



DERMATOLOGY TEAM 14

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Agenda



- Problem Statement
- Dataset
- Solution Approach
- Active Learning
- Results
- Accomplishments & Going Forward

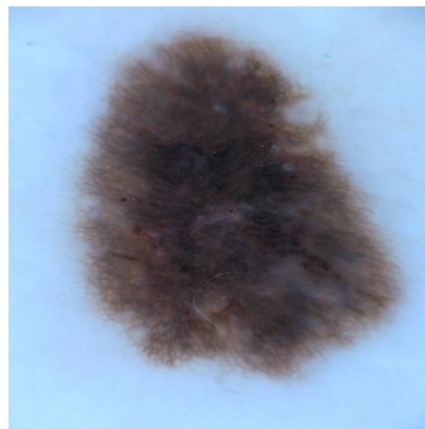
PROBLEM STATEMENT

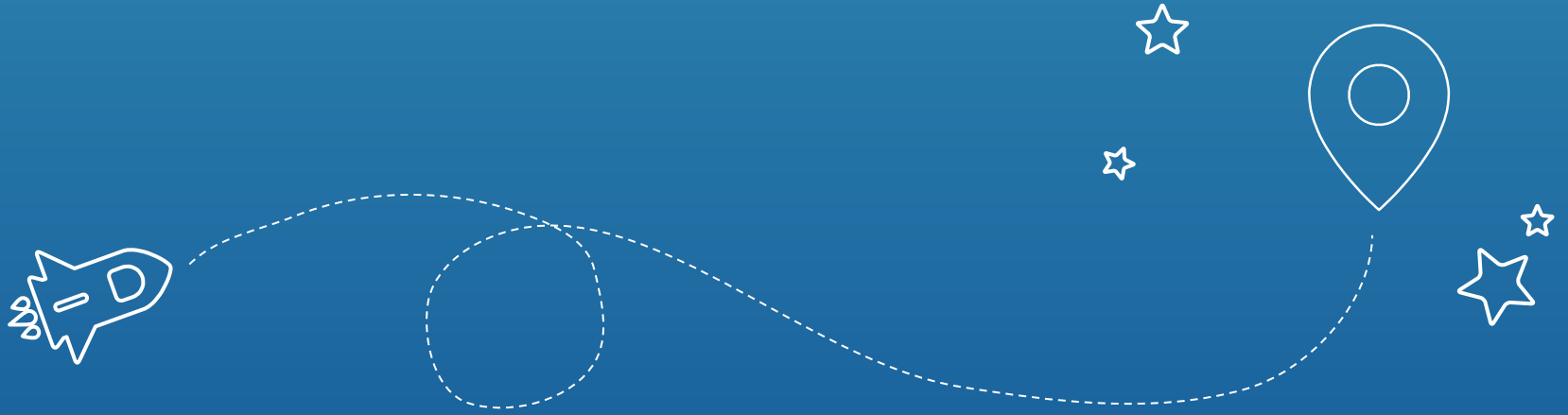
The dermatology department at the Duke Hospital has **25,509** images of skin lesions. All these images are unlabelled and scale from “a very clear centered lesion” to an image of a full body with tiny lesions.

Our task is to train a model to create bounding boxes around each of these lesions and classify them.

DATASETS

1. Our Dataset contains Duke Images as well as images from an online dataset (ISIC 2018).
2. To train our models, we use a combination of these images.
3. We have minimal number of ground truths to the 25,509 images provided by Duke Hospital. Therefore, we utilize Active Learning in training the model to maximize performance gain for each label.





SOLUTION APPROACH

CREATE APPLICATION

TEST OBJECT DETECTION MODELS

ACTIVE LEARNING SOLUTION

☐ clinical
☐ dermoscopy

☐ good
☐ bad
☐ unusable quality

☐ Melanoma
☐ Melanocytic nevus
☐ Basal cell carcinoma
☐ Actinic keratosis / Bowen's disease (intraepithelial carcinoma)
☐ Benign keratosis (solar lentigo / seborrheic keratosis / lichen planus-like keratosis)
☐ Dermatofibroma
☐ Vascular lesion
☒ other

☐ Good
☐ Bad
☐ Blurry
☐ Unusable

☐ pass
☐ not available

☐ light
☐ medium
☐ dark

notes

RetinaNet (Detectron):

```

Average Precision (AP) @ 1 IoU=0.50:0.95 | area= all | maxDets=100 | = 0.660
Average Precision (AP) @ 1 IoU=0.50 | area= all | maxDets=100 | = 0.659
Average Precision (AP) @ 1 IoU=0.75 | area= all | maxDets=100 | = 0.771
Average Precision (AP) @ 1 IoU=0.50:0.95 | area= small | maxDets=100 | = -1.000
Average Precision (AP) @ 1 IoU=0.50:0.95 | area=medium | maxDets=100 | = -1.000
Average Precision (AP) @ 1 IoU=0.50:0.95 | area= large | maxDets=100 | = 0.660
Average Recall (AR) @ 1 IoU=0.50:0.95 | area= all | maxDets= 1 | = 0.714
Average Recall (AR) @ 1 IoU=0.50:0.95 | area= all | maxDets= 10 | = 0.724
Average Recall (AR) @ 1 IoU=0.50:0.95 | area= all | maxDets=100 | = 0.725
Average Recall (AR) @ 1 IoU=0.50:0.95 | area= small | maxDets=100 | = -1.000
Average Recall (AR) @ 1 IoU=0.50:0.95 | area=medium | maxDets=100 | = -1.000
Average Recall (AR) @ 1 IoU=0.50:0.95 | area= large | maxDets=100 | = 0.725
    
```

Faster-RCNN (Detectron):

```

Average Precision (AP) @ 1 IoU=0.50:0.95 | area= all | maxDets=100 | = 0.645
Average Precision (AP) @ 1 IoU=0.50 | area= all | maxDets=100 | = 0.951
Average Precision (AP) @ 1 IoU=0.75 | area= all | maxDets=100 | = 0.727
Average Precision (AP) @ 1 IoU=0.50:0.95 | area= small | maxDets=100 | = -1.000
Average Precision (AP) @ 1 IoU=0.50:0.95 | area=medium | maxDets=100 | = -1.000
Average Precision (AP) @ 1 IoU=0.50:0.95 | area= large | maxDets=100 | = 0.645
Average Recall (AR) @ 1 IoU=0.50:0.95 | area= all | maxDets= 1 | = 0.708
Average Recall (AR) @ 1 IoU=0.50:0.95 | area= all | maxDets=10 | = 0.715
Average Recall (AR) @ 1 IoU=0.50:0.95 | area= all | maxDets=100 | = 0.715
Average Recall (AR) @ 1 IoU=0.50:0.95 | area= small | maxDets=100 | = -1.000
Average Recall (AR) @ 1 IoU=0.50:0.95 | area=medium | maxDets=100 | = -1.000
Average Recall (AR) @ 1 IoU=0.50:0.95 | area= large | maxDets=100 | = 0.715
    
```

Model Initialization (randomly select several images from the training dataset to initialize model)

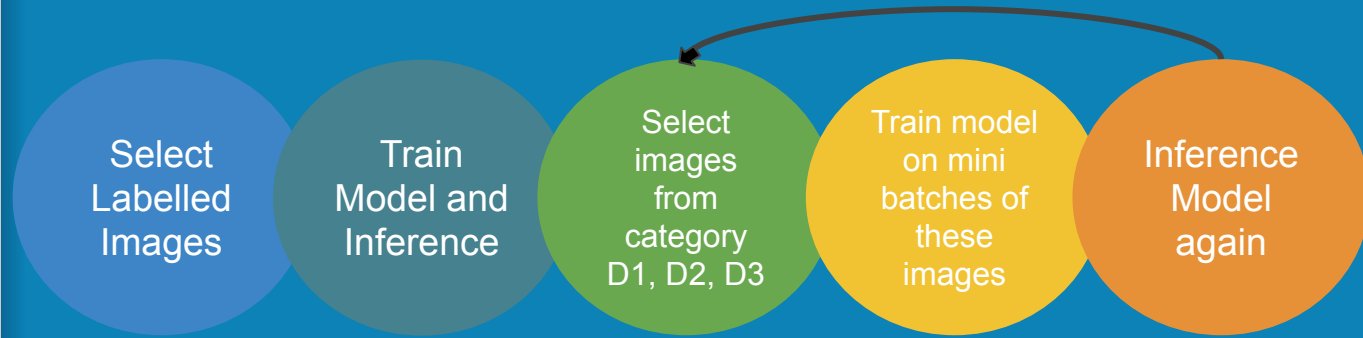
Inference on the whole dataset (both labeled data and unlabeled data) by using the trained model

Select most uncertainty images from the unlabeled dataset and give them to the orcl according to defined rules. Reconstruct the labeled and unlabeled dataset

Training the model again whose minibatch is constructed by our definition.

Repeat until the performance of dataset fit requirement. (performance is similar to use the whole training dataset)

Active Learning



D1 = 1 Random Labelled Image

D2 = 1 Labelled Image with Score $\sim 1/(N+1)$

D3 = 2 Unlabelled Images with Score $\sim 1/(N+1)$

N = Number of Classes, 1 = Background Class

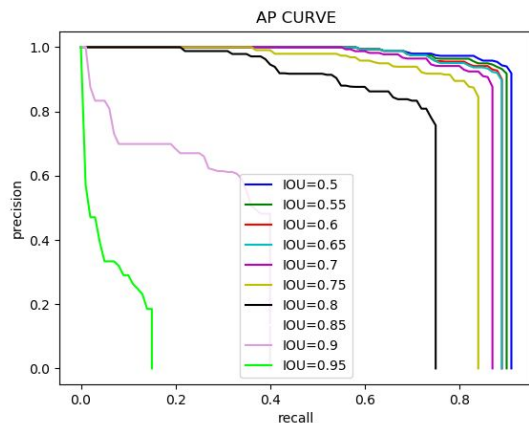


RESULTS



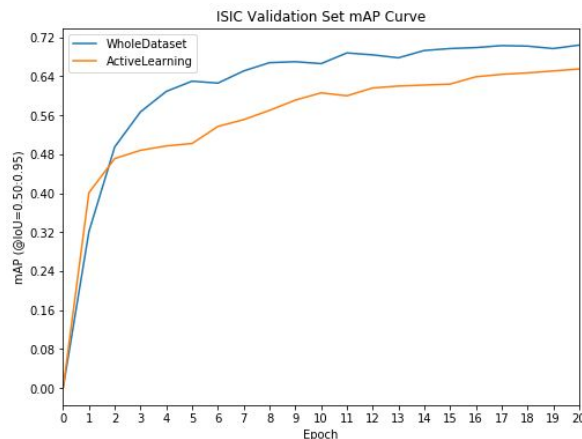
ISIC Dataset Results (RetinaNet):

Whole Dataset Training:

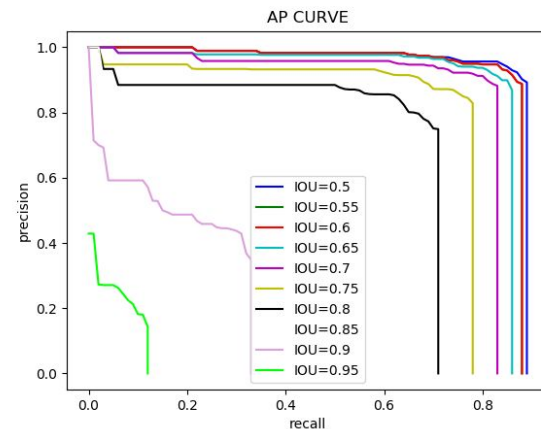


Training Process:

- Train on the whole dataset (2334 images) at every epoch



Active Learning:



Training Process:

- Train on random subset of 40 labelled images for 5 epochs
- At each following epoch, train on 20 mini-batches of 4 images selected based on D1, D2, D3 criteria
- Total # images used per epoch: **80**



ACCOMPLISHMENTS & GOING FORWARD



Accomplishments:

1. Successfully set up an AL pipeline using RetinaNet
2. Tested and validated its effectiveness and efficiency using the ISIC dataset
3. Recognized some key problems with performance on Duke dataset: varying image quality, glare, size of lesions, etc.

Going Forward:

1. Incorporate the Duke clinical data into the pipeline
2. Further automate the process by integrating the lesion app within the AL pipeline to serve as an oracle
3. Continue to improve the performance on the highly varying Duke dataset



Thank You