Deep Learning Based Melanoma Detection and Diagnosis System

Abstract

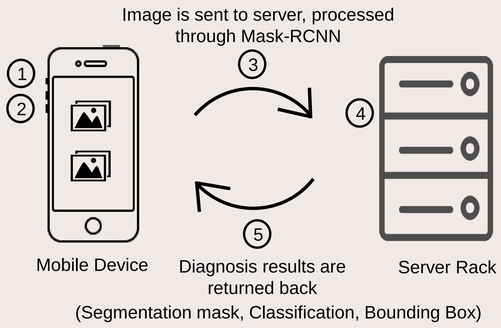
Every year in the US about 96,000 patients are diagnosed with melanoma cancer, and about 7,000 of those people are predicted to die. Skin cancer is the most common cancer in the US; melanoma is considered one of the deadliest skin cancers. With survival rates dropping dramatically everyday when melanoma is undiscovered in a patient, the hassle of arranging a specialized doctor examination often does not prove to be sufficient when time is valuable for survival. When melanoma is discovered and treated early, survival rates are almost as high as 99%. As melanoma can be discovered through skin lesions that appear on the surface of the skin, images are the main source of diagnosis. For early detection and prevention, we propose an accessible consumer machine learning computer-aided diagnosis system using mask region based convolutional neural network (Mask-RCNN) that can instantaneously distinguish if skin lesions are cancerous or not.

Keywords: Mask-RCNN, Melanoma, computer-aided diagnosis

Research Objective

Our system provides an online diagnosis service platform for early detection and prevention of melanoma, using a deep learning neural network, otherwise known as Mask-RCNN[2], to perform a combination of segmentation and classification.

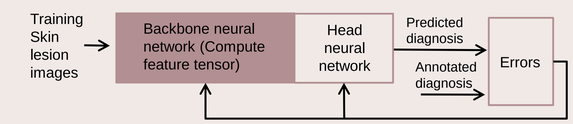
System Architecture



Step 1: Using a mobile device take a picture of skin lesion
Step 2: Open up the user application and upload the image of skin lesion
Step 3: Application will send image data to server
Step 4: Server will run Mask-RCNN using the image data as input, and outputs skin lesion with segmentation mask, classification, and bounding box results
Step 5: Results are sent back to user and will appear of the screen of the mobile device

Method

Training

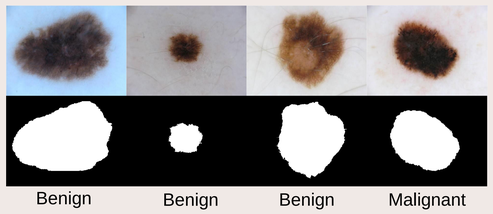


Uses Stochastic Gradient Descent

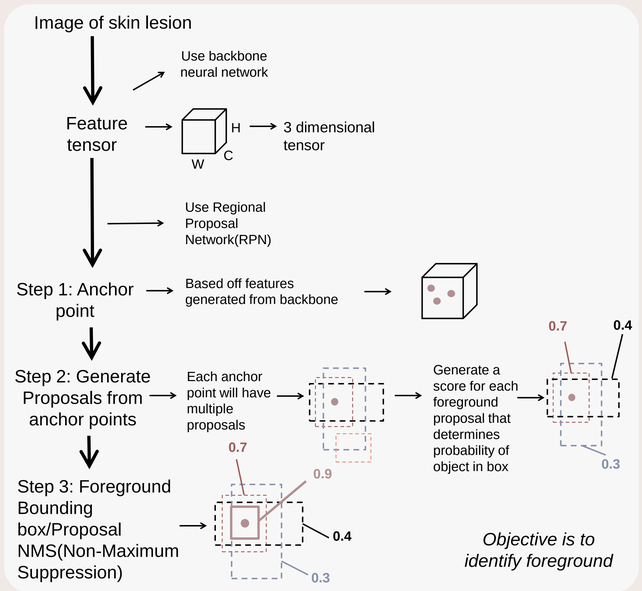
System is trained multiple times by decreasing the loss, also known as the error between its prediction and ground truth, and learns the ability to identify and mask skin lesions

1. Load pre-trained weights for Backbone Neural Network
2. Train the Head network using the lesion dataset
3. Refine the backbone using the lesion dataset
4. Refine the whole network using the lesion dataset

Training sample size is about 19,000 images [1].



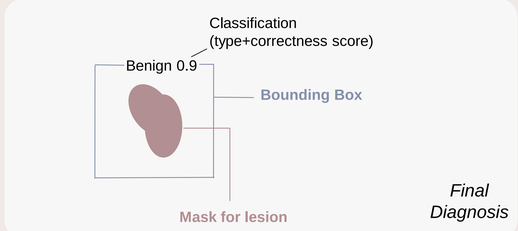
Diagnosis



For each high probability foreground score proposal the computer will do the following...

1. Classification Neural Network → Identifies what the lesion's specific class is → benign / malignant → Generates a score for the correctness of the identified class
2. Segmentation Neural Network → Generates a mask for the lesion
3. Bounding Box Refinement → Further refines the location and size of box

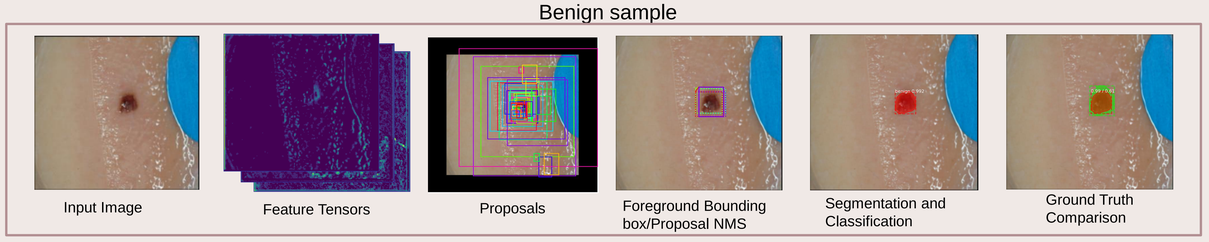
Foreground diagnosis



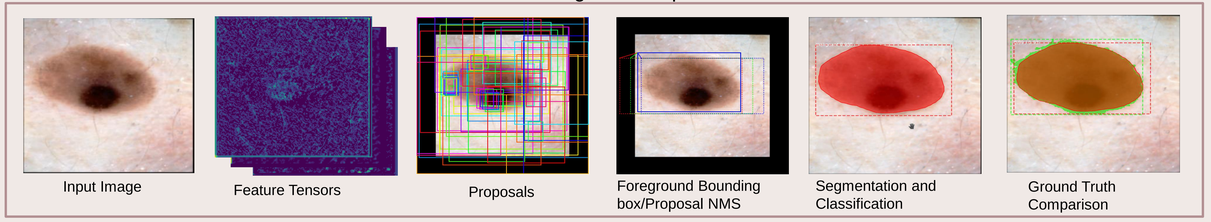
Results

Data: Testing sample of 100 images selected from the public dataset [1] is not used in training. Two samples are illustrated:

Benign sample



Malignant sample

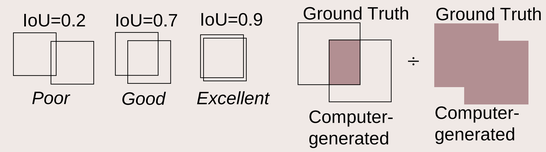


Evaluation

1) Intersection over Union(IoU) used for Image Segmentation

Evaluation metric used to measure the accuracy of the computer-generated segmentation mask → Compares ground truth segmentation mask to computer-generated segmentation mask and calculates accuracy score

$$\text{IoU} = \frac{\text{Area of Intersection}}{\text{Area of Union}} = 70.1\%$$



2) Confusion Matrix used for Classification

Evaluation matrix used to measure the performance of the computer-generated classification → To calculate the accuracy of our classification model

$$\frac{\text{True Positive+True Negative}}{\text{Total(n)}} = \frac{31+58}{100} = 89\%$$

n=100	Predicted: Malignant	Predicted: Benign	
Actual: Malignant	31 *True Positive*	7 *False Positive*	38
Actual: Benign	4 *False Negative*	58 *True Negative*	62

Future Work

1) More training samples of annotated skin lesions from experienced doctors, makes the system more precise and accurate
2) Better Neural Network design, makes learning more efficient and effective
3) Build a user-friendly application, to allow for easy access and assist more patients

References

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