WHAT IS THE CONNECTION BETWEEN

SUSTAINABILITY AND AI ?

In recent years, there has been a growing focus on using AI for sustainability, exemplified by actions aligning with the Sustainable Development Goals (SDGs). Within the same context, there is also a growing focus on the sustainability of AI systems themselves. The emergence of generative AI has further strengthened that focus. However, amidst the proliferation of terms like 'Sustainable AI' and 'AI for Sustainability,' there is a critical need for more clarity. As these terms become increasingly ubiquitous, ensuring a common understanding is essential to avoid misuse and confusion.

In this brAInfood, we try to clarify the various concepts around sustainability and AI. We explain how the three pillars of sustainability also apply to AI, clarify the issues surrounding the definition of sustainability and show how the concept of sustainable AI can be divided into different branches. The main focus is on the environmental sustainability of AI systems.

This BrAInfood was created in collaboration with Sophia Falk (University of Bonn - Sustainable AI Lab). For more information on the topic, please consult 'Challenging AI for Sustainability: what ought it mean?', authored by Sophia Falk & Aimee van Wynsberghe.

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Artificial Intelligence Flanders

AI & SUSTAINABILITY: THREE PILLARS

Looking at AI and sustainability with a holistic view, we can break down this theme according to the **three pillars of sustainable development**: social sustainability, economic sustainability and environmental sustainability.

1 SOCIAL SUSTAINABILITY

AI that is compatible with social values that are fundamental to a given society. This refers to the development and deployment of AI technologies in a manner that respects and upholds the core **social values, norms, and ethical principles of the community or society** in which they are used. Examples of the social dimension in the context of AI are transparency and accountability, nondiscrimination and fairness or technical reliability and human supervision.

2 ECONOMIC SUSTAINABILITY

AI should be compatible with societies' economic models. This means that AI systems are designed and implemented in a way that aligns with the **economic principles and goals of a given society**. It involves ensuring that AI contributes positively to economic growth, efficiency, and equity, while also addressing any potential challenges or disruptions it may pose to existing economic structures.

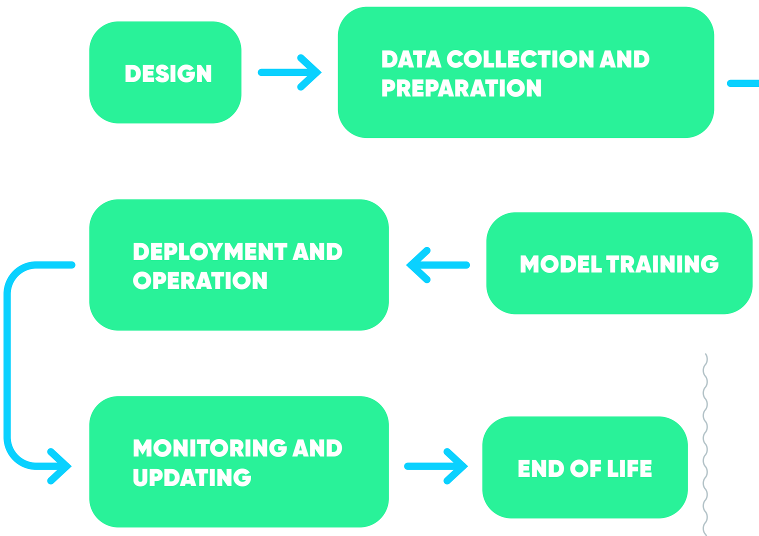
AI technologies are integrated into economic activities in a way that enhances efficiency, productivity, and competitiveness, while also generating positive economic outcomes for individuals, businesses, and society as a whole.

3 ENVIRONMENTAL SUSTAINABILITY

AI that is compatible with **sustaining environmental resources for current and future generations**. This includes topics such as energy consumption, CO_2 and greenhouse gas emissions and raw material consumption.

WHAT ARE THE VARIOUS NEGATIVE ENVIRONMENTAL EFFECTS AI CAN HAVE ALONG ITS LIFECYCLE?

The lifecycle of AI development consists of **6 phases**.



DIRECT NEGATIVE ENVIRONMENTAL IMPACT

- Research and development efforts require intensive computational resources, leading to high energy consumption and electronic waste.
- Data collection and preparation processes, along with model training, also demand significant energy and contribute to carbon emissions, especially in data centres.
- Deployment and operation further exacerbate environmental impact through ongoing energy consumption and maintenance requirements.
- Continuous monitoring and updates sustain energy usage, while end-of-life processes, if not managed responsibly, contribute to electronic waste accumulation and environmental pollution.

INDIRECT NEGATIVE ENVIRONMENTAL IMPACT

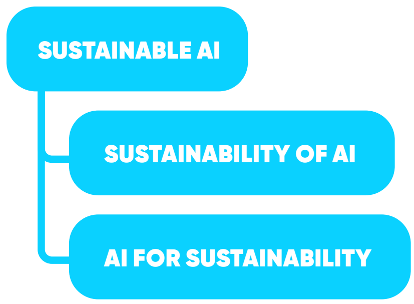
- Freshwater use, often depleted by industrial processes, including those associated with AI development and data centres, which require substantial water for cooling purposes.
- Biodiversity loss, driven by habitat destruction from infrastructure expansion for data centres and mining for rare earth metals used in AI hardware and pollution from electronic waste.

THE SUSTAINABILITY ISSUE

The concept of sustainability has been receiving a lot of attention lately, especially in discussions related to AI. However, there is a growing concern that the term 'sustainability' is being used too casually, often to simply make things sound good without much substance behind it. This casual usage has turned the term sustainability into a bit of a **buzzword**, lacking a clear definition and being used to justify almost anything.

Similarly, phrases like 'Sustainable AI' and 'Sustainability of AI' have been thrown around so much that their original meaning has become diluted. They're often used without much thought, simply to give the impression of being environmentally or socially conscious. Given these issues with the vague use of 'sustainability,' it is **necessary to delineate the term** to avoid the risk of misappropriation and or ethics washing.

WHAT IS SUSTAINABLE AI?



Sustainable AI can be seen as an umbrella term for two other items:

- **Sustainability of making and using AI:** Important considerations include energy consumption, natural resource use, waste generation (especially electronic waste), water consumption and land use, which collectively determine the ecological footprint of AI systems.
- **Using AI for sustainability:** AI for sustainability describes how AI systems can contribute to the achievement or approximation of sustainability.

For an AI system to be labelled sustainable, the system must approach both tasks. It also applies to the entire life cycle of the application.

3 APPLICATION GROUPS OF AI FOR SUSTAINABILITY

1 AI IN THE APPLICATION DOMAIN

This refers to the **utilization of AI within specific sectors**, such as agriculture or energy management, **to address sustainability goals**. More specifically, this involves monitoring and providing information (for example yield prediction in agriculture).

2 AI TOWARDS SUSTAINABILITY

This entails predictive systems that serve as **monitoring systems or information providers**, consider their own sustainability or improve their own functioning by doing but do not involve any direct action.

3 AI FOR SUSTAINABILITY

This refers to **autonomous AI systems which consider their own sustainability and perform an action**: directly contribute to sustainability outcomes through actions such as for example, pesticide reduction in agriculture, renewable energy management, and traffic scheduling optimization.

ACTION AS A DIFFERENTIATOR FOR AI SYSTEMS

The presence of information (e.g. climate predictions) is not decisive for a positive sustainability result. We are still confronted with a climate crisis, even though we have had plenty of information on that issue for years. **Only acting towards a sustainable goal can change the outcome of the situation in a sustainable direction.**

AN EXAMPLE

Using advanced machine learning techniques to manage power flow in a community microgrid demonstrates AI's potential for sustainability. With more renewable energy sources being integrated, the grid faces challenges due to its fluctuating nature. Machine learning enables swift and precise control strategies, improving grid efficiency by optimizing power flow in real time.

By addressing operational constraints and adapting to changing conditions, machine learning helps stabilize renewable energy fluctuations, reducing power loss and increasing renewable energy utilization. These algorithms autonomously make decisions, reducing reliance on fossil fuels and cutting energy-related emissions, aligning with sustainability goals.

This application satisfies the 'AI towards sustainability' conditions, by learning from past data to improve its functioning and, the 'AI for Sustainability' criterion by using the generated information to carry out an action that has a beneficial impact on climate change.

OVERCOMPENSATION

Since the development and use of an AI system itself lead to negative environmental impacts, t**he use of the AI system must overcompensate for the previous damage**. Therefore, all environmental impacts must be assessed to ensure that the use of "AI for sustainability" outweighs the various negative impacts of its production, development and disposal.