RESEARCH ARTICLE

The ethics of sustainable AI: Why animals (should) matter for a sustainable use of AI

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Abstract

Technologies equipped with artificial intelligence (AI) influence our everyday lives in a variety of ways. Due to their contribution to greenhouse gas emissions, their high use of energy, but also their impact on fairness issues, these technologies are increasingly discussed in the "sustainable AI" discourse. However, current "sustainable AI" approaches remain anthropocentric. In this article, we argue from the perspective of applied ethics that such anthropocentric outlook falls short. We present a sentientist approach, arguing that the normative foundation of sustainability and sustainable development—that is, theories of intra- and intergenerational justice—should include sentient animals. Consequently, theories of sustainable AI must also be non-anthropocentric. Moreover, we investigate consequences of our approach for applying AI technologies in a sustainable way.

KEYWORDS
animals, artificial intelligence, ethics, sustainability, sustainable AI, sustainable development

1 | INTRODUCTION

Technologies equipped with artificial intelligence (AI) influence our everyday lives (at least in industrialized countries) in a variety of ways. Due to their omnipresence, a constant reflection of these technologies' ethical challenges is central. For good reason, the field of AI ethics has become a very large area of applied ethics, which is growing steadily. Furthermore, the necessity of a transformation toward more sustainable societies is also intensively discussed, within philosophy as well as in a variety of policy papers and reports. In short, sustainable development (SD)[1] discusses the fairest possible distribution of existing resources between people living today, while leaving sufficient resources for future generations as fairly as possible. The urgent

need for this discussion is due to circumstances that also influence our everyday lives (all over the world). It is widely recognized that societies that build upon a materialist notion of economic growth, must be considered unsustainable due to their massive use of resources, and that unsustainable societies come along with negative consequences on a larger scale. Such negative consequences of unsustainable societies and lifestyles represent some of the major challenges of our time, such as biodiversity loss, global warming, or the increased likelihood of pandemic and epidemic outbreaks.

Because of their significant relevance, AI technologies as well as (opportunities for) SD are intensively discussed in academia, politics, and the media. More recently, the two fields have been brought together under the term "sustainable AI" or "green AI" (cf. Section 2). On the one hand, AI systems can accelerate the transformation to SD if used appropriately. On the other hand, AI technologies can be accompanied by high energy and resource consumption (cf. Dauvergne, 2020; Dhar 2020; van Wynsberghe, 2021; addressing

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[1]For the purpose of this paper, we use the terms Sustainable Development and sustainability synonymously, while being aware that they come with slightly different connotations. We prefer the term Sustainable Development (SD), since it indicates terminologically the processual nature of transformations towards SD / sustainability.

"ecological sustainability,") as well as by reproducing social inequalities and increasing unemployment and labor displacement due to higher degrees of automation in manufacturing as well as service industries (cf. Barocas & Selbst, 2016; Dauvergne, 2020; Frey & Osborne, 2013; addressing "social sustainability," including the economic realm). This potential of AI systems about SD is highlighted by van Wynsberghe (2021), when differentiating between "AI for sustainability" and "the sustainability of AI".

What is common for these discussions—about AI, SD as well as sustainable AI—is that they are predominantly morally anthropocentric in nature, that is, only take human interests into account and hold this to be morally sufficient. AI ethics is concerned about how the technologies can and should be designed, developed, and used for benefiting humans while not violating crucial human interests, for example, reproducing sexist, racist, or classist biases (Barocas & Selbst, 2016), diminishing privacy (Stahl & Wright, 2018) or replacing esteemed human interactions (Brand et al., 2023). SD is often referred to as being about how to meet the needs of all human beings living today "without compromising future generations [of humans] to meet their own needs" (WCED, 1987, chapter 2). Accordingly, sustainable AI is mostly discussed within an anthropocentric framework, according to which technology is to be developed and used in such a way that it balances the interests of humans living today with those of humans living in the future. In doing so, a careful treatment of nonhuman individuals and ecosystems is considered and addressed, but for the sole reason that they should benefit today's living humans and be preserved for humanity's future generations. While this is a highly important endeavor, in this article we want to argue that such an anthropocentric perspective on AI, SD, and sustainable AI falls short. Nonhuman animals are also to be considered morally for their own sake (cf. Section 4) and accordingly, their interests should be considered in these debates.[2] Since, we have discussed elsewhere the need to include animals in AI ethics (Bossert & Hagendorff, 2021) as well as SD ethics (Bossert, 2022), in this article we focus on the debate about sustainable AI. Next to a rather small number of investigations on sustainable AI that are at least open for going beyond anthropocentric perspectives (Bolte et al., 2022; Owe & Baum, 2022; van Wynsberghe, 2021), we are not aware of any further non-anthropocentric contributions to the sustainable AI debate. While being valuable contributions to an otherwise anthropocentric discourse, these investigations do not go into detail about ethical arguments for why animals need to be included in the debate on sustainability and SD—including sustainable AI. We present such arguments in this article.

We hold this to be a contribution to the debate on sustainable AI from the field of applied ethics. A central task of (normative) ethics is to evaluate actions in order to distinguish what is morally right and wrong, thereby giving arguments for how to treat other individuals in

a morally sound way. Applied ethics is discussing this regarding particular fields of application as we do here for AI technologies and other animals under the "umbrella" of SD. Therefore, we think this contribution goes beyond the practical philosophical discussion on AI technologies, and contributes to a broader spectrum of disciplines that engage with AI, SD, and/or non-anthropocentric perspectives.

To do so, in the following, we will give a brief overview of our understanding of AI, the aspects of AI ethics important to our argument, as well as a brief overview of the current debate on sustainable AI (Section 2). We will then make an argument why an anthropocentric perspective on SD and sustainable AI falls short when ignoring the human treatment of animals (Section 3) since this treatment manifests itself in an industry that needs to be perceived as a highly unsustainable industry. Afterwards, we will present the normative foundation which underpins that SD—and sustainable AI accordingly—should be framed in a non-anthropocentric way (Section 4). What such extension would mean for this debate, we discuss in Section 5, before the final section summarizes our arguments and considers research desiderata arising from them (Section 6). The upshot is that using AI technologies for, for instance, further automation and improvement of animal agriculture is nothing that can be promoted in the name of SD.

2 | THE ANTHROPOCENTRIC TAILORING OF AI ETHICS AND SUSTAINABLE AI

When referring to AI technologies, we mean different techniques in machine learning, ranging from model architectures like transformers to classical deep learning methods (CNNs, RNNs, and GANs), decision tree learning, support vector machines, clustering methods, regression analysis, and so forth. These approaches to machine learning are primarily used in computer vision, natural language processing, robotics, or recommendation systems for means of classification, continuous estimations, ranking, clustering, anomaly detection, or data generation. Normative discussions surrounding these technologies comprise alignment or AI safety research as well as approaches that are based on traditional discourses in the field of applied ethics. The former aims at using technical means to align AI systems, primarily large language models, with human interests. Such alignment research is solely based on an iterated amplification of human, not nonhuman interests. Of course, nonhumans cannot interact with AI systems the same way as humans can. However, since AI systems affect human as well as animal lives in many ways, the idea that AI systems have to be aligned solely with human but not animal interests, is problematic from an animal ethics perspective but also regarding non-anthropocentric concepts of sustainability (cf. Section 3).

Next to alignment research, AI ethics has established itself as a branch in applied ethics research (for an overview of its guidelines cf. Hagendorff, 2020). Over the last few years, the field honed on a specific set of moral principles that are specific to AI research and development. According to most guidelines, these principles comprise fairness, transparency, non-maleficence, accountability, privacy, autonomy, well-being, as well as sustainability (Jobin et al., 2019).

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[2]Regarding the usage of the term "(nonhuman) animal," we want to refer to our statement in [removed for anonimization]: "quote removed for anonimization" Furthermore, animals that possess interests are sentient animals (cf. Section 4). Again, for the sake of readability, we speak of animals instead of sentient animals. Keep in mind that in this paper, we are dealing with sentient animals, not all animals.

Whereas some of these principles may exclusively pertain to humans, others solicit the inclusion of animals, except for transparency, accountability, and privacy. This can be argued for not just theoretically. Research on AI systems that are applied specifically to animals (Bossert & Hagendorff, 2021), as well as empirical investigations of speciesist bias in foundational language and vision models (Hagendorff et al., 2022; Takeshita et al., 2022) reveal the many disadvantages and harms that AI systems can afflict on animals. However, although a handful of papers demanding otherwise (Bendel, 2018; Owe & Baum, 2021; Singer & Tse, 2022; Ziesche, 2021), AI ethics has a purely anthropocentric tailoring where nonhumans are not part of normative considerations, despite the overlaps between concepts like fairness, well-being, sustainability, and so forth, with issues in animal ethics.

Sustainable AI is currently intensively discussed. Numerous academic contributions address, for example, economic (Vaio et al., 2020), operationalization-oriented (Rohde et al., 2021), and SDG (Sustainable Development Goals)-related aspects (Gill & Germann, 2022; Sætra, 2021a, 2021b; Truby, 2020; Vinuesa et al., 2020) of how AI systems can be designed, developed, and applied in more sustainable ways. This discussion is necessary because of the negative environmental impacts AI systems can come along with (due to high greenhouse gas emissions and energy use, cf. Coeckelbergh, 2021; van Wynsberghe, 2021) as well as their potential to reproduce social injustice due to fairness biases or a focus on the needs of people in the Global North (Zou & Schiebinger, 2018). Explicit ethical contributions, addressing the normativity of sustainable AI, have been elaborated by van Wynsberghe and colleagues (Bolte et al., 2022; Coeckelbergh, 2021; Owe & Baum, 2022; van Wynsberghe, 2021). Thereby, the approaches of Bolte, van Wynsberghe, and their colleague are open to non-anthropocentric perspectives, but do not address how these might be conceived and with what consequences for AI ethics they would be accompanied. Owe and Baum (2022) illustrate the urgency of a non-anthropocentric view on sustainable AI and show that, on the one hand, the field of sustainability still comes (too) short in AI ethics and, on the other hand, where it is thematized, nonhuman individuals do not play a role. However, Owe and Baum do not offer an argument why animals need to be included in the debate on sustainability and SD—including sustainable AI—as we do in the following.

3 | SD AND SUSTAINABLE AI CANNOT IGNORE ANIMAL-RELATED ISSUES

Pressing current socio-environmental crises like climate change or biodiversity loss are related in one way or another to the prevalent human treatment of animals. For example, emissions from global animal agriculture are driving climate change, deforestation for grazing and animal food crops contributes to biodiversity loss, and keeping many animals in (too) confined spaces can lead to outbreaks of zoonotic infectious diseases, which in turn can reach epidemic or pandemic dimension (UNEP, 2020). This is equally true of human contact

with wild animals when they are traded. The negative consequences of global animal agriculture have been identified by numerous scientists as including extremely high land consumption, deforestation, degradation of arable land, consumption of very large quantities of freshwater, increased ocean acidification and pollution of water, air, and soil by manure, hormones, antibiotics, and other "by-products" of animal farming (Boscardin, 2017; Kemmerer, 2015; Steinfeld et al., 2006; Twine, 2010; Weis, 2013). The latter are accompanied by impacts on the global nitrogen and phosphorus cycles, contributing to the fact that these cycles represent one of the two so-called planetary boundaries that humanity has already crossed.

For these reasons, global animal agriculture is not sustainable. The negative environmental impact of this industry harms many people, today and in the near future. Further, it comes along with negative social consequences as well (Hodson & Costello, 2012), leading, for example, to a higher degree of domestic violence among slaughterhouse workers (Pachirat, 2013). Therefore, even from a purely anthropocentric perspective, animal agriculture needs to be discussed within SD. However, current debates on SD do not discuss this as a major field of practice that needs to be reduced. If at all, then proposals are discussed on how to advance the "sustainable intensification" of animal agriculture (Dubeux et al., 2017), sticking to the perspective that animal agriculture is needed also in a framework of SD. A reason for this blind spot in the SD debate may be the so-called agricultural exceptionalism, according to which agriculture is politically and market-economically treated differently than other industries (Blattner, 2020; Eisen, 2020).

This is relevant to AI issues in that AI technologies are being used to "perfect" this unsustainable industry (cf. Carpio et al., 2017; Menaker, 2020; Neethirajan, 2021). Like other AI applications, this use should be accompanied by ethical reflection. On the one hand, questions of animal welfare are significant. Increased animal welfare is often referred to as justification for applying the technology (cf. Carpio et al., 2017; Neethirajan, 2021). On the other hand, it is also necessary to ask whether this industry should continue to be desired at all or whether a reduction is not rather ethically preferable. If the latter, AI ethics should as well address the question of whether or not the application of AI systems should take place in a negatively valued industry. This is closely linked to the debate around sustainable AI. If one understands sustainable AI as referring to the concrete ecological (and socio-ecological) impacts of the specific technology ("the sustainability of AI" according to van Wynsberghe, 2021), it may be evaluated detached from the field of application. However, if one considers the application area of the AI system ("AI for sustainability" according to van Wynsberghe, 2021), the usage in an unsustainable area leads to the conclusion that this is not a sustainable use of AI technology. To be sure, one goal often emphasized for applying AI in animal agriculture is to make this field more sustainable. However, in our view, evidence is strong that the solution in terms of a transformation toward SD should be to reduce the scale of animal agriculture (cf. Blattner, 2020; Steinfeld et al., 2006; Twine, 2021), rather than trying to intensify it using new technologies (cf. Section 5).

This conclusion can be reached with a perspective focusing on human interests only, since the animal industry entails strongly negative consequences for humans—today and in the future. We consider this argumentation important. But going beyond that, we want to argue that animal interests should also be considered directly in the debates on SD and sustainable AI and that the normative basis of SD allows or—depending on the perspective—requires this.

4 | "NOT FOR HUMANS ONLY": A NON-ANTHROPOCENTRIC NORMATIVE FOUNDATION OF SD

Most animal ethicists agree that the interests of animals should be taken into consideration when evaluating actions (asking if a particular action is ethically speaking right or wrong), as is one major task of normative ethics.[3] The argument builds upon the assumption that sentience is the prerequisite for having interests and that individuals who have interests have—at least—an interest in being free from pain and feeling positive emotions. Thereby, interests are seen as strong interests (related to one's own well-being), that is, that something is not only *in the* interest of someone or something (weak interests), but that someone *has* this interest themselves. When evaluating actions, all affected interests by all individuals who have interests (in a strong sense), need to be considered. Since sentient animals have interests (Bekoff & Pierce, 2009; Bradshaw, 2009), they need to be taken into consideration as well.[4]

From this, one can conclude that the interests of animals need to be taken into consideration if they are affected by actions that fall in the realm of SD. However, going beyond that argument, we argue that the normative foundation of SD itself requires to take animals into account.

The normative foundation of SD is intra- and intergenerational justice. This is derived from the important Brundtland report, which states that "[s]ustainable development is development that meets the needs of the present without compromising future generations ability to meet their own needs" (WCED, 1987, chapter 2, 1.). To be able to concretize this normative foundation, *theories of justice* are needed. One needs to find answers to the question of *what* should be distributed to *whom* and *how*. Accordingly, to be more precise, theories of distributive justice are needed since they provide answers to the what, whom, and how questions.

Furthermore, to give convincing answers to the question, of what should be distributed to whom and how, one must know what humans and other animals need for a good life. Thus, also *theories of the Good Life* are needed for concretizing what intra- and intergenerational justice can (and should) mean. These theories must be normatively demanding and at the same time empirically founded.

Normatively demanding in the sense that a convincing understanding of good life must go beyond a basic needs approach. Individuals need more than just sufficient food, water, adequate clothing, and a roof over their heads for a truly good life (Nussbaum, 2000). It must also provide sound empirical evidence for what it claims regarding the (normatively demanding) needs of individuals. In the case of animals, moreover, this empiricism is needed in order to actually meet the needs of animals and not to apply a naive anthropomorphism.[5] Insofar as scientific studies prove that certain animals actually have certain needs, the assumption of these needs does not correspond to a mere transfer of human value concepts to these animals (De Waal, 1999).

So, derived from the "abstract" normative foundation of SD, intra- and intergenerational justice, theories of distributive justice, and theories of the Good Life are the (more concrete) philosophical basis of SD. Both of them can convincingly be—and are—applied to animals, and, as we argue, also *should* be applied to them.[6]

Within the last decades, animal ethicists (as well as environmental ethicists, cf. Wienhues, 2020) developed theories of interspecies justice and argued that animals need to be included in the community of justice (for many, cf. Garner, 2013; Nussbaum, 2022). The community of justice thereby is not the same as the moral community since justice and morality are overlapping but not congruent concepts. The arguments by which animals are included in the moral community are therefore not sufficient to include them in the scope of justice.

For this inclusion, it is noteworthy that, in our opinion, all counter arguments against including animals in the community of justice fail. A common counter argument holds justice to be something that rational beings owe each other, thus excluding both animals and non-reasoning humans. Since a broad consensus exists that no groups of humans should be excluded, the argument is usually constructed in a way that includes all humans but leaves animals excluded. This is often justified with so-called *kind-of* arguments. According to these arguments, the average adult human is rational and human individuals who are of a kind like this prototype of the human species should be treated in the same way as they are for reasons of justice. This is equally true if the individuals lack certain abilities that the human prototype possesses, such as rationality. Kind-of arguments refer to different kinds of similarity. It can refer to what is considered the *natural* endowment of the average adult human, to what is considered *normal*, or to *potentialities* or *group*

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[3]"Not for humans only" is the title of Singer (2003).

[4]Things are getting more complicated when asking about how different interests should be weighted and which interests should be given priority. Principles and normative guidelines need to be elaborated to answer this (as is done within animal ethics), but this is the same for intra-human ethics and no reason for an exclusion of particular interests from the beginning.

[5]Naive anthropomorphism refers to ill-considered attributions of human characteristics or values to animals that do not stand up to scientific scrutiny and say more about the attributing person's set of values than they do about the animal (De Waal, 1999, pp. 260–262, who calls this anthropocentric anthropomorphism). It's opposed to a so-called critical anthropomorphism that can be used as a method to generate and test behavioral hypotheses and to better understand individuals of other species by trying to empathize with them (Burghardt, 2007).

[6]It can of course be challenged that intra- and intergenerational justice are the most convincing normative foundation of SD (for another approach cf. Becker, 2012). Furthermore, it needs more philosophical discussion if justice is the appropriate normative foundation for non-anthropocentric approaches to SD. For the purpose of this paper, we take it as an appropriate foundation while being open for debate.

membership (e.g., species membership). However, these kind-of arguments are not convincing (Nobis, 2004).

Using a kind-of-argument regarding to what abilities people "naturally" possess is problematic, since on the one hand it involves a normative exaggeration of "the natural" and on the other hand it is questionable why, for example, a high cognitive ability should be more natural than a very low one, when both occur in uninfluenced human reproduction.

To define a "normal" human being against whom all other humans are measured is also questionable. Among other things, this may lead to a pathologization of all those who do not fit into this scheme. A certain type of human is set as a normative standard instead of acknowledging diverse expressions of being human.

When referring to group membership, most often the belonging to the species of *Homo sapiens sapiens* is addressed, as the argumentation is based on the desire to include all humans while excluding animals. Within animal ethics, this is known as speciesism. "Speciesism (…) is a prejudice or attitude of bias in favor of the interests of members of one's own species and against those of members of other species." (Singer, 2015, p. 35) As the term prejudice indicates, the arguments for such attitude often are missing, unconvincing, or rather easy to disprove. We think animal ethicists did a good job in arguing why speciesism is problematic (Bekoff & Gruen, 1993; Horta, 2010; Jaquet, 2021; Singer, 2015, 2016).

Already the initial argument, according to which justice is something that rational beings owe to each other, is problematic. The capacity to reason should be irrelevant to whether or not an individual is considered from a justice perspective. It does not follow that reason should not play a role within the sphere of justice. To be able to act justly and to take responsibility for one's own actions, it is necessary to be able to reason. Further, to establish convincing principles of justice, this is equally true. But it is not sufficient for the sole justification of who is part of the community of justice. Thus, an important argument for including sentient animals in this community is that the common counter arguments are based on problematic assumptions.

Theories of justice that can be considered a useful foundation for SD need to focus on distribution justice and theories of Good Life, as already mentioned.[7] One particularly useful approach, which represents a theory of justice *as well as* a theory of the Good Life, is Martha Nussbaum's capabilities approach, which Nussbaum (2007, 2022) extended to animals. Like justice and morality, the just and the good are not congruent, but Nussbaum's capability approach aims to illustrate what it takes for a good human and animal life[8] as well as how just societies can be constituted. With this, the capability approach can be seen as a useful specification of intra- and intergenerational justice.

Following from the above, we argue that the normative foundations of SD must be framed in a non-anthropocentric way. This should be included in the academic debate (there are few exceptions to the anthropocentric framework, cf. Bergmann, 2019; Boscardin & Bossert, 2015; Earnshaw, 1999; Narayanan, 2016; Twine, 2010; Verniers, 2021) as well as the political (for an exception cf. pertinently Sebo et al., 2022) and media debate. Thereby, it is important to note that animals do not "only" fall within the realm of so-called ecological sustainability, but also within the realm of so-called social sustainability. Due to the close entanglements of both realms, it would be more precise to instead speak of socio-ecological sustainability. But since the terms ecological and social sustainability are common, we use them here as well. Of course, ecological sustainability is important for animals as well. Wild animals need sufficient habitats and a climate in which they can flourish and all animals need food and fresh water. However, domesticated animals—whose numbers significantly exceed those of wild animals—are part of human societies. Within current animal ethics there is a large debate on which status these animals should receive and if they could and should be represented in political decision-making (for many cf. Donaldson & Kymlicka, 2013; Hooley, 2018). No matter how one answers these controversially discussed questions, one cannot negate that domesticated animals are part of human societies. Accordingly, they must be considered in the realm of social sustainability. In the next section, we investigate what consequences such a rethinking might have specifically for the field of sustainable AI.

5 | THINKING "SUSTAINABLE AI" NON-ANTHROPOCENTRICALLY

As pointed out in Section 3, if one does not only focus on the sustainability related issues of a particular AI technology—like the amount of energy it needs or of carbon emissions it emits ("the sustainability of AI")—but takes the *application field* of the particular technology into account, it follows that many AI technologies currently used on animals should not be evaluated as being sustainable. The field of animal agriculture, where much of the current use of AI for animal-related issues takes place, as such is a highly unsustainable field. It may be true that this field could be transformed into being more sustainable with the help of AI technology in regard to its carbon emissions, water and land use, and so forth. However, we argue that the animal

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[7]One (if not the) most influential theory of (distributive) justice is John Rawls' *Theory of Justice* (1979). While Rawls himself excludes animals from the community of justice, his theory has been extended to include animals, and important theories of justice oriented towards Rawls that include animals have been elaborated (Coeckelbergh, 2009; Gabardi, 2017; Rowlands, 1997, 1998). We will not recapitulate them here, but it should be highlighted that these important contributions incorporate animals into contractarian approaches to justice, which are more difficult to apply coherently and consistently to non-rational individuals than others (Garner, 2012, p. 166). Thereby, even those approaches to justice which are the most difficult to apply for animals have been developed in an animal ethical way.

[8]Nussbaum's approach allows for assumptions about a good animal life that build on a sophisticated philosophical theory of the Good Life and at the same time are grounded in natural science. They go beyond a mere determination of animal well-being that can be measured physiologically or ecologically only. Such assumptions are important for investigation what may constitute a form of interspecies justice. They allow to approach the question of what should be distributed to whom and how, and bequest for whom and how, in a way that it can be considered just and enables all (sentient) individuals—today and in the future—to live as well as possible.

agriculture is at odds with SD since it is not in accordance with the normative basis of SD, namely intra- and intergenerational justice. This normative basis must be applied on animals, meaning that animals—based on the arguments briefly discussed above—belong to the scope of justice as well. It is not compatible to belong to the scope of justice on the one hand and being treated merely as a sellable product on the other hand.[9]

Linking this to the sustainable AI debate, it follows that using AI technologies for further automation and improvement of animal agriculture is nothing that can be promoted in the name of SD. It is not a sustainable application of AI since it contradicts interspecies justice (meaning theories of justice that include humans and animals) and therefore the normative foundation of SD.

AI applications within animal agriculture are most often surveillance technologies that monitor animal's behavior and health condition (Manning, 2019; Zhang et al., 2019). For instance, camera vision-based AI systems are used to analyze animals for herd "management" purposes like fattening control, tracking, or facial recognition. Furthermore, AI systems are applied to automatically detect and track farmed animals such as pigs, aiming at an automatic detection of potential health problems without the need of human observation. AI based robots collect floor eggs not placed in nest boxes in industrial poultry houses. In aquacultures, echo-sounder technologies are applied for detecting whether caged fish swim near the water surface and use this as a signal for feeding times. Robotic vehicles drive around in factory farms for so-called "broilers" and move the animals around to improve the feed conversion ratio. And there are many more fields of application where AI is currently used in animal agriculture (e.g., cf. Bossert & Hagendorff, 2021; Singer & Tse, 2022).

When introducing the use of AI applications within the global animal industry, we focus on animal agriculture for two main reasons. Firstly, as argued above (Section 3) this field is—or, to be more precise, should be—of particular interest for sustainability debates, including debates on sustainable AI since it comes with many disastrous consequences for the environment and ecological as well as social systems. Secondly, it represents the field where AI technologies are most intensively used on animals.

However, it also follows from our argument that the application of AI, for example, zoos and other animal-related entertaining business should also not be seen as sustainable or as benefiting a transition to SD as long as they are used in a way that perpetuates the exploitation of animals. We hold that the animal-based entertainment industry also is at odds with interspecies justice since it comes with many different forms of harm and suffering for the animals (for many cf. Marino et al., 2020; Nussbaum, 2022, 237 ff.).[10]

To the contrary, some of the current AI applications on animals can be seen as sustainable according to our argument. This holds true when AI is used for wild animal's protection, as one can find it in many conservation projects such as _BirdVision_, _Wildbook_, the _Elephant Listening Project_, _TrailGuard AI_, or _ChimpFace_ (Bossert & Hagendorff, 2021, p. 5; Dauvergne, 2020, p. 60). To be sure, these projects focus on species protection rather than on the protection of individual animals. Nevertheless, they truly benefit individual animals. As conservation is already of great importance for SD, such applications may be at the core of what can be considered as sustainable AI.[11]

Certain AI applications that also affect animals are less clear-cut in terms of whether they are sustainable or unsustainable. This applies, for example, to automated driving (in regard to animals intensively discussed in Singer & Tse, 2022). On the one hand, this benefits individual animals, as there will be significantly fewer road kills (Singer & Tse, 2022). On the other hand, individual mobility with passenger cars is not a truly sustainable mobility concept, and is therefore—like global agricultural livestock farming—also to be assessed as rather unsustainable regardless of the impact on animal individuals. Like the animal industry, this field of application can be made more sustainable by means of AI. Automated driving would very likely lead to a reduction in CO_2 emissions generated by this sector, as cars that drive automatically are often more environmentally friendly (Liu et al., 2019). In regard to the animal industry, however, this aspect relating to the sustainability of a particular AI technology is not sufficient to assess the application as sustainable. The difference to the animal industry for us, however, is that automated driving is a field of application that also benefits animals instead of harming them.[12] In this respect, this application field could be seen as a sustainable use of AI from a non-anthropocentric perspective, provided that (i) enormous reductions of CO_2 emissions are indeed possible, (ii) the automatically driving cars are powered by energy from renewable energy sources, and (iii) the production of the lithium batteries of the e-cars is as environmentally and socially compatible as possible. Even if all this is the case, it still remains suspicious if individual mobility by means of passenger cars will be a truly sustainable mobility concept in the future either, as production is accompanied by high energy and resource requirements and countless cars for single individuals clog up cities and landscapes in times when affordable housing has become a scarce resource in many areas. Self-driving public transport, with fewer road kills happening through the use of the latest technologies, to the contrary, seems a sustainable endeavor. The use of AI technologies for this can probably be considered sustainable AI.

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[9]Obviously, some farmers would deny that they only treat "their" farmed animals as sellable products. It is beyond the scope of this paper to enter this discussion, however, we think there are convincing arguments underpinning that it is at odds to include animals in the realm of justice and continue animal agriculture as well as other forms of treating animals as merely serving human ends.

[10]In regard to animal experiments, AI technologies have a strong potential to benefit animals since they may be applied in a way that can replace lots of animals still being used for invasive experimentation.

[11]With saying this, we do not mean that ecological sustainability is more important than social sustainability. As already pointed out, it is more reasonable to use the term socio-ecological sustainability due to the deep entanglements of both realms. Protecting the planet's ecosystems and fighting climate change—important goals of conservation—is of great importance for the social realm as well.

[12]It needs to be weighed up whether the benefits of significantly fewer road kills (human and nonhuman) outweigh the harm to humans and animals associated with the production of self-driving cars and AI technologies. This goes beyond the scope of this paper.

6 | CONCLUSION AND RESEARCH OUTLOOK

Most of the debate on sustainable AI takes place in an anthropocentric manner, focusing on human interests only and ignoring the interests of animals as well as the ways humans are currently treating them within the global animal industry. Within this article, we argued that an anthropocentric perspective on SD and sustainable AI has many shortcomings. According to our argument, the normative foundation of SD—the principles of intra- and intergenerational justice—requires that animals are included within SD. Animals are convincingly included within theories of justice. To be more precise, they are convincingly included in theories of distributive justice as well as in theories of the Good Life. While the former is important for SD due to SD's strong dealing with scarce resources, the latter is needed to make claims on what should be distributed in which way. Therefore, they are also highly important for SD's normative foundation. We argue that it is not compatible to belong to the scope of justice on the one hand and being treated merely as a sellable product on the other hand. From this, we follow that the dominant treatment of animals is not something that can be evaluated as sustainable, even if technologies may help to reduce the negative environmental consequences of the animal industry. This leads us to conclude that applying AI technologies for the perpetuation of the animal industry—which currently is their main field of application in regard to animals—is not a sustainable use of AI.

As the debate on sustainable AI is still relatively young, it goes without saying that there is still a lot of research to be done. We would like to encourage both the AI and the SD community to continue working on this important topic. Preserving the basis of life and using the latest technologies for this purpose seems to us to be an extremely important challenge of our time. Doing this not only for our fellow humans (or future generations of humans) but also for our fellow (nonhuman) animals seems to us of high moral significance. In this respect, as much of this further research as possible should also take the non-anthropocentric perspective into account.

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