

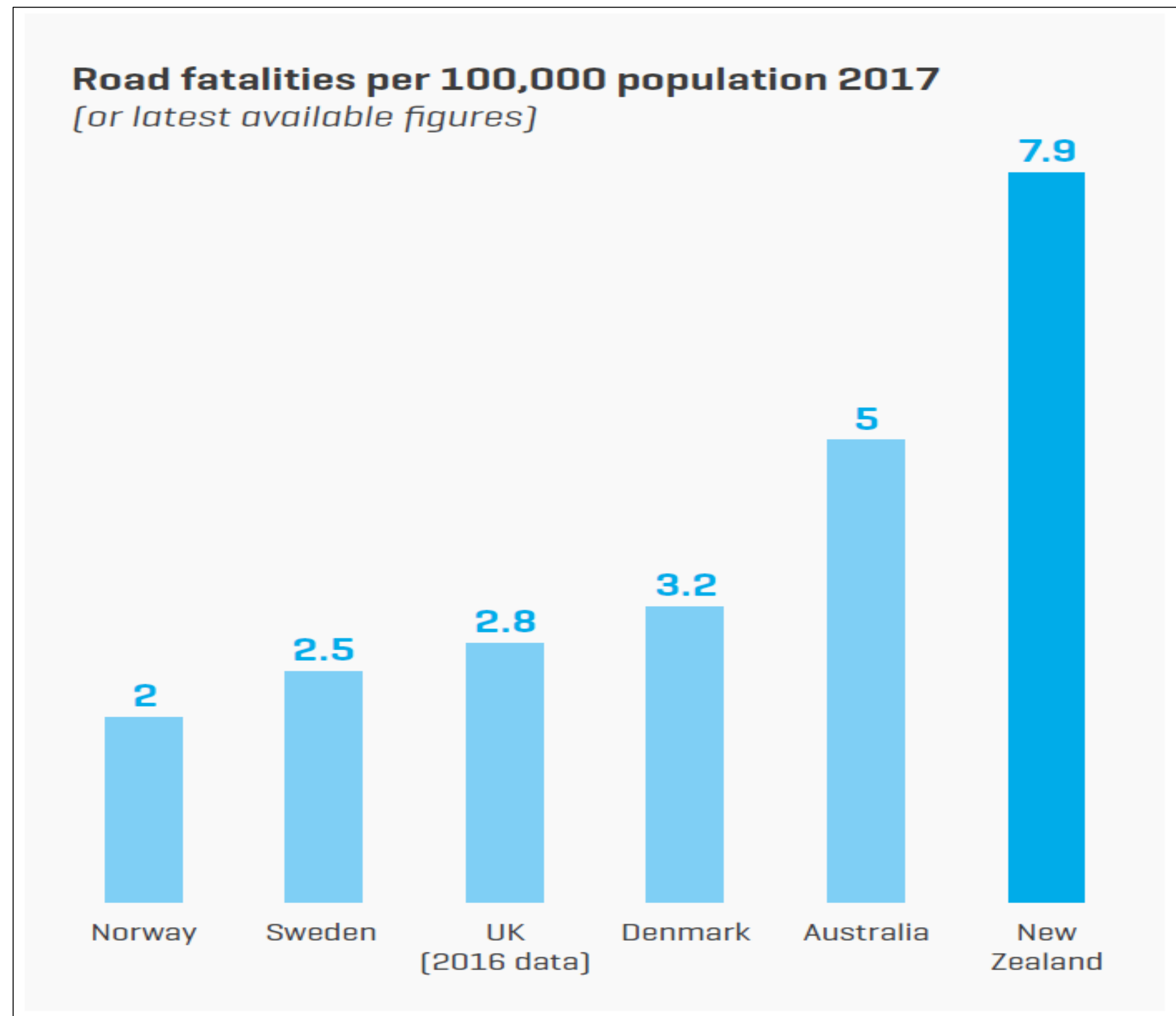
Are Autonomous Vehicles Safe?

Wen Zhang 2021/03/19



Actual Fatalities Rate

Norway with the similar
road network and population
to New Zealand



refer to: "New Zealand's road safety strategy 2020-2030"

Dr. Alexandra Muller


















- 94% car crash caused by human error
- **Sensing/Perceiving** (not recognizing hazards)
- **Predicting** (misjudging behavior of other vehicles)
- **Planning/Deciding**
(poor decision-making behind traffic law adherence and defensive driving)
- **Execution/Performance** (inappropriate vehicle control)
- **Predicting** (alcohol-impaired or otherwise incapacitated driver)



Research Scientist, iihs.org

Dr. Alexandra Muller

Crash Avoidance Systems, Driving Automation and Autonomous Vehicles

SAE International's automation levels				
	Who or what is driving?			Where and when does it operate?
	Sustained control	Detection & response	Fallback	
Level 0: none			none	n/a
Level 1: assistance				limited
Level 2: partial				limited
Level 3: conditional				limited
Level 4: high				limited
Level 5: full				unlimited

Dr. Alexandra Mueller (IIHS) on Crash Avoidance Systems, Driving Automation and Autonomous Vehicles

<https://www.youtube.com/watch?v=8wJOqjm1hLw>

AVs Potential Benefits

- Reducing injuries and fatalities
- Economic cost saving (Cost of Traffic Crashes: 242 billion)
- Reducing congestion
- Reducing emission
- Providing new mobility options (disabled, elderly people)

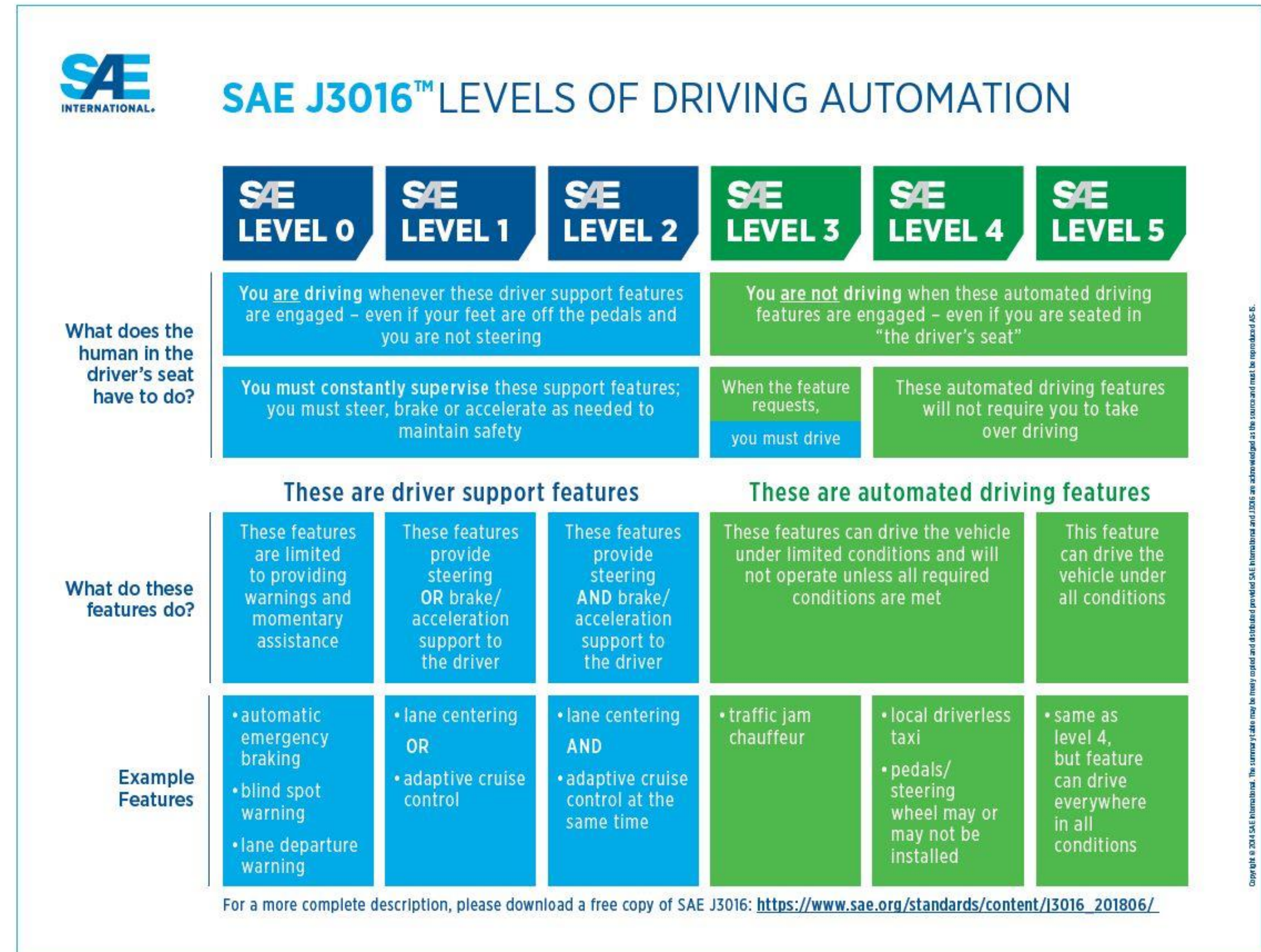
SAE Levels of Driving Automation

- level 0 – level 2

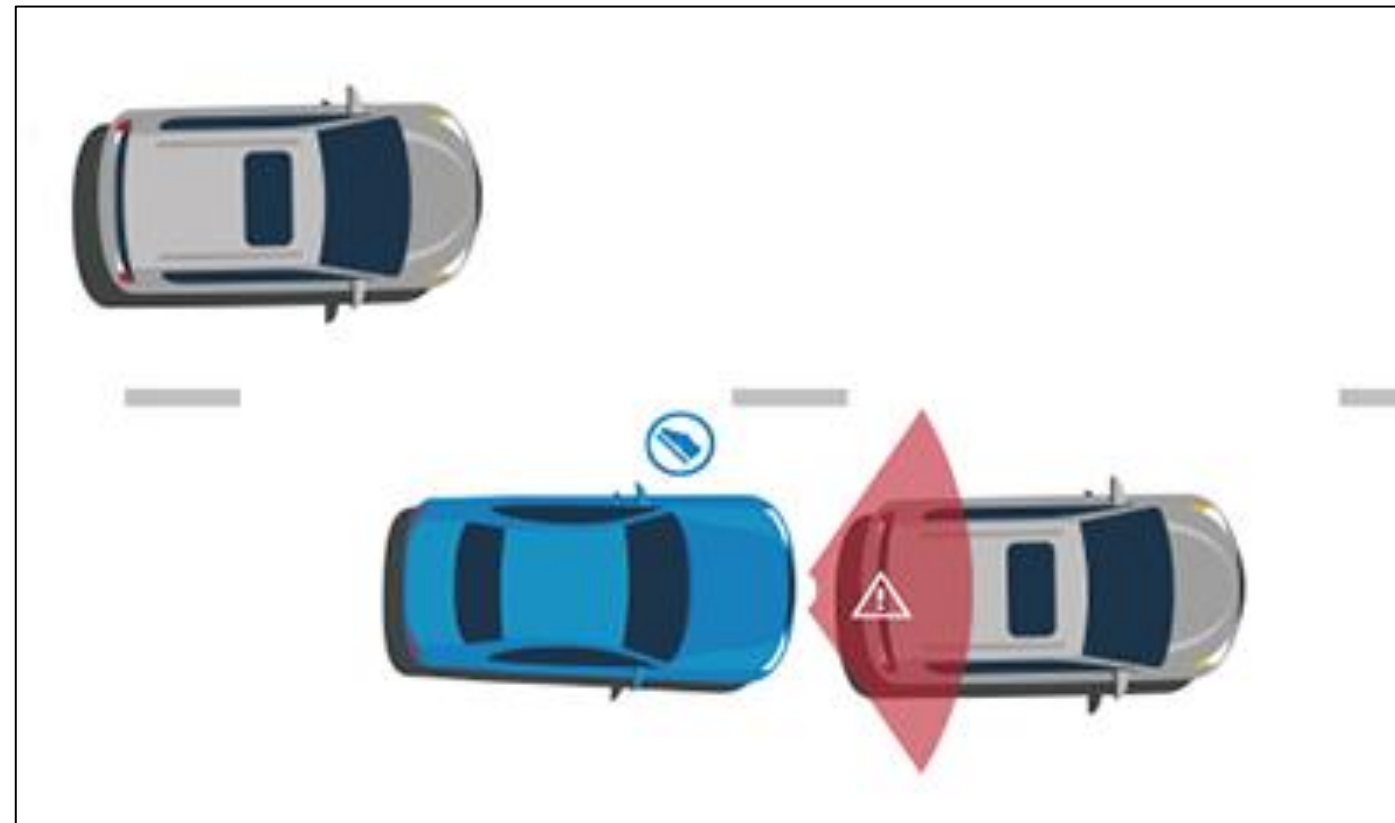
Human drivers must watch to road and prepare to control the car.
steering, accelerating,
lane centering / adaptive cruise control.

- level 3 – level 5

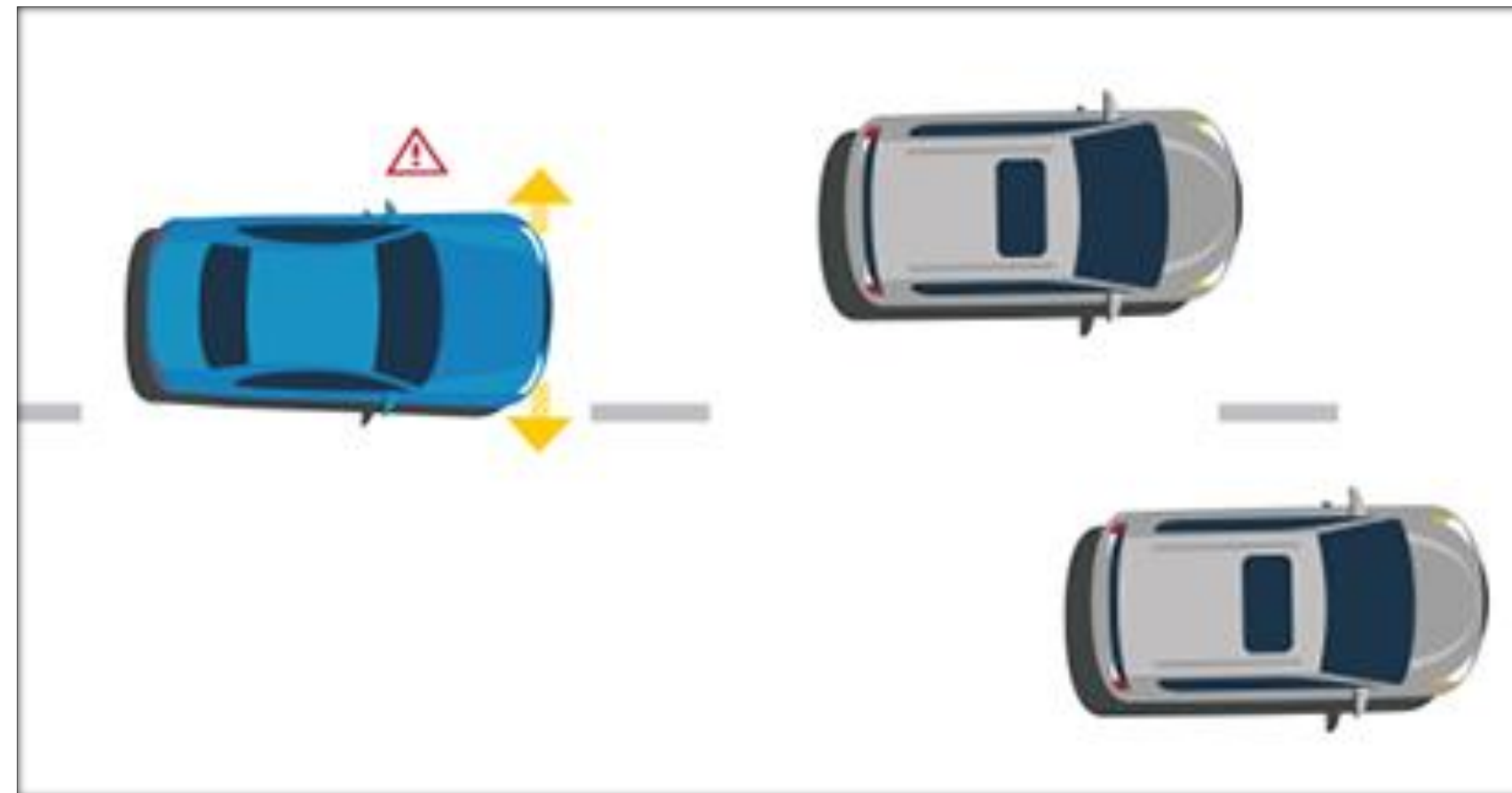
Human drivers no need to control,
Automated driving features engaged,
Under different conditions.



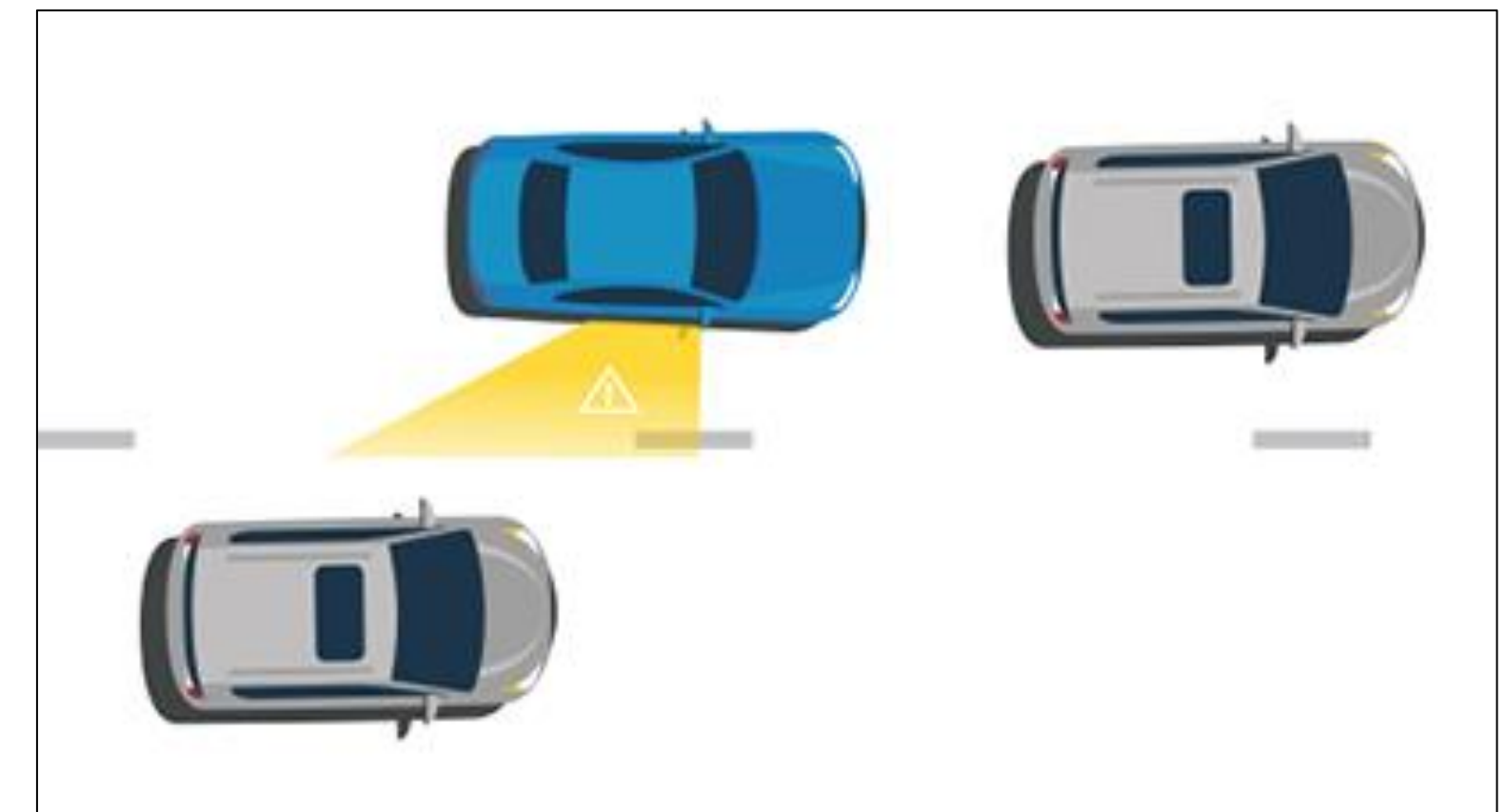
Driver Assistance Technologies



01 Automatic Emergency Braking

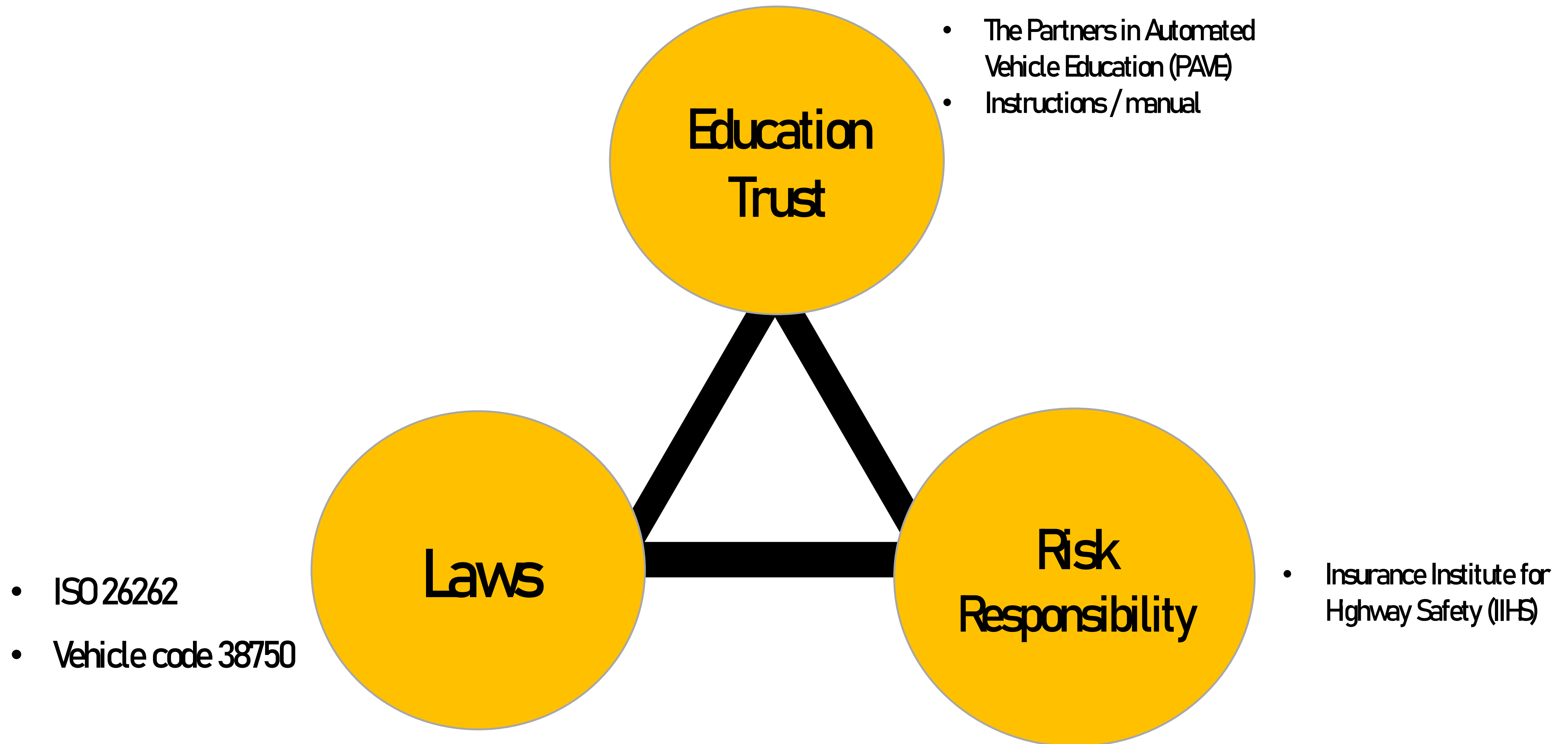


02 Lane Assist



03 Blind Spot Detection

Bring a New Technology



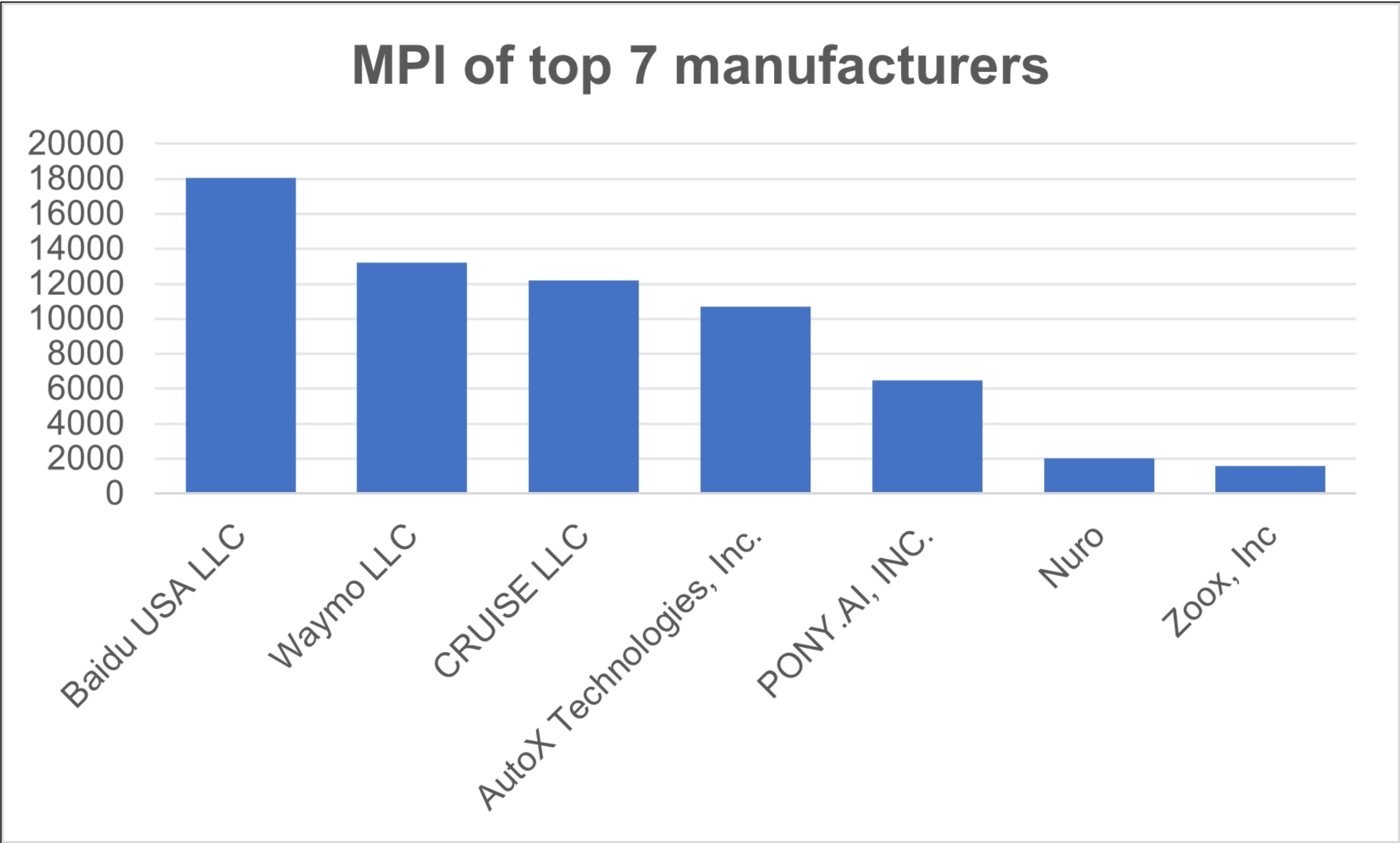
Terminology

- Disengagement Rate: How often human drivers were forced to take control of their vehicles.
- Fatalities Rate: Fatalities per 100,000 Population / Fatalities per 100 Million Vehicle Miles Travelled
- DMV: California Department of Motor Vehicles.
- ADOT: The Arizona Department of Transportation.
- NHTSA: National Highway Traffic Safety Administration (USA).
- TIMS: Transportation Injury Mapping System

Dsengagement Rate

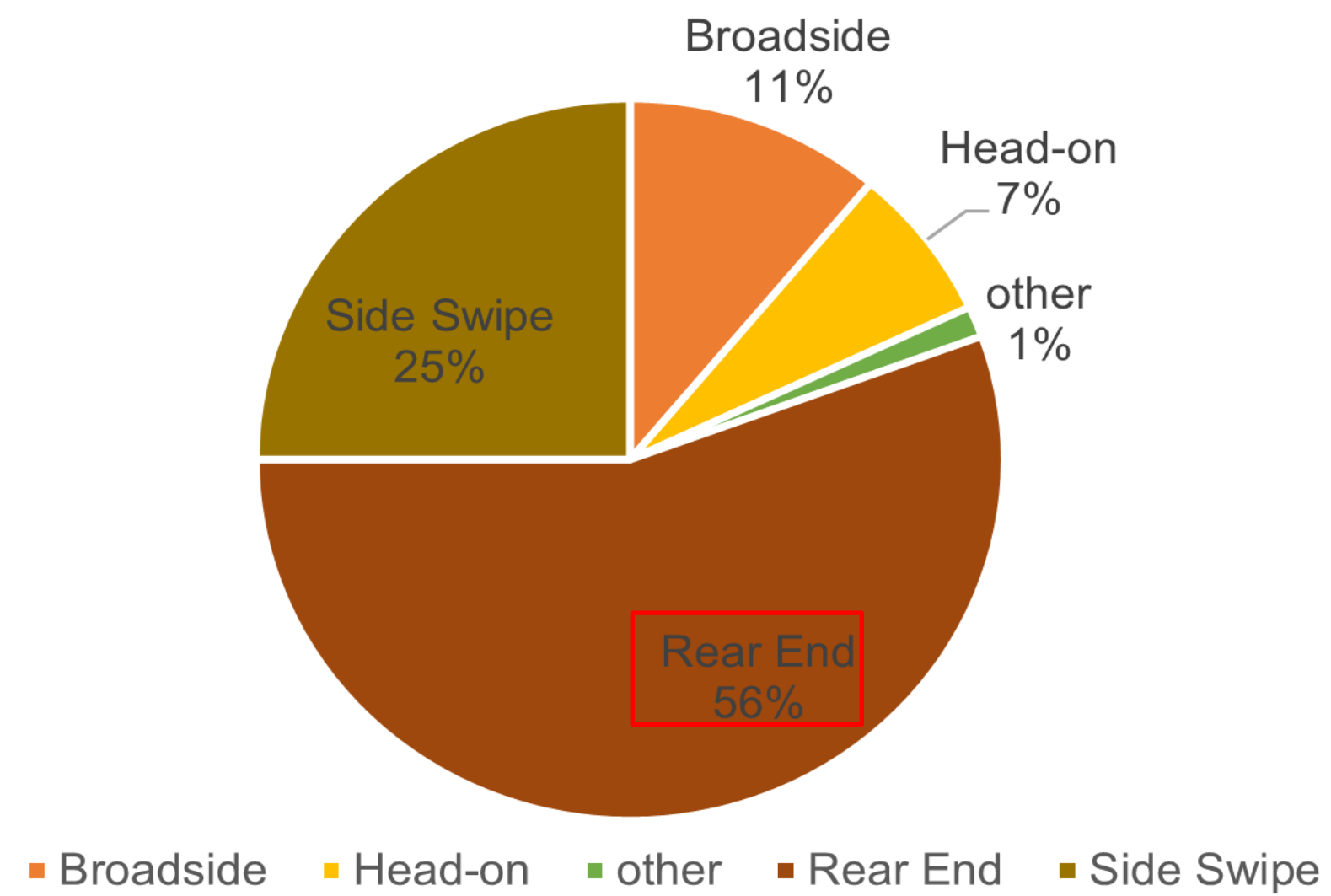
Manufacturer	Mileages in CA	Dis. Count	MPI	Dis. Per 1k miles
Baidu USA LLC	108300.2	6	18050.03	0.055402
Waymo LLC	1454137	110	13219.43	0.075646
CRUISE LLC	831039.9	68	12221.17	0.081825
AutoX Technologies, Inc.	32054	3	10684.67	0.093592
PONY.AI, INC.	174845.3	27	6475.751	0.154422
Nuro	68761.94	34	2022.41	0.49446
Zoox, Inc	67015	42	1595.595	0.626725

Baidu USA Ranked the top 1

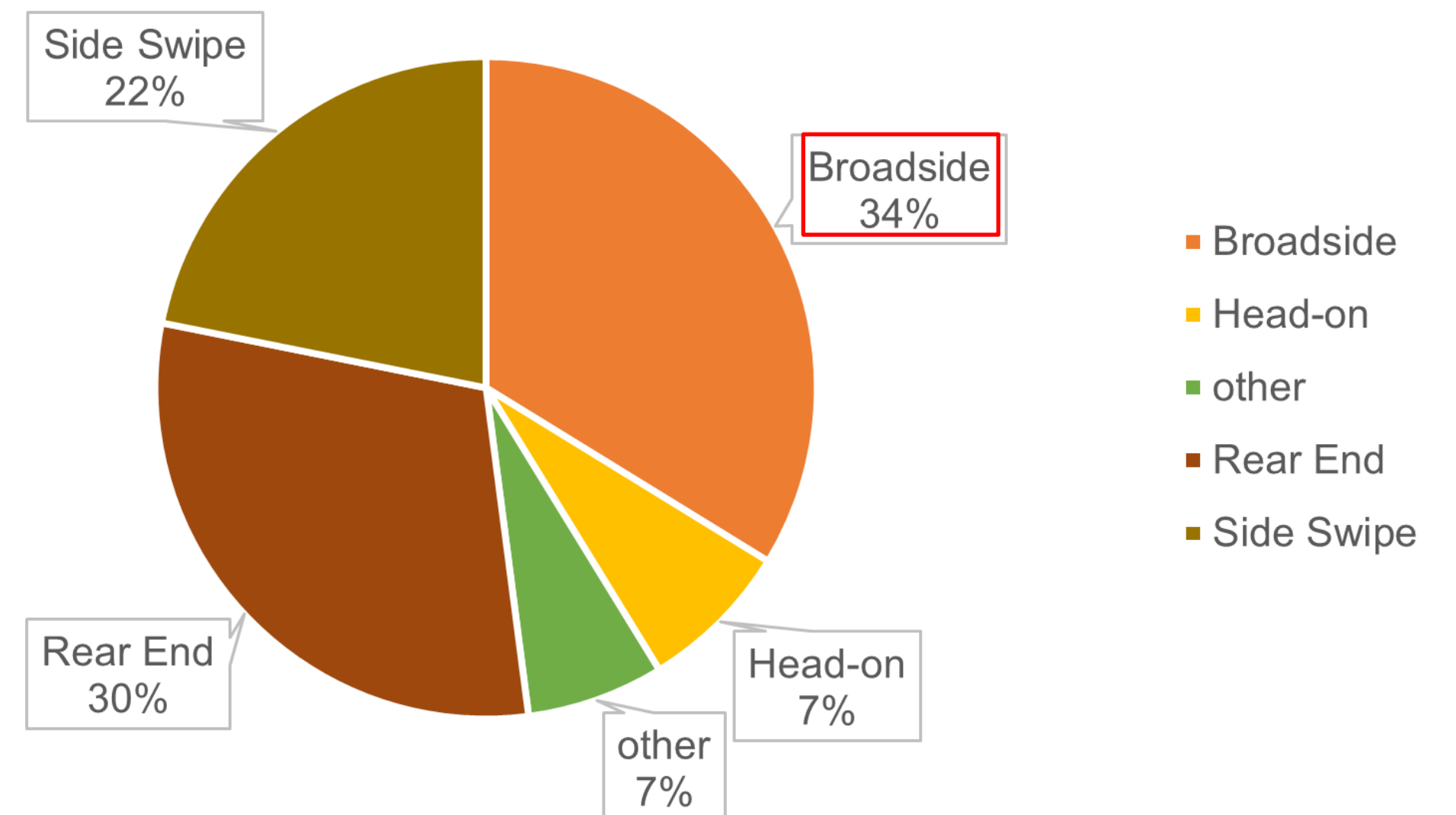


Collision types proportion

AVs collision type

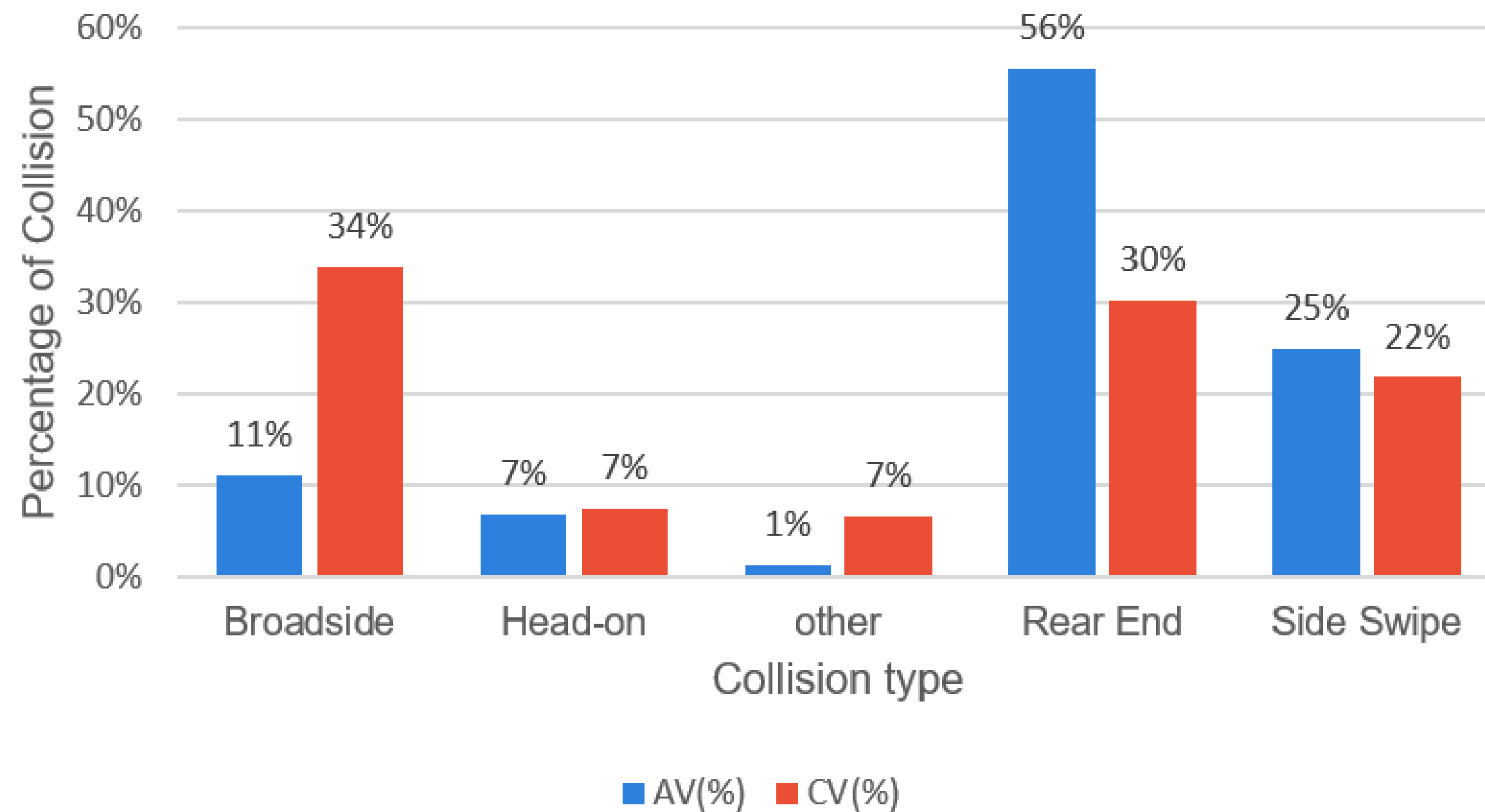


CVs collision type

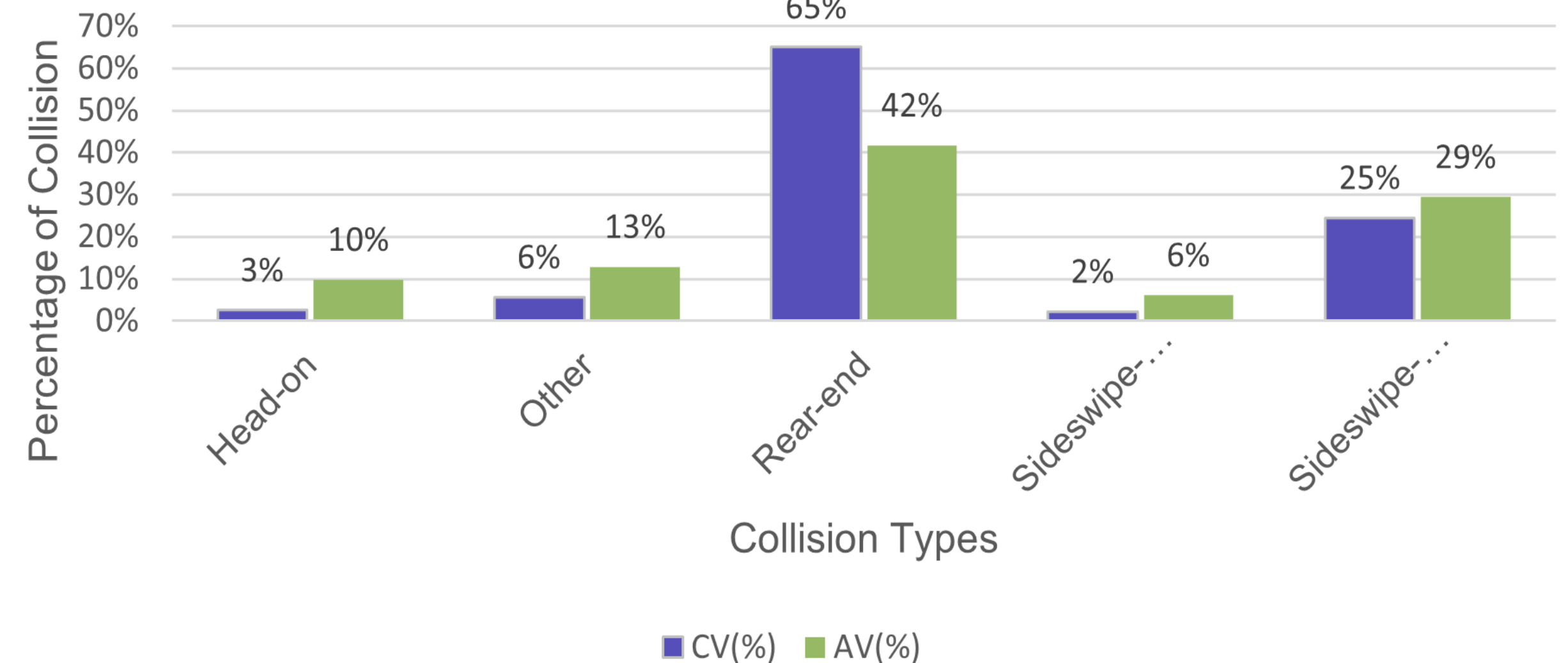


Comparison with AVs and CVs

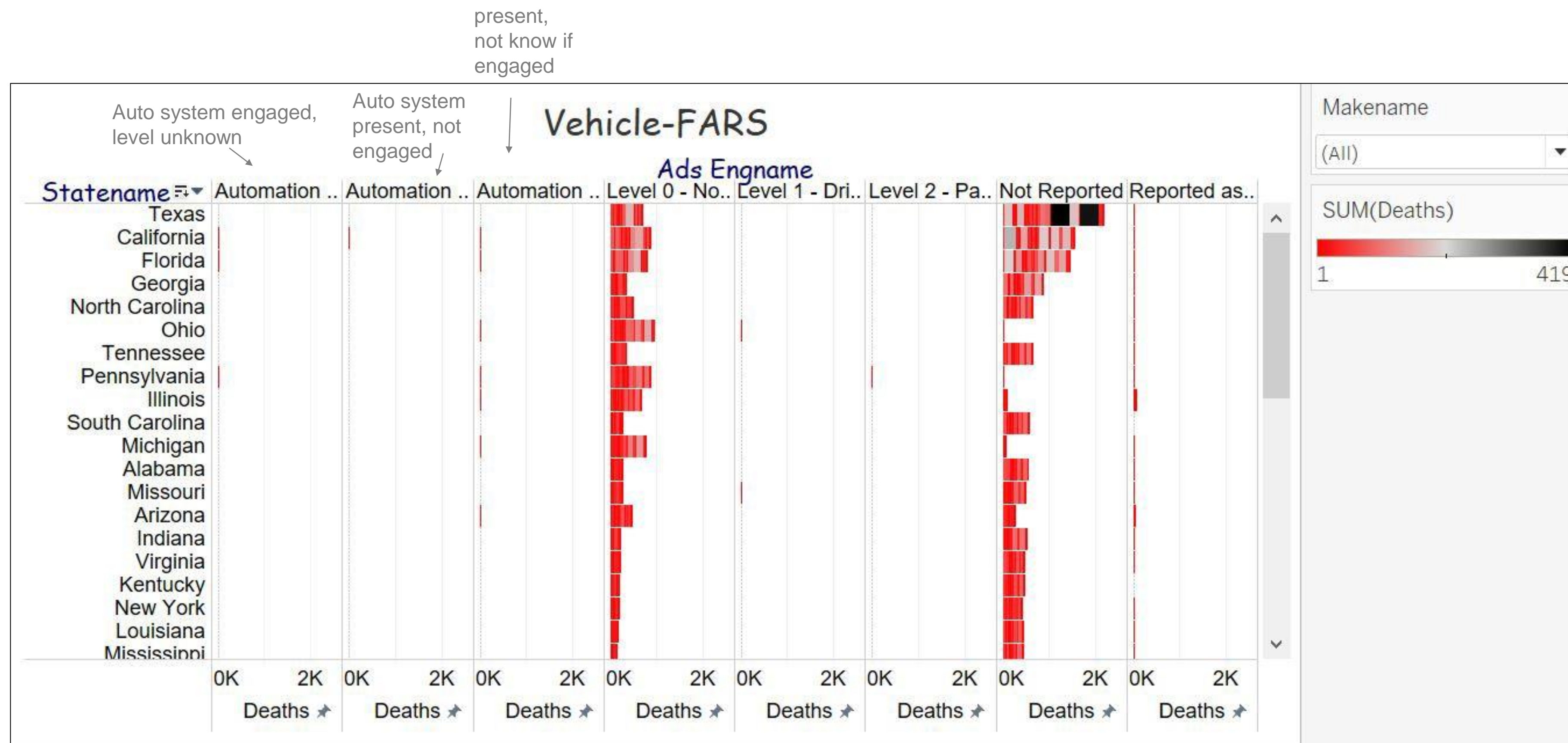
Collision Comparison with AVs and CVs in CA



Comparison with CVs and AVs in Arizona



Fatalities Distribution in USA



- level 1 – Assistant engaged
- level 2 – Partial engaged
- Automation present / engaged
- Not reported or as unknown

<https://public.tableau.com/profile/wen.zhang5307#!/vizhome/test-vehicle/Vehicle-FARS-data>

Beijing AVs Road Testing

Manufacturer	2020				2019				2018	
	total	cars driver	no driver	miles total	total	cars driver	miles total	cars total	miles total	
Baidu	55	43 [†]	5 ^{††}	1,125,305	52	40	754,038	45	139,888	
NIO	0	0	0	0	1	0	1,100	2	2,415	
BAIC BJEV	0	0	0	0	0	0	0	1	235	
Daimler AG	2	0	0	16	2	0	434	2	476	
Poni.ai	5	5 ^{†††}	0	41,938	5	0	111,179	2	10,133	
Tencent	0	0	0	0	1	0	3,898	1	259	
DiDi	0	0	0	0	2	0	1,254	2	78	
Audi	2	0	0	194	1	0	869	1	81	
Idiverplus	0	0	0	0	2	0	1,403	0	0	
SOKON	0	0	0	0	1	0	0	0	0	
NAVINFO	0	0	0	0	1	0	1,220	0	0	
Toyota	4	0	0	3,893	4	0	11,129	0	0	
BSOT*	1	0	0	330	1	0	133	0	0	
Beijing WOYA	4	0	0	1,540	0	0	0	0	0	
Total	73	48	5	1,173,216	73	40	886,657	56	153,565	

[†] only phase 3

^{††} only phase 1

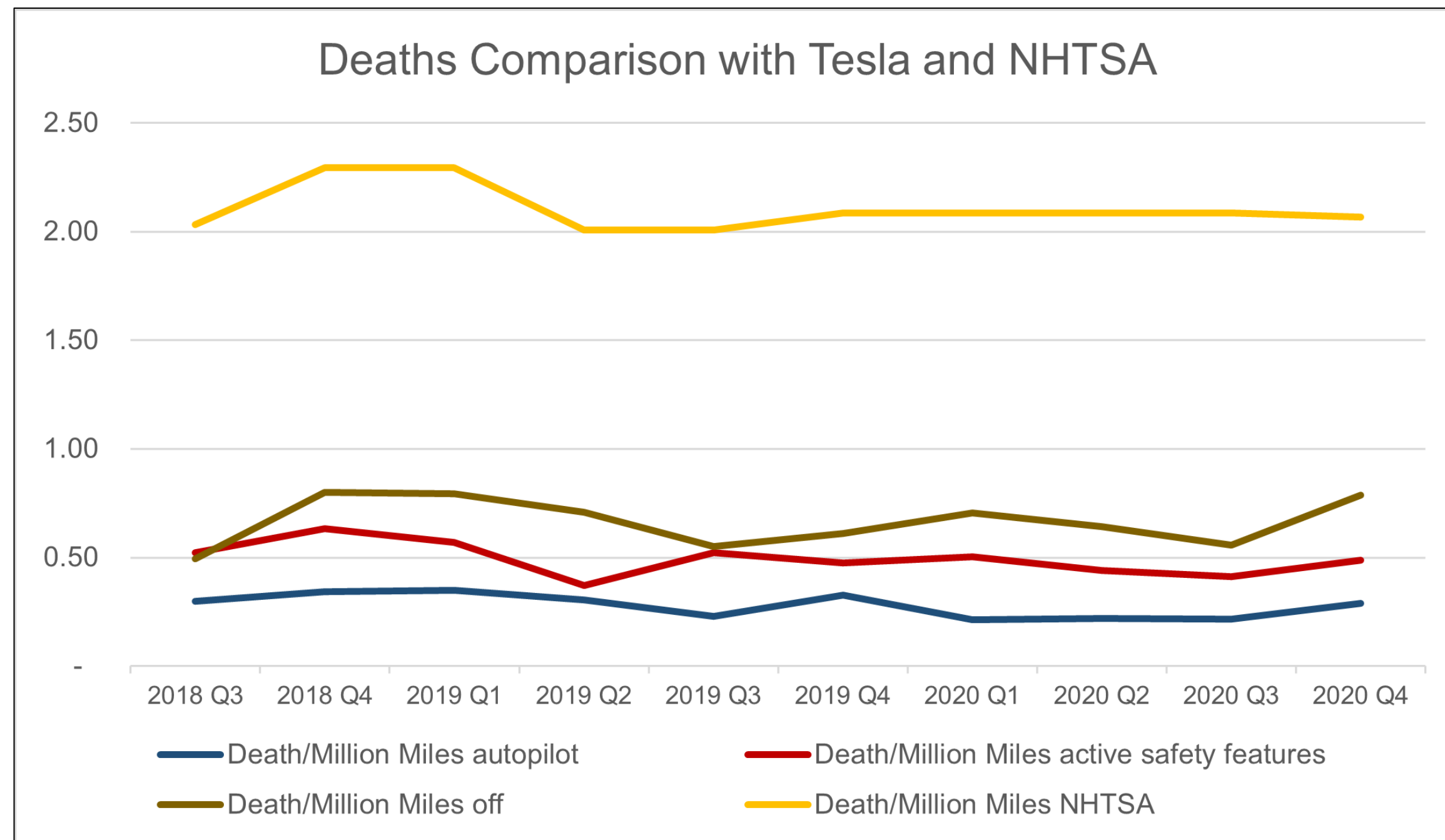
^{†††} only phase 1

* Beijing Sankuai Online Technology Co., Ltd.

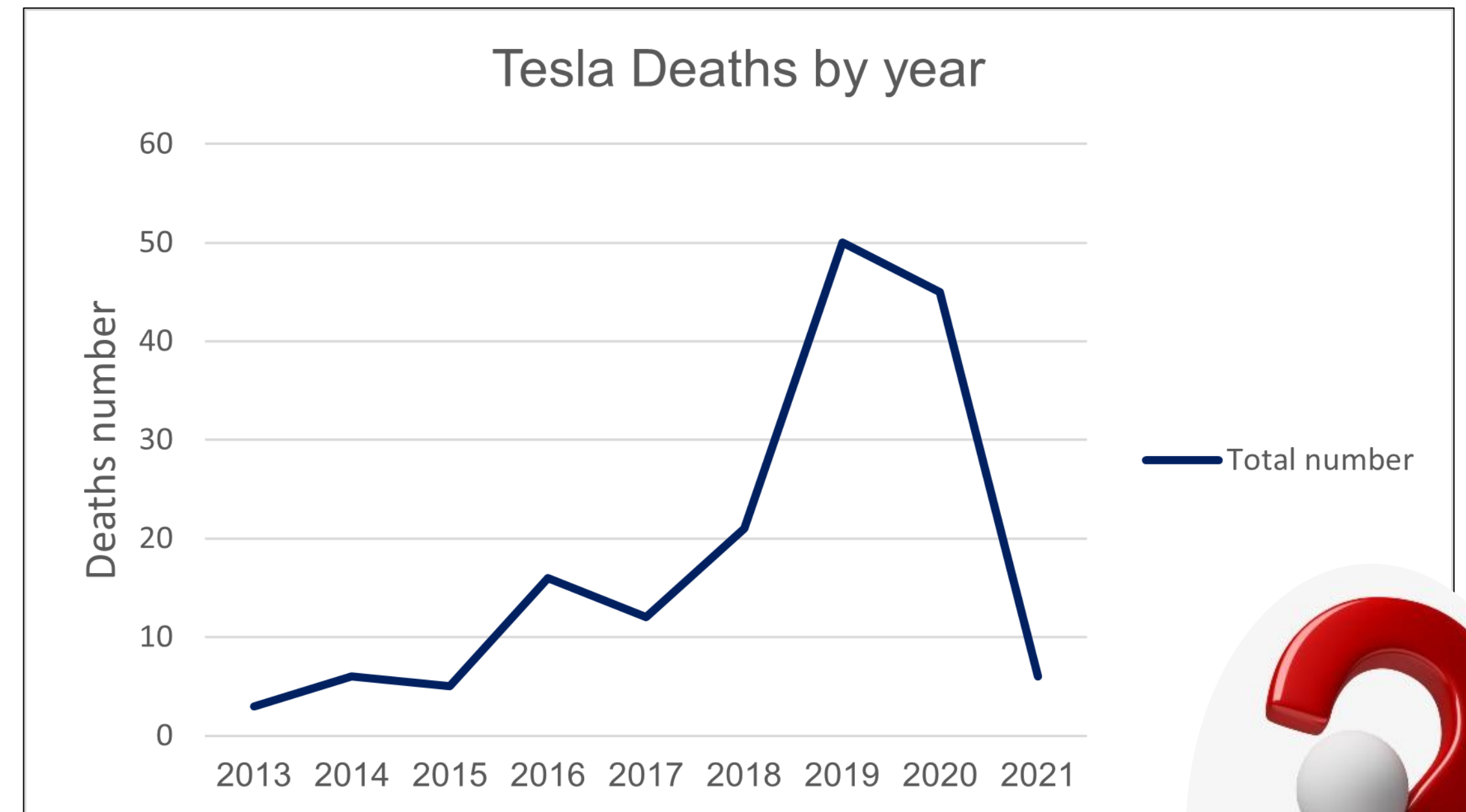
Baidu Ranked the top 1

Manufacturer	2018-2020	
	testing cars #	Total miles
Baidu	57	2,019,230
NIO	2	3,515
BAIC BJEV	1	235
Daimler AG	2	926
Poni.ai	7	163,249
Tencent	1	4,157
DiDi	2	1,332
Audi	2	1,144
Idriverplus	2	1,403
SOKON	1	0
NAVINFO	1	1,220
Toyota	4	15,022
Beijing Sankuai Online Technology Co., Ltd.	1	464
Beijing WOYA (Parent company: DiDi)	4	1,540
Total	87	2,213,437

Tesla Deaths Facts



01 Tesla Safety Report



02 Tesla Individual Record



AV Crash in Real World



<https://www.abc.net.au/news/2018-05-10/tesla-crash-battery-fire-kills-two-teenagers/9747648>

Robert Sumwalt (NTSB):
“There still exists limitations of AVs to the current consumers.”



Elon Musk's Claim

“Tesla's Full Self-Driving tech will have Level 5 autonomy by the end of 2021”



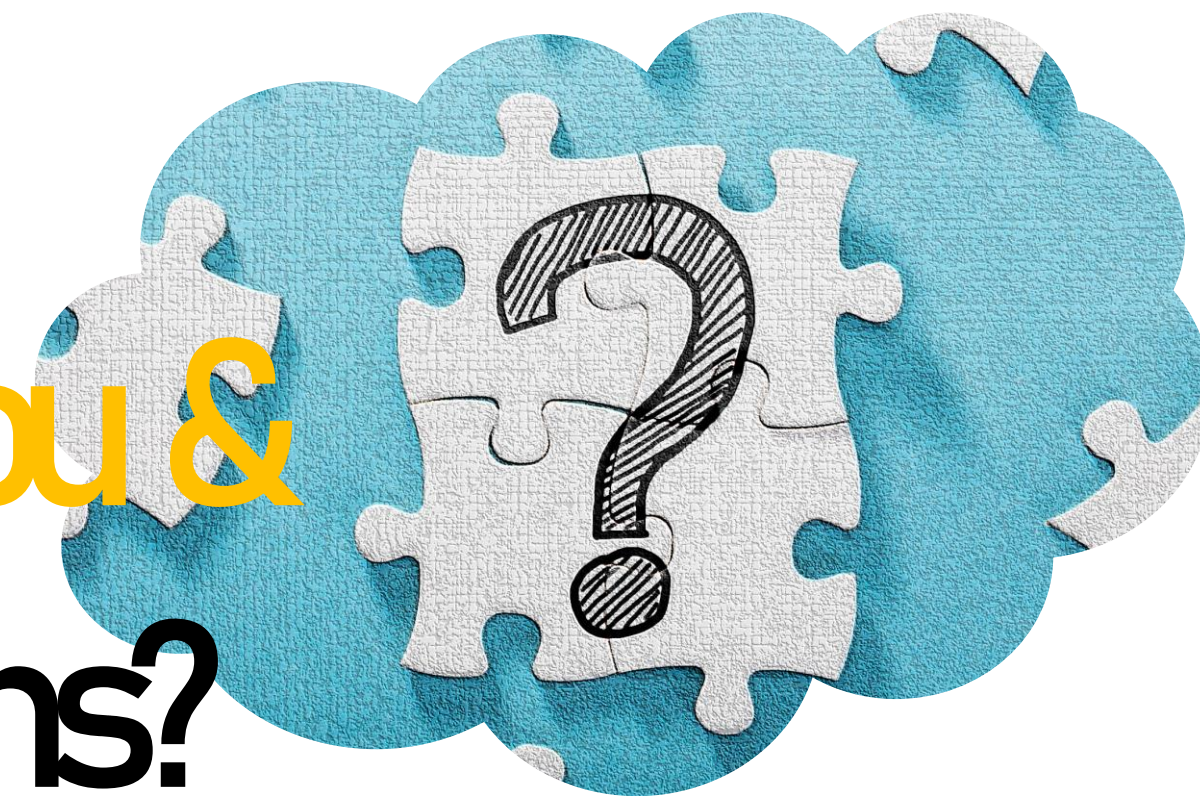
Model 3 has the lowest overall probability of injury for any car ever tested by [@nhtsagov](#). Model S is #2. Model X is #3. There is no safer car in the world than a Tesla



Conclusions

- Fatalities in Real World
- Human Error and AV Potential Benefits
- SAE Levels of Driving Automation and Driver Assistance Technologies
- Disengagement Rate and Collision Comparison with AVs and CVs
- Beijing AVs Road Testing
- Tesla Deaths Facts and Musk's Claim

Thank you &
Questions?



References

- Ministry of Transport. New Zealand's road safety strategy 2020-2030. Report, 2019. URL https://www.transport.govt.nz/assets/Uploads/Report/Road-to-Zero-strategy_final.pdf.
- S. Mueller Alexandra, B. Cicchino Jessica, and S. Zuby David. What human-like errors do autonomous vehicles need to avoid to maximize safety? *Journal of Safety Research*, 75:310-318, 2020. ISSN 0022-4375. doi: <https://doi.org/10.1016/j.jsr.2020.10.005>.
- Kyle Hyatt. Elon musk says tesla's full self-driving tech will have level 5 autonomy by the end of 2021. *cnet*, 2021. URL <https://www.cnet.com/roadshow/news/elon-musk-full-self-driving-tesla-earnings-call/>.
- Beijing mzone. Beijing autonomous vehicles testing reports (2020). *Finance sina*, 2020. URL <https://finance.sina.com.cn/tech/2021-02-17/docikftpnny7088836.shtml>.
- abc. Teenagers killed in fire after tesla crashes, battery bursts into flames. *abc*, 2018. URL <https://www.abc.net.au/news/2018-05-10/tesla-crash-battery-fire-kills-two-teenagers/9747648>.

Extensions

Dorde Petrovic, Radomir Mjailovic, and Dalibor Pesic. Trac accidents with autonomous vehicles: Type of collisions, manoeuvres and errors of conventional vehicles' drivers. *Transportation Research Procedia*, 45: 161-168, 2020. ISSN 2352-1465. doi: <https://doi.org/10.1016/j.trpro.2020.03.003>. URL <http://www.sciencedirect.com/science/article/pii/S2352146520301654>.