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Ethics of Design and Values: Solutions and Trade-offs in H-IoT and Beyond

Outline

- Ethics of **design** and the **moralization** of technologies
- Ethics of the design of IoT systems for medical and social care (H-IoT)
- Case: **glucose-monitoring** to raise **alerts** of critical situations and **four different scenarios** with a different role for ML
- **Ethical values and concerns**
- A possible **solution**? Soft personalization

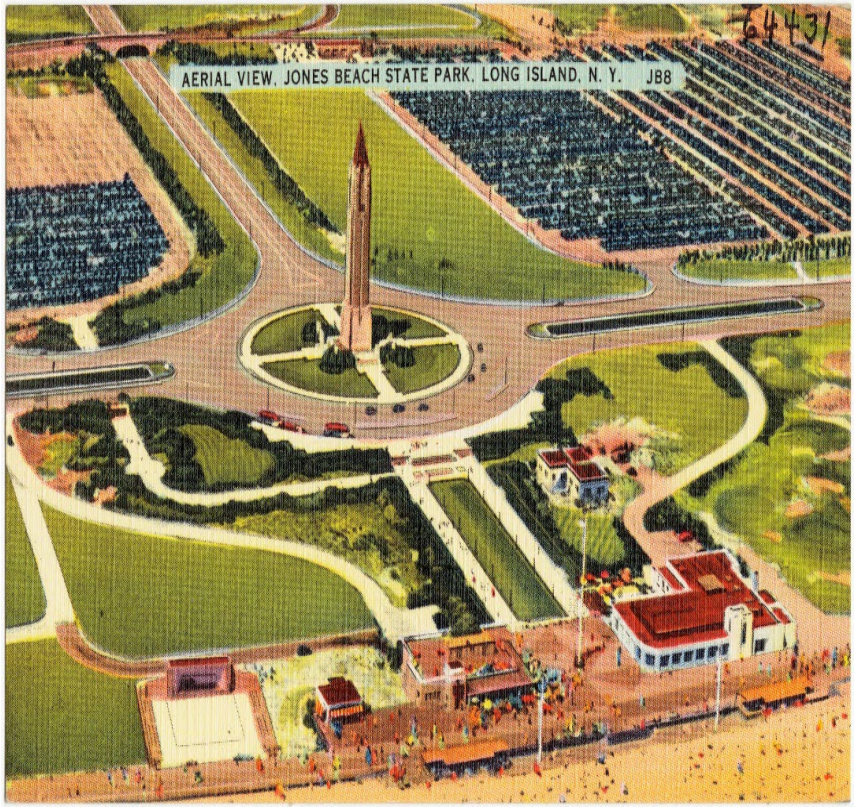
Take home message: **design is powerful but not all problems can be solved by design**

Ethics of design

Robert Moses' overpasses

Racist overpasses

- Robert Moses (1888-1981) was a very influential and contested **urban planner**
- He designed several **overpasses** over the parkways of Long Island which **were too low to accommodate buses**
- Only cars could pass below them and for that reason the overpasses complicated access to Jones Beach Island
- **Only people who could afford a car** – and in Moses' days there were generally not Afro-Americans – could easily **access the beaches**



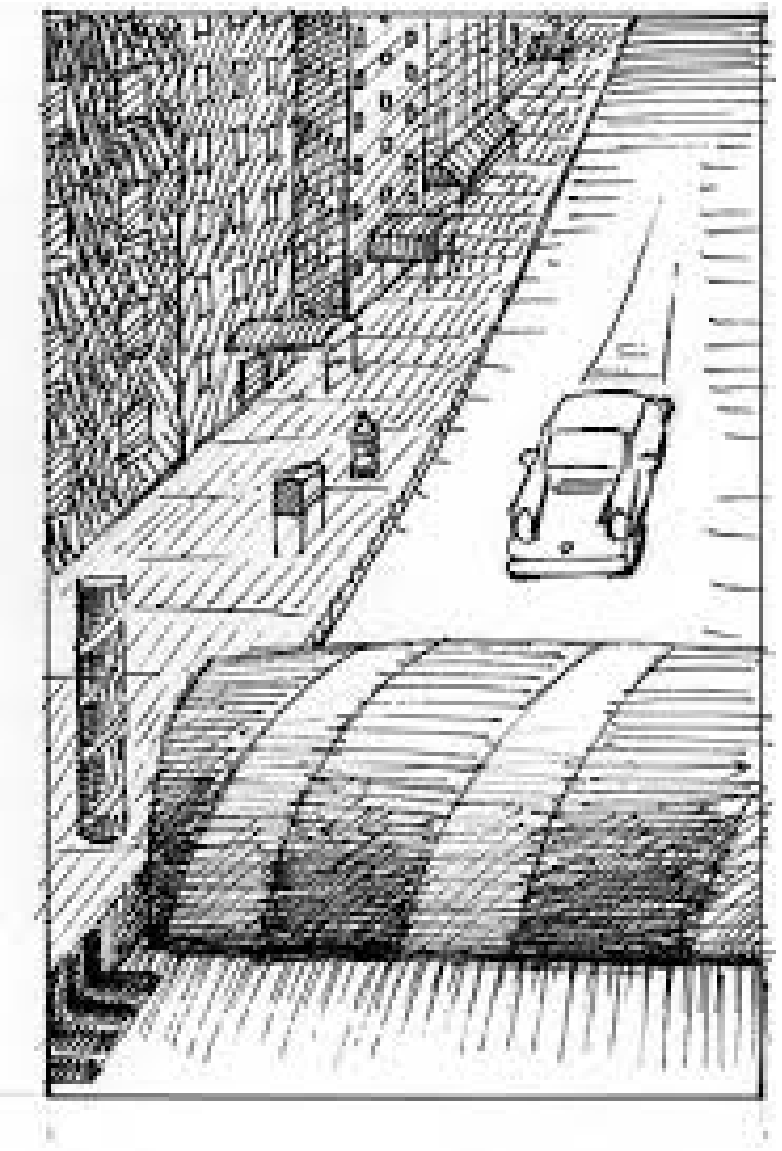
“Do Artifacts Have Politics?”

*“Robert Moses, the master builder of roads, parks, bridges, and other public works from the 1920s to the 1970s in New York, had these overpasses built to specifications that would **discourage** the **presence of buses** on his **parkways**. According to evidence provided by Robert A. Caro in his biography of Moses, the reasons reflect **Moses's social-class bias** and **racial prejudice**. Automobile owning whites of "upper" and "comfortable middle" classes, as he called them, would be free to use the parkways for recreation and commuting. **Poor people** and **blacks**, who normally used public transit, **were kept off the roads** because the **twelve-foot tall buses** could **not** get through the **overpasses**. One consequence was to **limit access** of **racial minorities** and **low-income groups** to Jones Beach, Moses's widely acclaimed public park.”*

(Winner, 1980)

Beyond racist overpasses

- **Technological artifacts** can be **politically** or **morally** charged
- We should not consider **morality** as a solely **human affair** but also as a **matter of things**
- Artefacts are **bearers of morality**, as they are constantly taking all kinds of moral decisions for people (Latour, 1992)
  - Ex.: moral decision of how fast one drives is often delegated to a speed bump which tells the driver “slow down before reaching me”



Moralizing technologies (Verbeek, 2011)

- Instead of only moralizing other people humans should/could also moralize their **material environment**
  - Metro barriers: “Buy a ticket before you enter the subway”
- Moralization of technology is the deliberate development of technologies in order to **shape moral action** and **decision-making**
- Many of our actions and interpretations of the world (also moral ones!) are co-shaped by the technologies

Alcohol lock for cars

- Alcohol lock for car (car lock that analyzes your breath): “Don’t drive drunk”
- Suppose that a car with such a system is not more expensive than the one without it and works perfectly

How many of you would buy such a car? Why?

How many of you would not buy such a car? Why?

Smart showerhead

- Smart showerhead (showerhead that regulates and reduces the flux of water to save water): ”Don’t waste water”
- Suppose that this showerhead is not expensive and allows you to save 50% of your daily consumption of water

How many of you would buy it? Why?

How many of you would not buy it? Why?

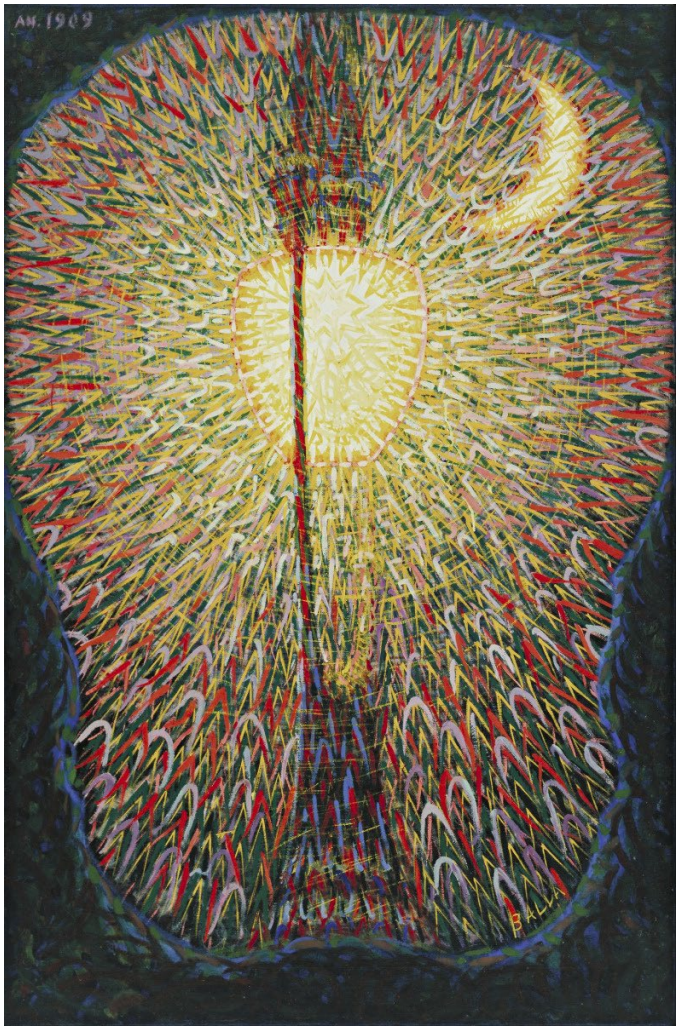
Critizing the moral character

- Variety of **negative reactions** to explicitly behavior-steering technologies (also when they are for the good!)
- Fear that **human freedom** is threatened and that democracy is exchanged for **technocracy**
  - Reduction of **autonomy** perceived as a threat to **dignity**
  - Not humans but **technologies** are in **control**
- Risk of **immorality** or **amorality**
  - Form of moral laziness with behavior-steering technologies
- It is important to find a **democratic ways** to “moralize technology”
  - The processes used to insert values must be transparent and publicly discussed and a public oversight guaranteed

Ethics of engineering design

- Technology design appears to entail more than inventing functional products
- **Designing** should be regarded as a form of **materializing morality**
- The ethics of engineering design should take more seriously the **moral charge** of **technological products**
- **Unintentional** and **unexpected** forms of mediation

  Eex.: energy-saving light bulbs used in places previously left unlit and hence increasing energy consumption



IoT for health

IoT and health

Internet of Things (IoT) in Healthcare: Benefits, Use Cases and COVID Impact

By Stuart Rauch

Last updated on Dec 12, 2022

1443

HEALTHCARE TECHNOLOGY IOT: THE INTERNET OF THINGS

IoT in Healthcare: 15 Examples of Internet of Things Healthcare Devices and Technology

novate using the vast, connected universe

7 examples of how the internet of things is facilitating healthcare

In a new age of remote healthcare, how is the internet of things enabling new forms of medical treatment, understanding and care?

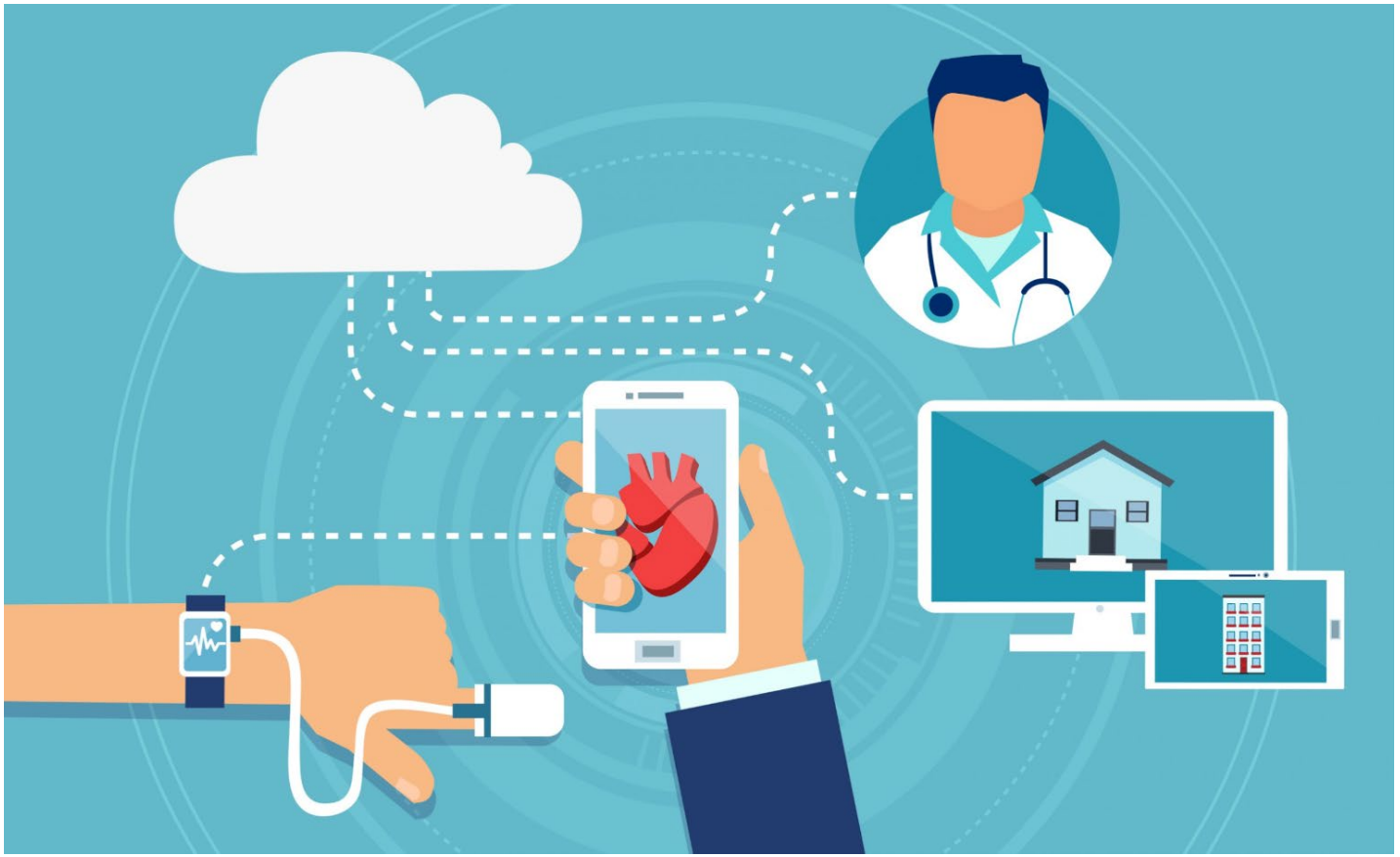
Har

May 5, 2023

Wearable technologies

Big promises…

Personalization, monitoring, assistance



Not just promises…

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PERSONAL TECH

Just How Accurate Are Fitbits? The Jury Is Out

By MIKE McPHATE MAY 25, 2016

Fitbit Charge HR Tony Cenicola/The New York Times

Many users of activity trackers have always harbored suspicions: How accurate are these things?

A handful of tests by journalists and researchers have tried to bring clarity to the issue. Results, alas, have been mixed.

The latest study, released by the plaintiffs in a class-action lawsuit against Fitbit, found that the pulse-monitoring technology used in the company's wrist-bound Surge and Charge devices was "highly inaccurate during elevated physical activity."

Researchers from California State Polytechnic University, Pomona, had 43 subjects wear the devices as they ran, jogged and jumped rope, among other activities, and then compared the readings with those of an electrocardiogram.

Datafication, surveillance, profiling, …

Open issues

- **Privacy** and low **security** standards (Elkhodr, 2011)
- User **access** and **ownership** of data (Hummel et al., 2020; Hummel & Braun, 2020)
- **Datafication** of private spaces and **privatization** of medical services (Ishmaev, 2020)
- **Reuse** of medical data for other purposes and **limits** of **informed consent** (Mittelstadt & Floridi, 2016)

A (real-world) example: glucose-monitoring for diabetes

An interdisciplinary effort

Manuel Roveri

Viola Schiaffonati

Design and development of TinyML systems

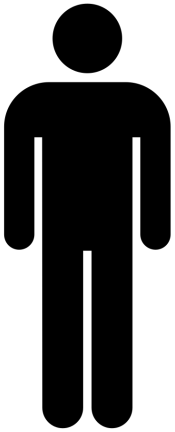
Massimo Pavan

Ethical concerns and values

Alessandro Falcetta

Stefano Canali

Glucose-monitoring to raise alerts of critical situations



Personal data

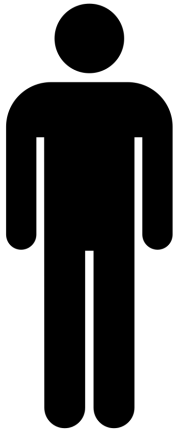
Alert/alarm

AI Model

Which are the technological actors involved in the processing?

How to get a personalized model for glucose-monitoring?

Glucose-monitoring to raise alerts of critical situations



AI Model

Scenario #1: Inference on Cloud and pre-defined model

Scenario #2: Inference on Cloud and personalized model

Scenario #3: Inference on device (TinyML) and predefined model

Scenario #4: Inference on device (TinyML) and personalized model (On-device TinyML)

Ethical values and concerns

Different solutions, different issues

	Inference on Cloud	Inference on Device
Pre-defined model	• Traditional solution • Personal data must flow through the internet • Less effective model • "Connected" device	• "TinyML for inference" • Personal data remain on the device • Less effective model • Intelligent tiny devices
Personalized model	• More advance solution • Personal data must flow through the internet • More effective model • "Connected" device	• "TinyML for training" • Personal data remain on the device • Personal model • Intelligent tiny devices • Requires a powerful device

Different solutions, different issues

- From the first part of the class:
  - Ethical and moral status of technology design
  - Specific values presented and promoted through different technological solutions and design choices

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Different solutions, different issues

- Which values then?

	Inference on Cloud	Inference on Device
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Different solutions, different issues

- Different solutions, different values promoted
- E.g. Promotion of value of privacy with inferences are performed on device, possibly at the expanse of values of reliability and efficacy

	Inference on Cloud	Inference on Device
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Different solutions, different issues

- Different solutions, different values promoted
- Different solutions, different ethical concerns too!

Ethical issues for H-IoT (Mittelstdat, 2017)	Inference on the Cloud with predefined model (I)	Inference on the Cloud with personalized model (II)	Inference on device with predefined model (III)	Inference on device with personalized model (IV)
Privacy	Constant monitoring and surveillance	Constant monitoring and surveillance	Constant monitoring and surveillance	Constant monitoring and surveillance
	Data control	Data control	Data control	Data control
	Data security	Data security	Data security	Data security
Autonomy	Freedom & independence	Freedom & independence	Freedom & independence	Freedom & independence
Consent	Limits of informed consent	Limits of informed consent	Limits of informed consent	Limits of informed consent
	Limits of anonymization	Limits of anonymization	Limits of anonymization	Limits of anonymization
Ownership and data access	Data access	Data access	Data access	Data access
	Transparency of results	Transparency of results	Transparency of results	Transparency of results
	Sharing of benefits	Sharing of benefits	Sharing of benefits	Sharing of benefits
Social isolation	Use IoT devices as replacement of social interactions	Use IoT devices as replacement of social interactions	Use IoT devices as replacement of social interactions	Use IoT devices as replacement of social interactions
decontextualization of health and well-being	Simplification of parameters	Simplification of parameters	Simplification of parameters	Simplification of parameters
	Lack of integration of complex and contextual information	Lack of integration of complex and contextual information	Lack of integration of complex and contextual information	Lack of integration of complex and contextual information
'Good' care and user well-being	Quality of care delivered through H-IoT	Quality of care delivered through H-IoT	Quality of care delivered through H-IoT	Quality of care delivered through H-IoT
Risks of non-professional care	Privatization, marketing, targeting	Privatization, marketing, targeting	Privatization, marketing, targeting	Privatization, marketing, targeting

Privacy – Constant monitoring and surveillance

- Concerns on **constant surveillance**
  - E.g. **More data** collected to develop personalized models
  - **Very serious** in the case of **personalized models** rather than in the case of predefined models (serious)
  - E.g. **Sharing** of personal data on the cloud with third parties
  - **Very serious** in the case of **personalized models** rather than in the case of predefined models (serious)

Ethical issues for H-IoT (Mittelstdat, 2017)	**Inference on the Cloud with predefined model (I)**	**Inference on the Cloud with personalized model (II)**	**Inference on device with predefined model (III)**	**Inference on device with personalized model (IV)**
Privacy	Constant monitoring and surveillance	Constant monitoring and surveillance	Constant monitoring and surveillance	Constant monitoring and surveillance

Beyond privacy: new issues

- Promotion of one value through mitigation by technical means (e.g., HE, TinyML): privacy
- But this also means **new emergent issues:**
  - **Transparency** of results and **accessibility** of encrypted models
  - **Quality** and evaluation of **efficacy**
  - **Responsibility** of evaluation

Ethical issues for H-IoT (Mittelstdat, 2017)	Inference on the Cloud with predefined model (I)	Inference on the Cloud with personalized model (II)	Inference on device with predefined model (III)	Inference on device with personalized model (IV)
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	Data security	Data security	Data security	Data security
Autonomy	Freedom & independence	Freedom & independence	Freedom & independence	Freedom & independence
Consent	Limits of informed consent	Limits of informed consent	Limits of informed consent	Limits of informed consent
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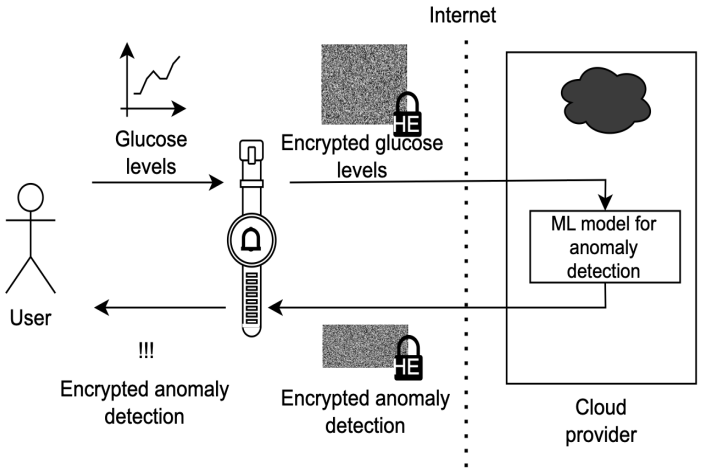
Risks of non-professional care	Privatization, marketing, targeting	Privatization, marketing, targeting	Privatization, marketing, targeting	Privatization, marketing, targeting

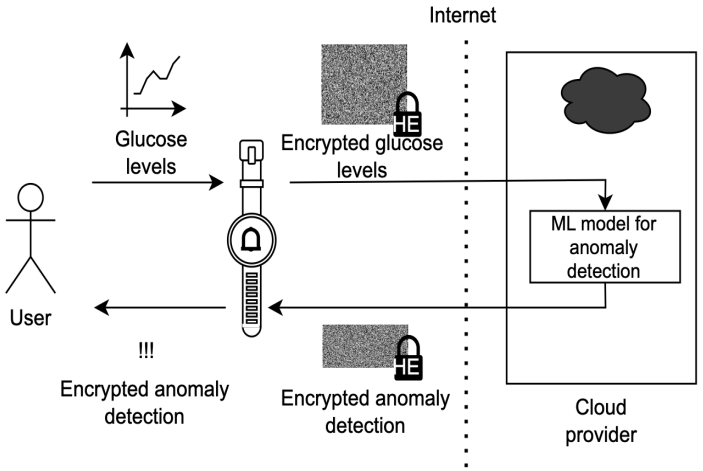
New issues and trade-offs: glucose monitoring

- **Encrypted personalized models** raising concerns for **transparency**
  - Impossible to inspect the trained models without secret keys
  - **Burden** on the **user** of checking results of the models and their **quality** and **reliability**



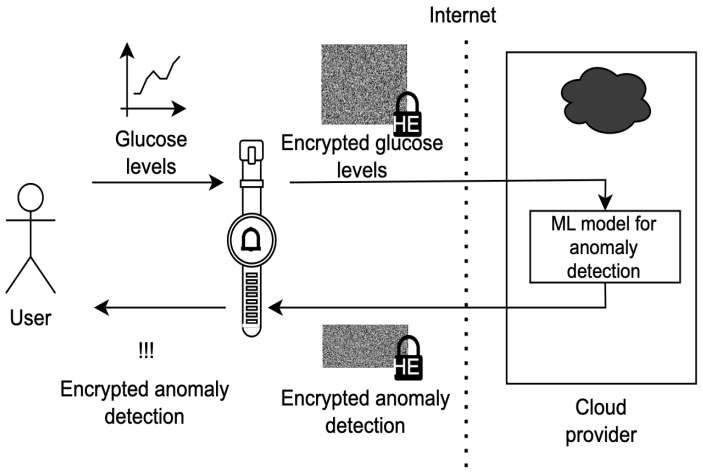
New issues and trade-offs: glucose monitoring

- Personalized models running the risk of **learning** as “normal” **situations** that are instead **harmful** for the health of the users
  - TinyML model trained directly on device, with unpredictable evolution of the learning)
  - **Experts** increasingly **less involved**



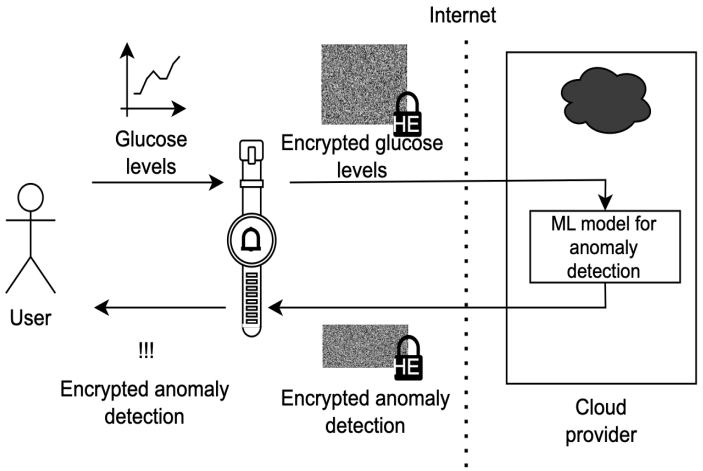
New issues and trade-offs: glucose monitoring

- How can me make sense of these concerns in terms of values?
- Here's some **guiding tools** to make sense and questions to consider when designing IoT and TinyML technology
- We'll now present these guiding tools and questions and follow up with an **example** of how we've implemented them in our own collaborative research



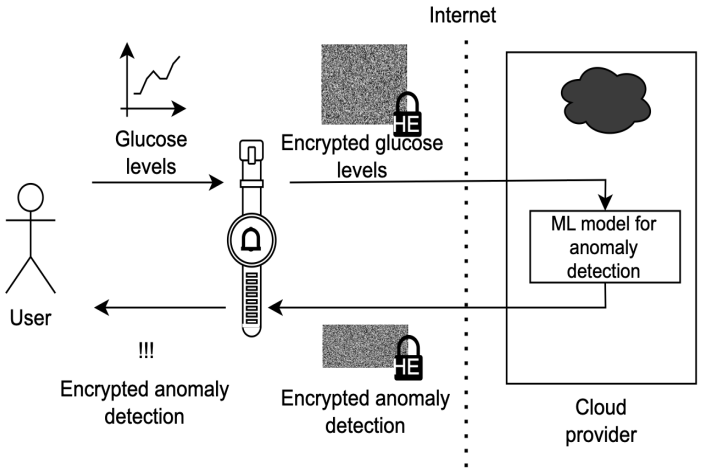
New issues and trade-offs: glucose monitoring

- **Transparency** of results and **accessibility** of encrypted models
  - Are the data and code accessible?
  - Who owns them?
  - Who has access and why?



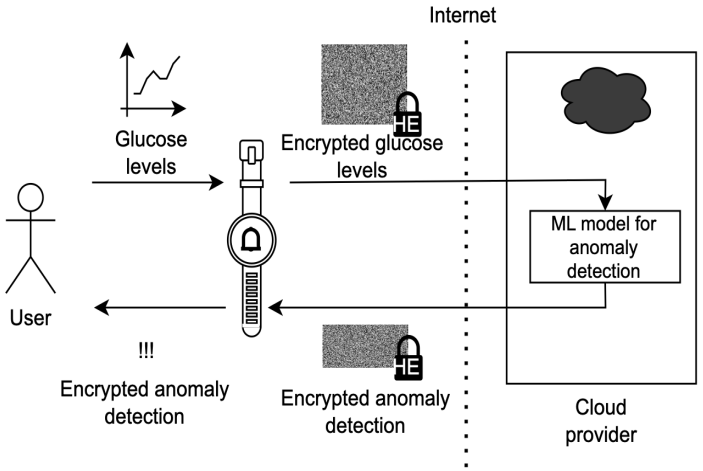
New issues and trade-offs: glucose monitoring

- **Quality** and evaluation of **efficacy**
  - How are you testing the quality of the model and the data?
  - Quality in which sense and for whom?
  - Who evaluates and how?



New issues and trade-offs: glucose monitoring

- **Responsibility** of evaluation
  - Who is liable in the process and when something goes wrong?
  - Who assess the process?
  - Which kind of responsibility do you envision?



Soft personalization

Privacy and personalization

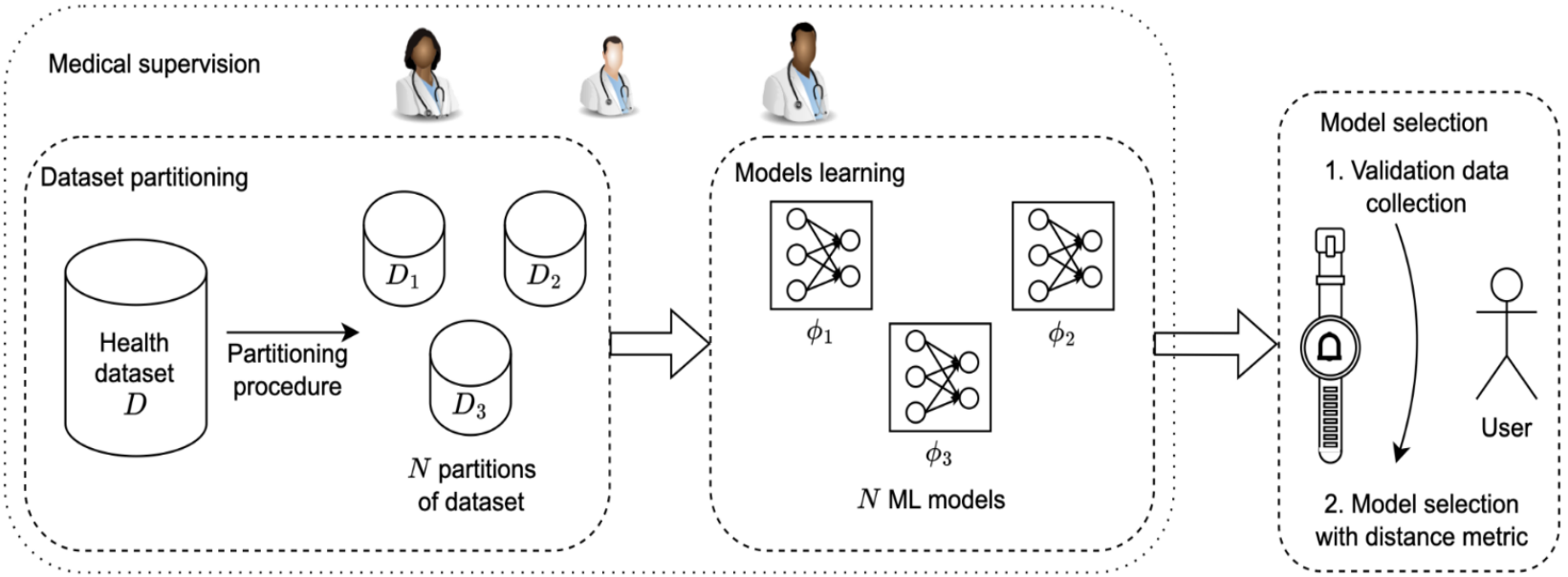
- Work so far
  - **Interplay of values** connected to specific and different technical implementations
  - Privacy, autonomy, justice, fairness, transparency, beneficence, non-maleficence, etc.
  - Guiding **tools and questions** for your design and implementation of your technical solutions
- How can these be used?
- Let’s see an example from our work

The proposed approach: soft personalization

- Case: personalized models for glucose-monitoring for diabetes
- **Value-based requirements**
  - Models not **overestimating** and properly classifying problematic states as anomalies
  - Models not **harming** users and not problematic from principles of non-maleficence and beneficence
  - **Privacy** and **security** remain central concerns
- On this basis, we have developed a new approach based on
  - Need to **control** the learning and evolution of **personalized models**
  - Respect of **ethical values** and **epistemic requirements** necessary in the biomedical context

Soft personalization: the idea

- In our case of IoT and ML for glucose
  - Development of **different models** starting from personal data and more
  - **Selection** and **evaluation** of models by **users** and **experts**
  - Greater guarantees of **reliability** (beneficence, non-maleficence)



Soft personalization: the limitations

- Some limitations remain
  - **Responsibility** on **user**
  - Pathologies and lifestyles **evolving** over time

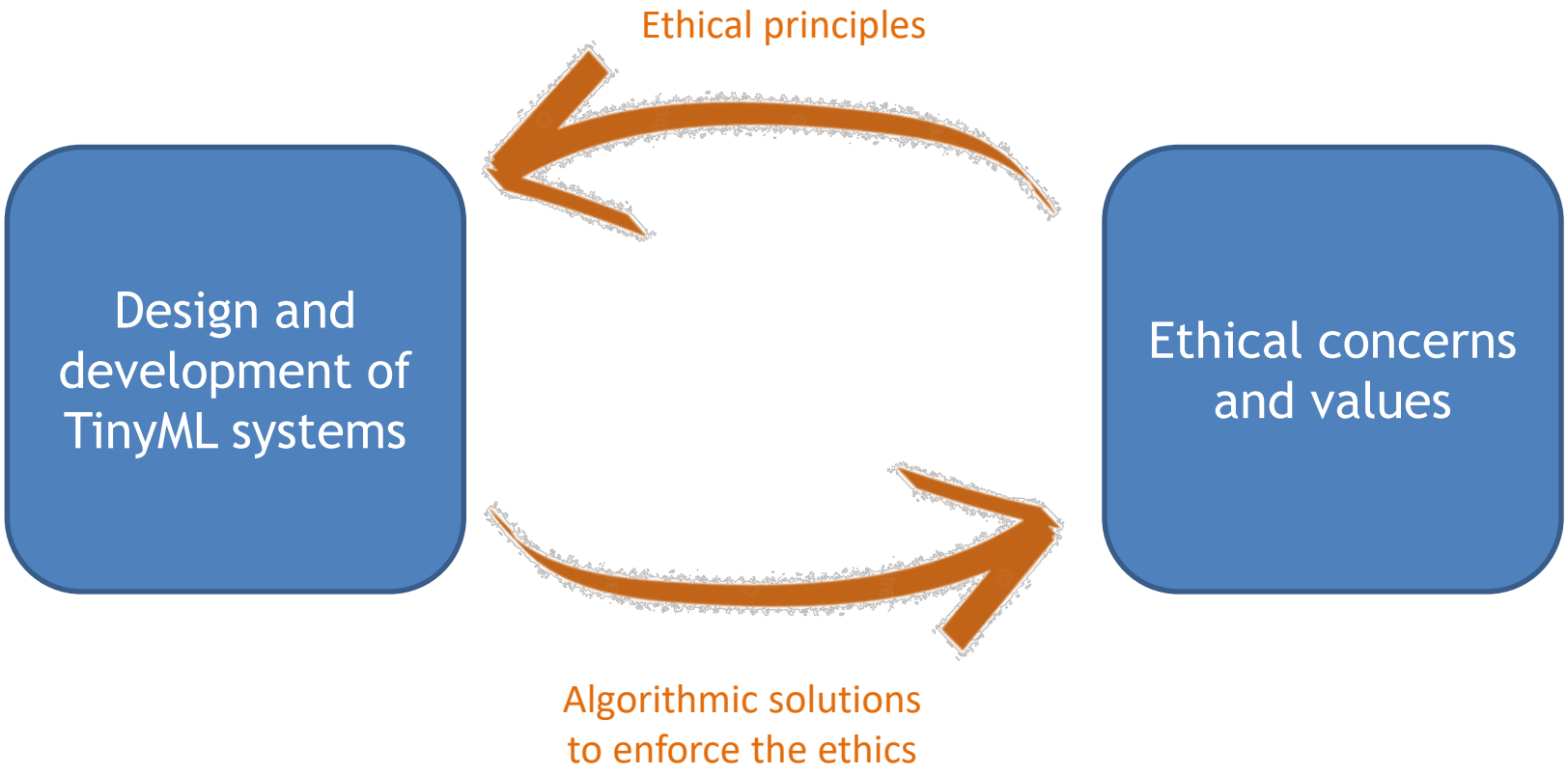
Soft personalization: the limitations

- More importantly: **impossible** to solve these issues **only by technical means**
- Always a matter of **trade-offs**
  - Choice of **specific values** to respect (privacy, accuracy)
  - **Exclusion** of **others** (general effectiveness, transparency)
- As we attend to one value, possible issues emerge on other ends
- Need to constantly implement guiding tools and questions and identify limitations that **cannot be solved by technical means**

Take home messages

Conclusions and future directions

- **Promises** for IoT, ML and health, but also **significant problems** and **open issues** (privacy, personalization, control)
- Development and **innovative algorithmic solutions** for **privacy** preservation and their limitations
- **Soft personalization** as a way to **mitigate issues** and go in specific value directions, but **various trade-offs** and issues between values remain **open**


Ethical principles
Design and development of TinyML systems
Ethical concerns and values
Algorithmic solutions to enforce the ethics