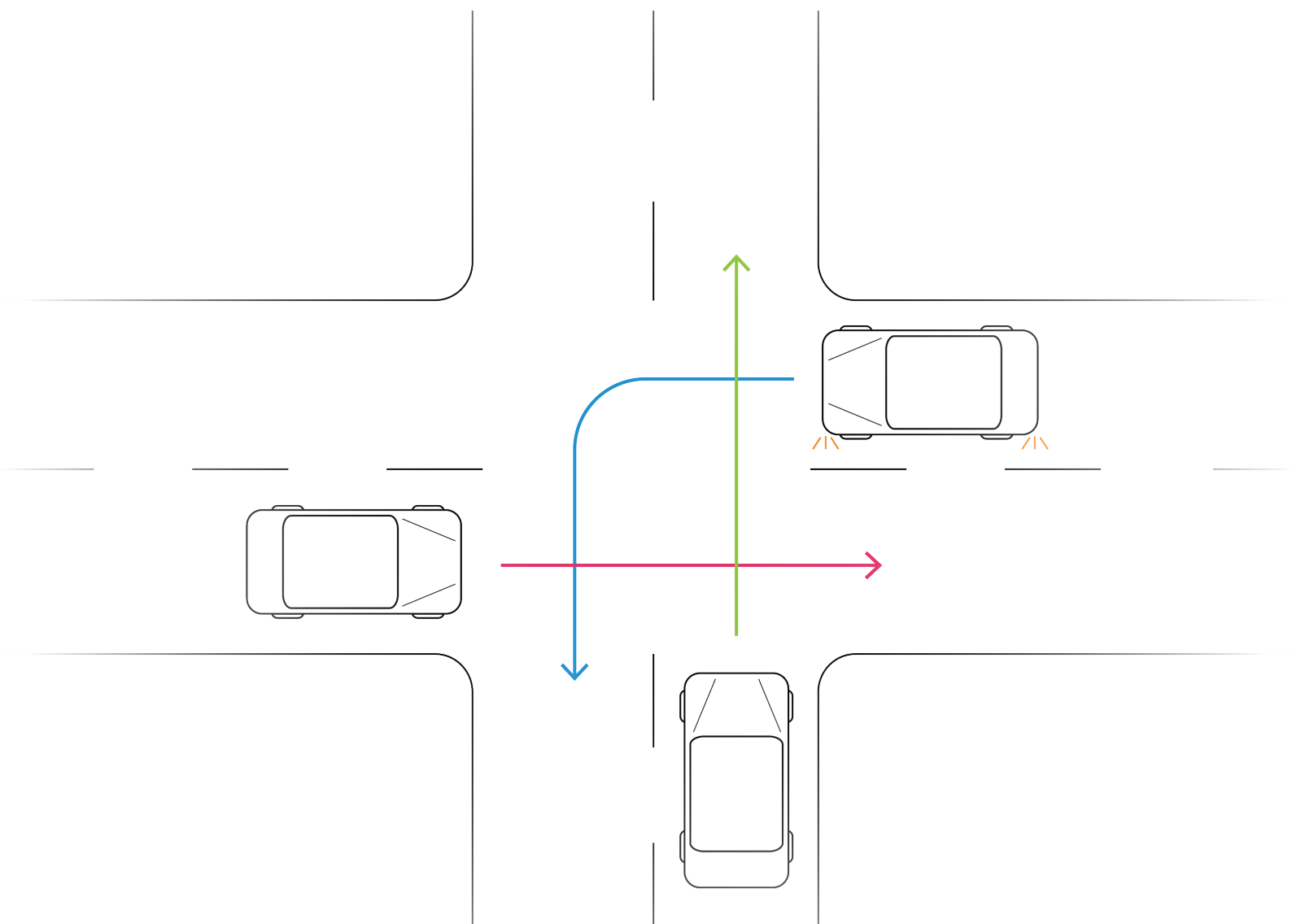


Future Vehicle Social Skills

Apps on Wheels

Bram Rutten



June 2015

Theme:

Playful Interactions

Project:

Apps on Wheels DPI63

Coach:

dr. J.M.B. Terken

Student:

Bram Rutten

s140795

Industrial Design, M1.1

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Introduction

Will the automobile finally become auto mobile?

5

The technology is almost there. The first automated vehicles are hitting the road. It is not yet clear how these vehicles will have to behave in daily traffic situations. The purpose of this research project is to investigate how automated vehicles should behave in certain situations where normal traffic rules are arguably not appropriate. By examining peoples experiences and expectations desired behavior for robots on the road is determined in relation to human driving behavior.

... to assume more
... already available
... Examples of
... systems (ADAS)
... vision systems,
... warning
... all
... the

TQT	Critical Incident	
	Absent	Present
Absent (manual)	69.56 (0.74)	72.94 (0.77)
70.46 (0.83)	68.53 (0.72)	14.760 (0.52)
0.49 (0.03)	0.46 (0.02)	0.48 (0.02)
0.18 (0.0)	0.18 (0.0)	0.18 (0.0)

Task. Standard errors are in parentheses.

driver, as the traffic cones forced
absence of the
ing lane



Guest editorial
**Human factors in
understanding and**

1. Background

Advances in vehicle-based technology are no longer restricted to Original Equipment mobility and a number of research institutes roads is currently underway, with Volvo Cars and the UK Government recently encouraging citizens January 2015 (BBC, 2014). However, the homogeneity

Driver State Measures

FaceLAB Version 4.5 was used for eye tracking. The mean number of blinks per second and the mean length of time the eyes were closed during each blink over a 60-s window were measured throughout the drive. As the quality of eye-tracking data was poor for 6 of the participants, with many missing values, results are reported for the remaining 44. Analyses showed a main effect of TQT and scenario on the average frequency of blinks. Blink frequency was measured to be higher in the presence of the participant with IQT vs. 0.46 Hz with no TQT, $F(1, 43) = 9.17, p < .01, \eta^2 = .18$, but a lower blink frequency was observed overall when driver required to negotiate the critical incident (CI), $F(1, 43) = 9.04, p < .01$. However, there was no main effect of TQT on the blink frequency was not significant, $F(1, 43) = 2.25, p > .10$.

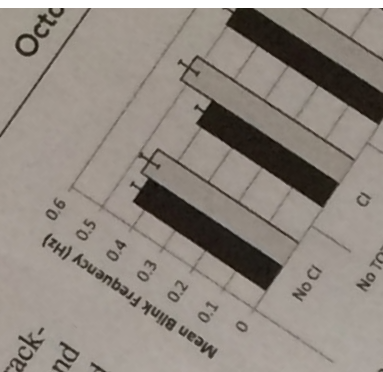


Figure 2
driver

Method

To get acquainted with the topic a literature study about the subject was conducted.

With the knowledge of this explorative study a questionnaire was made in which drivers, cyclists and possible future users of automated vehicles were asked about their experiences and expectations.

Literature

Most research about automated driving behavior is about human machine interaction and about technology that is already on the market.

for example how advanced driver assistance systems (ADAS), such as adaptive cruise control (ACC) effects the driver's experience. (Merat, de Waard 2014) It is currently unknown how fully automated vehicles will behave in traffic and how they influence the user's traffic experience.

The question rose, what should automated vehicles do in unexpected daily life situations?

How can we prepare automated vehicles for instance for a busy pedestrian crossing. Is it going to wait for 10 minutes until the continuous stream of pedestrians dissolves or do we want it to behave with a more proactive attitude? To study the experiences and expectations from possible future users of automated vehicles a questionnaire was made.

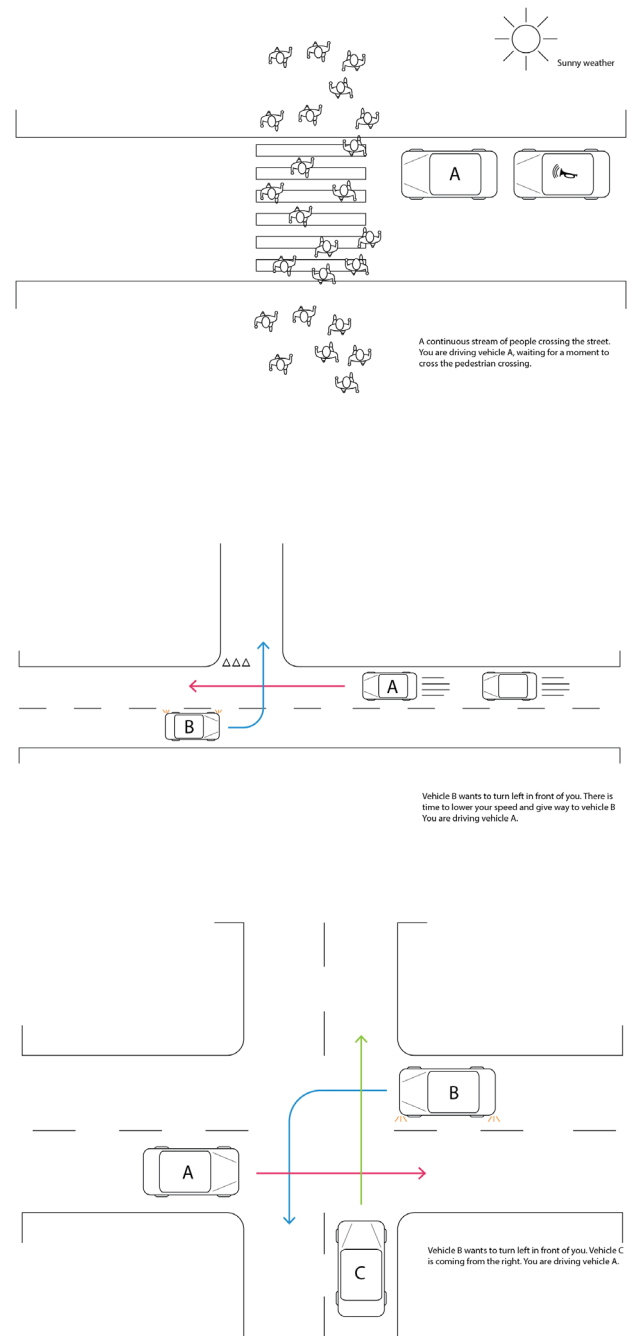
Questionnaire

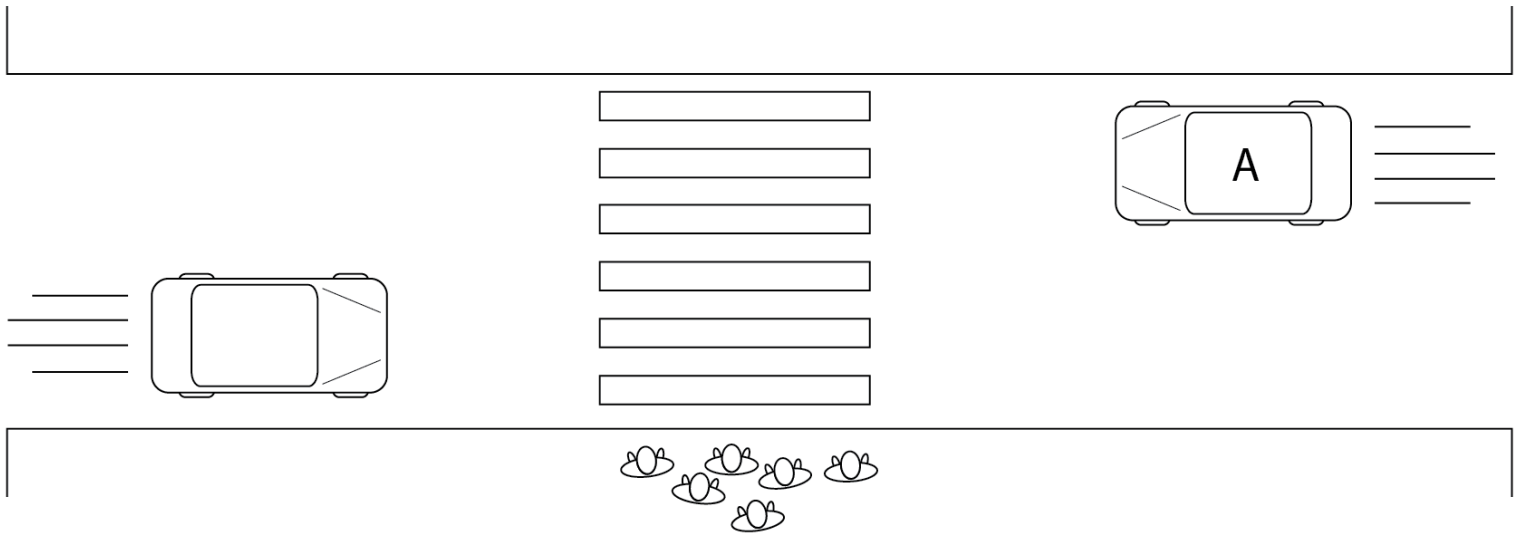
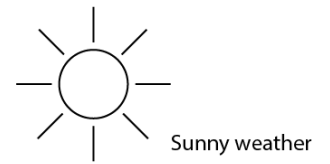
The questionnaire consists of three main scenarios. A pedestrian crossing, a T-intersection and a intersection with a grid lock. Each scenario is presented to the participants multiple times in different variations. In total the questionnaire consists of 18 scenarios. The questionnaire is designed in such a way that it minimizes the chance of people being persuaded to choose for the “right” answer. The order in which the questions are displayed is not in order of scenario or variable. This is done to prevent participants from predicting the next question in which case they could possibly start relating their answers to each other instead of the question it is about.

All scenarios are presented twice. Once participants are asked what they would do in the situation if they would drive the vehicle themselves and once what an automated vehicle should do in the situation if they were inside.

The pedestrian crossing is designed to gain insight in the topic of traffic interaction by automated vehicles in relation to human traffic participants. The variables in this scenario are the weather, sunny or rainy, and automated vehicle or not.

To determine the influence of the participant’s background, questions about gender, age, primary means of transport, etc are asked and participants were asked to fill out a driving style test.

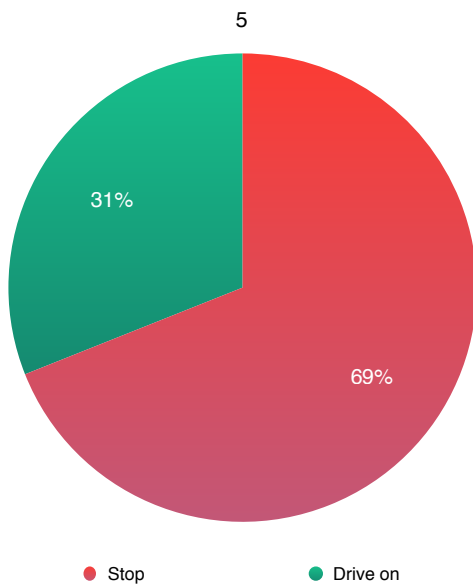




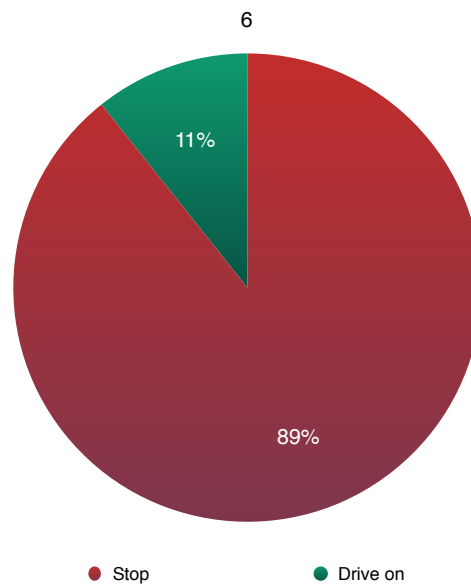
People are waiting at a crossing. Another vehicle is oncoming and you are not sure it stops. You are driving vehicle A. There is enough time to slow down.

10

What would you do?



What should automated vehicle A do?



Here is an obvious difference to what we would want an automated vehicle to do and what drivers would do themselves. Especially drivers with a risky or dissociated driving style answer that they would drive on themselves, but would want an automated vehicle to stop.

Results

The number of respondents is 29, of which 19 female and 10 male. The average age is 34 with the eldest at 71 and the youngest at 21. Almost all have got a drivers license and they mostly commute for work. The participants filled out a driving style test. This is a short version of the method described in the paper: Measuring Driving Styles: A Validation of the multidimensional Driving Style Inventory by H. Hooft van Huysduynen, J.M.B. Terken, J.B.O.S.Martens, J.H.Eggen. This method spreads the respondents over six driving styles. angry-, risky-, anxious-, dissociated-, careful- and distress-reduction driving style. From the 29 respondents in this study 8 have a angry Driving Style, 2 risky, 5 anxious, 2 dissociated, 7 careful and 3 have a distress-reduction driving style. When this is linked to the results from the scenarios, it seems that people with an angry or anxious driving style, respond to the scenarios with more conservative answer, whereas people with a dissociated or distress-reduction driving style, respond with a more assertive answer. For question 17 and 18 the results are the same when you add them, so it seems that the respondents' answers are equal for both questions, but they are not. 21 respondents gave the same answer at both questions, but 8 gave different answers at question 17 and 18. Anxious, dissociated and careful drivers tend to give the same answer, whereas angry drivers are less coherent with their answers. It is interesting to note that some angry drivers would like the automated vehicle to be more assertive than themselves in the gridlock scenario.

?? ??

I think AVs should always stick to the rules!

Discussion

The method asks for an opinion from respondents about a subject they experience daily. Everyday traffic is a phenomenon everyone encounters every day, but not in relation to automated vehicles. They are not yet on the road in large numbers. It is very likely that the general opinion will change over time. When the autonomous car will be more widespread adopted, people get to experience the automated vehicles in traffic. The results make clear that people expect autonomous vehicles to behave in more coherence with the traffic rules, than a human driver would do. There are more rules in traffic, than the basic rules. Rules like the momentum or the vulnerability of a traffic participant. These unwritten rules are arguably of influence for the decision making in situations where the main traffic rules are inconvenient or must be overruled for example, to solve a gridlock.

It is probable that some respondents were unable to fully understand the scenarios. The questionnaire was in English and most respondents were Dutch. With an interview setting it is possible to discuss the scenario and its nuances to find out what the reason is behind an opinion. The number of respondents is preferably larger. Dividing 29 respondents over 6 driving styles, results in two driving styles with only two respondents. The results are not very conclusive. There is reason to believe that users of autonomous vehicles switch autopilot off when the situation occurs that the car is not acting as expected by the user. It is important to please the users of automated vehicles, so they are persuaded to leave the vehicle in control.



Future

It is recommended to do studies in practice with real automated vehicles. This would help in establishing an opinion based on a real product instead of an opinion based on imagination. To gather more valuable data it is recommended to perform the study with interviews instead of an online questionnaire. To maximize the chance of mass adoption of automated vehicles, it would be interesting to look not only from the driver's perspective, but also from the perspective of the pedestrian or cyclist.





Acknowledgements

Many thanks to all the people who supported me past semester. Special thanks to Jacques Terken who has been a great support throughout the semester. He is the person who brought me new insights in the subject of automated driving. Jacques helped me develop my knowledge and skills about research. I very much appreciate the attention. Also many thanks to Robert Szulc. It is great to have someone to reflect on your activities during the semester. We have learned a lot from each other. Finally I would like to thank the respondents of the questionnaire.

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dr.ir. M.M. Bekker

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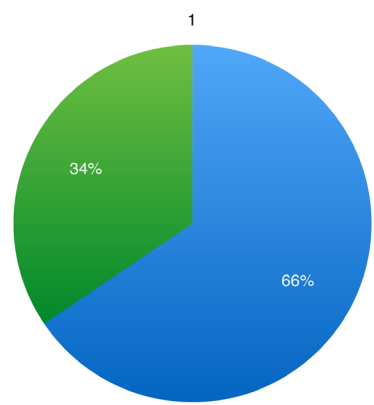
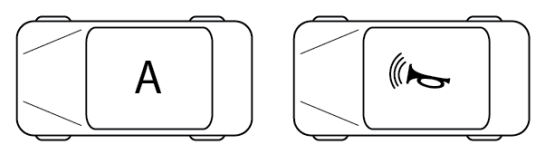
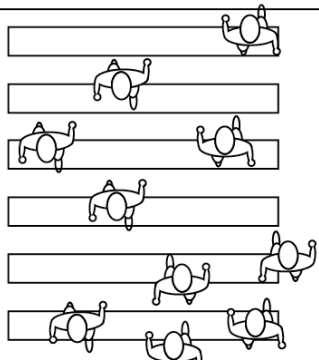
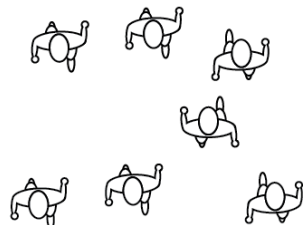
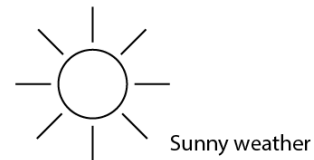
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Appendix

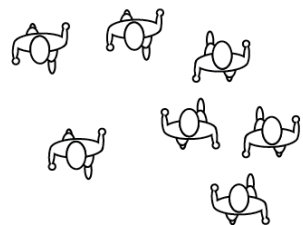
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Scenarios
Results

What would you do?

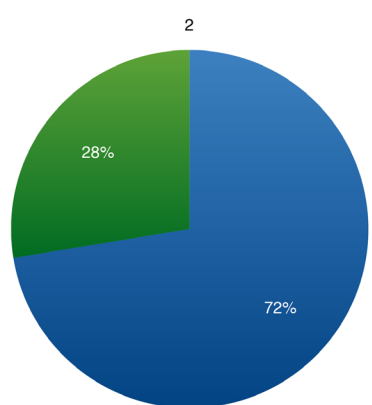
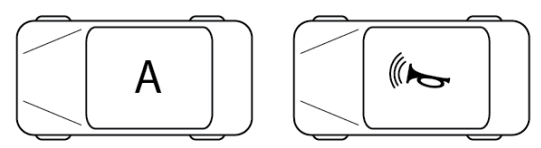
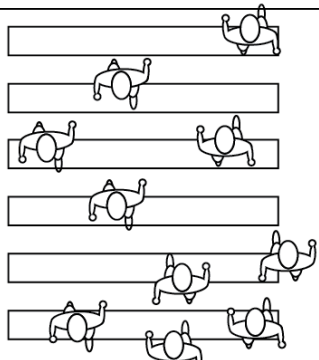
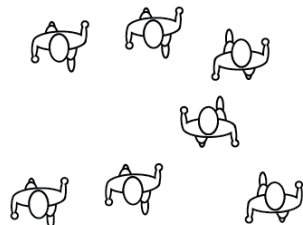
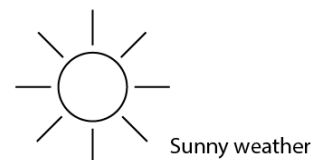


- Wait until the people stop crossing
- Slowly drive forward, so people stop crossing

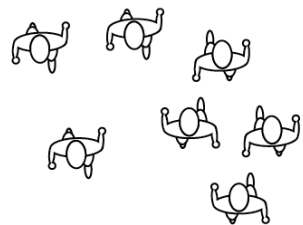


A continuous stream of people crossing the street. You are driving vehicle A, waiting for a moment to cross the pedestrian crossing.

What should automated vehicle A do?

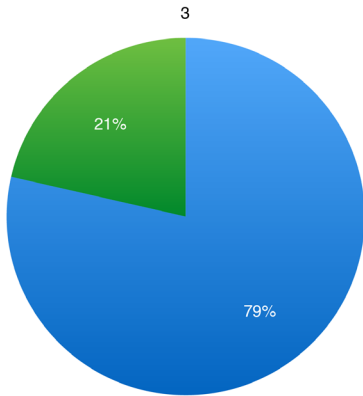
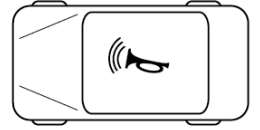
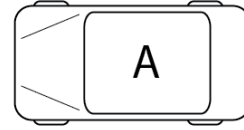
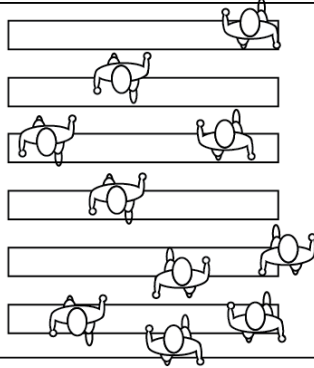
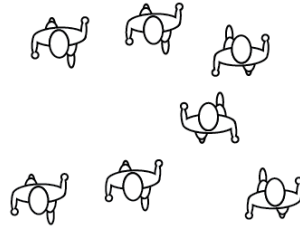


- Wait until the people stop crossing
- Slowly drive forward, so people stop crossing

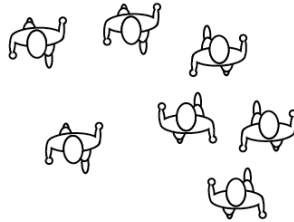


A continuous stream of people crossing the street. You are inside vehicle A, waiting for a moment to cross the pedestrian crossing.

What would you do?

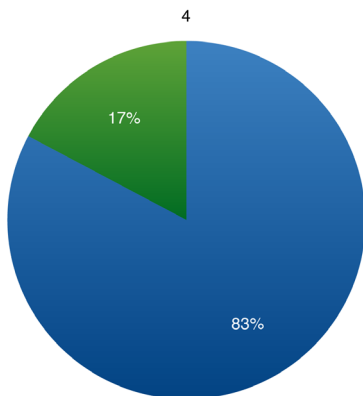
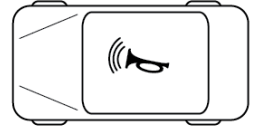
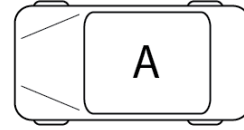
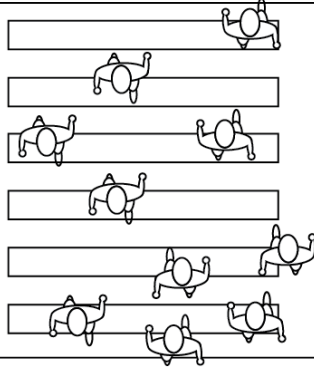
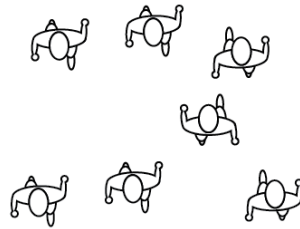


- Wait until the people stop crossing
- Slowly drive forward, so people stop crossing

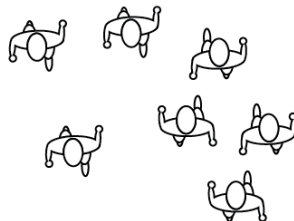


A continuous stream of people crossing the street. You are driving vehicle A, waiting for a moment to cross the pedestrian crossing.

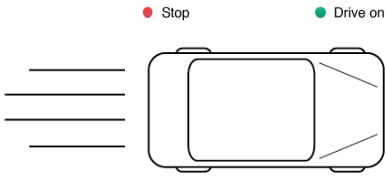
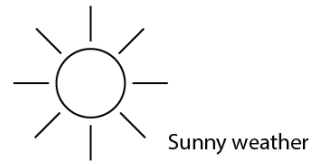
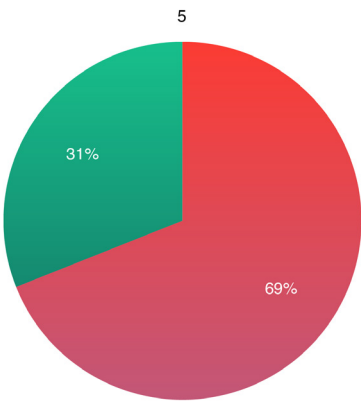
What should automated vehicle A do?

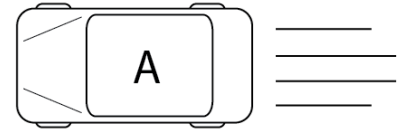


- Wait until the people stop crossing
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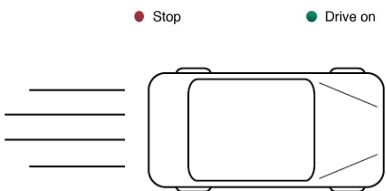
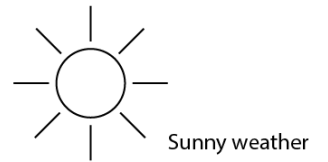
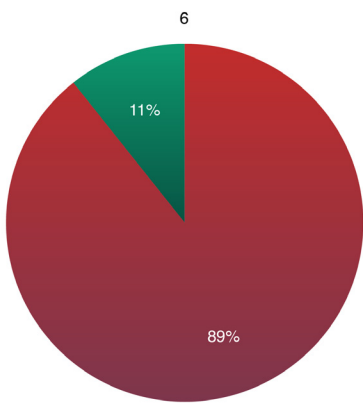
A continuous stream of people crossing the street. You are inside vehicle A, waiting for a moment to cross the pedestrian crossing.





What would you do?

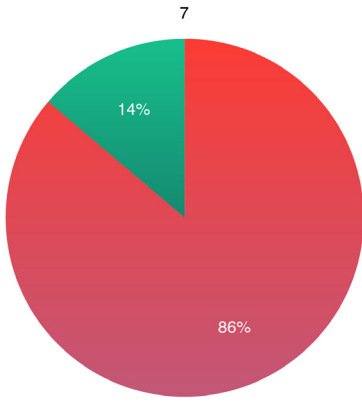
People are waiting at a crossing. Another vehicle is oncoming and you are not sure it stops. You are driving vehicle A. There is enough time to slow down.



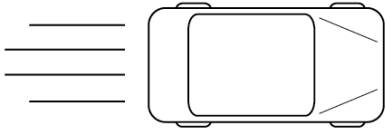


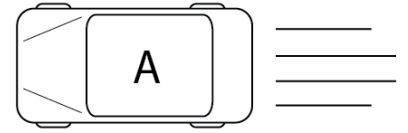
What should automated vehicle A do?

People are waiting at a crossing. Another vehicle is oncoming and you are not sure it stops. You are inside vehicle A. There is enough time to slow down.



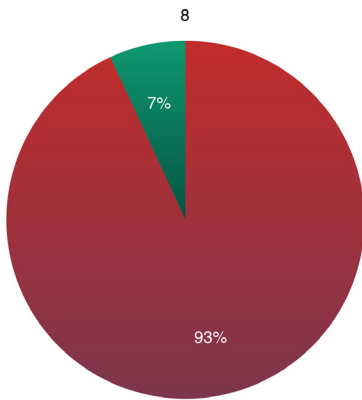
● Stop ● Drive on



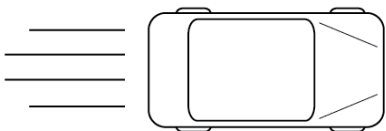


What would you do?

People are waiting at a crossing. Another vehicle is oncoming and you are not sure it stops. You are driving vehicle A. There is enough time to slow down.



● Stop ● Drive on

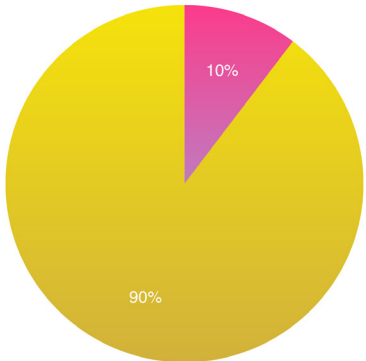




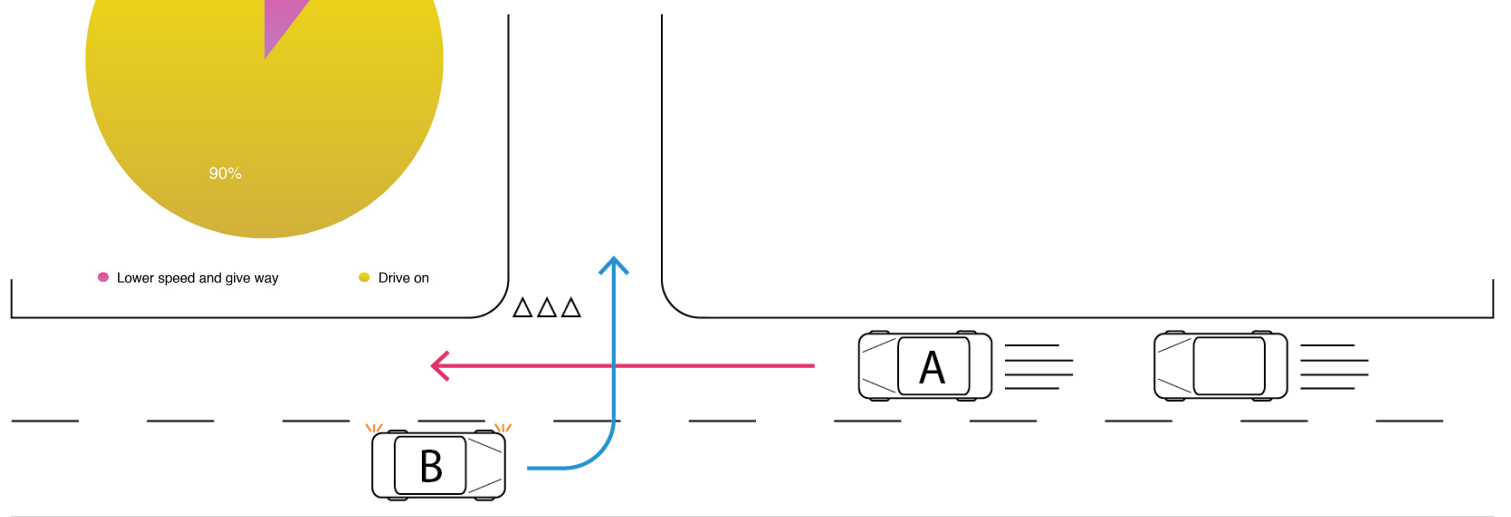
What should automated vehicle A do?

People are waiting at a crossing. Another vehicle is oncoming and you are not sure it stops. You are inside vehicle A. There is enough time to slow down.

9



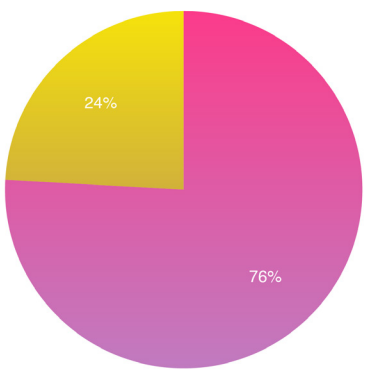
● Lower speed and give way ● Drive on



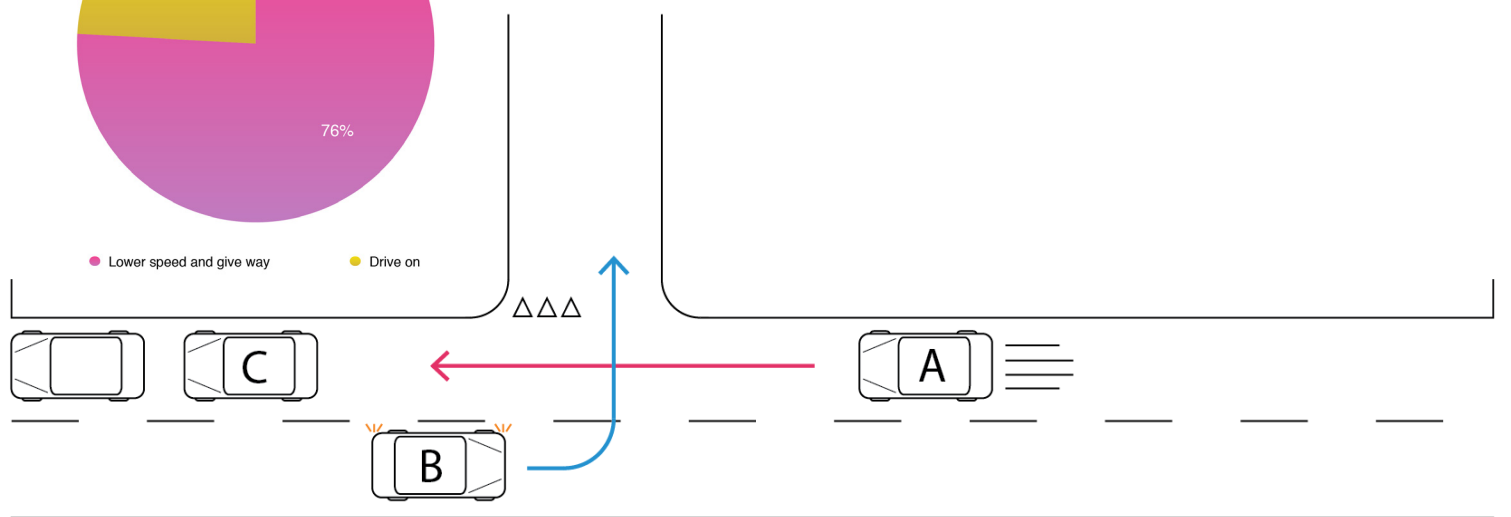
Vehicle B wants to turn left in front of you. There is time to lower your speed and give way to vehicle B
You are driving vehicle A.

What would you do?

10



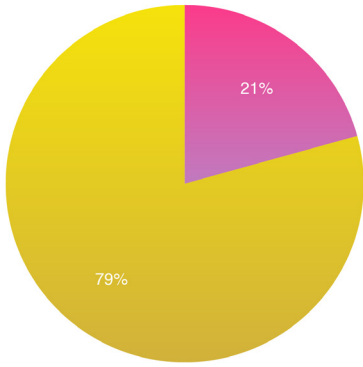
● Lower speed and give way ● Drive on



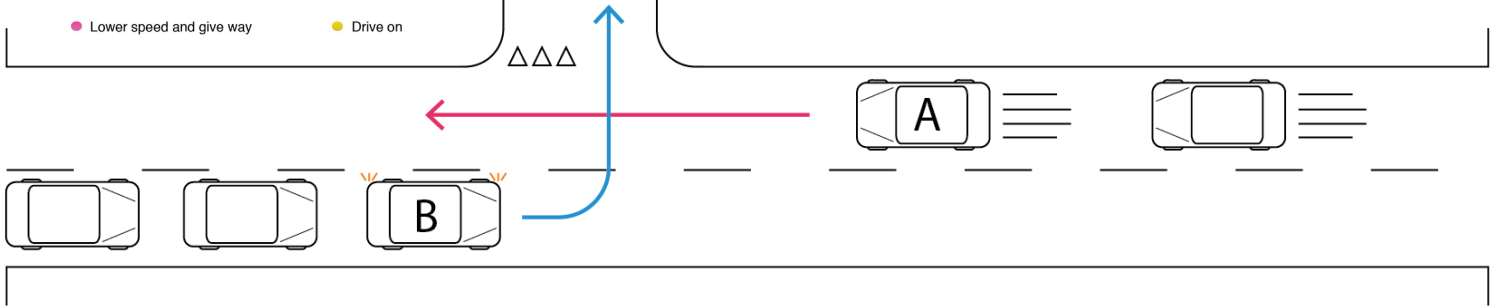
Vehicle C is standing still. Vehicle B wants to turn left in front of you. There is time to lower your speed and give way to vehicle B. You are driving vehicle A.

What would you do?

11



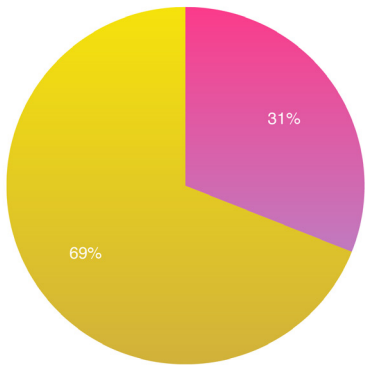
● Lower speed and give way ● Drive on



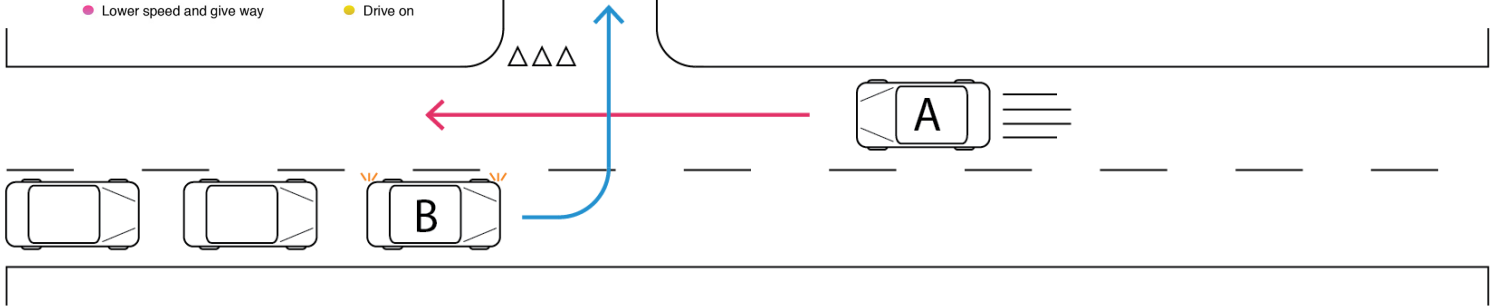
Vehicle B wants to turn left in front of you. There is time to lower your speed and give way to vehicle B. You are driving vehicle A.

What would you do?

12

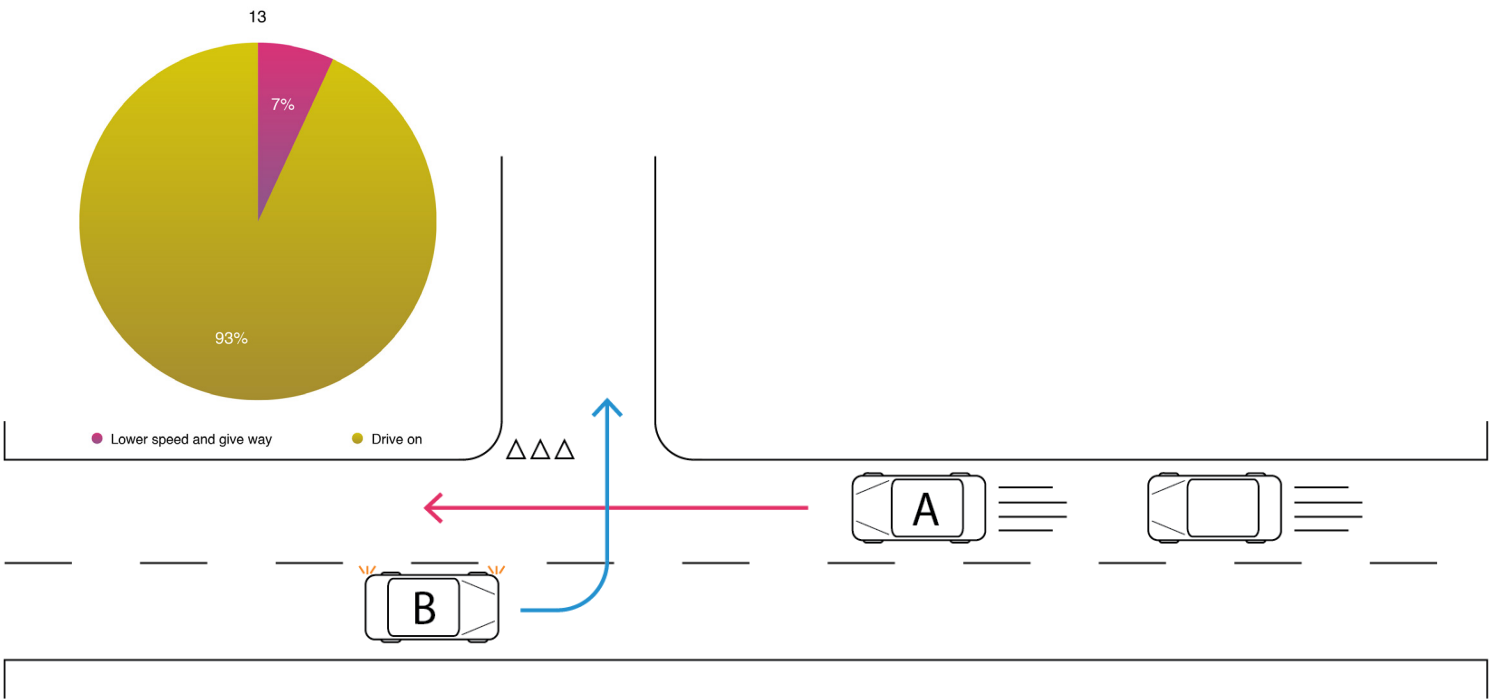


● Lower speed and give way ● Drive on



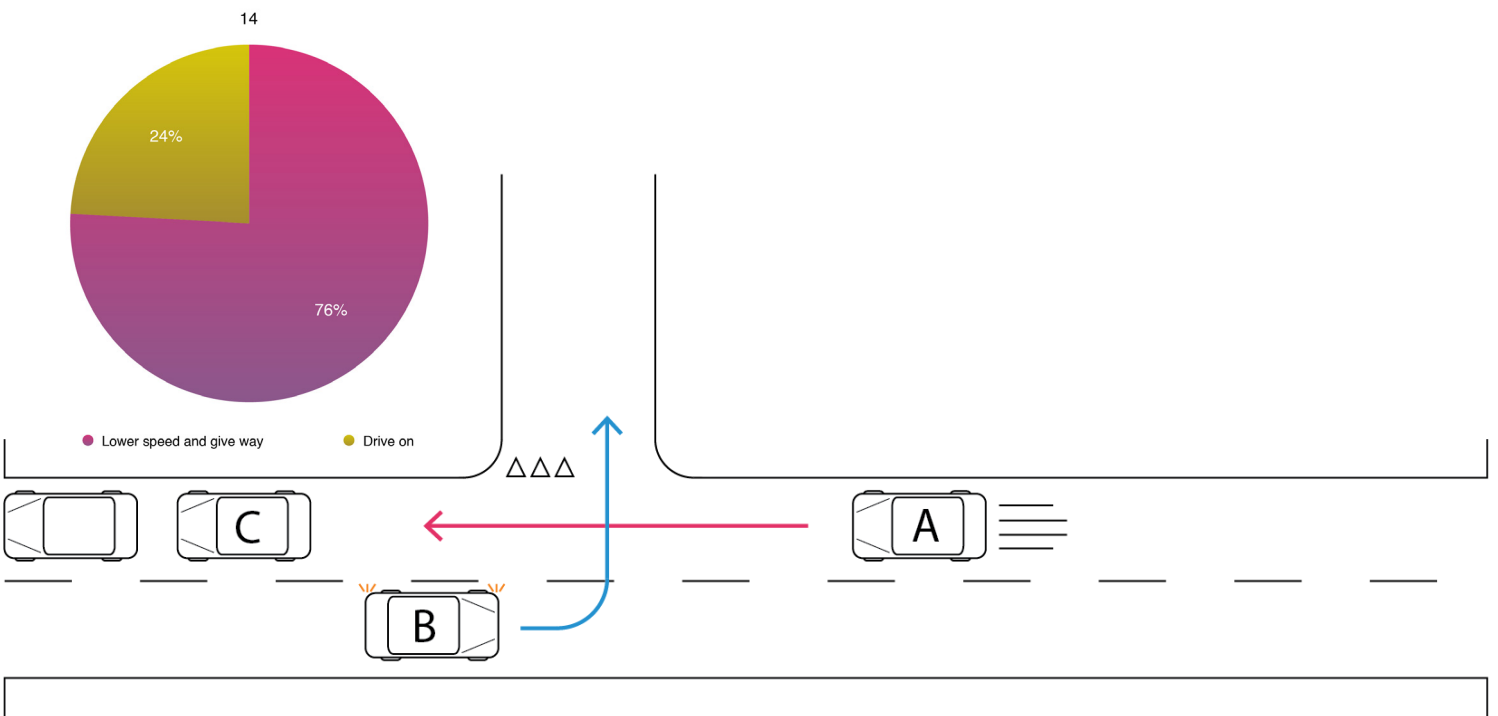
Vehicle B wants to turn left in front of you. There is time to lower your speed and give way to vehicle B. You are driving vehicle A.

What would you do?



What should automated vehicle A do?

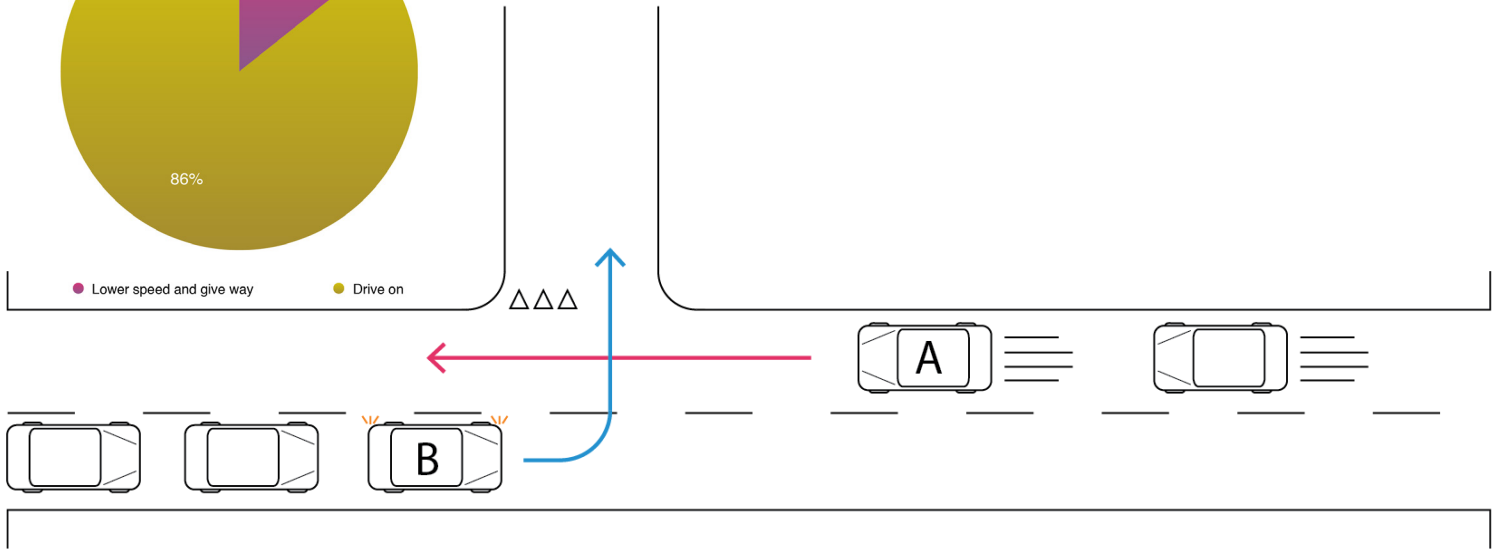
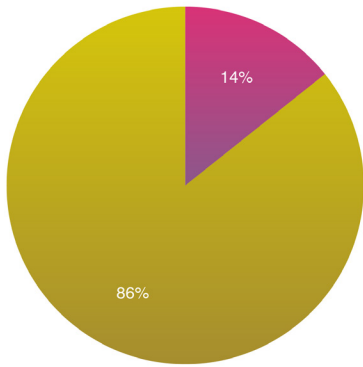
Vehicle B wants to turn left in front of you. There is time to lower your speed and give way to vehicle B. You are inside vehicle A.



What should automated vehicle A do?

Vehicle C is standing still. Vehicle B wants to turn left in front of you. There is time to lower your speed and give way to vehicle B. You are inside vehicle A.

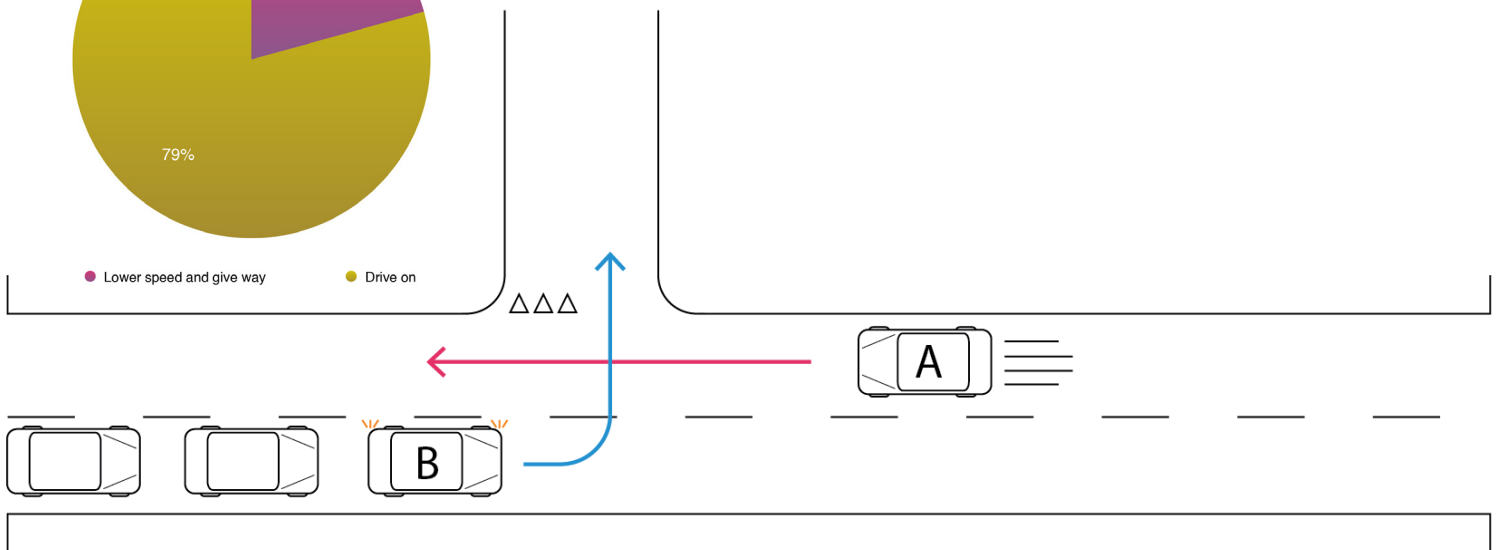
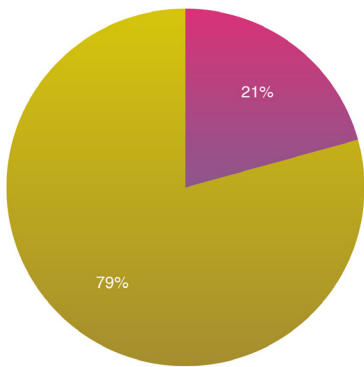
15



What should automated vehicle A do?

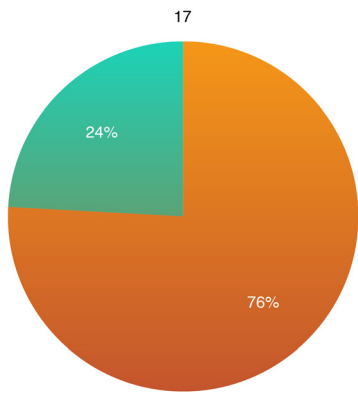
Vehicle B wants to turn left in front of you. There is time to lower your speed and give way to vehicle B. You are inside vehicle A.

16

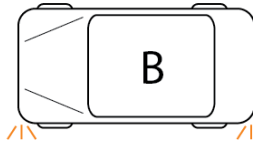


What should automated vehicle A do?

Vehicle B wants to turn left in front of you. There is time to lower your speed and give way to vehicle B. You are inside vehicle A.

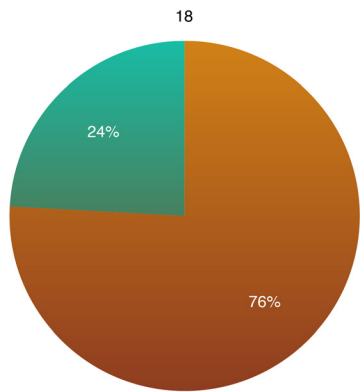


● Wait until someone makes a move ● Start driving

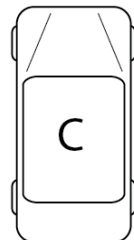
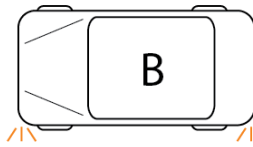


Vehicle B wants to turn left in front of you. Vehicle C is coming from the right. You are driving vehicle A.

What would you do?



● Wait until someone makes a move ● Start driving



Vehicle B wants to turn left in front of you. Vehicle C is coming from the right. You are inside vehicle A.

What should automated vehicle A do?

