



Identification of Crash Types, Risk Factors, and Countermeasures to Implement Systemic Safety

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Systemic Safety Management

- Widely implements lower unit-cost safety improvements at sites with characteristics that indicate high-risk of a focus crash type.
  - Focus crash types may not have high frequencies at specific locations
  - But high frequencies scattered across the road system at low densities
- Identifies sites to treat based on estimated crash potential or risk, not necessarily because of crash history.

Objective and Needs

Identify focus crash types, focus facility types, and their associated risk factors for systemic safety improvements applications

Agency experiences with systemic approaches to safety management continue to increase

There is considerable interest in quantitative approaches to systemic safety analysis

Task Order Activities

Select data resources and statistical methodologies.

Identify focus crash and facility types with their associated risk factors.

Identify potential low-cost safety strategies to be used as systemic safety improvements.

Develop a technical report and a Quick Reference Guide

Develop a criteria to identify volunteer agencies to implement systemic safety improvements.

Recommended Data Resources

Fatality Analysis Reporting System (FARS)

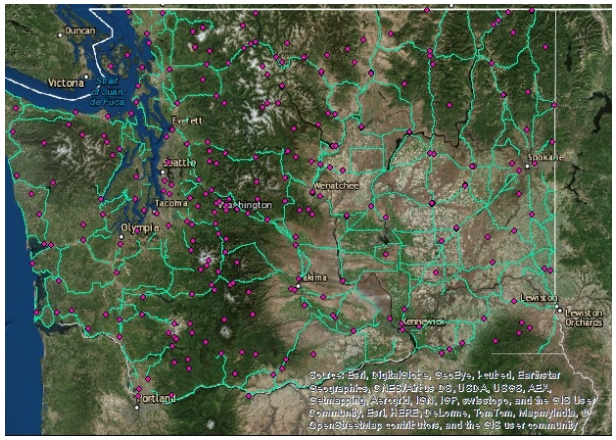
Highway Safety Information System (HSIS)

Databases from the NCEI-NOAA

Databases from the U.S. Census Bureau

“New” Safety Data Sources

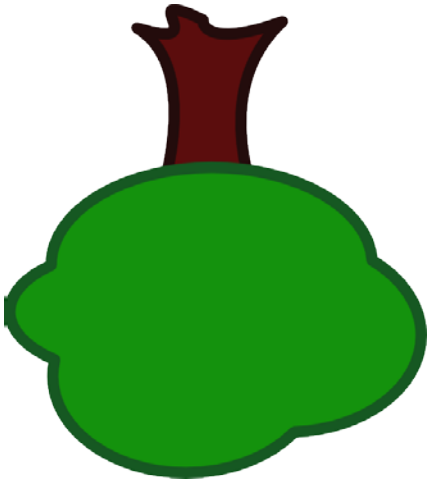
- National Oceanic and Atmospheric Administration
  - Data reporting generally occurs hourly, daily, monthly, and annually
  - These data are being used to allow weather to be considered for crash frequency-based analyses
- U.S. Census Bureau
  - Provides detailed socio-economic and demographic data.
  - Intent is to provide insights into population-based risk factors



United States™ Census Bureau

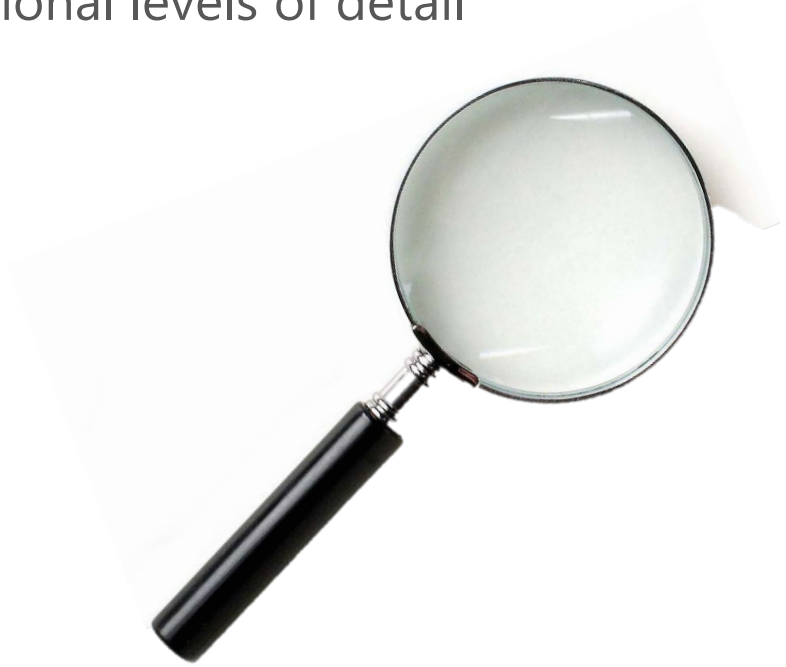
Identification of Risk Factors (methods)

- Negative binomial regression models
- Classification and Regression Trees (CARTs)
  - Non-parametric methods
  - Compared to regression models, CART is able to more efficiently identify complex interactions between variables
- Random Forests
  - Instead of having one tree, multiple trees are produced using a resampling method, and the aggregate results are then combined
  - Provides a plot to identify the most important independent variables



Identification of Focus Crash and Facility Types

- Definition
  - "First Harmful Event," "Manner of Collision," facility type, site type, geometrics, possibly additional levels of detail



- FARS Analysis (2009-2014)
  - Total number of fatal crashes
  - Total number of fatalities
- CA, MN, OH, WA (2009-2014)
  - Total number of fatal crashes
  - Total number of fatal plus incapacitating injury crashes
  - Total number of fatalities and incapacitating injuries

Focus Crash Types

- Pedestrian crashes not included (covered in NCHRP Project 17-73)
- Non-intersection (16 combinations)
  - Roadway type
    - Rural two lane
  - Crash Type
    - Run off road
    - Lane departure
    - Head on
    - Rollover/overturn
  - Time of day
    - Daytime
    - Nighttime
  - Curvature
    - Straight
    - Curved

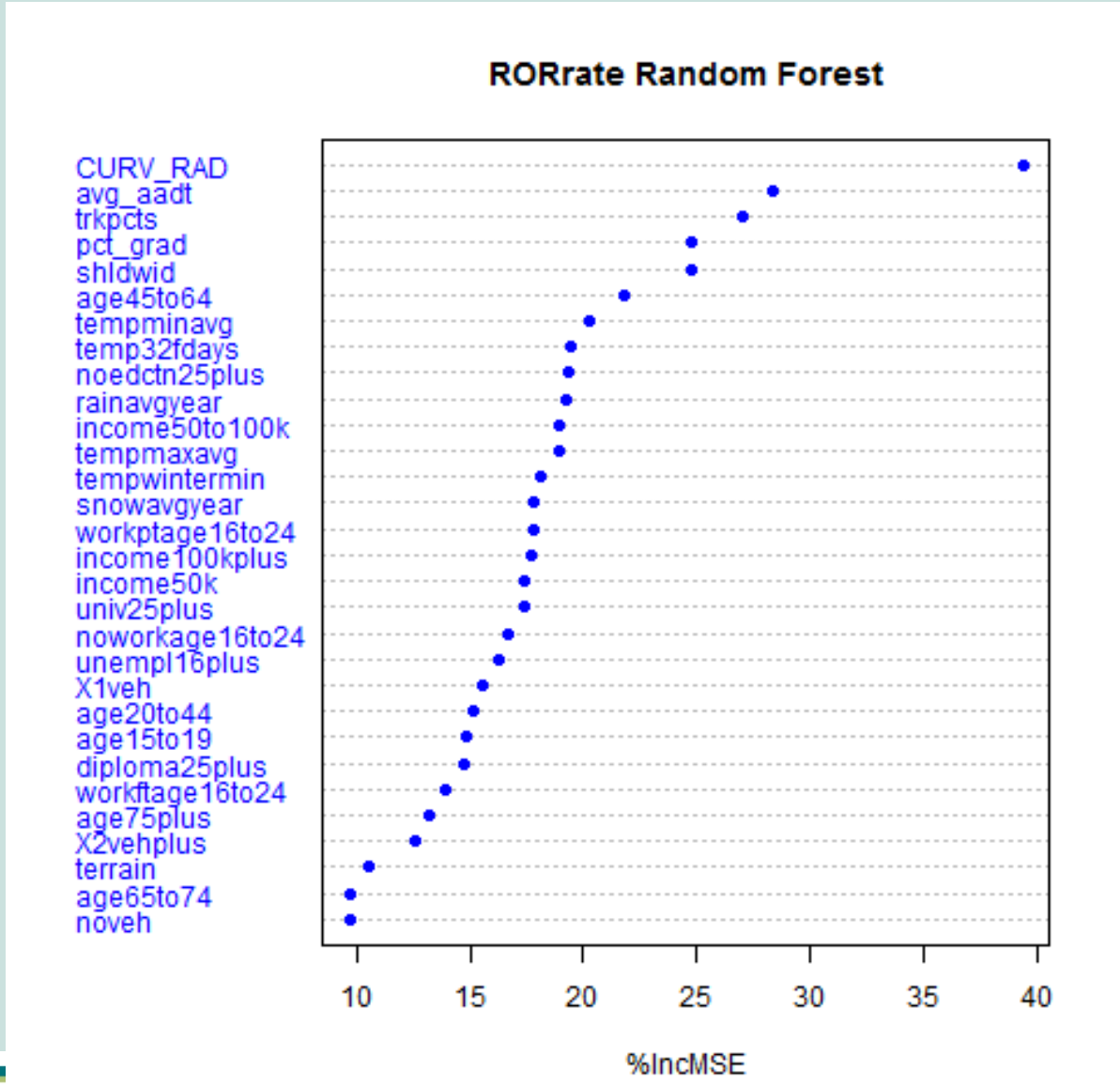
Focus Crash Types, *contd.*

- Intersection (only angle crashes)
  - Rural two-lane roads at 4-leg minor road stop controlled intersections (daylight and nighttime).
  - Urban two-lane roads at 4-leg minor road stop controlled intersections (daylight).
  - Urban multi-lane divided roads at 4-leg signalized intersections (daylight).
  - Urban multi-lane undivided roads at 4-leg signalized intersections (daylight).
  - Rural two-lane roads at 3-leg minor road stop controlled intersections (daylight).
  - Rural multilane divided roads at 4-leg minor road stop controlled intersection (daylight).

Identification of Risk Factors (for each selected crash type-facility type)

- Factors that increase crash frequency (for KABC and KAB crashes) at the site level
- Identify variables based on results from random forest
- Use predictions from random forest to determine the direction of the safety effect (i.e., increase or decrease in crashes)

Example plot from random forest (WA rural two-lane roads on horizontal curves during daytime)



Example Risk and Protective Factor Table (ROR-KAB daytime on rural two-lane tangent sections)

Variable	Factor Type
Percent Grade	Risk
Average AADT	Risk
Truck Percentage	Protective
Average Shoulder Width	Protective
Average Annual Rainfall Total	Risk
Percentage of Population (Ages 20 - 44)	Risk
Percentage of People (Ages 16 - 24) Unemployed	Risk
Annual Average Maximum Temperature	Protective
Percentage of Population (Ages 25 plus) with High School Diploma (but no University degree)	Protective
Percentage of Population (Ages 25 plus) without High School Diploma	Protective

Identification of Risk and Protective Factors

- 57 such Tables were generated based on data from Washington, California, and Ohio
- Top 10 variables from each Table selected to determine whether it is risk or protective
- Some results are counterintuitive based on existing literature
- Census and weather variables were in the top 10 variable in many cases
  - Possibility of multicollinearity
  - Exploring the use of factor analysis

Countermeasure Selection Process (Steps)

- Step 1: Identify focus crash type
- Step 2: Identify risk factors for focus crash type
- Step 3: Assemble list of potential countermeasures that address the crash type
- Step 4: Identify countermeasures that address the risk/protective factors associated with the focus crash type
- Step 5: Identify countermeasures with crash modification factors (CMFs)
- Step 6: Select countermeasures

Countermeasure selection (description of steps)

- Identify focus crash type
  - Priorities of an agency
  - Analysis of crash data
- Identify risk factors for focus crash type
  - Using the results of this study, identify risk factors
  - Agency may choose to do their own statistical analysis
- Assemble list of potential countermeasures that address crash type
  - CMF Clearinghouse
  - Highway safety manual
  - Pedsafe and bikesafe
  - Jurisdiction-specific CMF list

Countermeasure selection (description of steps), *contd.*

- Identify countermeasures that address the risk factors
  - Not all countermeasures may address the risk factor
- Identify countermeasures with CMFs
  - Identify countermeasures with CMFs that are considered reliable by the agency
- Select countermeasure
  - Select appropriate countermeasure based on cost and CMF value

Technical Report and Quick Reference Guide

- Draft 1 of Technical Report has been reviewed by FHWA and Expert Statistician Support Team
- A Quick Reference Guide is under preparation
  - More concise
  - Identification of focus crash types, risk factors, and targeted systemic countermeasures
  - Description of a repeatable process
- As focus crash types and treatments are identified, we will be interested in the involvement of agencies to implement systemic safety improvements for evaluation.





Thank You

Questions?