# Zero Fatalities: Applying the Roadway Safety Analysis Methodology in Utah

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Zero Fatalities®
A Goal We Can All Live With

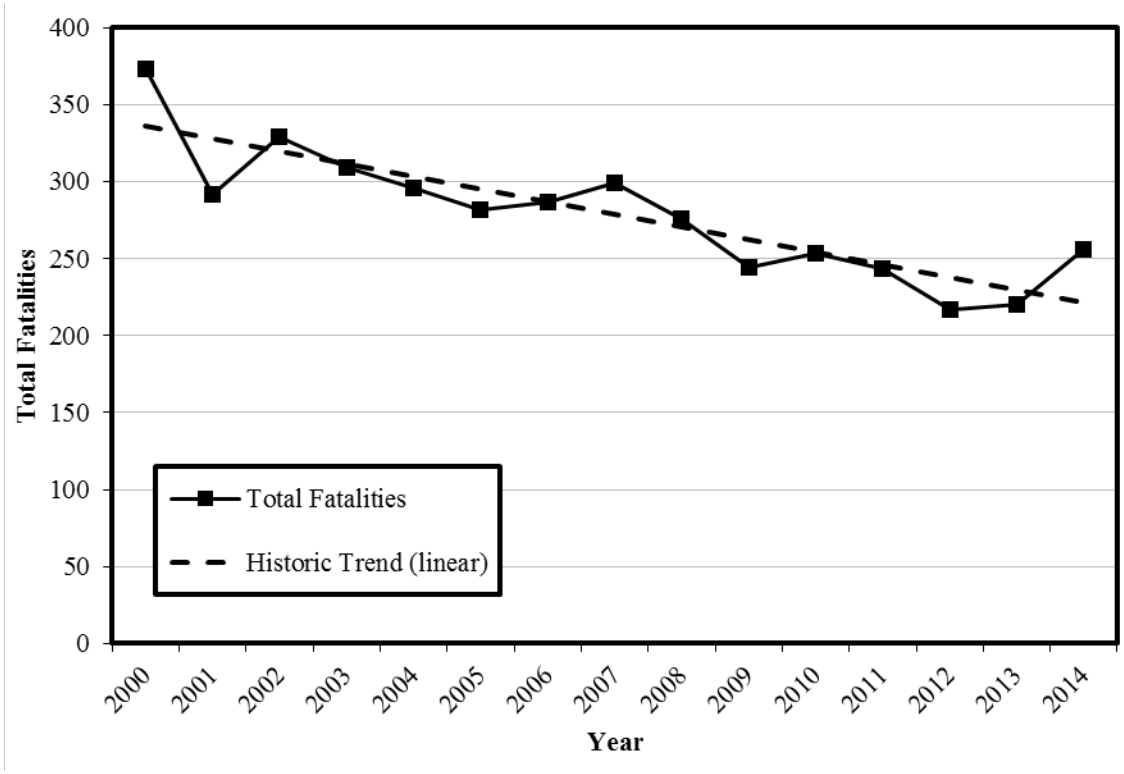
UDOT
Keeping Utah Moving

# Outline

- Background
- Data and Automation Tools
- Roadway Safety Analysis Methodology:
  1. Crash and Roadway Data Segmentation
  2. Statistical Network Screening of Roadway Data
  3. Report Compilation for Segments of Interest
- Summary
- Concluding Remarks

# Background

- Goals:
  - Zero Fatalities
  - Identify "Hot Spots"
  - Project Prioritization



# Background

- "Hot Spot Identification and Analysis":
  - Utah Crash Prediction Model (UCPM)
  - Utah Crash Severity Model (UCSM)
  - Roadway Safety Analysis Reports (RSARs)

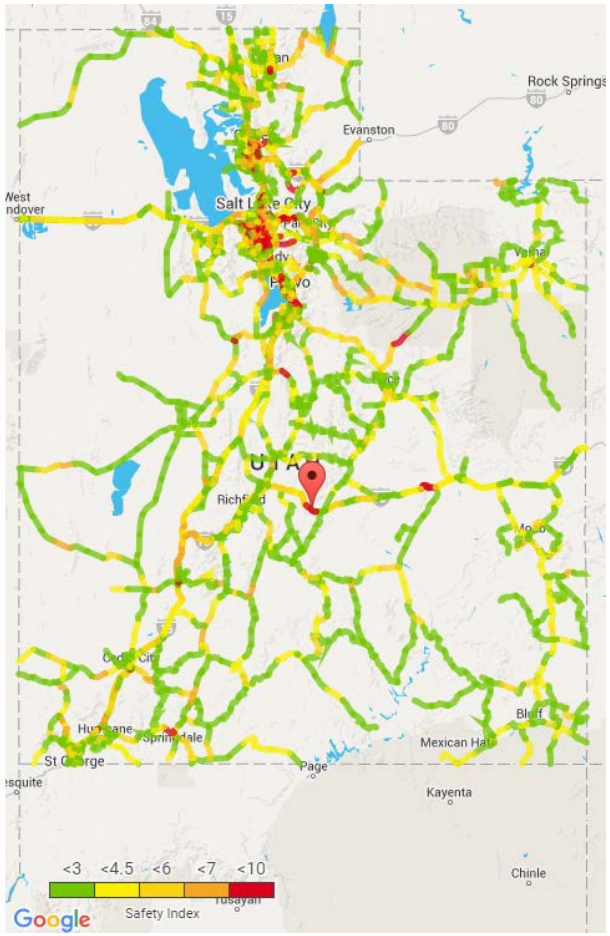
| UDOT-FHWA Scale | Injury Status |
|---|---|
| 5-K | Fatal Injury: injury that results in death within 30 days of crash |
| 4-A | Suspected Serious Injury: serious injury not resulting in fatality; incapacitating injury results from the crash |
| 3-B | Suspected Minor Injury: minor injury evident at the scene of the crash, not serious injury or fatality |
| 2-C | Possible Injury: injuries reported but not evident at the scene of the crash |
| 1-O | No Apparent Injury: the person receive no bodily hard; property damage only (PDO) |

# Background

- Safety countermeasures:
  - NCHRP 500 Report volumes (23):
    - Aggressive driving, unlicensed drivers, collisions with trees, head-on collisions, unsignalized intersection collisions, etc.
  - "Countermeasures that Work":
    - Alcohol and drug impaired driving, seat belts, speeding, distracted/drowsy, etc.
  - CMF Clearinghouse website

# Background

- UDOT SafeMap web interface:

# Data and Automation Tools

- UDOT Open Data and UDOT Traffic & Safety Division*:
  - Crash data*
  - AADT (truck AADT)
  - Functional class
  - Through lanes
  - Urban code
  - Speed limit
  - Horizontal curves*
  - Shoulder
  - Medians
  - Rumble strips
  - Walls
  - Barriers
  - Intersections
  - Sign face
  - Route grade

# Data and Automation Tools

*Uniform Data Columns*

| Data Field | Meaning |
|---|---|
| "ROUTE_ID" | Contains four numeric digits with the route number and leading zeros |
| "DIRECTION" | Contains "P" "N" or "X" corresponding to route direction |
| "LABEL" | Five digit code with the ROUTE_ID and DIRECTION fields joined |
| "BEG_MILEPOINT" | Beginning MP of the segment |
| "END_MILEPOINT" | Ending MP of the segment |

*Speed Limit Critical Data Columns*

| Heading | Description |
|---|---|
| Route | Route ID: Route ID number with direction letter (i.e. 0089N) |
| Direction | Direction: Route direction (P, N) |
| Beg_MP | Beginning MP: The milepost where the sign appears |
| End_MP | End MP: The end milepost of the road segment |
| Speed_Limit | Speed Limit: number signifying the speed limit (in mph) of a particular segment. |

# Data and Automation Tools

*Python Script*

Python 2.7.8: SpatialJoinONETOMANY.py - C:\Users\stminee...

File Edit Format Run Options Windows Help

```
# Environment Variables
arcpy.AddMessage("Environment Variables..."+ " \n   "
arcpy.env.overwriteOutput=True
arcpy.env.workspace = os.path.join(folder,"SpatialJoi
arcpy.AddMessage(arcpy.env.workspace + " \n   ")

def SpatialJoinOTMExcel (TargetFeature, RoadwayFeatur
        arcpy.AddMessage("Spatial Join Data for " + E
        OutputFeature = ExcelName+"_joined"
        arcpy.SpatialJoin_analysis(TargetFeature, Roa

        arcpy.AddMessage("   Exporting " + ExcelName
        OutputExcelFile = os.path.join(ExcelOutputFol
        arcpy.TableToExcel_conversion(OutputFeature,

SpatialJoinOTMExcel(SelectedSegments, Barriers, "Barr
```

Ln: 83 Col: 0

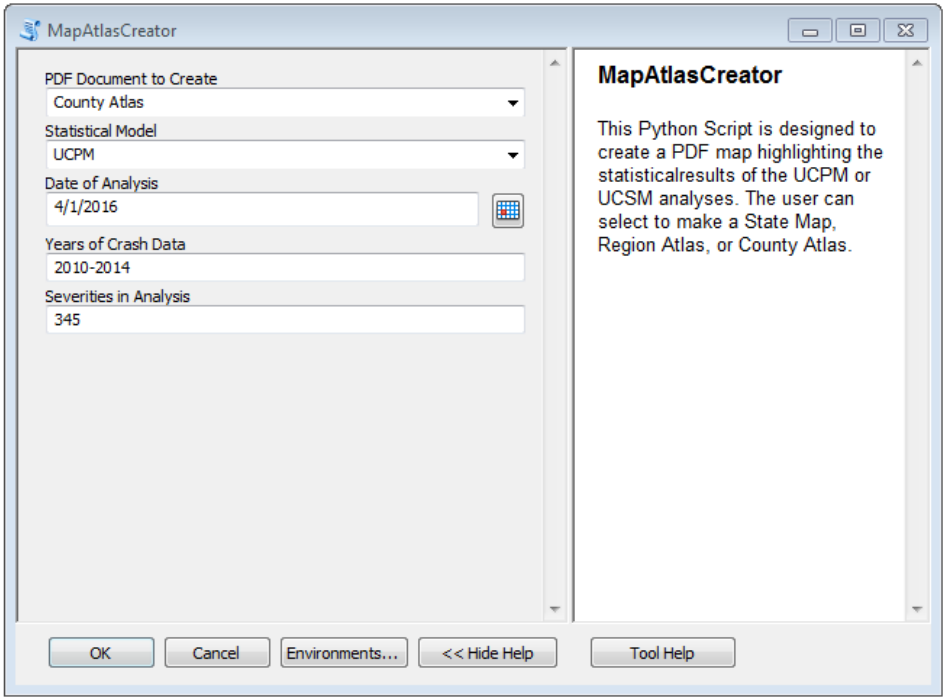
*MS Excel VBA*

(General) (Decla

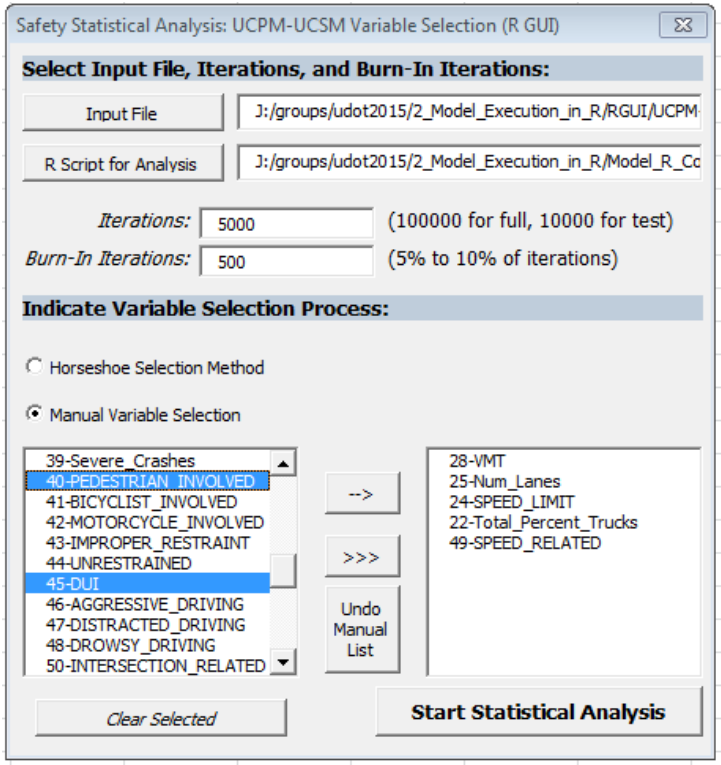
```
Option Explicit

Function checkRlibraries()
' The purpose of this fuction is to check if the r

Dim n As Integer

Dim Rlibrary(1 To 6) As String
Rlibrary(1) = "MASS"
Rlibrary(2) = "mnormt"
Rlibrary(3) = "rjags"
Rlibrary(4) = "R2WinBUGS"
Rlibrary(5) = "arm"
Rlibrary(6) = "ggplot2"

checkRlibraries = True

For n = 1 To 6
    If FolderExists("C:\Program Files\R\R-3.2.3\li
    Else
```

# Data and Automation Tools

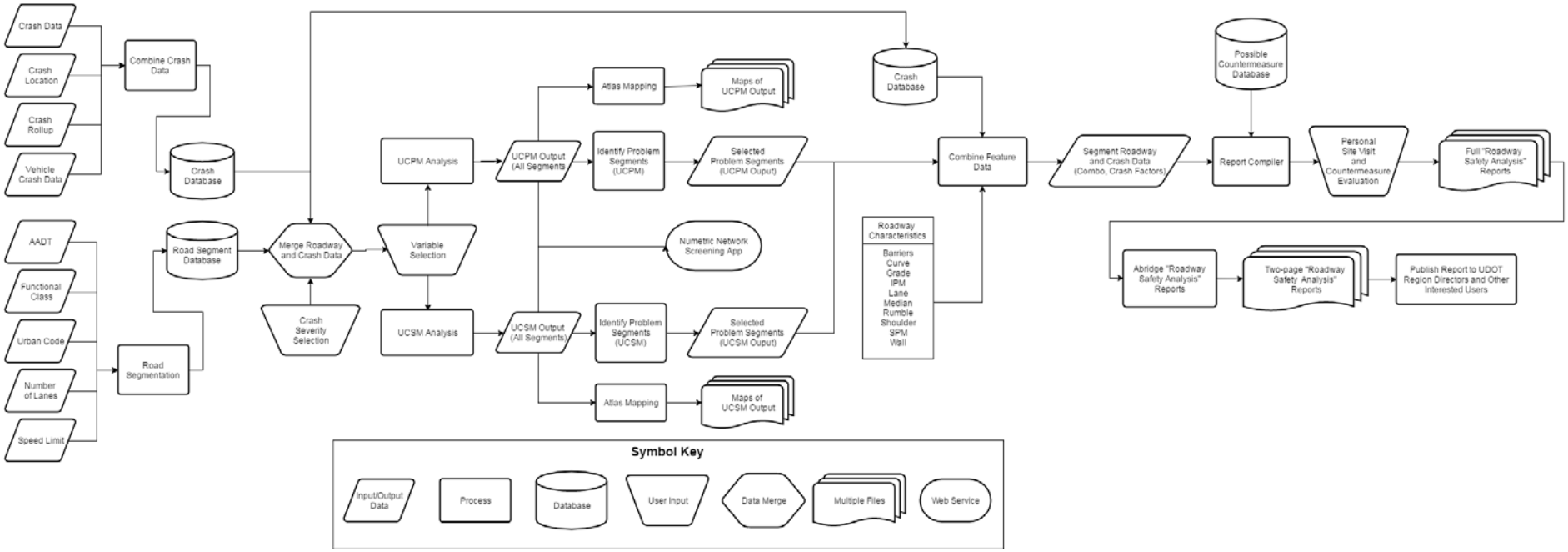
*ArcMap GUI*



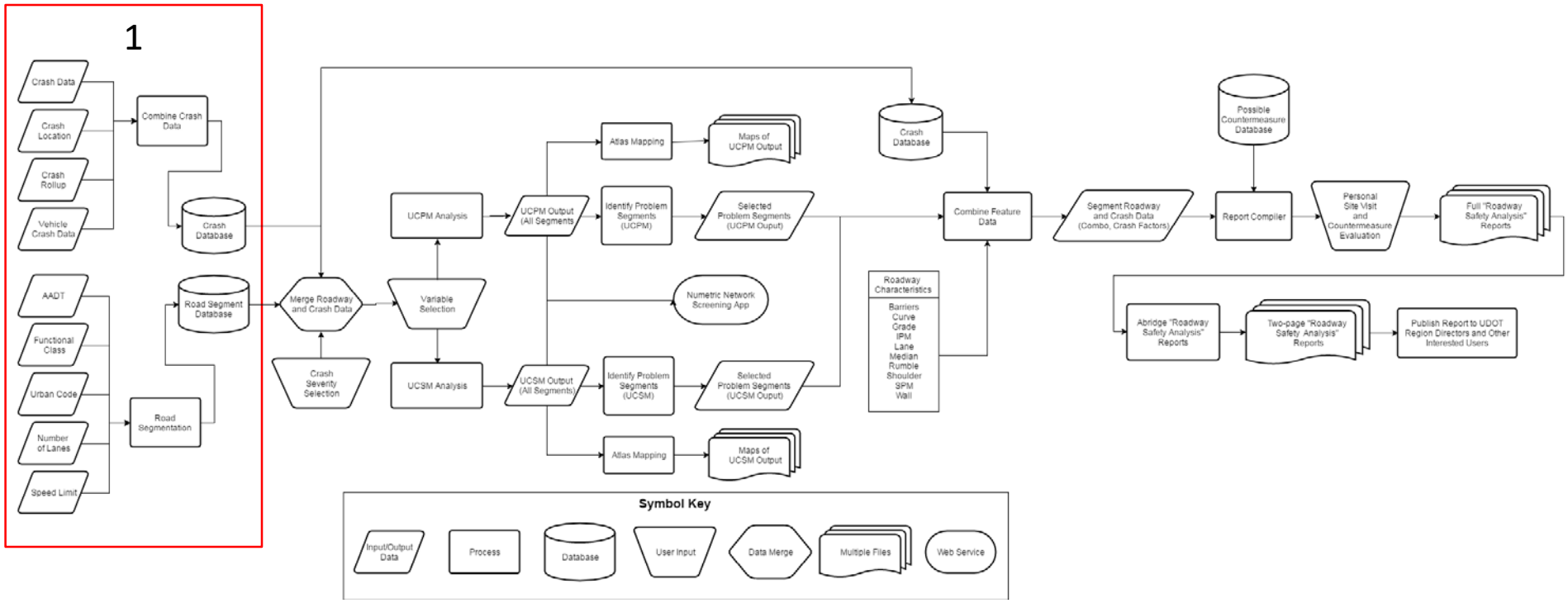

*MS Excel GUI*



# Roadway Safety Analysis Methodology

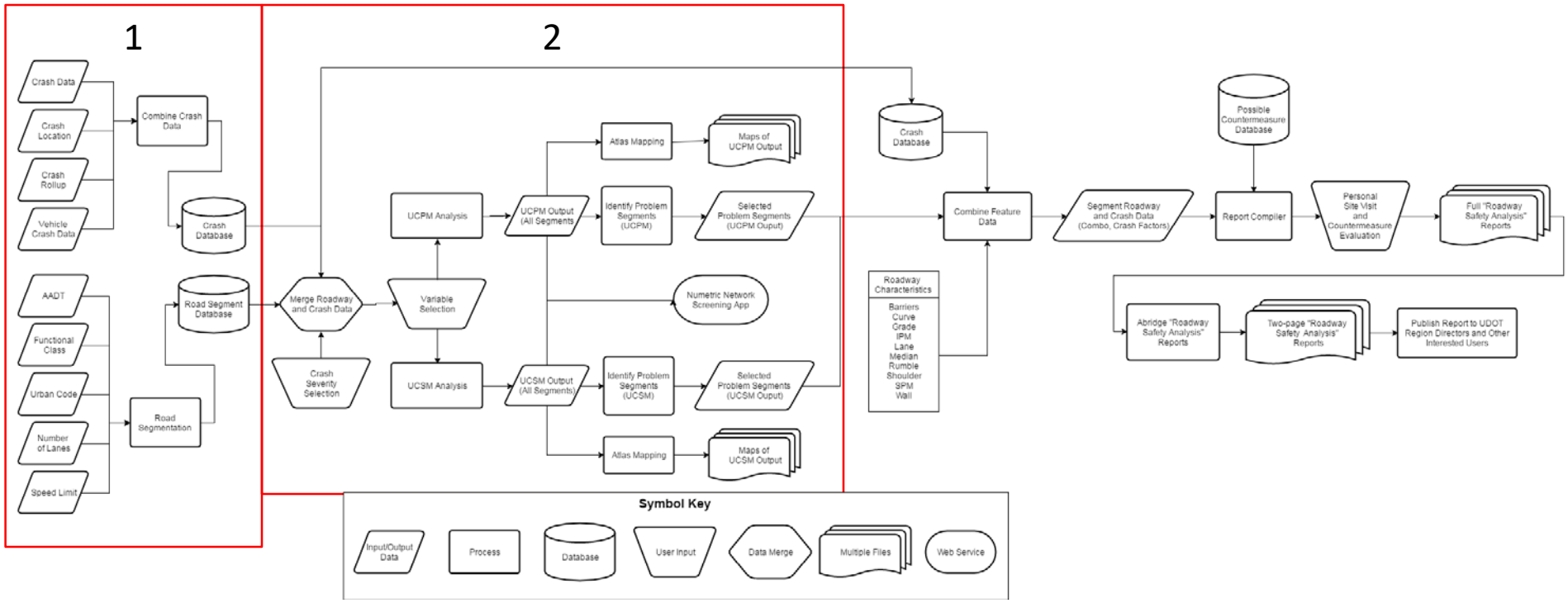


# Roadway Safety Analysis Methodology



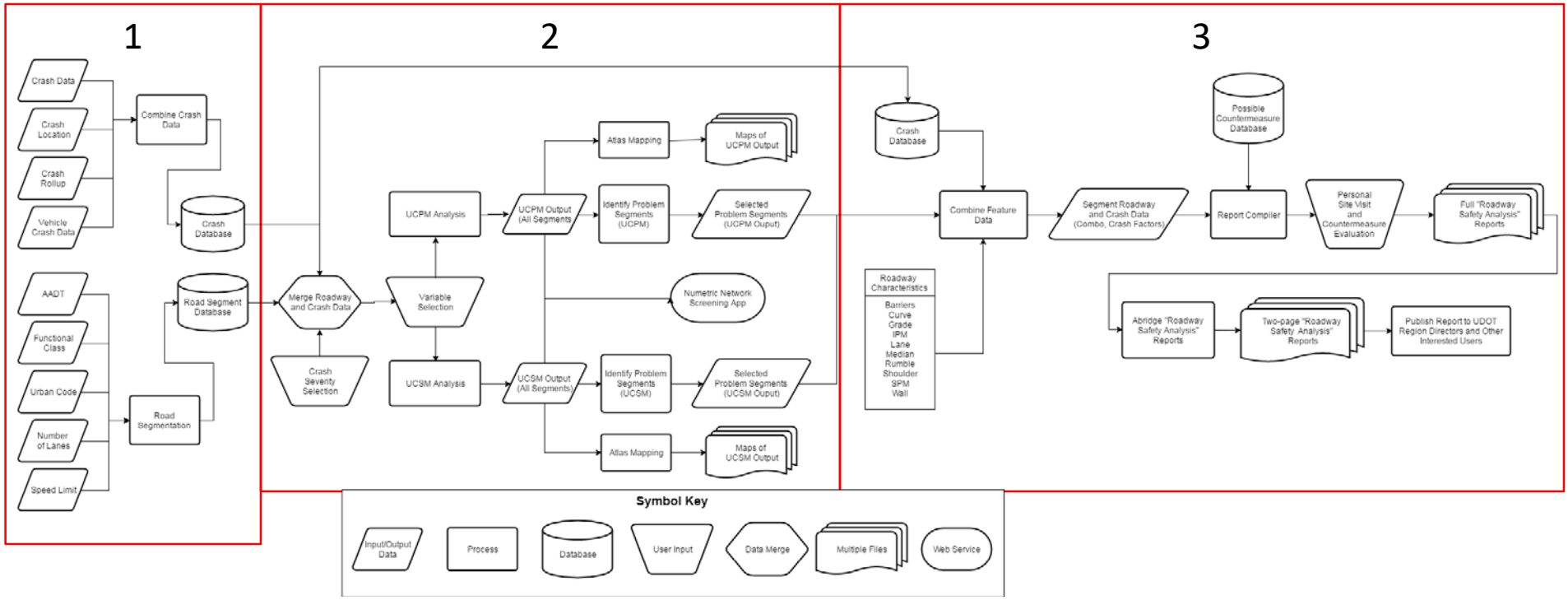

1) Crash and Roadway Data Segmentation

# Roadway Safety Analysis Methodology




2) Statistical Network Screening of Roadway Data

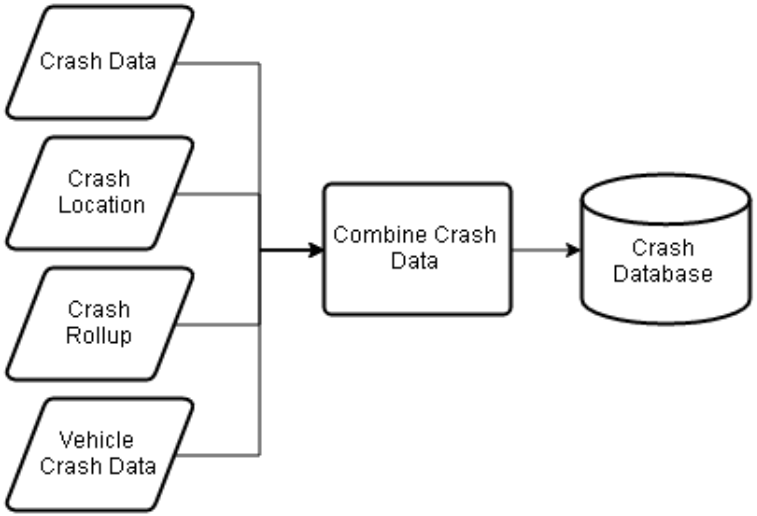
# Roadway Safety Analysis Methodology




3) Report Compilation for Segments of Interest

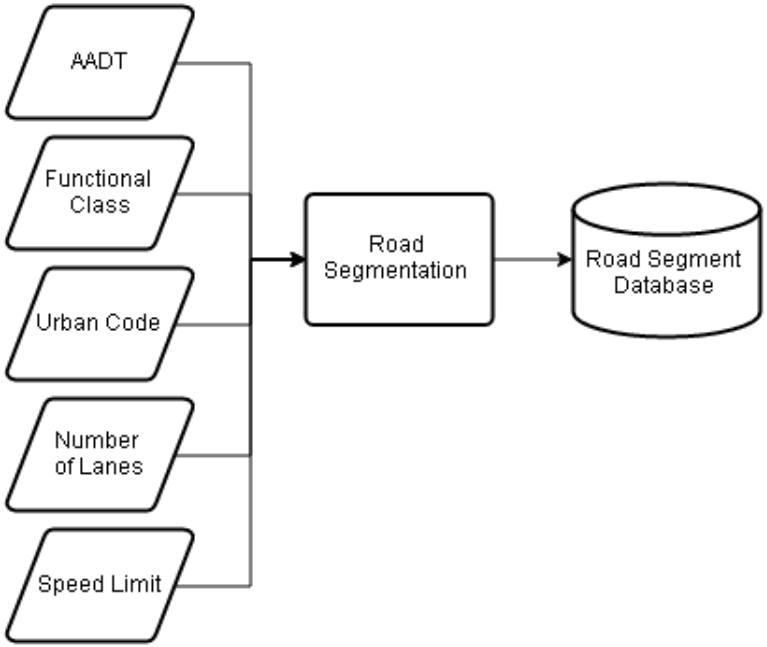
# *1) Crash and Roadway Data Segmentation*

- Crash data:
  - Crash data
  - Crash location
  - Crash rollup (crash factors)
  - Vehicle crash data



# *1) Crash and Roadway Data Segmentation*

- Roadway data:
  - AADT, functional class, urban code, number of lanes, speed limit
- Segmentation:
  - By attribute change
  - By length (e.g., 0.1 mile)



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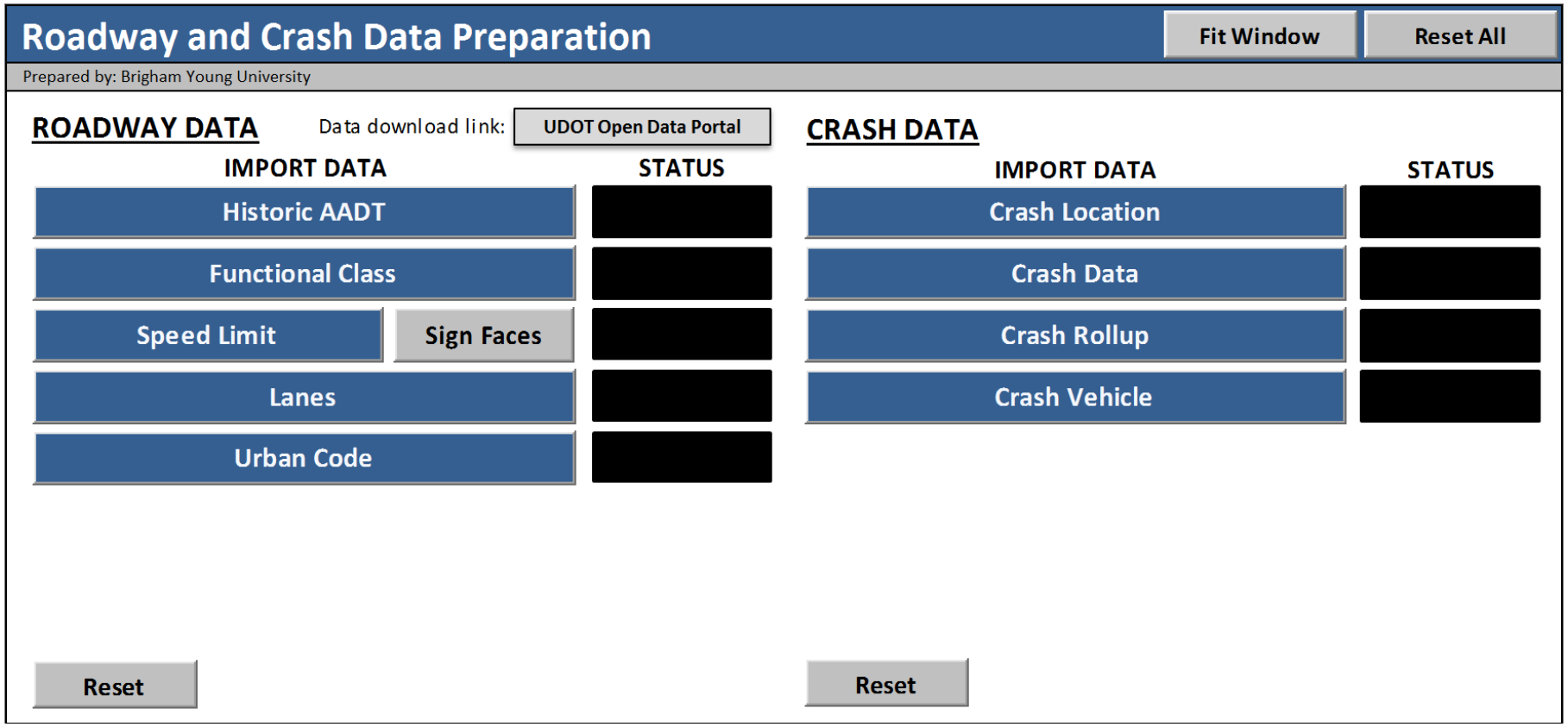
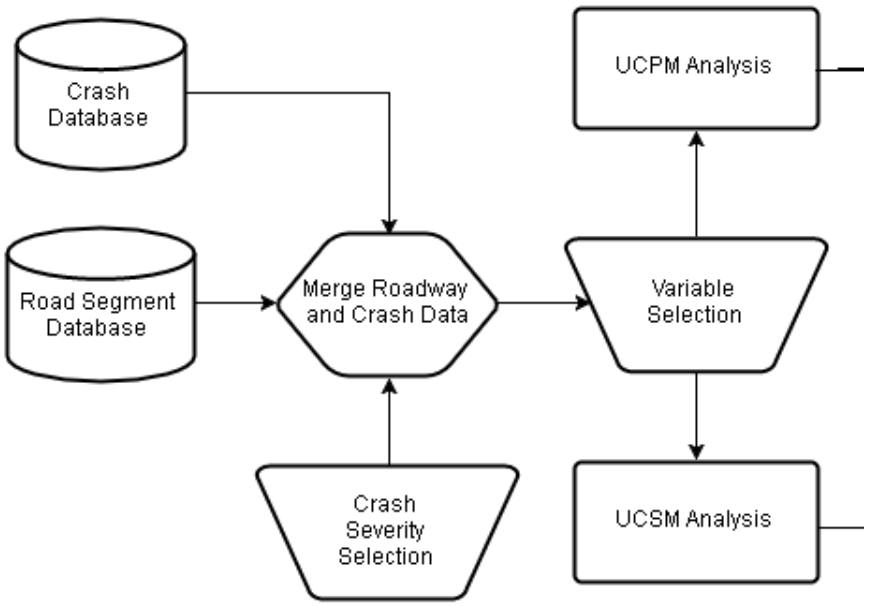
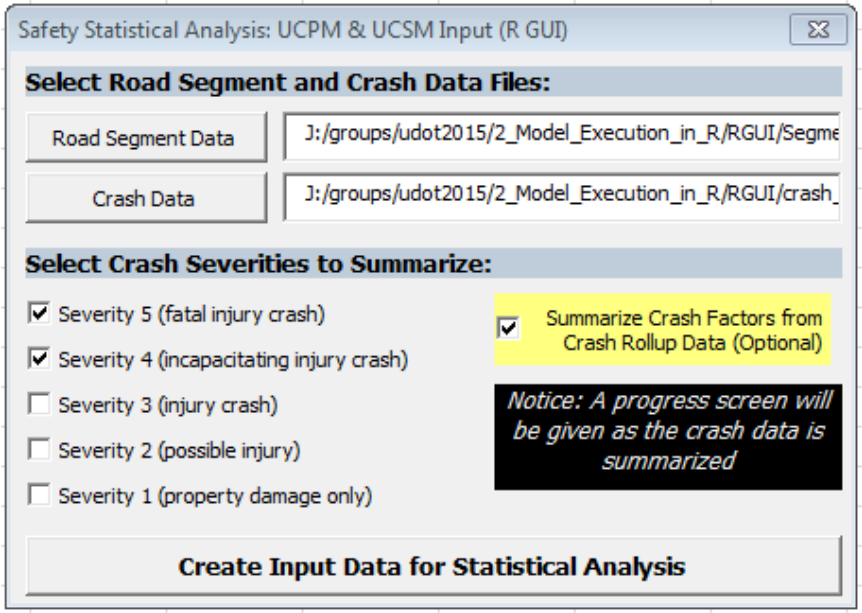


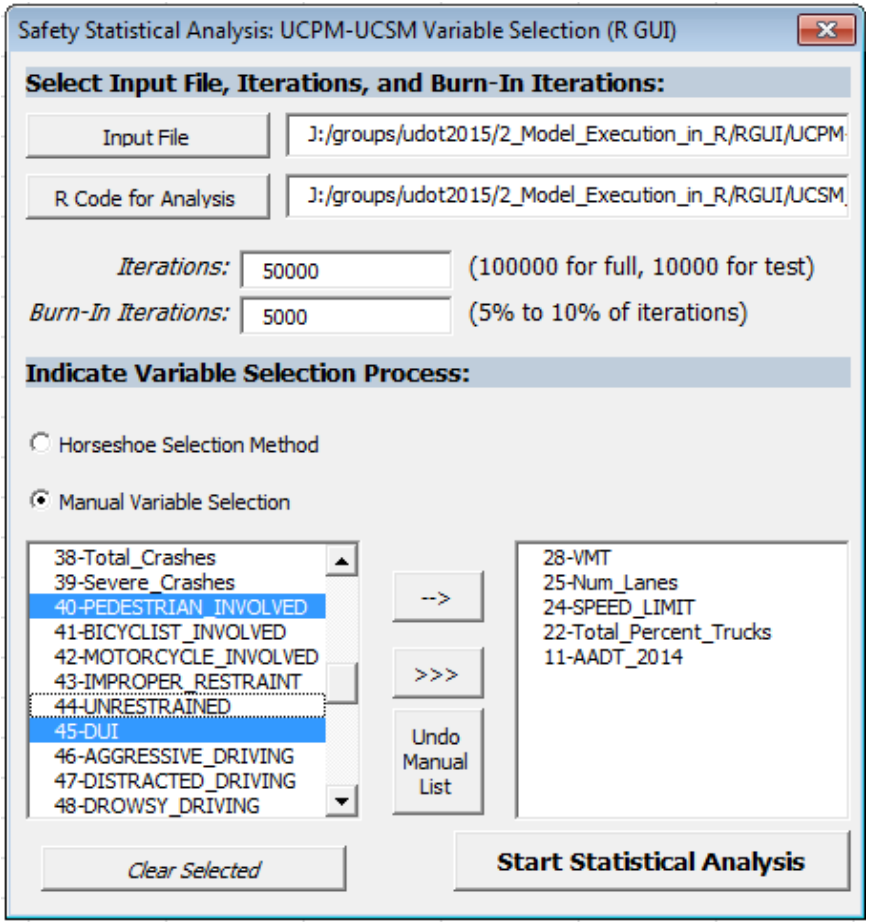
# 2) Statistical Network Screening of Roadway Data

- Merge roadway and crash data:
  - Select severities
- Model variable selection:
  - Horseshoe (step-wise)
  - Manual selection



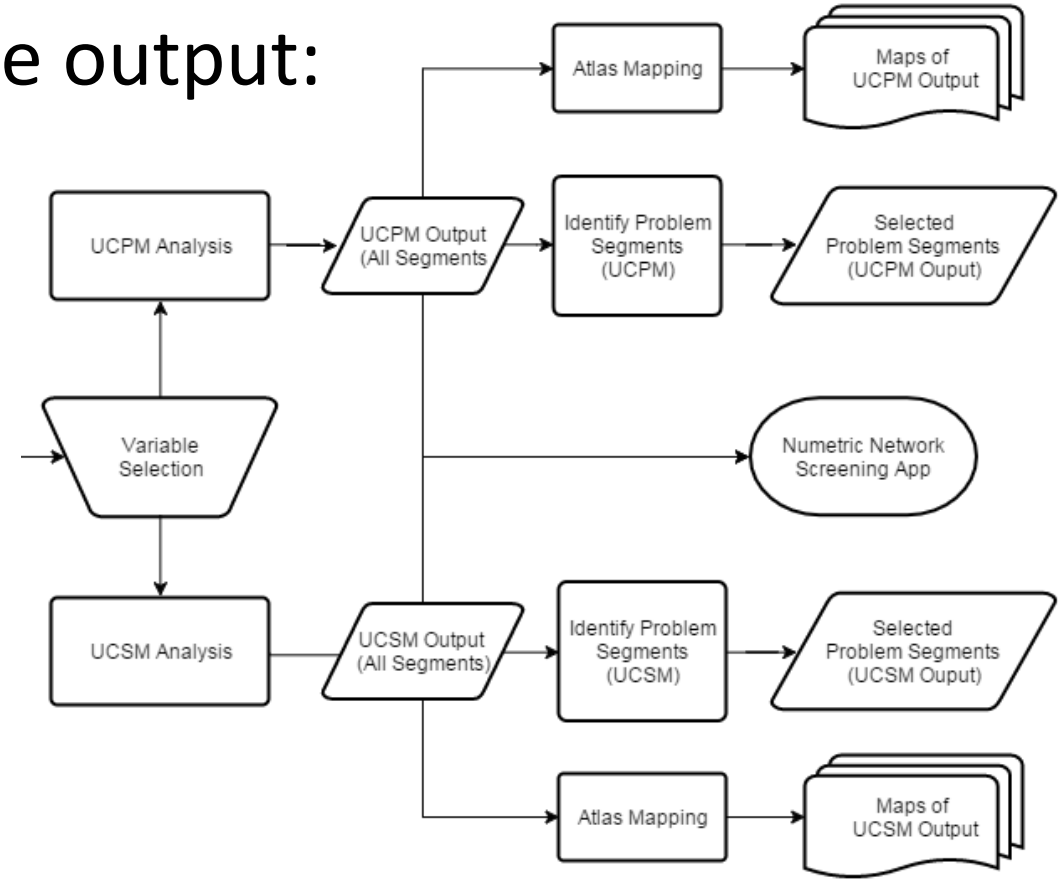
# 2) Statistical Network Screening of Roadway Data



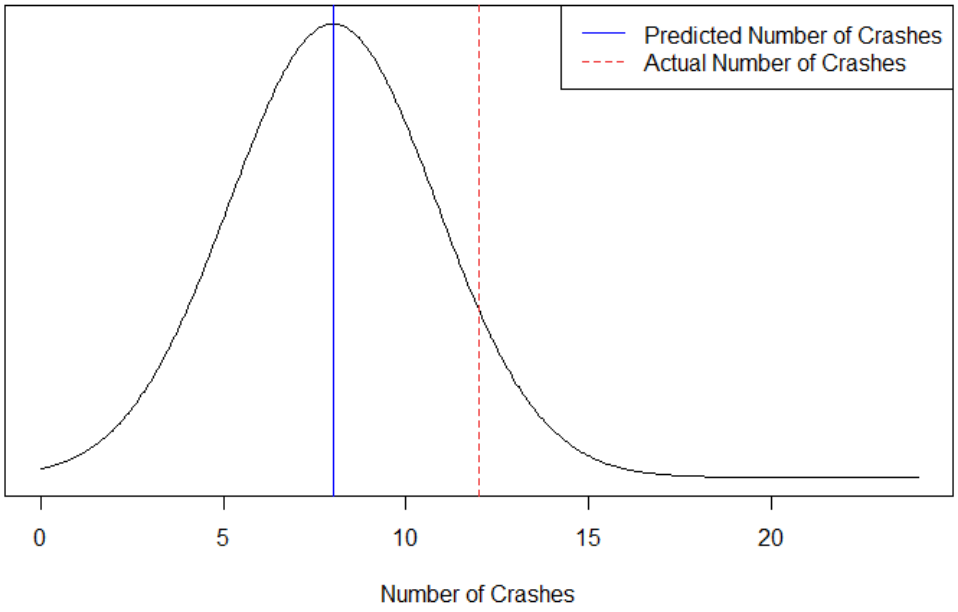
# 2) Statistical Network Screening of Roadway Data

- Analyze output:



# 2) Statistical Network Screening of Roadway Data

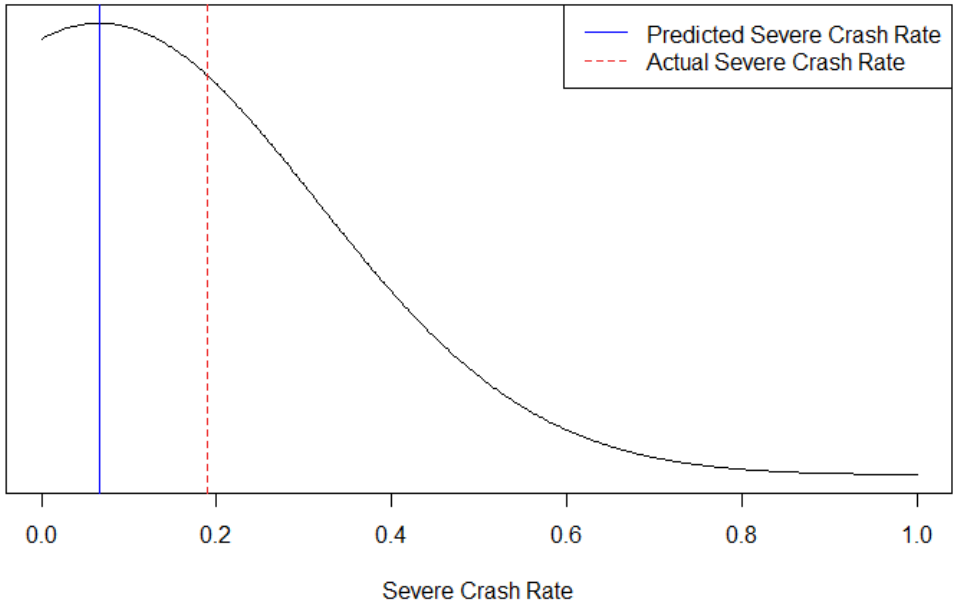
- UCPM output interpretation:
  - Compare predicted and actual number of crashes
  - High percentile = "hot spots"




$$UCPM\ Normalizing\ Index = Perc$$

# 2) Statistical Network Screening of Roadway Data

- UCSM output interpretation:
  - Compare predicted severe crash rate to actual severe crash rate
  - High percentile and high difference = "hot spot"




$$UCSM\ Normalizing\ Index = Perc * Diff$$

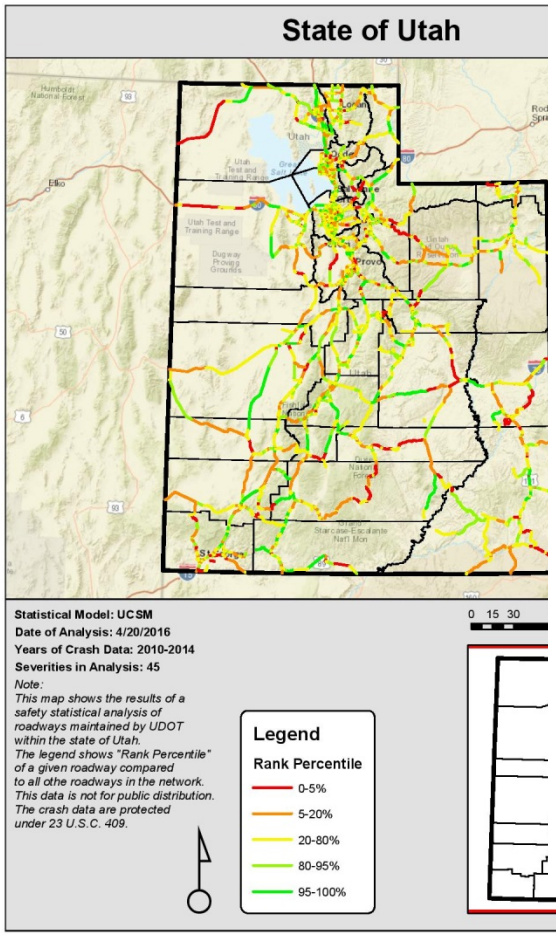
# 2) Statistical Network Screening of Roadway Data

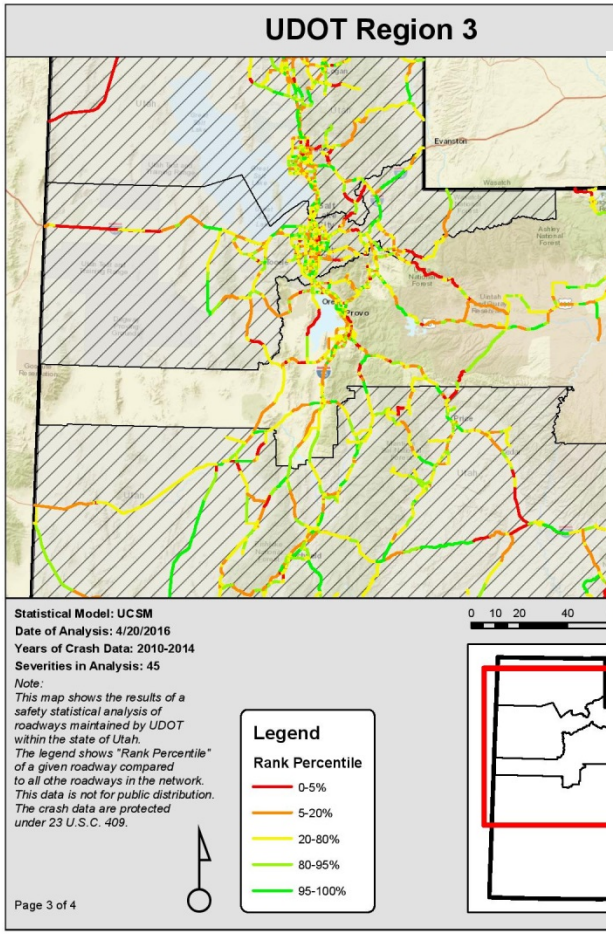
- Hierarchical ranking:
  - Statewide rank
  - Region rank
  - County rank
- Categorical ranking:

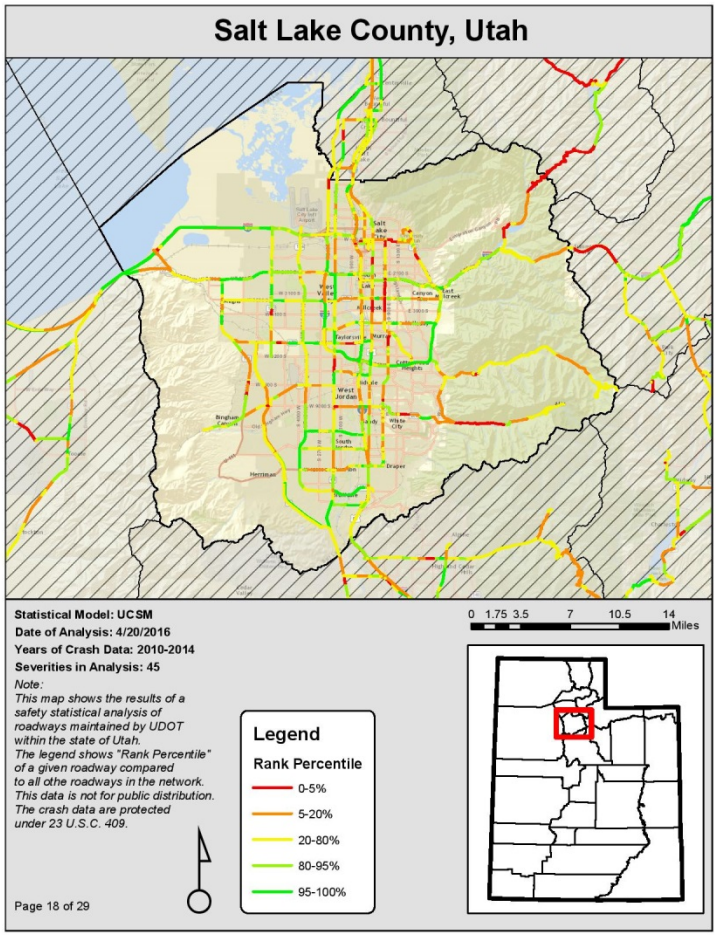
| UDOT Classification | UDOT Percentile |
|---|---|
| Most Problematic | 0% - 5% |
| More Problematic | 5% - 20% |
| Some Problematic | 20% - 80% |
| Less Problematic | 80% - 95% |
| Least Problematic | 95% - 100% |

| Route Label | Beginning MP | End MP | County | UDOT Region | State Rank | Region Rank | County Rank |
|---|---|---|---|---|---|---|---|
| 0089P | 388.438 | 389.123 | DAVIS | 1 | 1 | 1 | 1 |
| 0015P | 250.923 | 253.557 | UTAH | 3 | 2 | 1 | 1 |
| 0089P | 415.425 | 415.994 | WEBER | 1 | 3 | 2 | 1 |
| 0015P | 292.596 | 293.634 | SALT LAKE | 2 | 4 | 1 | 1 |
| 0089P | 369.036 | 369.532 | SALT LAKE | 2 | 5 | 2 | 2 |
| … | … | … | … | … | … | … | … |
| 0015X | 312.319 | 313.275 | SALT LAKE | 2 | 55 | 19 | 19 |
| 0089P | 371.471 | 372.037 | SALT LAKE | 2 | 56 | 20 | 20 |
| 0089P | 233.46 | 238.035 | SANPETE | 4 | 57 | 4 | 4 |
| 0080P | 146.876 | 150.724 | SUMMIT | 2 | 58 | 21 | 1 |
| 0126P | 8.738 | 9.126 | WEBER | 1 | 59 | 18 | 6 |
| 0089P | 470.371 | 471.607 | CACHE | 1 | 60 | 19 | 1 |

# 2) Statistical Network Screening of Roadway Data



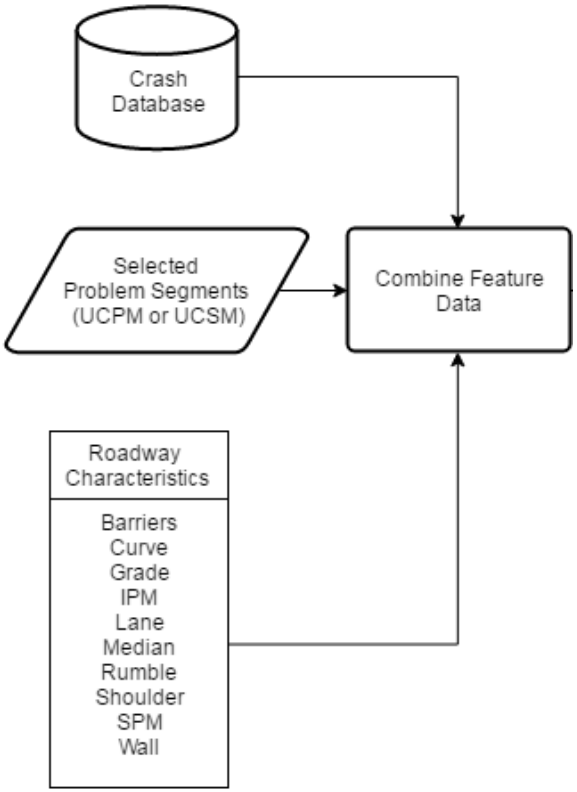



# *2) Statistical Network Screening of Roadway Data*

- Select segments of interest:
  - Top 40 in the State
  - Top 30 in a Region
  - Top 20 in a County
  - Planned corridor maintenance/rehabilitation

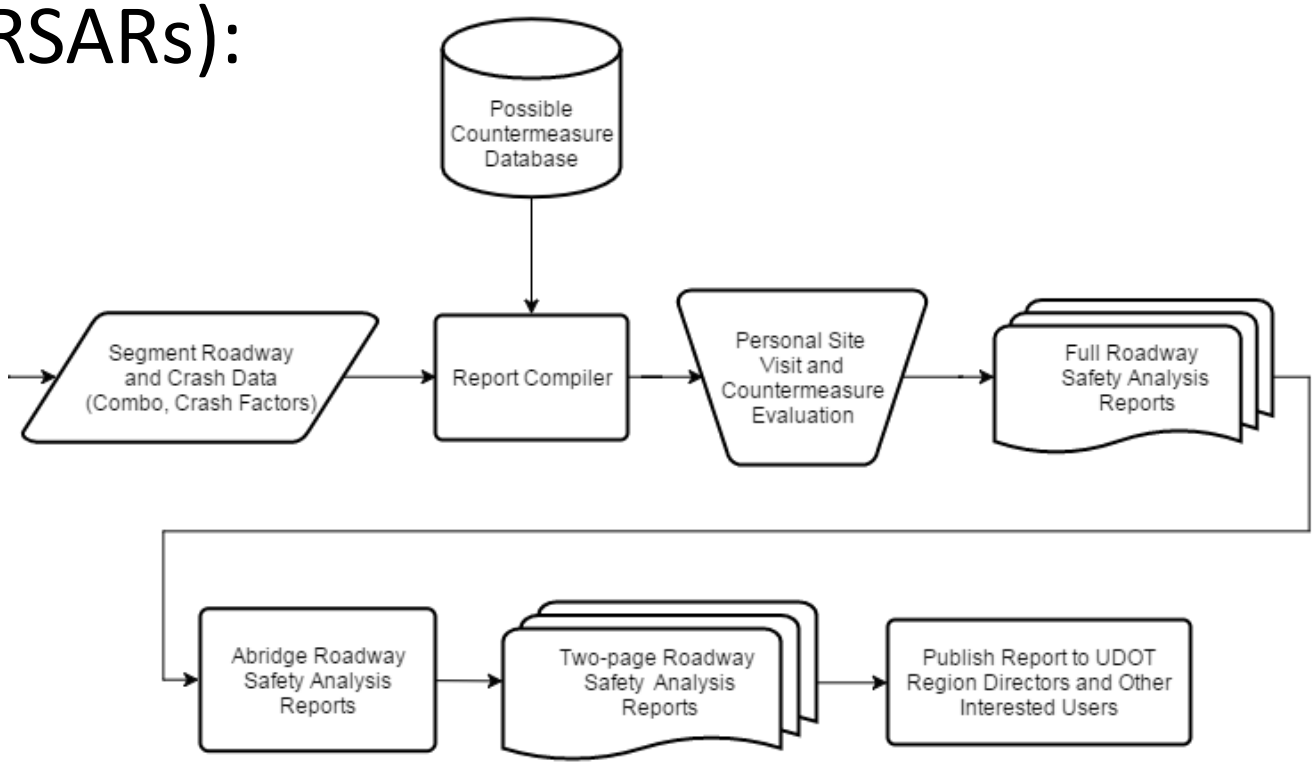
# *3) Report Compilation for Segments of Interest*

- Spatial roadway characteristics:
  - Downloaded
  - Derived
- Spatially join crash and roadway characteristics with segments of interest (i.e., “hot spots”)



# *3) Report Compilation for Segments of Interest*

- Create Roadway Safety Analysis Reports (RSARs):



# 3) Report Compilation for Segments of Interest

- Segment identification and roadway characteristics:

| | | | |
|---|---|---|---|
| Road Name: | _____ | UC Model Used: | _____ |
| Road Direction: | _____ | State Rank: | _____ |
| Beginning, Ending MP: | _____ | Rank, Region: | _____ |
| Length (miles): | _____ | Rank, County: | _____ |
| Dates of Data Source: | _____ | Date of Analysis: | _____ |

| | | | |
|---|---|---|---|
| Function Class: | _____ | AADT: | _____ |
| Number of Thru Lanes: | _____ | Speed Limit (MPH): | _____ |

| MPs | Median | IPM | SPM | Shoulder | Grade | Curve | Lanes | Wall/ Barrier | Rumble |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

# 3) Report Compilation for Segments of Interest

- Micro-analysis of crash data:

| MP | Total Crashes on Roadway | Severity 5 (Fatal) | Severity 4 (Incap. Injury) | Severity 3 (Non-incap. Injury) |
|---|---|---|---|---|
| | | | | |

| Crash ID | MP | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Factor 8 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Segment Total | | | | | | | | | |

| Crash ID | MP | First Harmful Event | Manner of Collision | Event Sequence | | | | Most Harmful Event | Vehicle Maneuver |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | | |
| | | | | | | | | | |

# *3) Report Compilation for Segments of Interest*

- Possible countermeasures:
  - Based on top 8 crash factors
  - Auto-populated from NCHRP 500 series reports
  - List narrowed down by analyst
- Historical perspective, current conditions:
  - Site visit
  - Internet tools (Google Earth, Roadview Explorer)
  - Communicate with experts

# 3) Report Compilation for Segments of Interest

## *Roadway Safety Analysis Report*

### Introduction

*The purpose of this report is to summarize and present preliminary results from a safety-specific micro analysis on an identified segment of interest. This report includes identification of the roadway segment and sub-segments, micro-analysis of the crash data, site visit notes, and a list of possible countermeasures.*

### Segment Identification and Roadway Characteristics

**Table 1: Segment Metadata**

| | | | | | |
|---|---|---|---|---|---|
| **Road Name:** | SR-68 | | **UC Model Used:** | UCSM | |
| **Road Direction:** | Positive | | **State Rank:** | 5 | |
| **Beginning, Ending MP:** | 11.648 | 23.709 | **Rank, Region:** | 1 | 3 |
| **Length (miles):** | 12.061 | | **Rank, County:** | 1 | UTAH |
| **Dates of Data Source:** | 2010-2014 | | **Date of Analysis:** | 4/29/2015 | |

**Table 2: Segment Characteristics**

| | | | |
|---|---|---|---|
| **Function Class:** | Minor Arterial | **AADT:** | 1,165 |
| **Number of Thru Lanes:** | 2 | **Speed Limit (MPH):** | 55 |

**Table 3: Roadway Characteristics**

| MPs | Median | IPM | SPM | Shoulder | Grade | Curve | Lanes | Wall/ Barrier | Rumble |
|---|---|---|---|---|---|---|---|---|---|
| 11.648-23.709 | Undivided, 0 ft | 36/1.6 | 144/6.5 | Asphalt, 4 ft | 4 (max) | None | 2 Thru | No (Wall), No (Barrier) | No |

### Micro-Analysis of Crash Data

*Crash Data Summary*

**Table 4: Crash Count and Severity**

| MPs | Total Crashes on Roadway | Severity 5 (Fatal) | Severity 4 (Incap. Injury) | Severity 3 (Non-Incap. Injury) |
|---|---|---|---|---|
| 11.648-23.709 | 63 | 4 | 54 | -- |

**Table 5: Top 8 Crash Factors**

| Crash ID | MP | URBAN COUNTY | SINGLE VEHICLE | INTERSECTION RELATED | OVERTURN ROLLOVER | NIGHT DARK CONDITION | ROADWAY DEPARTURE | SPEED RELATED | ROADWAY GEOMETRY RELATED |
|---|---|---|---|---|---|---|---|---|---|
| 10349772 | 11.8 | Y | Y | N | Y | Y | Y | N | Y |
| 10351891 | 7.59 | Y | N | Y | N | N | N | N | N |
| 10352569 | 7.59 | Y | Y | Y | N | N | N | Y | N |
| 10354978 | 84.7 | N | Y | N | Y | N | N | N | N |
| 10361476 | 21.2 | Y | Y | N | Y | N | Y | Y | Y |
| 10362936 | 7.6 | Y | N | Y | N | N | N | N | N |
| 10364008 | 7.59 | Y | N | Y | N | N | N | N | N |
| 10364263 | 7.6 | Y | N | Y | N | Y | N | N | N |
| 10370997 | 90 | N | Y | N | Y | Y | Y | Y | N |
| 10375094 | 85.8 | N | Y | N | Y | Y | Y | Y | N |
| 10380760 | 84.4 | N | Y | N | Y | Y | Y | Y | N |



| | | |
|---|---|---|
| N | N | N |
| Y | Y | Y |
| Y | N | Y |
| Y | N | Y |
| Y | Y | Y |
| Y | N | Y |
| N | Y | N |
| N | Y | N |
| N | N | N |
| N | N | N |
| N | N | N |
| Y | N | N |
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| Y | Y | Y |
| N | N | N |
| Y | N | Y |
| N | Y | N |
| N | N | N |
| N | N | N |
| N | N | N |
| 18/58 | 16/58 | 16/58 |

| Event Sequence (4) | Most Harmful Event | Vehicle Maneuver |
|---|---|---|
| Not applicable | Overturn/Rollover | Straight Ahead |
| Not applicable | Operating Motor Vehicle | Turning Left, Turning Left |
| Not applicable | Operating Motor Vehicle | Straight Ahead |
| Not applicable | Utility Pole/Light Support | Changing Lanes |
| Overturn/Rollover | Overturn/Rollover | Straight Ahead |
| OR Right | Overturn/Rollover | Straight Ahead, Straight Ahead, Straight Ahead |
| Not applicable | Operating Motor Vehicle | Straight Ahead, Straight Ahead, Straight Ahead |
| Not applicable | Operating Motor Vehicle | Stopped in Traffic Lane, Stopped in Traffic Lane, Stopped in Traffic Lane, Stopped in Traffic Lane |
| Not applicable | Operating Motor Vehicle | Stopped in Traffic Lane |
| Operating Motor Vehicle | Operating Motor Vehicle | Turning Left |
| Not applicable | Operating Motor Vehicle | Straight Ahead |
| Not applicable | Operating Motor Vehicle | Turning Right, Turning Right |
| Not applicable | Operating Motor Vehicle | Straight Ahead |
| Not applicable | Operating Motor Vehicle | Stopped in Traffic Lane |
| Not applicable | Operating Motor Vehicle | Stopped in Traffic Lane |
| Not applicable | Operating Motor Vehicle | Other |
| Not applicable | Overturn/Rollover | Straight Ahead, Straight Ahead |
| Not applicable | Overturn/Rollover | Overtaking/Passing |
| Not applicable | Overturn/Rollover | Straight Ahead, Straight Ahead, Straight Ahead |
| Not applicable | Operating Motor Vehicle | Turning Left, Turning Left |
| Not applicable | Operating Motor Vehicle | Straight Ahead, Straight Ahead |
| Fence | Overturn/Rollover | Straight Ahead, Straight Ahead |
| Not applicable | Overturn/Rollover | Slowing in Traffic Lane, Slowing in Traffic Lane |
| Embankment | Overturn/Rollover | Straight Ahead, Straight Ahead |
| Not applicable | Overturn/Rollover | Straight Ahead, Straight Ahead, Straight Ahead |
| Not applicable | Operating Motor Vehicle | Straight Ahead, Straight Ahead |
| Not applicable | Operating Motor Vehicle | Straight Ahead, Straight Ahead |
| Not applicable | Utility Pole/Light Support | Straight Ahead, Straight Ahead, Straight Ahead, Straight Ahead |
| Not applicable | Operating Motor Vehicle | Straight Ahead |
| Not applicable | Operating Motor Vehicle | Stopped in Traffic Lane |
| Not applicable | Operating Motor Vehicle | Straight Ahead, Straight Ahead |
| Not applicable | Operating Motor Vehicle | Straight Ahead |
| Not applicable | Operating Motor Vehicle | Straight Ahead, Straight Ahead |
| Not applicable | Operating Motor Vehicle | Stopped in Traffic Lane, Stopped in Traffic Lane |
| Not applicable | Operating Motor Vehicle | Stopped in Traffic Lane, Stopped in Traffic Lane, Stopped in Traffic Lane, Stopped in Traffic Lane |
| Not applicable | Operating Motor Vehicle | Stopped in Traffic Lane, Stopped in Traffic Lane, Stopped in Traffic Lane, Stopped in Traffic Lane |
| Not applicable | Operating Motor Vehicle | Making U-turn, Making U-turn |
| Not applicable | Operating Motor Vehicle | Straight Ahead, Straight Ahead |
| Not applicable | Operating Motor Vehicle | Turning Left |
| Not applicable | Operating Motor Vehicle | Straight Ahead, Straight Ahead |
| Fence | Overturn/Rollover | Changing Lanes, Changing Lanes |
| Not applicable | Operating Motor Vehicle | Straight Ahead |
| Not applicable | Operating Motor Vehicle | Turning Left, Turning Left, Turning Left |
| Not applicable | Operating Motor Vehicle | Straight Ahead, Straight Ahead |
| Not applicable | Operating Motor Vehicle | Straight Ahead |
| Not applicable | Operating Motor Vehicle | Stopped in Traffic Lane, Stopped in Traffic Lane, Stopped in Traffic Lane, Stopped in Traffic Lane |
| Not applicable | Operating Motor Vehicle | Stopped in Traffic Lane, Stopped in Traffic Lane, Stopped in Traffic Lane, Stopped in Traffic Lane |
| Not applicable | Operating Motor Vehicle | Straight Ahead, Straight Ahead, Straight Ahead, Straight Ahead |
| Not applicable | Operating Motor Vehicle | Stopped in Traffic Lane |
| Not applicable | Operating Motor Vehicle | Stopped in Traffic Lane |
| Not applicable | Operating Motor Vehicle | Turning Left |
| Not applicable | Operating Motor Vehicle | Stopped in Traffic Lane |
| Not applicable | Operating Motor Vehicle | Turning Left, Turning Left |
| Not applicable | Operating Motor Vehicle | Straight Ahead, Straight Ahead |
| Not applicable | Overturn/Rollover | Straight Ahead |
| Not applicable | Operating Motor Vehicle | Straight Ahead, Straight Ahead, Straight Ahead |
| Not applicable | Operating Motor Vehicle | Turning Left, Turning Left |
| Not applicable | Operating Motor Vehicle | Straight Ahead, Straight Ahead, Straight Ahead, Straight Ahead |
| Not applicable | Operating Motor Vehicle | Turning Left |

...any curves along the segment.
...involved. Some of the possible
...ed, light conditions, and

...UT, is a two lane-two way
... road. In the proximity of a
...n 2 feet to 11 feet, to
...no apparent changes to the
...epaved in in 2012.

...l curves along the roadway,
...the day, it was noted at the
...ugh the curves created a "roller

...ted in Table 5. The
...0 Report volumes. (P) = Proven

...road collisions (P)

# Roadway Safety Analysis Report

## Introduction

*The purpose of this report is to summarize and present preliminary results from a safety-specific micro analys segment of interest. This report includes identification of the roadway segment and sub-segments, micro-anal site visit notes, and a list of possible countermeasures.*

## Segment Identification and Roadway Characteristics

### Table 1: Segment Metadata

| | | | | | |
|---|---|---|---|---|---|
| **Road Name:** | SR-68 | | **UC Model Used:** | UCSM | |
| **Road Direction:** | Positive | | **State Rank:** | 2 | |
| **Beginning, Ending MP:** | 11.648 | 23.709 | **Rank, Region:** | 1 | 3 |
| **Length (miles):** | 12.061 | | **Rank, County:** | 1 | 1 |
| **Dates of Data Source:** | 2010-2014 | | **Date of Analysis:** | 7/26/2016 | |

### Table 2: Segment Characteristics

| | | | |
|---|---|---|---|
| **Function Class:** | Minor Arterial | **AADT:** | 1,165 |
| **Number of Thru Lanes:** | 2 | **Speed Limit (MPH):** | 55 |

### Table 3: Roadway Characteristics

| MPs | Median | IPM | SPM | Shoulder | Grade | Curve | Lanes |
|---|---|---|---|---|---|---|---|
| 11.648-23.709 | Undivided, 0 ft | 21/1.7 | 109/9 | Asphalt, 4 ft | 4 (max) | Class D, L = 440, R = 627 | 2 Thru |

## Micro-Analysis of Crash Data

*Crash Data Summary*

### Table 4: Crash Count and Severity

| Predicted Number of Crashes | Total Crashes on Roadway | Severity 5 (Fatal) | Severity 4 (Incap. Injury) |
|---|---|---|---|
| 8.8 | 63 | 2 | 8 |

### Table 5: Top 8 Crash Factors

| | Urban County | Roadway Geometry Related | Single Vehicle | Overturn Rollover | Roadway Departure | Motorcycle Involved |
|---|---|---|---|---|---|---|
| Segment Total | 33/33 | 27/33 | 27/33 | 24/33 | 24/33 | 14/33 |

*Safety Problem Summary*

This segment has a very low AADT but high number of crashes. Most of the accidents are roadw Also, there are a large amount of rollover accidents and accidents with a single vehicle involved attributed to the many curves on this segment. Some of the possible contributing factors are geo curve), speed and improper restraint.



## Historical Perspective, Current Conditions, Site Visit Notes

It was observed that the 12-mile segment of SR-68, located south of Saratoga Springs, UT, is a two-lane highway. There are no rumble strips in the centerline or on the shoulder. There is approximately 2 feet of asphalt on the shoulder of the roadway. According to Roadview Explorer, there have been no apparent changes to the geometry or features of the roadway in recent years, other than a portion of the road segment being repaved in 2012.

In a site visit conducted on 7/26/2016, it was observed that there were many horizontal curves along the roadway, with some rolling effect in the vertical transition. While the site visit was done during the day, it was noted that the curves may not be visible during the night time. Driving at the posted speed limit through the curves created a "roller coaster" effect. It was also observed the shoulder of the road has not been well maintained. Weeds have been growing into the shoulder, which may make it hard for vehicles to pull over or get back onto the road.

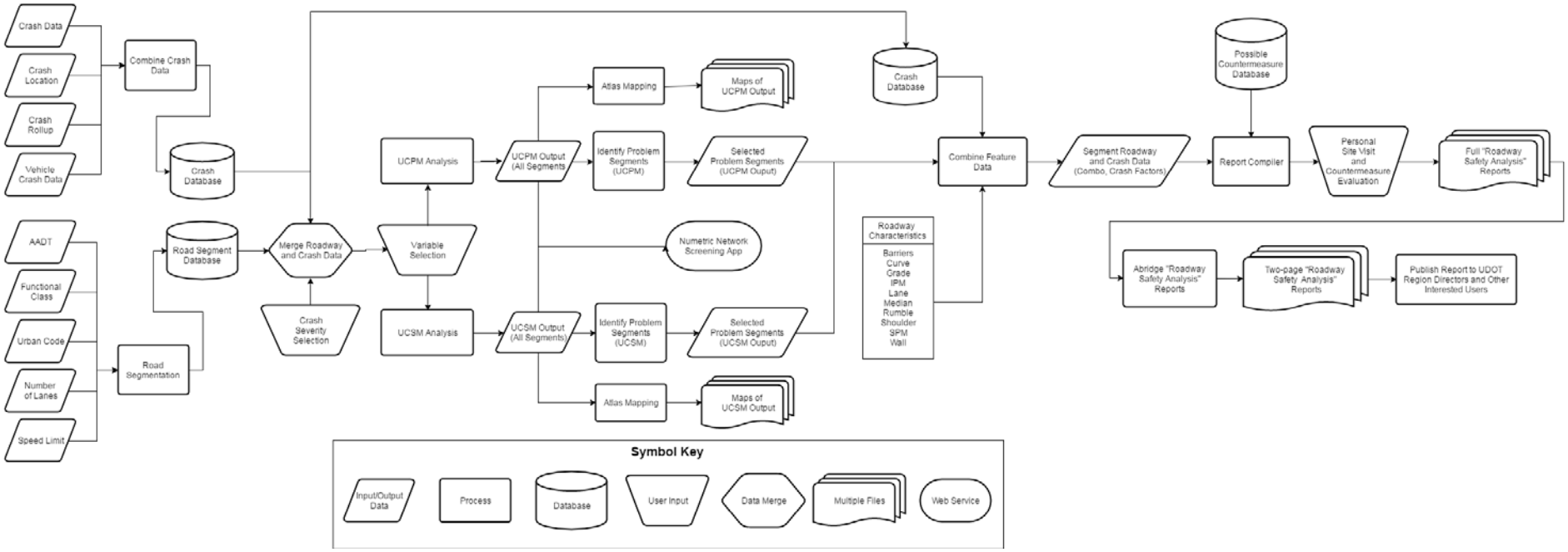
**Figure 1: SR-68 in Mosida, Utah**

## Possible Countermeasures

The following is a list of possible countermeasure related to the top 8 crash factors listed in Table 5. The countermeasures listed were compiled using the coutermeasures from the NCHRP 500 Report volumes. (P) = Proven (T) = Tried (E) = Experimental (NA) = Data not available.

Design safer slopes and ditches to prevent rollovers (P)
Eliminate shoulder drop-offs (shoulder treatment) (E)
Improve access to safe stopping and resting areas (T)
Increase public awareness of risks of not wearing seatbelts (T)
Install centerline rumble strips (T)
Install shoulder rumble strips (P)
Modify horizontal alignment (P)
Provide adequate sight distance for expected speeds (P)
Provide advance warning of unexpected changes in horizontal alignments (T)
Widen and/or pave shoulder (shoulder treatment) (P)
Widen the roadway (P)

# Summary


Crash Data
Crash Location
Crash Rollup
Vehicle Crash Data
Combine Crash Data
Crash Database
AADT
Functional Class
Urban Code
Number of Lanes
Speed Limit
Road Segmentation
Road Segment Database
Merge Roadway and Crash Data
Crash Severity Selection
Variable Selection
UCPM Analysis
UCSM Analysis
UCPM Output (All Segments)
UCSM Output (All Segments)
Atlas Mapping
Maps of UCPM Output
Identify Problem Segments (UCPM)
Selected Problem Segments (UCPM Ouput)
Numetric Network Screening App
Identify Problem Segments (UCSM)
Selected Problem Segments (UCSM Ouput)
Atlas Mapping
Maps of UCSM Output
Crash Database
Roadway Characteristics
Barriers
Curve
Grade
IPM
Lane
Median
Rumble
Shoulder
SPM
Wall
Combine Feature Data
Segment Roadway and Crash Data (Combo, Crash Factors)
Possible Countermeasure Database
Report Compiler
Personal Site Visit and Countermeasure Evaluation
Full "Roadway Safety Analysis" Reports
Abridge "Roadway Safety Analysis" Reports
Two-page "Roadway Safety Analysis" Reports
Publish Report to UDOT Region Directors and Other Interested Users
Symbol Key
Input/Output Data
Process
Database
User Input
Data Merge
Multiple Files
Web Service

# Concluding Remarks

- New automation tools and GUIs:
  - Improved interface to access tools
  - Runtime of tools decreased
  - “Critical Data Columns”
- Three User’s Manuals created for each part:
  1. Crash and roadway data segmentation
  2. Statistical network screening of roadway data
  3. Report compilation for segments of interest

# Concluding Remarks

- Future research includes:
  - Continued development of Roadway Safety Analysis methodology:
    - Statewide analysis of intersections
    - Statewide analysis of horizontal curves
    - Implement in other states
  - Contribute to safety countermeasures effectiveness research
  - Expand GIS tools for crash analysis

# Concluding Remarks

- Students involved:
  - Daniel Thurgood (consultant, UT)
  - Andrew Olsen (PhD – Statistics)
  - Brad Brimley (PhD – Texas A&M)
  - Steven Dudley (consultant, AB)
  - Scott Johnson (consultant, UT)
  - Clancy Black (consultant, UT)
  - Devin Francom (Statistics)
  - Jacob Farnsworth (consultant, NV)
  - Ryan Roundy (consultant, CO)
  - Trevor Briggs (consultant, CA)
  - Mitchell Hess (consultant, NV)
  - Casey Knecht (DOT, OR)
  - Aaron Cook (MS student, IL)
  - Daniel Jean (municipality, VA)
  - David Bassett (consultant, UT)
  - Samuel Mineer (consultant, WA)
  - Jordan Frustaci (consultant, FL)
  - Natalia Brown (student)
  - Josh Gibbons (student)
  - Peter MacArthur (student)

# Questions

- For more information, contact:

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