Artificial Intelligence and Autonomous Vehicles,

A Survey to Collect Data and Discover the Moral Dilemmas That are Involved

Chad-Michael Muirhead & TJ Nagy

**Abstract**

Artificial Intelligence is the capability of a machine to imitate intelligent behavior. The purpose of self-driving vehicles is to increase traffic efficiency, reduce pollution, and to reduce the number of accidents. Autonomous vehicles are driverless vehicles that use complex sets of sensors to collect and process data for decision-making. The objective of this research is to determine the choices individuals would want AVs, to make in an unavoidable accident. To measure the preferred choices by individuals, a survey was conducted to assess choices based on age, occupational status and gender. Most experts consulted that, technologically, we are about 85 to 90 percent of the way to perfecting the hardware and software to make vehicles that can reliably and safely drive themselves [1].

It was determined that the selected factors could have an impact on the preferred choices an AV should make in an unavoidable accident dilemma.

**Introduction**

Self-driving vehicles or autonomous vehicles are going to play an important role in the future and though there are already a few on the road, that number will increase substantially in the future. There has been plenty of talk whether or not we as humans trust a vehicle that we have no control over. In several recent surveys on the topic of self-driving vehicles, the public has generally expressed some concern regarding owning or using vehicles with this technology [3]. Conducting surveys talking about self-driving cars plays a huge role for car companies that build them so they can receive feedback from potential customers and see what they need to do to make their product sell. Also, the government can benefit from surveys based off of self-driving car questions to help them regulate laws and to figure out what people prefer.

Moral or utilitarianism programming is a major factor in the design and development of self-driving vehicles. Moral programming involves the choice an autonomous vehicle must make when there is an unavoidable accident. The issue to protect the occupants or to choose the most utilitarian approach . If autonomous vehicles replace conventional vehicles then it is important that an acceptable decision be made in regards to the choice the vehicle should make when encountering an unavoidable accident. This is important to address, as a solution must be found to ensure that customers, manufacturers and governments have an agreement, which satisfies all their needs.

Autonomous vehicles will reduce approximately 90% of traffic accidents, which were influenced by human errors [4].  A reduction of 90% will possibly influence the private and public sector to integrate self-driving technology into their operations.  The usage of fossil fuels for energy to operate vehicles will also be significantly reduced and replaced by autonomous vehicles powered by electricity or other forms of renewable energy.

**Background**

Autonomous Vehicles (AVs) should reduce traffic accidents, but they will sometimes have to choose between two evils—for example, running over pedestrians or sacrificing itself and its passenger to save them. Defining the algorithms that will help AVs make these moral decisions is a formidable challenge [4]. In response to the rapid technological progress in the realm of self-driving vehicles, government both local and national have already begun to develop strategies to address the challenges that may result from the introduction of such vehicles. For example, with the announcement of policies to support self-driving vehicles in the U.K, one city (Milton Keynes) has developed plans for self-driving vehicles within the city as a new form of public transportation by the year 2017, with on- road testing planned to begin in 2015 [3].  In the U.S., the state of California recently enacted legislation to permit testing of self-driving vehicles on public roads, following Nevada, Florida, and Michigan in allowing operation of such vehicles on public roads [3]. As you can see the process of autonomous vehicles has already started in the US, across the UK, and Europe. Self-driving vehicles are going to revolutionize how we travel significantly. The government and these manufactures are going to try and design a self-driving vehicle to fit the needs and preferences of the consumers, the best way to do this is to create a survey with a bunch of questions about moral dilemmas of self-driving vehicles and what people prefer and what they don’t like about the AVs. This is going to help the government and manufactures maximize income by producing autonomous vehicles that people want to buy and feel safe driving in.

**Methodology**

We utilized a survey to measure and analyze, the preferred choices individuals would want AVs to perform in the case of an unavoidable accident.We administed the survey to students in Eastern’s Senior Research course, CSC 450-02. Participants were notified that they should not identify themselves in any form on the survey. A consent was also provided form which provided detailed information about the survey and the results that we were conducting. There were two sections of questions, with the first section divided into two sub parts. The first subsection measured participant comfort with autonomous vehicles through a range of choices such as: strongly agree, agree, neutral, disagree and strongly disagree. The second subsection of questions were designed to analyze how participants would utilize their time when the vehicle is driving and to identify how fault in the case of an accident should be determined.

The second section of questions were developed to simulate participants in different scenarios of unavoidable accidents. The section consisted of five different questions identified as dilemmas. Questions were designed to measure and identify the priority or preference occupational status, sex or gender provided. Participants were asked to select their preferred choice for the vehicle to make, options being “A” or “B”. Different factors such as  gender, age and social standing, were integrated into these pictorial questions to assess whether they affected selections.

Different measures were used to identify highest priority and different correlations in the surveys. Surveys were divided into different categories based on their selection in choices. After the division into different categories, various similarities and differences were noted, all while with no identification of who submitted which survey.

As seniors, pursuing our bachelors  in Computer Science  at Eastern Connecticut State University, we identified autonomous technology as an intriguing area to study and analyze. We have completed several courses such as Programming 1 and 2, Data Structures, Net Centric and various other electives focusing on different specialization areas in computer science. These have assisted us in better assessing information whether technical or non-technical which were obtained from different articles for references in this proposal. We are also proficient in numerous programming languages ranging from Python, SQL, Java and C++, which assist in better understanding the control specified programming will possibly have on autonomous vehicles.

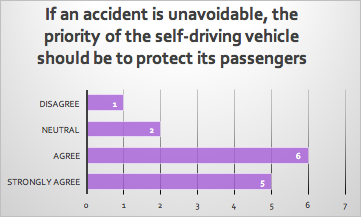
As we continue to learn more in the areas of technology, we will implement skills and knowledge we are currently learning in our final semesters at the university. Senior Research is a critical course in understanding how assessments, studies and data collection procedures should be done will be used in the collection of data from our surveys. We will use the skills learned in the course to ensure that data provided by participants are honest, without any bias and without any risks of judgment to the participant.

We have also ensured that different technical jargons have been made more relatable and easy to understand for most readers. This we believe is important as autonomous technology continues to advance, resulting in  the need for individuals to understand and prepare for its complete integration into society.

**Results**

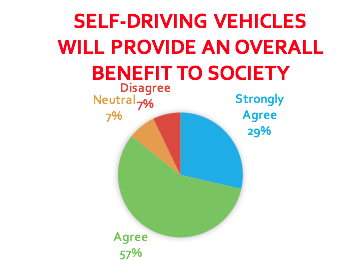
The survey produced a wide variety of information on the perspectives of the participants about autonomous vehicles. These results were analyzed to identify the impact of age, sex and occupational status, on the choices of participants.

For the first part of the survey with the questions listed 1-8 we gathered questions to help us better understand and analyze, what people think of self driving vehicles. Questions 1 - 6 are questions that participants had to answer questions from strongly agree, to strongly disagree. For  the first question it asks if self driving car will benefit society overall. Eighty percent of the class thought that self driving cars will be a benefit to society, only one participant was neutral and one student disagreed, while four students strongly agreed and eight students agreed. Almost the same percentages came with the second question. We asked if the participant would buy a self-driving vehicle if it was available and comparable to a regular vehicle. The results surprised us because we weren't expecting a majority of the people to want to purchase a self-driving vehicle if they were available. Only 27% of the students said they either weren’t sure if they would buy a self-driving car if they were available while 73% of the class said they would. For the next question we asked if an accident is unavoidable if the priority of the vehicle should be to protect its passengers. The majority of the class said strongly agree (5 votes) and agree (6 votes). Two people were neutral and one person disagreed. We expected most people to agree with this because who would want a car that doesn’t protect you? In figure 1 show below shows the results of people in the class who would want a self-driving car to protect themselves.These are the results that we expected with 11 people saying they rather have a car protect themselves instead of other people.



**FIG 1**

In figure two we asked who if participants think that self-driving vehicles would produce an overall benefit to society? The results we got are below in figure 2. We were happy with the results because most people agreed that self-driving vehicles would result in an overall benefit to society because of many reasons including reducing traffic, reducing accidents, senior citizens will be able to drive, and drunk driving should be eliminated.

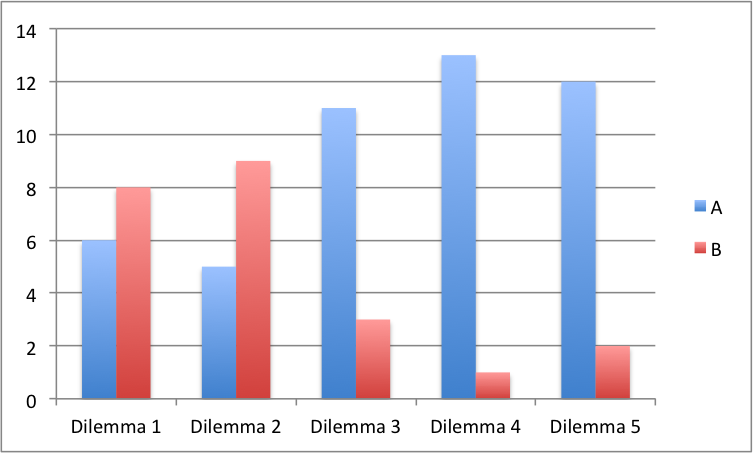


**Fig 2**

The fourth question on the survey asked if an accident is unavoidable, the priority of the vehicle should save as many lives as possible, even if it means sacrificing the passengers. Majority of the students (6) said that they were neutral. The next highest amount said they disagree (4). The next question we predicted that people would not want their self-driving vehicle to sacrifice themselves for the greater good. Eight students were neutral and the next most votes was four, saying the strongly disagree. For the last question being regarding if participants agree or not asked if a pet or animal should always be chosen over the sacrifice of a person. Only sixteen percent disagreed with this and the remaining eighty four percent of the class were saying animals or pets lives should not be valued as the same as a humans which we expected to happen.

For the last two multiple choice questions we asked who should be responsible for the cost of damages in the case where a self-driving car gets into an accident. Participants were allowed to circle multiple answers they thought were necessary. 39 % of the class thought it should be the autopilot software company, 27% said the car insurance company, 17% said it should be the car manufacturer, and 17% said none of the above. For the last multiple choice question it asked if you had an autonomous vehicle how would you spend your time instead of driving. The majority of the participants selected being productive and sleeping which combined for 28%. 10% of the class thought they would use entertainment such as being on their phone or playing games.

The second section of the survey provided information about participant choice in the case of an unavoidable accident. The 5 dilemmas developed were used to measure the effect of occupational status, age and gender, as can be seen in (Fig 3).



**Fig 3**

Dilemma 1(D1) results consisted of 6 participants choosing “A” and 8 choosing “B”, depicting a 57% preference in sacrificing 2 elderly individuals(male and female), young boy and a cat rather than sacrificing themselves.Dilemma 2(D2) results consisted of 5 participants choosing “A” and 9 choosing “B”, depicting a 64% preference in sacrificing 5 toddlers rather than 5 newborns. This is the first major identification of age’s impact on the choice the participant would prefer the vehicle perform.

Dilemma 3(D3) results consisted of 11  participants choosing “A” and 3 choosing “B”, depicting a 78% preference in sacrificing a man and 2 toddlers(male and female) rather than sacrificing themselves. The cat and dog in this dilemma were allowed to survive but there is no relation as to whether this caused the participants choice.. Dilemma 4(D4) results consisted of 13  participants choosing “A” and 1 choosing “B”, depicting a 92% preference in sacrificing 5 newborns rather than 5 pregnant women. This is the second preference in selection by participants which depicted the highest priority as age. Based on this dilemma, it could be assumed that an unborn or pregnant woman should receive the highest priority in any unavoidable accident scenario.

Dilemma 5(D5) results consisted of 12  participants choosing “A” and 2 choosing “B”, depicting a 85% preference in sacrificing a man, 2 thieves, a pregnant woman and another woman rather than a doctor, 2 elderly men, a man and homeless man. These results conflict with the idea of age being the highest priority as the pregnant woman was not saved. It is however noted that a doctor was introduced in this dilemma which may have swayed participants to select “B”.

One of the most staggering results is the choice of participants when self-sacrifice is an option(Dilemma 1 & 3). Participants in dilemma 3 preferred to sacrifice a man and 2 toddlers(male and female) rather than self-sacrifice. In dilemma 1 however, participants were almost equally divided with 57% sacrificing 2 elderly individuals(male and female), young boy and a cat  rather than self-sacrifice. This is a clear indication of age being ignored as in D3, the toddlers were sacrificed in an effort to save the driver/participant. In D1 however it was close in regards to percentage in selection. This however is not the main issue, it is difficult to understand why participants selection in self-sacrifice was decreased, when elderly individuals were at risk.

Based on the results from the survey completed by the participants in the study it was determined that different factors may affect choice in an unavoidable accident in an AV. An example of this can be seen in D5 choices by participants in the survey. Gender however appeared to have the least priority as it seemed to be ignored by participants in their selections.

**Discussion**

The results of the survey gathered enough data for us to see how students feel about self-driving vehicles. A majority of the students said that they think self-driving vehicles would provide an overall benefit to society, which explains to us that more people are starting to believe in this technology. Same for the next question asking if they would purchase a self-driving vehicle if it was available and comparable to a conventional vehicle. A majority of the class over 50% said they would buy a self-driving vehicle which surprised us thinking that people are not completely comfortable with this technology yet. Most participants agreed that self driving vehicles should protect the passengers over other obstacles or bystanders, which we predicted because who would want to buy a vehicle that does not protect yourself.

The last section of questions provided information into whether the factors we specified to analyze affected participant selection. Priority in the case of age, sex and status were measured based on selection to see which factor was favored more by participants. Age is one of the major factors with highest priority based on answers from the dilemmas, however this can change if an occupational status provides much value to society. Age was identified as being of the highest priority based on dilemmas 1-4. This would mean that unborn children or pregnant women were of the highest priority. However age also seemed to be ignored as the loss of life of 2 toddlers had no effect on participants selection. In dilemma 5 however, age appeared to have been ignored and occupational status given priority. It must also be noted that participants preferred to sacrifice to 2 elderly individuals(male and female), young boy and a cat  and save themselves. This is another clear disregard for age as despite their being 2 elderly individuals, the young boys life was still ignored to protect the passenger.

Sex did not appear to have much effect on the selection of participants based on the surveys. A clear observation of this is in dilemma 5, which despite “A” consisting of 2 women(1 pregnant) , selection “B” was still of a higher selection percentage of 85%. Age thus had greater priority in reference to sex.

Analysis proved that the 3 participants that chose “B”, for question 4 (If an accident is unavoidable, the priority of a self-driving vehicle should be to save as many lives as possible rather, even if this means sacrificing one or more passengers) were “strongly agree”, “agree” and “neutral”.  This small group of participants which chose B, consisted of the only individual which selected “strongly agree” out of the entire participants. These individuals were consistent with their answers and chose the most utilitarian approach(saving the most lives).

There are various other studies which have been performed to analyze the integration of autonomous vehicles into a society. MIT has performed studies which assist in identifying the preferred choice for participants in the case of an unavoidable accident. They measured this by the means of a pictorial survey which allowed participants to choose one of two options. They provided the results for each participant which analyzed whether different situations or factors affected their selection.

There has also been studies which focus primarily on the different steps and categorization for the implementation of autonomous vehicles. As self-driving technology improves more vehicles integrate it into their systems. however this will take time for customers to adjust to such a change. There are ideas of providing different levels of autonomy in vehicles rather than a complete replacement of conventional vehicles instantaneously. The lowest level (Level 0) utilizes manual effort of the driver completely. Followed by Level 1 which, has less manual dependency than level 0 and thus requires the human driver performs all remaining dynamic aspects of the driving task. The highest level of 5 , the vehicle is of full autonomy and the driver can choose monitor any changes to input of their preference[7].

**Limitations**

There are different limitations which were encountered during the development and analysis of this research. Correlation and causation were difficult to determine based on the factors measured. The correlation between the target variables sex, age and social status could not always be linked to the causation of participant choice. A mere choice in a dilemma by a participant does not guarantee that this will always be their choice in a different scenario.Despite dilemma 5 appearing to provide the highest priority as one of the “individuals” saved was the doctor, this does not specifically determine causation. Other skilled professionals could receive higher priority based on the participants or their occupational value. The group of students which participated in the survey all had a similar background(Computer Science), thus making it difficult to measure whether this would be preference for other majors or individuals. The participants were also majority males(12) in comparison to females(2), another limitation which affects whether the survey can be effectively used to represent society. If there were more female participants than males, results may have differed.

**Improvements**

There are multiple improvements which could be done to improve this research. One of the major improvements would be to use a more diverse group of students which effectively models society. This would include getting participants of different races,sex, culture and majors to better determine a preference in selection. By using a more diverse group the greater needs or wants for potential customers can better be analyzed. These results will differ not only by the race, sex or culture of an individual but also their personal experiences. More occupational jobs in dilemmas to assist in measuring their value or priority level based on selections.

Another possible scenario of interest would be the integration of intoxication while operating a AV. Liquor intoxication would be the primary focus as DUI instances have resulted in different types of harm to the driver and others. An example of this question would be “Should driving liquor intoxicated be allowed for self-driving vehicle owners?”.Another possible scenario is whether driving licenses would become unecessary for the use of a vehicle.

**Author Contributions**

TJN

For the contributions I talked about my half of the project regarding the survey questions part 1-8. I reviewed them and collected and analyzed the data based on what the participants answered. I calculated percentages and put them into our results section of the paper. We both analyzed the data and wrote the paper equally through google docs to see the changes and how far along the paper and everything is coming along.

C-MM

Contributions in the development of this research article were divided between Tj and I. We utilized Google Docs to manage and organize the paper in real time, as we did in previous projects. We shared detailed insight into how each section could be analyzed to determine any correlations in participant selection. In the effect to assess results based on similarities and numerical data from participants, surveys were placed into different categories based on participants choice in the survey. The last section of the questions were analyzed by me to determine any further correlation and the impact of sex, occupational status and age. I made Fig 3 to allow for better and ease of understanding the case for each dilemma. Presenting a more interesting and understanding representation of the data.

Bibliography

[1]**PLUNGIS, J.**

#### Self-Driving Cars: Driving Into the Future

(Plungis, 2017)

Plungis, J. (2017). *Self-Driving Cars: Driving Into the Future*. [online] Consumer Reports. Available at: https://www.consumerreports.org/autonomous-driving/self-driving-cars-driving-into-the-future/

[2] **A. Shariff, J. Bonefon and I. Rahwan**

"**Autonomous Vehicles Need Experimental Ethics: Are We Ready for Utilitarian Cars?**"

no. 1, p. 15, 2015.

[3]**B. SCHOETTLE and M. Sivak**

**A Survey Of Public Opinion About**

**Autonomous And Self- Driving Vehicles In The U.S., The U.K., And Australia**

Jul-2014

(Jul-2014)A Survey Of Public Opinion About

Autonomous And Self- Driving Vehicles In The U.S., The U.K., And Australia

. [Online]. Available at:

<https://deepblue.lib.umich.edu/bitstream/handle/2027.42/108384/103024.pdf?sequence=1&i> sAllowed=y

[4]

**Belloc, 1967**

Belloc, H. (1967). *On*. Freeport, N.Y.: Books for Libraries Press.

[5]**J.-F. C. A. Bonnefon, A. Shariff, and I. Rahwan**

**The Social Dilemma of Autonomous**

**Vehicles**

(24-Jun-2016)

(24-Jun-2016).The Social Dilemma of Autonomous

Vehicles.Available at:<https://arxiv.org/pdf/1510.03346.pdf>

[6]**H. Abraham**

**Autonomous Vehicles, Trust, and Driving Alternatives: A Survey of Consumer**

**Preferences**

(Limited,2016)

(Limited,(2016).Autonomous Vehicles, Trust, and Driving Alternatives: A survey of consumer

preferences.Available at:<http://agelab.mit.edu/files/publications/2016_6_Autonomous_Vehicles_Consumer_Preferences.pdf>

[7] **LIMITED, E.**

#### The Evolution in Self-Driving Vehicles

(Limited, 2017)

Limited, E. (2017). *The Evolution in Self-Driving Vehicles*. [online] EY.com. Available at: https://webforms.ey.com/Publication/vwLUAssets/ey-self-driving-vehicle-v2/$File/ey-self-driving-vehicle-v2.pdf