



HUMAN-COMPUTER INTERACTIONS IN AUTONOMOUS VEHICLES

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INTRODUCTION

- Autonomous vehicles (AV) are gaining popularity in the automobile markets
- In 2019, there were about 39 million vehicles with some AV features; this will grow to 55 million by 2024
- This technology introduces a solution that eliminates human error from the equation in accidents
- The technology leaves much to be desired as it is still in its early stages of development

AUTONOMOUS DRIVING

- The concept of this technology is not new (first occurrences in 1900s), but it did not gain popularity until the early 2000s
- Several automakers began investing heavily in this domain along with aid from U.S. government departments
- Tesla became one of the earliest contenders in the race to full vehicle autonomy
- The NHTSA classifies vehicle autonomy on 6 levels from 0-5; U.S. based vehicles have only reached level 2 for now

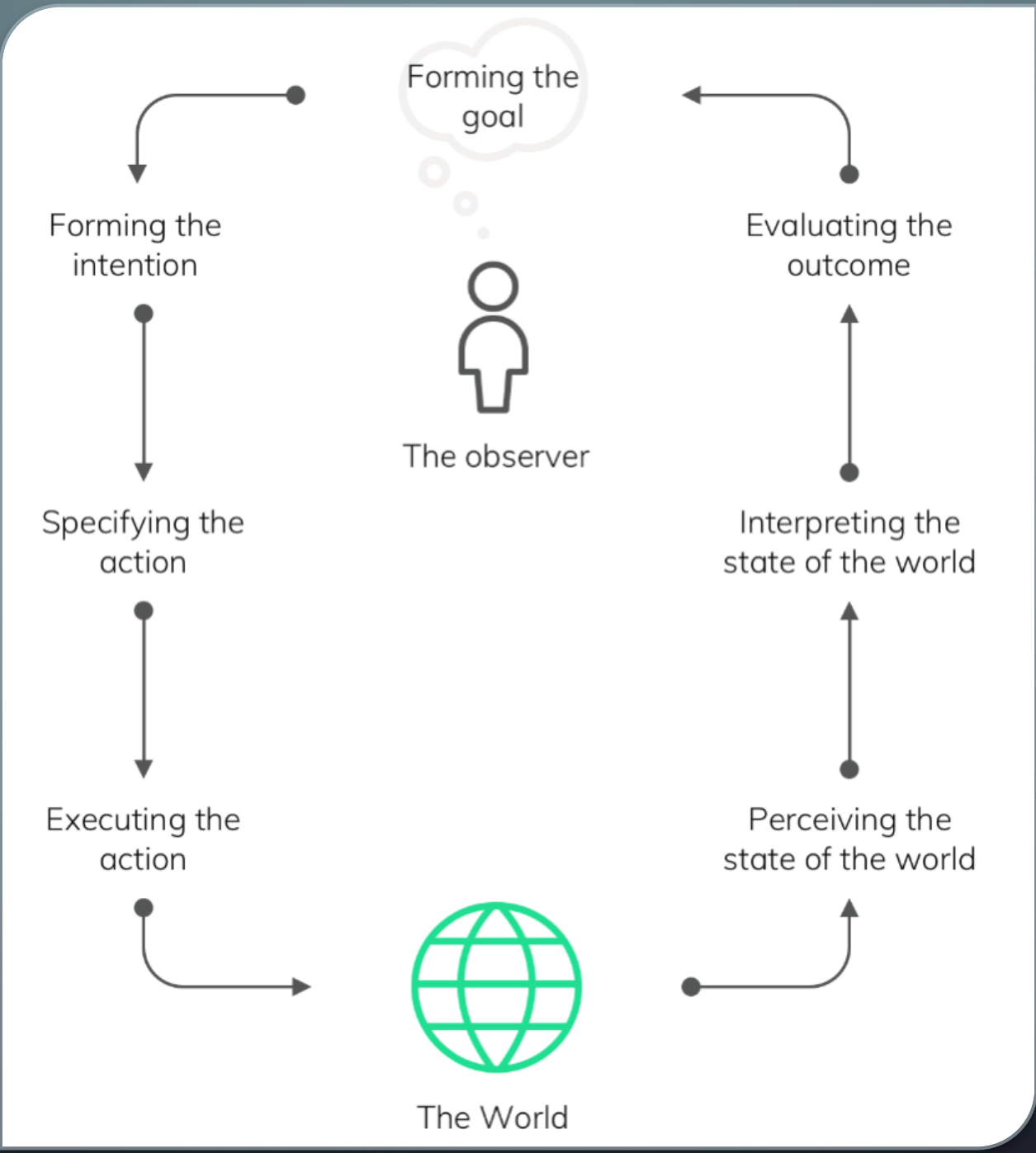
ELECTRIC VEHICLES WITH AUTOMATION



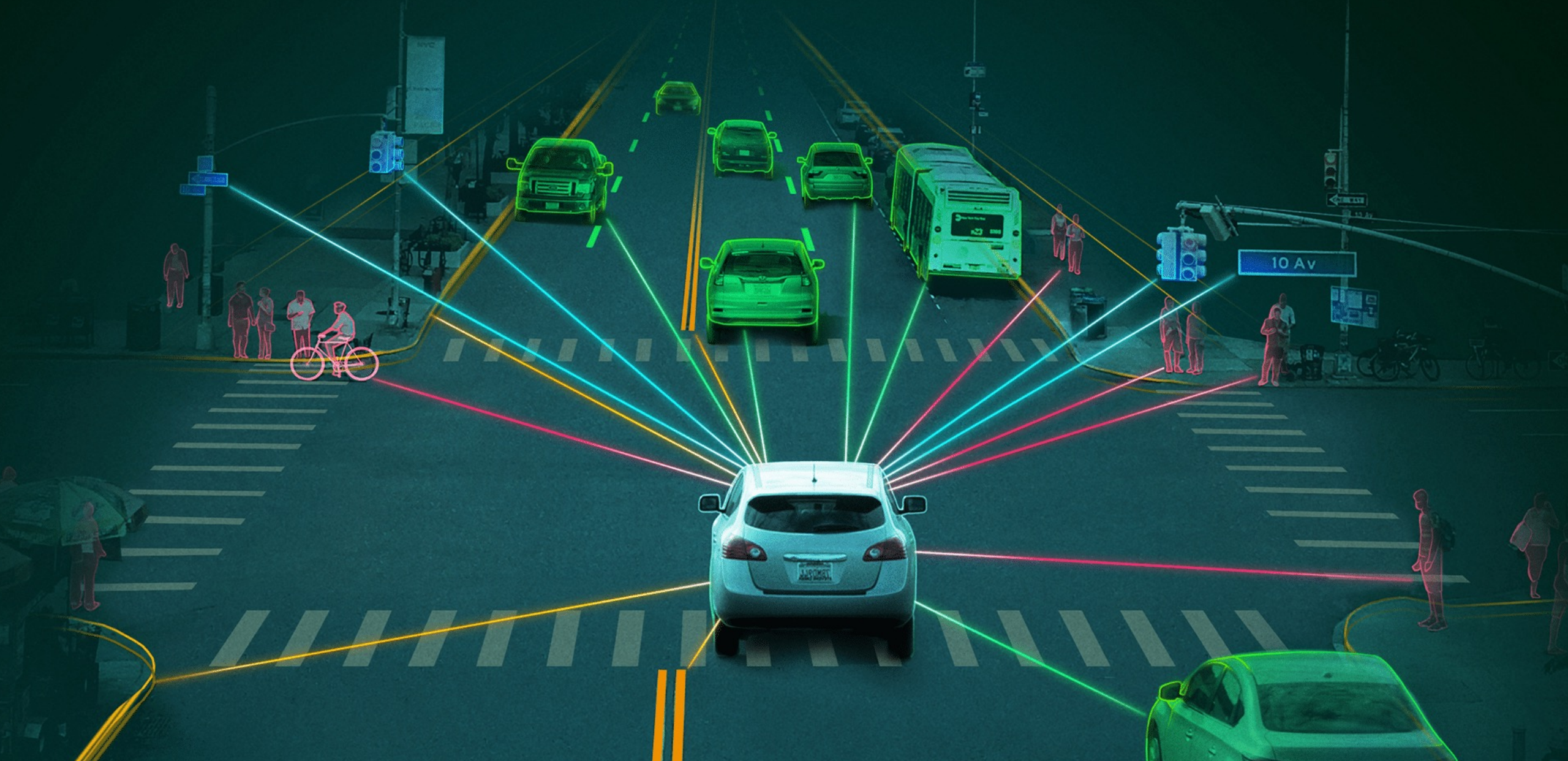
- Most EVs are equipped with some degree of driving automation for two reasons: much newer vehicles, an existing reliance on battery-operated functionality
- GM stated that battery powered vehicles are better equipped to provide stable power supply for autonomous systems
- AV's success depends heavily on an immense amount of road condition data, minimal system reaction times, and real-world situations with solutions
- Tesla currently offers its users three levels of driver assistance: Autopilot, Enhanced Autopilot, Full Self-Driving Capability

HCI PRINCIPLES FOR VEHICLE AUTONOMY

- In HCI, the three primary intersecting components are known as the human, the computer, and the interactions between them
- The interactions between humans and computers are critical in technologies such as AV
- Norman's Seven Stages of Action have been the backbone of HCI study
- These principles aid the understanding of how vehicles interact with other humans, vehicles, objects, or signs on the road



HUMAN-COMPUTER INTERACTIONS IN AUTONOMY



BENEFITS OF AUTONOMOUS DRIVING

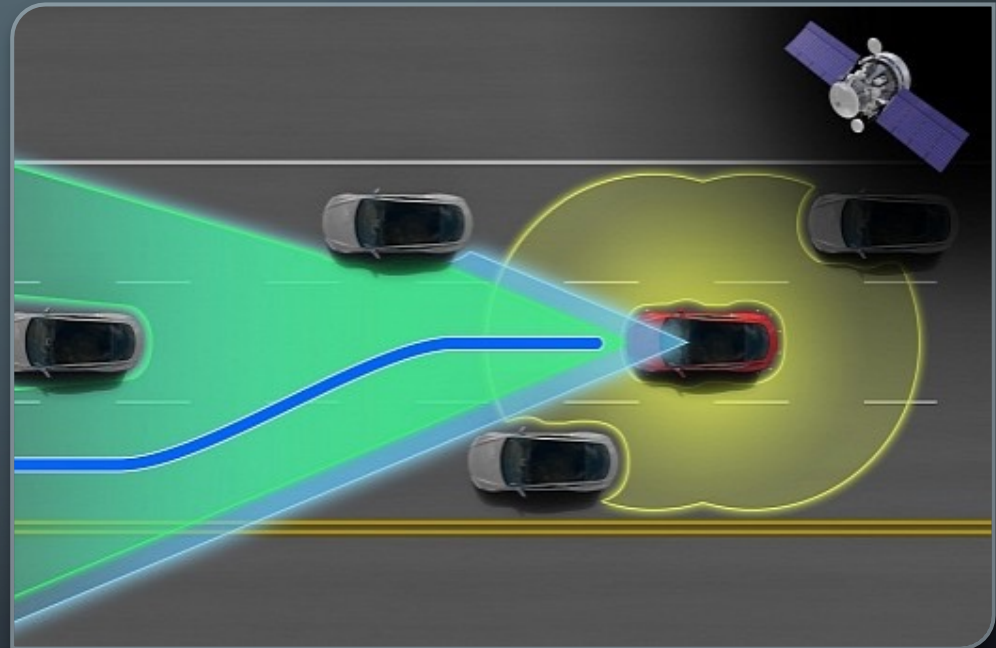
- Safety
- Efficiency and Convenience
- Independence for the Disabled

ISSUES WITH AUTONOMOUS DRIVING

- Premature infrastructure is one of the most limiting factors for this technology: lack of sufficient charging stations, lack of clearly marked road lane lines
- AVs will thrive most in environments where they are surrounded by other AVs and can communicate with each other
- Liability and insurance will become major concerns when it comes to determining fault in accidents
- People may expect insurance rates to drop, but companies are expecting them to rise (accounting for more expensive vehicles and complexity of fault)

HCI LIMITATIONS IN TESLA'S AUTOPILOT

- Tesla's autopilot system often runs into issues with object vs. human identification on the roads
- The system is not equipped to handle all possibilities on the road; it ran into major issues seeing a horse chariot on its sensors

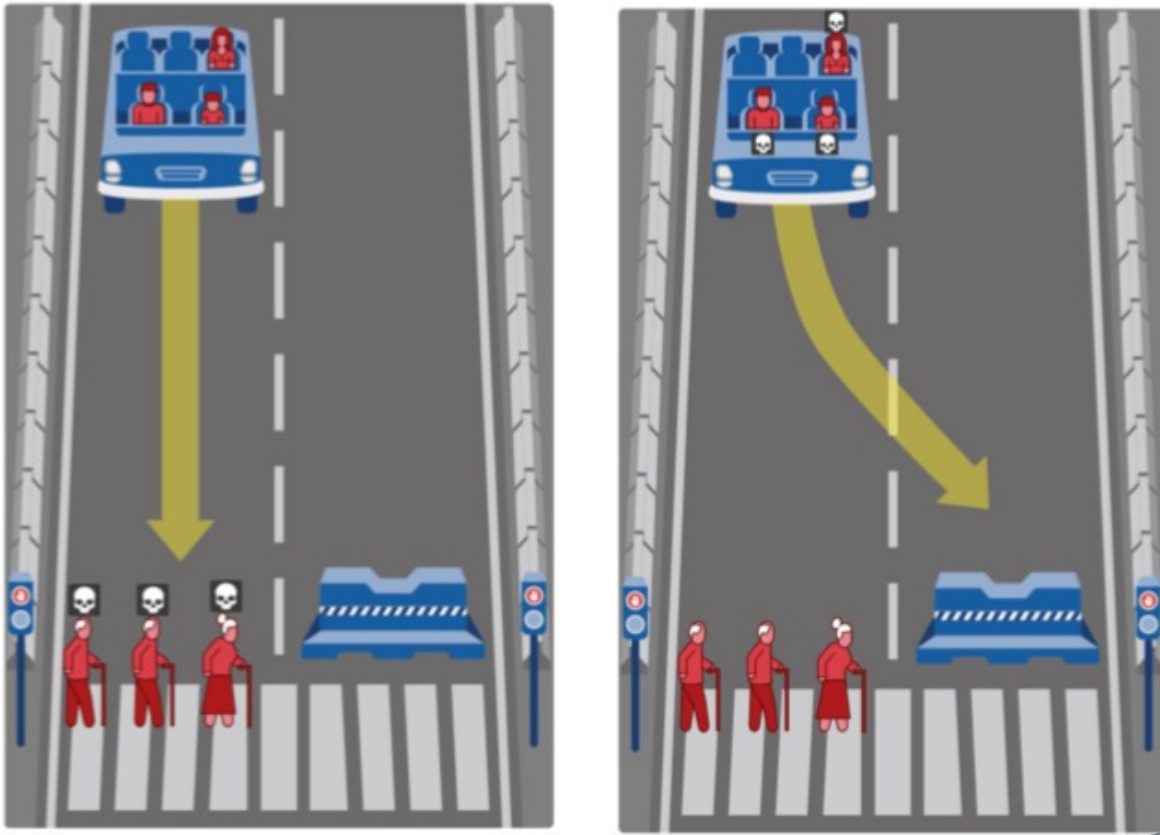


PASSENGERS VS. PEDESTRIANS IN ACCIDENTS

- One of the most critical challenges for AV technology is decision-making with consideration for human morals
- In a situation where the vehicle must save either its passengers or the pedestrians on the road, any lapses in judgement could be catastrophic
- Such situations could be cars vs. cars, cars vs. pedestrians, cars vs. semi-trucks
- Humans may be able to consider more options beyond the scope of those that a programmed computer will be weighing

PASSENGERS VS. PEDESTRIANS IN ACCIDENTS

What should the self-driving car do?



- In this figure, the AV must choose between two options, both of which will cost lives
- The autonomous system has limited options, but a human may be able to consider other possibilities costing no lives

PASSENGERS VS. PEDESTRIANS: PBS STUDY RESULTS

- PBS carried out a study that received over 2 million responses from participants across 233 countries
- Response trends varied based on cultures, backgrounds, and traffic rules of the participants' countries
- Responses suggested these trends: save humans over animals, pick the option that saves the most lives, save younger lives over older ones

RISK ASSESSMENT FOR LANE CHANGING

- A driver must consider several factors to successfully change lanes, most of which are instinctual. An AV will need to carry out all these calculations before it can successfully execute the same desired action.
- On locations such as interstates, this high-speed maneuver becomes even more risky.
- This can be a challenging task for AVs, any errors here could have severe consequences.

SUMMARY

- Reasons to consider autonomous driving vehicles:
 - Improved safety
 - Improved travel and fuel efficiency
 - Independence for the disabled
- Challenges limiting AV adoption
 - Premature infrastructure
 - Liability and insurance
 - Increased expenses for ownership
 - Limited set of options in critical accident situations

REFERENCES

- NHSTA (automation levels)
- PBS (passenger vs. pedestrian study)
- Statista (statistics on increasing AVs)
- GM (why AVs should be EVs)
- Tesla (developments in the autopilot system)
- Thales Group (benefits of autonomous vehicles)
- GovTech (challenges for autonomous vehicles)
- Progressive (insurance for AVs)
- ResearchLeap (image: Human-computer interactions in autonomy)