Object Detection & Classification for Chest X-Ray Images

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GitHub: https://github.com/wenchengking/End-To-End-CXR-Hybrid-Deep-Learning-Solution

10cm

Table of contents

01 Business Problems

02 Data Description & EDA

03 Object Detection

04 Classification

05 Model Operation

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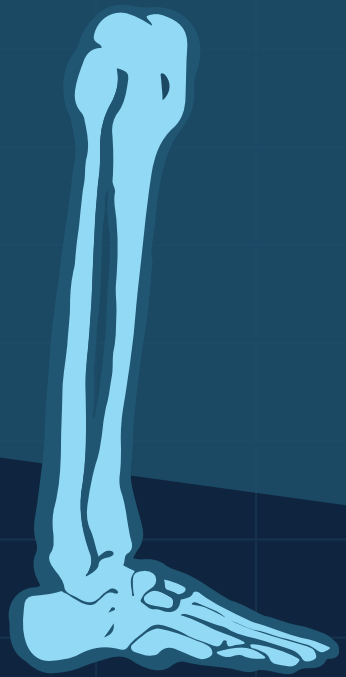

01
Business Problems

Market Value

$733.5 Billion
in 2020

$1683.52
Billion by 2030

According to Precedence Research, the global biotechnology market size was valued at USD 733.5 billion in 2020 and is anticipated to surpass around USD 1,683.52 billion by 2030.

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Shortage In Healthcare Provision

Physical Resource

Human Resource

Lack of Awareness

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Step 1: Object Detection for foreign objects

Step 2: Multi Classification for pneumonia

02
Data Description

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Our Data

Object Detection

397 Images

1 foreign object present in each

60/15/25 Train Validation Test Split

Classification

5842 Images

3 classes: Normal, Virus, Bacteria

- Normal: 1583 images, 27.1%
- Virus: 1490 images, 25.5%
- Bacteria: 2769 images, 47.4%

60/20/20 Train Validation Test Split

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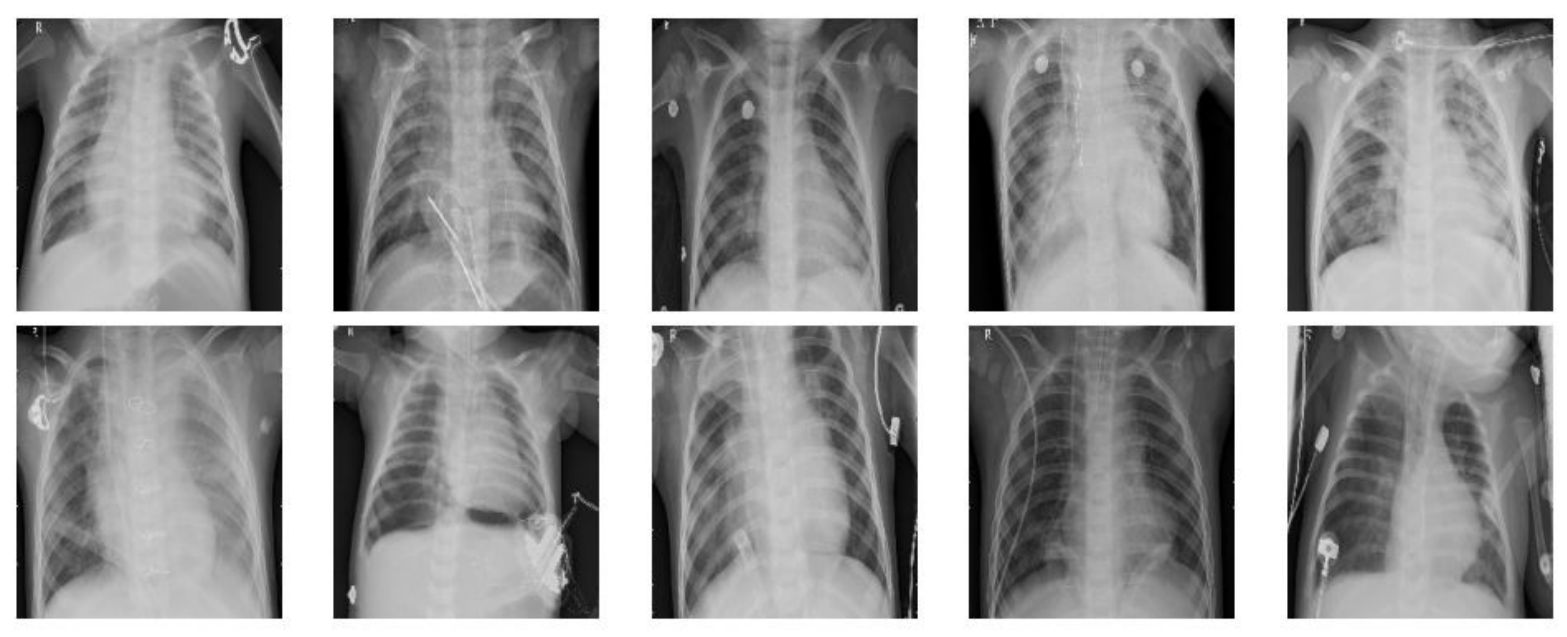
Foreign Object Example



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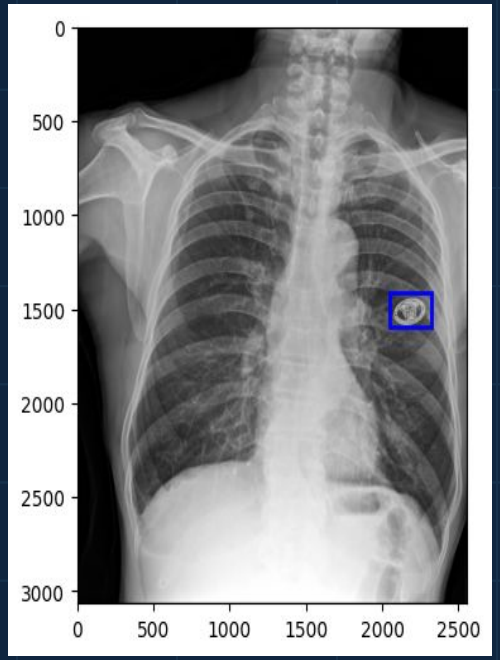
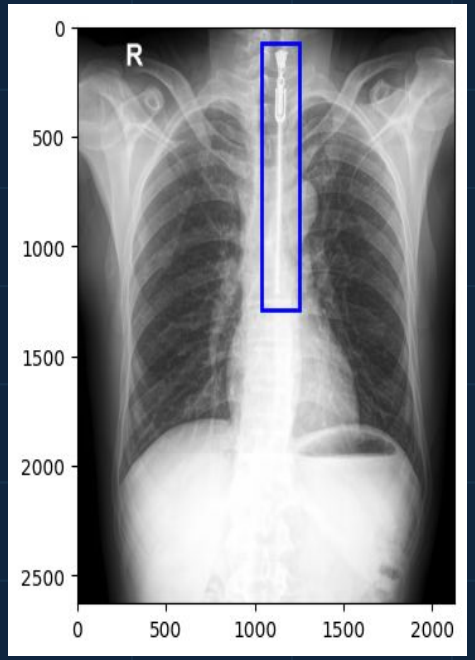
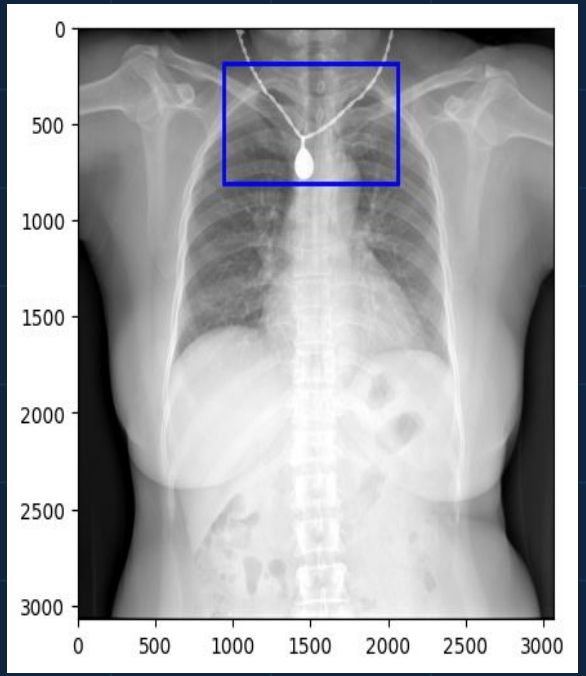
Foreign Object Example







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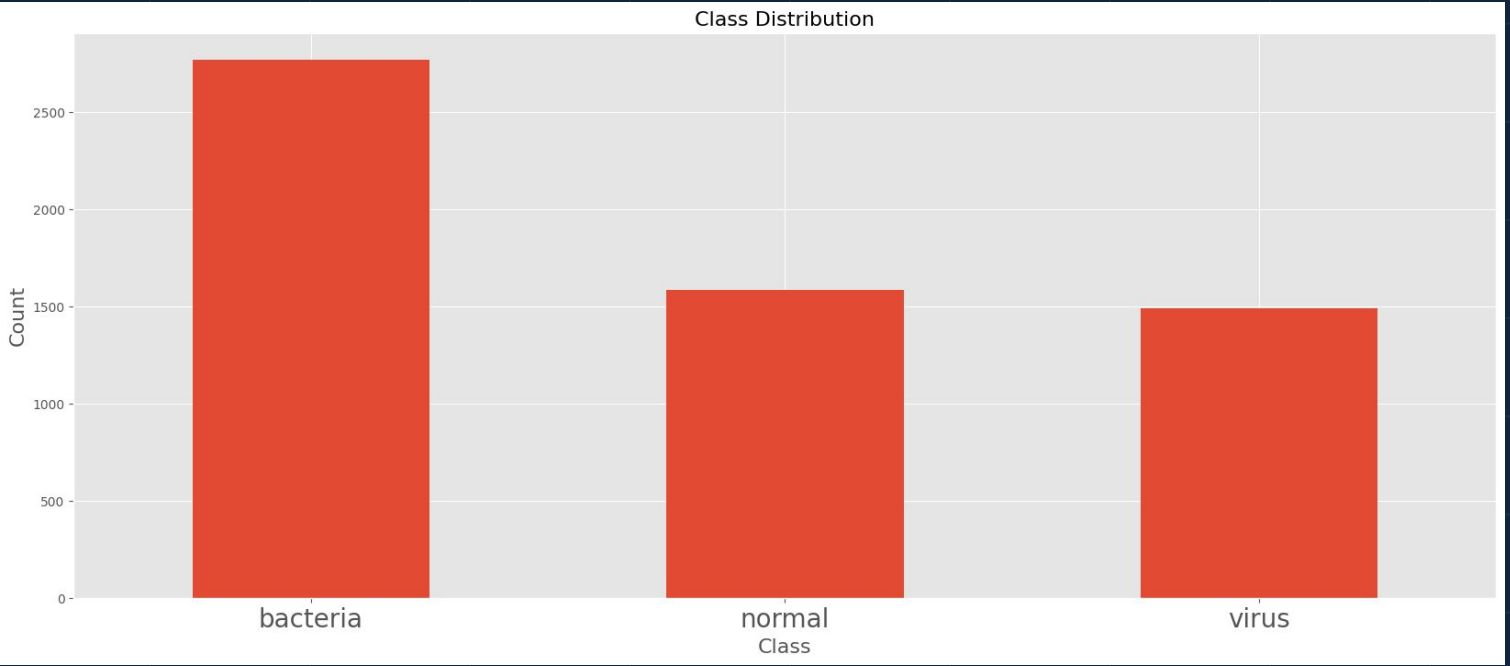
Pneumonia Class Distribution



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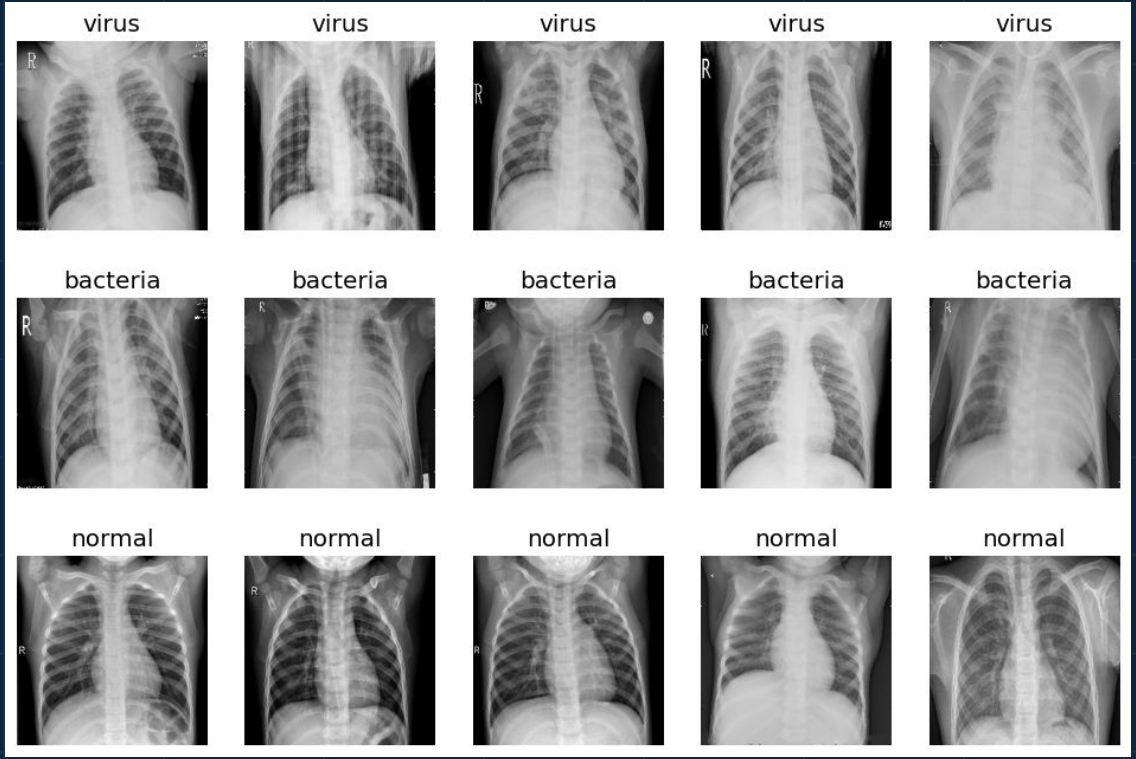
Pneumonia Classes Example



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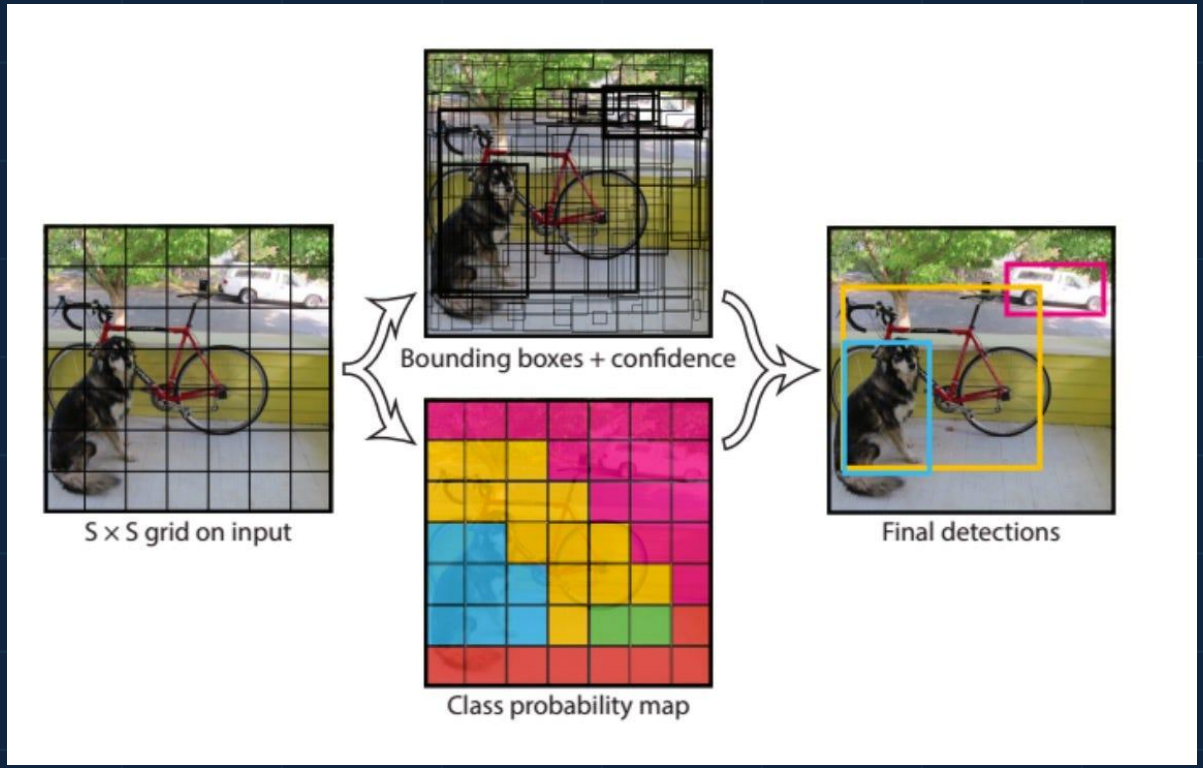
03

Foreign Object Detection Models

Challenger Model: YOLO



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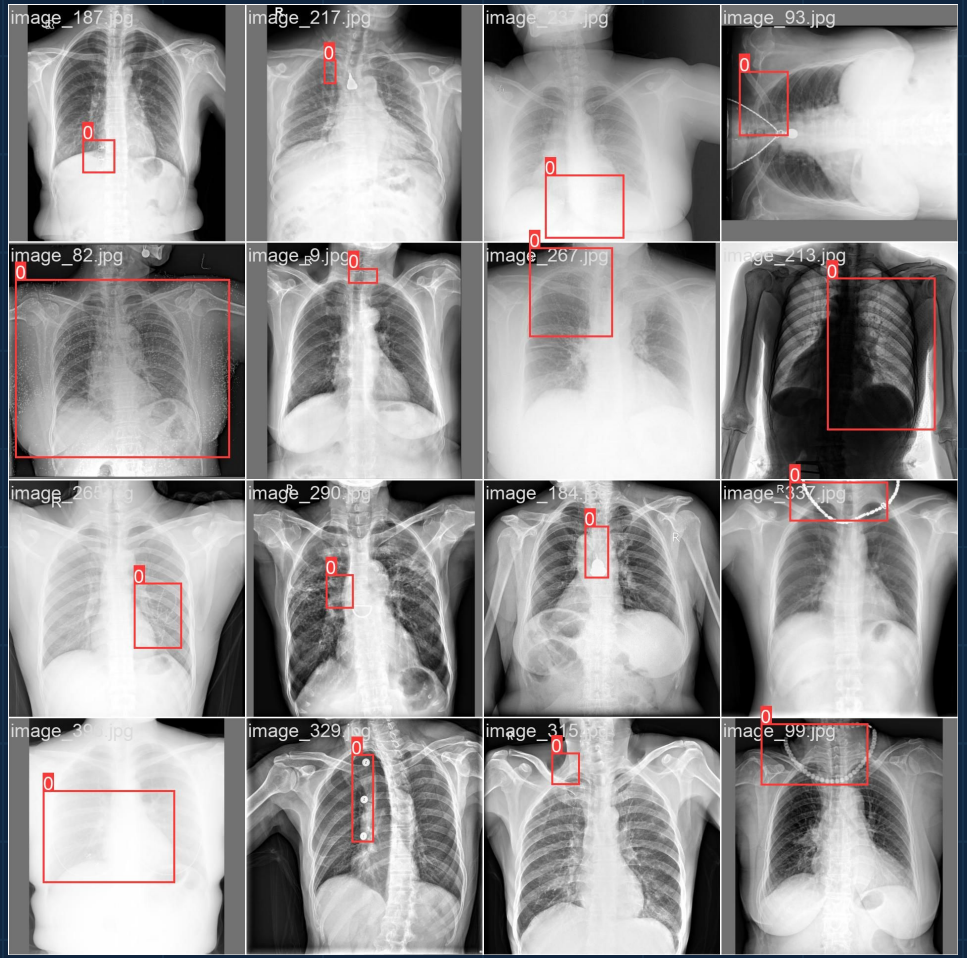
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image_315.jpg
image_99.jpg

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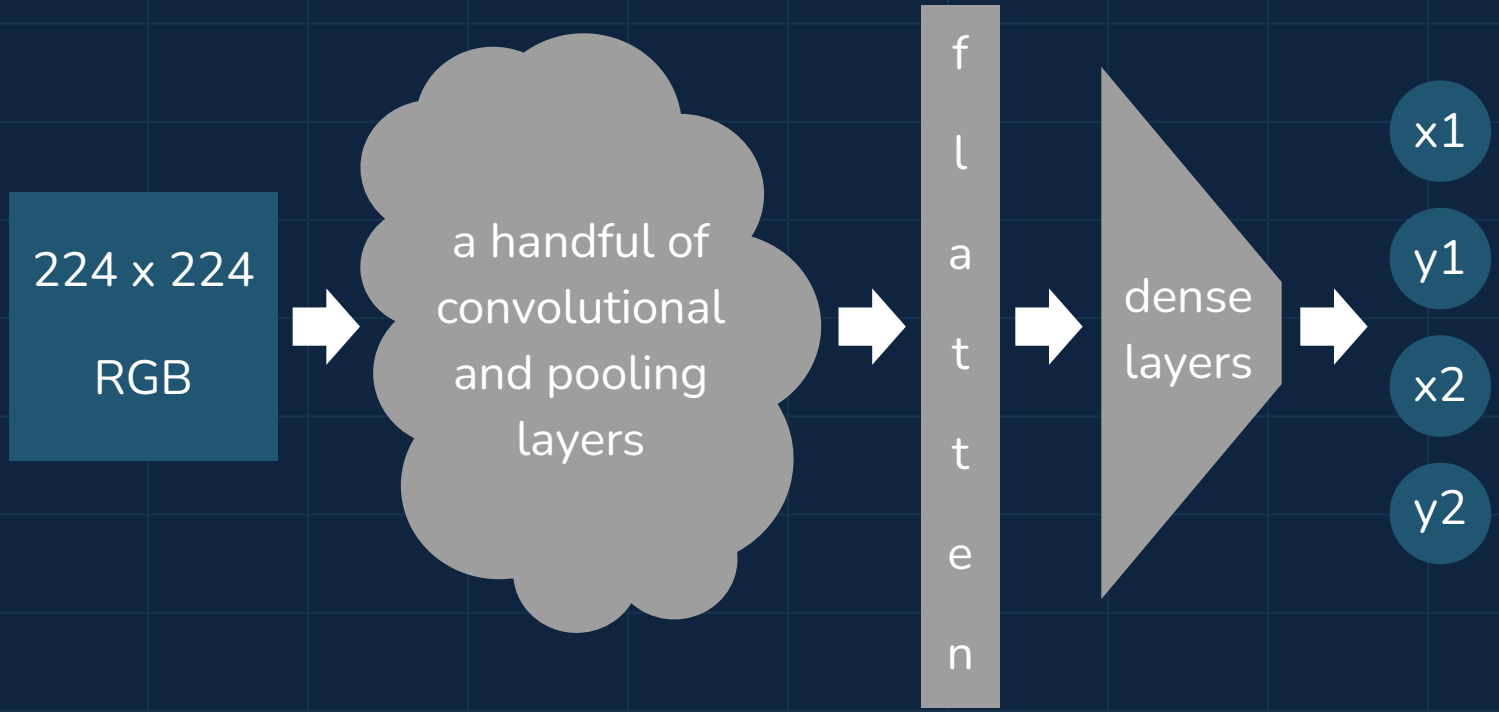
Champion Model: Custom BBR



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Performance / Metrics

YOLO Transfer Learning

0.6%

IOU

Bounding Box Regression

11.4%

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Model Comparison

Why Are Our Models Bad?

YOLO:

- Inadequate labelling
- “Fit” of model

BBR:

- Extreme variation
- Position vs. presence

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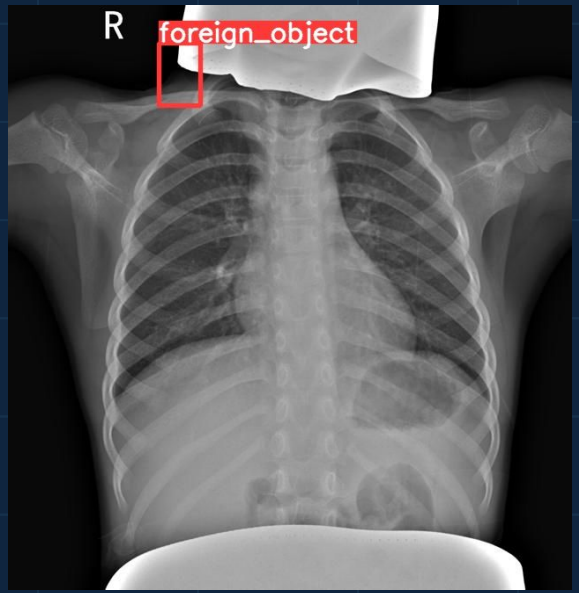
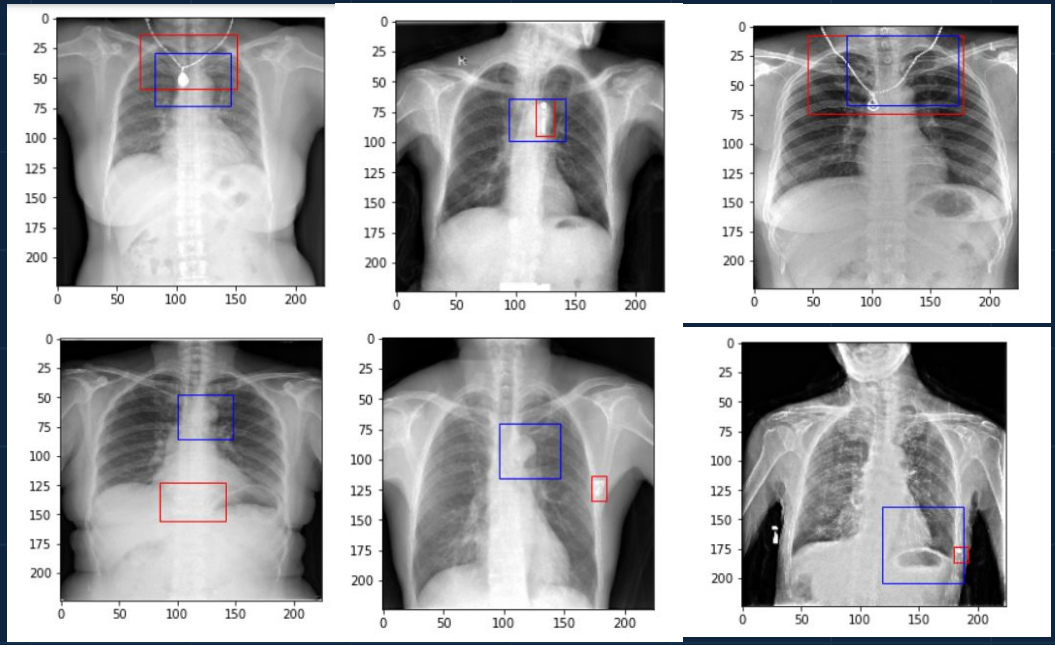
Test Results Illustration

YOLO:



BBR:



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04
Classification Models

Challenger Model: CNN

3 Convolutional layers
- 32, 64, 128 filters respectively
- Max pooling, batch normalization, dropout regularization (0.4)

2 Dense layers
- 64, 3 units respectively

ReLU activation throughout, softmax for last layer

Exponential decaying Learning Rate
- Start: 0.001
- Decay Rate: 0.85
- Decay step: 100

Metrics: Accuracy, Precision, Recall

16 epochs, Adam optimizer, cross-entropy loss

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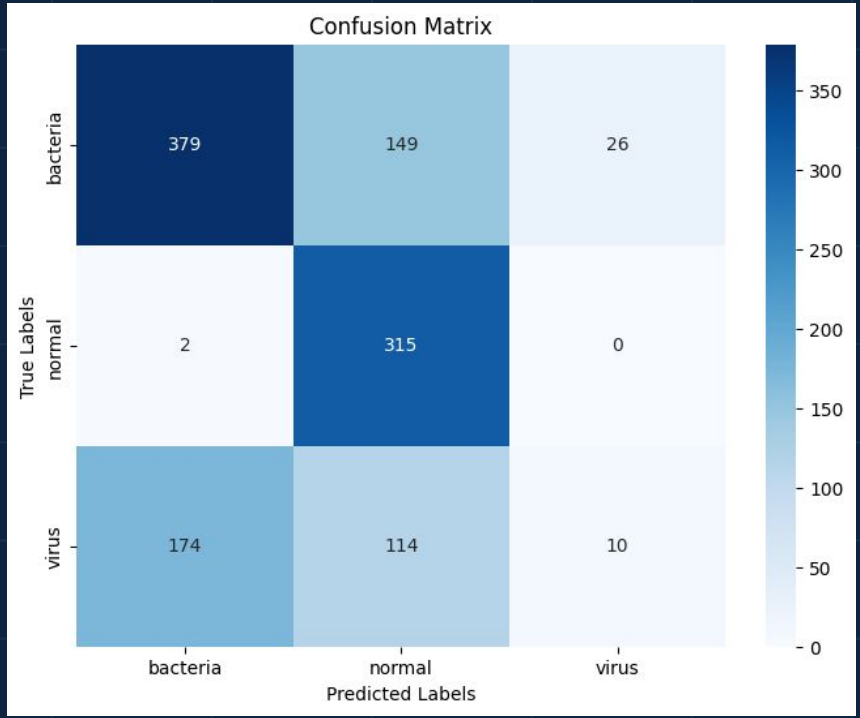
Model Performance

Test Set

- Accuracy: 0.60
- Precision: 0.65
- Recall: 0.55

Class Level Recall

- Normal: 0.99
- Bacteria: 0.68
- Virus: 0.03



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Champion Model: UGG16

All layers freezed except last 2

4 Dense Layers

- 512, 128, 64, 3 units respectively
- Global average pooling, batch normalization, dropout regularization (0.2)

ReLU activation throughout, softmax for last layer

Exponential decaying Learning Rate

- Start: 0.001
- Decay Rate: 0.85
- Decay step: 100

Metrics: Accuracy, Precision, Recall

16 epochs, Adam optimizer, cross-entropy loss

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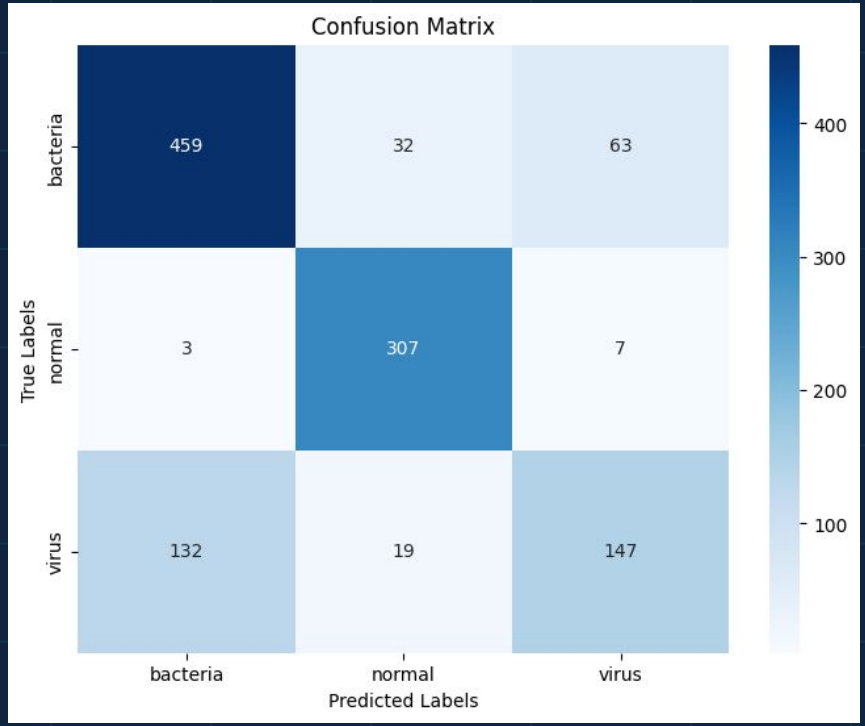
Model Performance

Test Set

- Accuracy: 0.78
- Precision: 0.79
- Recall: 0.77

Class Level Recall

- Normal: 0.96
- Bacteria: 0.83
- Virus: 0.49



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Model Comparison

	Overall Performance	Class-level Performance
CNN	Lower precision, recall, and accuracy	Better at predicting normal class, due to tendency of classifying all classes as normal
VGG16	Better in all metrics, yet still prone to overfitting	Better at telling bacteria class apart from other classes, yet still fail to tell virus class apart from bacteria class

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05
Model Operation

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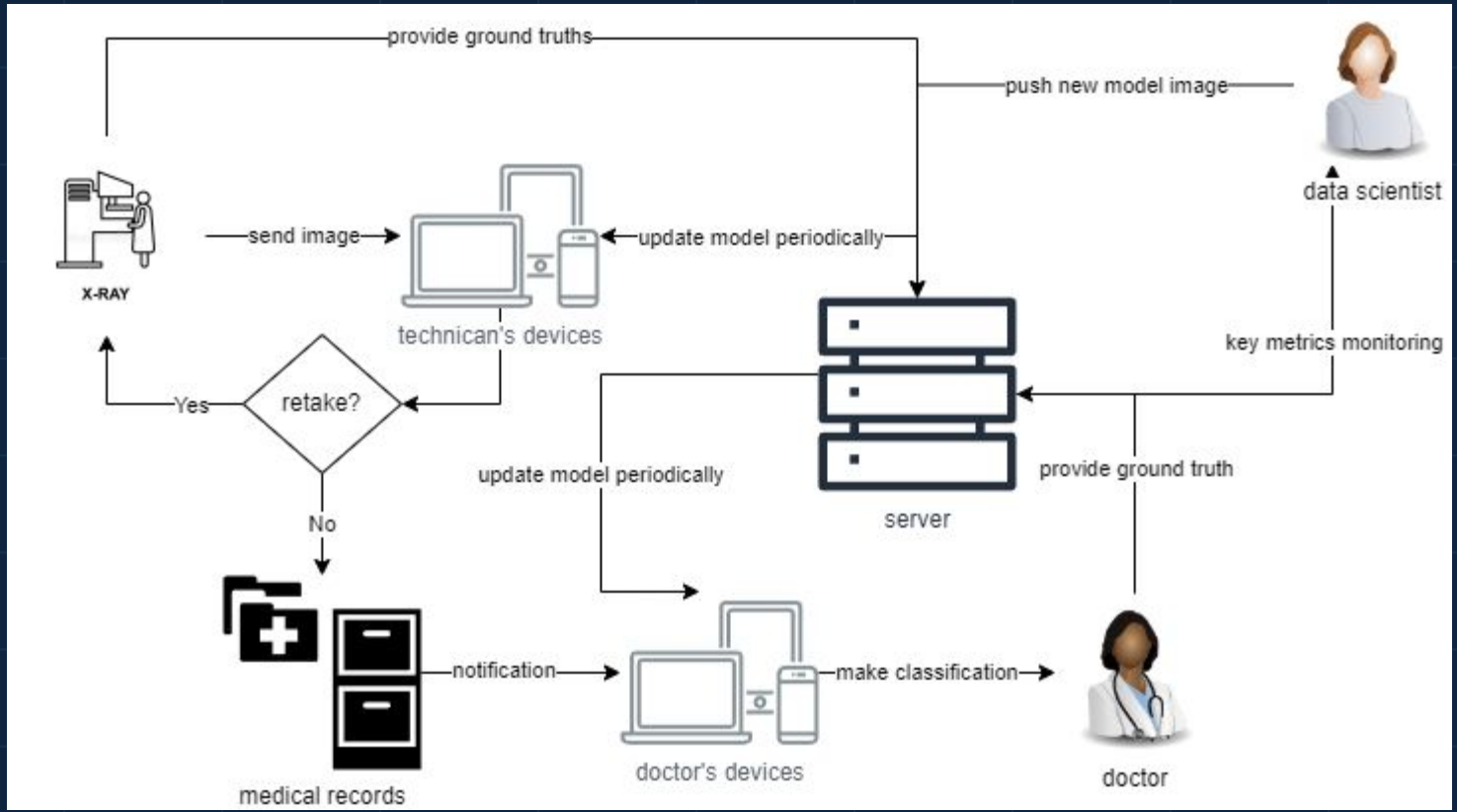
provide ground truths
push new model image
data scientist
X-RAY
send image
update model periodically
technician's devices
key metrics monitoring
Yes
retake?
No
update model periodically
server
provide ground truth
notification
make classification
medical records
doctor's devices
doctor

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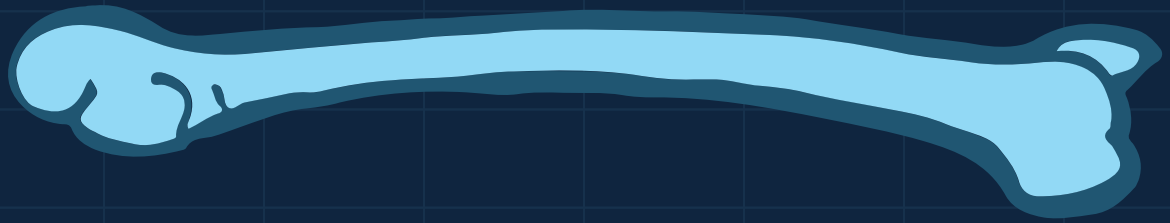
MAVEN IMAGING

Thank You



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