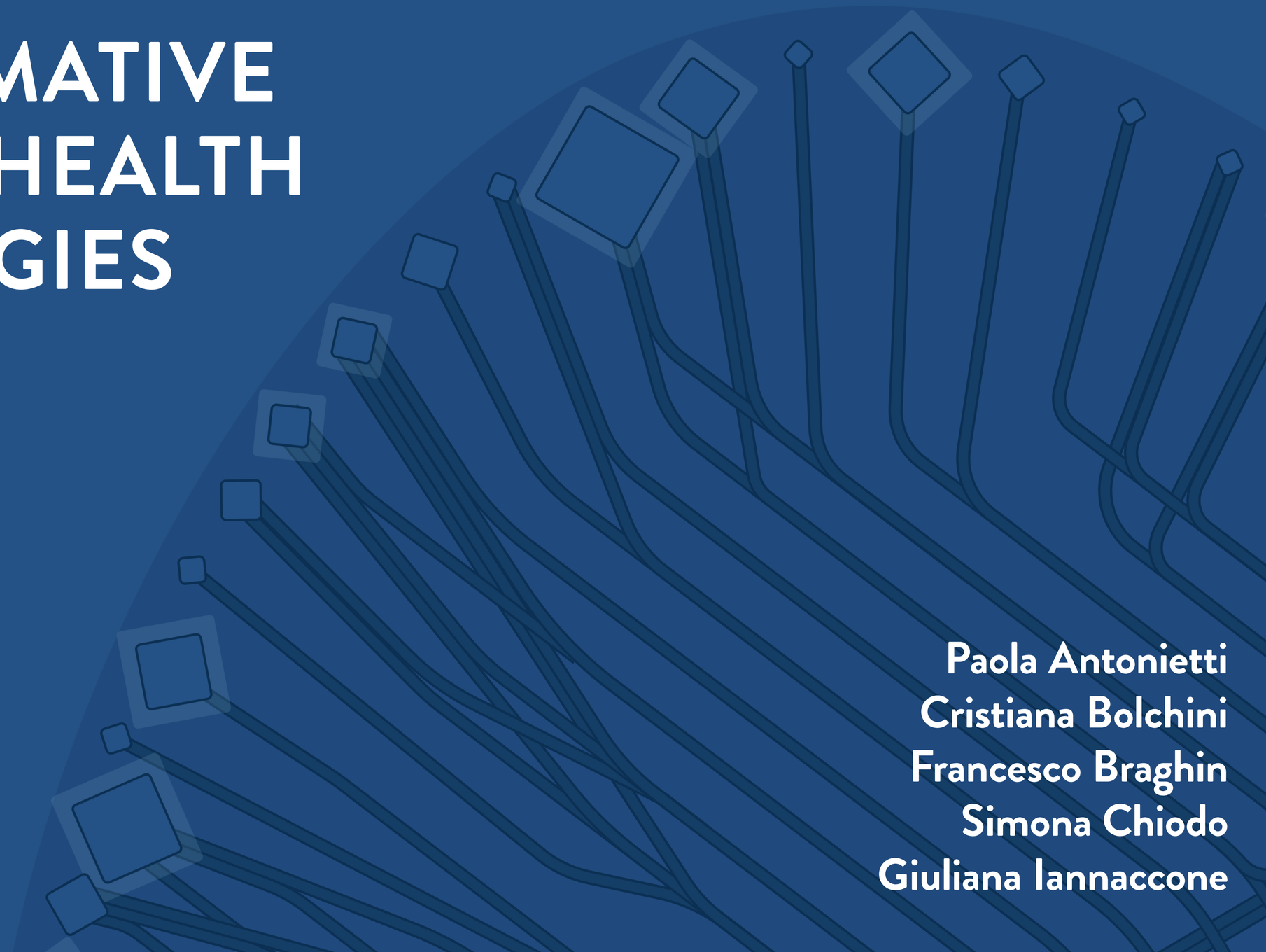
TRANSFORMATIVE PERSONAL HEALTH TECHNOLOGIES IN 2040



Paola Antonietti
Cristiana Bolchini
Francesco Braghin
Simona Chiodo
Giuliana Iannaccone

POLITECNICO
MILANO 1863

TECHNOLOGY FORESIGHT

GOALS

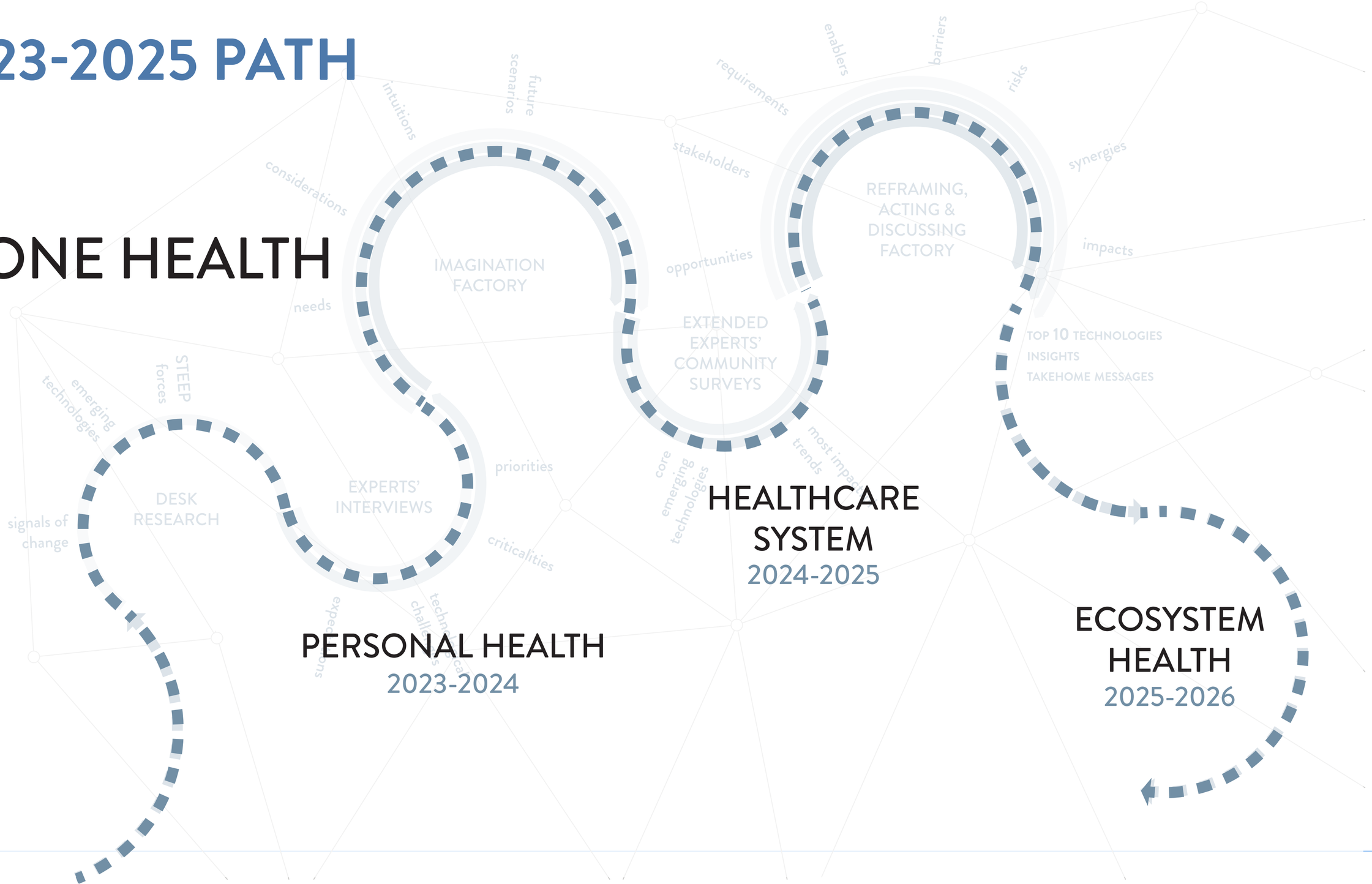
- ◊ advance our path towards technology foresight activities to empower our community and facilitate our industrial partners
- ◊ challenge our vision on important matters
- ◊ promote and increase awareness on Politecnico di Milano's expertise in areas that can be further valorised

life sciences ▸ health

image credits: https://t.ly/bezFI

2023-2025 PATH

ONE HEALTH



PERSONAL HEALTH
2023-2024

HEALTHCARE SYSTEM
2024-2025

ECOSYSTEM HEALTH
2025-2026

TECHNOLOGY FORESIGHT

detect “weak signals” of change that might not be already part of ongoing trends

explore possible futures

highlight pre-conditions and necessary ecosystems to facilitate new technologies

evaluate enablers & barriers towards desiderable futures

support innovation and technology transfer processes

highlight strategic medium/long-term choices

TECHNOLOGY FORESIGHT @ POLIMI

◊ leverages POLIMI's community **independent** expertise

» network of academic/industrial experts

◊ explores medium/long-term horizon to investigate technologies' role

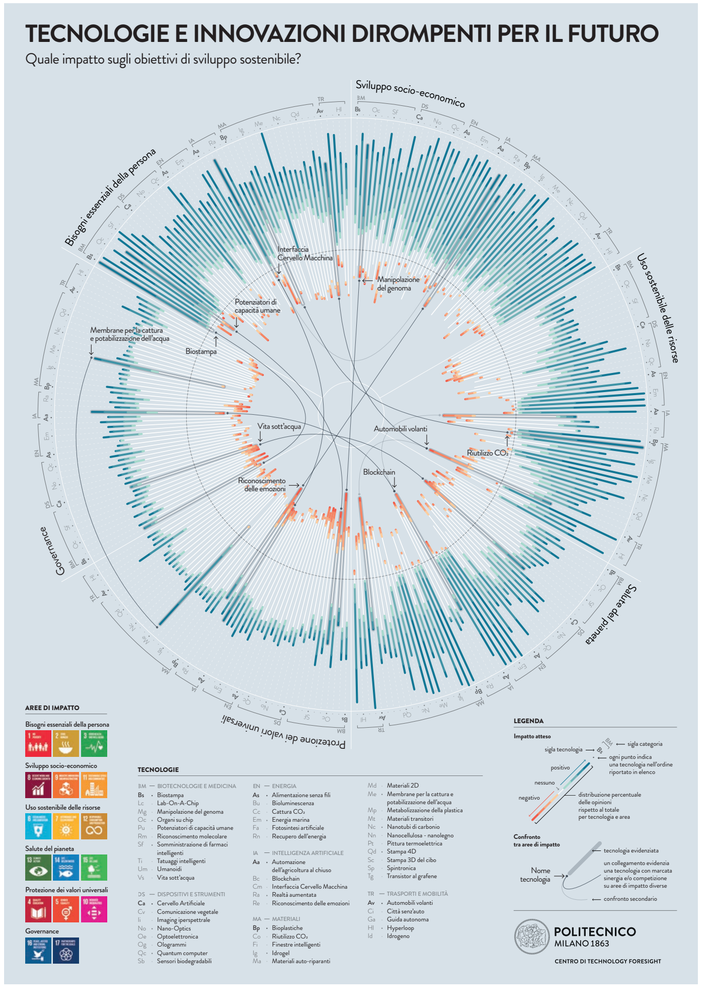
» opportunities, requirements, expected impact and risks

→ empowers a forward-thinking perspective

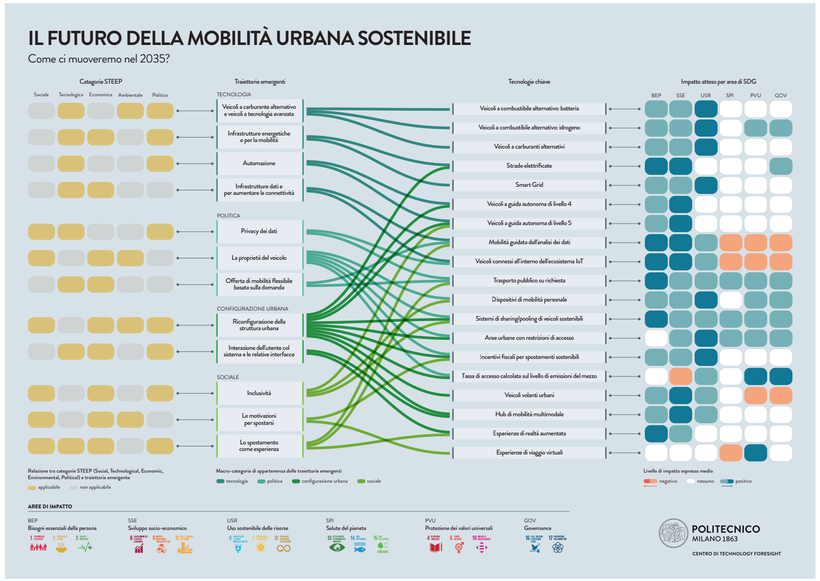
→ informs key decision-makers

TECHNOLOGY FORESIGHT AT POLIMI

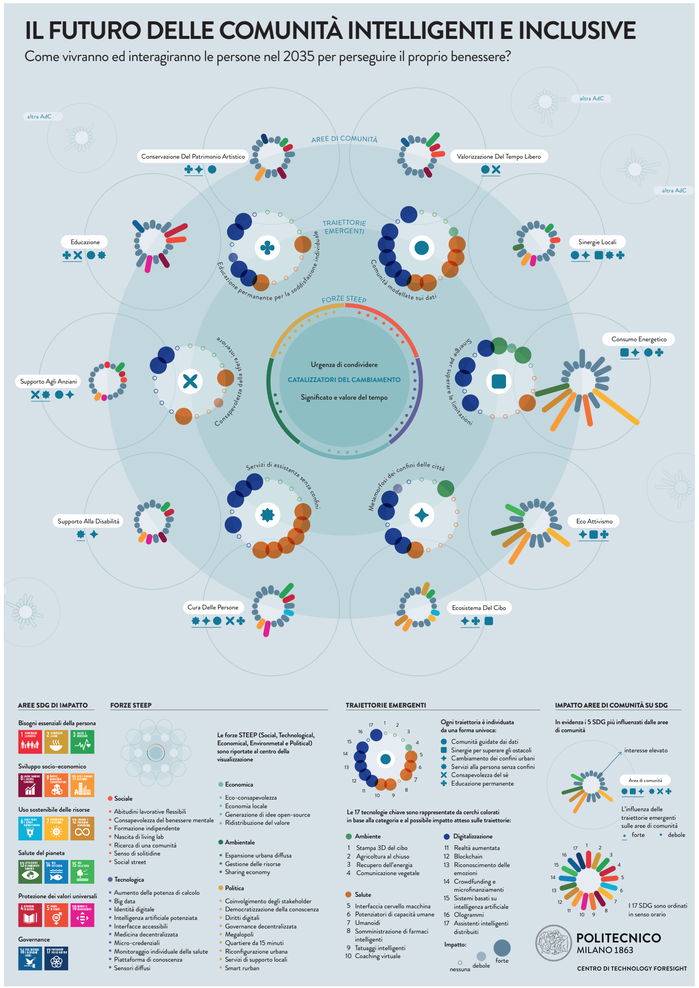
PAST ACTIVITIES



2020-2021



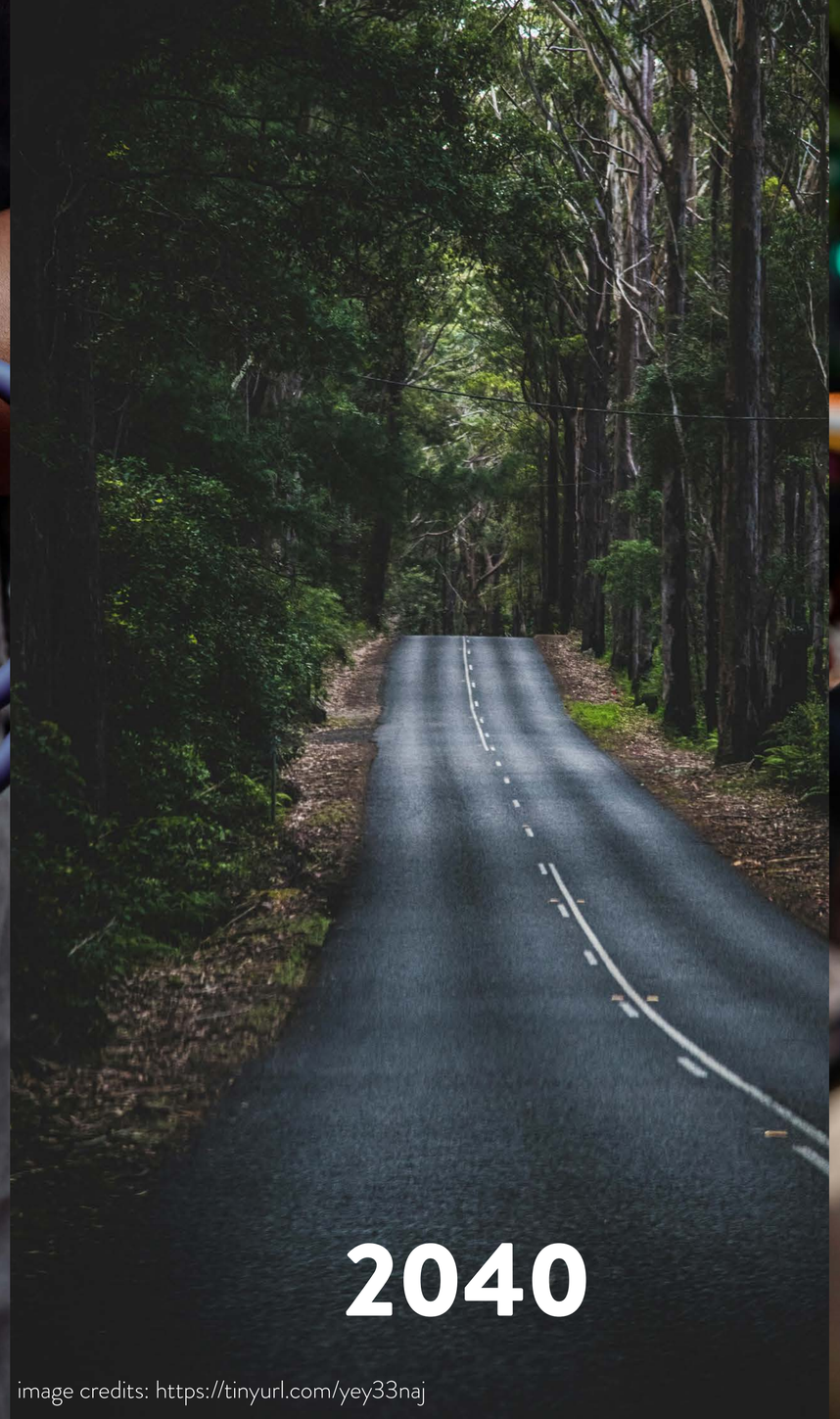
2021-2022



2022

HEALTH

image credits: https://rb.gy/bb7tmg



2040

image credits: https://tinyurl.com/yey33naj

PERSON

image credits: https://shorturl.at/VRIlw

WHAT TECHNOLOGICAL ADVANCES WILL BE MORE TRANSFORMATIVE IN 2040?

HOW CAN OUR RESEARCH CONTRIBUTE TO SUCH A TRANSFORMATION?

HEALTH

image credits: https://rb.gy/bb7tmg

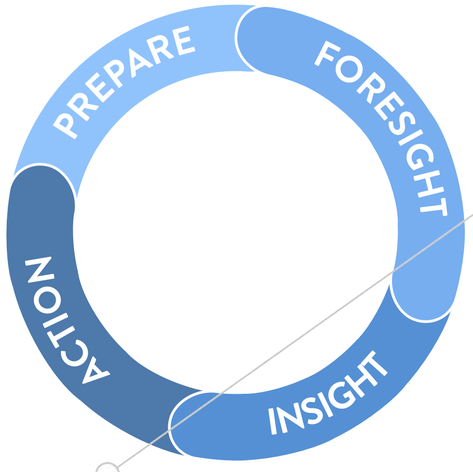
2040

image credits: https://tinyurl.com/yey33naj

PERSON

image credits: https://shorturl.at/VRIlw

THE FORESIGHT METHODOLOGY



considerations
intuitions
future scenarios
requirements
enablers
barriers
risks
stakeholders
synergies
impacts
opportunities
needs
emerging technologies
STEEP forces
signals of change
priorities
criticalities
expectations
technological challenges
core emerging technologies
most impactful trends

IMAGINATION FACTORY

DESK RESEARCH

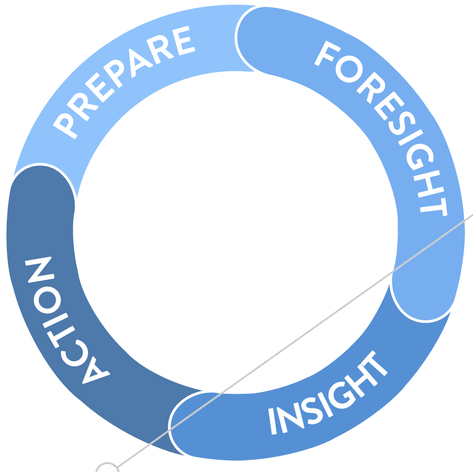
EXPERTS' INTERVIEWS

EXTENDED EXPERTS' COMMUNITY SURVEYS

REFRAMING, ACTING & DISCUSSING FACTORY

TOP 10 TECHNOLOGIES
INSIGHTS
TAKE-HOME MESSAGES

THE FORESIGHT METHODOLOGY



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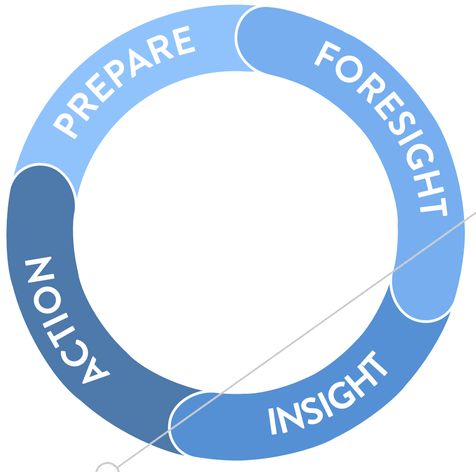

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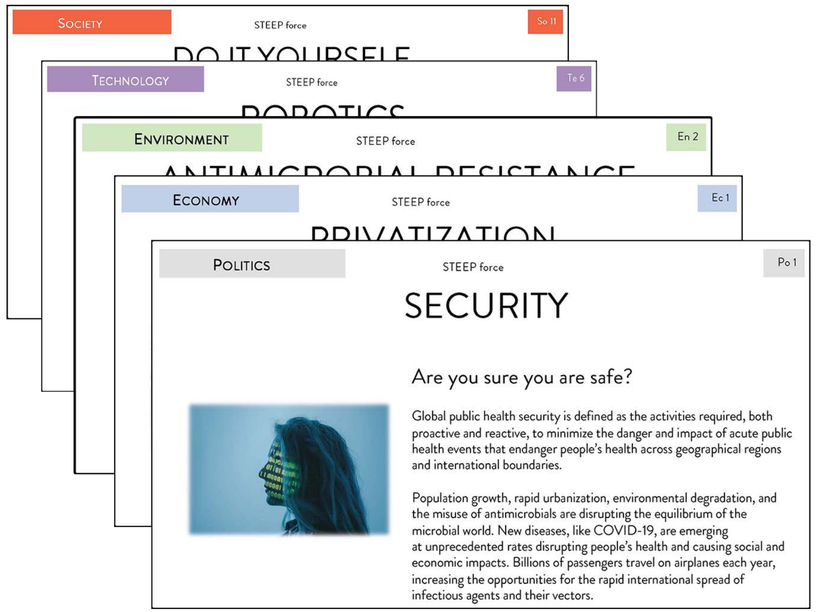
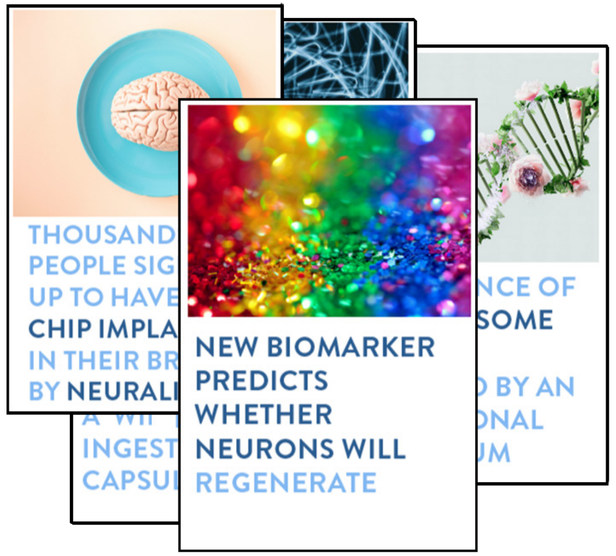
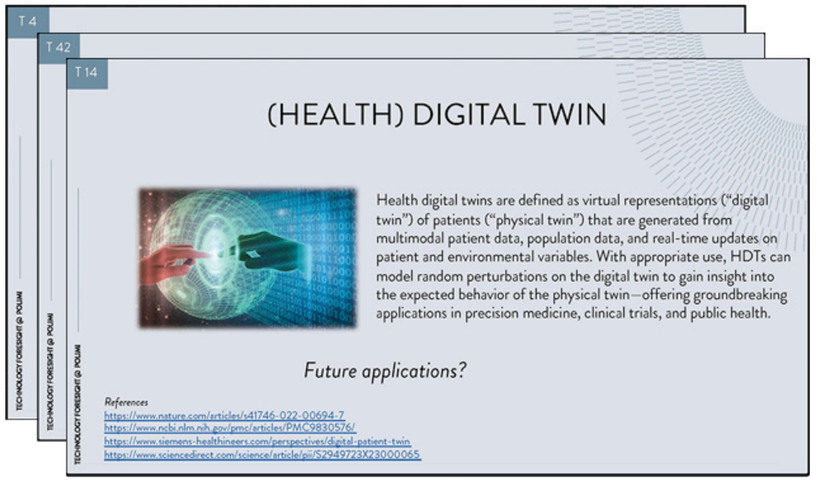
METHOD: INGREDIENTS

- 50 STEEP forces
- 83 signals of change
- 50 technologies
- 24 POLIMI's participants
- 3 physicians



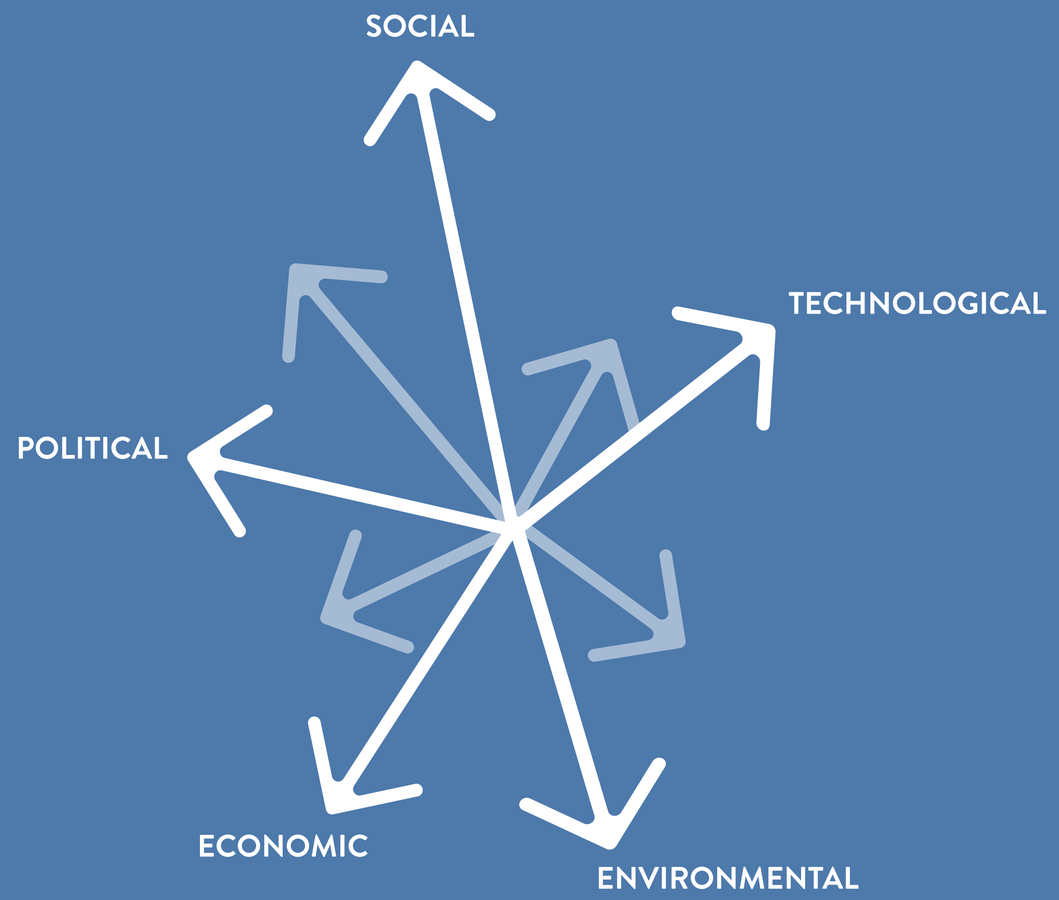




STEEP FORCES

- “stable enough” major trends that will possibly shape our future
- broadly recognised trajectories we observe today
- referred to a broad spectrum, not context-specific

desk research ▸ 50 most relevant forces



STEEP FORCES

SOCIAL

AGEING
DEMOGRAPHIC CHANGES
MENTAL HEALTH
LIFESTYLES
DEEPENING DISPARITIES
NON-COMMUNICABLE DISEASES
BEYOND GENDER
MIGRATIONS
WORK FROM EVERYWHERE
DO IT YOURSELF

TECHNOLOGICAL

MED(AI)CINE
AUTONOMOUS SYSTEMS
HYPER-CONNECTED
HUMAN ENHANCEMENT
AVATARS
EXTENDED REALITY
ROBOTICS
DIGITAL TWIN
CRYONICS
GENETIC CONTROL

ENVIRONMENTAL

PANDEMICS
ANTIMICROBIAL RESISTANCE
GLOBAL CLIMATE CHANGES
EXTREME EVENTS
ENVIRONMENTAL DEGRADATION
PERMAFROST MELTING
POLLUTION
FOOD WASTE
CIRCULAR ECONOMY
BIODIVERSITY LOSS

ECONOMIC

PRIVATISATION
MORE PREVENTION, LESS CURE
TECH GIANTS' PERVASIVENESS
NEW SPACES, NEW RELATIONS
(UN)PREDICTABLE INSTABILITY
INSURANCE MARKET PLAYERS
DATA EXPLOITATION
E-COMMERCE
COST OF LIVING INCREASE
LACK OF SKILLED WORKERS

POLITICAL

SECURITY
COLLAPSE OF DEMOCRACY
WELFARE
(TRANS)NATIONAL IDENTITIES
INFORMATION & CONNECTION
GEOPOLITICAL COMPETITION
NUCLEAR PATHS
GLOBAL COMMONS
THE RISE OF ETHICAL QUESTIONS
STATES LIKE SILOS

AGEING

Are we all gonna be Dorian Grey?

Aging is progressive physiological changes in an organism that lead to senescence, or a decline of biological functions and of the organism's ability to adapt to metabolic stress.

Aging occurs in a cell, an organ or throughout the organism with the passage of time. It is a process that goes on over the entire adult life span of any living thing.

What do we know?

There is much debate among researchers about the mechanisms that contribute to the ageing process. However, it is widely accepted that damage to genetic material, cells and tissues that accumulates with age (and cannot be repaired by the body) is the cause of the loss of function associated with ageing.

Main causes of ageing are genomic instability, telomere degradation, epigenetic changes, loss of proteostasis, impaired perception of nutrients, mitochondrial disfunctions, cellular senescence, exhaustion of stem cells, altered intercellular communication, deteriorated autophagy.

What do we not know?

What does ageing cause at the molecular level? Why can it be repaired in young organisms but not in old ones?

Clinical trials of senolytics might move toward studies in presymptomatic individuals to delay or prevent age-related conditions.

The remaining gaps in senescence research are the study of the function of senescent cells in other neurological disorders, including traumatic brain injury, spinal cord injury, chronic pain, epilepsy, etc.; the translation of potentials of senolytics in neurological disorders; the study of the dynamics of senescent cell accumulation.
But what can senolytics do in the future?

Inspiring Examples

Unity Biotechnology was one of the darlings of the nascent anti-aging biotech sector. It listed big-name investors, such as Jeff Bezos and Peter Thiel, an impressive lineup of academic founders and a market valuation that once reached $700 million. The company was, in effect, the industry's standard-bearer for the therapeutic idea of destroying senescent cells to blunt the ravages of aging.

References

https://www.who.int/health-topics/ageing#tab=tab_1
https://www.age.mpg.de/how-do-we-age
https://www.nature.com/articles/s41587-020-00750-1
https://www.herl.pitt.edu/symposia/metabolic-pathways/presentations/MP-Zhu.pdf

Nov. 2023

TECHNOLOGY FORESIGHT @ POLIMI

STEEP FORCES - MOST IMPACTFUL ONES

SOCIAL

AGEING · DEMOGRAPHIC CHANGES · **MENTAL HEALTH** · LIFESTYLES · DEEPENING DISPARITIES

NON-COMMUNICABLE DISEASES · BEYOND GENDER · MIGRATIONS · WORK FROM EVERYWHERE · DO IT YOURSELF

TECHNOLOGICAL

MED(AI)CINE · AUTONOMOUS SYSTEMS · HYPER-CONNECTED · HUMAN ENHANCEMENT

AVATARS · EXTENDED REALITY · ROBOTICS · DIGITAL TWIN · CRYONICS · GENETIC CONTROL

ENVIRONMENTAL

PANDEMICS · **ANTIMICROBIAL RESISTANCE** · **GLOBAL CLIMATE CHANGES**

EXTREME EVENTS · **ENVIRONMENTAL DEGRADATION** · PERMAFROST MELTING · POLLUTION

FOOD WASTE · CIRCULAR ECONOMY · BIODIVERSITY LOSS

ECONOMIC

PRIVATISATION · MORE PREVENTION, LESS CURE · **TECH GIANTS' PERVASIVENESS**

NEW SPACES, NEW RELATIONS · (UN)PREDICTABLE INSTABILITY · INSURANCE MARKET PLAYERS

DATA EXPLOITATION · E-COMMERCE · COST OF LIVING INCREASE · LACK OF SKILLED WORKERS

POLITICAL

SECURITY · COLLAPSE OF DEMOCRACY · **WELFARE** · (TRANS)NATIONAL IDENTITIES

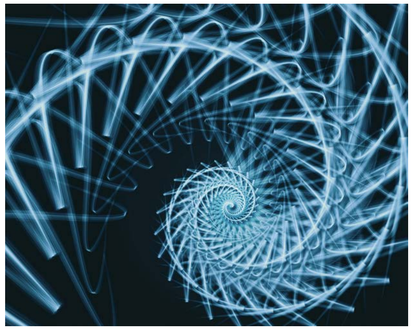
INFORMATION & CONNECTION · **GEOPOLITICAL COMPETITION** · NUCLEAR PATHS · GLOBAL COMMONS

THE RISE OF ETHICAL QUESTIONS · STATES LIKE SILOS

SIGNALS OF CHANGE

- A small or local innovation with the potential to scale in size, impact, and geographic distribution
- Focus attention at the margins of society rather than the core
- Concrete observations about how the world is changing today

THOUSANDS OF PEOPLE SIGNED UP TO HAVE CHIP IMPLANTED IN THEIR BRAIN BY NEURALINK



TYPING "I HAVE ANXIETY" INTO CHATGPT HELPS YOU IMMEDIATELY: THIS HAPPENS IN TAIWAN

NEW SMART TOILET TECH TRACKS YOUR HEALTH STATS

images credits:
https://t.ly/95jsl
https://t.ly/Oshdy
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SELECTED LONG-TERM IMPACT TECHNOLOGIES

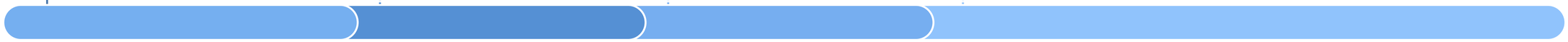
1 **MAPPING THE LANDSCAPE:**
DESK RESEARCH ON THE FUTURE OF HEALTH

2 EXPERTS' PRELIMINARY ANALYSIS

3 EXTENDED AND IN-DEPTH ANALYSIS

4 IMPACT AND RELEVANCE ASSESSMENT:
THE FINAL OUTCOME

- APPLIED ARTIFICIAL INTELLIGENCE
- NEXT GENERATIONS VACCINES
- BIOIMAGING
- DRUG DELIVERY SMART SYSTEMS
- DATA SCIENCE
- BIOSENSORS
- DIGITAL TWIN/MODELLING
- GENETIC EDITING
- IMPLANTABLE DEVICES
- NEUROTECHNOLOGY



FROM 50 TECHNOLOGIES ...

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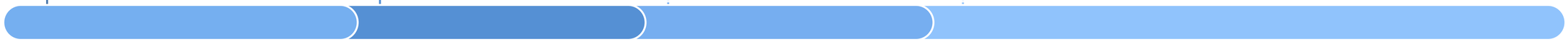

... TO 28 TECHNOLOGIES

- DATA, XR & AI
  - APPLIED ARTIFICIAL INTELLIGENCE
  - EXTENDED REALITY
  - DATA SCIENCE
- GENETICS
  - CAR-T CELLS
  - GENETIC EDITING
  - IN VIVO CELL REPROGRAMMING
  - LIQUID BIOPSY CHIP
  - NEXT GENERATION VACCINES
  - OLIGONUCLEOTIDE THERAPEUTICS
  - OMICS TECHNOLOGY
  - STEM CELL TECHNOLOGY
- DIGITAL
  - DIGITAL THERAPEUTICS
  - DIGITAL TWIN/MODELLING
  - WEB 4.0 TECHNOLOGIES
- NANO
  - DRUG DELIVERY SMART SYSTEMS
  - NANOMATERIALS
  - NANOMEDICINE
  - SMART PILLS
- IMAGING
  - BIOIMAGING
  - ULTRASOUNDS
- WEARABLE & SENSOR
  - BIOSENSORS
  - INTERNET OF MEDICAL THINGS/WEARABLE
- DEVICES
  - 3D PRINTING
  - EXOSKELETON/ROBOTICS
  - IMPLANTABLE DEVICES
  - NEUROTECHNOLOGY
- OTHERS
  - FLUID INTERFACES
  - MICROPHYSIOLOGICAL SYSTEMS

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- IMPLANTABLE DEVICES
- NEUROTECHNOLOGY

IMPLANTABLE DEVICES

An implantable device is an active medical device intended to be fully or partially inserted into the human body for diagnostic or therapeutic purposes, with the intention of remaining in place. Due to their direct and long-term contact with the body, implantable devices are subject to rigorous standards and requirements to ensure the health and safety of patients.

Not only implantable, but also wearable technologies will play a central role. The ubiquity of wearable computing elements is on the rise, albeit hindered by inherent limitations in resolution and bandwidth imposed by current digital technology paradigms. This evolution now intersects with biological frameworks and processes, paving the way for a transformative era in healthcare.

EXAMPLES OF POTENTIAL FIELDS OF APPLICATION

- Remote patient monitoring
- Glucose monitoring
- Heart rate monitoring
- Connected contact lenses
- Parkinson's disease monitoring
- Depression and mood monitoring
- Ingestible sensors connected inhalers

PHASES

PREDICTION | **PREVENTION** | DIAGNOSIS | TREATMENT | REHABILITATION

OPPORTUNITIES

→ Continuous monitoring of vital parameters
→ Citizen-centred care and 6P medicine (Preventive, Predictive, Participatory, Personalized, Psychosocial, Platforms)
→ Development of new families of wearable sensors (smart rings, smart glasses)

REQUIREMENTS

→ Massification of wearable and implantable technologies
→ Availability and affordability
→ Miniaturized batteries
→ Data analysis
→ Data management models
→ Organisation of information campaigns

RISKS

→ Psychological stress, agitation and/or hypochondria due to control and technological dependence on continuous measurement
→ Over-diagnosis and obsession
→ Invasiveness of drug delivery for implantable devices
→ Possibility of self-determination and the choice to refuse continuous control
→ Medicalisation of existence
→ Lack of common platforms for data collection and analysis

IMPACTS

→ Quasi-normal lifesyle for individuals requiring medications and continuous monitoring

DIGITAL TWIN/MODELLING

A Digital Twin is a set of virtual information constructs that mimics the structure, context, and behaviour of a natural, engineered, or social system. It is dynamically updated with data from its physical twin, has a predictive capability, and informs decisions that realise value. Health digital twins (HDTs) are virtual representations of patients, derived from diverse patient data sources, population data, and real-time updates concerning patient and environmental variables. Through meticulous application, HDTs can simulate random deviations in the digital twin to elucidate anticipated behaviours of the physical counterpart, thereby offering revolutionary implications in precision medicine, clinical trial methodologies, and public health initiatives.

EXAMPLES OF POTENTIAL FIELDS OF APPLICATION

Access to data-driven insights regarding operational strategies, capacity, staffing and care models

Monitoring

Development of a unique model for each patient

PHASES

PREDICTION | **PREVENTION** | **DIAGNOSIS** | **TREATMENT** | REHABILITATION

OPPORTUNITIES

→ Prediction of disease progression
→ Identification of high-risk individuals
→ Recommendation of preventive measures
→ Monitoring without the implications of presence checks
→ Relief for the healthcare system
→ Personalised medicine

REQUIREMENTS

→ Creation of predictive models
→ Data collection and data availability
→ Interoperability of data
→ Development of decision models (with probabilistic formulation)

RISKS

→ Lack of systems allowing for interoperability of data
→ Privacy of data and non-medical uses
→ Overconfidence in the adoption of the tool within the clinical decision-making process

IMPACTS

→ Reshaping industries to increase efficiency and identify issues
→ Treatment of patients as virtualised standalone assets
→ Improvement in treatment and diagnostics within hospitals and for individual patients

IMAGING OUR FUTURE … ENVISIONING TOGETHER

- ◊ alternative visions and futures' analysis
- ◊ personal health paradigm
- ◊ opportunities and challenges' discourse
- ◊ insights: in-depth analysis into possible future developments

EMERGENT ASPECTS: INSIGHTS

AUTO-MONITORING & SELF-TRACKING FOR AN ACTIVE POPULATION ENGAGEMENT

ETHICS, PRIVACY, AND SECURITY

MORE PREVENTION, LESS CURE

MODELLING AND DATA

(RE)NEW(ED) RELATIONSHIPS: CAREGIVERS, FAMILY, AND NEW COLLABORATIVE COMMUNITIES

MENTAL HEALTH AND WELL-BEING

NEW DISEASES AND NEW FORMS OF DISCRIMINATION

HEALTHCARE SUSTAINABILITY

A REMOTE ONLINE LIFE

EMPATHY AND THE NARRATIVE DIMENSION OF THE PATIENT

PERSONALISED MEDICINE

WIDESPREAD EDUCATION: HEALTH PROFESSIONALS' EDUCATION, AND HEALTHCARE NETWORKS

AUTO-MONITORING AND SELF-TRACKING FOR AN ACTIVE POPULATION ENGAGEMENT

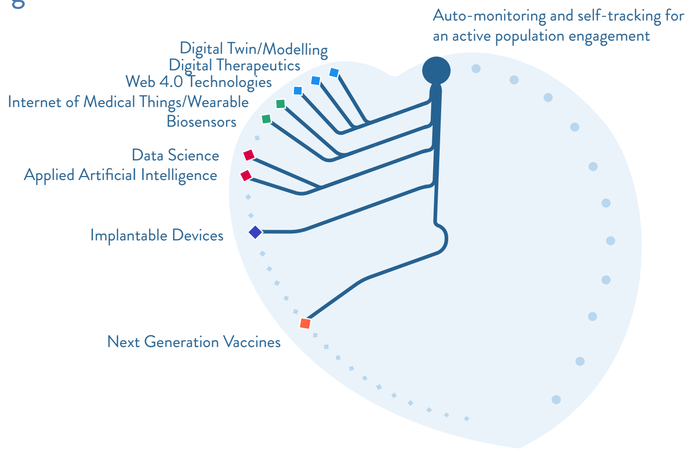
The **active involvement of patients**, families, and the community at large is essential to advance predictive models. The overall goal is to promote autonomy and self-sufficiency by empowering people to effectively manage their own care.

To this end, harnessing **collective intelligence** through information crowdsourcing is crucial. It is necessary to promote awareness through widespread dissemination and create care networks that incorporate voluntary resources as additional support to the healthcare system.

Self-monitoring could support the maintenance of physical and mental health through constant monitoring of vital parameters. Collectively, continuous monitoring could benefit healthcare by providing data for predictive and preventive modelling.

At the same time, the implications of **self-monitoring** are manifold. Sociality could change and psychological risks increase in a context where existence is pervaded by progressive medicalisation.

Technologies



STEEP Forces

SOCIAL AGEING · DEMOGRAPHIC CHANGES · MENTAL HEALTH · LIFESTYLES · DEEPENING DISPARITIES · NON-COMMUNICABLE DISEASES · BEYOND GENDER · MIGRATIONS · WORK FROM EVERYWHERE · DO IT YOURSELF

TECHNOLOGICAL MED(AI)CINE · AUTONOMOUS SYSTEMS · HYPER-CONNECTED · HUMAN ENHANCEMENT · AVATARS · EXTENDED REALITY · ROBOTICS · DIGITAL TWIN · CRYONICS · GENETIC CONTROL

ENVIRONMENTAL PANDEMICS · ANTIMICROBIAL RESISTANCE · GLOBAL CLIMATE CHANGES · EXTREME EVENTS · ENVIRONMENTAL DEGRADATION · PERMAFROST MELTING · POLLUTION · FOOD WASTE · CIRCULAR ECONOMY · BIODIVERSIT LOSS

ECONOMIC PRIVATISATION · MORE PREVENTION, LESS CURE · TECH GIANTS' PERVASIVENESS · NEW SPACES, NEW RELATIONS · (UN)PREDICTABLE INSTABILITY · INSURANCE MARKET PLAYERS · DATA EXPLOITATION · E-COMMERCE · COST OF LIVING INCREASE · LACK OF SKILLED WORKERS

POLITICAL SECURITY · COLLAPSE OF DEMOCRACY · WELFARE · (TRANS)NATIONAL IDENTITIES · INFORMATION & CONNECTION · GEOPOLITICAL COMPETITION · NUCLEAR PATHS · GLOBAL COMMONS · THE RISE OF ETHICAL QUESTIONS · STATES LIKE SILOS

MODELLING AND DATA

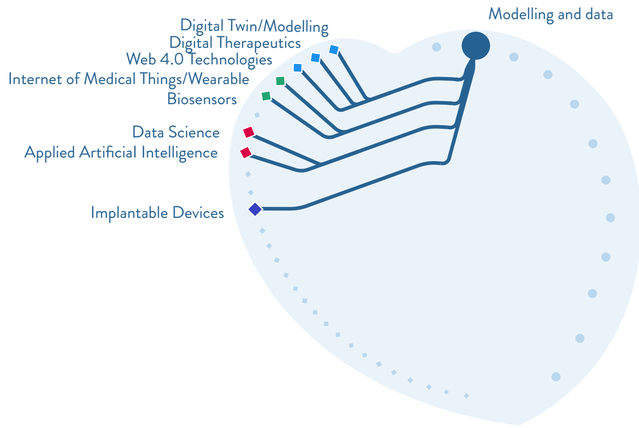
The availability of data and the ability to analyse them are the new gold rush to predict and prevent diseases. It is necessary to develop simulation systems and technologies to implement clinical research based on **real world data** and define new criteria for **predictive modeling**.

Advanced predictive models and extensive data availability can enhance health outcomes. However, due to the intimate nature of this data, **data protection** and **new privacy paradigms** are essential to prevent unauthorised use.

An information system for citizens must be developed so that they are aware of the use of monitoring systems.

Situations where individual narratives are depersonalised through the use of models and data, as well as their inappropriate use for non-medical purposes, raise significant questions for the future.

Technologies



STEEP Forces

SOCIAL AGEING DEMOGRAPHIC CHANGES MENTAL HEALTH LIFESTYLES
DEEPENING DISPARITIES NON-COMMUNICABLE DISEASES BEYOND GENDER
MIGRATIONS WORK FROM EVERYWHERE DO IT YOURSELF

TECHNOLOGICAL MED(AI)CINE AUTONOMOUS SYSTEMS HYPER-CONNECTED HUMAN ENHANCEMENT
AVATARS EXTENDED REALITY ROBOTICS DIGITAL TWIN CRYONICS GENETIC CONTROL

ENVIRONMENTAL PANDEMICS ANTIMICROBIAL RESISTANCE GLOBAL CLIMATE CHANGES
EXTREME EVENTS ENVIRONMENTAL DEGRADATION PERMAFROST MELTING POLLUTION
FOOD WASTE CIRCULAR ECONOMY BIODIVERSIT LOSS

ECONOMIC PRIVATISATION MORE PREVENTION, LESS CURE TECH GIANTS' PERVASIVENESS
NEW SPACES, NEW RELATIONS (UN)PREDICTABLE INSTABILITY INSURANCE MARKET PLAYERS
DATA EXPLOITATION E-COMMERCE COST OF LIVING INCREASE LACK OF SKILLED WORKERS

POLITICAL SECURITY COLLAPSE OF DEMOCRACY WELFARE (TRANS)NATIONAL IDENTITIES
INFORMATION & CONNECTION GEOPOLITICAL COMPETITION NUCLEAR PATHS GLOBAL COMMONS
THE RISE OF ETHICAL QUESTIONS STATES LIKE SILOS

TRANSFORMATIVE PERSONAL HEALTH TECHNOLOGIES IN 2040

STEEP Forces, Technologies and Insights

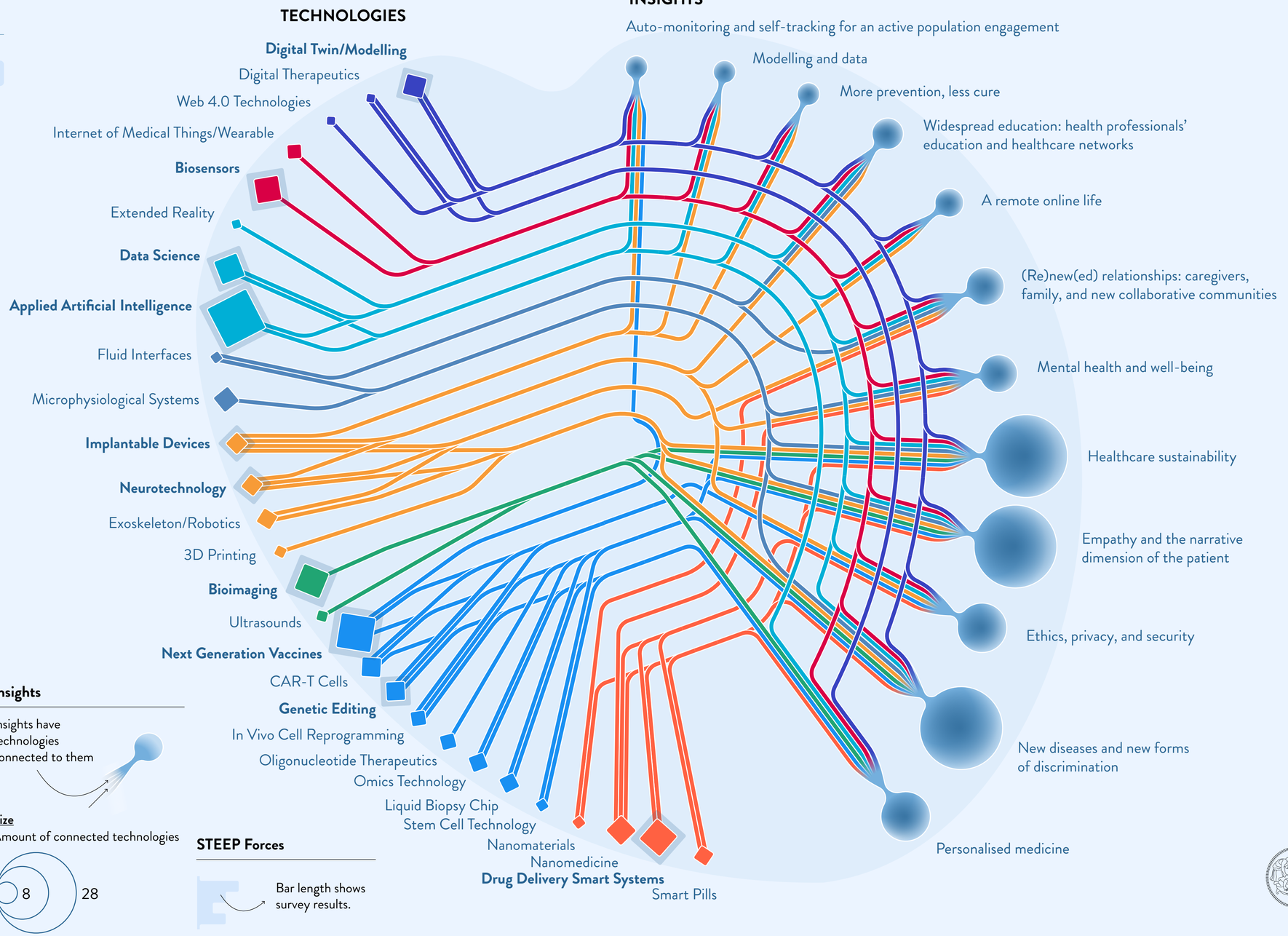
STEEP FORCES

Social

- Ageing
- Non-communicable diseases
- Mental health
- Lifestyles
- Deepening disparities
- Demographic changes
- Beyond gender
- Migrations
- Work from everywhere
- Do it yourself

Technological

- Med(AI)cine
- Autonomous systems
- Hyper-connected
- Human enhancement
- Extended reality
- Robotics
- Digital twin
- Cryonics
- Genetic control
- Avatars



Environmental

- Pandemics
- Antimicrobial resistance
- Global climate changes
- Extreme events
- Environmental degradation
- Permafrost melting
- Pollution
- Food waste
- Circular economy
- Biodiversity loss

Economic

- Privatisation
- E-commerce
- Cost of living increase
- More prevention, less cure
- Insurance market players
- (Un)predictable instability
- New spaces, new relations
- Tech giants' pervasiveness
- Data exploitation
- Lack of skilled workers

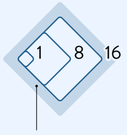
Political

- Security
- Collapse of democracy
- Welfare
- (Trans)national identities
- Information and connection
- Geopolitical competition
- Nuclear paths
- Global commons
- The rise of ethical questions
- States like silos

HOW TO READ IT

Technologies

Size
Amount of votes



Highlight
Most relevant technologies emerged from the participants' survey results

Colour
Category

- Digital
- Wearable & Sensors
- Data, XR & AI
- Others
- Devices
- Imaging
- Genetics
- Nano

Insights

Insights have technologies connected to them

Size
Amount of connected technologies

STEEP Forces

Bar length shows survey results.

POLITECNICO MILANO 1863

TECHNOLOGY FORESIGHT

TECHNOLOGIES' ANALYSIS

- **opportunities** provided by technologies with respect to the application contexts
- enabling factors, **requirements** necessary for the technology to make an impact
- evaluating potential **risks** related to the use of technology (often technological dual use)
- expected **impacts** the technology can actually have in transforming the personal health scenario

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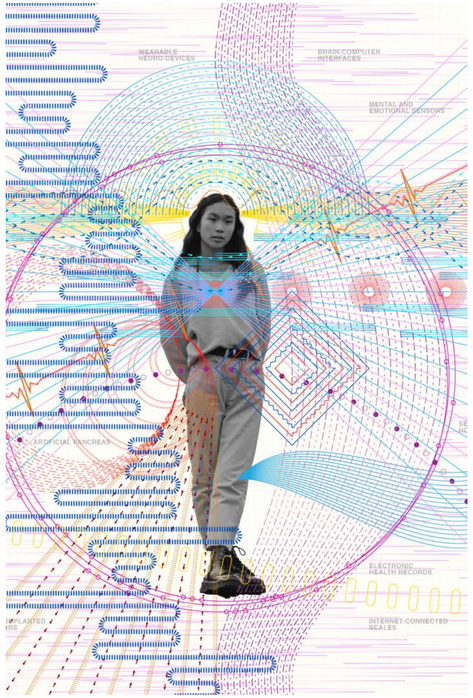
TAKE-HOME MESSAGES

DIGITAL HEALTH

humans as data in hyper-connected societies



PROACTIVE HEALTHCARE

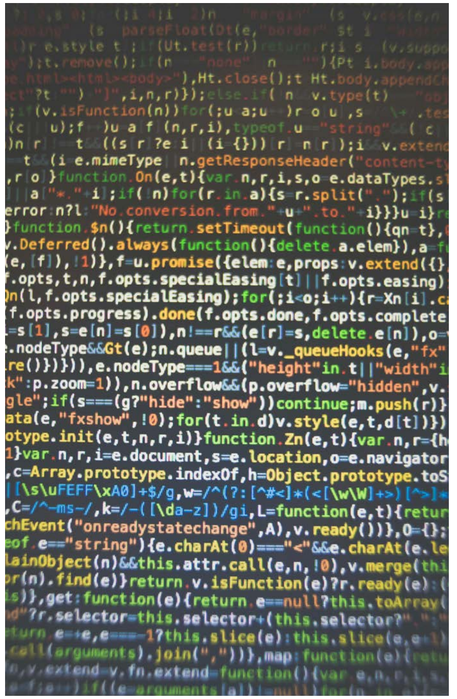
from cure to prevention through prediction

MYDICINE

increasingly tailored medicine

SUSTAINABILITY & EQUITY

challenges to reduce the gaps



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NEXT STEPS

- How will new technologies change the structures of the **healthcare system**?
- What new relationships will be established with the advent of new technologies at the **ecosystem level**?

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LEADIN' LAB
LEAdership. Design. Innovation.

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