Available online at www.sciencedirect.com

SciVerse ScienceDirect

00 (2016) 000–000

Transportation Research Procedia

www.elsevier.com/locate/procedia

International Conference on Mobility and Transport, mobil.TUM 2019, 11-12 September 2019, Munich, Germany

Crowdsourcing the Ethics of Autonomous Vehicles under Constrained Budget and Quality Restrictions

Magdalena Peksa [a,*], Klaus Bogenberger [a], Bipin Indurkhya [b]

[a] *Institute for Intelligent Transportation Systems, Bundeswehr University Munich, Neubiberg 85577, Germany*
[b] *Institute of Philosophy, Jagiellonian University, Krakow 31044, Poland*

Keywords: autonomous vehicles; crowdsourcing; ethical dilemmas; online resource allocation

. Extended abstract

1. Introduction

Semi-autonomous and autonomous technologies are already present on public roads. In the coming years they may contribute to the elimination of traffic congestion, allow everyday commuters more hands-free time and make transport greener by lowering emissions and improving fuel economy. Technology is also promising in that it could reduce traffic fatalities. However, to achieve this vision, certain technological challenges must be met. Among them, there are problems of developing a new traffic control system, efficient management of autonomous mobility fleets, vehicle control and trajectory optimization, to name just a few. What is more, in the course of superseding human driving, driver-less cars may encounter ethically complex problems which they should be able to handle.

Levels of autonomy determine autonomous capabilities of a certain vehicle (SAE International, 2014). At level 2 of autonomy, a human driver is responsible for taking over the control in a dicey situation when multiple courses of action are possible. Once the autonomy level increases, human choices regarding the response to driving hazards, which incorporate moral decision-making, will be consigned to the vehicle. Government representatives together with academics and experts in the fields of technology, law and ethics are working on establishing official guidelines for the development of a moral decision-making system which is able to gain social acceptance. Some general ethical dilemmas are solved in the report of Ethik-Kommission zum automatisierten Fahren, published in June 2017. Saving human life must always take precedence over the protection of animals or property. Another ethical rule forbids any distinction based on personal features in case of accident (Ethik-Kommission, 2017). However, there are cases when ethical norms cannot be clearly standardized. One example would be whether it is permissible to sacrifice one human to save others (e.g., choosing between running over pedestrians or sacrificing the occupants of a vehicle (Bonnefon et al., 2016)).

* Corresponding author. Tel.: +48-511-96-8104
E-mail address: magdalena.peksa@unibw.de

Peer-review under responsibility of the scientific committee of the International Conference on Intelligent Transport Systems in Theory and Practice.

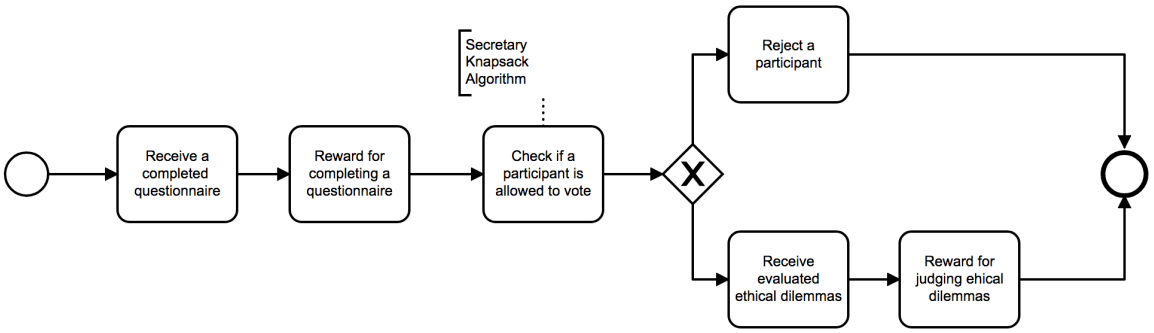

Fig. 1. A graphical representation of the proposed workflow.

Autonomous decision-making may be more persuasive for humans once it reflects their values and judgements (Indurkhya and Misztal-Radecka, 2016). Therefore, researchers have taken an interest in crowdsourcing a human sense of morality and giving it to machines. Among them, there is MITs Moral Machine, an online platform dedicated to the moral decisions regarding autonomous driving technology. It generates traffic scenarios and gathers human opinion on the desirable behaviour of autonomous vehicles. The dataset is limited to the situations where, in the face of a break failure, an autonomous vehicle has to choose between two unfavourable outcomes, sacrificing a group of pedestrians or running into an obstacle and killing its passengers. The participants are presented with 13 dilemmas, which differ in respect of the characters involved.

Publicly available crowdsourcing markets, e.g. Amazons Mechanical Turk, are promising for gauging public opinion on self-developed problems due to their open call format as well as large and diverse participant poll. However, conducting experiments using such services implies a trade-off between the sample size, time, monetary restrictions and the quality of the participants (Kittur et al., 2008).

2. *Research Objectives*

The purpose of this research is to address the above problem by proposing a mechanism for participant evaluation and expert team formation, which could be used in crowdsourcing. Its aim is to minimize the participation of potentially low-performing individuals. More specifically, each participant would undergo a quality assurance procedure before being presented with an actual task. The proposed system differs from existing solutions in that it is capable of providing immediate information on sustainability of prospective participants. To achieve this objective, we refer to the online resource allocation domain (ORA), which aims to find the optimal strategy for choosing the best offers from the ones presented over a certain time horizon. The difficulty is that once rejected, an offer cannot be recalled. According to ORA, our problem can be depicted as the best possible selection of k elements out of an n-element set. In this study, the solution presented by Babaioff et al. (2007), who studied the multiple-choice secretary problem as an unweighted case of the knapsack secretary problem, was used. Two versions of the algorithm, virtual and optimistic, are implemented. As a result, only the most qualified participants take part in a whole study. This, in turn, allows introducing an alternative participant reward policy. Those who successfully pass a quality assurance procedure and complete an actual task could receive higher compensation. In figure 1 the process is illustrated.

3. *Methodological Approach and Expected Results*

The described approach will be assessed by an experiment which goal is to crowdsource opinions on autonomous technology capable of augmenting human moral decision-making. For this reason, five different ethical dilemmas are prepared. Each of the dilemmas includes a driving scenario together with two opposing choices. Also, two graphical

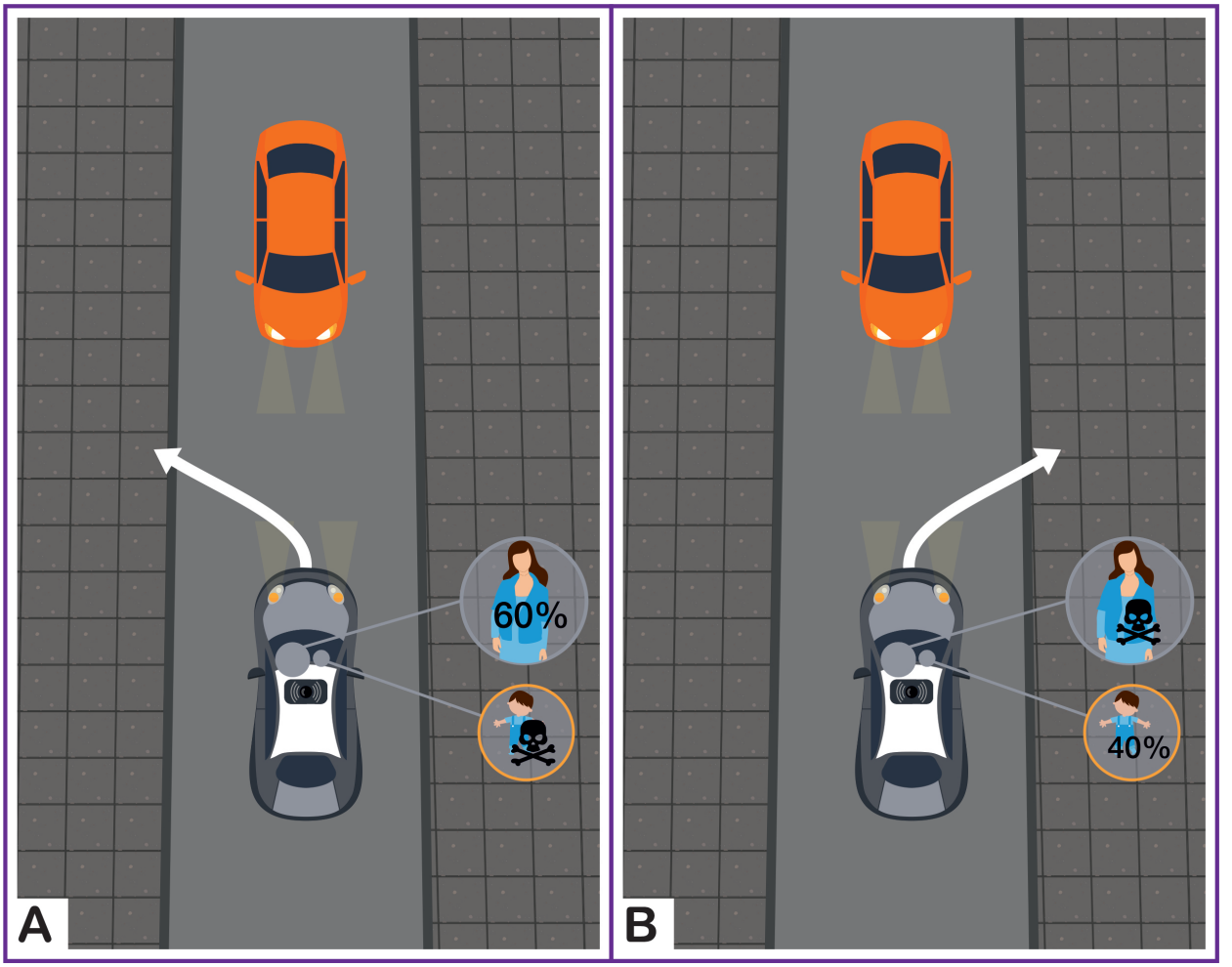

Fig. 2. An example of a traffic situation with two possible outcomes (A - save a woman; B - save a child) which will be evaluated by participants.

illustrations support each example to enhance participants understanding. In figure 2 a sample situation is shown. In this case, the participant has to decide on the reaction of an autonomous vehicle which was on a collision course with another car, whereby the vehicle could choose to save either a woman (A) or her child (B). The woman had a greater chance of survival (60%) but had her car set so that it would always protect her child. Additionally, a participant will be asked to estimate how likely they would be to use a vehicle which was programmed according to their response on a five-point agreement scale.

A prospective participant will be verified by a quality assurance procedure in the form of a questionnaire. The process would resemble a legal proceeding called *Voir dire*, which aims to eliminate individuals unsuitable for serving on a jury during a jury trial (Hans and Vidmar, 1986). The questionnaire is divided into three main sections, *demographic information*, *general quality questions* and *quality questions for drivers*. The last part is directed at those who declared possession of a driving licence. The questions are designed to score drivers who obey traffic rules more highly and eliminate those potential voters who may be guilty of unconscious bias due to having been involved in a road accident or having little knowledge about self-driving technology. The quality score of a potential voter can be calculated according to the tables 1 and 2. The *demographic information* section has no effect on the overall score. The maximum scores are 11 and 16 for drivers and non-drivers, respectively.

Based on the voter quality assessment, two sets of participants (juries) will be selected by the virtual and optimistic secretary-knapsack algorithms. These will be invited to take part in the next part of the study which is judging the

Table 1. The questionnaire: *general quality questions*.

Question	Response
Do you consider traffic regulations as well-formulated?	No - 0 ; Yes - 1
Are there any routes on which you regularly break road traffic rules (e.g. jaywalking, ignoring mandatory signs)?	Yes - 0 ; No - 1
Do you think that there are too many road accidents?	No - 0 ; Yes - 1
Do you find it difficult to obey traffic rules while under time pressure?	Yes - 0 ; No - 1
Do you think that the overall quality of your participation in road traffic declines significantly under powerful emotions, stress or fatigue?	Yes - 0 ; No - 1
Have you ever been injured in a traffic collision?	Yes - 0 ; No - 1
Has a member of your immediate family been injured in traffic collision?	Yes - 0 ; No - 1
Have you ever caused a traffic collision?	Yes - 0 ; No - 1
Do you follow the latest news on autonomous car technology?	No - 0 ; Yes - 1
Do you think that a car equipped with autopilot can be called autonomous?	Yes - 0 ; I don't know - 0 ; No - 1
Do you think that automatic emergency braking systems improve driving safety?	No - 0 ; I don't know - 0 ; Yes - 1

Table 2. The questionnaire: *quality questions for drivers*.

Question	Response
How long have you got a driving license (consider the date of obtaining your first driving category)?	Under 3 years - 0.25 ; 3 - 5 years - 0.5 ; 6 - 10 years - 0.75 ; Over 10 years - 1
How many kilometres in total have you driven?	I don't know - 0 ; Under 10 k - 0.2 ; 10 - 49 k - 0.4 ; 50 - 99 k - 0.6 ; 100 - 500 k - 0.8 ; Over 500 k - 1
Do you regularly drive your family?	No - 0 ; Yes - 1
Do you always keep a safe following distance?	No - 0 ; Yes - 1
Do you think exceeding speed limits can be acceptable under certain conditions?	Yes - 0 ; No - 1

ethical dilemmas. For each created dilemma the aim is to find out if the proposed system is able to select a k-member jury with the best average possible quality. Another point of interest is to check whether the virtual algorithm slightly outperforms the optimistic one, as predicted by theoretical analysis (Babaioff et al., 2007). Finally, the results of the voting on the moral dilemmas together with demographic information of participants will be obtained.

References

Babaioff, M., Immorlica, N., Kempe, D., Kleinberg, R., 2007. A knapsack secretary problem with applications, in: Proceedings of the 10th International Workshop on Approximation and the 11th International Workshop on Randomization, and Combinatorial Optimization. Algorithms and Techniques, Springer-Verlag, Berlin, Heidelberg. pp. 16–28.

Bonnefon, J.F., Shariff, A., Rahwan, I., 2016. The social dilemma of autonomous vehicles.

Ethik-Kommission, 2017. Automatisiertes und Vernetztes Fahren. Technical Report. Eingesetzt durch den Bundesminister fr Verkehr und digitale Infrastruktur.

Hans, V.P., Vidmar, N., 1986. Judging the Jury. Springer, Boston, MA, New York.

Indurkhya, B., Misztal-Radecka, J., 2016. Incorporating human dimension in autonomous decision-making on moral and ethical issues, in: 2016 AAAI Spring Symposia, Stanford University, Palo Alto, California, USA, March 21-23, 2016.

Kittur, A., Chi, E.H., Suh, B., 2008. Crowdsourcing user studies with mechanical turk, in: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, ACM, New York, NY, USA. pp. 453–456.

SAE International, 2014. Taxonomy and definitions for terms related to on-road motor vehicle automated driving systems j3016.