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SUSTAINABILITY RESEARCH

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EVA MAYR-STIHL
STIFTUNG

SUSTAINABLE ARTIFICIAL INTELLIGENCE: NATURE ORIENTATION AS AN ETHICAL PRINCIPLE

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ABOUT ME AND MY RESEARCH INTERESTS



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- Postdoctoral research fellow within the framework of the “Young Academy for Sustainability Research” (YAS) at the “Freiburg Institute for Advanced Studies” (FRIAS), University of Freiburg
- Main areas of research: **practical philosophy and ethics**, with a historical focus on the 19th and 20th centuries and a systematic focus on environmental philosophy, technology ethics, and the Anthropocene discourse

SUSTAINABLE ARTIFICIAL INTELLIGENCE: NATURE ORIENTATION AS AN ETHICAL PRINCIPLE

Structure of my presentation

1. Nature Orientation as an Ethical Principle
 - a) Challenges in 21st Century Bio-engineering*
 - b) Challenges of AI in terms of sustainability*
2. Normative attitudes towards nature in the present age
3. Tasks of technology ethics: The pragmatic relation of technical behaviour
4. What are ethical values (a. values in technology, b. values of nature for sustainability)?
5. Sustainable Artificial Intelligence as nature-oriented technology
 - a) The supposed immateriality of intelligence*
 - b) Situatedness of intelligence*
 - c) Relational and implicit ethical values of nature*
6. How can nature-ethical values be included (a. The value sensitive-design approach, b. Cognitive-affective mapping)?

1. Nature Orientation as an Ethical Principle

a) Challenges in 21st Century Bio-engineering

Source of inspiration	Bio-inspired	Cogno- and socio-inspired
<i>Micro-organism</i>	Proto-cell Minimal genomes Synthetic Biology	
<i>Insect, animal</i>	Cultured neuronal networks Hybrid artefact: animat Biomimetics	Animalistic robot (e.g. Paro), avatar Neurocomputer
<i>Human</i>	Biopharmaceuticals Engineered tissues (hybrid materials with living ingredients) Stem cells Hybrid artificial organs	Humanoid robot, avatar AI robots and softbots Social robots Ambient persuasive technology

**Nature
orientation
as
challenge**

1. Nature Orientation as an Ethical Principle

b) Challenges of AI in terms of sustainability

AI for Sustainability

- Reduced need for resources
- Reduction of greenhouse gases
- Efficiency of transport, e-mobility, autonomous driving, digitalized car sharing
- Electricity savings thanks to smart grids
- **Digital approaches for the optimal use of technologies** (sustainable energy sources, agriculture)
- Digital building control systems, smart home systems
- Location-independent and generally accessible knowledge and learning
- **Holistic understanding of the Earth system**

Sustainability of AI

- Increasing demand for electronic devices (demand for rare earths, **digital waste**)
- Large server and data centers with **high energy consumption**
- Trust in technological progress as an **obstacle to efforts to achieve sustainability**
- **Western, capitalist biases (or even ontologies)** that can lead to unsustainability



**Nature
orientation
as
solution:
linking the
ethics of
nature and
technology**

Creutzig, F. et al. (2022). Digitalization and the Anthropocene. In: *Annu. Rev. Environ. Resour.* 47, 479–509.

van Wynsberghe, A. (2021). Sustainable AI: AI for sustainability and the sustainability of AI. *AI Ethics* 1, 213–218. <https://doi.org/10.1007/s43681-021-00043-6>

2. Normative attitudes towards nature in the present age

- The central thesis of the **Anthropocene debate** is that, through technology-driven actions, humans are currently leaving an irreversible mark on nature in ways that are, in some cases, ecologically irresponsible.
- This debate frequently emphasizes the need for a **‘different,’ ‘new’ relationship between humans, technology, and nature**. At the heart of this demand lie normative concepts that advocate recognizing a **‘symbiotic’ relationship with nature, increasingly ‘orienting’ oneself toward nature, or living more ‘in harmony with nature’** – concepts that are **historically and interculturally conditioned** and can only be understood within that context. (cf. e.g. the briefing of the „European Environment Agency“: <https://www.eea.europa.eu/publications/exiting-the-anthropocene>).
- Against this backdrop, I aim (1) to examine and to evaluate the **relationship between nature and technology in the present day** and (2) to explore which **normative relationships with nature** can be observed here (a), and whether and under what conditions these are **justified** (b) [cf. ‘naturalistic fallacy’].
- In order to achieve this overarching goal, it is necessary to examine the **discourses on normative orientations toward nature from a historical and intercultural perspective [‘ethical naturalism’]**, and to relate this line of discourse within the framework of ethics of nature, with the one **in the context of technology ethics**, specifically in the wake of the Anthropocene debate and the environmental challenges discussed here.
- This results in a plea for an **intertwining of the disciplines of nature ethics (esp. discourse on the climate crisis) and technology ethics (esp. discourse on AI)**, based on the shared methodological foundation of **value ethics**.

Köchy, K. 2003: Perspektiven des Organischen. Biophilosophie zwischen Natur- und Wissenschaftsphilosophie. Paderborn/München/Wien/Zürich.
Marzi, Thomas et al. 2018 Fragen zu einer biologischen Technik. Oberhausen, <https://www.umsicht.fraunhofer.de/content/dam/umsicht/de/dokumente/publikationen/2018/umsicht-diskurs-biologisierung.pdf>

3. Tasks of technology ethics: The pragmatic relation of technical behaviour

Actor (technology user)

(+) instrumental relation
(-) anthropomorphic / slavish

Material (technical device)

+ norm-compliant, value-rational relation
- instrumentalistic

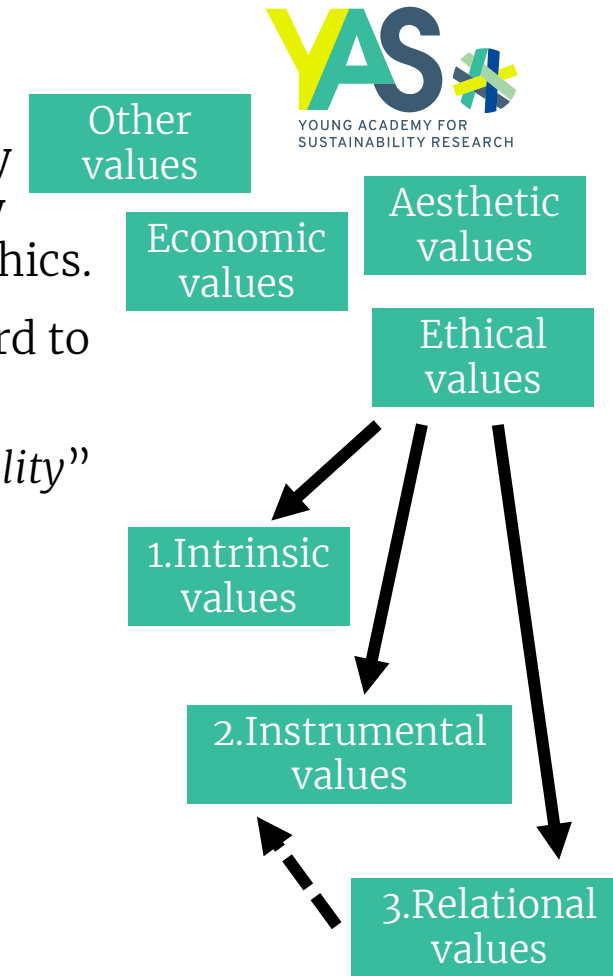
increasing convergence
(e.g. biomimetics, synthetic biology, AI)

Co-subjects (humans, animals, environment)

Ott, K. (2005). Technikethik. In: Nida-Rümelin, J. (ed.): *Angewandte Ethik. Die Bereichsethiken und ihre theoretische Fundierung*. 2nd ed. Stuttgart: Kröner, 568–647.
van Est, Rinie et al. 2012: Making Perfect Life. European Governance Challenges in 21st Century Bio-engineering. Brüssel.
https://www.europarl.europa.eu/RegData/etudes/etudes/join/2012/471574/IPOL-JOIN_ET%282012%29471574_EN.pdf

4. What are ethical values?

- Value ethics have a tradition dating back to ancient Stoicism. In the 20th century, they were primarily represented by Scheler (1916) and Hartmann (1926), and recently they have been playing an increasingly important role in environmental and technology ethics.
- Values reflect an **explicit or implicit preference behavior**: they are relational with regard to the persons, societies or cultures advocating them.
- Ethical values: “*what is important to people in their lives, with a focus on ethics and morality*” (Friedman/Hendry 2019, p. 24). They have to be **accepted** (by persons or groups of persons who tolerate an action, do nothing about it or consent to it) and **acceptable** (conform with societal principles, values, priorities, adopted norms).
- Three sorts of values (with fluid transition):
 - (1) **Intrinsic value**: inherent worth of someone or something as end in and of her- or itself
 - (2) **Instrumental value**: means to an end, usefulness for someone
 - (3) **Relational value**: something is of fundamental, eudaimonistic or *instrumental* importance for a person, a society or a culture



Friedman, B., and Hendry, D.G. (2019). *Value Sensitive Design: Shaping Technology with Moral Imagination*. Cambridge: MIT.

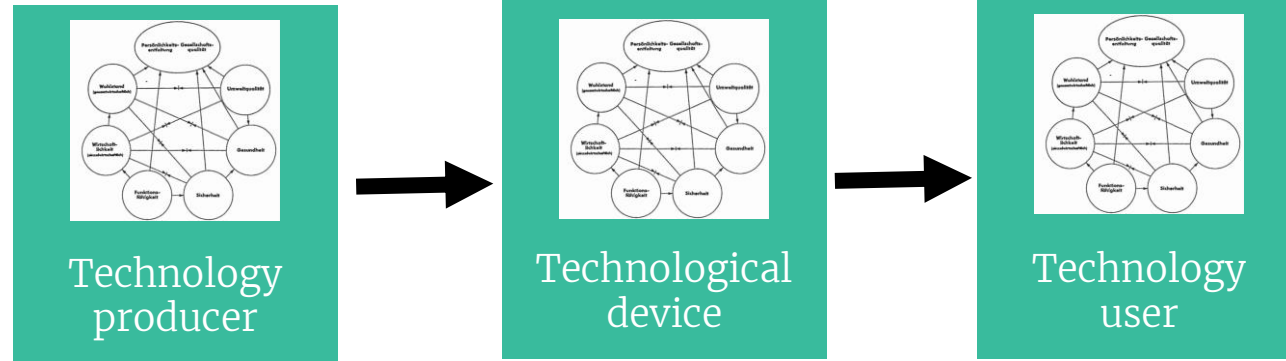
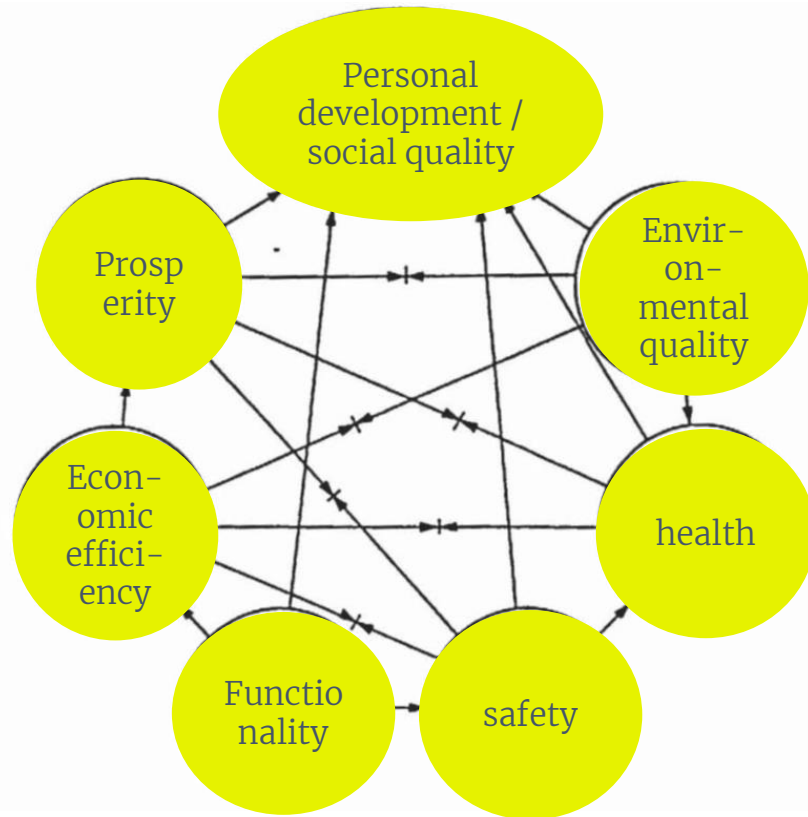
Hartmann, N. (1926). *Ethik*. 3rd ed., Berlin: de Gruyter.

Muraca, B. (2016). Relational Values. A Whiteheadian Alternative for Environmental Philosophy and Global Environmental Justice. In: *Balkan Journal of Philosophy* 8(1), 19–38.

Scheler, M. (1916). *Der Formalismus in der Ethik und die materiale Wertethik: Neuer Versuch der Grundlegung eines ethischen Personalismus*. Halle: Max Niemeyer.

4. What are values

a) Values in technology



- Hubig (1993) lists values for technologies, based on VDI 3780: Functionality, economic efficiency, prosperity, safety, health, environmental quality, personal development and social quality
- Not only values in humans, but also **embedded in technical devices** (1. in the form of the original use plan, 2. as properties that trigger actions to realize values, 3. as values autonomously generated by technical devices, esp. in AI and life-like systems)
- **Pluralism of values** that makes it necessary to weight the values
- **Conflicts** between values
- **Option and legacy values as fundamental values**, with legacy values being more fundamental in cases of doubt
 - **Option values:** options for action, variability spectra and future viability
 - **Legacy values:** identity-forming social structures and traditions
- Hubig (1993), VDI 3780 and VSD only look at the **effects or consequences for nature** (cf. ontology of the vulnerable nature), but they do not focus on **natural-ethical values in a broader sense**, some of which are **culturally or group-specific**.

Hubig, C. (1993). *Technik- und Wissenschaftsethik. Ein Leitfaden*. Berlin et al.: Springer, 142.

Friedman, B., and Hendry, D.G. (2019). *Value Sensitive Design: Shaping Technology with Moral Imagination*. Cambridge: MIT.

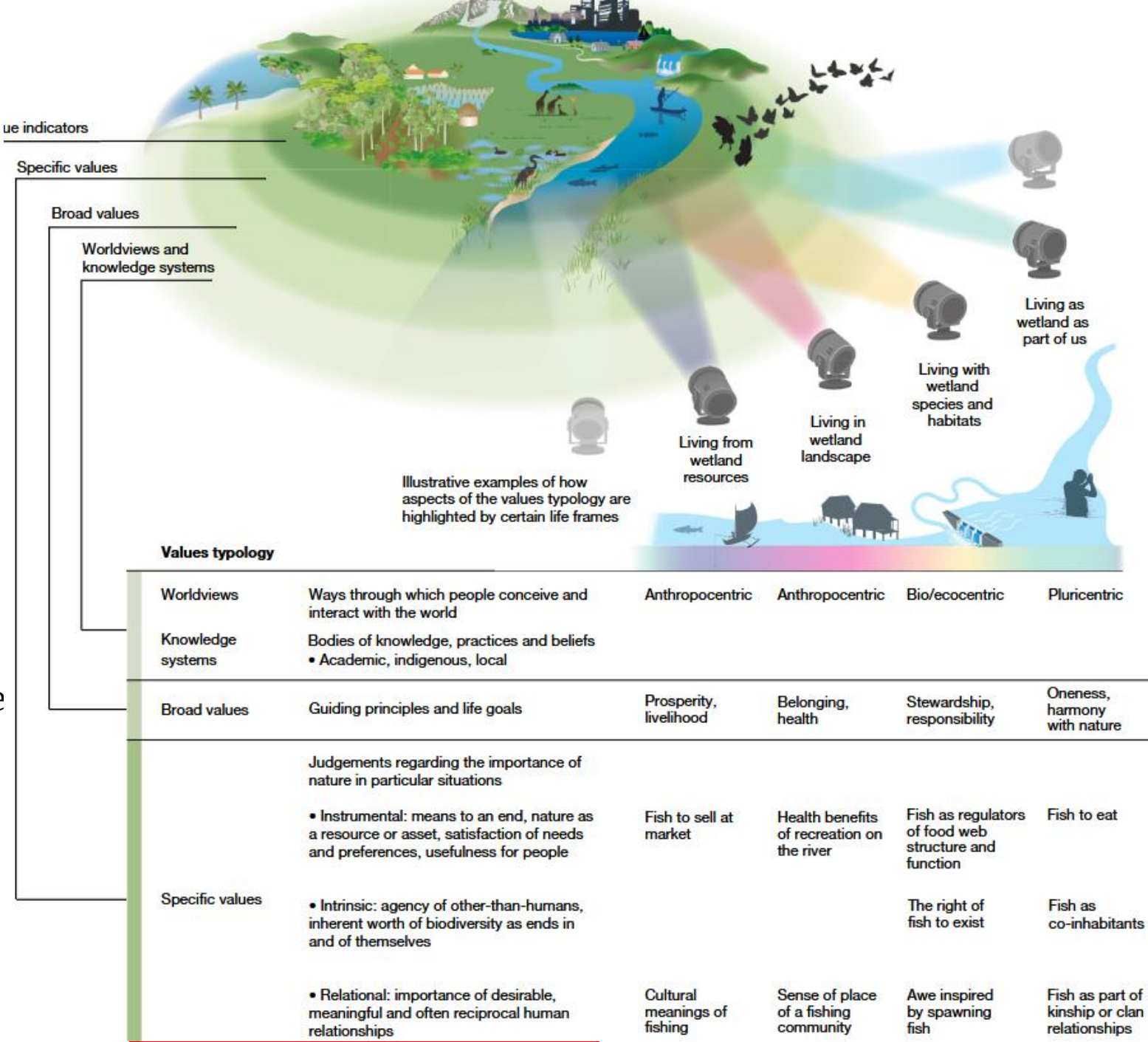
VDI 3780. 2000. *Technikbewertung: Begriffe und Grundlagen = Technology assessment*. Düsseldorf: VDI.

4. What are values?

b) Diverse values of nature for sustainability

- On the one hand, technical devices rely on nature-ethical values in form of procurement chains, ecosystem services, etc.
- On the other hand, they should take into account their **influence on images, understandings, and prejudices** regarding what nature and the natural are.
- They have explicitly or implicitly influence on nature-ethical values that are dependent on or **relational to culturally differing worldviews and knowledge systems**.

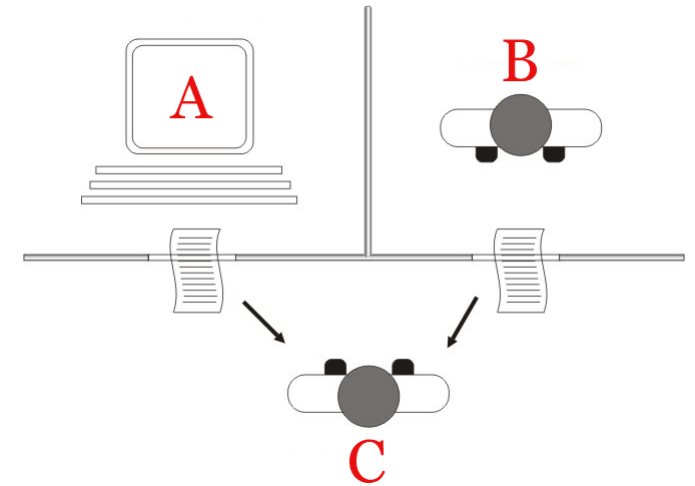
Pascual, U., Balvanera, P., Anderson, C.B. et al. (2023). Diverse values of nature for sustainability. In: *Nature* 620, 813–823. <https://doi.org/10.1038/s41586-023-06406-9>



5. Sustainable Artificial Intelligence as nature-oriented technology

a) *The supposed immateriality of intelligence*

- From the outset, AI was conceived as a **nature-oriented technology in a narrow sense**, insofar as it is intended to imitate natural human intelligence (cf. Turing Test).
- However, AI is not yet a **nature-oriented technology in a broader sense**: AI is often not sustainable, integrated into nature, and does not take nature-ethical values into account, some of which are culturally or group-specific.
- This has to do with the fact that (1) nature-ethical values are **often not explicitly present** in our technical relationship with the world and that (2) AI is often considered **immaterial and contextless**.
- Cf. Chinese Room Argument: “it is **Cartesian** in the sense that it insists that what is specifically mental about the mind has no intrinsic connection with the actual properties of the brain..” (Searle 1980, 424; my emphasis) → **nature-culture distinction, ontology of nature as ‘other’**



https://en.wikipedia.org/wiki/Turing_test#/media/File:Turing_test_diagram.png

Turing, A.M. (1950). Computing Machinery and Intelligence. In: *Mind* LIX(236), 433–460.
Searle J.R. (1980). Minds, brains, and programs. *Behavioral and Brain Sciences* 3(3):417–424.
doi:10.1017/S0140525X00005756

5. Sustainable Artificial Intelligence as nature-oriented technology

b) Situatedness of intelligence

- “human experience as being-already-in-a-situation” (Dreyfus 1972, 202)
- “need for essential/inessential discrimination” (Dreyfus 1972, 210)
- “computers are not in a situation” (Dreyfus 1972, 211)
- “this problem [i.e. the simulation of the environment] is avoided by human beings because their model of the world is the world itself” (Dreyfus 1972, 212)
- “symbiosis between computers and human beings” (Dreyfus 1972, 213)
- Dreyfus’ criticism is no longer relevant, as stages III and IV of intelligent activities can now be implemented by AI to a greater or lesser extent.
- However, Dreyfus does not sufficiently take into account the concept of “relevance (*Bewandtnis*)”, another aspect of Heidegger’s concept of “being-in-the-world”, which is important in terms of **implicit values implemented in technologies.**

Dreyfus, H. (1972). *What Computers Can’t Do: A Critique of Artificial Reason*. New York et al.: Harper & Row.

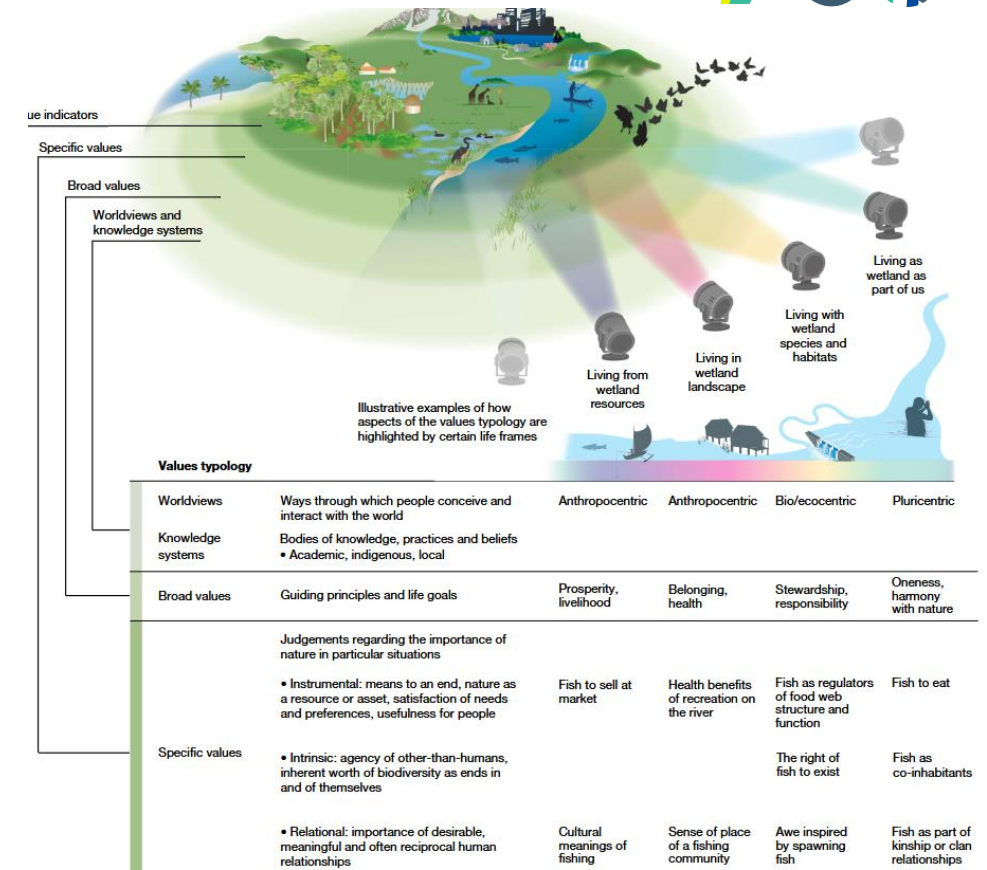
CLASSIFICATION OF INTELLIGENT ACTIVITIES

I. Associationistic	II. Simple Formal	III. Complex Formal	IV. Nonformal
<i>Characteristics of Activity</i>			
Irrelevance of meaning and situation.	Meanings completely explicit and situation independent.	In principle, same as II; in practice, internally situation-dependent, independent of external situation.	Dependent on meaning and situation which are not explicit.
Innate or learned by repetition.	Learned by rule.	Learned by rule and practice.	Learned by per-spicious examples.
<i>Field of Activity (and Appropriate Procedure)</i>			
Memory games, e.g., “Geography” (association).	Computable or quasi-computable games, e.g., nim or tic-tac-toe (seek algorithm or count out).	Uncomputable games, e.g., chess or go (global intuition and detailed counting out).	Ill-defined games, e.g., riddles (perceptive guess).
Maze problems (trial and error).	Combinatorial problems (nonheuristic means/ends analysis).	Complex combinatorial problems (planning and maze calculation).	Open-structured problems (insight).
Word-by-word translation (mechanical dictionary).	Proof of theorems using mechanical proof procedures (seek algorithm).	Proof of theorems where no mechanical proof procedure exists (intuition and calculation).	Translating a natural language (understanding in context of use).
Response to rigid patterns (innate releasers and classical conditioning).	Recognition of simple rigid patterns, e.g., reading typed page (search for traits whose conjunction defines class membership).	Recognition of complex patterns in noise (search for regularities).	Recognition of varied and distorted patterns (recognition of generic or use of paradigm case).
<i>Kinds of Program</i>			
Decision tree, list search, template.	Algorithm.	Search-pruning heuristics.	None.

5. Sustainable Artificial Intelligence as nature-oriented technology

c) Relational and implicit ethical values of nature

- The nature-ethical values that AI systems (and other technical devices) should take into account are inherent in each individual's being-in-the-world, i.e., they are dependent on or **relational to culturally differing worldviews and knowledge systems**.
- There is no single nature; nature is different for different people and cultures and has different values for them.
- At the same time, in Heidegger's sense, these values are often **present without being thematized**, even though they are of **fundamental significance**. They are **implicit and, in some cases, marginalized or suppressed**.
- The aim is to recognize a context of reference consisting of **explicit significance and implicit relevance**. In this way, the unthematized nature-ethical values on which AI systems (and other technical devices) depend and which they should take into account also become visible.



Pascual, U., Balvanera, P., Anderson, C.B. et al. (2023). Diverse values of nature for sustainability. In: *Nature* 620, 813–823. <https://doi.org/10.1038/s41586-023-06406-9>

Mensah, J.O., Van Wynsberghe, A. Where are the missing values: an exploration of the need to incorporate Ubuntu values into African AI policy. *AI Ethics* 5, 4365–4375 (2025). <https://doi.org/10.1007/s43681-025-00746-0>

6. How can nature–ethical values be included?

a) *The value–sensitive design approach*



1. Stakeholder Analysis
2. Stakeholder Tokens
3. Value Source Analysis
4. Co-evolve Technology & Social Structure
5. Value Scenario
6. **Value Sketch (problem: only stakeholders' non-verbal understandings, views, and values; anthropocentric and interest-focused)**
7. Value-oriented semi-structured interview
8. Scalable Assessments of Information Dimension
9. Value-oriented Coding Manual
10. Value-oriented Mock-up, Prototype, or Field Deployment
11. **Ethnographically Informed Inquiry on Values and Technology (challenge: in-depth engagement in the situated contexts over longer periods of time)**
12. Model for Informed Consent Online
13. Value Dams and Flows
14. Value Sensitive Action Reflection Model
15. Multi-lifespan Timeline
16. Multilifespan Co-design
17. Envisioning cards

6. How can nature–ethical values be included?

a) *The Value–sensitive design approach*



- Although the value sensitive design (VSD) approach (Friedmann/Hendry 2019) and the value–ethical design of AI systems proposed by Spiekermann (2019; 2024) are promising approaches.
- VSD distinguishes among designer values, values explicitly supported by the technology, and stakeholder values; considers individual, group, and societal levels of analysis; and carries out integrative and iterative conceptual, technical, and empirical investigations.
- However, these approaches are limited in that they require an innovation team to use scenario methods to put themselves in the future system world. The *implicit and culturally differing nature–ethical values* are not the focus here.

Friedman, B., and Hendry, D.G. (2019). *Value Sensitive Design: Shaping Technology with Moral Imagination*. Cambridge: MIT.

Spiekermann, S. (2019). *Digitale Ethik: Ein Wertesystem für das 21. Jahrhundert*. München: Droemer.

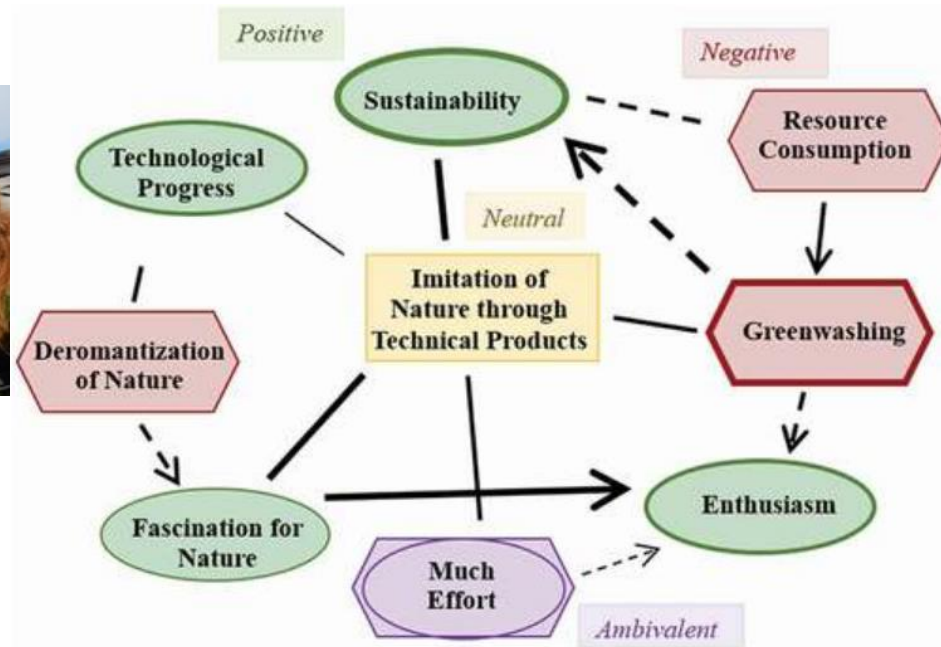
Spiekermann, S. (2024). Digitale Ethik und die Künstliche Intelligenz. In: Mainzer, K. (ed.). *Philosophisches Handbuch Künstliche Intelligenz*. Wiesbaden: Springer, 741–764.

<https://vsdesign.org/vsd/>

6. How can nature-ethical values be included?

b) Cognitive-affective mapping

Empirical ethics: In addition to generally acceptable ethical principles, it takes into account the acceptance by various stakeholder groups and the greatest possible conformity with their values



Please refer to the explanation of "Virtue ethics" you have just read and indicate on the following scale how you would ethically evaluate the technology. The technology ...

Read the items and then mark the appropriate answers.

	1	2	3	4	5	6	7	
is developed by someone who is indifferent towards nature	☐	☐	☐	☐	☐	☐	☐	is developed by someone who is respectful towards nature
is developed by someone who is insensitive to interactions with society	☐	☐	☐	☐	☐	☐	☐	is developed by someone who is sensitive to interactions with society
is developed by someone who has a bad character	☐	☐	☐	☐	☐	☐	☐	is developed by someone who has a good character
is developed by someone who is not reasonable	☐	☐	☐	☐	☐	☐	☐	is developed by someone who is reasonable



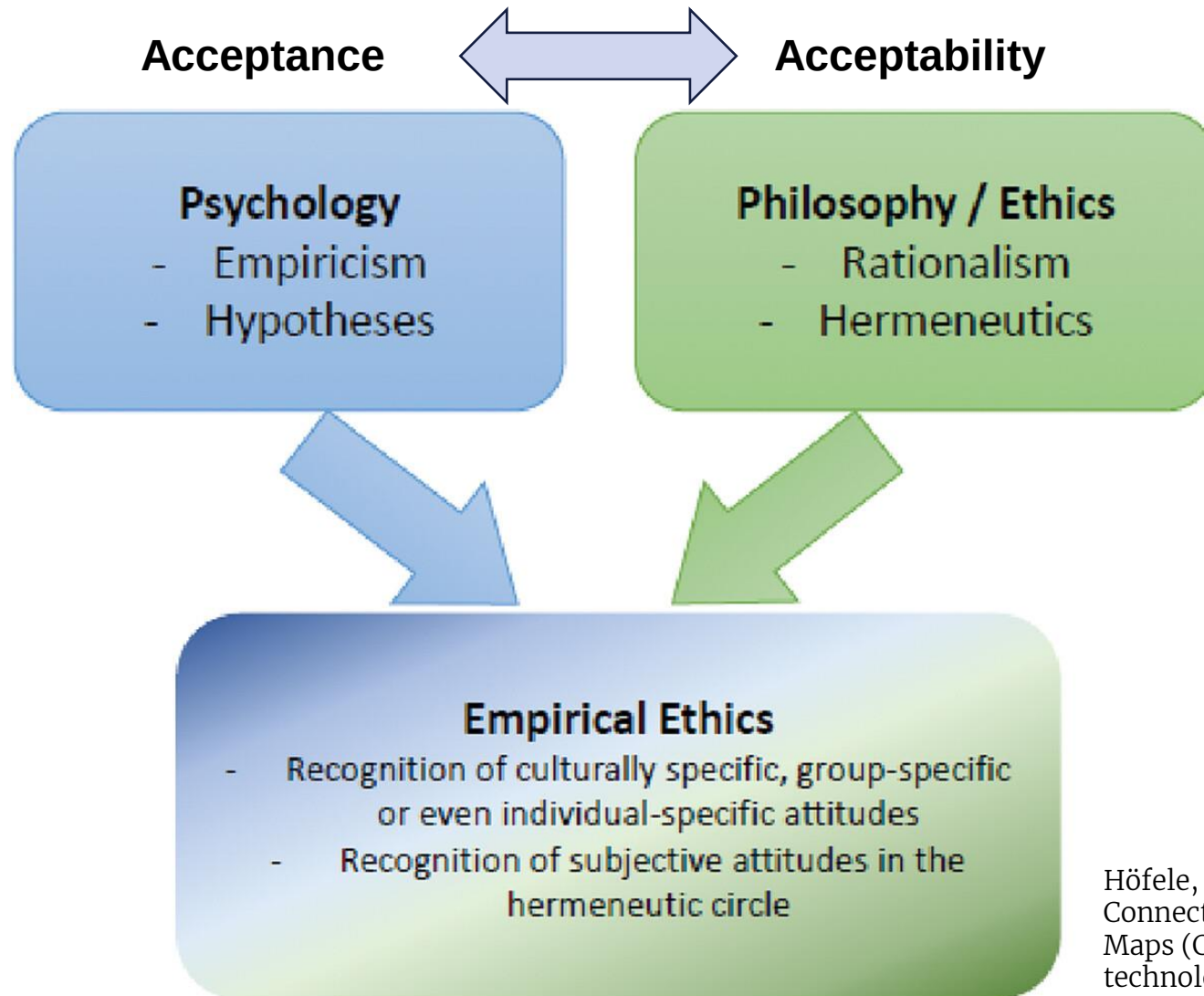
Co-author:
Dr. Julius
Fenn
Psychology

Höfele, P.*, Reuter, L.*, Estadieu, L., Livanec, S., Stumpf, M., & Kiesel, A. (2022). Connecting the methods of psychology and philosophy: Applying Cognitive-Affective Maps (CAMs) to identify ethical principles underlying the evaluation of bioinspired technologies. In: *Philosophical Psychology*, 1–24. doi: 10.1080/09515089.2022.2113770

Fenn, J.*, Höfele, P.*, Sölder, P., Kiesel, A. (in prep.). Development and Validation of an Empirical Ethics Scale for Technology Assessment – Challenges and Perspectives for a Real Time Ethics for Emerging Technologies.

6. How can nature–ethical values be included?

b) Cognitive–affective mapping



- On the one hand, CAMs, due to their associative–affective nature, also allow *implicit or marginal ethical values to be made visible*, which should be taken into account by AI systems.
- On the other hand, laypeople of all kinds and backgrounds who have not received ethical training can also be surveyed; CAMs thus enable a *broadening of perspectives*, especially towards partly marginalized groups (e.g. indigenous peoples) who are more focused on the natural environment.
- At the same time, however, CAMs need to be *interpreted by experts* with regard to ethically relevant aspects (acceptability).

Höfele, P., Reuter, L., Estadieu, L., Livanec, S., Stumpf, M., & Kiesel, A. (2022). Connecting the methods of psychology and philosophy: Applying Cognitive–Affective Maps (CAMs) to identify ethical principles underlying the evaluation of bioinspired technologies. In: *Philosophical Psychology*, 1–24. doi: 10.1080/09515089.2022.2113770

Art Matters

An artistic reasearch event on Art,
AI and Sustainability with workshops,
concert and performance.

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Art matters challenges the prevailing
perception of Artificial Intelligence
as "immaterial" by investigating the
material foundations, extractive
processes, and value chains upon
which it relies.



<https://uni-freiburg.de/frias/art-matters/>

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Sustainability and Technology: Ethical Perspectives

Workshop by the Young Academy for Sustainability
Research (YAS) at Freiburg Institute for Advanced
Studies (FRIAS) and the Rock Ethics Institute at
Penn State University

20-22 October 2026

Freiburg Institute for Advanced Studies
FRIAS Seminar Room
Albertstraße 19
D-79104 Freiburg

Participation upon registration

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<https://uni-freiburg.de/frias/sustainability-and-technology-ethical-perspectives/>

Thank you for your attention!
Questions?

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