Identification of Cavities in Dental Imaging

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Project Overview

- Discuss project goals
- Make it equitable for all peoples
- Discuss the model architecture
- Discuss the challenges and results of the project

Project Goals

- Create a computer vision model that is capable of detecting dental caries in x-ray images and colored photos of peoples' teeth
- Address ethical disparities present in the dental industry
- Increase patient trust and efficiency of care

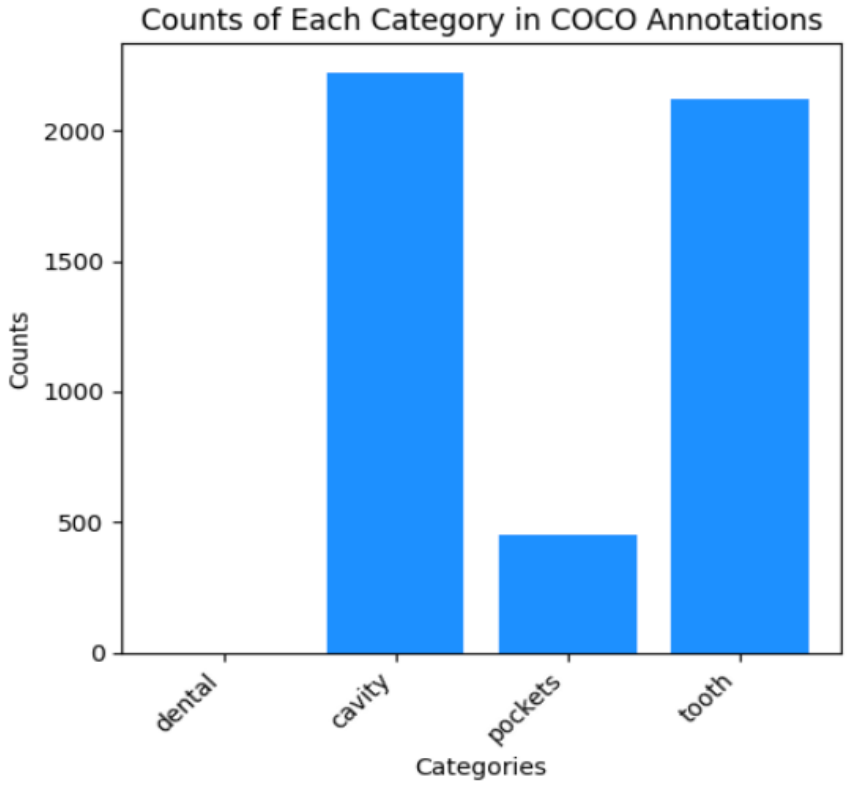
Value Proposition

- Increased cavity detection accuracy allows for better customer care and service which generates more revenue through recurring clients

- A higher rate of cavity detection will lead to more fillings which can generate more revenue than simple dental cleanings

Exploratory Data Analysis (EDA)

- First, we explored the data (images) and determined what information could be extracted to help us construct our model.



EDA (continued)

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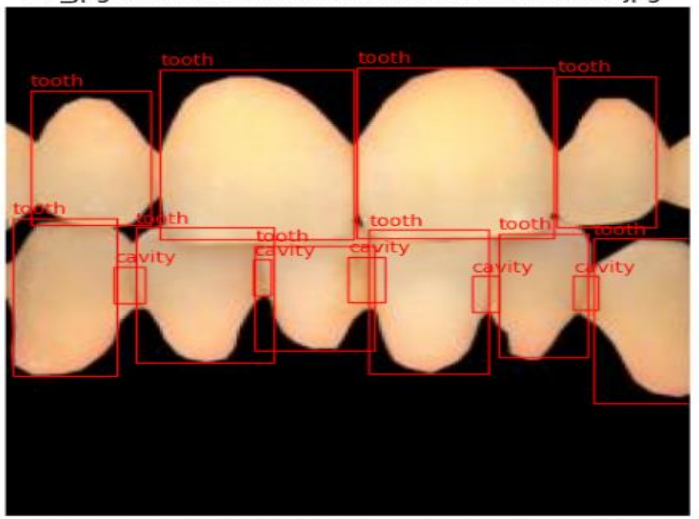

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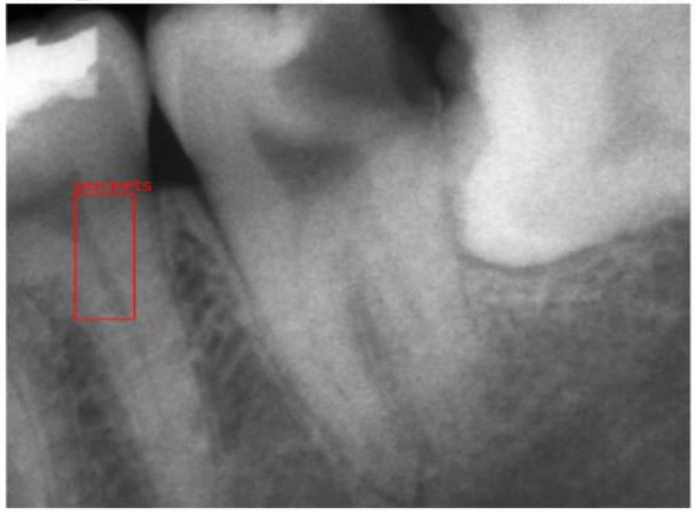

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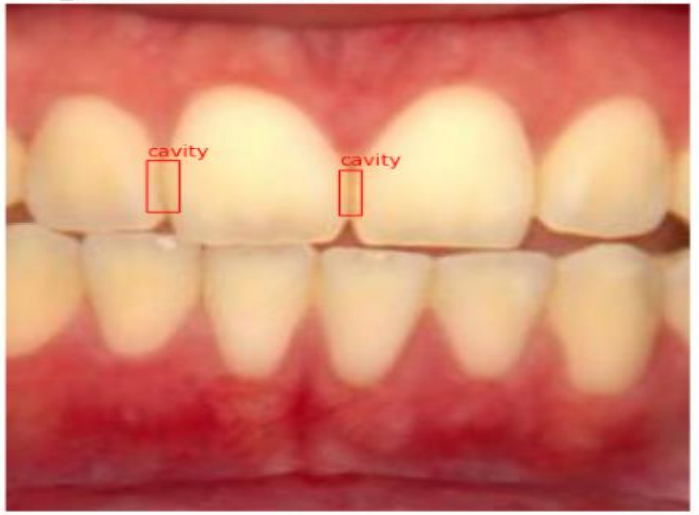


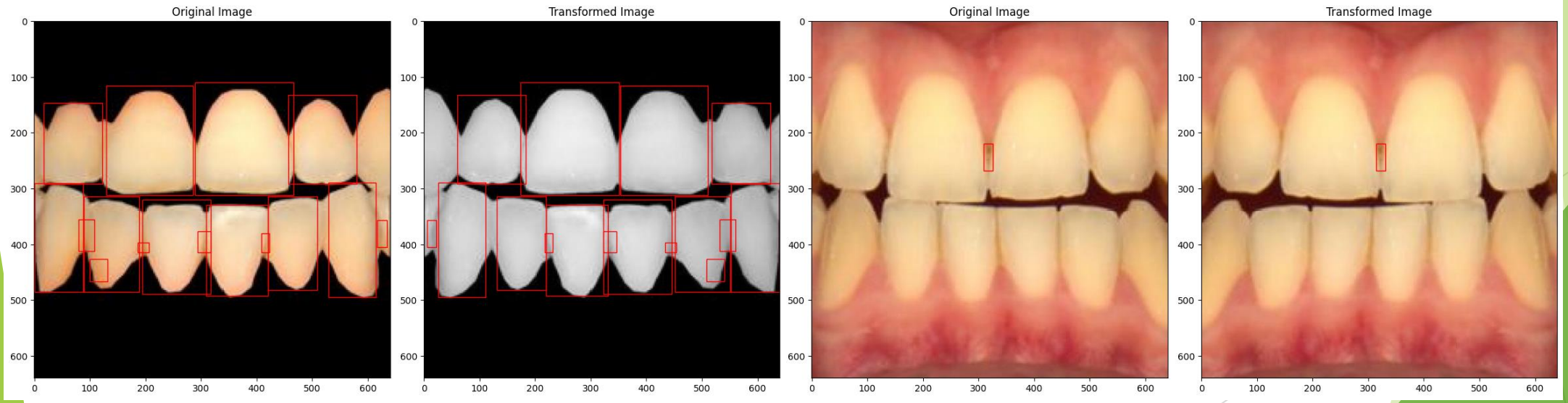
Data Preprocessing

- Consolidate labels (‘dental’, ‘pockets’, and ‘tooth’ >>> ‘non-cavity’
- Address images without any bounding boxes
- Convert data to torch tensors
- Split the dataset into train/validation/testing sets (85%, 5%, 15%)

```
Number of samples in train_dataset: 884
Number of samples in val_dataset: 52
Number of samples in test_dataset: 104
Number of images: 16
Boxes: [torch.Size([1, 4]), torch.Size([14, 4]), torch.Size([1, 4]), torch.Size([14, 4]),
```

Data Preprocessing – Define Augmentations

- Defined two separate transform functions that will augment our data during model training:
  - TransformV1: Convert to grayscale and random flip (both horizontal and vertical)
  - TransformV2: Same as V1 but without conversion to grayscale



TransformV1

TransformV2

Model Methodology –Architecture

- Tools/Libraries
  - PyTorch + Torchvision – A widely accepted machine learning framework that contains a variety of modules used to build and train neural networks for computer vision tasks

- Model
  - Faster-RCNN – A Region Convolutional Neural Network that utilizes a deep learning based framework for accurate and efficient object detection
    - Resnet50 – A pre-trained neural network architecture originally trained on ImageNet, which consisted of a million varied images

Model Methodology – Parameters and Optimization

- Base Model
  - A Stochastic Gradient Decent (SGD) optimizer was used because it is efficient and uses as little memory and processing power as possible
  - Learning rate = 0.005, momentum = 0.9, weight decay = 0.0005
  - Batch size of 16 & Trained over 20 epochs
  - TransformV1 Augmentation (all images converted to grayscale)
- Second Model
  - TransformV2 Augmentation (no grayscale conversion) + same parameters as base
- Third Model
  - TransformV2 Augmentation + Learning Rate adjustment >> 0.008

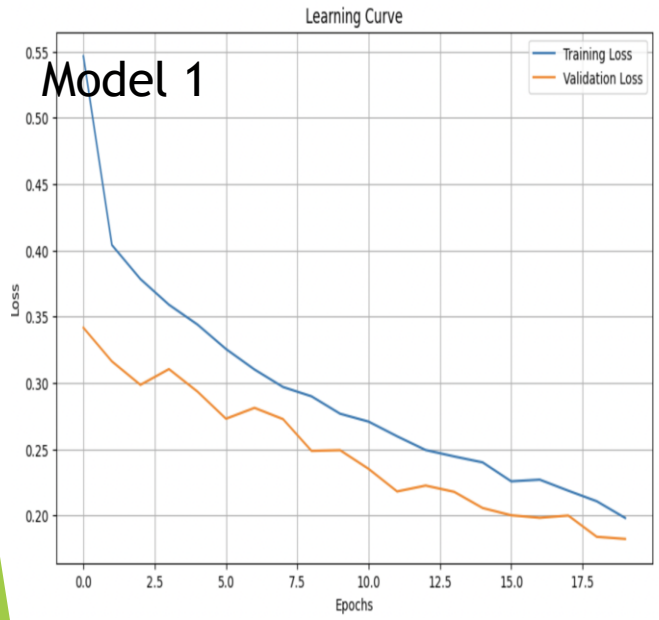
Models learning curve profile

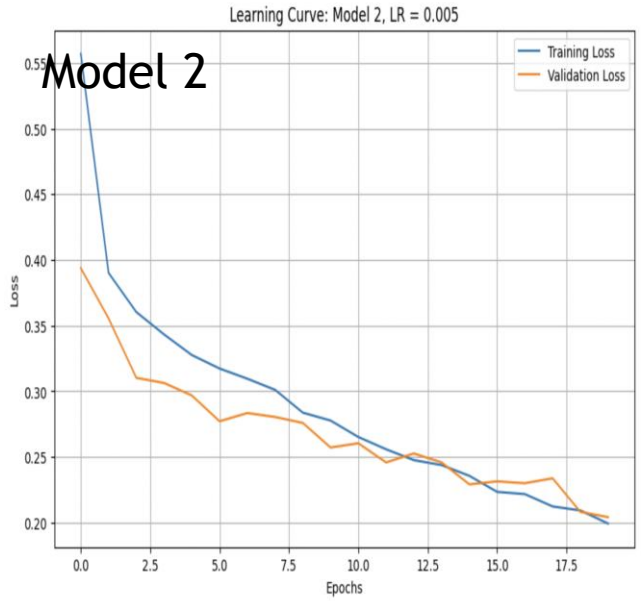
Model 1 **Dataset converted to greyscale**

Model 2 **Full color, no greyscale**

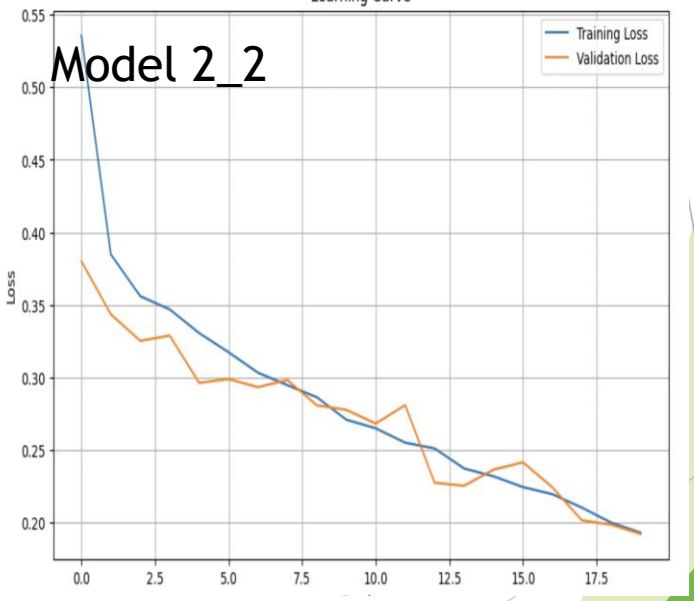
Optimizer parameters

- Learning rate
- Momentum
- Weight decay





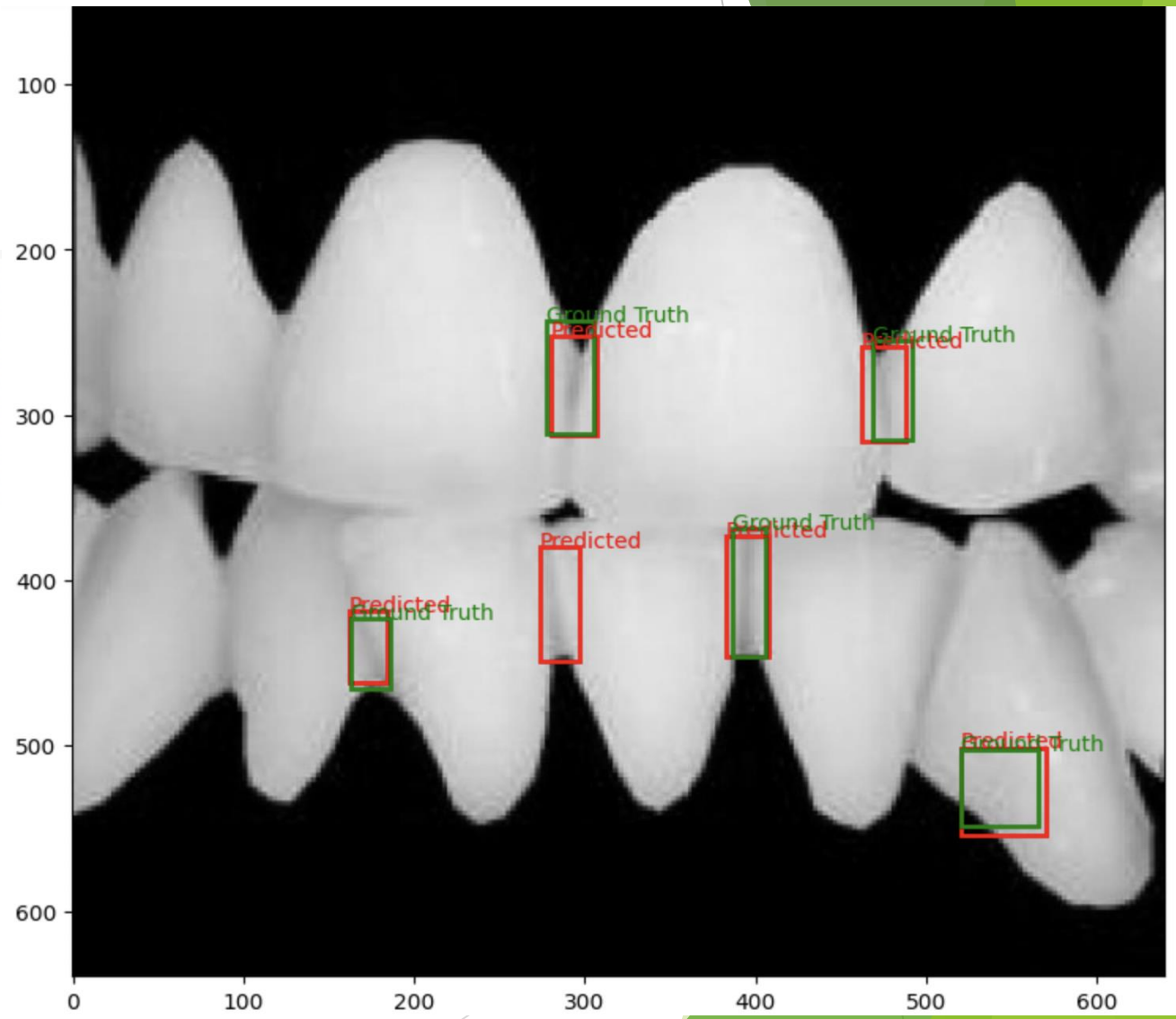
Lr = 0.008



Model1 prediction evaluation

```
Label: background
Precision: 0.0000
Recall: 0.0000
F1 Score: 0.0000
----------------------
Label: cavity
Precision: 0.4350
Recall: 0.9609
F1 Score: 0.5989
----------------------
Label: non_cavity
Precision: 0.5040
Recall: 0.9960
F1 Score: 0.6693
----------------------------
```

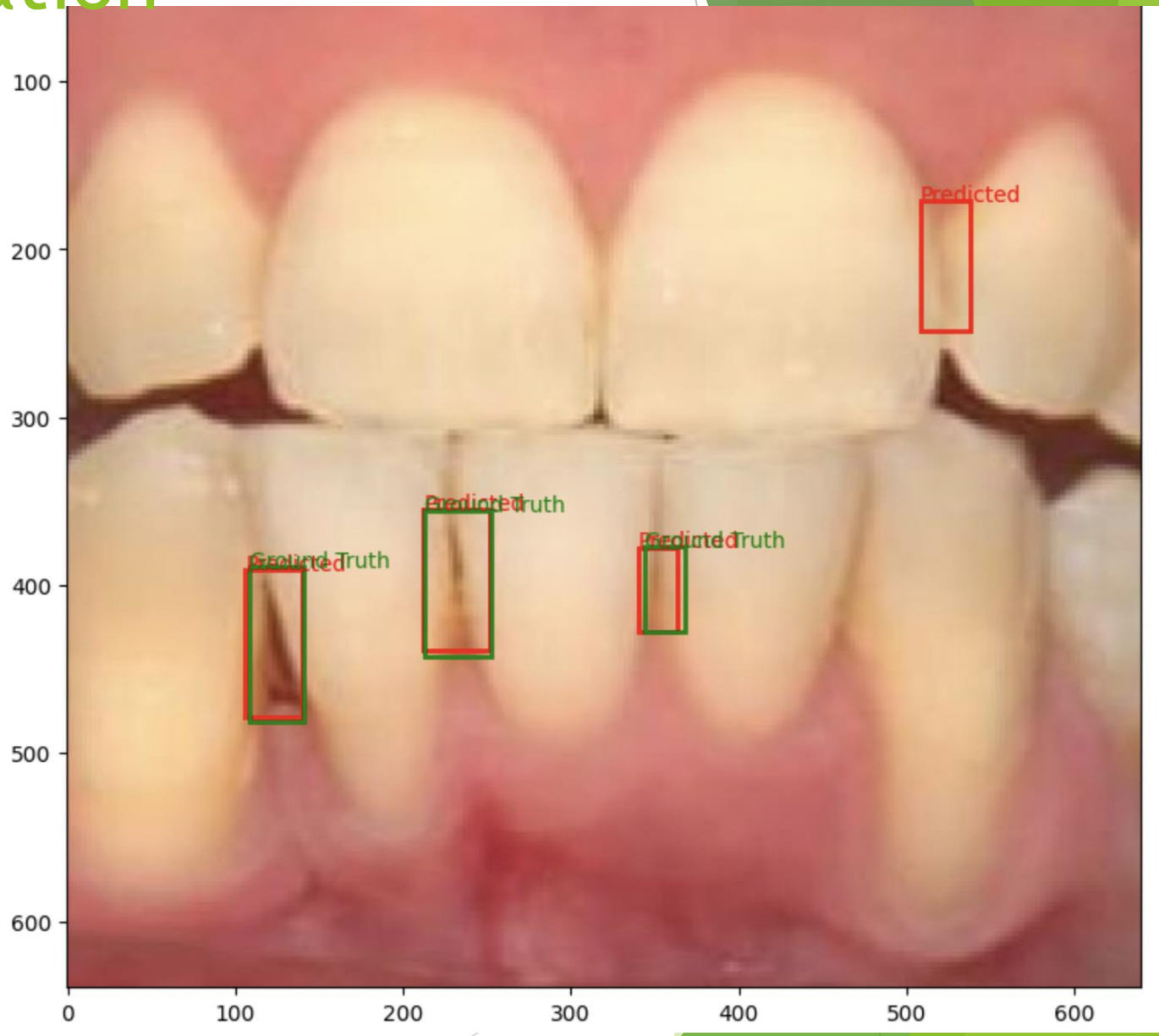
```
mAP: 0.3644
AP for class 0: 0.0000
AP for class 1: 0.4714
AP for class 2: 0.6218
```



Model2 prediction evaluation

```
Label: background
Precision: 0.0000
Recall: 0.0000
F1 Score: 0.0000
--------------------
Label: cavity
Precision: 0.4481
Recall: 0.9565
F1 Score: 0.6103
--------------------
Label: non_cavity
Precision: 0.5354
Recall: 0.9885
F1 Score: 0.6946
--------------------
```

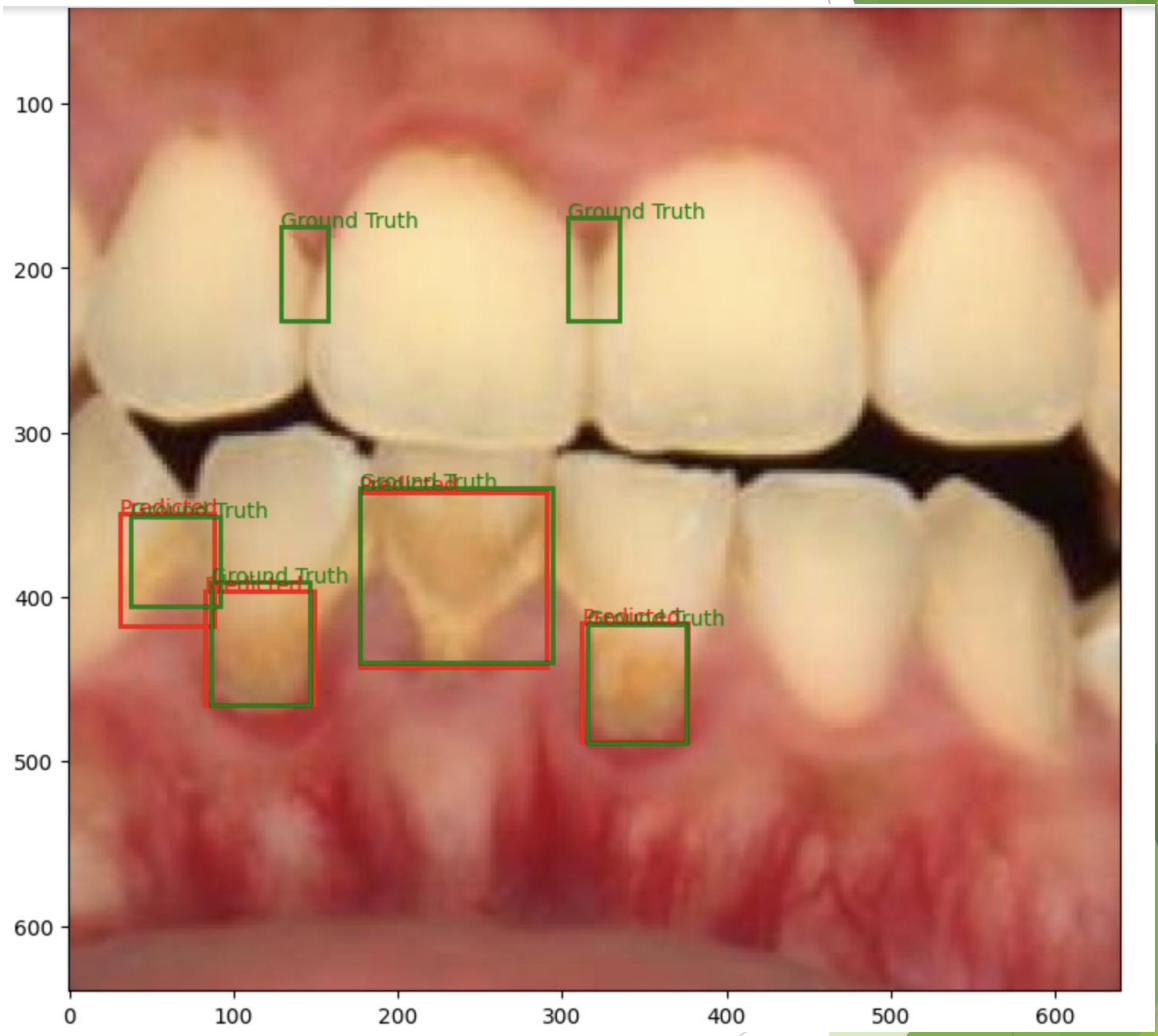
```
mAP: 0.3893
AP for class 0: 0.0000
AP for class 1: 0.5477
AP for class 2: 0.6201
```



Model2_2 prediction evaluation

```
Label: background
Precision: 0.0000
Recall: 0.0000
F1 Score: 0.0000
--------------------
Label: cavity
Precision: 0.5505
Recall: 0.9478
F1 Score: 0.6965
--------------------
Label: non_cavity
Precision: 0.5743
Recall: 0.9808
F1 Score: 0.7244
--------------------
```

```
mAP: 0.3846
AP for class 0: 0.0000
AP for class 1: 0.5610
AP for class 2: 0.5926
```



Summary

- Our model demonstrate good performance in detecting cavity and non cavity, thus showing capability of detecting dental caries in x-ray images and colored photos of peoples' teeth

- The potential of this model extends beyond improved cavity detection, encompassing the prevention of unnecessary decay escalation and painful procedures, thereby nurturing positive customer experiences that fuel customer loyalty and revenue expansion.