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Considerations about the relationship between animal and machine ethics

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Abstract Ethics researches morality in respect to humans and animals. Usually, it implies human morality; therefore, the focus is on human–human relationships (generally in ethics) and human–animal relationships (in animal ethics). Ethics can also deal with the morality of machines such as unmanned aerial vehicles, robots and agents or of self-driving cars and computers in automated trading, in other words more or less autonomous systems and programs. Machine ethics almost exclusively concentrates on machine–human relationships rather than on machine–animal relationships. Before this background, this article contributes some basic considerations about the relationship between animal and machine ethics.

Keywords Animal ethics · Machine ethics · Robot ethics · Information ethics · Technology ethics · Moral machines · Animal–machine interaction

1 Introduction

Descartes compared animals with machines. He said their sensations and movements followed the laws of mechanics only. Later this led to the ethically relevant term of animal machines (Wild 2006). The relationship between animal and machine can be analyzed in different specific ethics, for instance in animal ethics, technology ethics or

information ethics. Machine ethics—here to be understood as the counterpart to human ethics—still is a young discipline. So far it has concentrated on the relation between machines and humans. Considering that the number of (partly) autonomous machines is growing continuously, and their self-reliant decisions more and more frequently affect animals, it seems to be inevitable to analyze the related chances and risks.

This paper first explains the terms of animal ethics and machine ethics as well as the terms "information ethics" and "technology ethics" in order to integrate the affected specific ethics. Then general and specifically moral relationships between human, animal and machine will be represented, explained and assigned to situations or (fields of applied) ethics. Relationships that are relevant for animal and machine ethics will be discussed with selected examples. Conclusion and outlook complete the considerations.

2 The terms of animal and machine ethics

Animal ethics deals with the duties of humans toward animals and with the rights of animals. The ability to suffer is an important moral and ethical argument (Wolf 2012). It can be used to justify species-appropriate animal farming or a ban of animal farming and animal use. Information ethics is about morality in the information society (Bendel 2012b). It analyzes how we behave or should behave in questions of morality when offering and using information and communication technologies and digital media. Animals are furnished with radio chips, controlled with monitoring equipment and managed through machines. Before this background, information ethics also deals with the rights and duties of creatures in the information society as

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well as the opportunities for making information technologies and systems appropriate for species and for animals. Technology ethics refers to ethical questions of the use of technique and technology. The technology of vehicles or weapons and nanotechnology both are potential issues. Milking machines, animal traps as well as killing and utilization machines could be the object of analysis. Today, the transitions to information ethics are volatile.

The mentioned specific ethics are part of ethics, or more precisely of human ethics. Machine ethics focuses on the morality of machines, or more specifically of (partly) autonomous systems such as agents, robots, unmanned aerial vehicles (UAV), unmanned ground vehicles (UGV), self-driving cars and computers for automated trading (Anderson & Anderson 2011; Bendel 2012a). It can be classified within information and technology ethics or as a counterpart to human ethics. The term "algorithm ethics" is used partly as a synonym and partly for discussing the ethics of search engines and menu lists as well as big data. Robot ethics is a germ cell and a special field of and besides machine ethics. Machine ethics is more and more frequently used as a metrics system for ethics. It can describe new subjects and objects of morality, and it can show which normative concept is reasonable beyond the morality of human-related philosophy. The applications of machine ethics have highly relevant economic as well as technical implications.

As already mentioned, machines as the subjects of morality are autonomous or partly autonomous. In some areas, the development of self-reliance is proceeding rapidly. Some developers aim at the full autonomy for military UAV. Presently, UAV usually open fire on the target subjects on command from a human being. In the future, they might perform the "final act" on their own.

3 General and moral relationships

Evidently, not only human and animal are living together, but also encounter each other in all kinds of situations today. Humans and machines do so too. People are talking about human–machine interaction, human–machine communication and the human–machine interface. Technical systems appear not only as the objects we operate and use, but also as subjects that operate and use us, make proposals to us, and make autonomous or partly autonomous decisions for us. This is also a motif in the literature about the world of technology, the information society and the animal. The machine as subject and object, however, is frequently overlooked. In the following, we point out general subject–object relationships, illustrate them with examples and classify them by situation (Table 1).

The subject–object relationship is not always absolutely clear. Does the jogger let the machine analyze his performance, or does the machine analyze the performance of the jogger? Anyway the jogger still seems to be in control. Does the milking machine depend on humans? The overview is limited to 1:1-relationships respectively to relationships between subject and object. Of course, humans, animals and machines can meet at the same time. The use of the milking machine is one example of such a relationship. A modern war setting is another example, but this kind of constellations is discussed later on.

People can be subjects of morality while animals cannot. As already said, animal ethics deals with the duties humans have toward animals and with the rights of animals. Autonomous machines can also be subjects of morality from the perspective of machine ethics. They have to make relevant ethical decisions in situations that seem to be loaded with morality. Whether machines (like animals) also can be, or will be some day, objects of morality or not is disputed (Wendt 2013). If we recognize machines only as subjects of morality but not as objects, we can identify the following 2-angle relationships and reference the examples to the matching disciplines (Table 2):

Medical ethics, just like animal ethics, technology ethics and information ethics, is a specific ethics, and it is part of human ethics. Machine ethics can be classified as "sectional ethics" or "sub-sectional ethics," or—as explained above—as a counterpart to human ethics. Insofar, the

Table 1 2-angle relationships between human, animal and machine

Relationship	Example	Situation
Human–human	An older lady asks a young man for the way	Orientation
Human–animal	A young child entices a cat with a red string of wool	Game
Animal–human	A wolf scares away a hiker who had entered his territory	Defence
Animal–animal	A lioness in the Kalahari tends to her newborn cub	Breeding
Human–machine	A jogger uses a microcomputer to analyze his performance	Sports
Machine–human	A fight robot shoots an officer of the enemy army	War
Machine–machine	Two computers are communicating with each other in algo trading	Trade
Machine–animal	A brand new milking machine milks a black-and-white cow	Use
Animal–machine	An animal pushes a button in an experiment to get food	Nutrition

Table 2 Moral 2-angle relationships between human, animal and machine

Relationship	Example	Discipline
Human–human	A doctor treats a patient against his declaration of will	Medical ethics
Human–animal	An elderly man eats a rare steak in a restaurant	Animal ethics
Machine–human	A chatbot responds angrily because the user announces suicide	Machine ethics
		Human ethics
Machine–animal	An unmanned aerial vehicle shoots at an animal because it mistakes it for a human	Machine ethics
		Animal ethics

denominations of the disciplines might be located in different categories. Obviously, certain fields of applied ethics focus on the human–human relationship. The human–animal relationship is addressed mainly by animal ethics. As soon as the machine is a subject of morality, machine ethics is involved. Human beings as subject or object are a matter of human ethics, while animals as objects are a matter of animal ethics.

The mentioned subjects and objects all can appear together in moral 3-angle relationships. Examples for these relations are listed and classified below. When machines are objects, (partly) autonomous machines shall not have preference (Table 3).

The list with the examples and references clarifies several aspects:

- There can be different roles in the relationships between human, animal and machine—leading actors, actively involved or passively affected players.
- Some of the consequences were wanted and caused directly, and others are so called collateral damages.
- Other (predictable and unpredictable) consequences can occur further to the damages shown in the examples.
- The moral question by the way occurs at different positions in the relationships, or in some of the relationships.

- Most of the described relationships are a matter of several (specific) ethics.
- Machine ethics, as implied by the name, is involved whenever machines are the subjects of morality.
- Human ethics is included in applied ethics but—just like the machine-animal-human relationship—it can also be mentioned explicitly.

Information ethics was stated only spot-wise, but generally it is linked to all kinds of applied ethics and highly relevant for instance to medical, business and technology ethics (Bendel 2012d). Several examples and references need to be explained. In the relationship animal–machine–human, we mention the animal ethics because a machine terminates animal life. This example also shows how a subject—the flying bird—can be extinguished by an object. We also have to remark that the perception can differ very much: The pilot can be seen as the acting subject and the flock of birds as the disturbing object.

4 In-depth analysis and discussion of selected relationships

This paper is dedicated to the relationship between machine ethics and animal ethics. Therefore, the following

Table 3 Moral 3-angle relationships between humans, animals and machines

Relationship	Example	Discipline
Human–machine–animal	A farmer uses a poorly adjusted automated stable, which makes a cow suffer	Technology ethics
		Animal ethics
Human–animal–machine	A farmer furnishes his cows with radio chips to be able to identify and monitor them.	Animal ethics
		Information ethics
Animal–human–machine	A dog bites his master, who is a hacker who was supposed to avert a hyper attack that precise moment	Information ethics
		Animal ethics
Animal–machine–human	A flock of birds hits the turbines of an airplane, which crashes with 300 passengers on board	Animal ethics
		Technology ethics
Machine–human–animal	An unmanned aerial vehicle fires at a wanted dictator and kills a few chickens along	Machine ethics
		Military ethics
		Animal ethics
Machine–animal–human	A self-driving car rolls over a blind man's guide dog, and the owner loses orientation	Machine ethics
		Animal ethics
		Human ethics

focuses on the 2-angle relationship between machine–animal and the 3-angle relationships machine–human–animal and machine–animal–human. The machine in the focus is the (partly) autonomous, acting and deciding machine, which can act as a subject of morality.

In total, there are more types of (partly) autonomous systems and more (partly) autonomous machines than ever. All over the world, people are working to try to change partly autonomous machines to autonomous machines. Agents, chatbots, military UAV, robots such as care and service robots, self-driving cars and computers in the automated trading are the most popular examples. This list already shows that there are very different types for very different purposes.

4.1 Anthropomorphous agents and chatbots

Anthropomorphous agents assist in learning environments as teaching agents (Bendel 2003), and in virtual environments, they act as contact partners. Chatbots inform people about products and services, and they serve for entertainment and customer allegiance. Therefore, personal and social aspects are considered. One can ask them about their hobbies, their age, whether they have a partner, or compliment or taunt them. They are at work on websites all over the world. They are a fix part of e-business and more specifically of e-commerce.

Agents and chatbots are at home in the virtual reality while animals are at home in the physical reality. They are not users such as human, and therefore, a relation is not evident on first glance. However, TVs and screens are omnipresent, and by image and sound, they also influence animal life. Maybe one day agents and chatbots will also be involved in companion animal entertainment and companion animal care. They do not smell, and therefore, in the perception of most animals, they probably are no more than a shadow of their keepers. Still it can be imagined that they might play a role in animal husbandry. Intelligent systems also can recognize animals' needs. Furthermore, virtual animals might also appear as agents in conjunction with corresponding avatars.

Machine ethics tries to realize agents and chatbots as ethical machines. Of course natural language capacities are in the focus of attention (Bendel 2013b). The animal is part of the constellation of the frequently occurring human–machine–animal relationships rather coincidentally. Machine–human–animal and machine–animal relationships are also possible. Machine and animal ethics can analyze hand in hand how agents and chatbots could be designed in animal-friendly ways. This would require answers to the question how virtual beings and real animals interact, and which aspects of morality this raises. Animals should not encounter a void as response to their actions,

and they should be exposed to a virtual world free of scents and reduced to a screen.

4.2 Service robots

Service robots in the widest meaning of the term provide services, entertainment and care. They fetch and bring objects, food and medicine, or they monitor the environment of their owners or the status of patients. Mowing, vacuuming and nursing robots have become reality some time ago, and they are in use in many households or institutions. Frequently, they are partly autonomous and moving about in a certain area, for instance in gardens or in apartments. Robotics and artificial intelligence (AI) are applied to develop robots that imitate human appearance and behavior, and find their whereabouts in the human world.

Service robots are superior to agents and chatbots in that they can move in the real world, for instance they can really prepare and serve meals. They are well adjusted and have no problems with human dimensions or animal dimensions, at least on the scale of companion animals. This will probably make them relevant for animal keeping. They can play with animals, they can walk dogs, tend to companion animals, protect and feed them, or they can control and limit free-range animals such as bears or wolves.

Machine–human–animal relationships (a robot serving human, the animal is involved more or less by coincidence) and machine–animal–human relationships (a robot serving and monitoring the animal in the presence of human) are the most frequent relationships. There are also some pure machine–animal relationships. Machine ethics and animal ethics can work together to design animal-friendly service robots—from simple vacuum robots that spare spiders to very complex machines. The challenge is to find the best design in size, appearance, mimics and gesticulation, and which actions are morally justifiable, and in the interest of animals. Again, the question is how domestic and free-range animals feel when exposed to android objects quite similar to humans, but without their smell, with only limited gesticulation and mimics or otherwise seem artificial.

4.3 Animal robots

Most animal robots have a function in entertainment and care, and as such, they are special forms of service robots. The therapy seal Paro (www.pororobots.com), designed for demented patients, is a very popular example. Artificial animals are especially well accepted by humans. The expectations toward them are relatively low according to the theory of the uncanny valley (MacDorman 2005), so usually they can at least fulfill or even exceed the demands.

The expectations toward humanoid robots on the other hand are very high and hard to fulfill.

More and more animal robots are being developed to take over a function in swarms, flocks or herds in poorly accessible regions or in ecosystems that are out of balance, or to take over tasks of animals, for instance robofishs and robobees (see www.engr.washington.edu/facresearch/highlights/aa_robofish.html and robobees.seas.harvard.edu). In some cases, they can also act as service robots to assist game keepers or forest keepers with self-reliant work. Classic (military or civil) UAV can be used for monitoring.

Machine–animal relationships are typical of this range of application, where frequently few systems are opposed to many beings. Machine and animal ethics have to discuss in how far autonomous animal robots can be useful or even hazardous. Bioethics and environmental ethics can provide valuable contributions in this matter. Robot behaviors that scare animals, hurt them or endanger their lives, impair their habitation or limit their opportunities for development and unfolding have to be avoided. Attacks on animal robots which might damage the real animals, for instance when they bite animal robots, also are an issue to be considered.

4.4 Military unmanned aerial vehicles

The purpose of military UAV is to explore areas, to monitor objects, to destroy systems and to kill people. Military UAV usually are part of an unmanned aircraft system (UAS), which also includes the ground station for take-off, touch-down and refueling, as well as the station for controlling and monitoring of the flight. Their flight is (partly) autonomous or remote-controlled. Usually, any killing is initiated out of station at present.

When humans are on the attack, the killing of animals is widely accepted. Large-scale destructive actions always bear the risk of killing animals. Military UAV are no exception from this rule. An animal that is in the way of elimination will hardly be considered. The use of mass destruction weapons and masses of UAV, for instance if flocks of UAV fly over an area, which is the vision of many, creates a very high risk of collateral damages. Even if not on the attack, UAV might impair the habitation of animals, for instance, of birds, simply by their mere appearance, or by collision or noise.

Machine–human–animal relationships are in the focus except if a "war" is going on against animals (for instance to limit certain populations). Machine and animal ethics analyze ways to make UAV animal-friendly. This could lead to the conclusion that UAV must not be used in general, but this is not an object of machine ethics. Machine ethics in conjunction with animal ethics takes efforts to make sure that machines will recognize animals as protection-worthy beings even at war and in the defense against terrorism, so that they will take the necessary maneuvers and fire without creating risks for civilians.

4.5 Self-driving cars

Self-driving cars shall assist drivers or make drivers unnecessary, mitigate the risks of accident, and optimize traffic. There are many models that can park or brake on their own (for instance when approaching a road block). There are also successful prototypes, for instance the Google-car, or projects like the Safe Road Trains for the Environment (SARTRE) of the EU (Büttner 2011). At the time being, traffic characterized by such vehicles is still a vision.

Every year, millions of higher developed animals are killed on the road. In the USA alone, there is an estimated million road kills per day (Wollan 2010). Most of them probably are free-range animals, in particular birds, hedgehogs, deer and so on. Companion animals are also affected, especially dogs that are on board and killed in cities and villages. Self-driving cars might in certain circumstances respond better and faster on free-range animals than vehicles steered by humans, and warn them proactively.

Machine–animal–human relationships are typical of this range of application. Humans are usually only co-pilots or passengers and hence only marginally involved. Ethical machines in traffic would calculate and estimate the consequences of accidents by means of centralized or decentralized concepts (Bendel 2013a). This could help as well as damage animals. With formulas aligned to economic interests, humans might prefer damaging the animal rather than the car (Bendel 2012c). Obviously, this is another challenge for machine and animal ethics.

5 Conclusion and outlook

Technical systems have affected many relationships between humans and animals for many years. Assuming a certain level of autonomy and intelligence, they can even be the subjects of moral relations. They can be one on one with animals, without humans supervising them.

Machine ethics analyzes the morality of (partly) autonomous machines. So far, animals had not been in its focus of attention. This paper established a system for the relations between humans, animals and machines. Then, possible interactions between machine and animal ethics on certain fields were pointed out. Although the development is in full process, and moral machines mainly are in the design phase, the need for action and research has become obvious. Animal ethics has to meet new challenges, and

animal–machine interaction should be put on a level with human–machine interaction, with machine and information ethics as parts or partners.

Assigning responsibility will be more difficult. At the one hand, human morality is transferred to technical systems. On the other hand, technical systems are learning, observing their environment, analyzing cases and looking for references. One can imagine machines that would refuse to kill on command if this causes too many casualties—humans or animals. This means these machines would act against the will of the warlords or warladies. Obviously, it would be difficult to blame an individual system programmer or client. Making machines liable is also a questionable concept. Ethics has to face brand new challenges and questions, and there will be no simple answers.

New answers could also come from a look at Descartes and his successors. In general, a comparison between animals and humans is problematic. Even Descartes had seen the difference. In conclusion to the above explanations, we have to say that machines, just as animals, cannot assume liability ("liability" as in breeding, feeding, living in a herd or similar responsibilities be excluded at this time). Still they can have duties in a certain sense. They can make ethical decisions, and if they do so, they have to do so in a certain way. We cannot sue them, we cannot make them liable, but we can shake our heads and tell them they made a mistake (through our own failure). Then, we can help them to better fulfill their duties.

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