Understanding Acceptance of Self-Driving Cars:

New York Times 2013-2018

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Abstract

There's a great deal of uncertainty for the success of emerging technologies, and public perception of the technology can be a determining factor. The idea of self-driven cars has been fantasized over the last three decades, however it is over the last five years that major steps have taken in the development and implementation of the technology. This research is to observe the evolution of the perception of self-driving cars since 2013 and develop certain metrics to understand the trending reaction of public about the technology. This paper identifies crucial issues about public trust on self-driving cars and provides essential management concerns to help increase acceptance of autonomous cars. It also provides a machine learning model to help predict public response to the technology in the future to understand certain steps to be taken at present for positive development. Additionally, it indicates the changes in popularity of self-driving cars over the last five years and highlights major shifts in perception about self-driving cars among people.

Introduction

In the thrill of invention and innovation, transportation has been through a lot of trials and has evolved. According to Burns (2013), "Road transport system has remained stable because of its complexity, so overcoming problems requires rethinking the entire system" (np). One can agree that introducing self-driving cars for transportation does not just require a few tweaks, but an entire change of system is crucial for its effectiveness. For the past decades, significant research has been conducted on the topic of self-driving cars. Kyriakidis (2015) points out a survey of 5000 respondents around the globe to gather opinion on autonomous cars. 69% of the respondents agreed that 50% of the market share will be acquired by autonomous cars by 2050. This is a reflection of how general public is already anticipating a shift in the market and a big change in the transportation is expected.

Over the last decade, numerous companies have emerged with efficient driving software to resolve autonomous driving problems and the competition has triggered massive development. Companies such as, Google, Lyft, Uber, Baidu, Waymo, General Motors, Ford, and others have opened research and development centers primarily in Silicon Valley. In fact, several driverless cars have been running on the streets of San Francisco, learning to drive

autonomously. However, success of driverless cars is not just determined by the progress in their technology but by consumer acceptance.

With all this anticipation and progress, there have been growing ethical and liability concerns about self-driving cars. Gogoll and Muller (2017) talk about an ethical system and whether should it favor driver's personal safety over society's safety in case of an accident. Before deciding on an ethical system, one can argue that it is important to understand what public thinks about such policies and how can that help to go towards the right direction. Automotive and other related industries seem to have convinced themselves to believe that the future of mobility is in the hands of self-driving cars, however they may have underestimated the public misconception and reaction regarding this emerging technology. Siegerist (2000) stresses on the success of technology being determined by risk and benefit perception. One can argue that such assessment comes primarily from public perceptions. Thus, it can be affirmed that public perception about self-driving cars is pivotal for the success of this emerging technology.

Research in observing public perception about self-driving cars has been scarce. Survey's and other methods have been involved but there hasn't been significant research to amalgamate information about public acceptance. Relatively, there has been significant changes in the autonomous industry over the last five years and it seems crucial to understand the pattern associated with the development of the self-driving car. This research provides two new approaches to address this problem. Social media content is used to analyze public perception of driverless cars over the last five years to understand the changing patterns and acceptance of technology. The second approach is based on learning from current data to predict future public reaction to understand ideal steps to be taken currently for a better future for self-driving technology.

Following are research questions:

- How can we measure public perception to understand acceptance of self-driving cars?
- How do events play a role in driving public perception about the autonomous technology?

To answer these research questions, New York Times is taken as a social media platform to provide data for content analysis. Backed by scientific literature, certain metrics are used to understand risk and benefit perceptions. Based on these metrics, data is coded and analyzed to train a machine learning model to visualize future public perception based on current status of the self-driving technology. Additionally, crucial issues and concerns are highlighted to show how public perception has been triggered.

Background

To understand measurables for public perceptions on self-driving technology, a research about technology acceptance models was taken in account. In this study, Davis (1989) talks about how computers were perceived by the public when they were an emerging technology. It is to explain why public accepted or rejected computers? In order to understand this scenario, this research talked about observing public attitudes, intentions, concerns, and perceived usefulness to determine the acceptance of computers. After a longitudinal study on 107 users, it was concluded that attitudes, intentions and concerns were heavily correlated in determining the acceptance of computers. One can agree that simple models like the one indicated above can make a powerful difference when it comes to measuring public acceptance of any emerging technology. In the case of self-driving cars, a model can be used to analyze massive streams of similar data available on the internet through social media platforms. With this data, similar observations and metrics can be designed to determine what factors can be taken in account to measure public perception of self-driving cars.

In the contrary, alternative strategies have been used to have measurables of public perceptions. In 2014, a survey was conducted to gather public opinion of self-driving cars in US, UK and Australia (Schoettle and Sivak, 2014, np). 1533 useful responses were collected from respondents 18 years or older. 56% of people had positive opinions regarding self-driving cars, 28% were neutral and 13% were negative. Compared to UK and Australia, US responses showed higher level of concerns regarding privacy and ethical issues and people were more hesitant to replace their cars with autonomous vehicles. Although, the survey was able to demonstrate that there is a general acceptance of autonomous vehicles, it did not seem to deliver metrics to observe public perception meticulously. There is also a drawback of surveys where people may

not have experiences with self-driving cars, but their bias and fears may have an effect on contaminating the study.

Keeping both past practices in mind, it can be time consuming and less generalizable to conduct a longitudinal study on limited number of users to observe reaction to self-driving cars. On the other hand, surveys may not be able to effectively help in answering the research question which is to be able to precisely measure public perception on self-driving cars. Considering the advancement of social media on the internet and availability of content which may potentially provide public attitude, response and perceived usefulness on self-driving cars, this research veers towards data collection and analysis. Moreover, it leads to talking about how future perception may help in benefiting the autonomous car industry.

Methods

A mixed method was used to collect data and analyze it qualitatively and quantitatively. Initially New York Times Article Search API was used to collect articles, videos, reviews and opinions about self-driving cars from 2013 to 2018. Every data entry had a score metric which was also collected. The score metric is a measure of the popularity of the post which parametrizes the number of comments, recommendations and views.

After forming the dataset, the next task was to qualitatively go through each data entry and code it to a specific category. In order to make sure that the categories chosen were not entirely subjective, risk and benefit perception from previous research was extended (Siegerist , 2000, np). In this research it is explained how risk and benefit assessment from public can be utilized as a reflection of public acceptance on technology. For the purpose of this research and after qualitatively looking at 600 comments on self-driving car posts, four categories were decided to help classify articles. The risk factor was divided into two categories. First category is “concern” and second category is “negation”. Classification of risk into these two categories was necessary because public perception was divided into two segments. People either completely disapproved the idea or showed concern about certain steps being taken.

Similarly, benefits factor was split into “support” and “fantasy”. Perception of benefits seemed divided where there was either progress and development in the technology which was supported or there was fantasy of dreaming or idealizing a future of driverless cars. As a result, following were categories drafted to code all the data entries in the dataset:

1	Support
2	Concern
3	Negate
4	Fantasy

After coding the dataset, quantitative and qualitative analysis were conducted to observe measurables for public acceptance of self-driving cars. The coded categories were observed to see if events had shifted public perception in any way. Moreover, a machine learning model was programmed to predict future public perception in the form of four categories stated. For training the learning model, a pipeline was created to preprocess the text from each data entry, engineer features and compute multinomial logistic regression for classification. For engineering features, the transformer was used on the headline data of each data entry.

Reason for this approach to be effective for measuring and understanding public acceptance is because of its scalability. Public associated with New York Times articles is from all across the world and generalizability of conclusion will be much easier with a large sample size. Using data from social media will be very similar to the data collected by a longitudinal study in the past as one can equally observe public attitude, behavior and concern by analysis of their reactions on social media about self-driving cars. Additionally, the data received is reflective of public which is directly in experience with this technology or the general level of awareness is greater about self-driving cars. This eliminates the bias which seems quite prevalent in surveys. A futuristic approach to understand the importance of steps taken right now to ensure sustainability of self-driving cars is also an interesting point of view. One can predict the consequences of an action and try to eliminate mistakes.

Results

This mixed method was adopted, and approximately 200 data entries were collected, published from 2013 to 2018 using NYT Article Search API. One article from each year was picked and NYT Community API was used to read 600 comments to observe variation of categories required to skillfully classify data entries into metrics for public acceptance. Each row

in the dataset has the web URL, headline, score, published date and category column. Using the methodology stated in the previous section, each article was coded based on the categories given. Furthermore, after processing the dataset, visualizations were conducted to observe public perception.

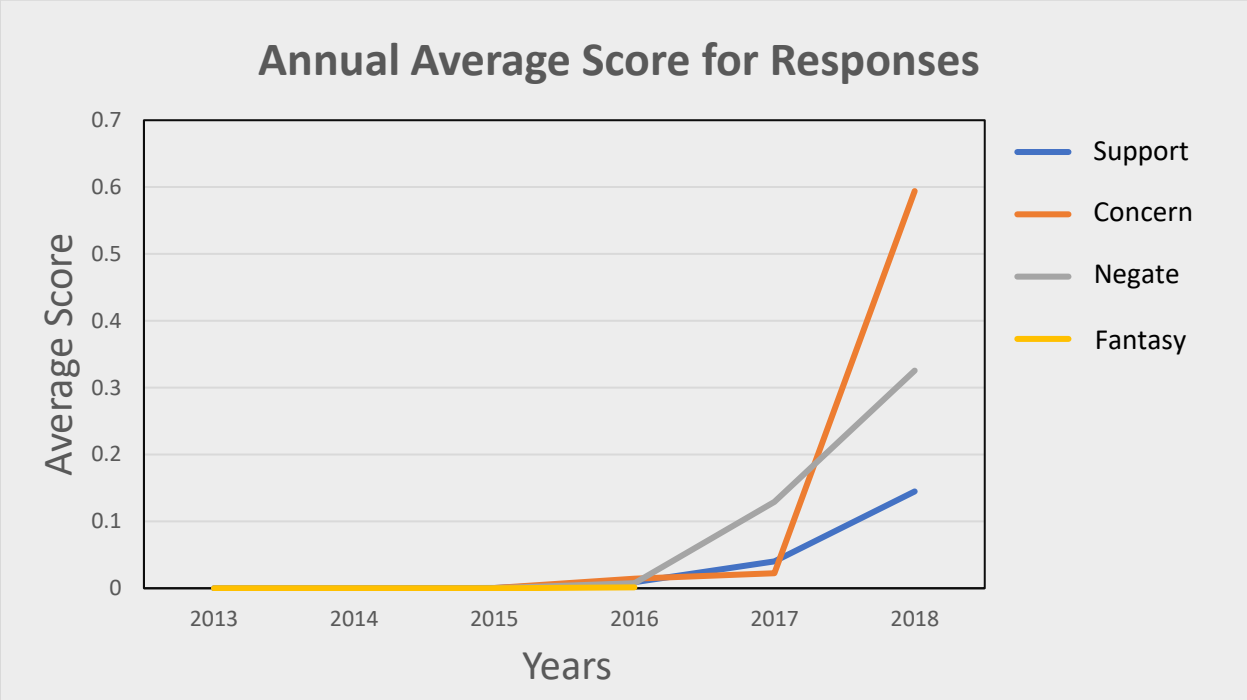

Figure 1: Changes in Score of Articles overtime with filter of categories.

Figure 1 shows the distribution of average score of articles each year filtered by the coded categories. The general popularity of posts related to self-driving cars has increased marginally. This shows that public attention towards the self-driving car as an emerging technology has greatly increased. From 2013-2015, there is some representation of the fantasy category which indicates that initially public fantasized about self-driving cars primarily and were less aware of what the technology was and what it was yet to bring to the transportation sector. After 2016, the increase in support of self-driving has a relatively smaller gradient to negation. After 2017 there is an overshoot of the concern perception and it appears to have increased the most over the course of last year until now. If we look at certain events which may have happened after 2017, it might be possible to understand this overshoot. On March 19th, there was an autonomous car crash in Arizona and slightly later an Uber autonomous car also

killed a pedestrian. These indicates that such events may have triggered this overshoot as public concern and negation seems to have increased in this period of time.

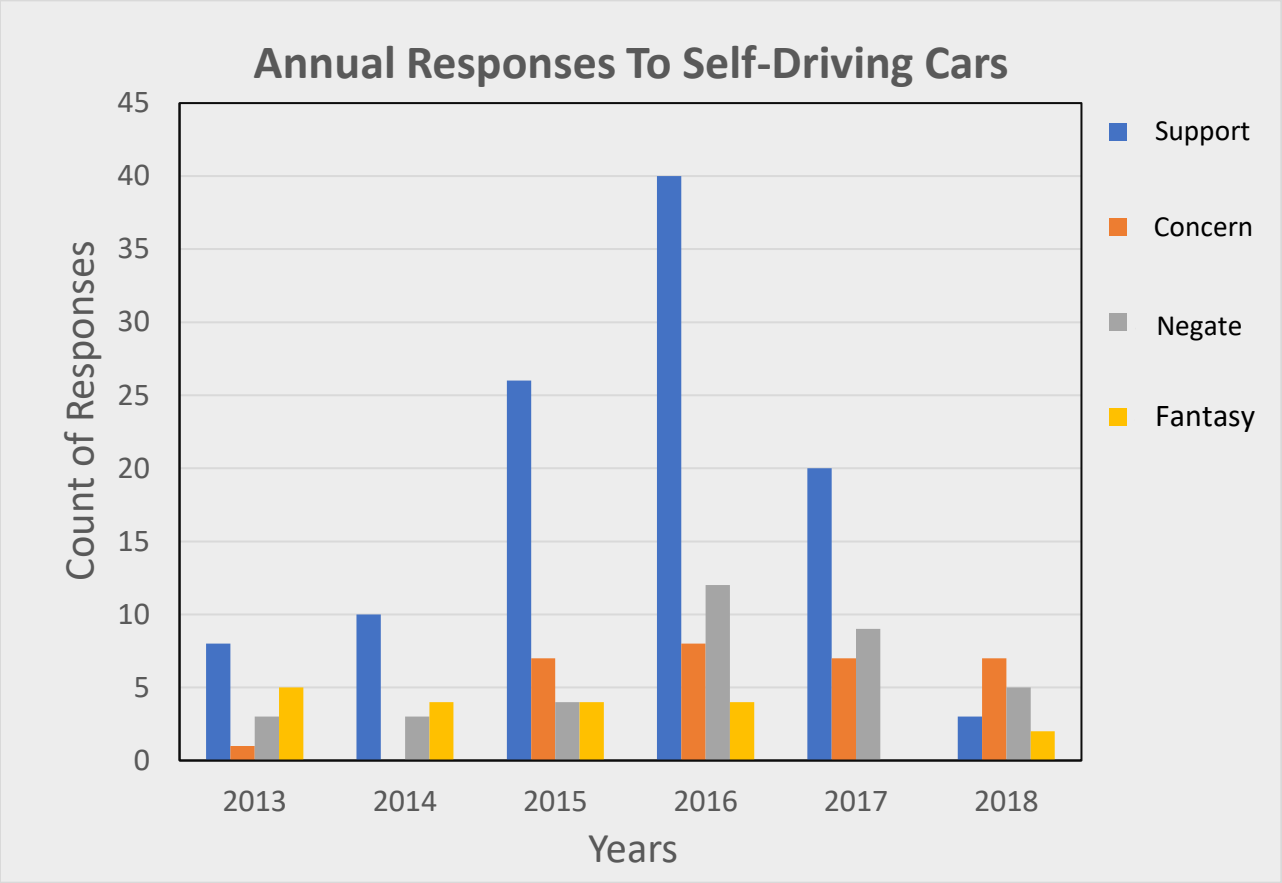

Figure 2: Distribution of Response to Self-Driving Cars over Years

Figure 2 shows the distribution different categories over the last 5 years. The blue bar reflects support and progress and one can observe it has relatively increased until 2016. It seems to have reached to a maximum point because at this time, the US government started incentivizing the development of autonomous cars. Online platforms such as Udacity started educating public about self-driving car and general awareness increased. A lot of startups emerged, and bigger companies started deploying driverless cars on roads such as, Google's Fiat Chrysler program in mid-2016. If we observe the concern and negation bars and compare them before 2016 and after 2016, they seem to have increased. In order to explain this phenomenon, one can deduce that before 2016, self-driving cars were not directly intervening in people's life but after 2016, public started coming in direct contact with the technology. From semi automation systems to fully self-driven cars, there was a greater involvement and thus more

problems arose. Ethical and liability issues started to come across and public concern about rules and regulations started to increase. With high risk bars, it can be seen that the support for autonomous driving technology has reduced massively in 2018 and it is crucial to take steps in making certain changes.

In the end, headlines of each article were preprocessed and used to train a machine learning model to predict future categories of articles to understand the consequences of current measures. Following is a classification report from the learning model:

	Precision	Recall	F1-score	Support
1 (Support)	0.57	1.00	0.73	31
2 (Concern)	0.10	0.1	0.18	10
3 (Negate)	0.10	0.30	0.10	10
4 (Fantasy)	0.20	0.10	0.20	7
Avg./total	0.61	0.55	0.62	58

With a 62% accuracy, it is definitely true that more work is required to improve the effectiveness of this learning model. Limitations regarding this model were primarily because of less data. Cross platforming will be an idea to collect more content and thus be able to improve the performance of the algorithm. Moreover, the headlines of the article do not seem to have enough features to classify categories of articles. Content analysis to the entirety of each article will also be required to further the development of this machine learning model.

Overall limitations of the methods used in this research may have also been the amount of data. New York Times API was not able to provide more articles and coding each article was also quite time consuming. There may have been some spurious affects due to the lack of control external variables. For instance, New York Time's influence on public may have not been consistent over the last 5 years. Public perception or awareness of New York Times itself may have played a role in the data visualized.

Conclusion

This research concludes that measurables for public perception such as, concerns, support, negation, and fantasy, can effectively measure public acceptance of self-driving cars. Moreover, these factors also have a direct impact on the future of self-driving technology. Events such as Uber's car crash can have marginal effects on public perception and thus change the acceptance of technology by significant amounts. The method used for this research was able to eliminate biases of online surveys about self-driving cars. It was also able to meticulously develop metrics for public perception regrading self-driving cars. The machine learning model has the potential to predict future prospects for the industry. However, the process time consuming as manual coding was involved. Limitation on data also hindered the performance of machine learning model. The outcomes of this research maybe difficult to generalize. Although the sample size was large, but more data had to be collected.

In the future, working more on the learning model is necessary. Finding more sources of data to fully scale the outcomes of this research are important. The entire text of articles has to be used to train weights of the training model. Certainly, this research can be extended on these grounds. Moreover, future work also lies in making an open source platform and extend this method to the public and create larger datasets with more outcomes and observations. The learning model can also be trained to predict categories, thus eliminating manual coding.

References

Burns, L. D. (2013). Sustainable mobility: a vision of our transport future. *Nature*, *497*(7448), 181.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: a comparison of two theoretical models. *Management science*, *35*(8), 982-1003.

Gogoll, J., & Müller, J. F. (2017). Autonomous cars: in favor of a mandatory ethics setting. *Science and engineering ethics*, *23*(3), 681-700.

Kyriakidis, M., Happee, R., & de Winter, J. C. (2015). Public opinion on automated driving: Results of an international questionnaire among 5000 respondents. *Transportation research part F: traffic psychology and behaviour*, *32*, 127-140.

Piao, J., McDonald, M., Hounsell, N., Graindorge, M., Graindorge, T., & Malhene, N. (2016). Public views towards implementation of automated vehicles in urban areas. *Transportation Research Procedia*, *14*, 2168-2177.

Schoettle B, Sivak M (2014) A survey of public opinion about autonomous and self-driving vehicles in the U.S., the U.K., and Australia.

Siegrist, M. (2000). The influence of trust and perceptions of risks and benefits on the acceptance of gene technology. *Risk analysis*, *20*(2), 195-204.