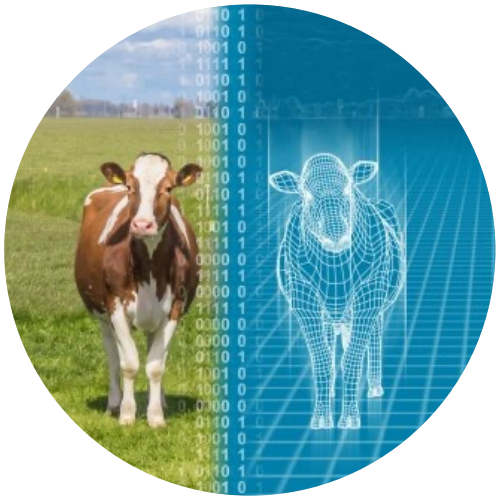
Digital Twins in the Living Environment

Investment theme Wageningen University & Research

Dick de Ridder, Jene van der Heide, Willem Jan Knibbe



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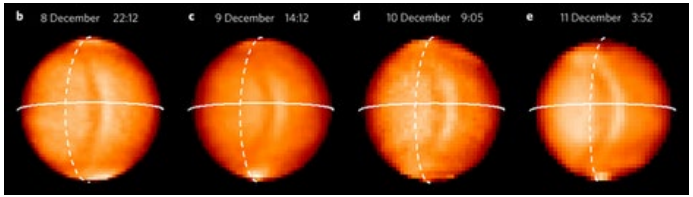
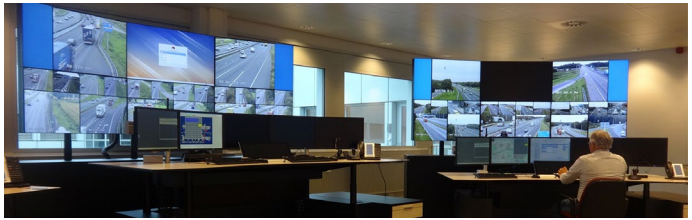
Who was Willem Jan Knibbe before joining WUR?



PhD in Physics & Astronomy



Research in highway traffic control

Department head at national bureau of statistics (CBS)

Head of drinking water technology and quality (Oasen)

What is the Wageningen Data Competence Center?

www.wur.eu/data

WR Institutes

WU Chair Groups

WUR Investment Programs

WUR Library

WUR Information Technology

WUR Information Management

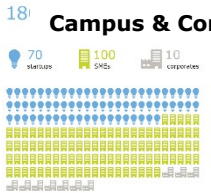
Education & Student Affairs

Corporate Strategy & Accounts

Corporate Value Creation

WDCC

connecting data



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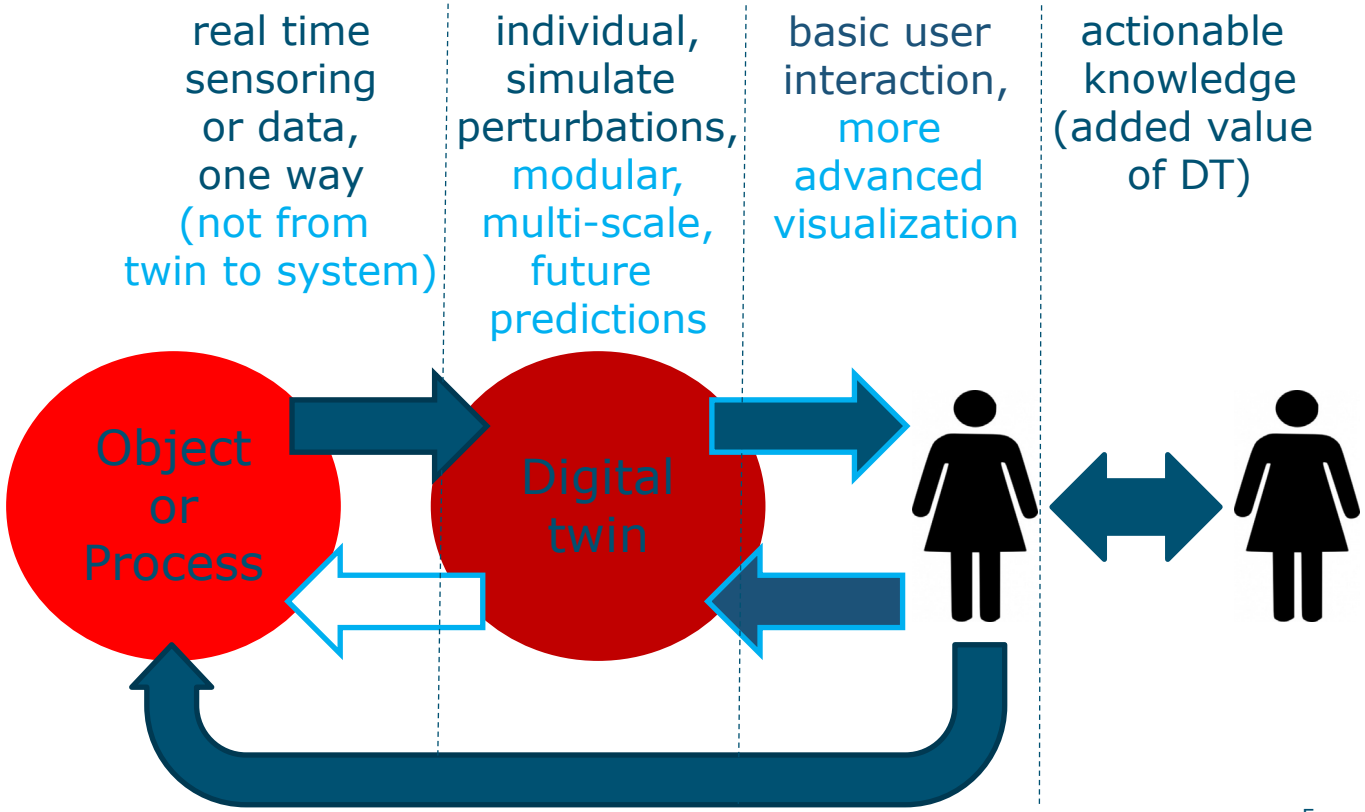
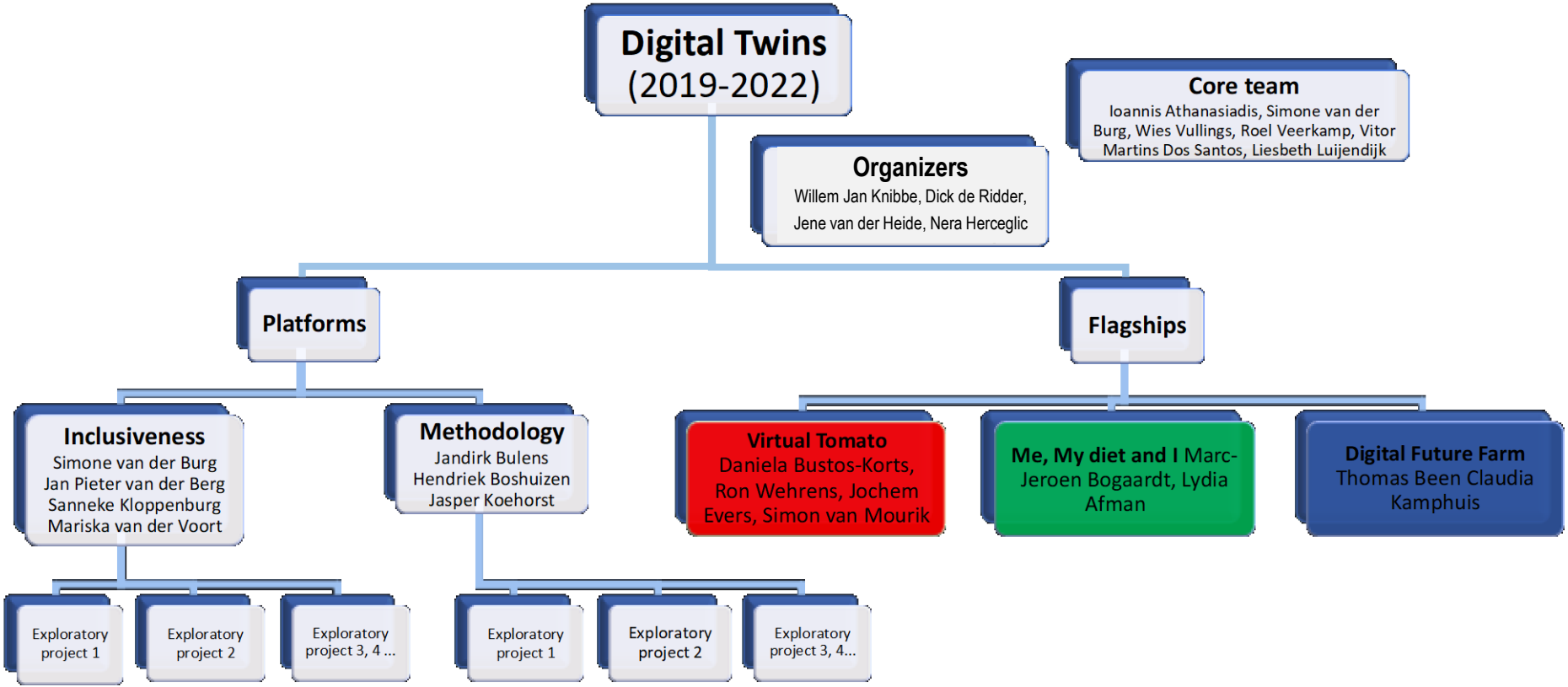
2019: start of WUR investment theme Digital Twins

Digital Twin distinguishing features



Program organization



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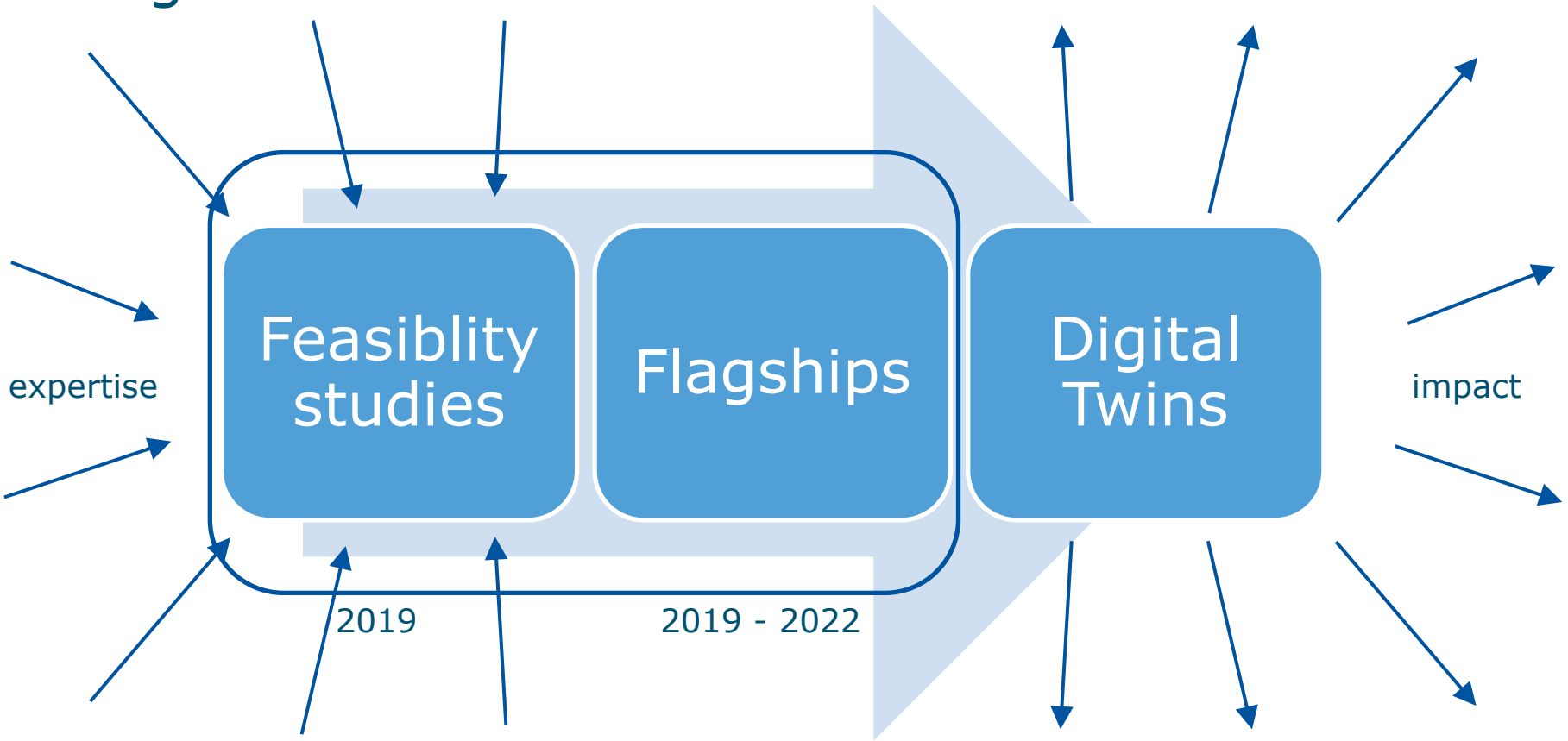
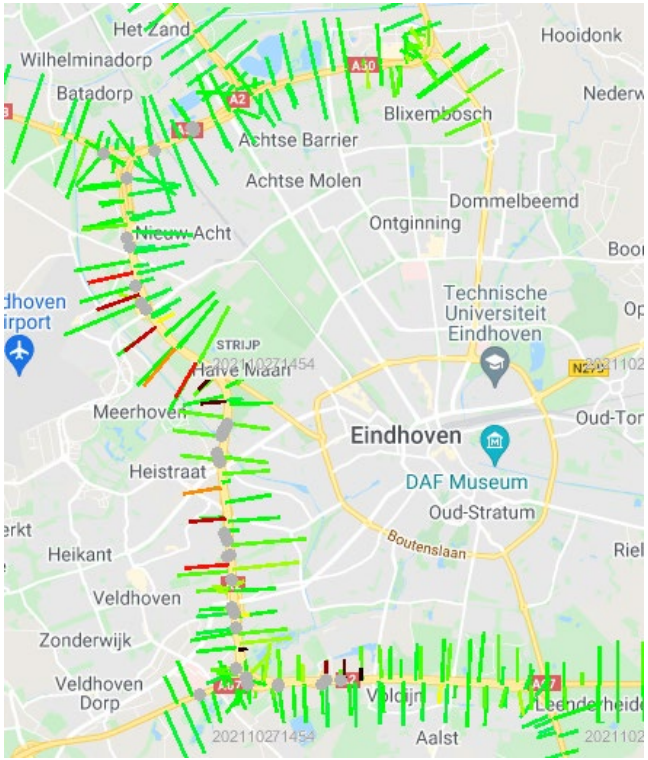
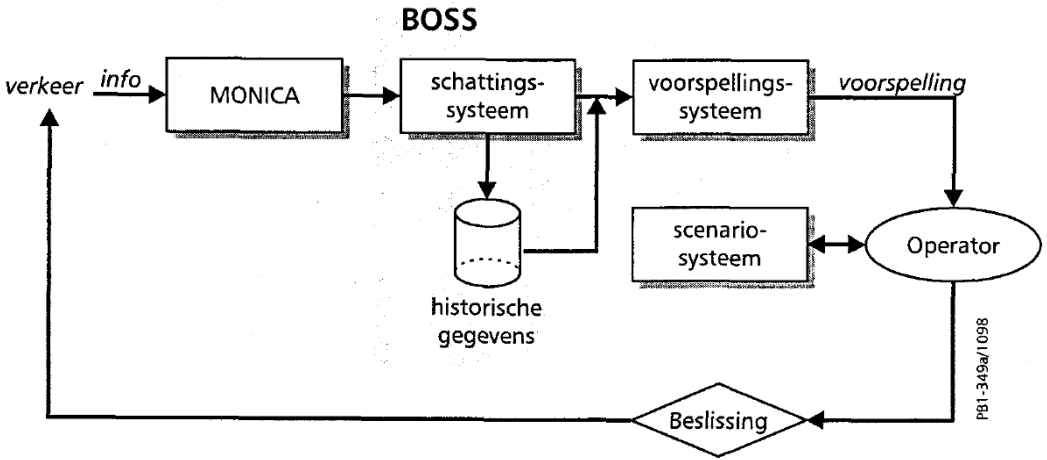
Programme evolution



Prehistoric example ...





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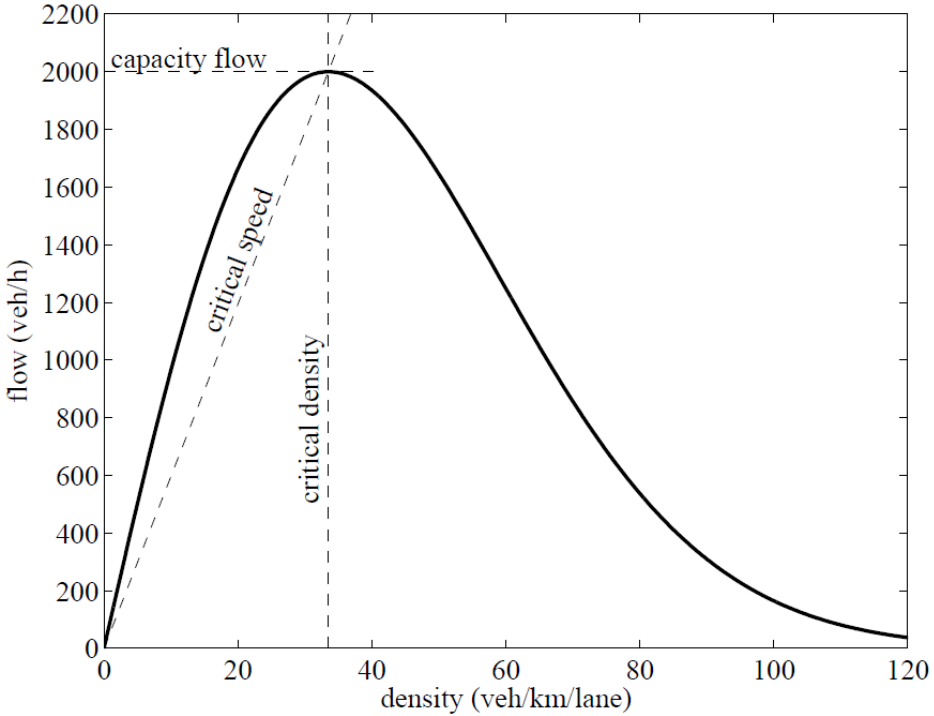
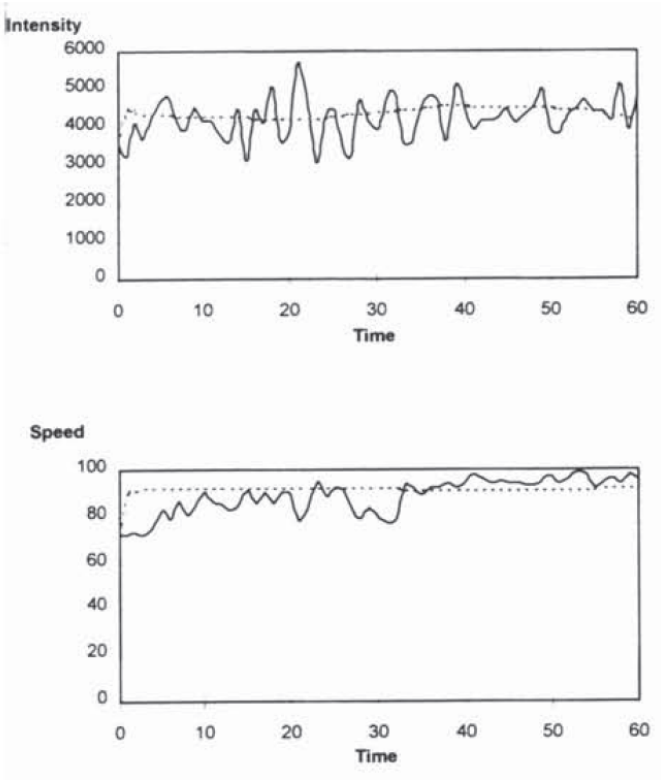
… based on a simple behavioural relationship



András Hegy, PhD TUDelft, 2004



Knibbe, IFAC, 2000

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But now ...

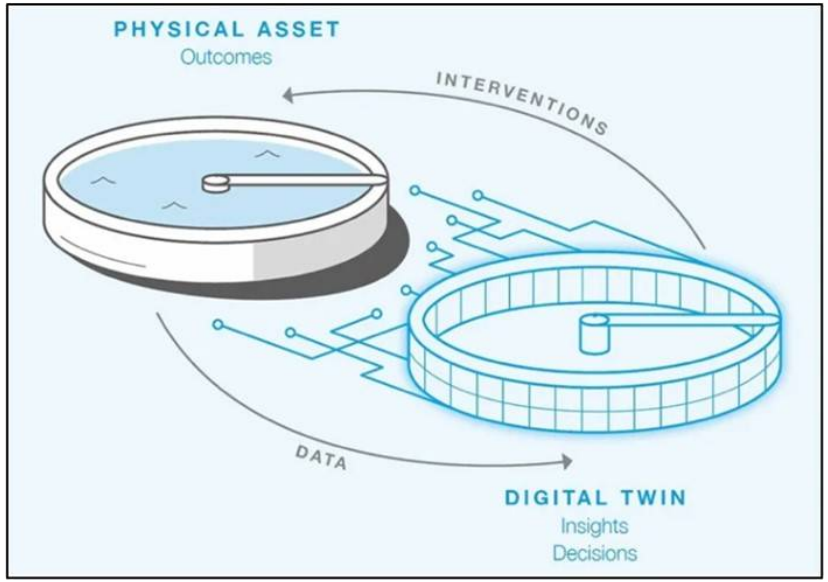
Flagship projects:

- Greenhouse plant growth
- Farm nitrogen management
- Human fat response

Many other initiatives such as:

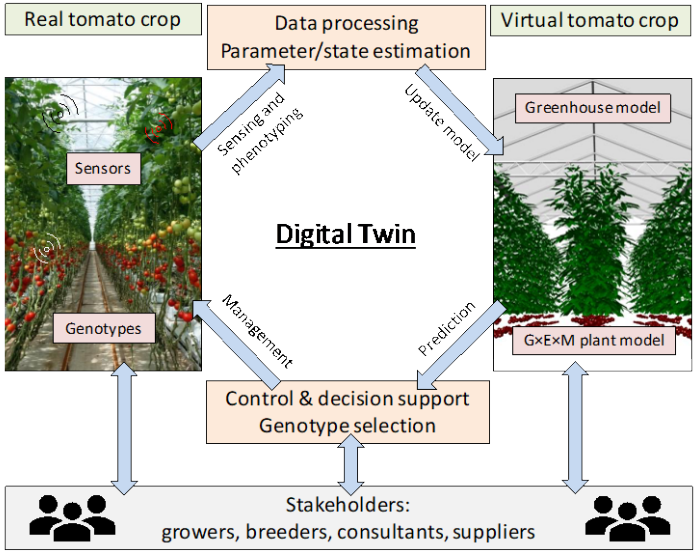
- Destination Earth global digital twins (EU)
- Digital cow (NL)
- Valuing waste streams (Africa)

Exploring a new concept in a complex domain



Virtual Tomato Crop

- 2020:
  - stakeholder analysis
  - phenotyping tested
  - models selected and partially fitted/integrated
- 2021:
  - phenotyping experiments
  - advanced model fitting (deep learning)
  - initial model integration
  - performance evaluation



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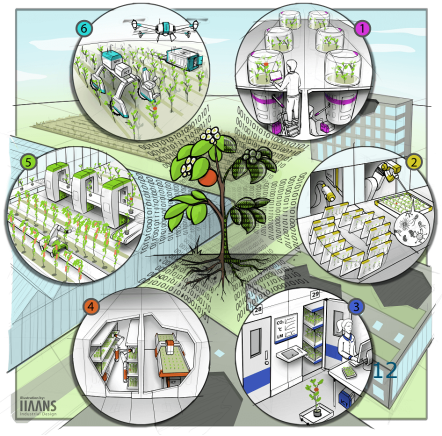

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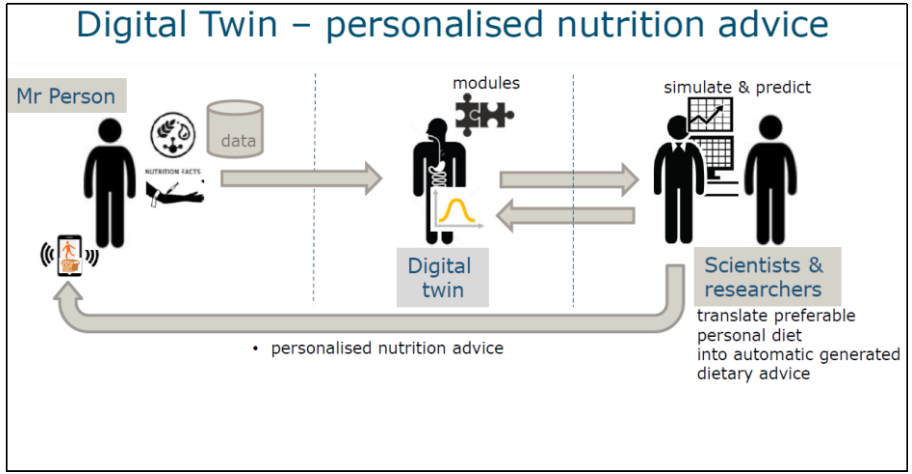
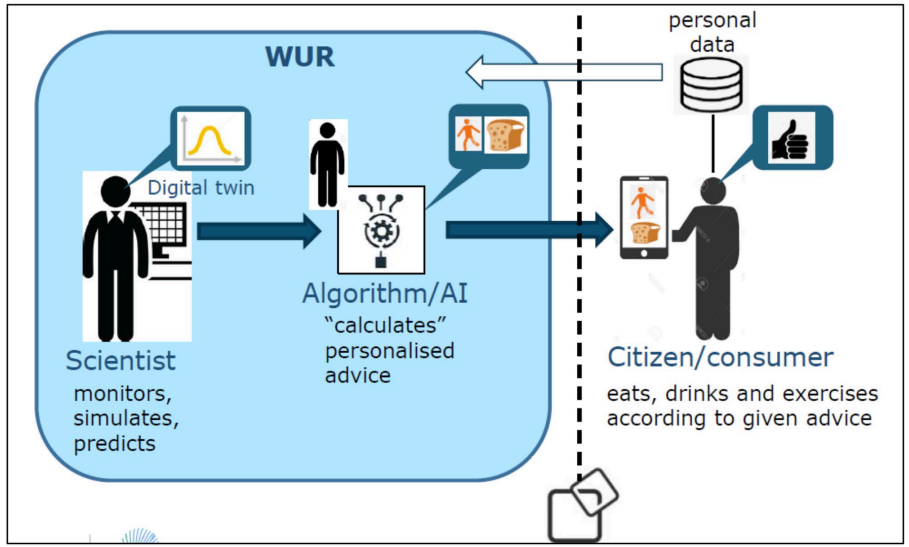
Me, My Diet & I

- 2020:
  - data collected
  - initial TAG response model
  - consumer acceptance review
  - stakeholder analysis
- 2021:
  - final model and fitting (ML)
  - additional data/knowledge
  - start proof-of-principle study





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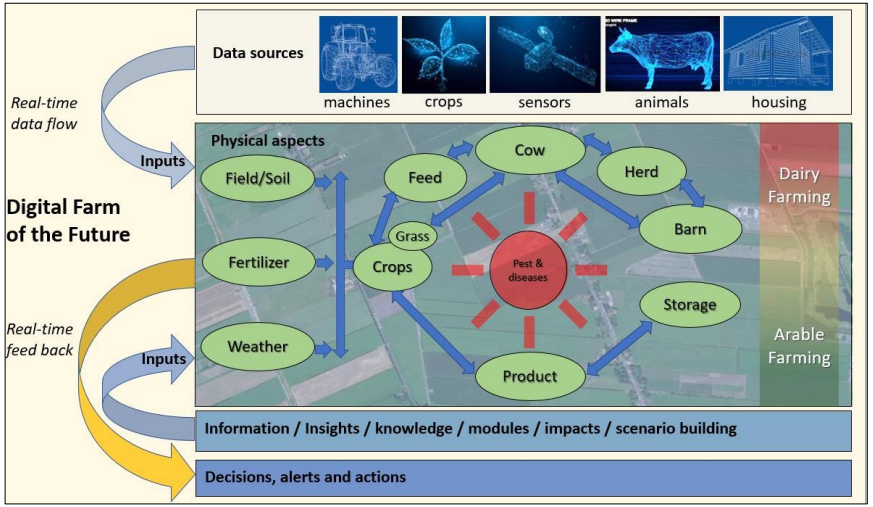
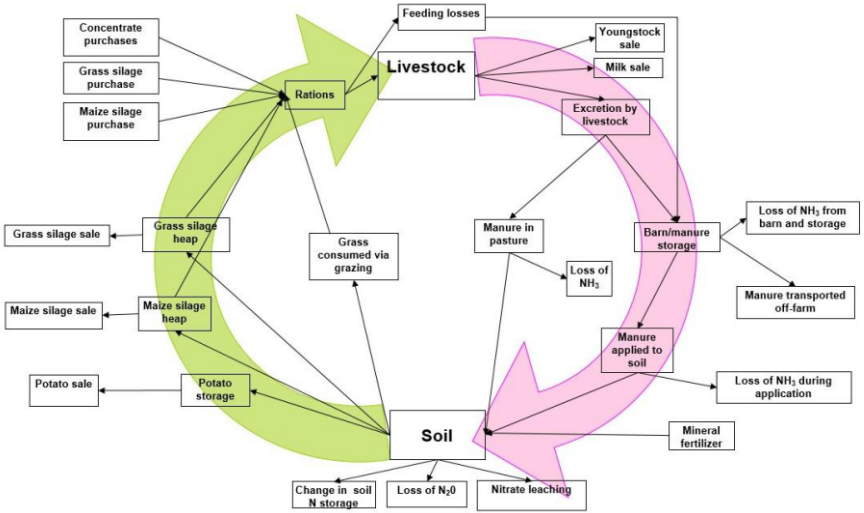
Digital Future Farm

- 2020:
  - basic infrastructure set up
  - models selected, focus:
    N-cycle, 1y, 1 potato/grass field
  - stakeholder discussions
  - requirement analysis
    (farmers, researchers)
- 2021:
  - connect final models, data
  - design interaction, dashboard
  - adapt to farm: transfer learning





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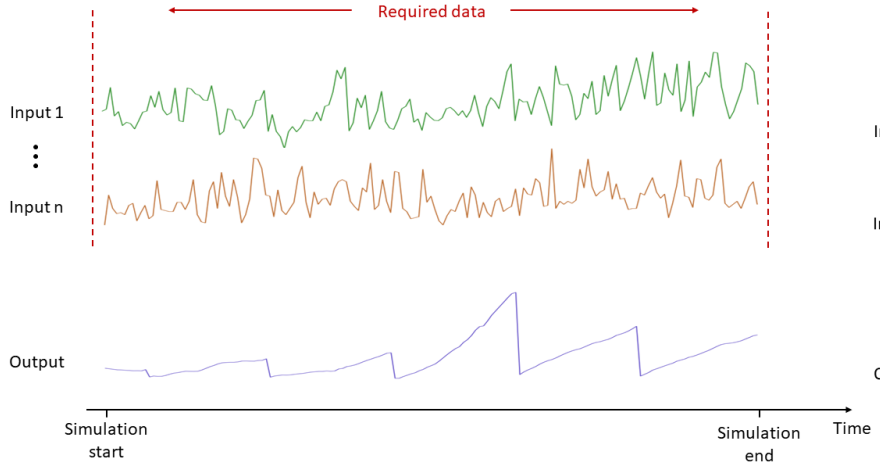
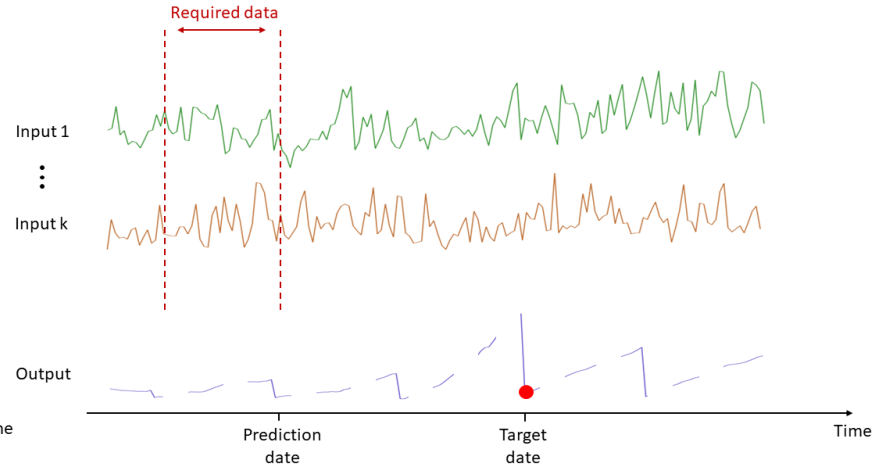
In more detail I: fertilization decision support

Crop growth model

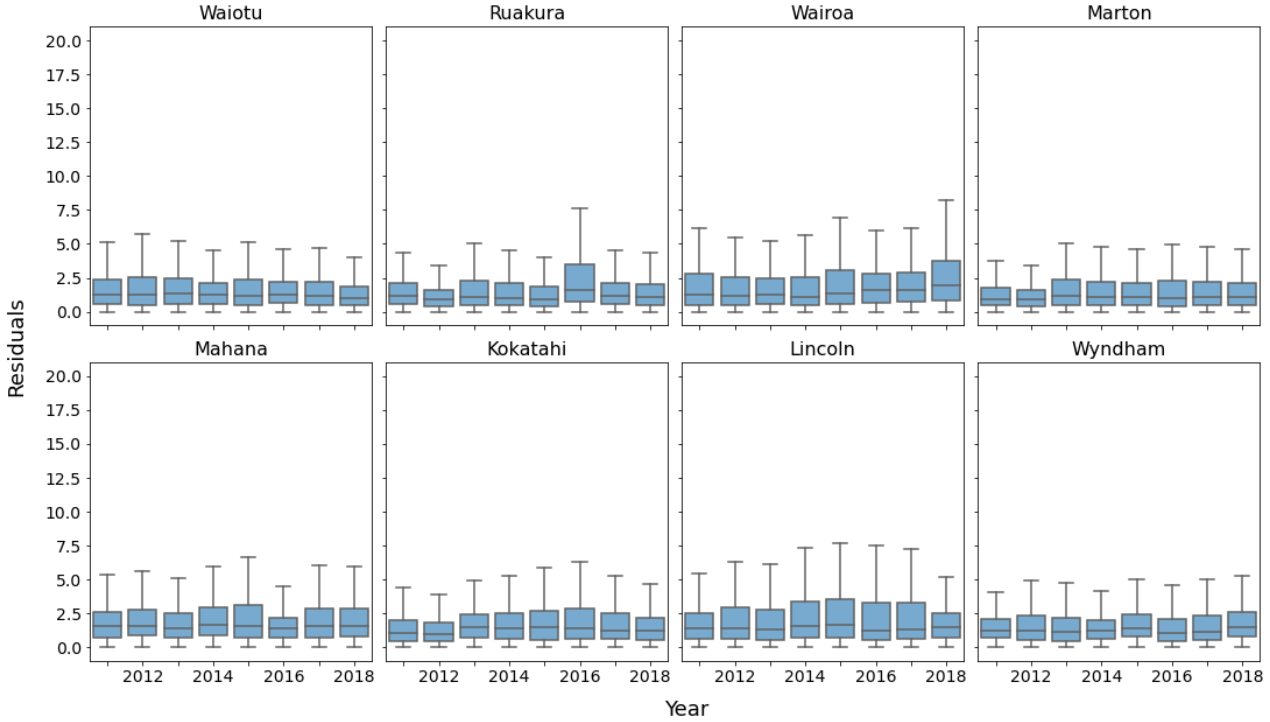


AI model

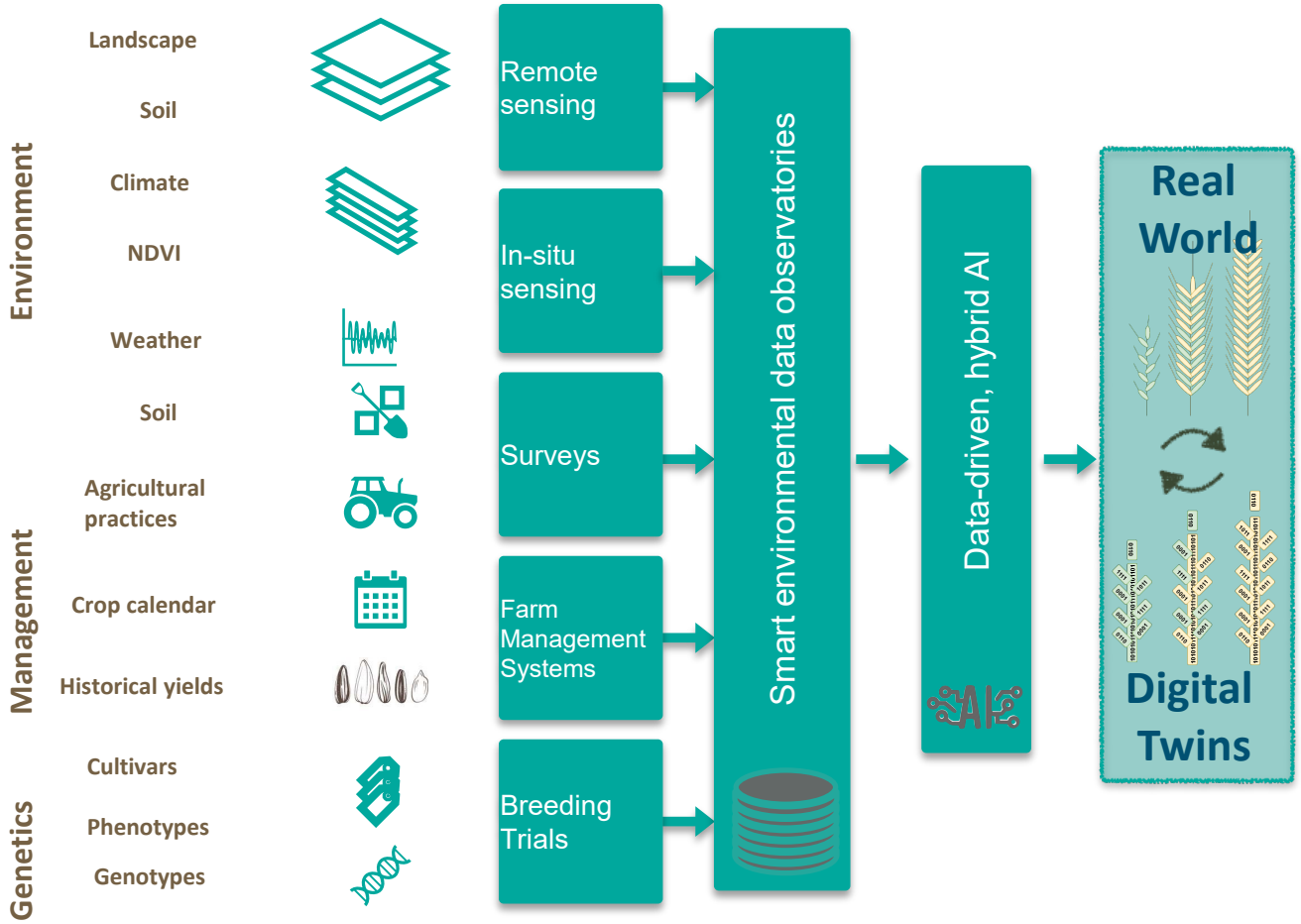


Pylianidis et al, MAES@ICPR 2021, http://doi.org/10.1007/978-3-030-68780-9_5

In more detail II: fertilization decision support

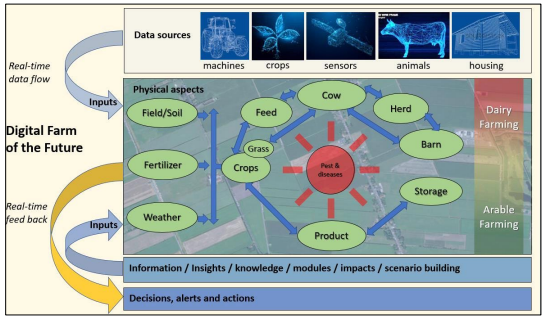


Scientific potential



Some remaining questions I

Benchmark	*Main difference*	*Potential benefits*
Simulation models, investigated in "Digital Future Farm"	Real-time data connection	More accurate simulation results due to more accurate initial conditions
		More accurate simulation results due to better parameter estimation
		More accurate simulation results due to model improvements



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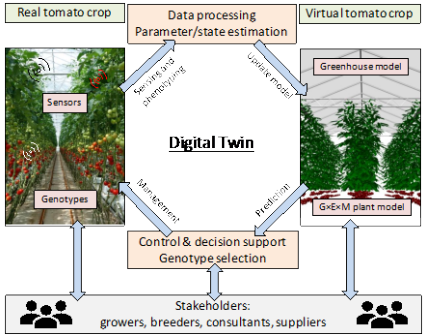
Some remaining questions II

Benchmark	*Main difference*	*Potential benefits*
Automatic control systems, investigated in "Virtual Tomato Crop"	Interactive scenario explorations	Possibility to recognize and prevent undesired scenarios
		Possibility to explore and select preferred scenarios



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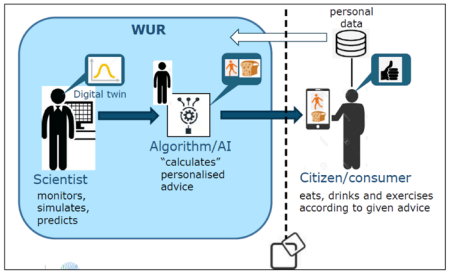
Some remaining questions III

Benchmark	*Main difference*	*Potential benefits*
Scientific advice, investigated in "Me, My Diet, and I"	User interactive advice	Better (immediate) online adaptation to specific user questions
		Possibility to collect user information for (later) offline adaptation to user questions
	User individualized advice	Higher impact of advice due to better individual adaptation
		Lower risks of wrong or ineffective advice due to better individual adaptation



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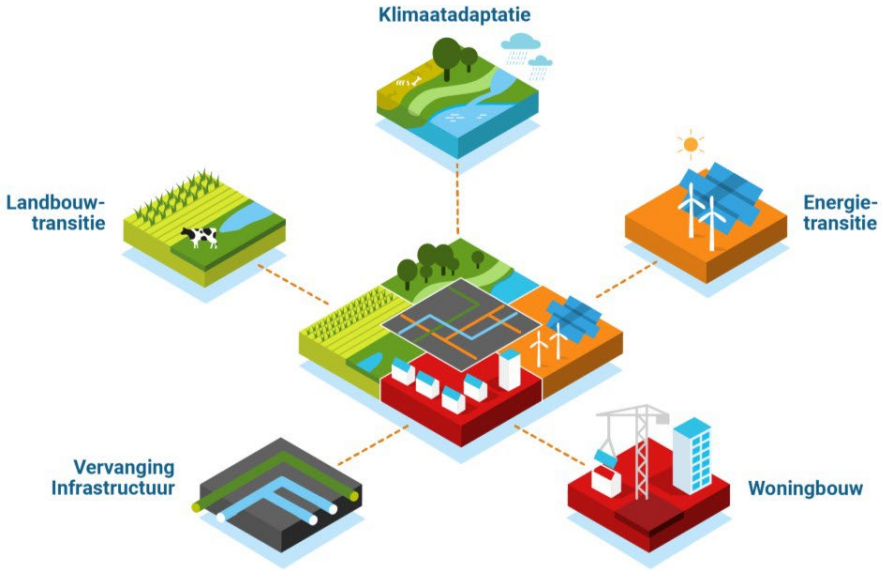
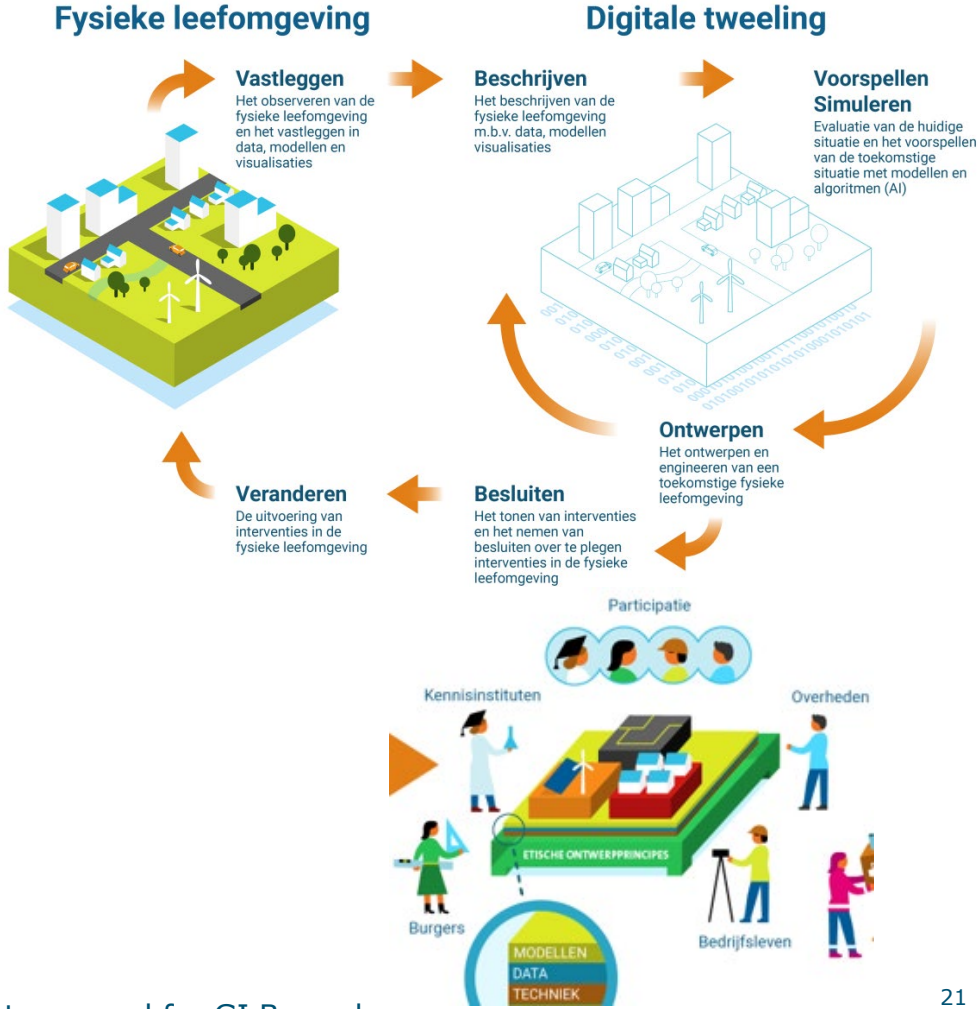
Societal potential





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Exploring the potential of data to improve the quality of life

www.wur.eu/data

data@wur.nl

Any questions?