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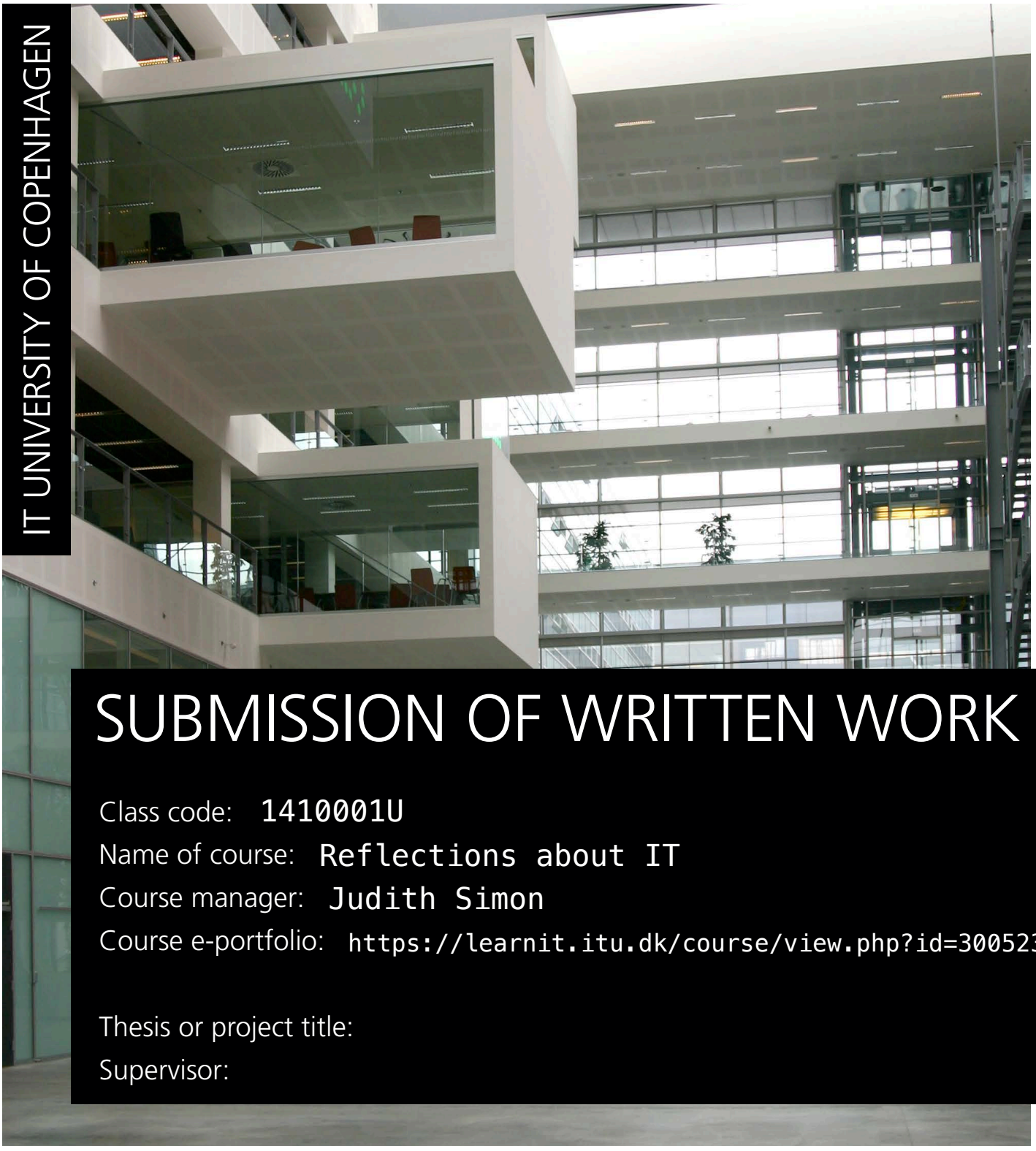

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Should the Designer of Your Car Determine Who It Kills? Ethics and Autonomous Vehicles

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Contents

Chapter 1

Introduction

The idea of creating mass-produced autonomous vehicle has seen more and more interest from researchers and car manufacturers in the last few years.

The idea of inventing an autonomous car is not a new thing. Dreaming up future societies where people would focus on other things while their cars drove them from A to B[1], has been a trope of science-fiction for decades. During the last decade these ideas are finally being realised with research projects such as Google's ongoing Self Driving Car Project, previous research projects such as the entries of Carnegie Melon and Stanfords in the DARPA Grand Challenge [12] and the recent undertakings of most car manufacturers, such as BMW, Audi, Toyota, VW etc. [10]

Certain ethical issues arise with autonomous vehicles, however. Since autonomous vehicles are programmed to handle preferably every possible scenario on the road in advance, autonomous vehicles present ethical dilemmas that human drivers in non-autonomous vehicles do not.

> "As we are about to endow millions of vehicles with autonomy, taking algorithmic morality seriously has never been more urgent. [5]"

Human drivers are rarely blamed for acting according to their instinct in life-threatening vehicle collisions, even if this means that they inadvertently make decisions that have fatal consequences for other people.

These decisions have to be programmed into autonomous vehicles in advance in order to make the "right" choice, should they occur. This raises interesting questions, such as; who should be blamed for an autonomous vehicle hitting, and possibly killing, one person over another? Should we even program autonomous vehicles to be able to select the "preferable" target of collision, or would it be better to not do any selection at all and make the vehicle choose some random behaviour in a critical situation?

The main question I will try to answer in this essay is; "Should the designer or programmer of your autonomous car determine who the car will hit in an emergency situation?" by looking into what ethical issues this question presents, and what theories can help answer this question.

[1] The popular TV show, *The Jetsons* is one of the more well-known examples of having autonomous vehicles. [14]

Chapter 2

Autonomous Cars

Experiments attempting to automate vehicles, mainly cars, have been made since the 1920's with varying degrees of automation and success.

This essay will focus on *autonomous* cars, and not *automated* cars. Autonomous is, as per Thesaurus, defined as:

> "*an autonomous republic*: self-governing, independent, sovereign, free, self-ruling, self-determining, autarchic; self-sufficient."

Automation implies that cars merely follow artificial hints in the environments, such as early experiments using magnetic strips in the road. [13] *Autonomous* implies that cars react to their environment independently, that is they cannot depend on unnatural artefacts in their surrounding environment in order to follow the road, not crash and avoid obstacles.

Modern research has been focused on autonomous cars, since it is unrealistic to add artificial hints on every road in the world. Rather, research has been focused on making autonomous cars adapt to environments with uncertainties, so that the same autonomous vehicle can drive both in the inner city and on unpaved mountain roads. Modern vehicles furthermore have an increasing amount of automation built in, which has not brought any ethical dilemmas. On the other hand, the idea of having truly autonomous vehicles brings certain dilemmas with it, that can be researched. I will therefore not look at *automatic* vehicles in this essay, but focus on *autonomous* vehicles.

Recent research projects use radar or radar-like technology in addition to GPS, odometers and computer vision in and on cars to detect the environment surrounding the car and recognise obstacles, such as people, other cars and structures, which the car will try to avoid. The addition of the radar-like LIDAR technology (a mix of the words light and radar) on the roof of the cars has provided the cars with a 200 foot-radius "view" of their surroundings, enabling them to sense the world around them in great detail. LIDAR generates a precise point cloud of the environment surrounding the car, enabling the on-board software to distinguish a running child from a bicyclist.

Google has been researching autonomous cars since 2009 [7]. Over the years the research project has been ongoing, the cars have developed a detailed view of their surroundings. In addition to the computer vision research the company has developed and implemented in the cars, LIDAR helps the car map its surroundings, enabling it to recognise smaller objects such as pedestrians and bicyclists. Google is using the computer vision technology it has been developing and

researching to analyse the surrounding environment perceived through stereo cameras mounted on the car to detect possible collisions around the car. The sensors on the car generate 1GB of data per second [3], which is analysed in order to give a precise depiction of the surrounding environment of the car.

2.1 Motivations for Developing Autonomous Vehicles

The main motivation for developing autonomous vehicles is that human drivers are prone to make mistakes. Human drivers get distracted, have relatively slow reaction times, especially when tired or under the influence of drugs. Driving with a lack of sleep, or while under the influence of drugs, severely inhibits the driver's ability to react in time to avoid collisions.

An autonomous car can register its surrounding environment many times a second and analyse this input to decide on the best possible action to take in a given situation. An autonomous driver does not get distracted unless programmed to do so, and has as fast a reaction time as hardware and software allows, almost guaranteed to be less than that of a human driver. An autonomous driver does not get drowsy and cannot ingest drugs.

An autonomous will therefore, almost guaranteed, be a safer driver.

In the United States during 2014 distracted drivers left 3179 people killed and 431000 people injured. [1]. 10% of all crashes in the United States were crashes where the driver was identified as distracted immediately before the crash. Data on how many accidents have been caused by speeding and driving aggressively are hard to find, but account for some percentage of all crashes. During 2014, 31% of all driving-related crashes were caused by impaired driving, that is driving while under the influence of alcohol or the like with 9967 people killed as a result of some of these crashes. [2]

Eliminating distracted driving and impaired driving would eliminate 41% of all driving-related crashes, sparing the lives of 13146 people every year. Taking human error out of the equation is hoped to save many people from injury or worse.

Furthermore, costs of human drivers can also be reduced, traffic jams might be reduced[1], and vehicles might be able to park more efficiently, and generally drive faster while still driving safely, saving time spent going from A to B.

In short, a computer driving your car will probably be a better driver than you. An autonomous car can sense its surroundings 200 times per second and make just as many calculations reasoning for its next move based on the input. A human driver cannot top that. [4]

This fact presents some interesting questions. Given the amount of input and processing power, an autonomous car should always be able to make the best possible choice. An autonomous car would register the child running across the road before a human driver ever could, and should therefore always make the right choice accordingly.

But what *is* the right choice? Most people would say that the car should always try to harm as few people as possible. That would be the "ethically correct thing to do". [5] But what happens in situations where someone *has* to get hurt? If an autonomous car is in a situation where it has the option of hitting two different people, but no option to avoid either one, who should it choose? What if saving both people involves killing the passengers of the car? Who should be to blame for any collisions or pay for any harm done to people or structures?

Specificér research question.

[1] So-called shockwave traffic-jams caused by human error, are researched in [11]

Answering these questions requires us to look at other ethical arguments described in the following sections.

Chapter 3

General Ethics and Computer Ethics

Overall, ethics is the study of morality and moral systems. These moral systems are compromised of many components, with some common features. Bernard Gert has described the four main features of a moral system as; Public, Informal, Rational, Impartial. These can be described cite. accordingly as; The rules of the system should be know to all its members, the rules should be based on logical reason accessible to its members, there is no authority enforcing them, and the system does not treat individuals or groups differently. Furthermore, the rules of the system have connections on different levels.

The first level of the system, which is the one that we interact with, is the rules of conduct that the system sets for us. These are rules that all members agree on, and that everyone is subjected to equally. These can either guide the actions of people or help establish social policies.

Rules of conduct are derived from a set of "basic moral values", a subset of the core values of a society, which are important to its thriving and survival. The rules are subject to principals of evaluation that will justify the rules. These principals are either Religion, Law or Ethics. (Tavani, 2003) cite.

The moral system of computer ethics is based upon the systems of general ethics, and uses the same concepts and categories as base values. The values in the field of computer ethics changes alongside the evolution of the technology, however, and actions occurring brings a policy vacuum that can end in new values being formed and changes happening to existing policies. As noted by Moor:

> "Computers provides us with new capabilities and these in turn give us new choices for action. [...] A central task of computer ethics is to determine what we should do in such cases, i.e., to formulate policies to guide our actions." [9]

Even though actions made by computers are the same as tasks previously performed by humans, tasks which already have certain morals, the way the action of a computer has been implemented can change the way the it is viewed.

A problem of this can be described as "the invisibility factor". Operations of a computer cannot be seen directly. Therefore it is difficult to know if the operations are unethical. (Moor, 1985) cite.

Invisibility of actions in computer systems makes it difficult to evaluate with ethical principles, but it is possible to examine the design of a system, and how this design makes people act. It can be examined if the system has been designed in a way as to promotes unethical behaviour. It is possible to evaluate the morals of actions someone has taken in many ways. Therefore a perspective to look at these actions has to be chosen.

3.1 Consequentialism

In the study of normative ethics, consequentialism holds that the consequences of one's conduct are the basis of which to determine the rightness or wrongfulness of one's actions. That is, the means to which you achieve your goal pose no ethical relevance, rather the end result is what has ethical relevance. It is the idea that the end justifies the means. [8]

"Every advantage in the past is judged in the light of the final issue. — Demosthenes"

3.1.1 Utilitarianism

Utilitarianism is a form of consequentialism, founded by Jeremy Bentham, holding that the best moral action is the one that maximises *utility*, that is the well being of sentient beings. The action that maximises the well being and minimises the suffering of humans is the one most ethically correct.

"The ethical theory that holds that the action that is morally right is the one that results in the greatest possible utility (or greatest possible happiness) for the greatest number of people. (Beck Holm: 207)"

Elaborate.

3.2 Deontological Ethics

"Kant's moral law. The point of this law is that we must always act in such a way that we can accept the consequences that would occur if all others were to act in the same way. (Beck Holm: 213)" Deontology argues that actions are inherently good or bad. If the action performed is bad, then the entire action, no matter the outcome is bad. An action should adhere to certain moral rules, and if it does not, then it must be bad.

Elaborate.

3.3 The Non-identity Problem

The nonidentity problem describes a situation where bringing a person with a so-called flawed existence into existence has to be determined as being good or bad. Bringing the person into existence brings a usually significant amount of good with it, but since the existence is flawed, necessarily also some bad with it. Three intuitions are at stake in the nonidentity problem. The first is the person-affecting, or person-based, intuition itself, that an act can only be wrong if that act makes things worse for some existing or future person.

The second is the intuition is that if the act gives a person an existence that is unavoidably flawed, that is the person would not exist if the act had not taken place, then the act does not make things worse for that person, because the person would otherwise not have existed.

The third intuition is that some existence-inducing act are wrong, even if they do not make things worse for either the person that they bring into existence, and therefore make suffer, or any other future or existing person.

Elaborate?

Chapter 4

Ethics of Autonomous Vehicles

Initially, autonomous vehicles might not present many ethical dilemmas, but as Moor says:

> "Although a problem in computer ethics may seem clear initially, a little reflection reveals a conceptual muddle. What is needed in such cases is an analysis that provides a coherent conceptual framework within which to formulate a policy for action." [9]

Defining and designing algorithms that will guide Autonomous Vehicles (AVs) when put in moral dilemmas is very challenging. So-called moral algorithms should accomplish and be evaluated against potentially incompatible objectives [6]:

- **Be consistent:** Take predictable measures in critical situations.
- **Not cause public outrage:** Act according to the moral principles of society.
- **Not discourage buyers:** Make the public comfortable buying and using AVs thereby allowing the widespread use of AVs.

Accepting autonomous vehicles into society presents some interesting ethical dilemmas. Because completely autonomous vehicles have only been on the road for a few years, no policy for action has been formulated regarding these vehicles. An example illustrates where debate can be held regarding autonomous vehicles is the example where you are sitting in your autonomous car, going to work. In front of you is a flatbed truck with a heavy load tied to the truck. On your immediate right is a motorcyclist and on your left is an SUV with a family of four in it. Your autonomous car is keeping a safe distance to the truck, so that if it breaks suddenly, you could stop.

Then the cable on the truck snaps, and the heavy load falls onto the road immediately in front of you. Your car could not predict this, it merely sees a new obstacle in front of you. Avoiding it without injuring you is impossible. Your car could choose to swerve, hitting either the motorcyclist or the SUV. Hitting the SUV might injure both you and the family inside, but hitting the motorcyclist would not injure you, instead it would injure the motorcyclist severely.

I will use this ethical dilemma for the following discussion of how to view the ethical issues involved.

These situations *can* occur, even though they may happen extremely rarely. The possibility of this happening forces us to reason about the validity of having autonomous vehicles, and who should be made responsible for any accidents that occur, if we can even hold anyone responsible.

According to utilitarianists, no matter the ethical issues involved in possible critical situations involving autonomous cars, having autonomous cars will always be ethically sound, since autonomous cars, even with many critical situations, will save more lives overall. Even if the act of selecting individuals to hit if it is unavoidable, the end result - drastically lowering the current amount of people killed in accidents - will maximise the well-being of humans. Therefore developing autonomous cars, as long as this saves more lives, will be a good thing. In the end, an autonomous driver will outperform a human driver, and therefore save more lives. No matter the implications, having autonomous drivers will be better.

If viewing possible ethical dilemmas involving autonomous cars in accidents as an utilitarianist, placing the responsibility either of who should be held responsible for accidents or determining whether to hit the motorcyclist, injure yourself or hit the SUV, would simply mean analysing the consequences of the hitting or blaming all possible actors, and choosing the one that brings the least human harm.

According to deontologicalists, the car should never choose to hit anyone, since deliberately hitting another person is wrong, and the entire act would therefore be wrong. Though, if the hitting of a person is seen as an accident then it is unavoidable, and would happen either way. Therefore it is hard to argue that the action is bad, since it is unavoidable.

Another argument for allowing the selection of a person to hit with the car, would be that since accidents happen, and that some number of people every year would be hit, whether it's this person or another person deos not matter. The person hit is just hit one of many accidents that happen every year, and the person is therefore not a victim of specific targeting, and therefore not a victim at all.

Ducking harm, the act of transferring harm to another person by stepping out of the dangerous situation, when the person is left behind, is generally considered better than explicitly sacrificing the other person, by placing him/her in harms way instead of one self [1]. This would seem to change the act of a car avoiding hitting five people, and instead hitting one person into being bad. Now the single person has been explicitly sacrificed, thereby transferring harm from the passengers of the car, which would be deemed worse than simply "doing nothing" and hitting the five people.

The non-identity problem comes into play when discussing the issue of bringing autonomous vehicles into the world that possibly have to choose to hit, and possibly kill, people. The existence of this car would be flawed, but choosing to bring a non-autonomous car into this world would not result in the same existence. Not bringing the car into this world would make life worse for future or existing people, since these people would be involved in possibly lethal accidents they otherwise would not have.

Giving designers and auto-manufacturers the responsibility of determining whether to hit or not hit a person is unrealistic, due to the nature of these situations. Choosing to always injure the driver of the car or always hitting the oldest person registered by the car is not really an option, since the situations in which these choices have to be made change.

[1] [6]

Chapter 5

Discussion

"On my view, computer ethics is a dynamic and complex field of study which considers the relationships among facts, conceptualizations, policies and values with regard to constantly changing computer technology. Computer ethics is not a fixed set of rules which one shellacs and hangs on the wall. - Moor"

Chapter 6

Conclusion

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