

# **Ethics and Social Implication of Intelligent Transportation System**

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On my honor as a University Student, I have neither given nor received  
unauthorized aid on this assignment as defined by the Honor Guidelines for  
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Approved \_\_\_\_\_ Date \_\_\_\_\_  
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## **I. A letter to Intelligent Transportation System:**

From the creation of wheels which moved the massive blocks of Pyramids to the success of fully autonomous vehicles, human beings have come a long way of trying to make the transportation faster, safer, and more comfortable. But sometimes I couldn't help wondering when I was stuck in a traffic jam: isn't it absurd that we created vehicles that can reach 130 miles per hour but we drive them at the same speed as 19th century horse carriages? For decades, our remedy of congestion was simple: build new roads or enlarge existing ones. But no matter how hard we tried, the transportation still can't efficiently serve, and I think it's because our traffic is always two dimensional on the surface. I vision the future of traffic to be a three-dimensional vascular system where communication is both collective and individual. It's like liquid, like our blood pumping in the veins which never stops. The more robotized our traffic grids will be, the more organic and alive its movement will seem to be. Or does it?

On the other hand, I also fear about this age to come. A digital machine following a set of instructions is a trivial task, but implementing these processes in our analog, non-deterministic world adds a layer of complexity. Can we trust an absolute rational machine with no emotion to rule a city's traffic? Or are we supposed to suffer in this inefficient operating system and bear with it? With such a huge amount of big data gathered by Tech tycoons, are they making our lives simpler or are we losing autonomy to make decisions? In 1984, George Orwell warned that we would be overcome by an externally imposed oppression. But from how I see it, people will come to love their oppression, to adore the technologies that undo their capacities to think. The trend of smart cities is necessary and unavoidable as technology advances and the population grows, but we have to be wary and cautious about the process of application by considering both human and nonhuman factors involved. Maybe one day the traffic around the world becomes blood flow that never gets clogged and the efficiency as well as the transmission of data becomes unparalleled. But I hope behind those developments there's still warmth and humanity, there's still ethical and social constraints that limit and nurture the growth of artificial intelligence.

## **II. Introduction:**

Nowadays, information and communication technologies (ICT) have been proposed and implemented everywhere in smart cities. They have become more than isolated systems, instead, they are evolving into an ecosystem which integrates sensors, robots, surveillance control tools, software, and even humans. The extensive use of information integration and cloud computing has led to a lightning speed of data sharing. To some extent, data has become an integral part of our lives which some may consider invasive. In an idealistic scenario, gathering information poses no threat to anyone and all smart city residents can benefit from it. However, in the real-world case, data comes from various sources and may carry private and sensitive information which poses threats to the well-being of smart city residents. Issues with regards to ethic and data privacy are always present yet few people have tried to minimize the risk. Policy makers want to know the preference of the populi and use technology to support their decision-making processes, businessmen are more concerned about making more profit, and technicians as well as developers are focusing on the technologies and benefits of those new technologies. The major players who are concerned about ethical use of data are the residents of the city. However, they have the least

control over who collects the data, how it is used, and what it is used for. As a consequence, it becomes a serious and important issue to consider the ethics in smart transportation applications.

Among the development of smart transportation designs, two nations stand out: The United States and China. Both countries have developed rigorous investment in big data driven, AI-facilitated transportation innovation, based on distinctive political, legal and economic systems as well as a “Me” vs “We” cultural difference. Most importantly, the mixture of those different beliefs yield a very different attitude towards the ethical conducts of artificial technology used in smart cities. This paper will research and compare the data and responses from both countries to study the applicability of ICT systems in a global market.

What are the social, political, cultural factors, as well as ethical and legal considerations that shape the design and implementation of transportation systems in the US and China? To address this question, the project views smart transportation as a socio-technical system composed of not just autonomous vehicles, but also vehicular communication systems and legislative components.

The research started with the foundation of reviewing works that considered ethics and studying how much emphasis there is on the ethical issues involved when smart city transportation applications are considered. Thus my methodology relied on finding scholarly work discussing ethics within the context of smart cities. I first identified representative smart city applications and use them to highlight the challenges and the types of ethical issues that may be involved. I investigated and compared several current and proposed projects in China and America for smart cities and attempted to identify how ethic issues may impact such projects and their outcomes. Since going smart in transportation development mainly involves data collection and analysis, it becomes of significant importance because most of the data pertain to humans and their lives. Using the survey results I gathered, I was able to create a list of challenges that could lead to ethical problems. For example, when talking about the vehicular communication system, it becomes evident that issues like who knows what about residents and what rules are used to regulate communication must be clearly defined. This paper can be considered an attempt to shine a light on the ethics of smart transportation applications and start a serious discussion of these issues for current and future projects.

### **III. Literature Review:**

In order to study the pros and cons of smart transportation application as smart cities continue to grow, this section tries to build a connection between applications for smart transportation and the impact they make in terms of ethical conducts. The following are the most significant four sub sections: autonomous vehicles, vehicular communication systems, GPS and legislative resistance. The examples are by no means comprehensive; however, the selected projects in the literature review can be considered a representative sample of different areas where smart applications can contribute towards building a smart transportation system. Some of the examples are actual projects that have been applied, while others are in their design or research phase. However, collectively these projects offer a general view of what technology offers and as a result allow us to identify where and how ethical issues may arise.

### *I. Autonomous Vehicles*

In many developed countries, transportation accounts for six to twelve percent of a nation's Gross Domestic Product. The cost expenditure of traffic congestion alone is estimated to be more than \$200 billion in four nations: the United States, the United Kingdom, France and Germany [Huawei,2016]. Thus solving traffic congestion issues is imminent in many nations. In China, a recent survey reported that 74 percent favored "the rapid transportation of automated driving in their country". On the other hand, implementation of smart transportation systems in other countries received more resistance. For instance, according to a study from Bosch, in Germany, 33 percent of Germans prefer self-driving cars and only 31 percent of Americans supported the rapid expansion of autonomous vehicles in the United States [Bosch,2017].

One potential solution to solve the traffic problem is autonomous vehicles. Tech magnates like Google, Uber and Tesla are currently experimenting with potential usage of such systems. A report from U.S. News points out that 94% of transportation accidents are caused by human error (US News), which makes self-driving vehicles a favorable alternative for private transportation. However, some recent incidents have posed doubts on the ethical and safety measures of autonomous vehicles. For instance, a self-driving Uber car killed a woman crossing the street in Arizona in March 2018 [Wakabayashi,2018] . The incident brings up an ethical question: Who is liable in a self-driving vehicle accident? Is the programmers who created the software culpable? Is the back-up driver who wasn't in control of the vehicle responsible for this accident? These questions are still left unknown. Another dilemma that autonomous transportation faces is how to choose who or what to crash into when an accident is unavoidable [Clever,2018].

### *II. Vehicular Communication Systems*

Vehicular Communication systems focuses on sharing data in a limited space in order to analyze and predict road conditions and improve traffic efficiency. For this type of application to work properly, the exchanged data is required to be accurate, relevant, and meaningful during the communication. However, this open source of data makes it vulnerable to cyberattack on data integrity. For instance, a hacker could perform numerous transmissions with different cookie location and platform keys to represent multiple vehicles, thus falsifying data and force certain drivers into traffic jams. Another issue arises as an authentication problem. When multiple vehicles are exchanging information, there's no way to instantaneously prove the accuracy of this big data, thus leaving ethical and legal issues unanswered. On the other hand, China has a more positive attitude towards the experimentation of vehicular communication systems. Most of the decisions involved in ICT construction are pushed forward by country legislatures from a top-down perspective. In February 2017, the State Council of China released the "13th Five-Year Plan for Modern Comprehensive Transportation System Plan". It calls for the large scale installation of ICT systems onto transportation systems in order to create a safer and more integrated commute system. Tech companies and city councils that don't respond well to the national summoning will receive low funding for infrastructure construction while communities that react positively from a bottom-up approach will receive more funding for city planning.

### *III. GPS*

Geographical Positioning Systems has become the most common and acceptable way of smart cities development which offers traffic condition sharing and location-monitoring functions.

Thus it becomes imminent to examine who is able to use location sharing data and how much information can be retrieved from those devices. GPS tracking has raised ethical concerns, since the technology has become so mature that it is capable of providing precise and personalized tracking information [Elmaghraby,2014]. This data is used mostly instantaneously but the traces it left behind can be stored and retrieved long after the data was collected, thus creating potential threats of breaching of privacy. The Supreme Court has forbidden the use of GPS tracking by law enforcement unless there's lawful and appropriate reason to do so. However, the definition and condition of "appropriate reasons" is still ambiguous which may lead to infringements of overusing this power.

#### *IV. Legislative resistance*

In the United States, smart cities proponents need to deal with fifty state rules which may differ dramatically. According to Chris Urmson, CEO of the start-up company Aurora Innovation, since 2015, 23 states have introduced 53 pieces of legislation that affect self-driving cars—all of which include different approaches and concepts. Five states have passed such legislation, and although all were intended to assist the development of the technology in the corresponding state, none of those laws shared common definitions, licensing structures or sets of expectations for what manufacturers should be doing [Urmson, 2016]. In order to meet the regulations of the National Highway Traffic Safety Administration, state legislators in America still have a long way to go. Considering safety and economic benefits and new regulations for autonomous vehicles, manufacturers generally are given five to ten years to adjust to new safety standards. On the other hand, due to the particular political situation in China, execution of smart transportation systems has become fairly easy. To better address the interdisciplinary coordination for the development of smart transportation, vehicle connection system and autonomous driving industries, China has set up a special committee to set up standards and boost connection across industries. It is responsible for advancing the development and application of the integration of 5G technology with the connected vehicles; and optimizing security management to ensure defense capability.

Current literature shows that there is a lack of an integrative understanding that combines different technical considerations with the legal and ethical concerns of regulating these innovations, No matter how much ethical instructions those systems carry, judgements and skepticism will arise after such incidents, which would eventually transform into constraints that limit the development of autonomous systems. It is extremely important to make sure autonomous systems are unbiased towards pedestrians or vehicles and are incapable of learning discriminations when confronting ethical dilemmas.

#### **IV. STS Framework:**

As shown in Fig.1. below, smart transportation is developed on the basis of smart infrastructure that includes not only multi-modal transportation connectivity but also automatic traffic signals, and toll collection stations. Data integration drives the system, collecting and incorporating weather and traffic data, as well as information from government agencies. On top of data integration, smart services provide commuters with different benefits, such as vehicle locating

service, smart parking allocation and route condition alerts. The framework is expanded by incorporating ANT diagram, which takes human actors into account, combining vehicle companies, commuter feedback and AI software development companies into a holistic socio technical system to support the conclusion. Also, users, designers, and technology are combined together to use technology mediation in order to analyze the ethics of smart transportation.

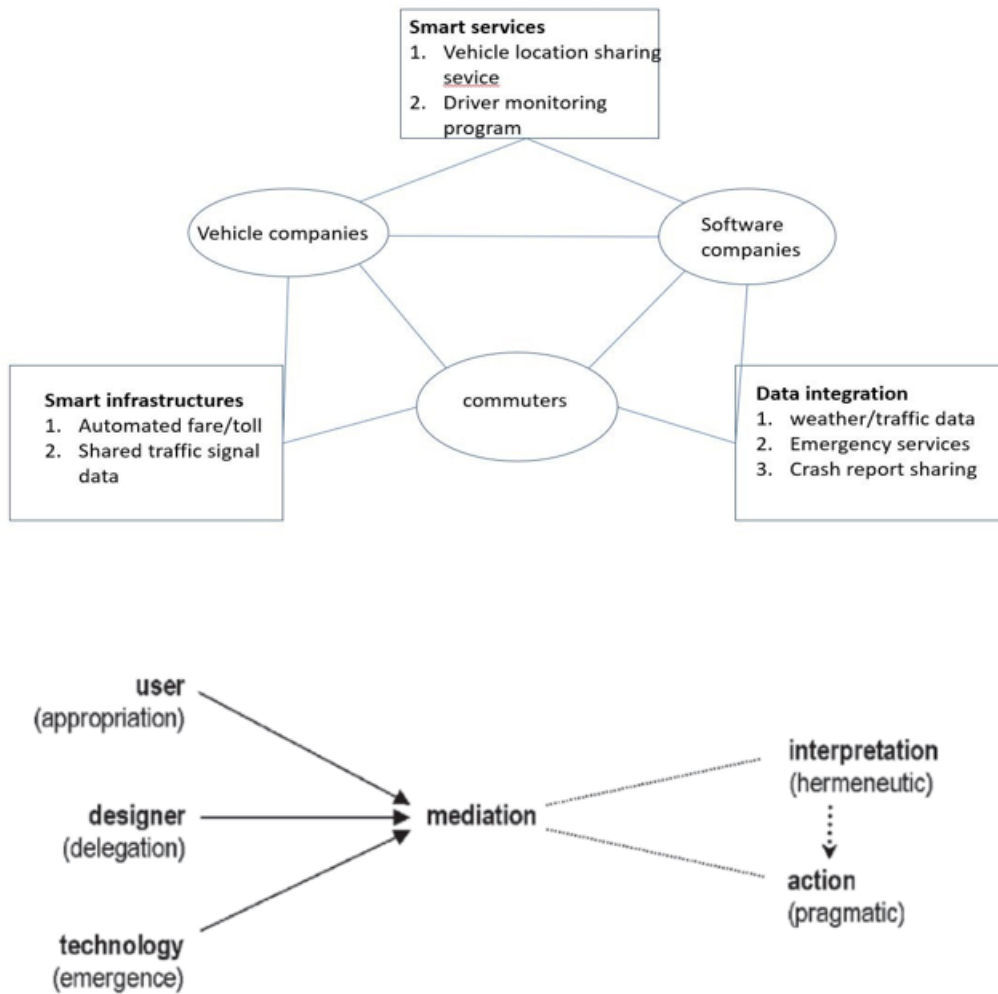


Fig. 1 ANT framework

**V. Technology Mediation on the smart transportation ethics in US and China**

To further understand big data’s ethical, social and technological constraints in smart transportation development, further research needs to be accomplished. Three methods have been conducted in order to achieve a holistic and impartial conclusion for ethical concerns in smart transportation system. First, a survey in both English and Chinese versions has been delivered to university students to compare the ethical concerns of the following smart transportation applications listed in Table 1. Second, I conducted field trips to Charlottesville legal legislations to study the impact and challenges from a government’s point of view. Third, interview information from Tsinghua University and Zhejiang University has been collected and documented in order to provide a picture of cultural factors in the development of smart transportation systems in China.

Table 1. Ethical concerns with respect to smart transportation application

Smart City Application	Application Challenges	Ethical Concerns
Autonomous Vehicles	Skill Inequality Wealth Inequality Data Access Data Sharing	Ethical questions regarding who gets access to such services arise. Data collected could be accessed or shared in inappropriate ways.
Vehicular Communication	Data Collection	This type of application usually operates on demand and does not have large storage of data. However, data collection may be misused when vehicles gain access to other vehicles OBD control units.
GPS tracking	Data collection	GPS tracking is mostly used and
	Data Access Data Sharing	accepted by the public, the main concerns are related to the proper methods of collection. Issues arise with data access rights and sharing.

**VI. Research Methods:**

1. Instruments

In order to measure the attitude towards ethical concerns about smart transportation, ten questions were devised specifically for citizens and students in Charlottesville and Hangzhou University for comparison and analysis. The first two questions asked about their basic information, including gender and age. Following the basic information were two specific questions about the most common way of commuting in Cville and Hangzhou, the scale and population of those two drastically different locations will probably yield distinctive results. The next two questions are more specific and more relevant to the ethical concerns with respect to people's conception of privacy and data sharing services. The following question I asked about the most important actor in implementing and proposing AI technology on transportation. I would like to see whether people's perception is lined up with facts listed in the literature review section. The last three questions are all about autonomous vehicles and the potential ethical threats they bring about. Those three questions are step by step that go deeper and further in order to find the biggest concern with regards to smart transportation applicants.

## 2. Procedures

The questionnaire was distributed to people in two ways. For people in Charlottesville, it was sent out into University of Virginia's Facebook discussion group as well as physical copies which were distributed randomly on campus in order to ensure the universality of the survey. The other half of questionnaire will be sent out into the wechat group (the Chinese communication app) for Zhejiang University students. I'm expecting a sample of 100 people from both sides so that I can compare the data on a larger scale. The data was organized automatically by the software and edited manually to fit with the original data collection. Main charts and tables are made in excel.

Other than the survey, a weekly interview was conducted with my Chinese partner through global classroom on WeChat. My partner and I kept a regular meeting every weekend through video calling to discuss culture differences, situation about coronavirus, and an insightful picture about his view on smart transportation ethics. Sometimes he sent me photos of Hangzhou transportation system which provides more information than merely words.

## **VII. Discussion:**

Stakeholders in such a system involve government agencies, commuters and tech companies. As shown in Fig. 2, an ANT diagram is introduced to illustrate the critical role of nonhuman actants that build the "intelligence" of the smart city. And this thesis is to unfold how this complex socio-technical system is built in the US and China, through which to develop a comparative analysis on the ELSI of smart transportation. Voices from cultural factors, state legislatures and ordinary travelers will be collected in order to provide a holistic picture of the challenges in ethical implications in smart transportation so that city planners can offer countermeasures in the future.



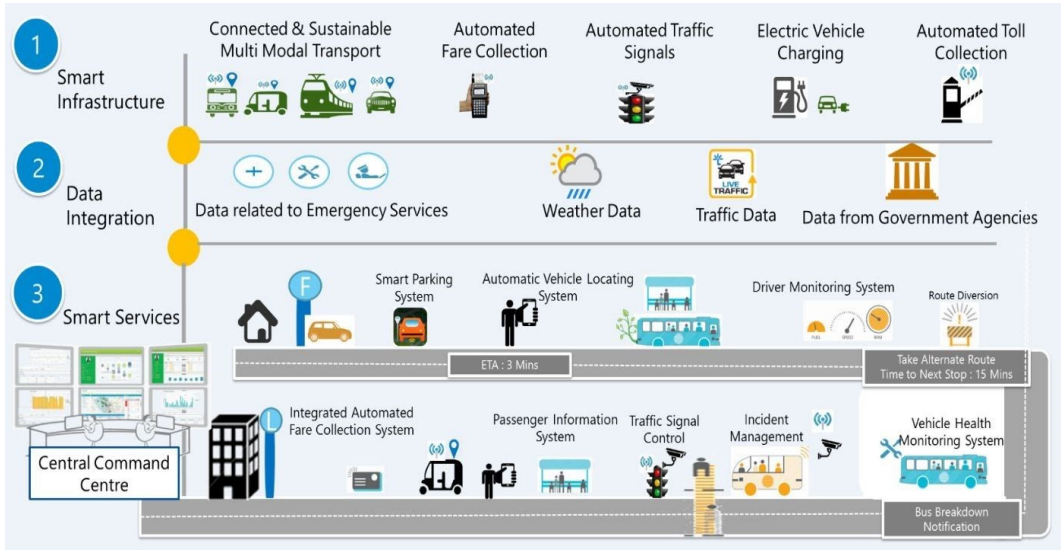
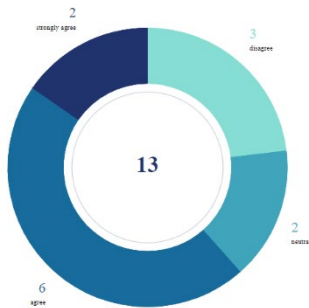


Fig. 2. Smart transportation framework (Mohit Kochar, KPIT Technologies)

Unfortunately, due to the current covid-19 situation, only 25 samples have been successfully collected from both sides, among them 13 samples are from Zhejiang University and 12 from UVA. About 76% of the people who took the survey are male and the age are mostly between 18-24 years old.

degree of comfort using GPS tracking devices and services (China)



degree of comfort using GPS tracking devices and services (US)

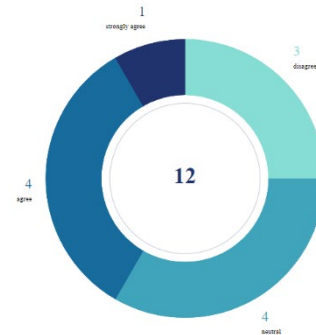


Fig. 3. Comparison of GPS usage

One of the questions that stand out to have distinctive differences is about the usage of GPS precise location services. Based on the data I acquired, Chinese college students seem to be more comfortable using those services, but most American students remain neutral on this matter, cautiously using tracking devices while enjoying the benefits they bring out.

What is the most liable factor in a self-driving vehicle accident? (China)

What is the most liable factor in a self-driving vehicle accident? (US)



Fig. 4. Comparison of autonomous vehicle liability

Another big difference appears when asked about the liability of autonomous vehicle. Even though the majority of people from both sides consider the backup driver behind the wheels to be the most liable in such accidents, only one student from China think the programmers who created the software to be responsible. On the other hand, one third of students from UVA consider the software developers who imbedded the bug are the most liable in self-driving accidents. This may imply that Chinese students consider the direct human intervention to be more important in a self-driving situation while American students think the indirect intervention---humans behind the technology is also an important factor for liability.

What is the biggest ethical concern for autonomous vehicles (China)

What is the biggest ethical concern for autonomous vehicles (US)



Fig. 5. Ethical concern for autonomous vehicles

Last but not least, another interesting survey result occurs when asked about the biggest ethical concern for autonomous vehicles: 6 students choose “liability when an accident occurred” and 6 students choose “How will AI choose who or what to crash into when an accident is unavoidable”. On the other hand, the majority of students from UVA select AI’s behavior under dilemmas. This result resonates with the questions in Fig.3&4, American students are more wary

about the side effects of AI technology and its ethical concerns while Chinese students consider human factors and technology to be equally important.

### **VIII. Conclusion:**

Smart transportation developments are an aspiration to many countries aiming to achieve optimal sustainability, operations, and a better quality of life. However, smart transportation applications require monitoring and gathering data continuously to achieve their goals. This data may be generic and open to the public, such as traffic and environmental data, but can also be very personal and private, such as locations, people's identities, and private activities. As a result, many questions may arise with regards to the safekeeping of this data and the ethics involved in its acquisition, ownership and utilization. The challenges involve several aspects, some of which can be solved with technology, while others need more human intervention in terms of rules, regulations, guidelines, and ethical codes. Like every other technology, the discussion of the ethical and legal implications starts with the public's concerns and views. However, a deeper understanding of how to control smart transportation applications to avoid ethical misconduct is also extremely important for the success of these applications.

There is a lot to be done and the picture seems dark at the moment. However, the main problem when I investigate smart city applications is the different categories involved and the fast pace at which the technologies are changing and penetrating our everyday lives. At such a rate, it is not easy to keep up with the growth of AI technology, which makes it essential to incorporate these concerns into the design and development processes of smart city applications. From my perspective, researchers and developers need to be more open about their experiences and sharing information about ethical issues to create a wider and more complete knowledgebase for everyone to use. Individual efforts are important as well and can make an impact on the specific application, sharing this success with others will allow them to address similar issues faster and more efficiently. As more information emerges on AI bias and discrimination, there is a strong need to find ways to isolate these problems and create some workable solutions.

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#### IV. Appendix: Survey Questions

1. What is your gender?
  - a. Female
  - b. Male
2. How old are you?
  - a. 18-24
  - b. 25-34
  - c. 35-44
  - d. 45-54
  - e. 55-65
  - f. 65+
3. What's the most common way of transportation for you in your city? (Charlottesville/ Hangzhou)
  - a. car
  - b. bike
  - c. bus
  - d. subway

- e. Walk
4. Are you satisfied with your city's public transportation?
    - a. Strongly disagree
    - b. Disagree
    - c. Neutral
    - d. Agree
    - e. Strongly agree
  5. To what degree do you agree or disagree with the following statement: **I'm comfortable using GPS tracking devices and services.**
    - a. Strongly disagree
    - b. Disagree
    - c. Neutral
    - d. Agree
    - e. Strongly agree
  6. To what degree do you agree or disagree with the following statement: **AI data collection and sharing is infringing privacy rather than providing convenience and efficiency.**
    - a. Strongly disagree
    - b. Disagree
    - c. Neutral
    - d. Agree
    - e. Strongly agree
  7. Which actor do you think plays the most important role in analyzing and implementing big data in your city?
    - a. government
    - b. Tech companies
    - c. local communities
    - d. citizens
  8. Do you think it's safe to drive an autonomous vehicle?
    - a. Yes
    - b. No
  9. Who do you think is most liable in a self-driving vehicle accident?
    - a. Programmers who created the software
    - b. The back-up driver who wasn't in control of the vehicle when the accident happened
    - c. Artificial Intelligence
  10. Rank your ethical concern with respect to autonomous vehicles. (from most important to least important)
    - a. Liability when an accident occurred

- b. How will AI choose who or what to crash into when an accident is unavoidable
- c. Wealth inequality
- d. Skill inequality
- e. People who can access those data and how much personal information they can use