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Road Profile Users' Group

VIRGINIA TECH
TRANSPORTATION INSTITUTE

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ASSESSING PAVEMENT NETWORK PERFORMANCE USING CROWD SOURCED CONNECTED VEHICLE DATA

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INTRODUCTION

- KEEPING PAVEMENTS IN GOOD CONDITION IS THE GOAL OF ROAD AGENCIES.
- INTERNATIONAL ROUGHNESS INDEX(IRI) IS USED IN FUNCTIONAL HEALTH MONITORING.
- EFFECTIVE AND EFFICIENT MAINTENANCE REQUIRES FREQUENT MONITORING.
- MONITORING IS DONE ANNUALLY WITH SPECIALIZED VEHICLES.
- CROWD SOURCED DATA CONNECTED VEHICLES USING ON-BOARD SENSORS CAN PROVIDE CONTINUOUS DATA.

OBJECTIVES

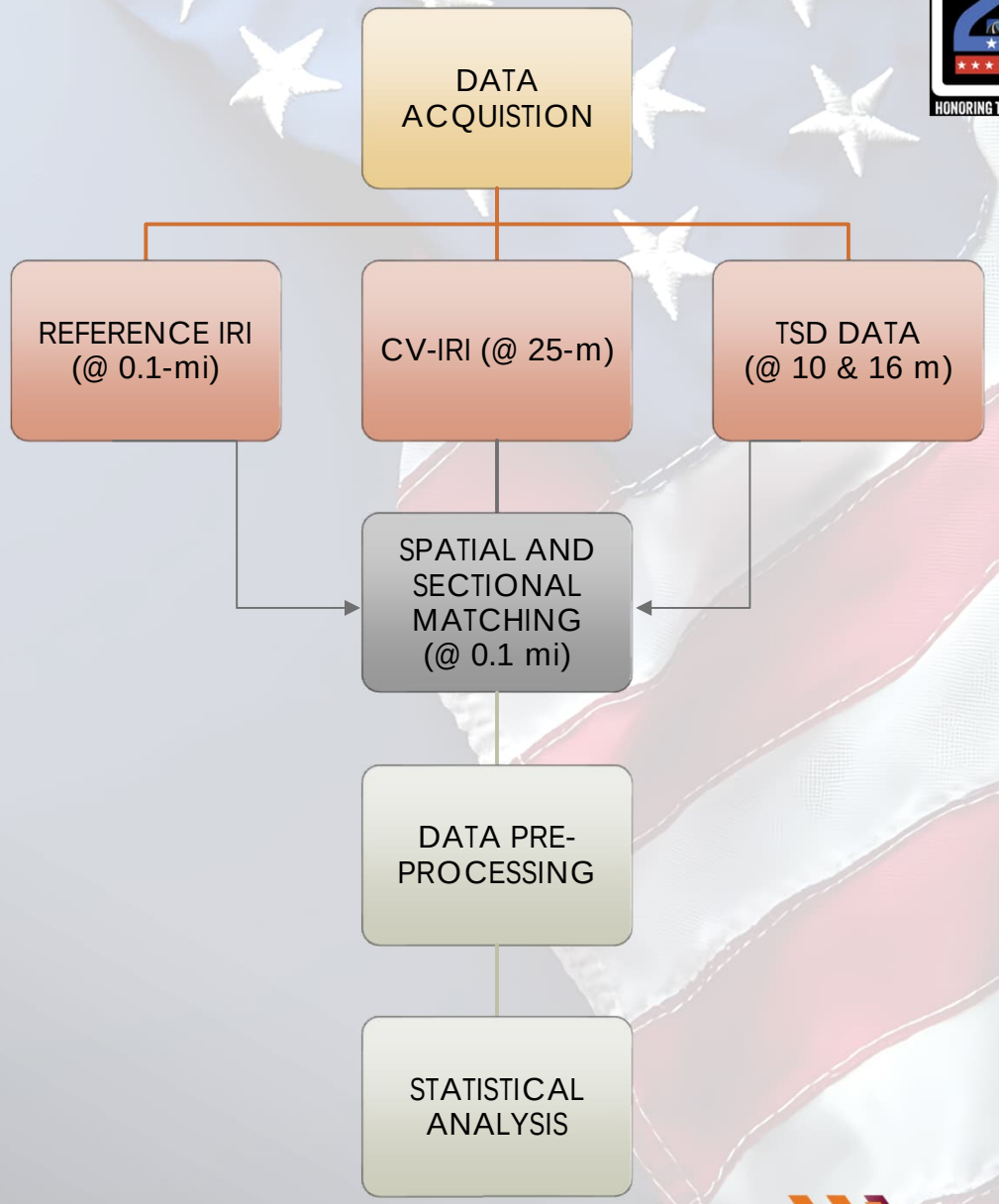
- Comparison of CV-IRI with reference IRI for network level monitoring.
- Analyzing seasonal variations in CV-IRI.
- Analyzing relationship of CV-IRI with structural indicators from TSD .

MERIT

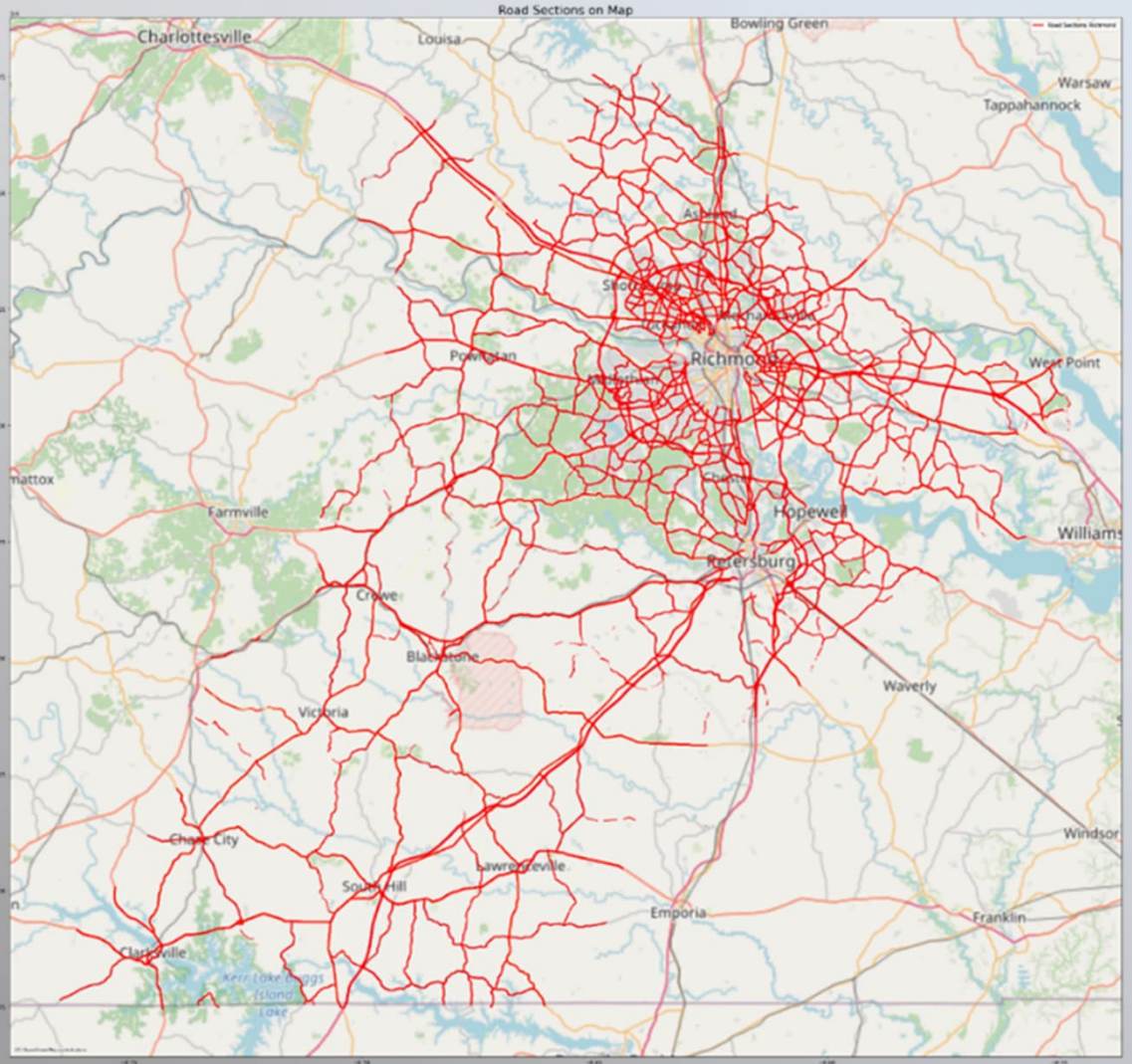
- This study explores potential of connected vehicle data for network level monitoring.
- Road agencies can monitor entire networks with minimum effort.
- Collect data for roads which are not monitored frequently.

METHODOLOGY

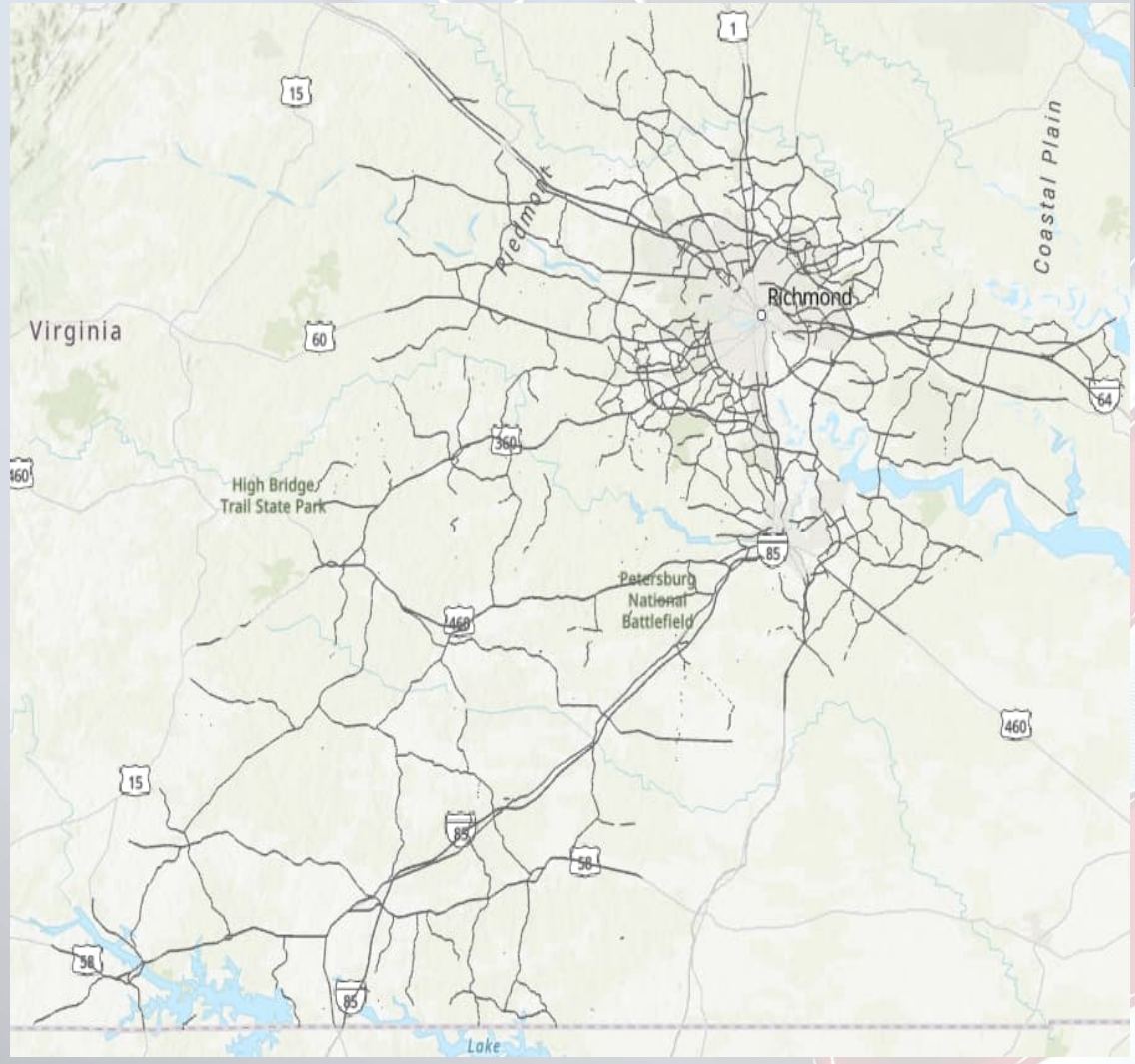
- Datasets:
  - Connected vehicle data (commercial)
  - Reference IRI data (PMS)
  - TSD data
- Spatial and sectional matching using GIS (0.1 mi and 1-mile aggregations)
- Filtering data (Trimming outliers, rehab) – 21013 sections left
- Statistical analysis (R^2, MAE, RMSE, Classification accuracy)



LOCATION



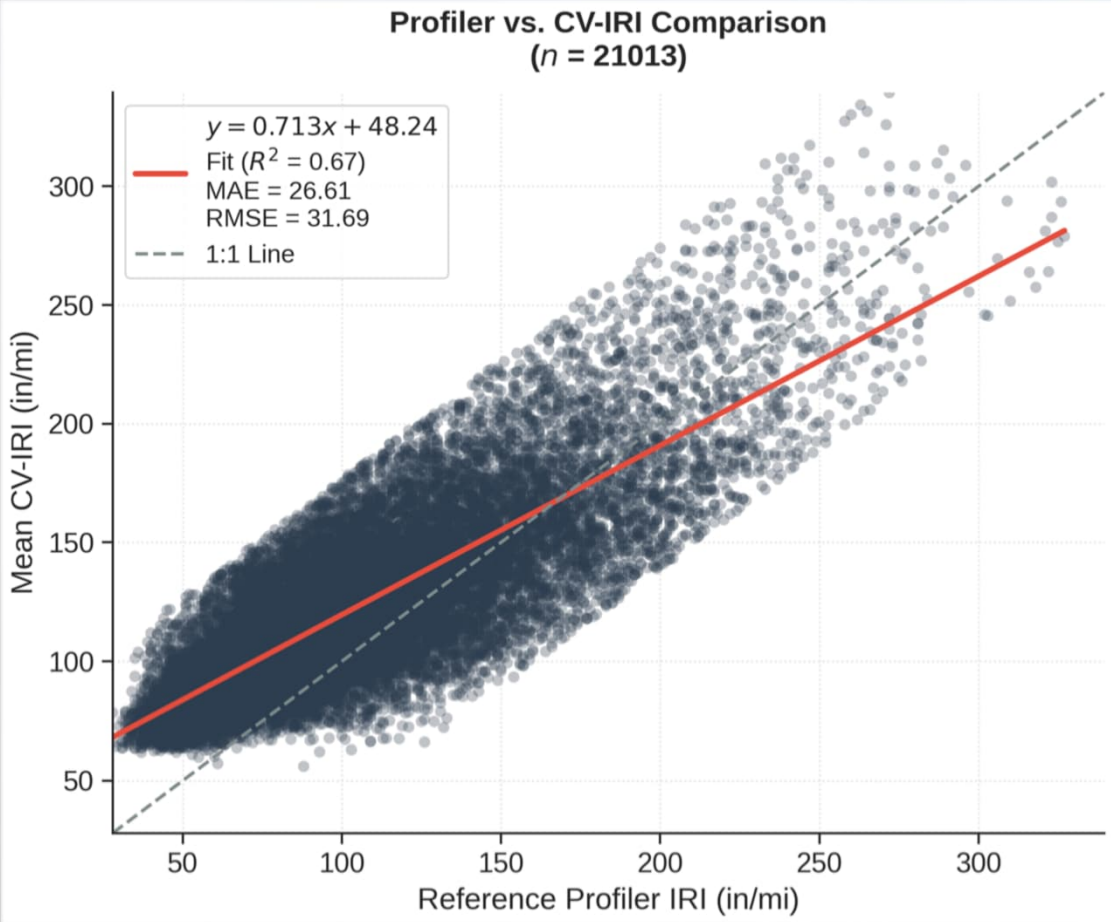
CV DATA (2023)

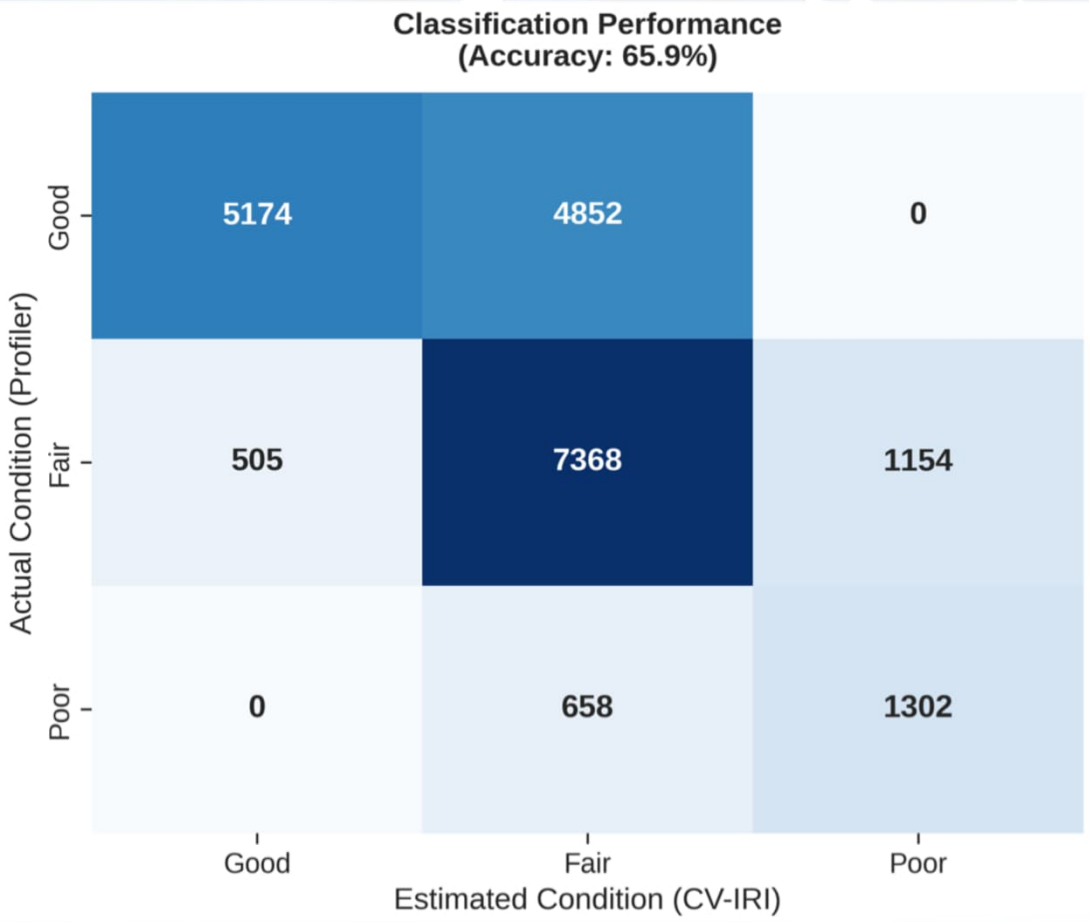


VDOT COVERAGE (2023)

- RICHMOND, VA – 2000 + MILES (2023)

RESULTS





- LINEAR FIT WITH AN R^2 OF 0.67
- CLASSIFICATION ACCURACY OF 66 %

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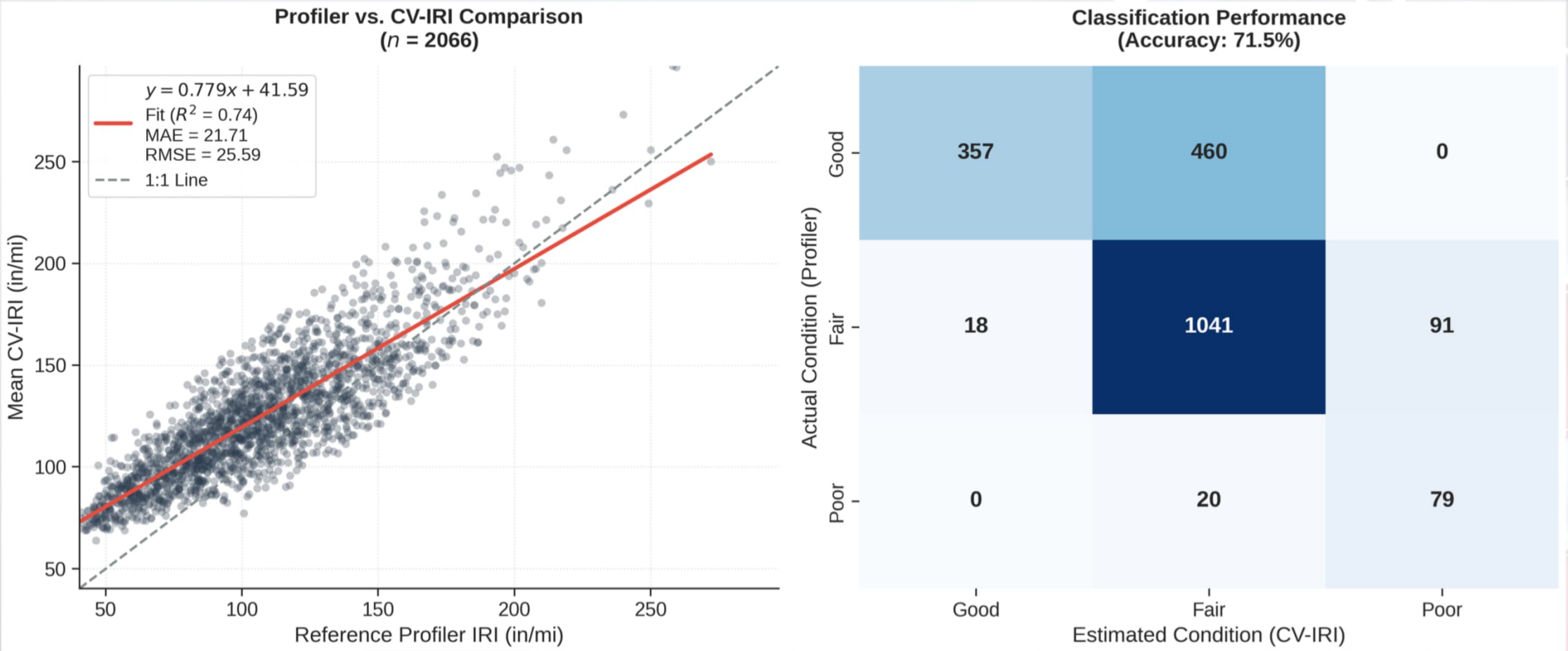
RESULTS



- LINEAR FIT WITH AN R^2 OF 0.74
- CLASSIFICATION ACCURACY OF 72 %

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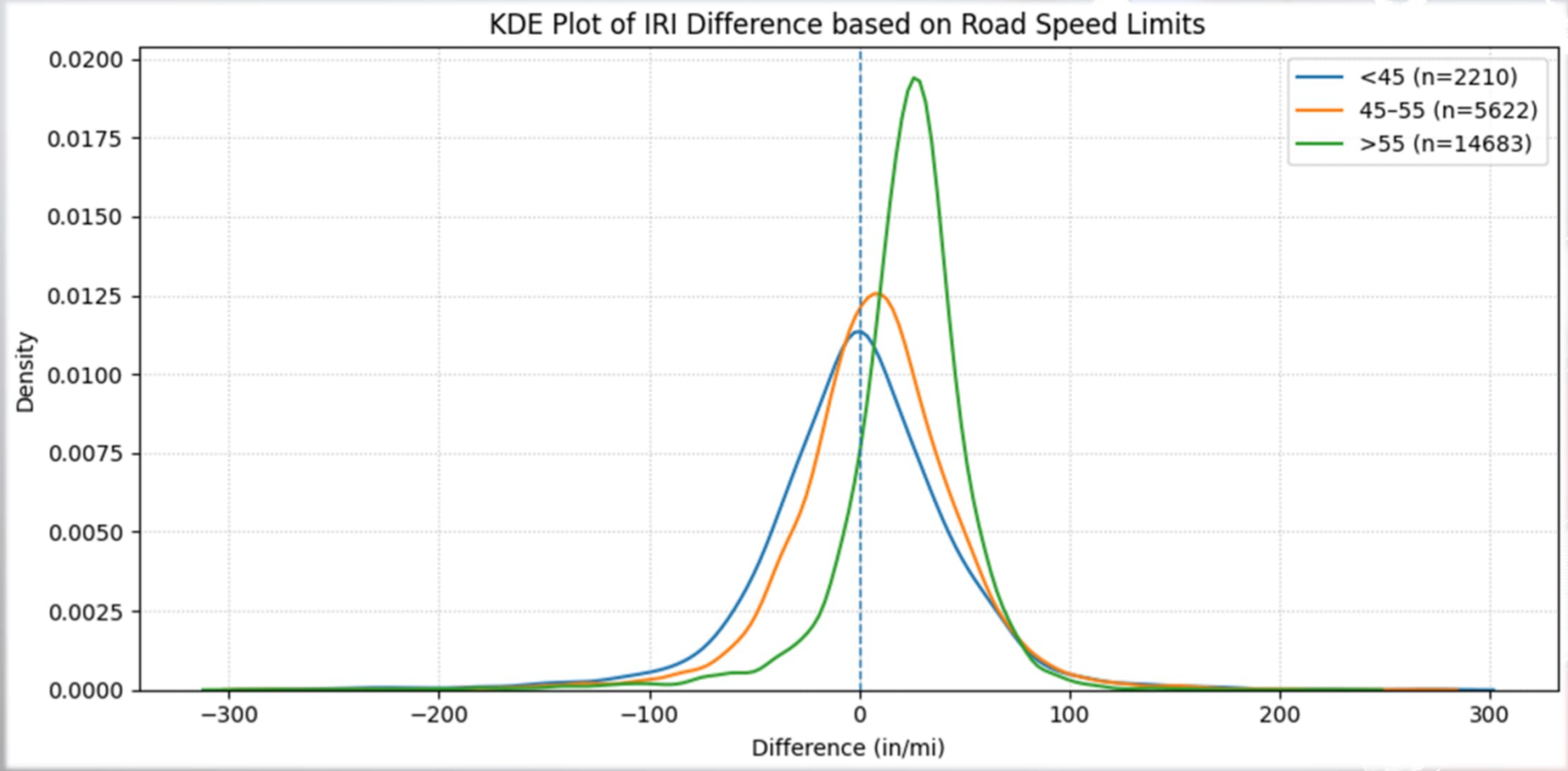
RESULTS

Aggregation Level	Road Classification	Number of Sections (n)	R^2 Value	Classification Accuracy
0.1-mi	Interstate	5095	**0.73**	**72.0%**
	Highway	12406	0.56	61.3%
	Secondary	3512	0.66	**73.1%**
1-mi	Interstate	485	**0.78**	**72.2%**
	Highway	1304	0.62	69.5%
	Secondary	277	**0.75**	**79.8%**

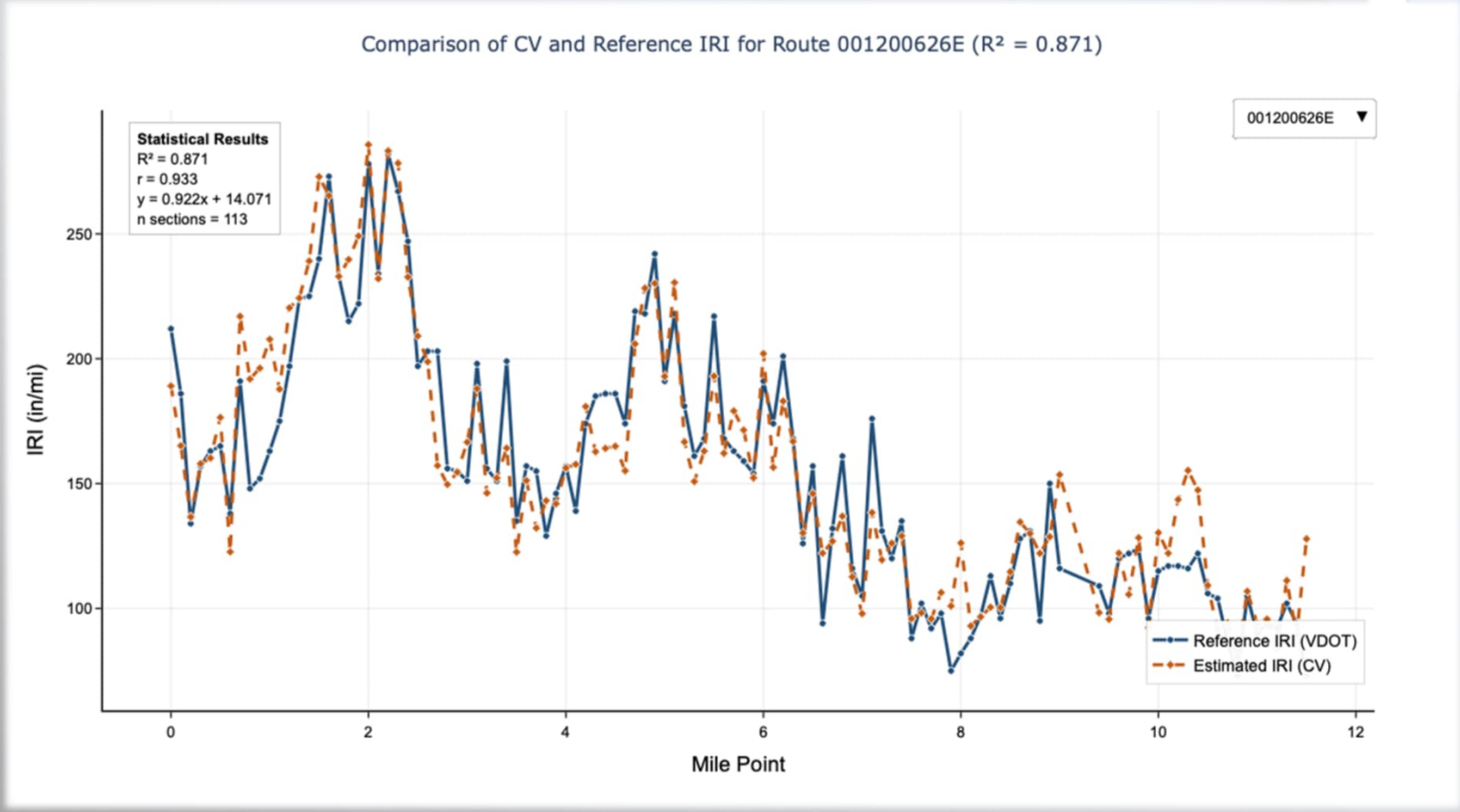
- BETTER RESULTS FOR LONGER SEGMENT AGGREGATION.

DIFFERENCE



- SEGREGATING THE SECTIONS BY ROAD SPEED LIMITS HIGHLIGHTS A DIFFERENCE IN BIAS WITH HIGHER ERROR FOR HIGH-SPEED SECTIONS AS COMPARED TO LOW-SPEED SECTIONS

CV-IRI ACCURACY (EXAMPLE SECTION)



Source: Google Earth Images

Road Name – VA-626EB
R^2 – 0.87
Miles – 11.3 (113 sections)
Speed Limit – 45 mph

- STRONG CORRELATION WITH REFERENCE IRI

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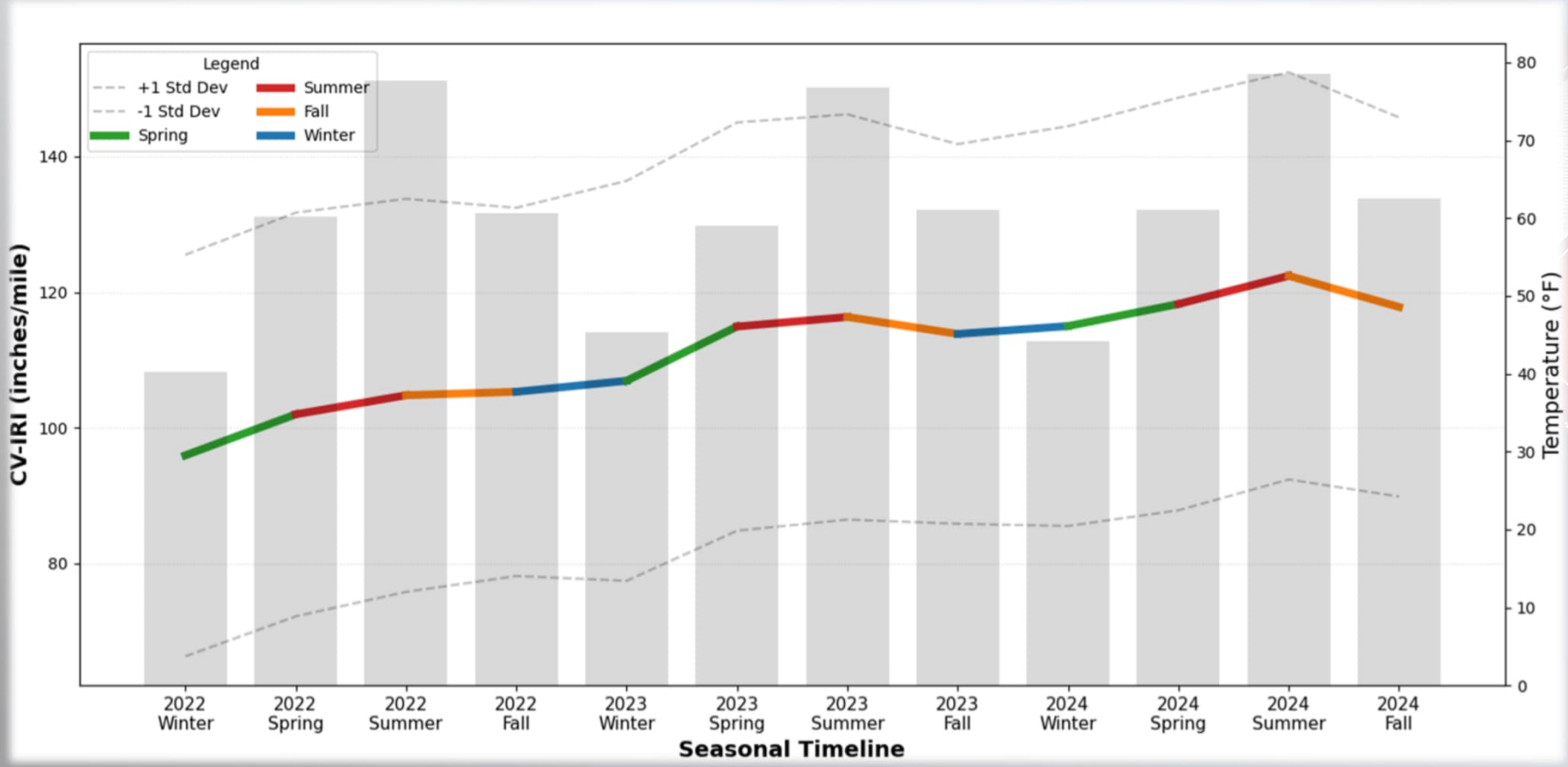
SEASONAL VARIATION CV-IRI (200 MI)



- AVERAGE IRI FOR 200+ MILES SHOWS SEASONAL DIFFERENCES.
- HIGHER GROWTH DURING THE 1ST HALF OF THE YEAR AND LOWER GROWTH IN 2ND HALF.

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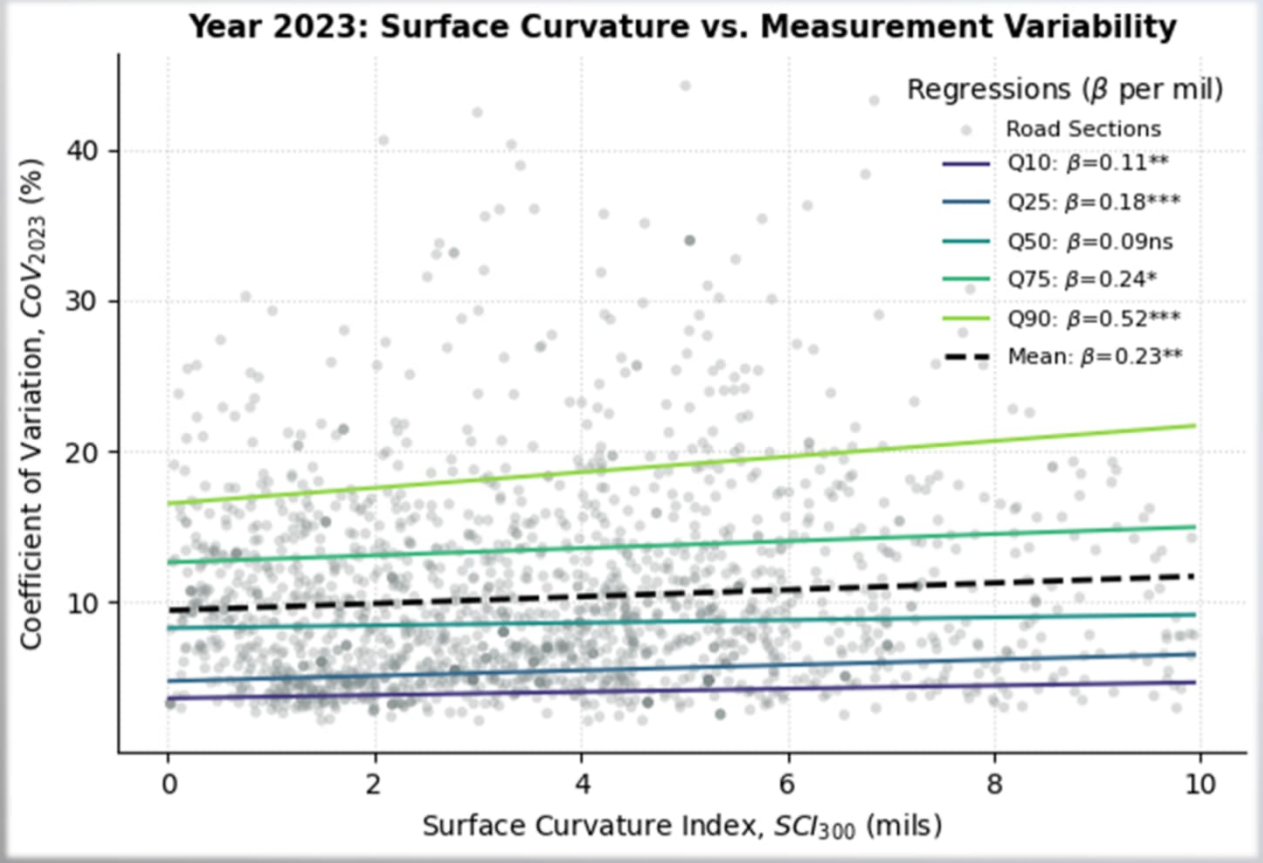
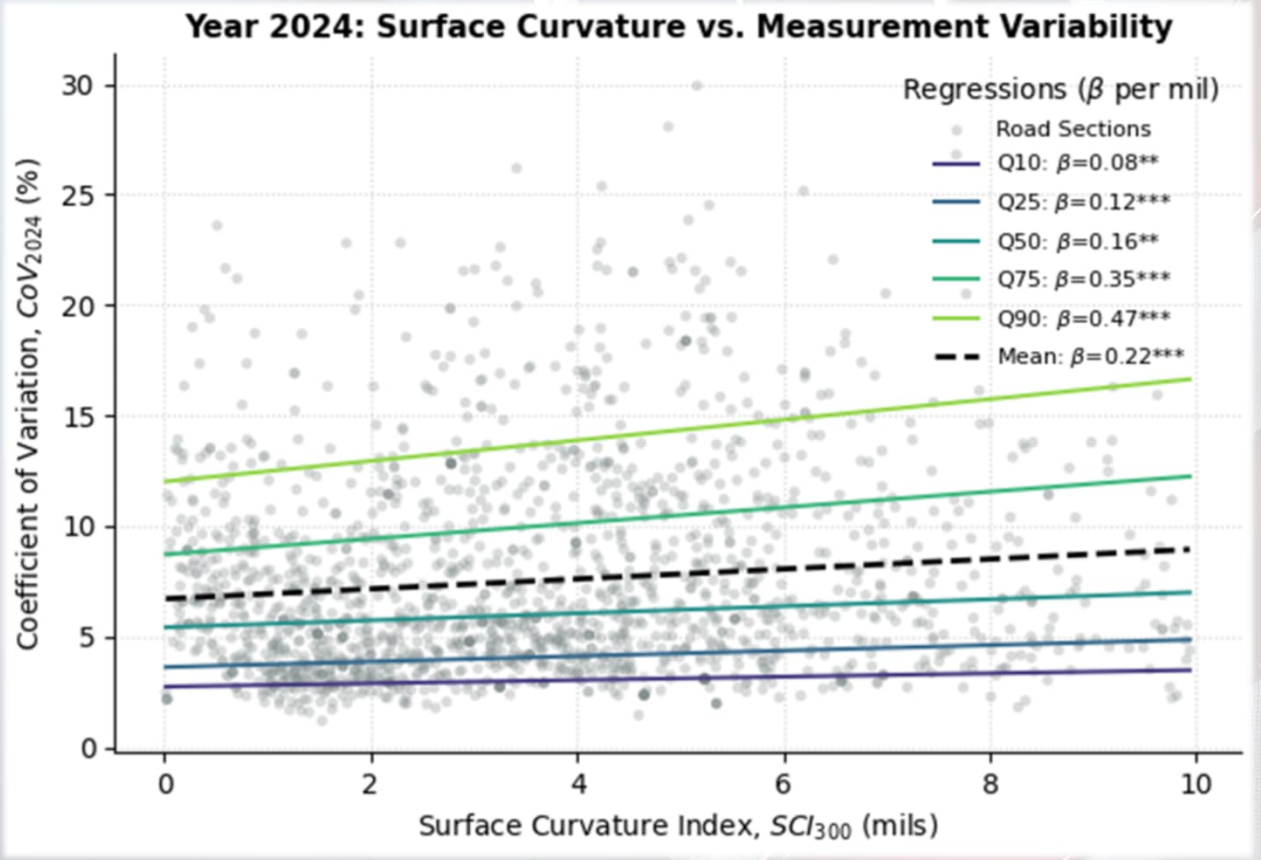
COV (CV-IRI) V/S SCI300





- INDICATES SECTIONS WITH HIGHER VARIABILITY HAVE STRONGER RELATIONSHIP WITH LOWER STRUCTURAL CONDITION

FINDINGS

- Moderate-to-strong correlation for network level analysis, fit with R^2 0.67 to 0.74 and classification accuracy of 66 % to 72 % going from 0.1 mi to 1 mi sectional aggregations.

- Seasonal variations indicates higher growth rates after winter till spring and slower growth rates after summer and fall.

- Relationship between COV of CV-IRI and SCI300 from TSD shows a higher positive slope for sections experiences more variability in a year.

CONCLUSIONS

- Network level comparison suggests that the crowd sourced connected vehicle roughness data has potential to be used as a supplementary tool.
- Roads monitored infrequently, like secondary roads could benefit more.
- Seasonal variations indicates higher growth rates after winter till spring and slower growth rates after summer and fall.
- CoV analysis for CV-IRI indicates increased variability might be related with lower structural strength.

FUTURE WORK

- Lane level segmentation of CV-IRI data.
- Explore Seasonal effects based on pavement types.
- Bias correction using Bayesian methods.
- LCA using lane level CV-IRI data.

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THANK YOU

QUESTIONS ?

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