Texas A&M Transportation Institute

Traffic Collisions Involving Autonomous Vehicles in California: Bayesian Model Based Clustering

Subasish Das (TTI)
Anandi Dutta (UTSA)
Ioannis Tsapakis (TTI)

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Overview

Synopsis

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- The emerging technology of autonomous vehicles (AV) has been rapidly advancing. This new is desired to reduce the number of crashes and travel time, as well as improving fuel efficiency and parking benefits.
- Safety outcomes from AV deployment is a critical issue. Ensuring safety of AVs requires a multi-disciplinary approach which monitors every aspect of these vehicles.
- To promote safety, the California Department of Motor Vehicles has mandated that autonomous car crash reports be made public in recent years.

Study Design and Analysis

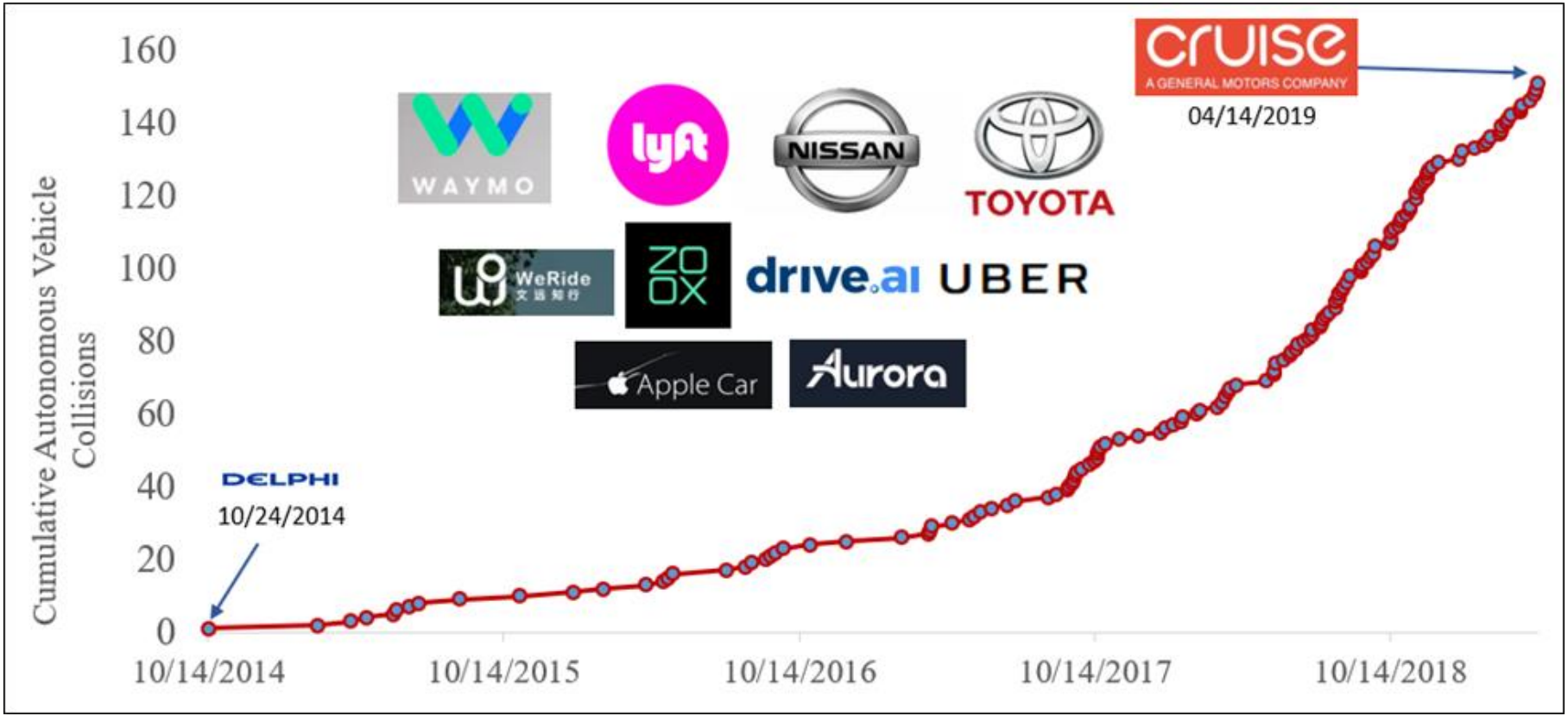
Objectives

- Provide when-where-how-who-why-what of CA AV crashes.
- Identify patterns and trends of AV crashes using Bayesian Clustering

Data

- Developed a database that provides descriptive and detailed reports of AV crashes in California during 2014-2019.
- The total number of reported crashes used in this study was 151.
- On October 24, 2014, Delphi was the first manufacturer to experience AV collision in California.
- After October 2017, there was a sharp increase in AV collisions as a greater number of companies deployed AVs.

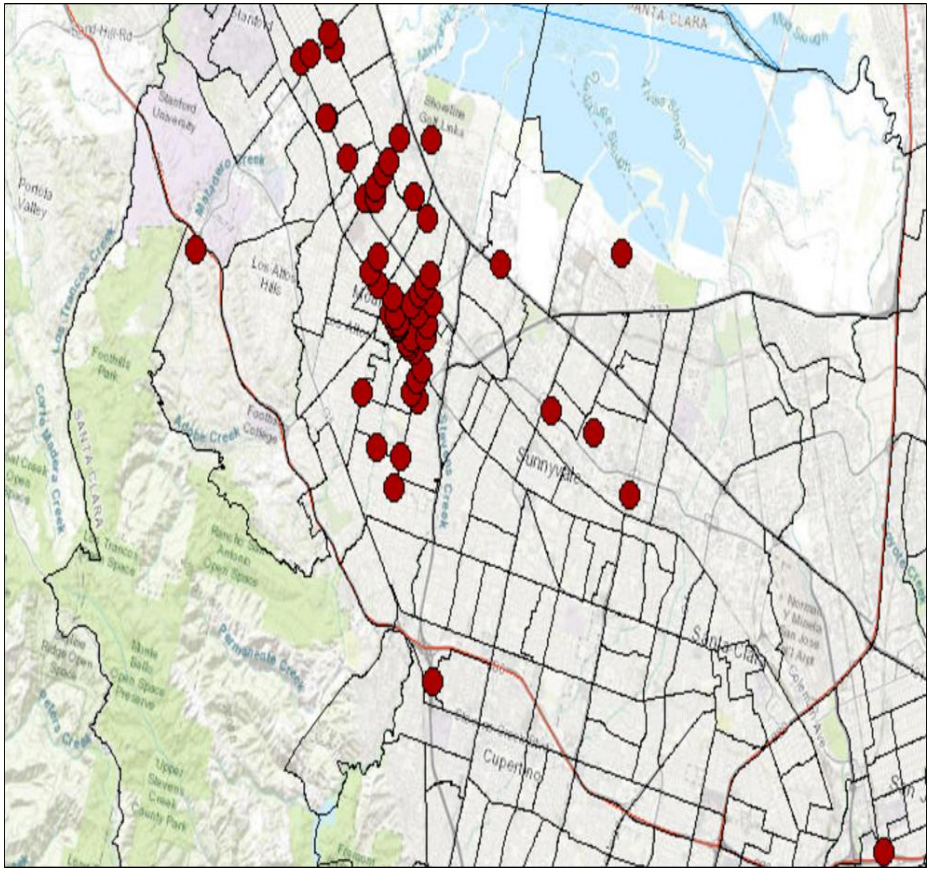
AV Crashes in California

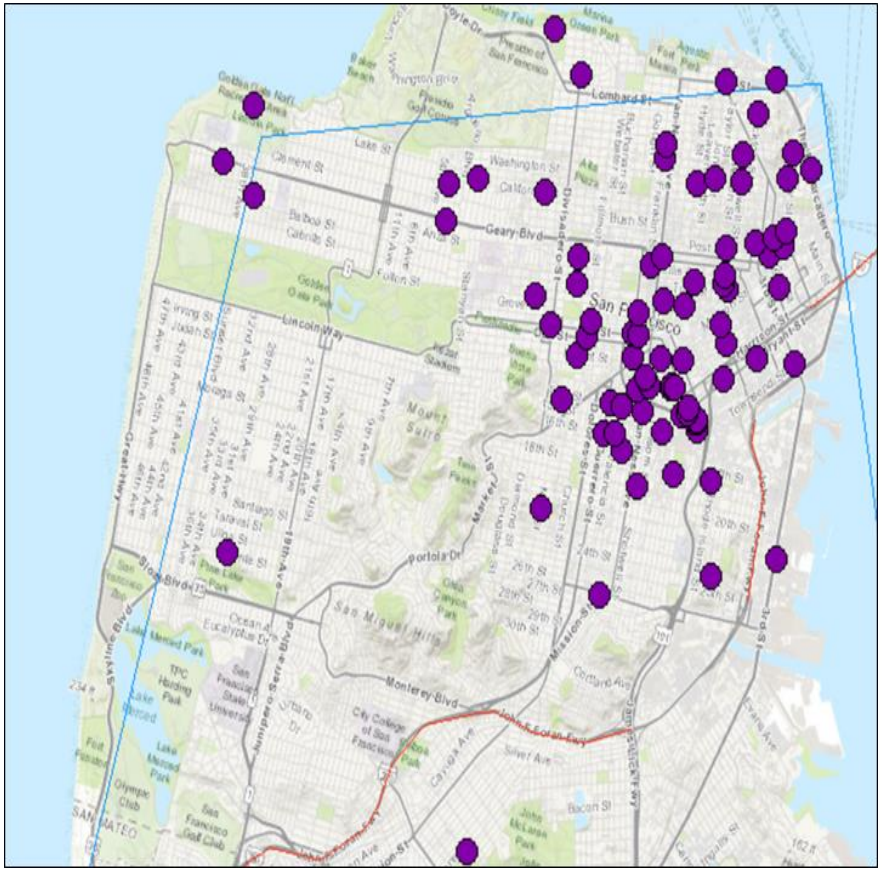


When?

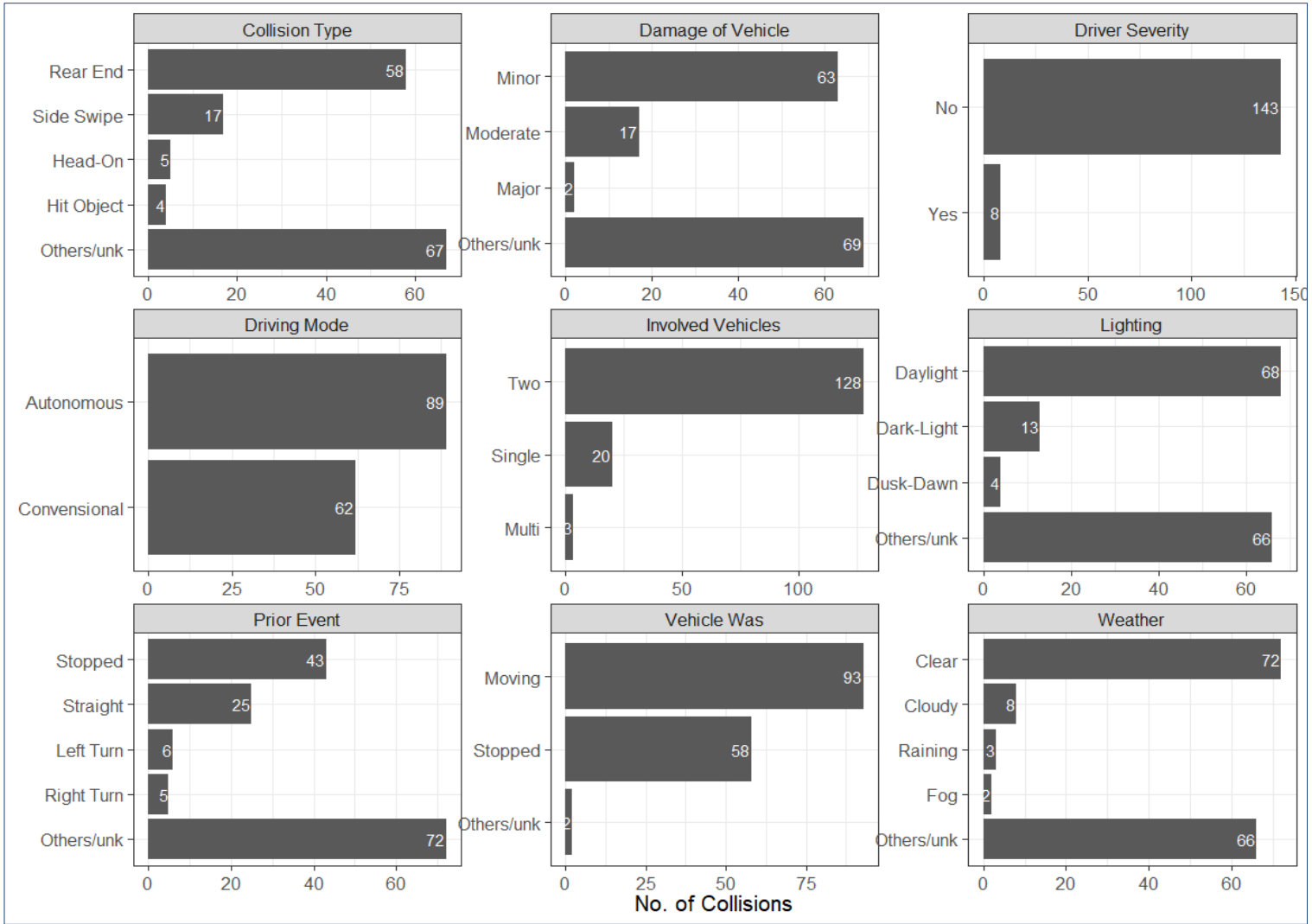
Day of Week	1- 6 AM	6- 12 PM	1- 6 PM	7-12 AM
Saturday	2	3	7	2
Sunday	2	2	4	6
Monday	2	6	8	4
Tuesday	3	7	5	8
Wednesday	3	5	11	9
Thursday	2	16	5	6
Friday	0	5	14	4

Where?

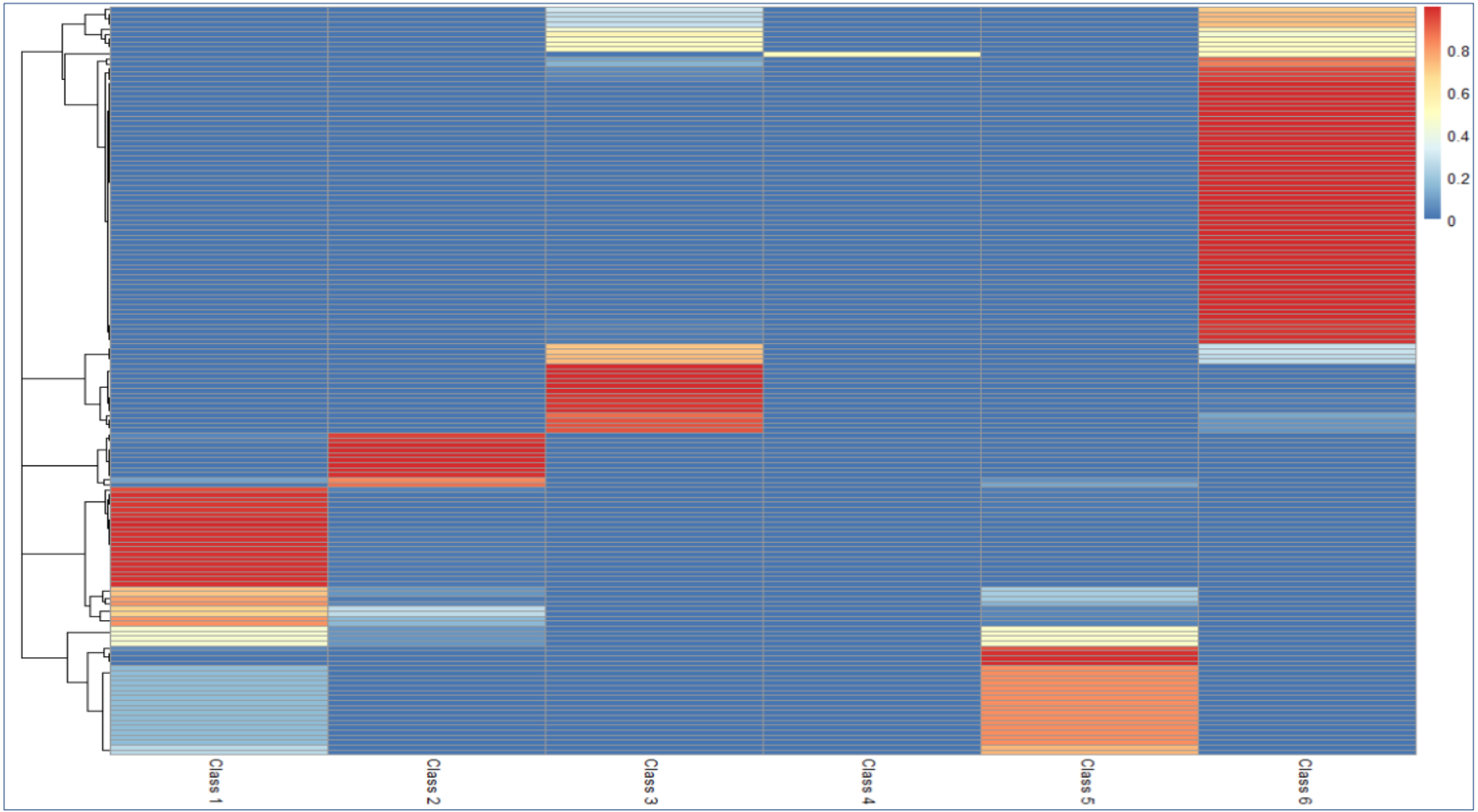

Sunnyvale
Santa Clara
Cupertino


Geary Blvd
Lincoln Way
Portola Dr
Monterey Blvd
Lombard St
Bacon St

How?
Who?


Collision Type
Rear End
Side Swipe
Head-On
Hit Object
Others/unk
58
17
5
4
67
0
20
40
60
Damage of Vehicle
Minor
Moderate
Major
Others/unk
63
17
2
69
0
20
40
60
Driver Severity
No
Yes
143
8
0
50
100
150
Driving Mode
Autonomous
Convensional
89
62
0
25
50
75
Involved Vehicles
Two
Single
Multi
128
20
3
0
50
100
Lighting
Daylight
Dark-Light
Dusk-Dawn
Others/unk
68
13
4
66
0
20
40
60
Prior Event
Stopped
Straight
Left Turn
Right Turn
Others/unk
43
25
6
5
72
0
20
40
60
Vehicle Was
Moving
Stopped
Others/unk
93
58
2
0
25
50
75
Weather
Clear
Cloudy
Raining
Fog
Others/unk
72
8
3
2
66
0
20
40
60
No. of Collisions

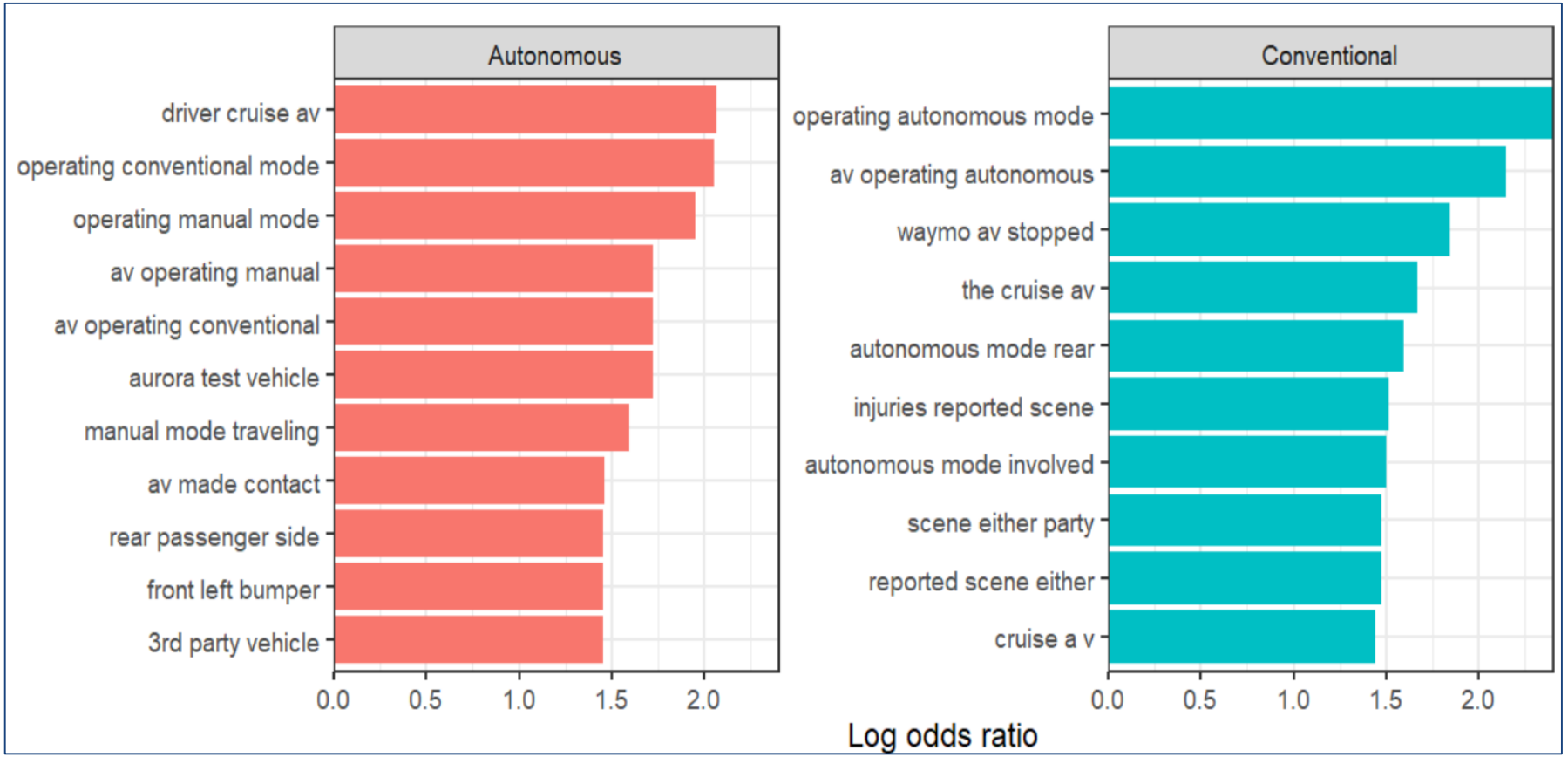
Why? What?



Why? What?

Attribute	Count	Class 1 (28)	Class 2 (11)	Class 3 (21)	Class 4 (1)	Class 5 (26)	Class 6 (64)
Driving Mode							
Autonomous	89	21.35	4.49	12.36	0	24.72	37.08
Conventional	62	14.52	11.29	16.13	1.61	6.45	50
Driver Severity							
No	143	19.58	7.69	11.19	0.7	16.08	44.76
Yes	8	0	0	62.5	0	37.5	0
Prior Event							
Left Turn	6	16.67	0	50	0	0	33.33
Right Turn	5	0	0	60	0	0	40
Stopped	43	0	0	2.33	0	0	97.67
Straight	25	0	0	56	4	0	40
Other/Unknown	72	37.5	15.28	0	0	36.11	11.11

Why? What?


Autonomous
driver cruise av
operating conventional mode
operating manual mode
av operating manual
av operating conventional
aurora test vehicle
manual mode traveling
av made contact
rear passenger side
front left bumper
3rd party vehicle
0.0
0.5
1.0
1.5
2.0
Conventional
operating autonomous mode
av operating autonomous
waymo av stopped
the cruise av
autonomous mode rear
injuries reported scene
autonomous mode involved
scene either party
reported scene either
cruise a v
0.0
0.5
1.0
1.5
2.0
Log odds ratio

Key Findings

Key Findings

- Demonstrated a variational inference algorithm for Bayesian latent class models. They also applied the clustering algorithm to complex AV collision data, yielding good and interpretable results.
- Classes associated with turning, multi-vehicle collisions, dark lighting conditions with streetlights, and sideswipe and rear-end collisions, were also associated with a higher proportion of injury severity level.
- A significant finding demonstrated by Class 6, is that when a vehicle was in autonomous mode, there was a high likelihood of adverse weather crash occurrences when the vehicle's prior condition was stopped.


Questions?

Texas A&M Transportation Institute

Subasish Das

s-das@tti.tamu.edu

979-317-2153