Dietary Digital Twin - DDTwin
Call for partners

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AgriFoodTop 2022

WAGENINGEN
UNIVERSITY & RESEARCH

Maastricht University
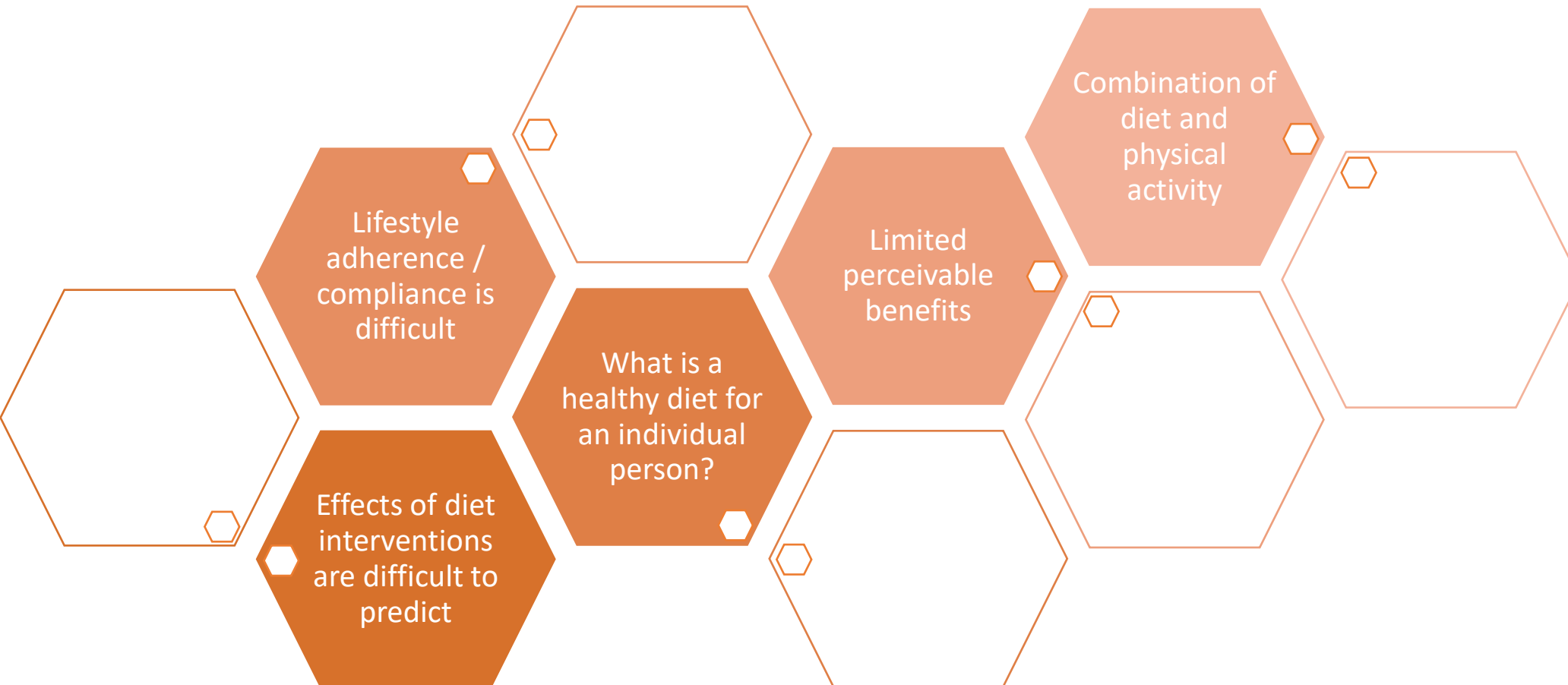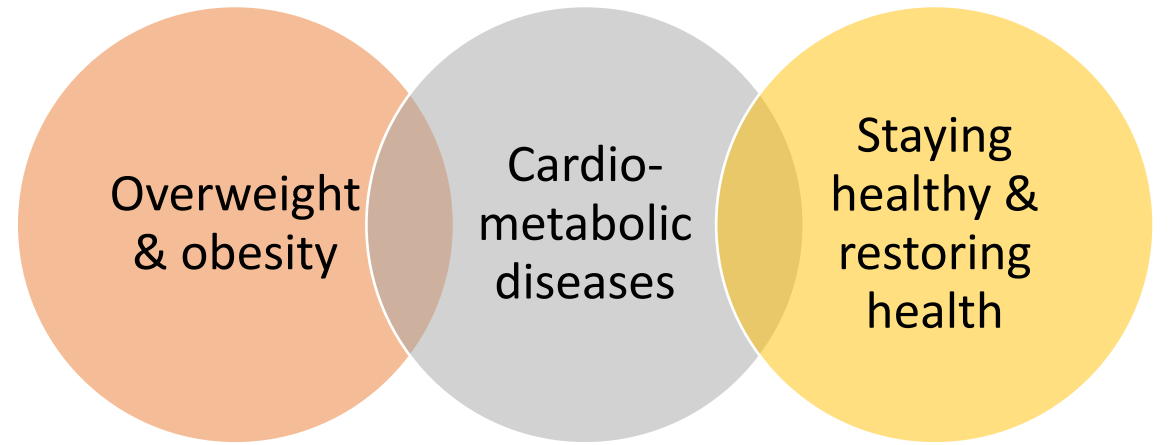
TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY
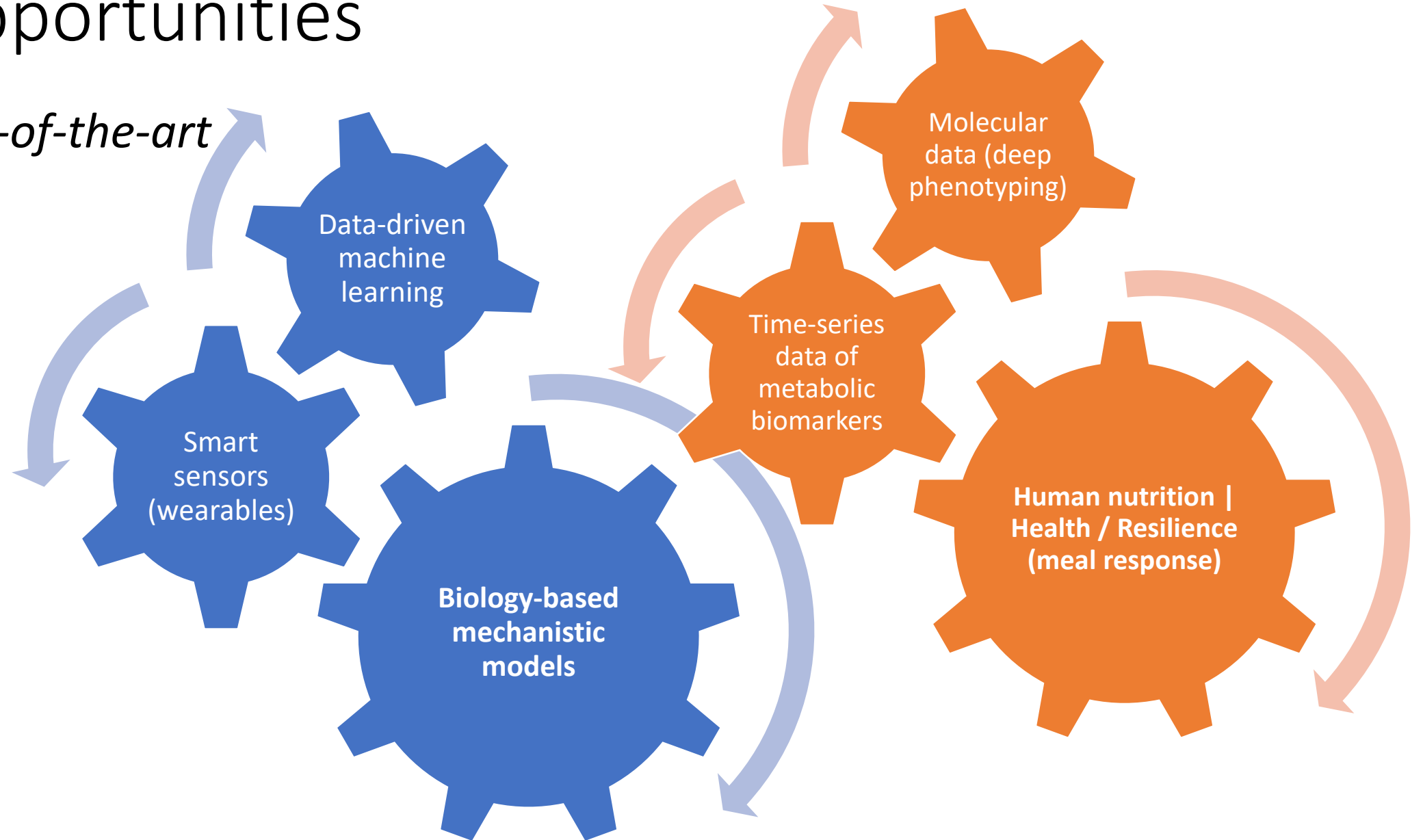
Topsector Agri & Food

Summary

- Goal: build a **Dietary Digital Twin** that can be used by consumers and producers to optimize diet

- Why interesting: **combine** diet, foods, sensors, data, AI and knowledge to generate actionable information

- How:
  - define flagship to address grant challenge
  - build consortium for NWO KIC - Partnerships in the Knowledge and Innovation Covenant (KIC)
  - develop ecosystem, based on 'lego bricks model', co-creation and citizen science
  - implement as transparent, open platform for science and technology, with specific, user-based applications

https://www.nwo.nl/en/researchprogrammes/knowledge-and-innovation-covenant/partnerships-kic-2020-2023

Why?

Overweight & obesity

Cardio-metabolic diseases

Staying healthy & restoring health

Lifestyle adherence / compliance is difficult

Effects of diet interventions are difficult to predict

What is a healthy diet for an individual person?

Limited perceivable benefits

Combination of diet and physical activity

Opportunities

❖*State-of-the-art*

Flagship project Dietary Digital Twin (DDTwin)

A **digital twin** is a versatile technological platform that can be used to simulate and predict the **dynamic** behavior of a real-world counterpart, in our case a person.

It is a collection of models that combine biology-based (mechanistic) and data-driven (statistical, machine learning, AI).

Digital twins are linked to sensors or Internet of Things (IoT) to enable real-time analyses of the status of the person.

'Hybrid intelligence': domain knowledge + AI

State-of-the-art: Meal Digital Twin

- Biology-based mechanistic model

- Connected to real-life data
  - Personalized
  - Evolving (adapting, self-learning)
- Prediction
  - ▶ study 'what if' scenarios *in silico*

o Simulates whole body glucose and lipid metabolism in response to meals containing carbohydrates, fats and proteins

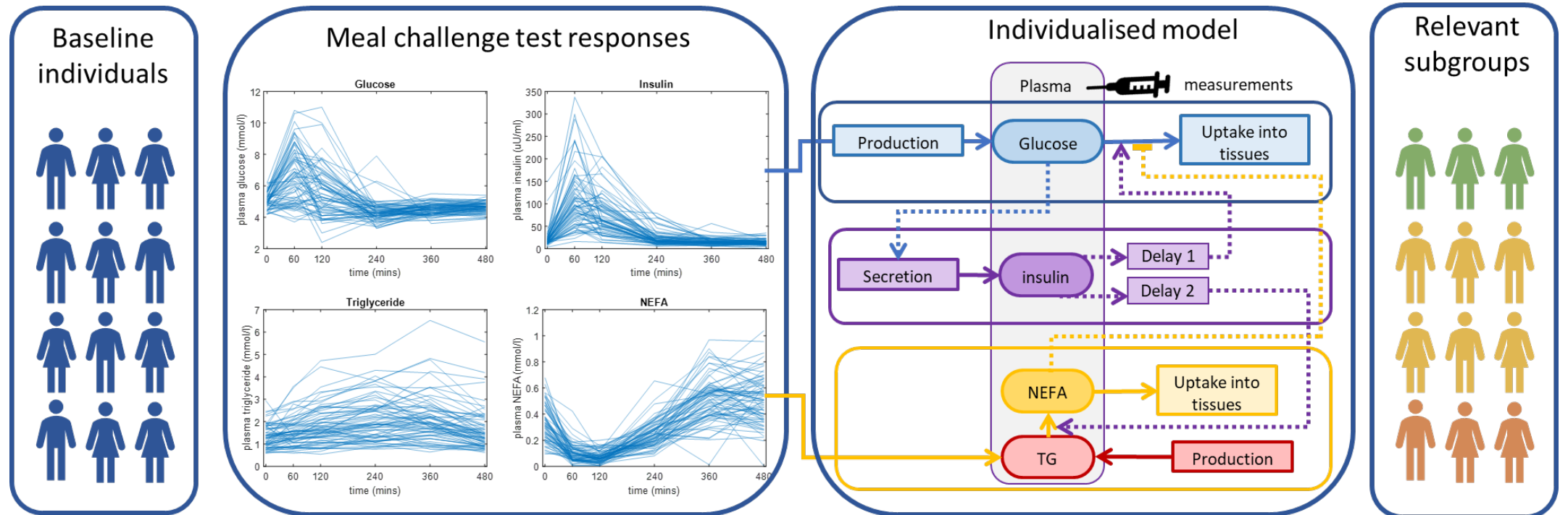o Validated for individuals who are healthy or live with obesity or diabetes
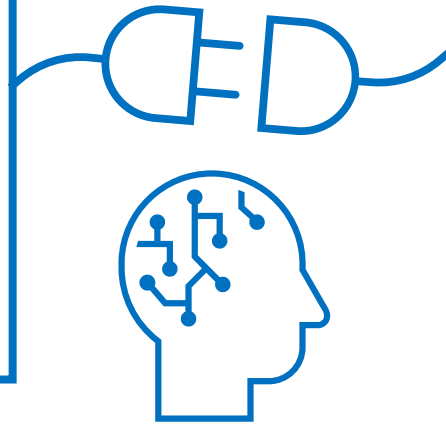
Meal   Digital   Twin

NWO MATRyOShka project

State-of-the-art: Personalized Meal Digital Twins

- Classification, monitoring, prediction

Meal Digital Twin: Foundation of Dietary Digital Twin
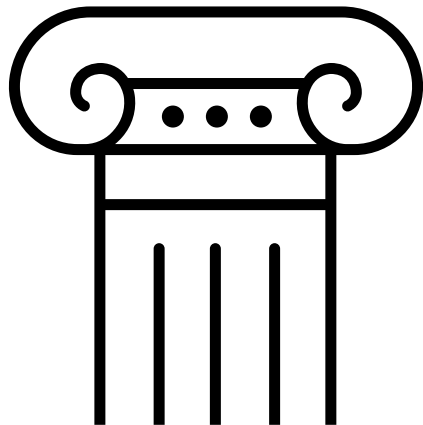
NWO MATRyOShka project

Building personalized Dietary Digital Twins

- Individual's response to food intake
- Meals as metabolic perturbations ('challenges')

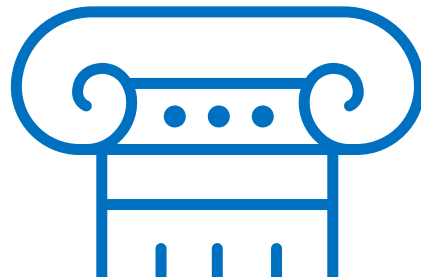- Biology & (patho)physiology
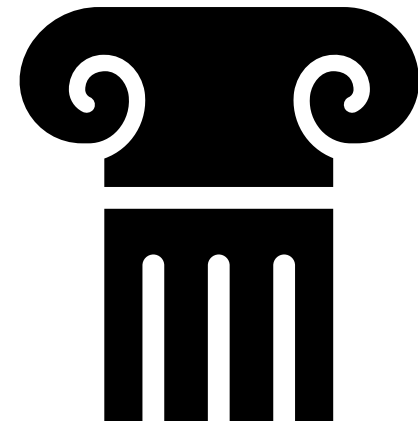- Mechanistic & dynamic models
- Simulation & prediction

DATA

data-driven machine learning/ AI models

DOMAIN KNOWLEDGE

Hybrid Intelligence

Digital twin technology is widely applicable

in context of

- health
- nutrition
- agrofood
- bioprocessing
- retail

Trends in Food Science & Technology 109 (2021) 245–258

Contents lists available at ScienceDirect

Trends in Food Science & Technology

journal homepage: www.elsevier.com/locate/tifs

ELSEVIER

Digital twins are coming: Will we need them in supply chains of fresh horticultural produce?

Thijs Defraeye [a,*], Chandrima Shrivastava [a,b], Tarl Berry [c], Pieter Verboven [d], Daniel Onwude [a], Seraina Schudel [a,e], Andreas Bühlmann [e], Paul Cronje [c], René M. Rossi [a]

FOOD AND BIOPRODUCTS PROCESSING 126 (2021) 317–333

Contents lists available at ScienceDirect

Food and Bioproducts Processing

journal homepage: www.elsevier.com/locate/fbp

ELSEVIER   IChemE

Applications of process and digital twin models for production simulation and scheduling in the manufacturing of food ingredients and products

Alexandros Koulouris [a,*], Nikiforos Misailidis [b], Demetri Petrides [b]

sensors

Review

Can a Byte Improve Our Bite? An Analysis of Digital Twins in the Food Industry

Elia Henrichs *[ID], Tanja Noack [ID], Ana María Pinzon Piedrahita, María Alejandra Salem, Johnathan Stolz and Christian Krupitzer *[ID]

MDPI

Henrichs et al. (2022)

Pillar 1: Technology development

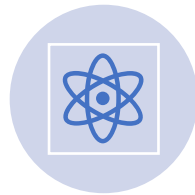Extending Mixed Meal Model (fibres, gut microbiome, incretins,…)

Biology-informed AI and machine learning algorithms

Use data collected during daily life (smart wearables)

Simulate life course trajectories

New biosensors
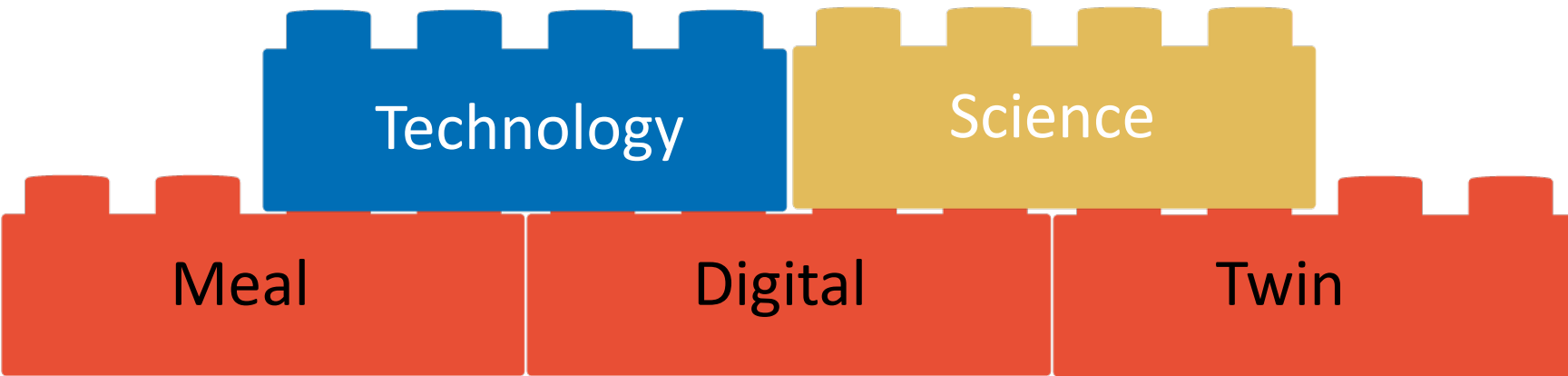
User interface

Technology

Meal

Digital

Twin

Pillar 2: Science

Scientific questions, such as

- What can meal responses tell us about metabolic resilience and long-term risk factors?
- How to link changes in gut microbiome to parameters of metabolic health?
    - glycemic control
    - lipid dynamics
- What is the synergy between diet, gut and liver?
- Diet and satiety
- ..

Pillar 3: Applications

Examples:

- How can I optimize the glycemic response from my product for several sub-groups of consumers?

- Which set of ingredients can promote a specific gut-health colonization related to specific human condition (stress, performance, viral infections etc.)

- How to return actionable information to user?
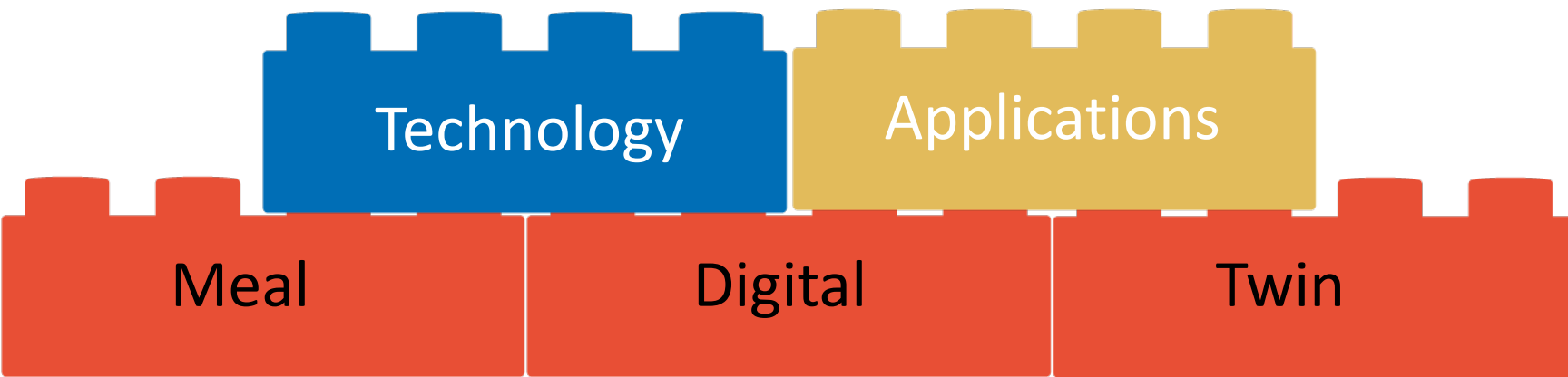
Call for partners

Stakeholders from academia & industry

- Scientists in human nutrition, multi-scale modelling, AI technologies
- Data and software engineers
- User System Interaction, social sciences

- Food industry
- Retail
- Regulatory bodies

❖TIFN

❖NWO MATRyOShka project

❖TIFN project Perceivable Benefits

❖WUR Me-my-diet-and-I
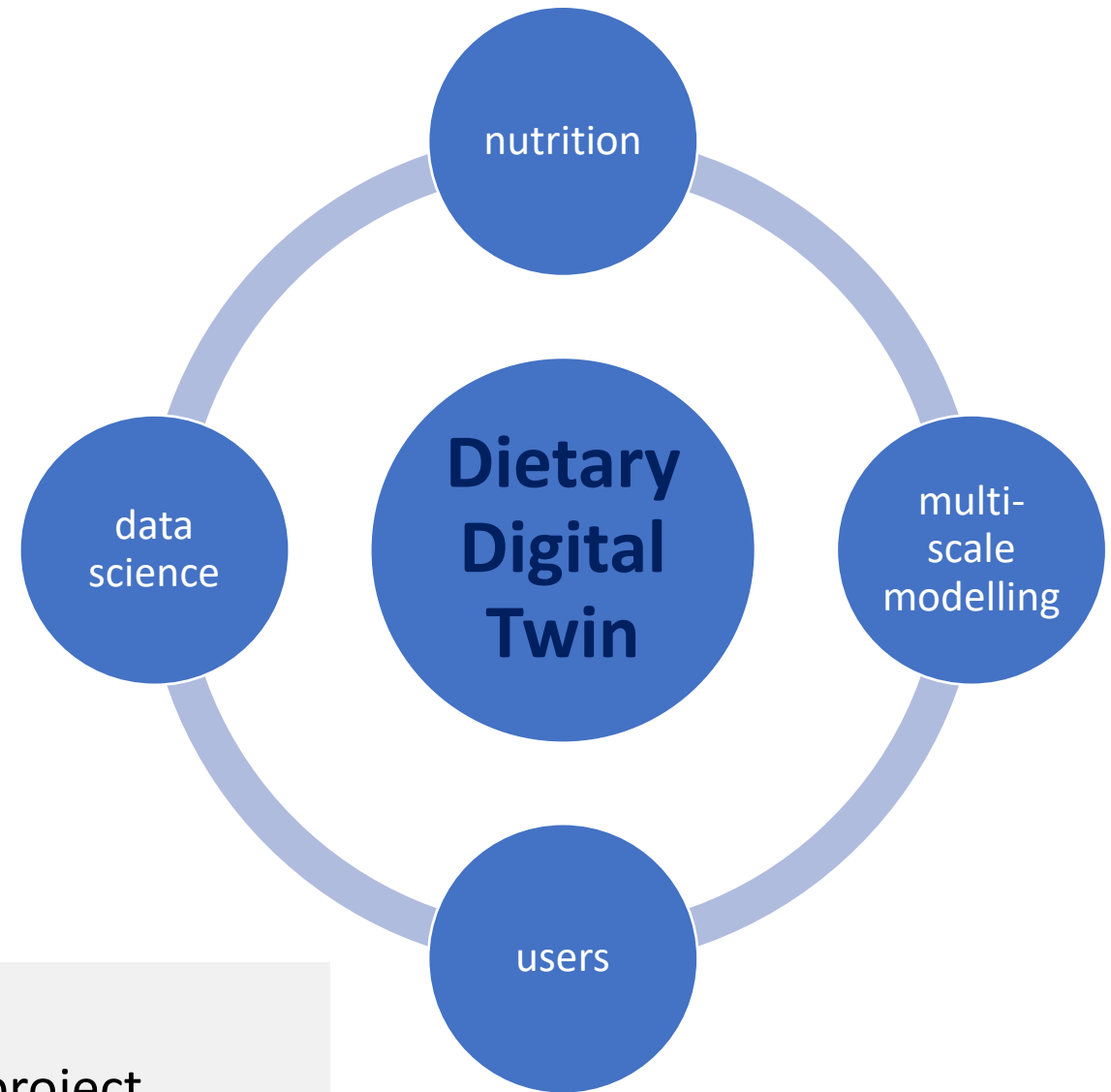
Afternoon discussion

SWOT analysis

- Possible applications
- What is needed / What is missing?
- NWO KIC - Partnerships in the Knowledge and Innovation Covenant (KIC)

https://www.nwo.nl/en/researchprogrammes/knowledge-and-innovation-covenant/partnerships-kic-2020-2023

News

Pre-announcement: Demand-driven Partnerships for Consortia 2022–2023
14 JUNE 2022

Call open for innovation in early cancer detection and diagnosis (KIC)
9 FEBRUARY 2022

New 2022 deadlines for initiatives for Demand-driven Partnerships (KIC 2020–2023)
15 DECEMBER 2021

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