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Self-Driving Cars:
An Examination of Ethical Issues at the Micro and Macro Scale

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Learning Objectives

- Describe key micro-level issues at the intersection of ethics and the self-driving car
- Describe key macro-level issues at the intersection of ethics and the self-driving car
- Discuss ethical responsibilities engineers have pertaining to the design and use of a self-driving car

Presentation Outline

- Introduction
- Levels of Automation
- Our Focus
- Microscale Issues
- Car Meets Trolley Problem
- Level 3 and Level 4
- Macroscale Issues
- Questions for Consideration
- Codes of Ethics
- Moral Responsibility for Computing Artifacts
- Conclusions

An Introduction to Self-Driving Cars

- Alleged benefits: improved safety and fuel economy; decreased congestion and parking needs (Eno Center 2013)
- $4 Billion investment proposed by DOE for R&D and infrastructure improvements (Vlasic 2016); the status of this investment is unclear at the present time
- Projected global sales by 2025 (Taylor 2015)
  - Semi Automated: 22.7 million
  - Highly Automated: 9 million

An Introduction (continued)

- NHTSA (2015): the "critical reason" accidents occur is related to the driver ~94% of the time.

- The Association for Safe International Road Travel (n.d.):
  - "Nearly 1.3 million people die in road crashes each year."
  - "An additional 20-50 million are injured or disabled"

- It has been claimed that "So by automating driving, we could save about a million lives a year" (Freeman 2016).

Levels of Driving Automation (adapted from SAE 2016)

Human Driver Monitors Driving Environment	
Level 0 - No Automation	Full-time operation by human driver
Level 1 - Driver Assistance	Single driver assistance system (steering or acceleration/deceleration)
Level 2 - Partial Automation	Driver assistance systems for both steering and acceleration/deceleration
Automated System Monitors Driving Environment	
Level 3 - Conditional Automation	Automated operation with human driver expected to respond to request for intervention
Level 4 - High Automation	Automated operation even if human driver fails to appropriately respond to request for intervention
Level 5 - Full Automation	Full-time automated driving system

At Least 33 Corporations are Working on Autonomous Vehicles

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Our Focus

- Identify key ethical issues related to self-driving cars at both the micro and macro scale.
- Inform engineering design and the policy decision-making process.

The “Micro” Scale

- The focus here is on the individual self-driving car and its interactions with the driver, passengers, and the external environment.

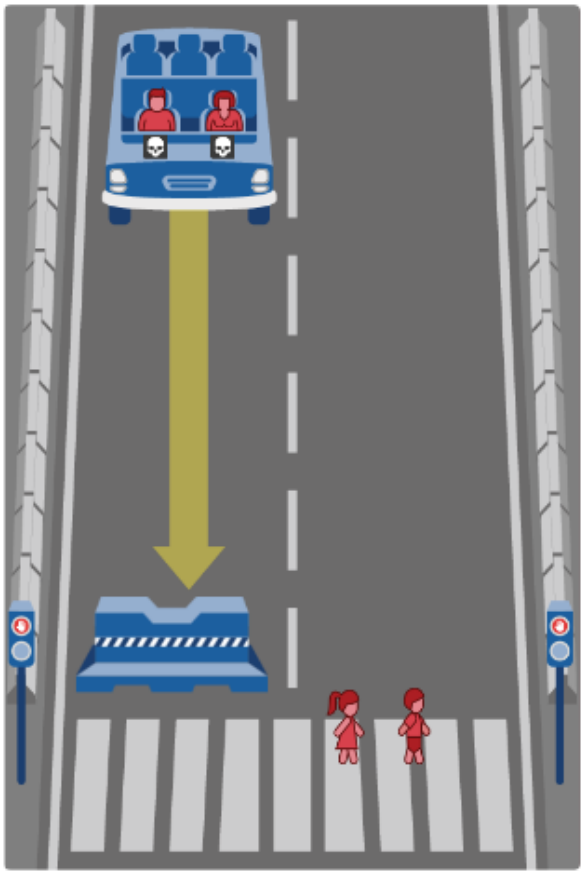
- The federal government released a 15 point checklist for the automobile industry that is interwoven with ethical concerns (Kang 2016); these concerns are largely within the “Micro” realm.

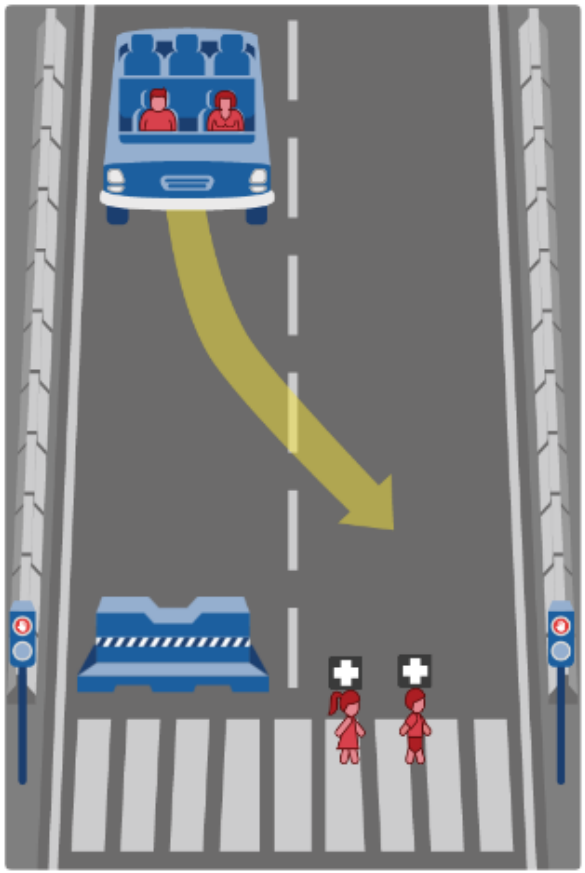
The "Micro" Scale (continued)

- Key Micro issues include:
  - Driver/passenger privacy
  - Pedestrians (Lafrance 2016)
  - Unexpected user behavior (e.g., placing a child in the car without an adult)
  - Intentional tampering/hacking (e.g., Greenberg 2015)
  - The Trolley Problem

The Self-Driving Car Meets the Trolley Problem

For example, from [MIT's Moral Machine website]





The “Micro” Scale and Level 3 Design

- What should the default expectation be in potentially dangerous scenarios? Should the automated system or the human driver be required to respond?

- “Consumer Reports believes automakers should take stronger steps to ensure that vehicles with those systems are designed, deployed, and marketed safely. Please heed all warnings, and keep your hands on the wheel” (2017).

- Should special licensing be required for the driver ?

The “Micro” Scale and Level 4 Design

- How will passengers communicate with the vehicle (e.g., what if someone experiences motion sickness)?
- Will passengers react unexpectedly (e.g., panic) in stressful situations due to the lack of control?
- Will users reject Level 4 due to the lack of interaction or control over the vehicle?

The “Macro” Scale

- The focus here refers to a level of analysis involving how multiple self-driving cars will interact with each other and with the larger sociotechnical systems within which they are embedded.

- Key Macro issues include:
  - How will self-driving cars from different manufacturers communicate with each other?
  - What will be the mechanism for encouraging (or requiring) rival companies to cooperate with one another?

The "Macro" Scale (continued)

- Will human drivers, bicyclists, pedestrians, etc. try to exploit the safety features of a self-driving car (e.g., by weaving in and out of self-driving traffic)?
  - If so, what happens if they anticipate a fully autonomous car's behavior but are interacting with the "wrong" type of car?

- Will human drivers experience "road rage" if self-driving cars strictly follow the law?
  - If so, how should self-driving cars behave in response?

The "Macro" Scale (continued)

- What will the mechanism be for encouraging / requiring car manufacturers to standardize safety rules?
  - For example, how much space should the system give behind another car?

- How should safety rules be determined when the vehicles have different designs and performance (different weights, braking systems, etc.)?

The "Macro" Scale (continued)

- What will be the effect on employment levels?
  - According to one estimate, 1.7 million truckers could lose their jobs within the next ten years (Kitroeff 2016).
- Optimizing the performance of self-driving cars may require significant investment in redesigning cities … are the necessary resources and political will going to be available?
- How will self-driving cars affect traffic congestion on the roads? (e.g., see Steinmetz 2016)

Questions for Consideration

- In the near term, which design pathway is more ethically defensible … Level 3 or Level 4?
- Alternatively, is it ethically appropriate to have both levels operating on the roads simultaneously?
- How much do passengers need to know about a self-driving car before they can genuinely provide informed consent to drive and/or ride in one?

Questions (continued)

- How transparent should car manufacturers be with the public about how their vehicles are designed to handle ethically fraught situations?
- How much uniformity in design / vehicle behavior should be demanded of car manufacturers?
- What responsibilities do engineers have at both the individual and organizational levels to address ethical and policy issues related to self-driving cars?

Codes of Ethics

- The Paramountcy clause, (i.e., “Hold paramount the safety, health, and welfare of the public”) is well-intentioned and important (NSPE 2007), but it can be difficult to apply in a particular case.

- Little specific guidance is provided by professional societies related to self-driving cars or other “autonomous” technologies.

Moral Responsibility for Computing Artifacts: The Rules

- A collection of rules, championed by Keith Miller and other computer scientists, engineers, and ethicists, that were created to provide guidance to the computing and engineering communities especially with respect to pervasive and autonomous technologies (Miller 2011).

- For more information: http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=5779006

Rule 1

- "The people who design, develop, or deploy a computing artifact are morally responsible for that artifact, and for the foreseeable effects of that artifact. This responsibility is shared with other people who design, develop, deploy or knowingly use the artifact as part of a sociotechnical system" (Miller 2011).

- Relevance:
  - Engineers and others have a shared responsibility for the ethical design, development and deployment of self-driving cars.
  - "Foreseeable use" of self-driving cars by driver/passengers and others is highly problematic (e.g., greatly complicates testing).

Rule 4

- "People who knowingly design, develop, deploy, or use a computing artifact can do so responsibly only when they make a reasonable effort to take into account the sociotechnical systems in which the artifact is embedded" (Miller 2011).

- Relevance:
  - Engineers and others must take into account the sociotechnical systems in which self-driving cars are embedded (e.g., interactions among drivers, passengers, pedestrians, all types of vehicles, infrastructure, and the external environment).

Conclusions

- Ethical analysis of self-driving cars must go beyond the typical focus on the individual vehicle.
- Sophisticated analysis at the system level is required.
- Corporations should not be the only decision-makers about crucial issues emerging out of the sociotechnical systems within which automated vehicles are embedded.

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Image Sources

Slides 2: https://waymo.com/

Slides 3 and 4: http://i.dailymail.co.uk/i/pix/2015/01/06/24711921000000578-2898517-German_company_Mercedes_has_unveiled_their_concept_self_driving_-a-1_1420538581285.jpg

Slide 6: https://cbi-blog.s3.amazonaws.com/blog/wp-content/uploads/2016/04/corps-autonomous-header-august-2016.png

Slide 7: http://healthland.time.com/2011/12/05/would-you-kill-one-person-to-save-five-new-research-on-a-classic-debate/

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