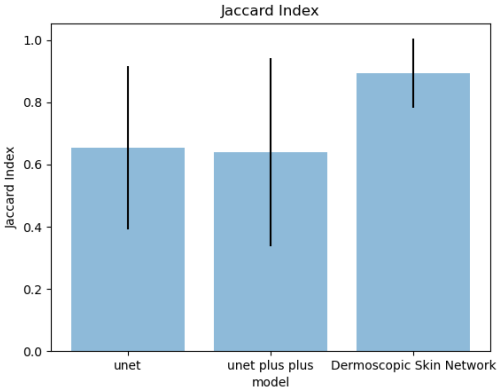
Biomedical Ultrasound System Lab

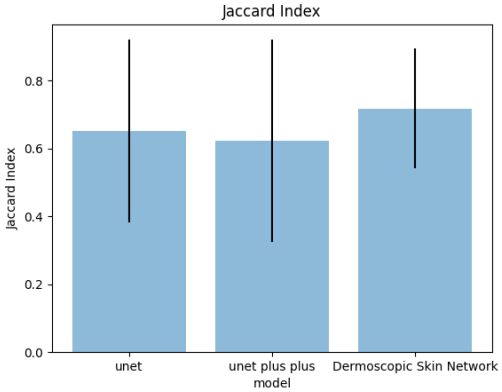
Without removing hair



With removing hair



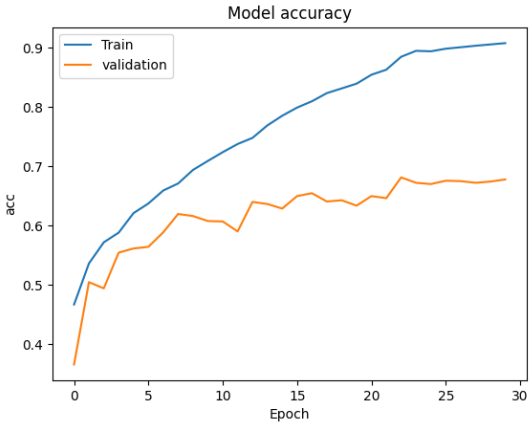


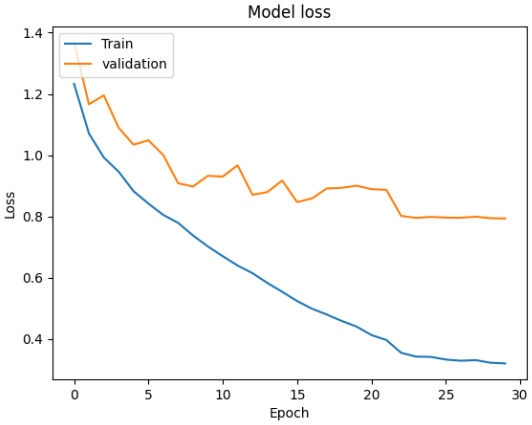


Results & Discussion
- Classification (with hair)

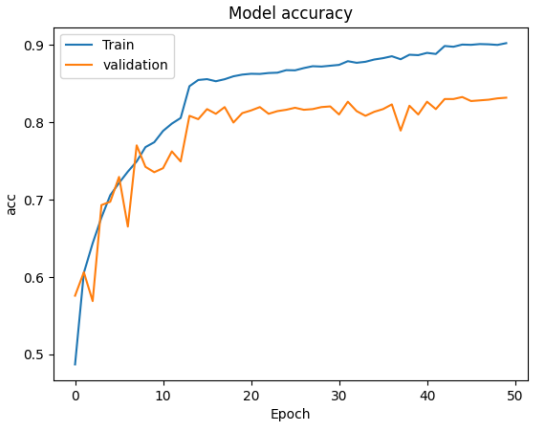
Biomedical Ultrasound System Lab

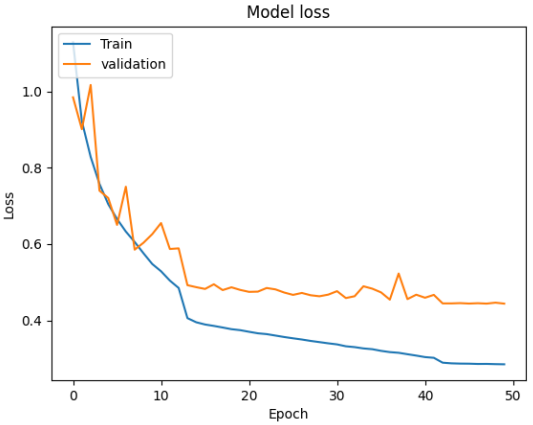
Resnet34



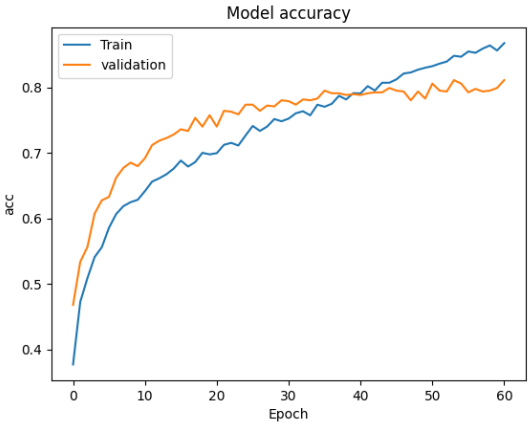


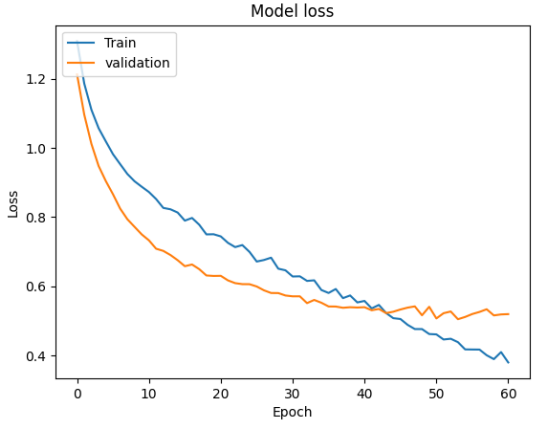
Vgg16
(transfer learning)





InceptionV3
(transfer learning)

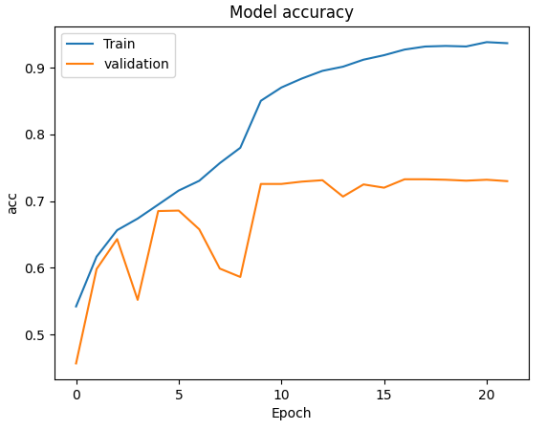


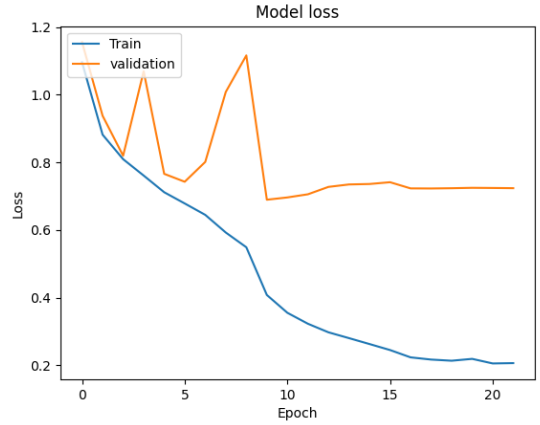


Results & Discussion
- Classification (without hair)

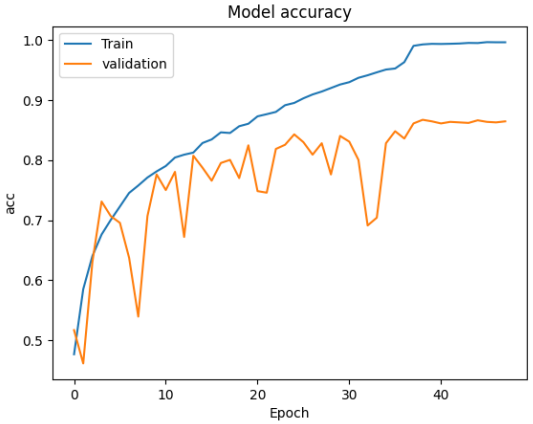
Biomedical Ultrasound System Lab

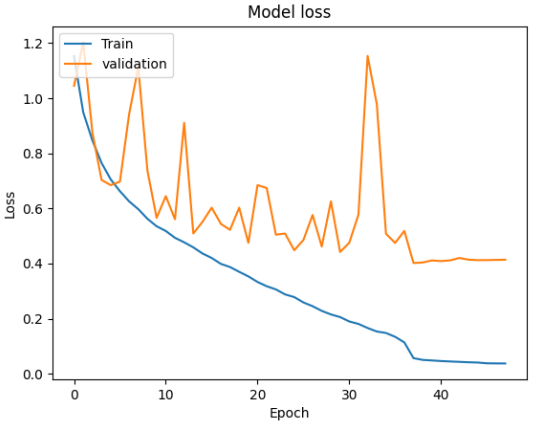
Resnet34



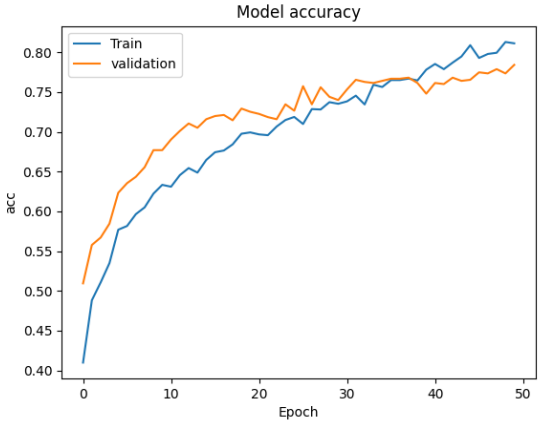


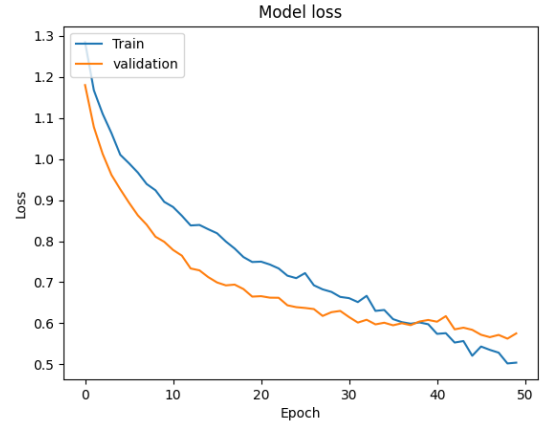
Vgg16
(transfer learning)





InceptionV3
(transfer learning)





Thank You
For Your Attention

國立成功大學
National Cheng Kung University

Biomedical
Ultrasound
System
Lab

2022/6/7