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ETHICAL SELF-DRIVING VS DATA ETHICS: THE NORMS OF COORDINATION AND THEIR CONSEQUENCES

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We are living in the age of self-driving. Level 3 self-driving cars are already released all over the world, and now many companies are struggling to develop level 4. In level 3 and 4 self-driving cars, a special interaction takes place between level self-driving cars and their drivers. Drivers and automated driving systems(ADS) give and take control of their vehicles. The process of driver's taking control back from ADS is called takeover. Engineers and researchers agree that takeover is one of the most critical issues in developing and commercializing safer level 3 and 4 cars. The topic of this paper is the moral consequences of takeover in self-driving cars. First, technical and normative issues of takeover are presented. Since takeover may seriously affect the safety of both drivers and others, takeover itself raises normative concerns. To protect drivers' and others' lives and properties, what should ADS and drivers do? To answer this concern, I will address this concern by summarizing what might be called 'the norms of coordination'. They consist of two norms, one for ADS and another for drivers. Second, it will be argued that fulfilling one of those norms inevitably leads to collecting and storing data from drivers and their vehicles. This kind of data collecting makes takeover a matter of data ethics because it may be considered as micro-surveillance on drivers and their driving activities. Here, making self-driving ethical creates tension with data ethics: for ethical takeover, data collection on drivers and their driving activities is technically inevitable. But such data collection increases the risk of micro-surveillance. As a conclusion, I argue data collection from self-driving cars should be allowed. Such data will accelerate the progress toward more efficient and safer takeover technology. However, the collected data must be used only for research and development and protected from any hacking or unethical use. To this end, data ethics tailor-made for self-driving should be developed. Based on data ethics for self-driving, data privacy laws concerning self-driving vehicles can be legislated.

1. Ethics of self-driving: takeover and the norms of coordination

About a year ago, Honda Motors released Legend, their own model of level 3 self-driving car. Many of those who have been eagerly waiting for real, genuine self-driving cars paid attention to Legend, since it was the first level 3 self-driving car approved by SAE (Society of Automotive Engineers). Though some of the big tech companies like Tesla, Google, or Waymo were advertising themselves as leaders of the self-driving industry, their models were not qualified as level 3 by the SAE standard until Legend was released.[1] Of course, SAE is just one association among others, but the level system of self-driving they established is most widely accepted both in academia and the field. After the release of Legend, nearly every week we can hear news about level 4 or even level 5 self-driving cars. In technology, nobody can be certain about anything. But one thing is clear. The age of self-driving has already arrived. We are living in it.

Instead of unguarded optimism or persistent skepticism about self-driving, I will modestly focus on real-world cases at hand: level 3 and 4 self-driving cars. Technically, level 0, 1, and 2 are not qualified as self-driving cars. Level 0 cars are fully controlled by a driver to perform all driving tasks. There is no automation. Level 1 vehicles merely assist the driver. They can control only the speed or steering but cannot control both at the same time. Level 2 cars differ from

[1] For the latest version, see [1].

level 1 in that they can perform the two primary lateral and longitudinal controls. Level 3 cars can take all the driving tasks on their own under limited conditions. In automated driving mode, the driver does not have to take the wheel or step on pedals. All the driver has to do is to remain alert and be ready to take back control when the vehicle signals for it. Level 3 and 4 differ in only one aspect. When things go wrong or there is a system failure, level 4 vehicles can intervene, but level 3 vehicles cannot. Due to the lack of legislation and infrastructure, in the real world, their automated driving mode can be used under very limited conditions. Level 5 cars are fully automated. They do not need to have even steering wheels and pedals. They require zero human attention and will be able to go anywhere and do anything as human drivers can do. Level 0~2 cars are not self-driving. There is still a long way to go for level 5 to be realistic. For now, self-driving cars are qualified as level 3 or level 4 at best. In this article, 'self-driving cars' basically means level 3 and 4 self-driving cars.

The topic of this article is the moral consequences of special interactions between human drivers and self-driving cars In level 3 and 4 self-driving cars, drivers and automated driving systems(ADS) give and take control of their vehicles each other. In certain situations, such as traffic jam or long, straight, wide-open highway, if a driver wants to, the driver can choose self-driving mode and let the ADS drive the vehicle. However, when it encounters challenging road, traffic, or weather conditions, ADS signals the driver to take the wheel. The latter, taking control back from ADS, is called 'takeover'. Engineers and researchers agree that takeover is one of the most critical issues in developing and commercializing safer level 3 self-driving cars. For a smooth and safe transition, two conditions must be met. First, the signal for transition must be sent from ADS to the driver. This signal is called TOR(takeover request).[2] Second, TOR must not be too late. The time left to get into so dangerous situations after TOR, TORlt(takeover request lead-time), must be precisely calculated[2, 3]. If TORlt is too short, it is possible that the driver would not be in a position to manually drive the vehicle even when it is already in a situation where ADS cannot handle. This unstable and dangerous situation might be called 'the control gap'. To commercialize level 3 self-driving cars, the control gap must be closed. But closing the control gap is not just about commercialisibility. Leaving it open may seriously affect not only the driver's and the vehicle's safety but also others' and surroundings'. In this sense, closing the control gap raises normative concerns: to close the control gap, or to make takeover safe, what should ADS and the drivers do? This is the moral question that takeover raises.

To address this question, I have suggested the norms of coordination[4]. The norms of coordination consist of two norms: one for ADS and another for drivers. The norm for ADS is the norm of personalization, which states that ADS must be as personalized as possible for each driver. Why should ADS be personalized? As stated above, the crucial issue in safe takeover is calculating TORlt. TORlt is a sum over three time periods, driver's perception-response time for TOR(T1), mental processing time(T2), and settling time(T3). In all of these times, there are individual differences. For instance, disability and age may affect T1, T2, and T3. Further, driving skills and experiences would affect T2 and T3. But the most crucial factor is drivers' states. For a more detailed description of takeover and transition time, see Figure 1.[3]

[2] TOR usually takes a form of multimodal signals, for example, visual + sound signals.
[3] 'Driver readiness' means alertness or attention level.

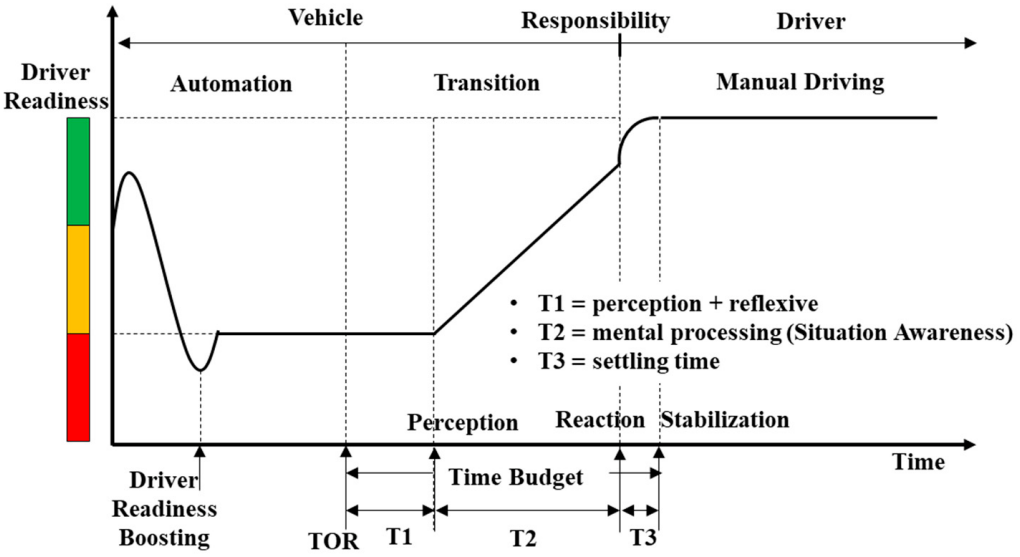

Figure 1. Concept of take-over transition time[5]

To calculate TORlt precisely, ADS must take account of how a driver is. Both physical and mental states are important. If a driver's head is turned to the back seats, it will definitely slow the driver's perception and reaction and affect T1. If the driver's attention level is low, it will affect T1~T3[6, 7, 8]. For precise TORlt calculation ADS must know detailed personal information about exactly in what state the driver is[9]. The norm for drivers is the norm of compliance, which states that drivers must comply to requests of ADS. Why should drivers comply to requests from ADS? To precisely calculate TORlt, ADS needs precise information about drivers. Providing false or unreliable information or even refusing to provide any information would necessarily disturb calculation of TORlt. From ADS's perspective, it is a sort of 'deception'. If a disabled driver does not comply to ADS's request of providing information about disability, such incompliance will make ADS miscalculate TORlt. The calculated TORlt may be actually too short for the driver, and this may open the control gap. Thus, for the sake of safe takeover, drivers must provide all the information ADS without any intended or unintended deceptions. That is, they must comply to requests of ADS. Both norms are not just about safety technology. They are ethical in nature, because any violation of them can cause serious harm to others' lives and properties. Also, both norms vividly show that the ethics of level 3 self-driving cuts both ways. ADS or drivers alone cannot guarantee safe takeover. To achieve safe takeover, both ADS and drivers should cooperate or coordinate with each other This is why they are called the norms of coordination. What should ADS and the drivers do for safe takeover? Coordination of personalization and compliance may be an answer to this question.

2. The norms of coordination vs data ethics: tension in the ethics of self-driving

Suggesting what should be done is one thing, and articulating how to do it is another. Drivers' compliance may be a matter of personal choice. ADS's personalization, however, is a matter of technology and design. As explained in Section 1, personalization of ADS is essentially about

how to gather and process detailed information about drivers. And to gather and process information about drivers, the first thing ADS should do is data collection. Without data about a driver's state and driving activities, ADS cannot do anything. Collecting data about the driver and driving requires monitoring how the driver is and how the car is. One of the most crucial technical issues in developing and upgrading level 3 self-driving cars is driver monitoring technology. For example, if the driver is distracted by non-driving related-tasks(NDRT) or tired, ADS should know about this to calculate TORlt. Besides calculation of TORlt, data must be collected to prevent the driver from being 'out-of-the-roof', a situation where the driver cannot be in a position to perceive and react to TOR. If the driver is falling asleep, passing out, extremely unstable, or deluded, sending TOR or calculating TORlt would not work. The driver's state must be managed not to encounter such situations. Effective data collection for driver monitoring is the key to personalization of ADS and risk management as well. To successfully personalize ADS, data about drivers and driving activities must be effectively collected and processed.

What kind of data should be collected? Both drivers and their driving activities should be monitored. Most of all, biometric data seem to be necessary for driver monitoring. For instance, eye and head movement and direction of face would be crucial. They tell ADS where the driver's attention is headed and whether the driver falls asleep. Indeed, camera technology for eye tracking and facial recognition is very popular in the field. Body posture and gesture are also important, because they may affect the time needed for the driver to reach the wheel and step on pedals. This time partially determines the driver's perception-response time for TOR and settling time. In fact, in some models of level 3 self-driving cars, if drivers recline their seat over a certain degree in automated driving mode, alarm goes off. To monitor affective or emotional states of the driver, facial expressions should be recognized. Since emotion and affect are closely related to vital signs of body, heart rate, blood pressure, body temperature, and even EEG can be measured in real time. These data can be collected by built-in sensors or wearing devices. EEG is also important data for attention management for the driver. Further, driving data are required to monitor driving activities. Speed, distance between surrounding cars, acceleration and deceleration should be measured and stored in real time. Of course, ADS needs these data to calculate TORlt. These data are about driving activities and states of the car. But they also show states of the driver. ADS may infer how the driver is from how the car is. Sudden acceleration and deceleration can be a reliable sign that the driver is unstable. In short, monitoring drivers and their driving activities requires biometric and driving data.

Then, the norms of coordination can be reformulated in terms of data collection. The norm of personalization says that ADS must be as personalized as possible for drivers. We have seen that such personalization implies collecting data about drivers and their driving activities. Thus, to fulfill the norm of personalization, ADS must collect biometric and driving data. The same goes for the norm of compliance. The norms of compliance states that drivers must comply to requests of ADS. What would ADS request drivers? It would request certain personal information, such as disability and age. To monitor drivers and driving activities, ADS must collect biometric data of drivers and driving data of their cars. If so, to fulfill the norms of compliance, drivers must let ADS collect biometric data of themselves and driving data of their cars. The norm of personalization turns into the norm of data collection on drivers and their driving activities, and the norm of compliance becomes the norm of providing biometric and driving data to ADS. The norms of coordination are translated into 'the norms of data production'.

This is where ethics of self-driving and data ethics meet. For self-driving cars to run safely and ethically, a tremendous amount of biometric data must be collected through cameras, sensors, and wearable devices installed in the vehicle. ADS continuously collect data about how drivers are and how they drive. Collecting data about drivers and their activities, ADS learns a lot. It knows too much. ADS knows everything about where the drivers have been, what they did while driving, and how they drove their car. Considering the nature of the data collected by ADS, drivers may take such data collection as serious invasion of privacy or micro-surveillance on their body and behaviors. Once we choose automated driving mode, almost everything about our body and our car is collected, processed, and stored by ADS. Also, there are many security issues regarding data collection. Nothing is easier for self-driving car companies to use those data. The companies will know what ADS knows. Nobody can be sure what they will do with the data. Further, if there are data and information, there are hackers. The more data are collected and stored, the higher the risk of hacking increases. The data collected by ADS can be hacked and if placed under the wrong hands can lead to serious crimes. All the issues of data ethics are revived in the case of self-driving.

It must be noted that the problems mentioned above are unique to level 3 and 4. Technically, issues concerning biometric data occur only in the case of level 3 and level 4. This is because the need for biometric data collection comes from the normative concerns about takeover, and takeover only takes place in level 3 and 4 self-driving cars. No other level self-driving car involves such interaction. Level 1and 2 self-driving cars are just partially automated' by definition. There cannot be any automated driving mode in those levels. Since there is no automated driving mode, giving or taking control cannot occur either. In level 3 and 4, ADS has to monitor its driver's state because when the time comes, it has to return control of the car. But in level1 and 2, cars cannot take control in the first place. This is the reason why they usually are not taken as genuine self-driving cars. What about level 5? Level 5 self-driving cars are fully automated or driverless. Thus, the interaction between drivers and ADS is eliminated. And this is the reason why level 5 self-driving cars do not involve driver monitoring. There is no one to monitor.

Also, note that the problematic consequences are originated from normative concerns about takeover. For ethical level 3 and 4 self-driving, safe takeover must be achieved. To achieve safe takeover, ADS and drivers should follow norms of coordination. Close technical observations presented above, however, show that fulfilling norms of coordination implies to allowing data collection on drivers and their driving activities. Some may think allowing ADS to collect biometric and driving data is in itself unethical, because such data are so personal and sensitive that misuse of them could do serious harm to others' rights, properties, and lives. Can we really accept these consequences of norms of coordination? If we cannot, we have to admit that ADS and drivers may refuse to follow norms of coordination. Nonetheless, without those norms, there seems to be no way to handle the risk of the control gap. As emphasized in Section 1, reducing the risk of the control gap to make takeover safe is a normative matter. When it comes to level 3 or 4 cars, ADS must reflect individual differences and drivers must comply with requests of ADS. They are like duties for ADS and drivers to follow. Not fulfilling those duties seems unethical, since it is to risk others' lives and properties for one's privacy and security. In so far as ADS and drivers are morally obliged to prevent the control gap, it is inevitable to fulfill norms of coordination. It is normative and ethical concerns that takeover enforces norms of coordination, and norms of coordination do not go well with those of personal data protection.

The technology of takeover should be taken seriously. To know how ethical self-driving is entangled with data ethics, one must understand how takeover actually works. If there was any

technically possible way for ADS to monitor drivers' states without collecting biometric data, and if monitoring driving activities did not require driving data, data ethics would not matter. However, monitoring without data appears to be technologically impossible. Without biometric data, ADS gathers no information about drivers' states. Collecting, processing, and storing driving data is the only way to have information about driving activities. As takeover necessarily involves data, data ethics always come in. Ethical self-driving will be a matter of data ethics, because takeover cannot be done without data collection.

If the argument so far is on a right track, there is tension in ethics of self-driving. On the one hand, the attempt to make self-driving ethical necessarily requires data collection and easily turns into micro-surveillance. On the other hand, it is highly likely that ethical concerns about data collection would hold back progress on the achievement of safe takeover and prevent self-driving from being ethical. For safe takeover and ethical self-driving, the norms of coordination must be fulfilled. However, the technology required in fulfilling those norms inevitably raises the risk of unethical use of personal data. For personal data protection, data collection should not be allowed. Or, it must be legally regulated at least. Banning or regulating data collection is likely to increase the risk of the control gap. To avoid the risk of the control gap, one should raise that of micro-surveillance and might face many security threats. To avoid the risk of micro-surveillance, one should raise that of the control gap by giving up making takeover safe.

3. Data ethics for self-driving: what is going on and what has to be done

Even though there is tension between ethical self-driving and data ethics, it does not have to be seen as an unsolvable dilemma. Self-driving is not merely an example for thought experiments or ethical debates. It is a pressing real issue. Thus, we have to assess the tension in ethics of self-driving not only ethically but also realistically. One may find a way to ease that tension by considering what is going on and what has to be done. What is actually going on in the self-driving industry tells us what has to be done for ethics of self-driving.

Given that various driver monitoring technologies are already used in self-driving vehicles, banning data collection from self-driving cars is unrealistic. Engineers and researchers in the self-driving industry are developing software and hardware for more comfortable and safe self-driving cars. Without data about drivers and their driving activities, nothing can be done in safe takeover. And without safe takeover, no one would use automated driving mode. In this sense, to ban data collection is just to ban self-driving cars. Further, data collection may provide extremely valuable resources for more efficient and safer self-driving vehicles. The more data are collected, the faster self-driving cars evolve. If so, banning data collection might be giving up the valuable opportunity to make better self-driving cars. As noted in the beginning of this article, we are living in the age of self-driving. People already drive self-driving cars and allow ADS to gather their data. All things considered, banning data collection seems anachronism.

Data collected from self-driving cars can be used for various purposes. Yet, this powerful resource comes with challenges. To meet these challenges, the most important thing would be data ethics tailor-made for self-driving. Takeover is in itself a matter of data ethics. Those who are involved in the development and production of self-driving cars, such as engineers, programmers, and data scientists, are likely to interact with data about drivers and their driving activities daily. Data ethics are of the utmost concern to them. They must be well-versed in basic concepts and principles of data ethics, which encompass the moral obligations of gathering, protecting, and using personal data. While they may not be directly responsible for designing or implementing code, managing a database, or training a machine-learning algorithm of ADS,

understanding data ethics can help them to detect any unethical collection, storage, or use of drivers' data. Catching unethical cases is crucial not only for protecting drivers' data but also for saving companies from legal issues. To this end, people in the self-driving industry should be familiar with general issues in data ethics, consent, transparency, privacy, etc. By adapting and translating data ethics into technical contexts of self-driving, they will have data ethics for self-driving. And based on data ethics for self-driving, data privacy laws concerning data collection in self-driving vehicles can be legislated. Since developing self-driving cars always involves intensive market competition, merely establishing and training a new field of ethics will not work. To properly and effectively regulate the use of data, laws concerning data collection must be legislated. Well-established data ethics and data privacy laws, once they are well-established, will effectively resolve the tension between ethical self-driving and data ethics.

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