Advance AI-Driven Urban Safety Systems for Smart Cities using YOLO9

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Motivation

- There are many discussions about creating safety within urban cities. With the development of AI, this idea can be achieved sooner than many may believe.
- Streetscapes (CS3) aims to modernize what improved safety in urban communities may look like with the development of AI.
- This project will use a SOTA machine learning algorithm and 3D LiDAR data to estimate the social distance, thus enhancing urban designs and safety.

Yolov5 ⇒ Yolov9

- Yolo (You Only Look Once) Is a popular CNN that specifics in handling models using object detection.
- Building upon a previous model it was important to update the Conventional Neural Network(CNN) to ensure efficiency and performance improvements.

YOLOV5

- Convolutional layers.
- Potential data lost.
- Efficiency in run time.
- Reduced over fitting.

YOLOV9

- No convolutional layers.
- Having the flexibility to adapt to various objects.
  classes, especially with complex sce nes.
- Tackles “Information bottleneck."

Research Goals

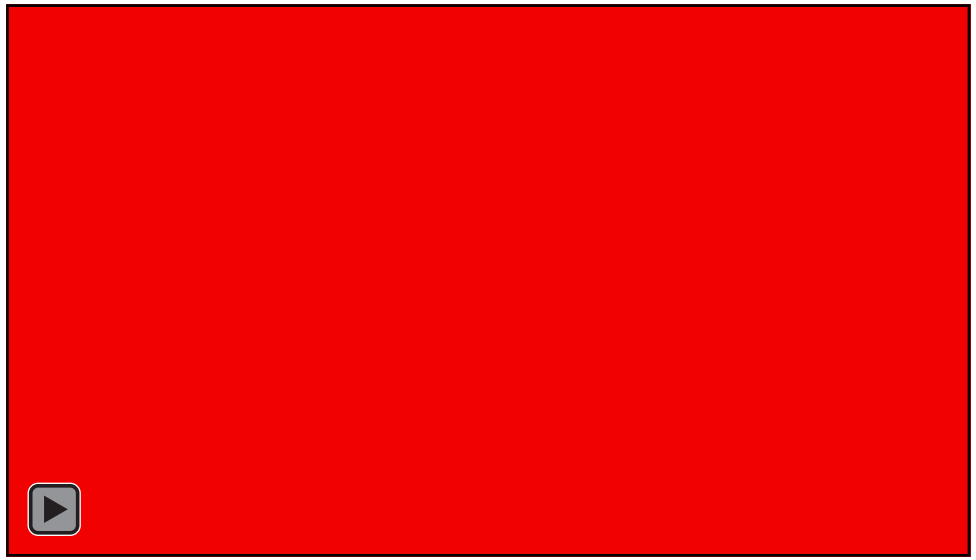
- **Generalizability:** create a robust model that can detect many different scenarios.
- **Training Efficiency:** propose an approach to augment image data for training.
- **Testing Accuracy:** obtain the best ratio of different classes.

Data Utilized

- Utilizing the existing social distancing(Ouster LiDAR) dataset and enhancing the model by incorporating additional dataset (Velodyne LiDAR) to replicate an urban city environment.
- Roboflow, a computer vision tool to help classify objects.
- The Codebase Google Colab. creates an ease application process for training data.

Velodyne LiDAR:

Ouster LiDAR:



Graph F1- Confidence Curve (Comparison)

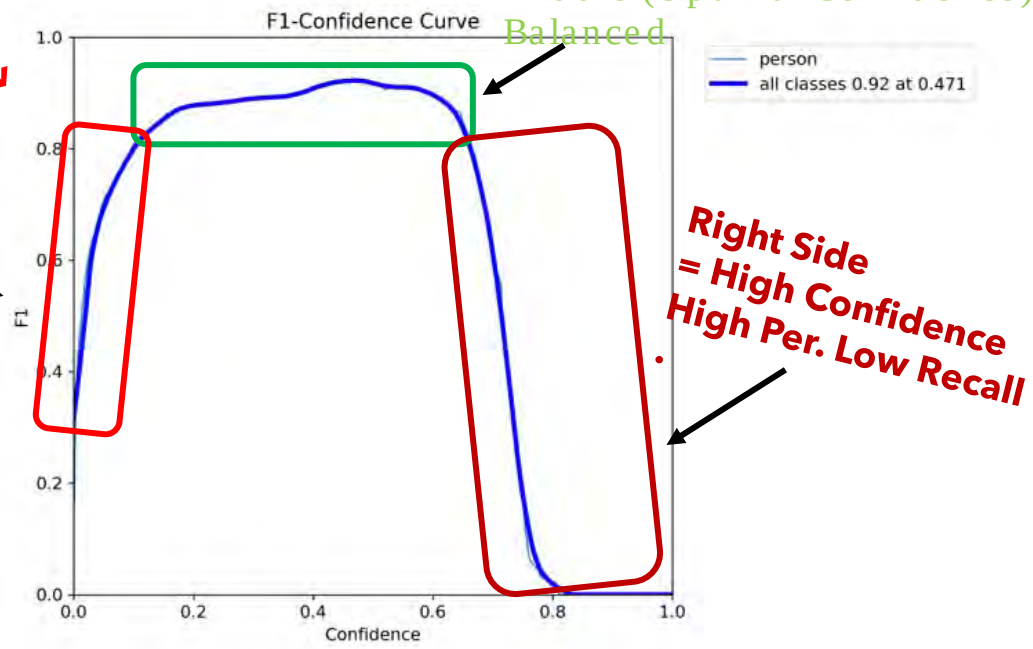
- F1 graphs are the combination of precision and recall. Precision is the ratio of true positive from the total positive. Recall, is the ratio of the total number of true positives from the actual positive predictions.

$$Precision = \frac{TP}{TP+FP}$$

$$Recall = \frac{TP}{TP+FN}$$

Yolov5

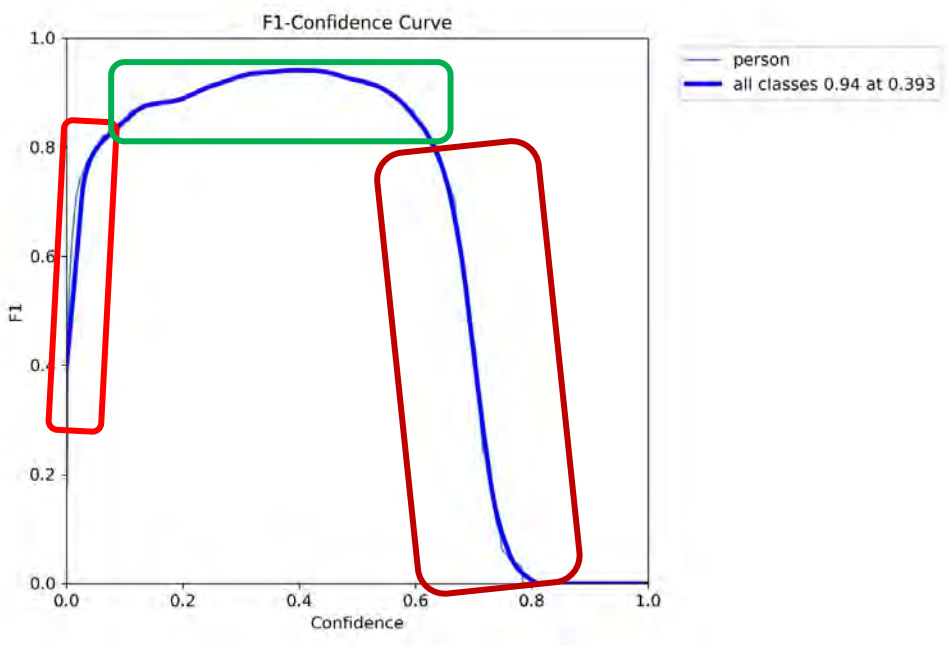
Middle (Optimal Confidence) Balanced



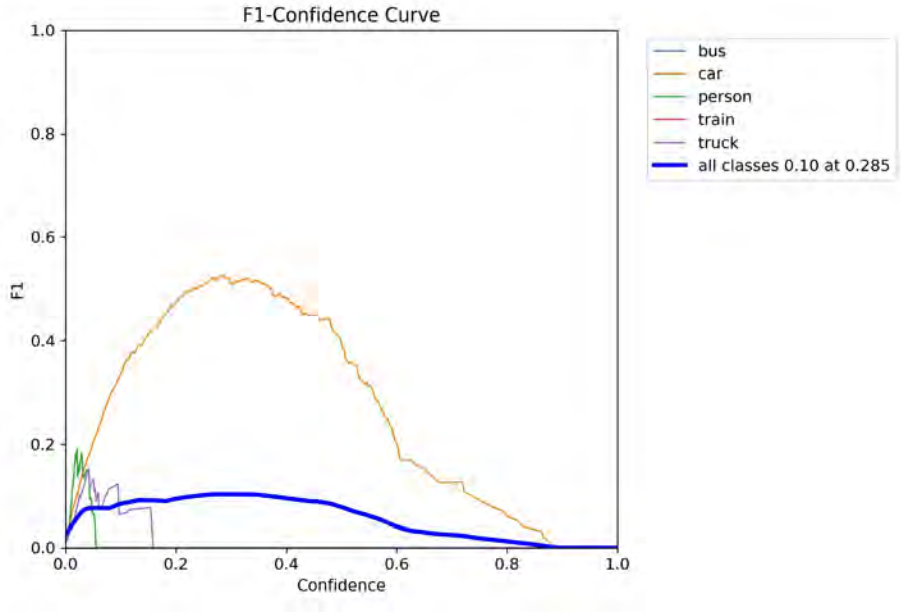
Left side = Low Confidence High Recall, Low Pre.

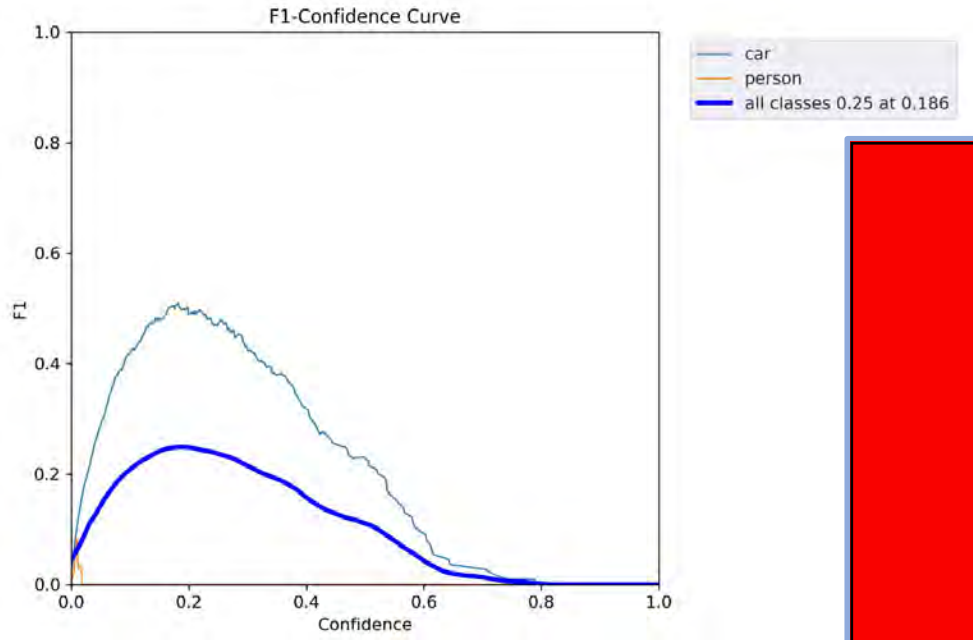
Right Side = High Confidence High Per. Low Recall

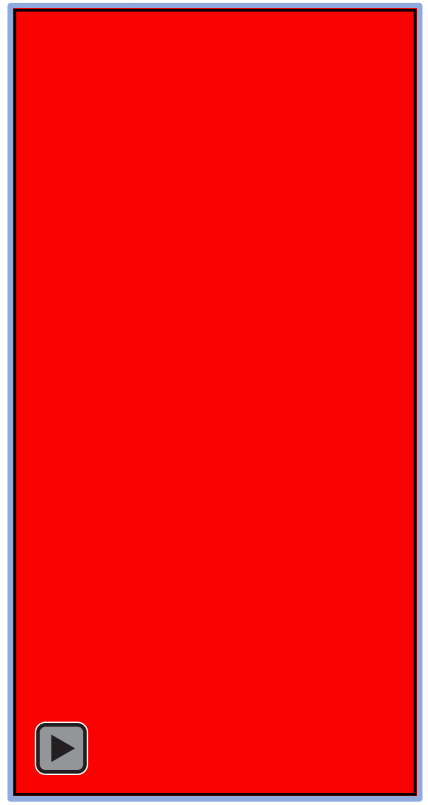
Yolov9



Results of Velodyne Dataset



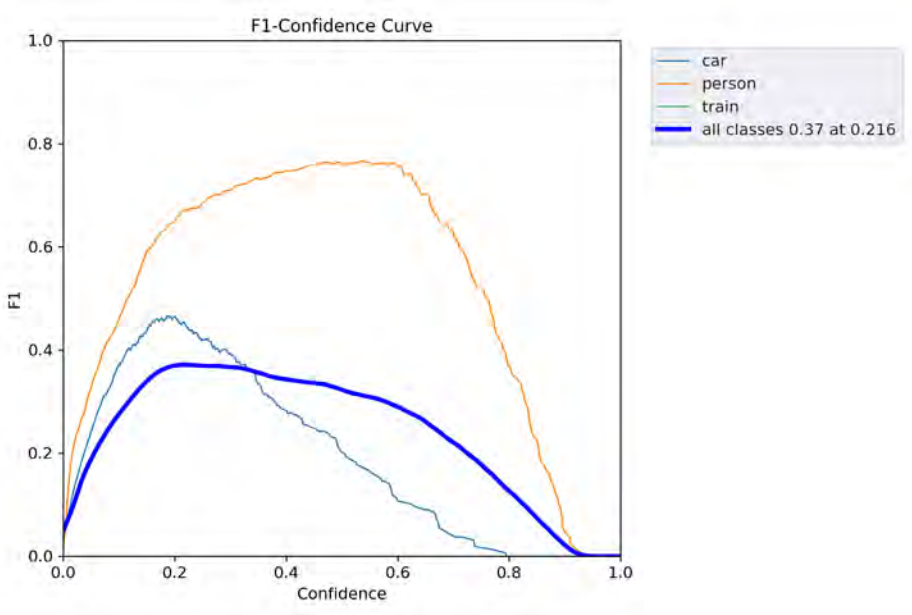




Each class represents each f1 score. The dark blue line represents the average f1 class between all of the classes.

Results on Combined Datasets

Combine the two datasets from Velodyne and Ouster Lidar scenarios to create a comprehensive dataset that captures a robust amounts of scenarios.



Conclusion

- Adopted Yolov9 for better model performance (accuracy and computational complexity).
- Used the previous dataset from the social distancing project and incorporated a new dataset to replicate the urban environment for object detection was successful.
- This project brings us one step closer to documenting urban safety and continuing the goal of CS3.

References

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Thank You

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