Predicting Connected Vehicle Alert Classification Based on Topography

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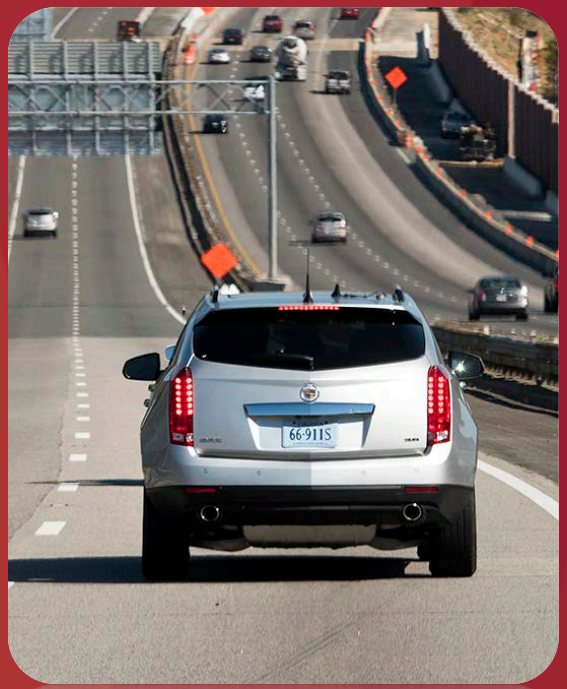

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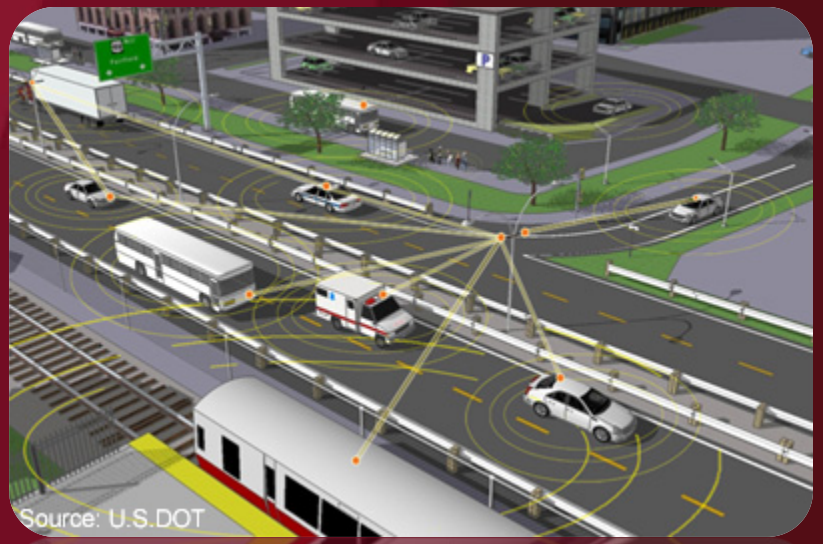
What is a Connected Car?

- V2V: Bi-directional information sharing between vehicles
- V2I: Bi-directional information sharing between a vehicle and the roadway
- V2X: Bi-directional information sharing between a vehicle and X (pedestrians, cyclists, trains, etc.)

- Alerts:
  - GPS-based, but there is more to the algorithm (proprietary)

- Cellular
  - For non-time critical info (2-10 s latencies)
  - Nearly ubiquitous coverage
- Dedicated short-range communications (DSRC)
  - Low-latency, robust, secure information (<.5 s latencies)
  - Short range (< 300 meters)



Problem

- CV communications have degraded performance in areas of high occlusion, such as urban environments
- Need to learn more about how topography of areas could affect CV communications
- Research Question:
  - How much error can be explained by the surrounding topography?

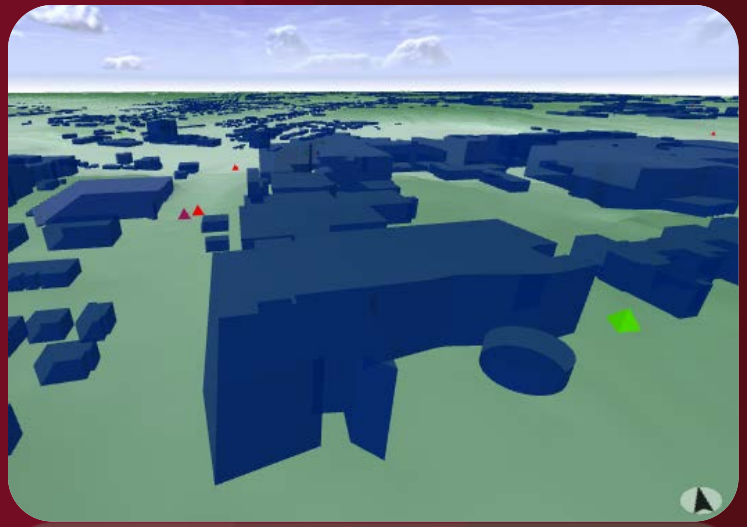
Methods Overview

- Perform spatial analysis to quantify environments in which alerts occurred

- Conduct discriminant analysis to determine if an alert classification could be predicted solely based on the topography surrounding a CV alert

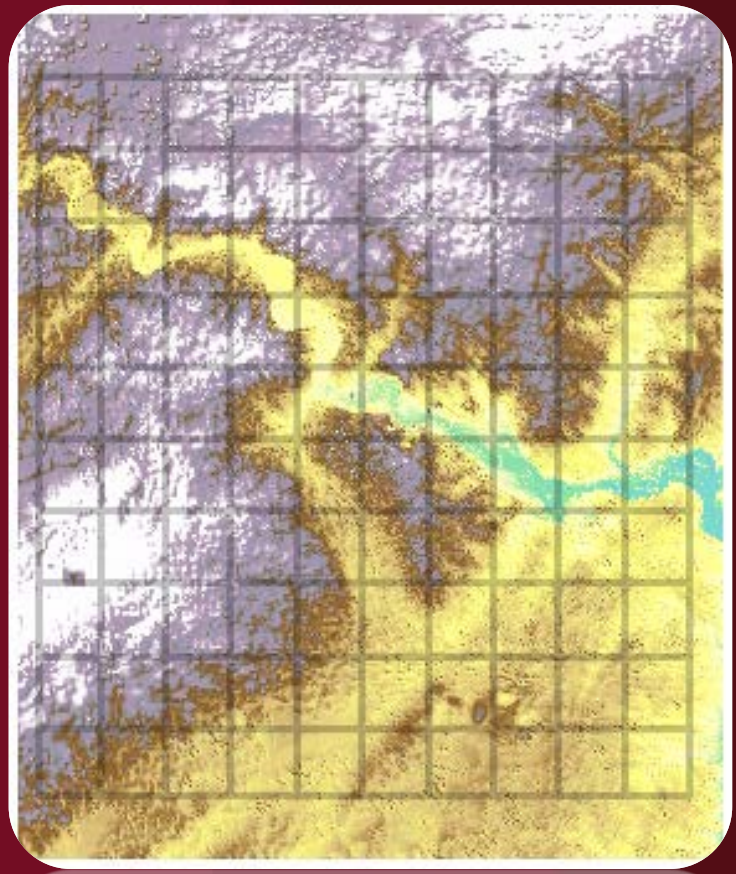
Data Acquisition/Preparation

- Proprietary data obtained which gave CV alert location and classification (binary)
- Processing power/time issues for all 891 CV alerts
  - Random sample of 38 valid, 40 valid alerts for analysis
- GPS coordinates/variables obtained:
  - Classification of CV alert (binary)
  - HDOP
  - PDOP
  - GPS Coasting
  - Fix Quality
  - Number of Visible Satellites



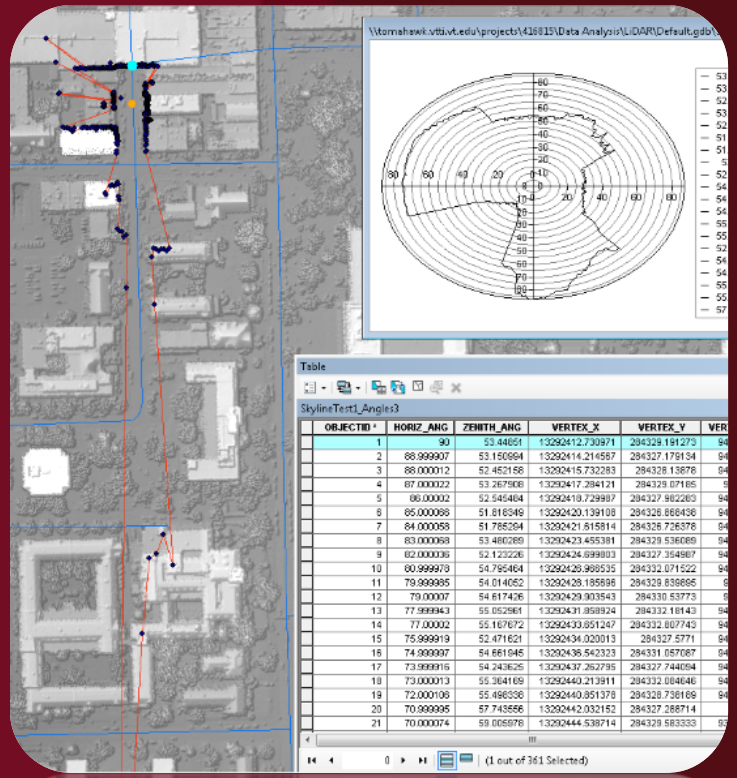
Data Acquisition/Preparation

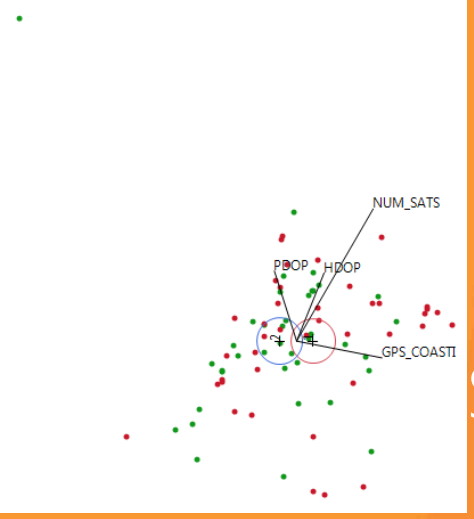
- LiDAR data publically available in area of interest
  - ~220km^2
  - 120 tiles in LAS format
- One-foot resolution raster image derived from 1st return points



Spatial Analysis

- Using ESRI ArcGIS:
  - Sample locations overlaid on 1-foot LiDAR-derived raster image
  - 3D Analyst-Visibility Toolset:
    - Skyline and Skyline Graph used to "look" around CV alert locations in 1-degree increments to obtain variables:
      - Percent Open Sky
      - Percent Shade
      - Maximum Zenith Angle
      - Minimum Zenith Angle





Statistical Analysis

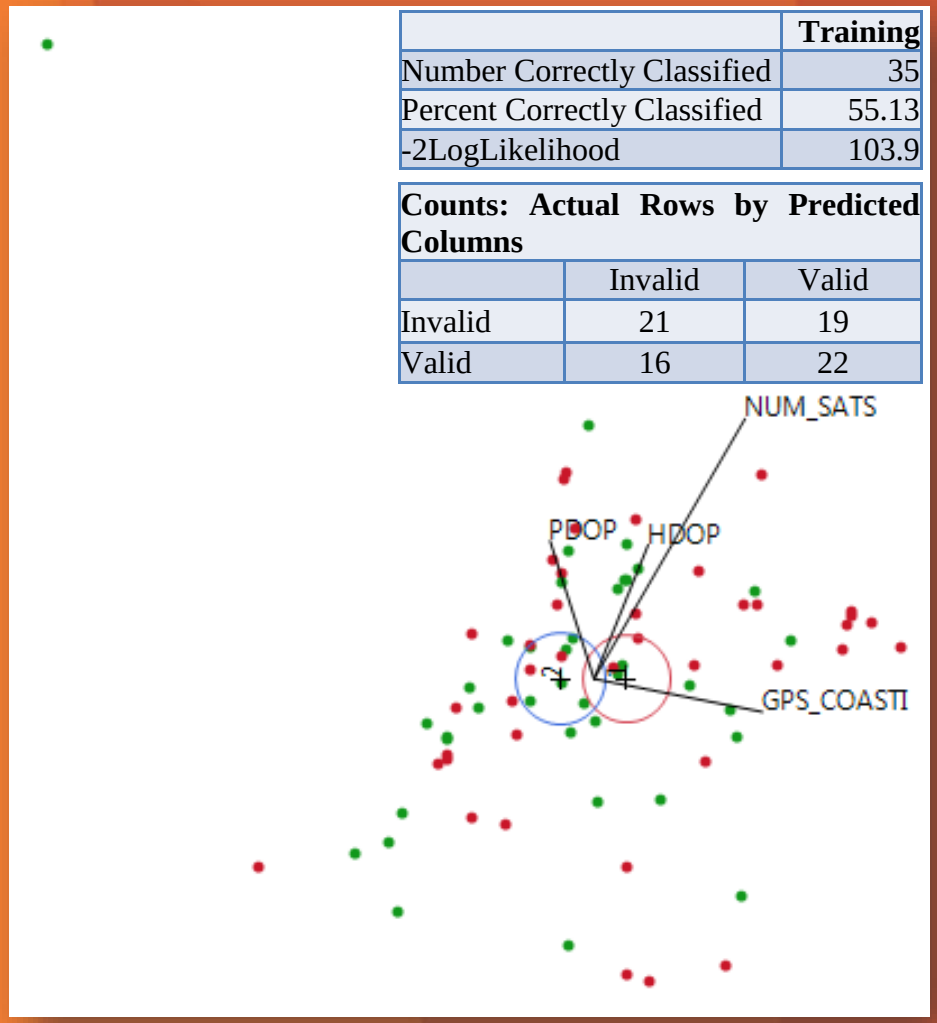
S Institute JMP software:

- Discriminant Analysis
  - First run using GPS-only variables, for comparison
  - Two CV classification groups are not statistically different from each other
  - Only able to achieve a 55.13% correct classification rate

	Training
Number Correctly Classified	35
Percent Correctly Classified	55.13
-2LogLikelihood	103.9

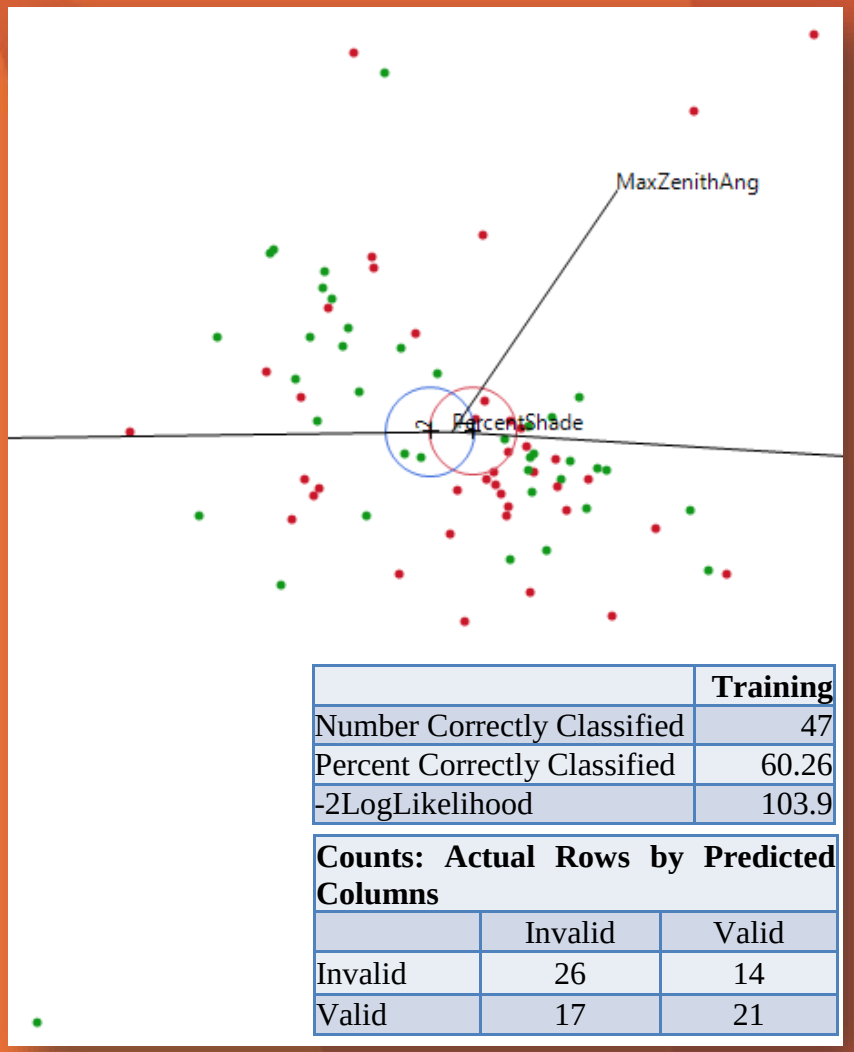
Counts: Actual Rows by Predicted Columns

	Invalid	Valid
Invalid	21	19
Valid	16	22



Statistical Analysis

- Discriminant Analysis
  - Re-run using variables from topographic analysis
  - Two CV classification groups are not statistically different from each other
  - Able to achieve a higher correct classification rate: 60.26%



	Training
Number Correctly Classified	47
Percent Correctly Classified	60.26
-2LogLikelihood	103.9

Counts: Actual Rows by Predicted Columns

	Invalid	Valid
Invalid	26	14
Valid	17	21

Discussion & Future Work

- Both models succeeded in predicting the classification of the CV alert better than mere chance
- Larger sample size and more refined analysis of the surrounding topography will lead to even lower misclassification rates
  - Issues with processing power/time
  - More efficient scripting of spatial analysis method
- Distinguishing ground, built environment, and vegetation may tease out differences in occlusion
- Explore effect of topography leading up to the point of alert on CV alert classification

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