PSNA Pneumonia Detection Challenge

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Team 19

Project repository: https://github.com/samuelyutt/Selected-Topics-in-Visual-Recognition-using-Deep-Learning-course/tree/final-project/FinalProject

Outline

- Introduction
- Related Work
- Methodology
- Experiments
- Conclusion
- Future Work

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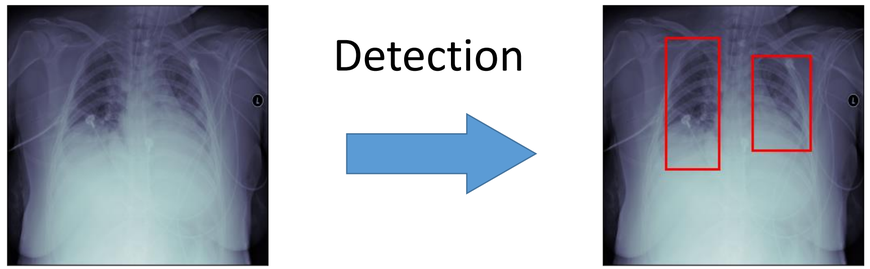
Introduction

Background

- Pneumonia is top 10 causes of death in both United States and Taiwan
- Analysis patient's chest radiographs (CXRs) is time consuming

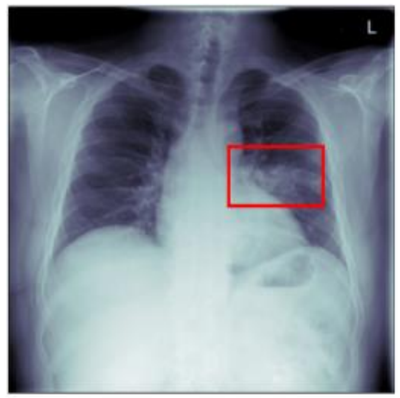
Task

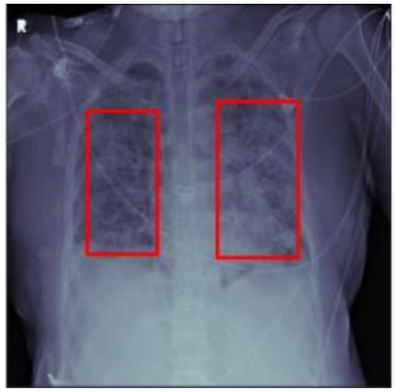
Build a model to detect lung opacities on CSRs

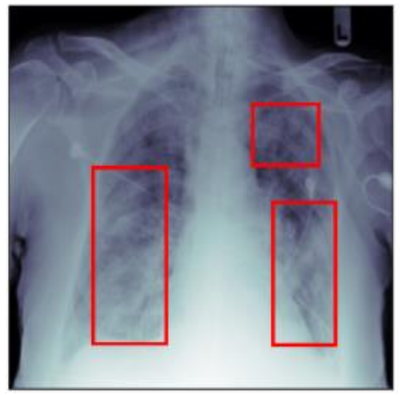


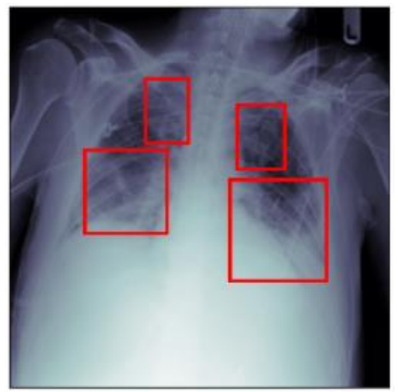
Challenge

- Not all of the input images contain lung opacities
- We can not predict 100% like ground truth
  - Not sure is there exists noise data
  - Hard to debug from the detection results









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Related Work

	YOLOv5	Faster R-CNN
Stage	One-stage	Two-stage
Speed	Faster	Slower
Accuracy	?	?

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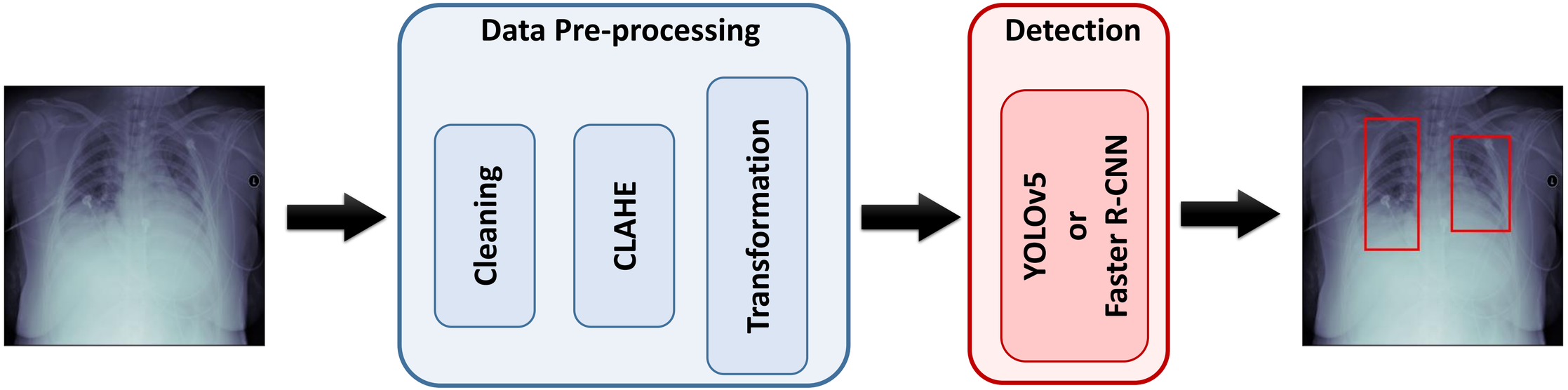
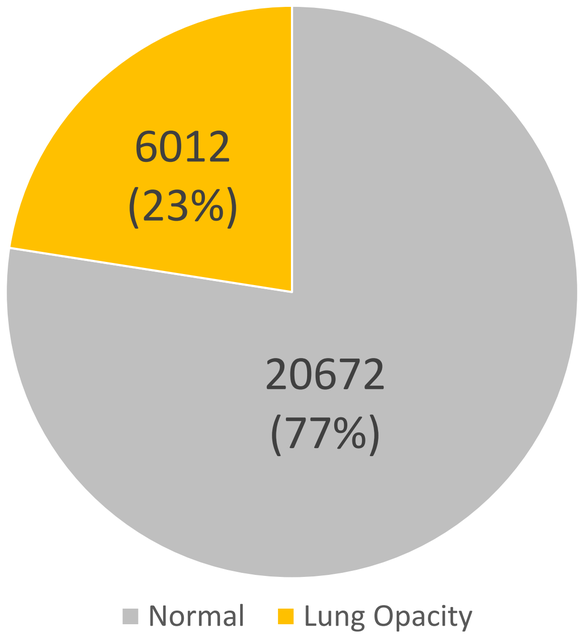
Overview



- In this project, we focus on data processing

Data Pre-processing – Cleaning

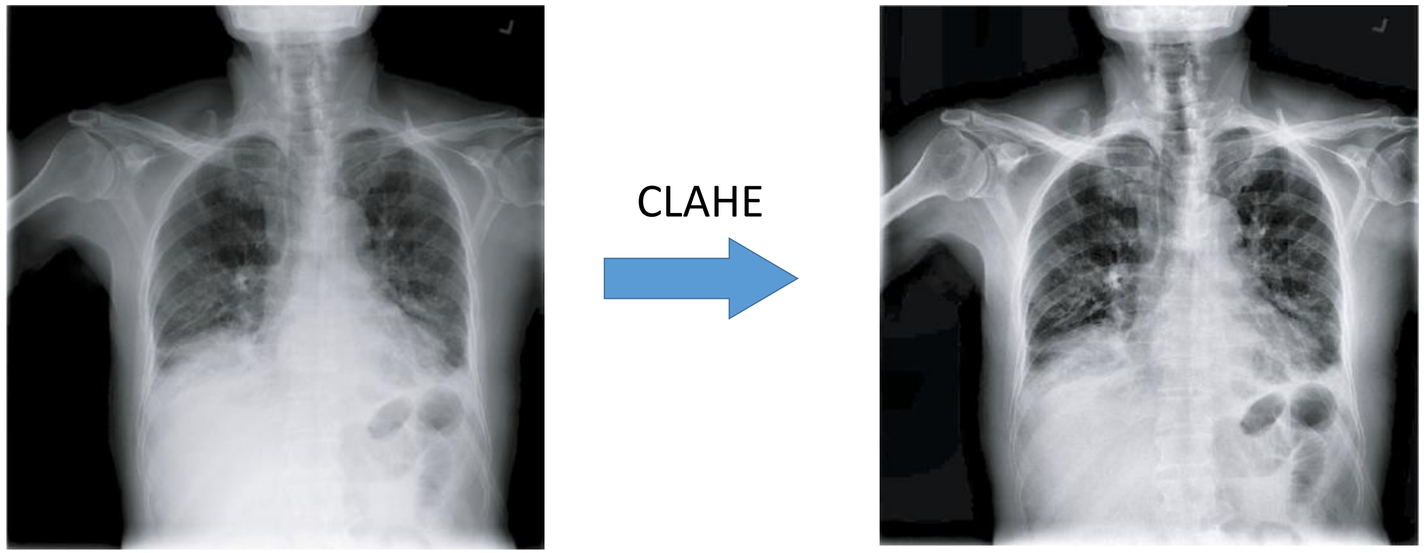
- Contain 26,684 image training dataset
- Use those images with lung opacity only



Data Pre-processing – CLAHE

Contrast Limited Adaptive Histogram Equalization (CLAHE)

- Improve contrast in images
- Widely used in medical images



Data Pre-processing – Transformation

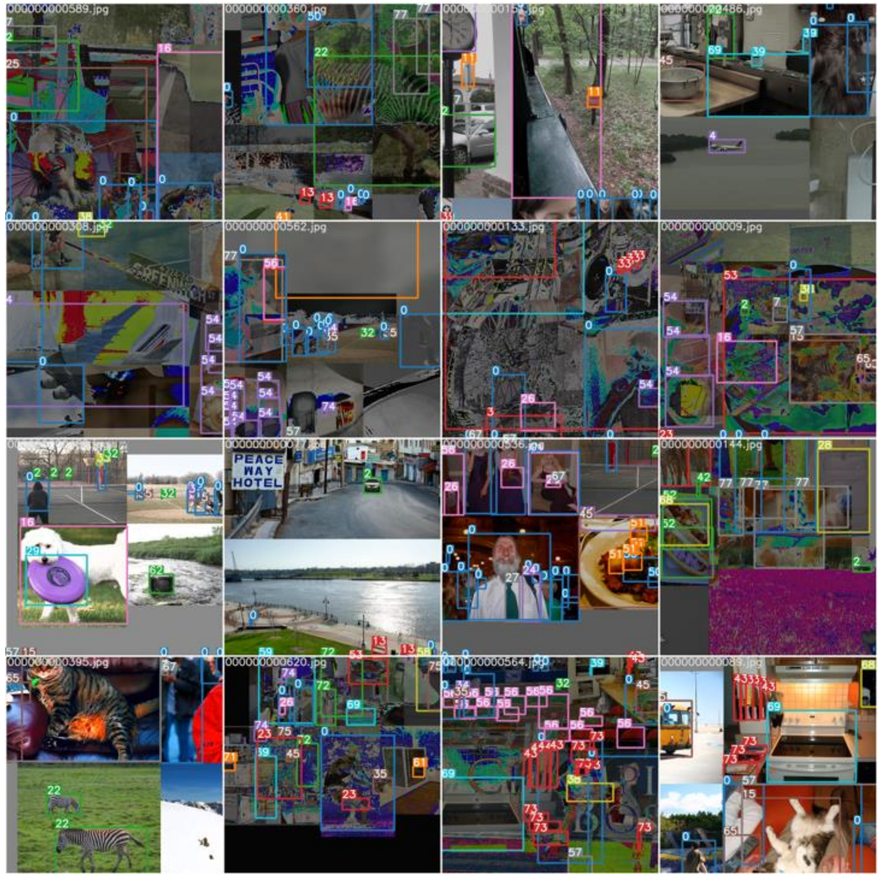
- Resize: $1024 \times 1024 \rightarrow 500 \times 500$ for saving computational resources
- Flip: randomly flipping for data augmentation
- Rotate: randomly rotate 90 degree for data augmentation

Mosaic in YOLOv5

- Mixing 4 training images into one
- Increase the variety of background

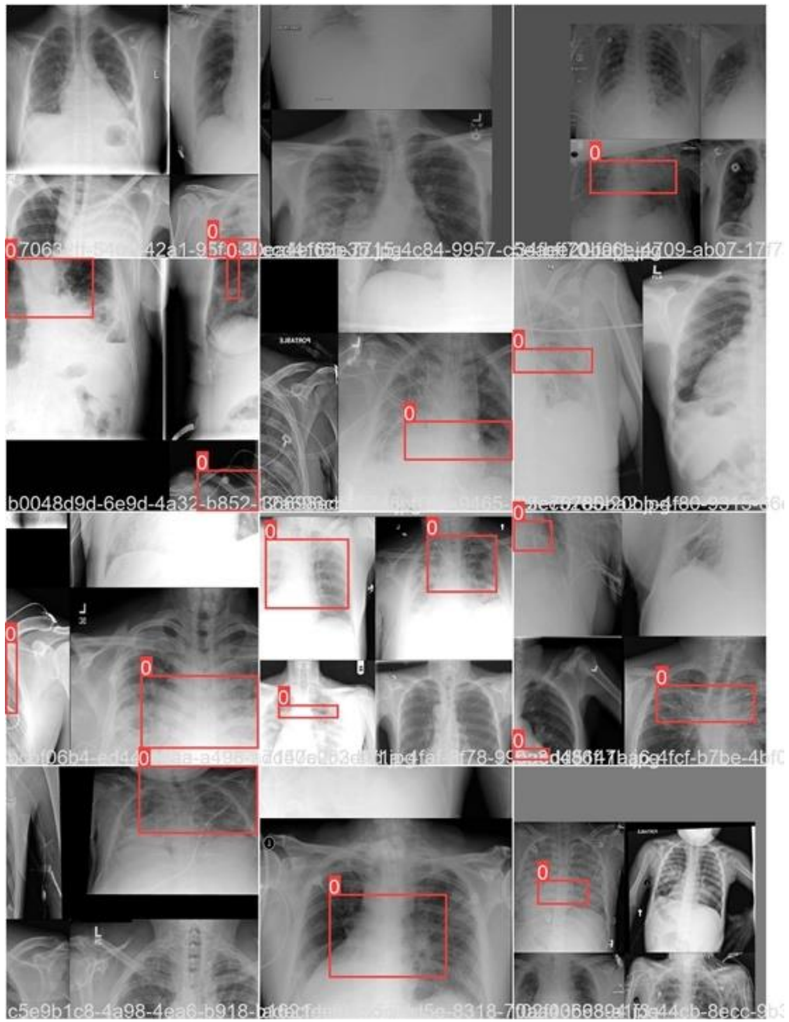
  → Identify the targets from a local view of an image
- BN from 4 different images on each layer

  → Reduce the need for GPU



Issue of Using Mosaic in Pneumonia dataset

- Mosaic is not suitable for Pneumonia dataset
- Pneumonia detection need to consider whole image
  - Find the location of lungs → Detect the opacities



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  - Experimental Results
  - Ablation Studies
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Setup

Dataset

- Training: 26,684 images (only 6,012 images are used for training after data cleaning)
- Testing: 3,000 images

Evaluation Metric

Mean Average Precision (mAP)

Model

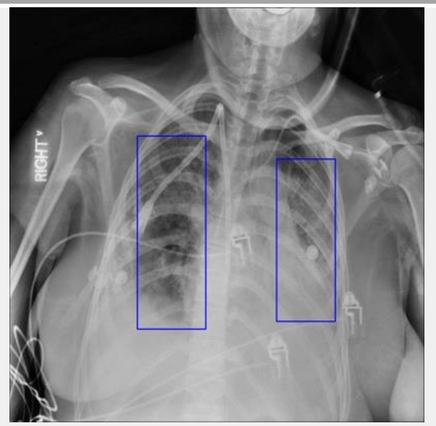
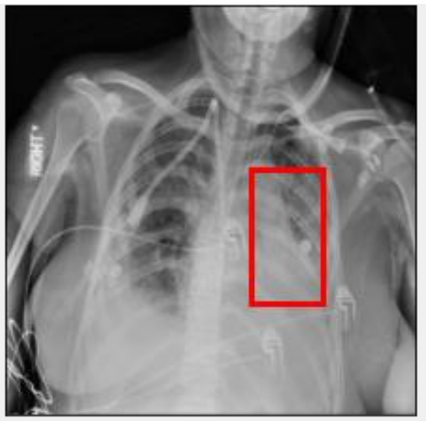
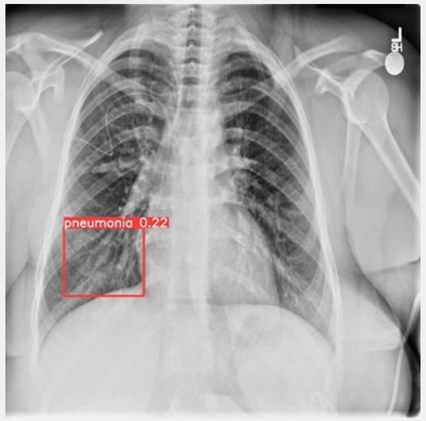
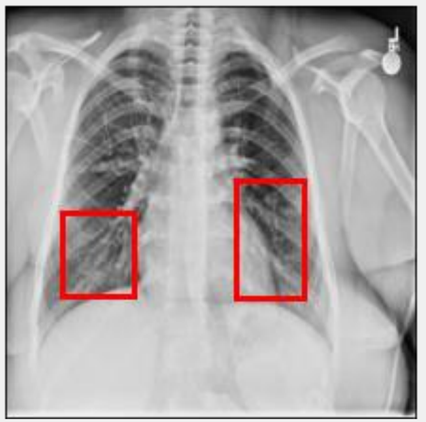
- YOLOv5: Pre-trained YOLOv5X with CSPDarknet53 as the backbone
- Faster R-CNN: Pre-trained Faster R-CNN with ResNet50 as the backbone

Experimental Results

Model	mAP
Baseline	**0.20125**
YOLOv5	0.05240
Faster R-CNN	0.14062

- Baseline > Faster R-CNN > YOLOv5

Detection Results

Type	Ground Truth	YOLOv5	Faster R-CNN
Training			
Test			

Ablation Studies

1. w/o Mosaic v.s. w/ Mosaic (YOLOv5)
2. w/o Data Cleaning v.s. w/ Data Cleaning (Faster R-CNN)
3. w/o CLAHE v.s. w/ CLAHE (Faster R-CNN)
4. w/o Resizing v.s. w/ Resizing (Faster R-CNN)
5. w/o Rotation v.s. w/ Rotation (Faster R-CNN)

w/o Mosaic v.s. w/ Mosaic

Setting	mAP
w/o Mosaic	**0.05240**
w/ Mosaic	0.01470

- **+ 0.0354** mAP without using Mosaic
- Mosaic is not suitable for this dataset

w/o Data Cleaning v.s. w/ Data Cleaning

Setting	mAP
CLAHE + rotate90 + resize	0.12755
CLAHE + cleaning + rotate90 + resize	**0.14062**

- **+ 0.01305** mAP with data cleaning

w/o CLAHE v.s. w/ CLAHE

Setting	mAP
cleaning + rotate90 + resize	0.13948
CLAHE + cleaning + rotate90 + resize	**0.14062**

- **+ 0.00114** mAP with CLAHE
- The gain of CLAHE is quite limited

w/o Resizing v.s. w/ Resizing

Setting	mAP
CLAHE + rotate90	0.12240
CLAHE + rotate90 + resize	**0.12755**

- **+ 0.00515** mAP with resize input 1024×1024 to 500×500
- Resize the inputs to smaller size do not hurt the performance

w/o Rotation v.s. w/ Rotation

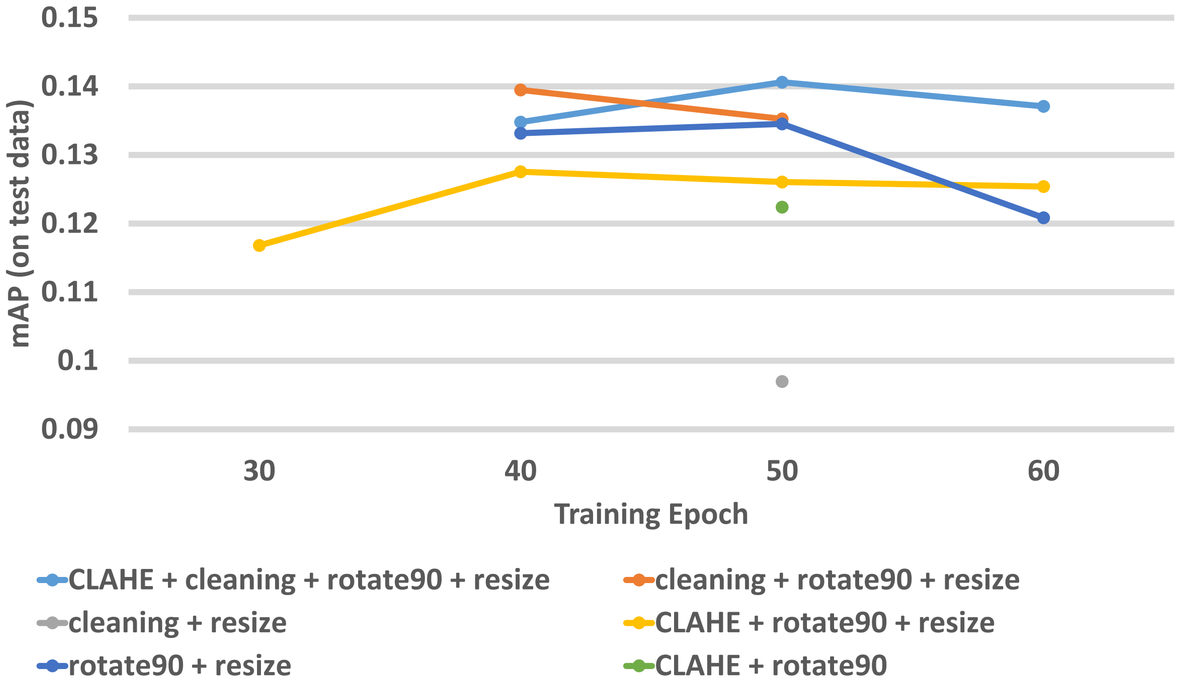
Setting	mAP
cleaning + resize	0.09697
cleaning + rotate90 + resize	**0.13948**

- **+ 0.04251** mAP with randomly rotate input 90 degree as data augmentation

Quick Summary of Ablation Studies

1. **w/o Mosaic** v.s. w/ Mosaic (YOLOv5) → + 0.03540
2. w/o Data Cleaning v.s. **w/ Data Cleaning** (Faster R-CNN) → + 0.01305
3. w/o CLAHE v.s. **w/ CLAHE** (Faster R-CNN) → + 0.00114
4. w/o Resizing v.s. **w/ Resizing** (Faster R-CNN) → + 0.00515
5. w/o Rotation v.s. **w/ Rotation** (Faster R-CNN) → + 0.04251

Discussion



- Test performance stays flat or even drops as training epoch increase
- Overfitting to training data or inappropriate hyper-parameter (e.g. schedule of LR)

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Conclusion

- Faster R-CNN performs better than YOLOv5 in our experiment
- Proper data processing does help to improve performance
- Mosaic in YOLOv5 is not suitable for this dataset

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Future Work

Modification on Faster R-CNN

- Apply K-Means++ to obtain the initial anchor box size
- Use multi-scale features to generate region of interests (original Faster R-CNN only use one scale feature)