PathSafe

A dive into the viability of detection models aiding in the identification of problematic roads

Reys Aden, Angel Castro, & Haris Mehuljic

The Problem

Vehicle Damage

Potholes can cause significant damage to vehicles, including bent rims, damaged suspension, and more.

Safety Hazards

Potholes present serious safety hazards to drivers, cyclists, and pedestrians.

Infrastructure

Potholes are a symptom of underlying issues in road maintenance and can indicate broader infrastructure problems

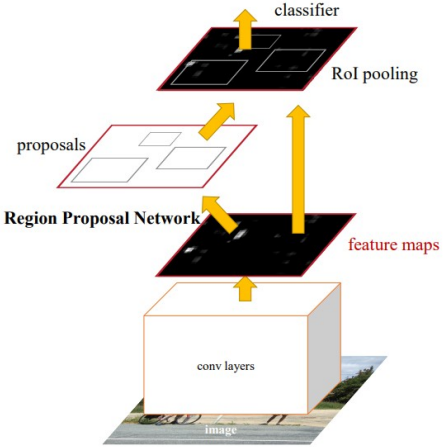
Our Approach

Obtain a Dataset

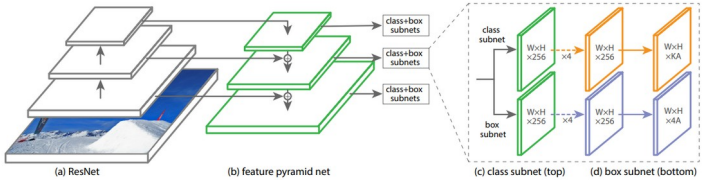
Pothole dataset obtained from Roboflow

Choose Models & Implement Using Detectron2

Faster R-CNN:

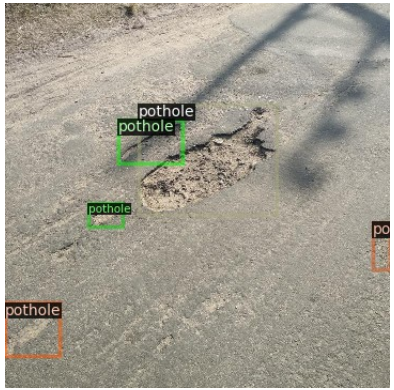


RetinaNet:



Detectron2:

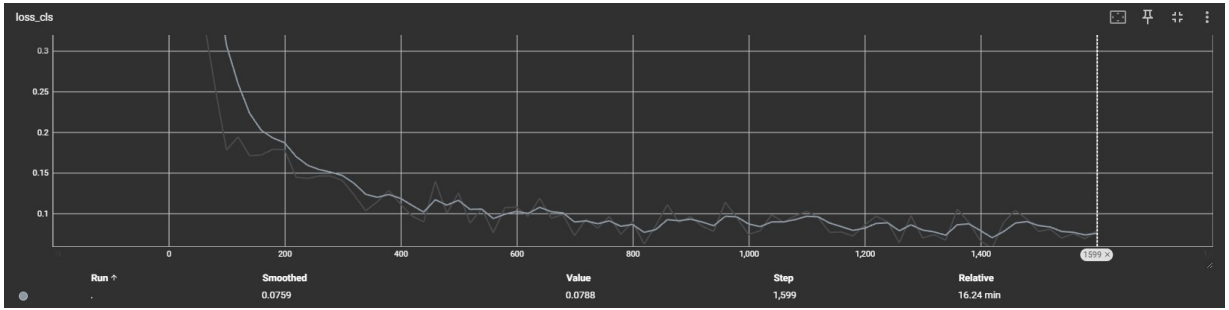
Dataset

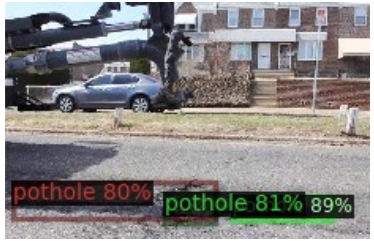


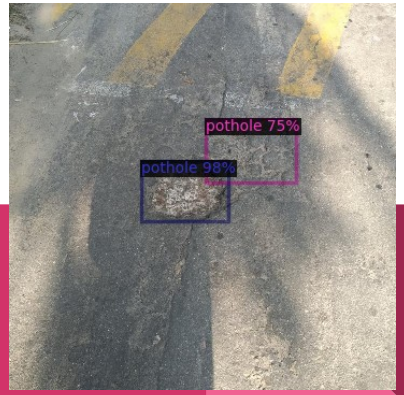
- 665 images of roads with potholes
  - 70/20/10 train, test, and validation split
- All data was already labeled
- No preprocessing was required as the dataset was already in the Detectron2 format

Results

Results – Faster R-CNN 101







	Average Precision					
IoU & Sizes	0.50:0.95	0.50	0.75	0.50:0.95 S	0.50:0.95 M	0.50:0.95 L
Score	47.1%	74.9%	54.3%	33.2%	41.9%	57.7%

	Average Recall					
Sizes & Max Detections	All (1)	All (10)	All (100)	Small (100)	Medium (100)	Large (100)
Score	27.2%	58.9%	61.1%	48.4%	56.7%	69.7%

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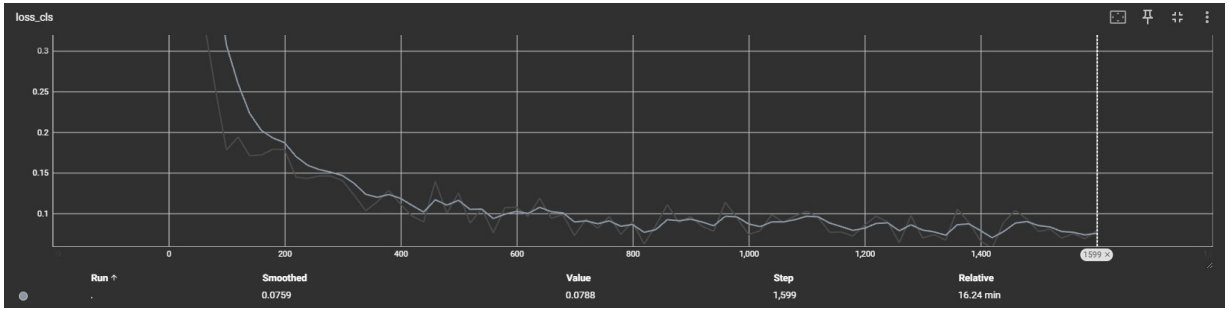

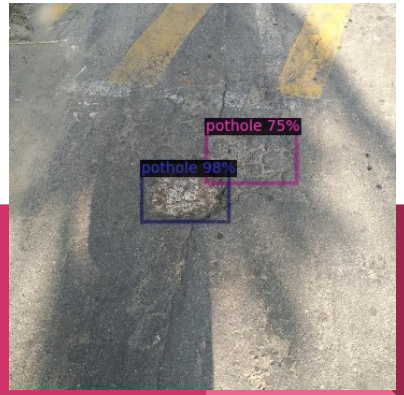

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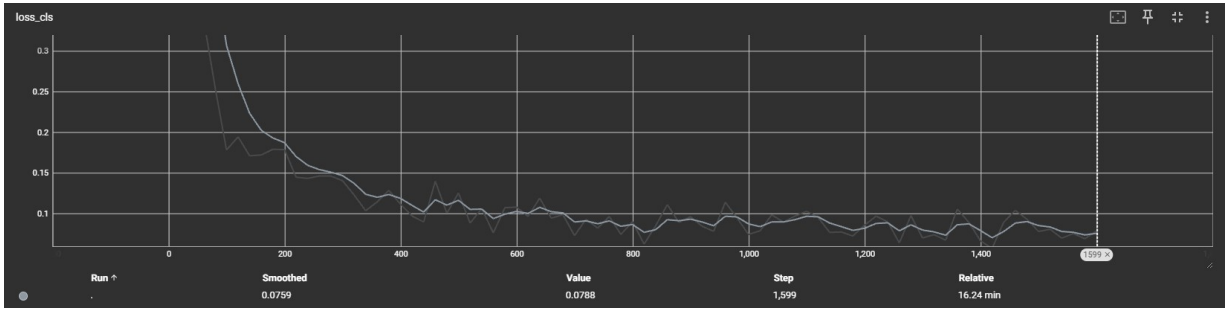

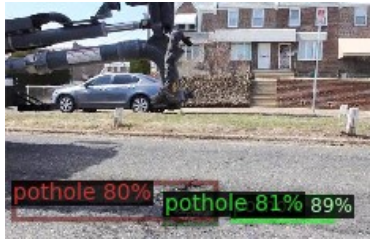

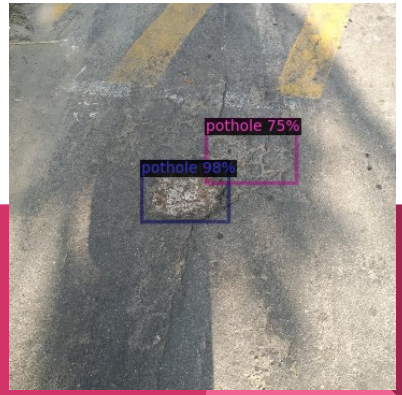

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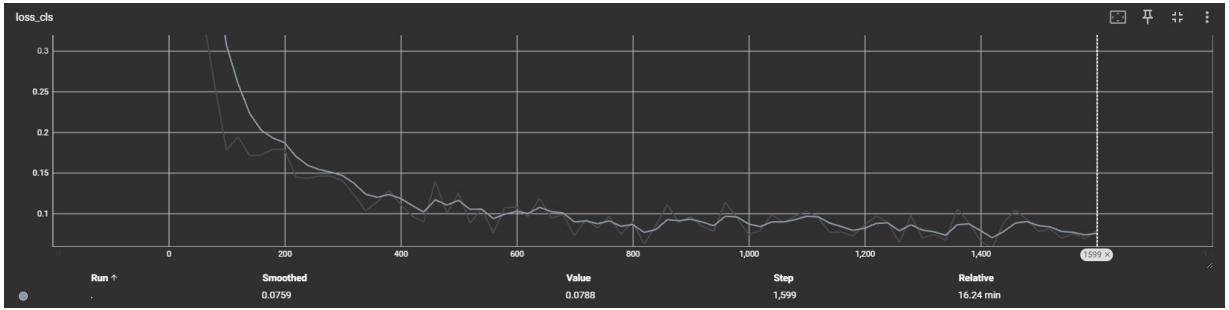

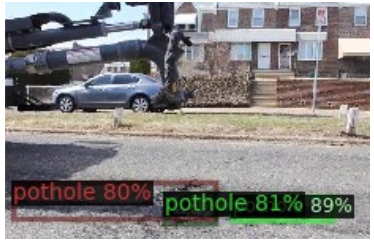

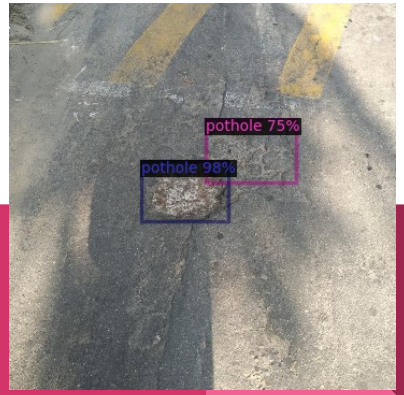

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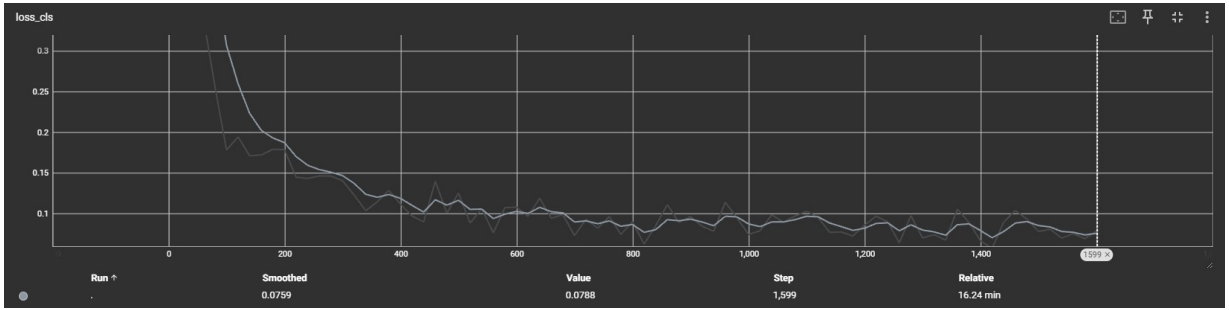

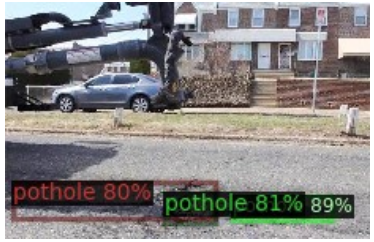

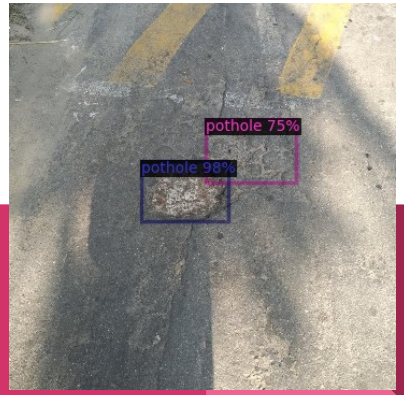

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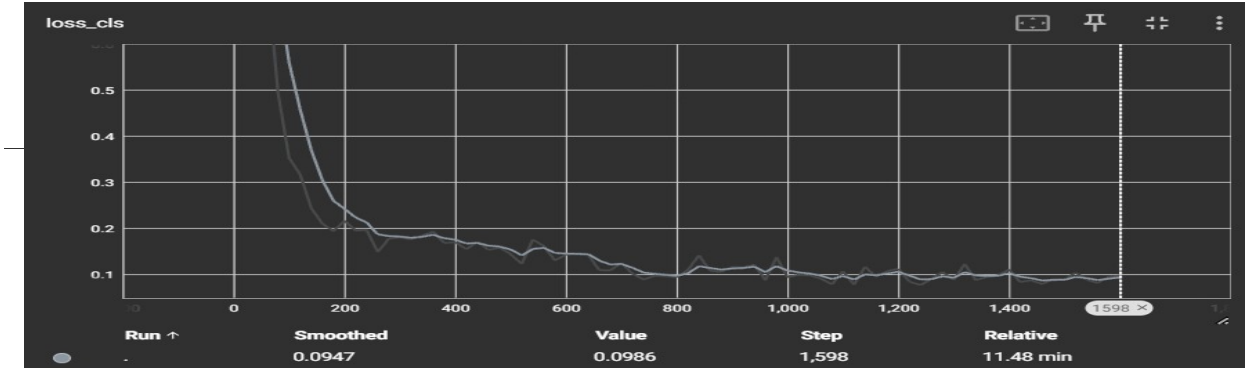
Sizes & Max Detections	All (1)	All (10)	All (100)	Small (100)	Medium (100)	Large (100)
Score	27.2%	58.9%	61.1%	48.4%	56.7%	69.7%

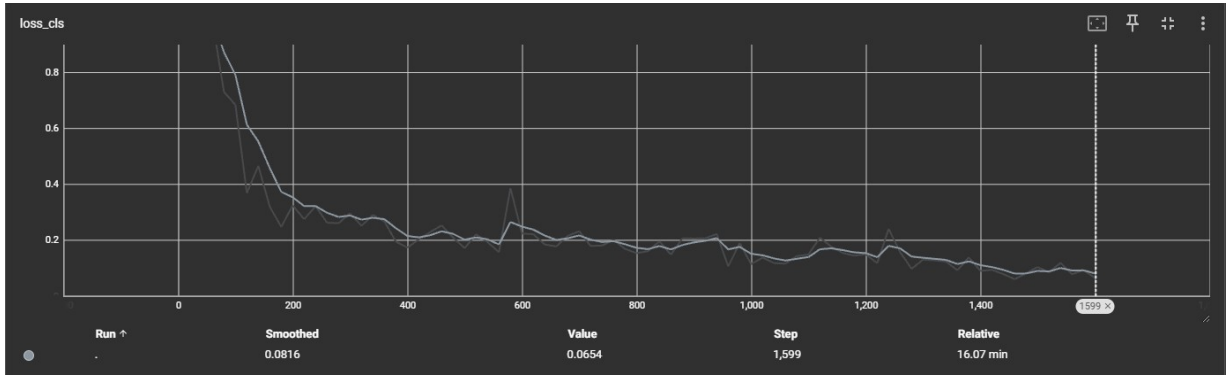
Results – Faster R-CNN 50



Average Precision					
0.50:0.95	0.50	0.75	0.50:0.95 S	0.50:0.95 M	0.50:0.95 L
38%	58%	43%	22%	31%	50%

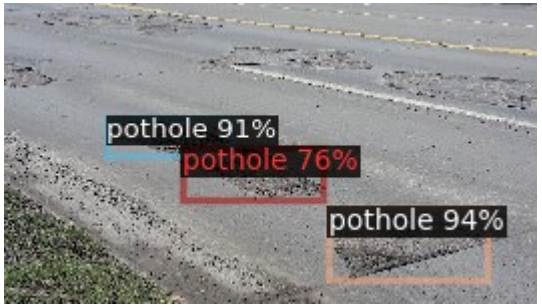
Average Recall					
All (1)	All (10)	All (100)	Small (100)	Medium (100)	Large (100)
26%	46%	46%	26%	43%	56%

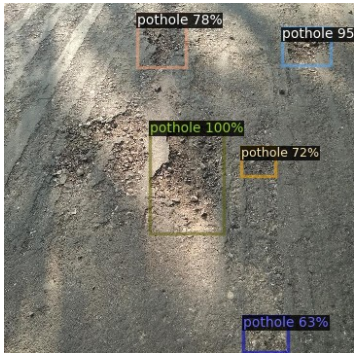
Results – RetinaNet

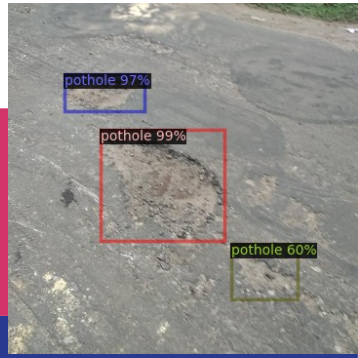


Average Precision					
0.50:0.95	0.50	0.75	0.50:0.95 S	0.50:0.95 M	0.50:0.95 L
48.1%	72.5%	58.3%	34.1%	37.3%	62.0%

Average Recall					
All (1)	All (10)	All (100)	Small (100)	Medium (100)	Large (100)
30.90%	60.1%	65.5%	53.6%	62.6%	72.4%







Overall Results – Avg. Precision & Avg. Recall

Considering just AP over IoU values in the range of 0.50-0.95 and considering all object sizes, testing the three models on the test set results in the following:

Model	Faster R-CNN 50	Faster R-CNN 101	RetinaNet
AP Score	38.0%	47.1%	48.1%

And, considering AR on all object sizes and allowing a maximum of 100 detections, resulted in the following:

Model	Faster R-CNN 50	Faster R-CNN 101	RetinaNet
AR Score	46.0%	61.1%	65.5%

Conclusion

RetinaNet stands out as our most effective model for pothole detection from our comparison, excels in both precision and recall metrics. For real-world implementations this model would offer the best balance between accuracy and reliability.

Further considerations :

- Larger Diverse Dataset
- Inference Speeds
- Efficiency