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Agroscope

LCIC 2024 by FSLCI

AI assisted prediction and optimisation of environmental impacts, nutritional and food quality in food product development

Thomas Nemecek — Agroscope
Daniel Auner — themakers
Romeo Racz — metacognis
Jasper Van Altena — pascal processing

Session 18 - Implementing Sustainable Innovation through AI and Digitalization

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Challenges for the food industry

Mitigate environmental impacts of the food system:

- Choosing ingredients with low environmental burdens
- Reduce environmental impacts of processing, packaging, storage, and transports
- Offer a product basket with low environmental impact, high nutritional value, high quality, which is at the same time safe, tasty, and attractive

Challenges:

- Time- and resource-intensive
- Information not easily available: environmental impacts, nutritional value
- Parameters difficult to predict: food safety and quality (e.g. microbial growth, pH value, colour, texture).

➡ Multidimensional optimization problem, with high complexity and many parameters to be considered.

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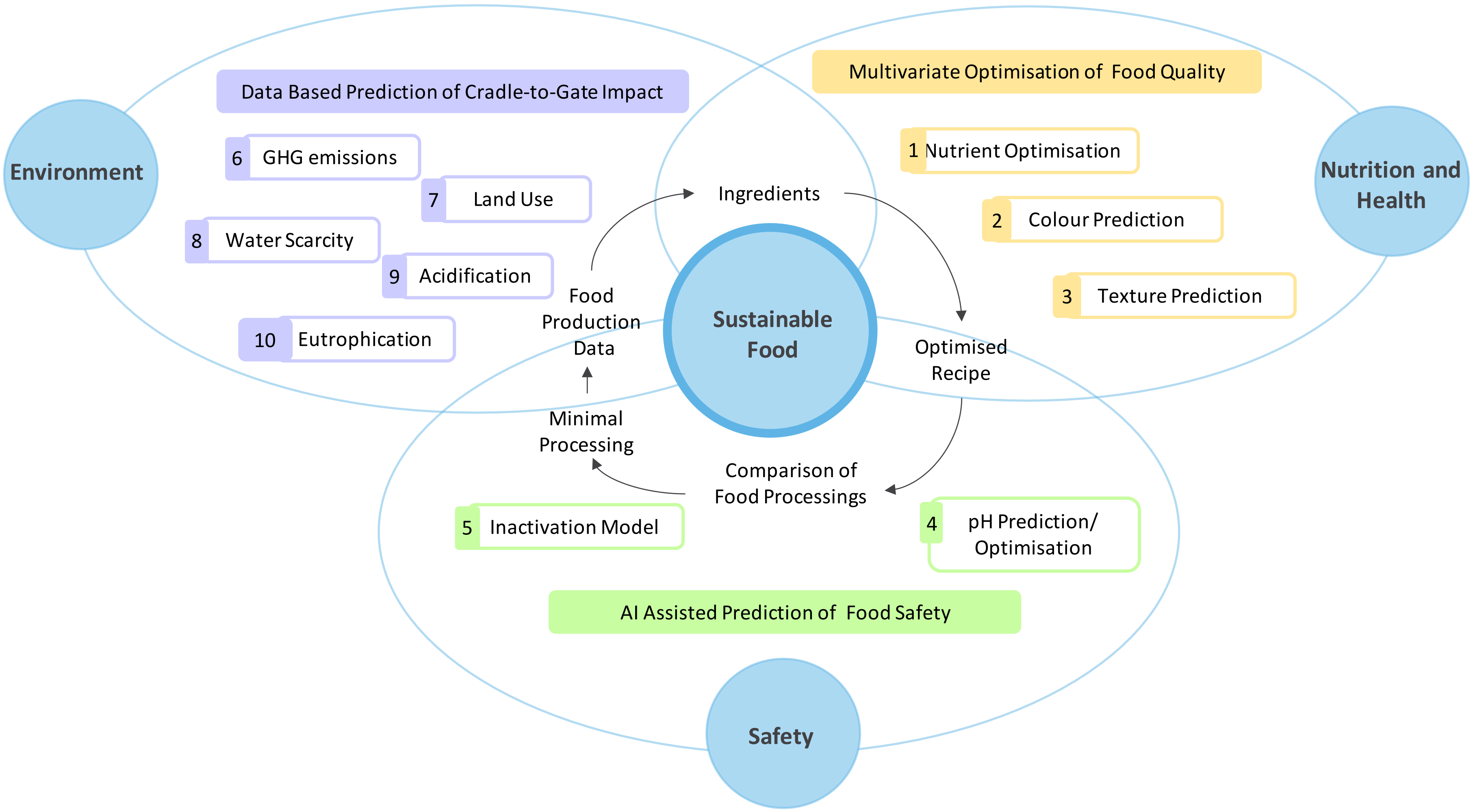
Concept of the OptiSignFood tool



- Horizon 2020 call EIC-FTI-2018-2020
- Project OptiSignFood
- Title: Data Science and AI assisted holistic software to digitally design optimized high quality and safe food products with minor environmental impact
- 1.7.2021-30.6.2024

Databases and environmental indicators used

- **LCI databases:**
  - ecoinvent v3.10
  - AGRIBALYSE 3.1
  - World Food LCA Database v3.5 (WFLDB)
  - Agri-footprint v6.3
  - Swiss Agricultural Life Cycle Assessment (SALCA), V2024
- **Nutritional composition databases:**
  - EuroFIR - FR
  - EuroFIR - UK
  - EuroFIR - SI
  - EuroFIR - EE
  - EuroFIR - DK
  - EuroFIR - CH

Environmental indicators:

- ~50 indicators: midpoint impacts and inventory indicators
- First version for users: limited to 3 indicators
- GWP100 (IPCC 2021)
- Water scarcity (AWARE)
- Land occupation

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Linking environmental and nutritional data
Methods

Relevant research areas for database interlinkage considered in this study

1. **Analysis** and **comparison** of databases → **Generic structure** of LCI and FCDB databases
2. Identifying relevant **meta data** → **Priorization** of relevant meta data fields
3. **Harmon-ization** & **classification** → **EFSA FoodEx2 classification** for controlled terms
4. **Semi-automatic data linkage** → Gather **relevant terms manually** and **create algorithm**
5. **Case study:** Applying data linkage & validate → **Applying** to data

Linking environmental and nutritional data
Standarding nomenclature using available meta data

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Name	**Specification**	**Treatment**	**Production System**
e.g., Apple	e.g., Juice	e.g., pasteurized	e.g., Organic
→ Describes **basic ingredient** without any further specification	→ Describes a food in **more detail**	→ Any further **procedures** applied to the food	→ Describes **how** the food is produced
Default Not applicable	Default None	Default Raw	Default Conventional

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Linking environmental and nutritional data
Standarding nomenclature: example

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Available in LCI databases

Frozen concentrated apple juice, 70° Brix, at plant (WFLDB)/**GLO** U

Apple juice, industrial production, at plant, NFC, 1L {**FR**} U

Created by workflow

Apple juice | **integrated production** | unspecified | {**CH**} | Unit process
Apple juice | **conventional production** | unspecified | {**IT**} | Unit process
Apple juice | **conventional production** | unspecified | {**ZA**} | Unit process
Apple juice | **conventional production** | unspecified | {**US**} | Unit process
Apple juice | **organic production** | unspecified | {**CH**} | Unit process
Apple juice | **conventional production** | unspecified | {**GLO**} | Unit process
Apple juice | **conventional production** | unspecified | {**FR**} | Unit process
Apple juice | **conventional production** | unspecified | {**RoW**} | Unit process
Apple juice | **organic production** | unspecified | {**FR**} | Unit process
Apple juice | **conventional production** | unspecified | {**NZ**} | Unit process
Apple juice | **conventional production** | unspecified | {**CN**} | Unit process
Apple juice | **conventional production** | unspecified | {**CL**} | Unit process

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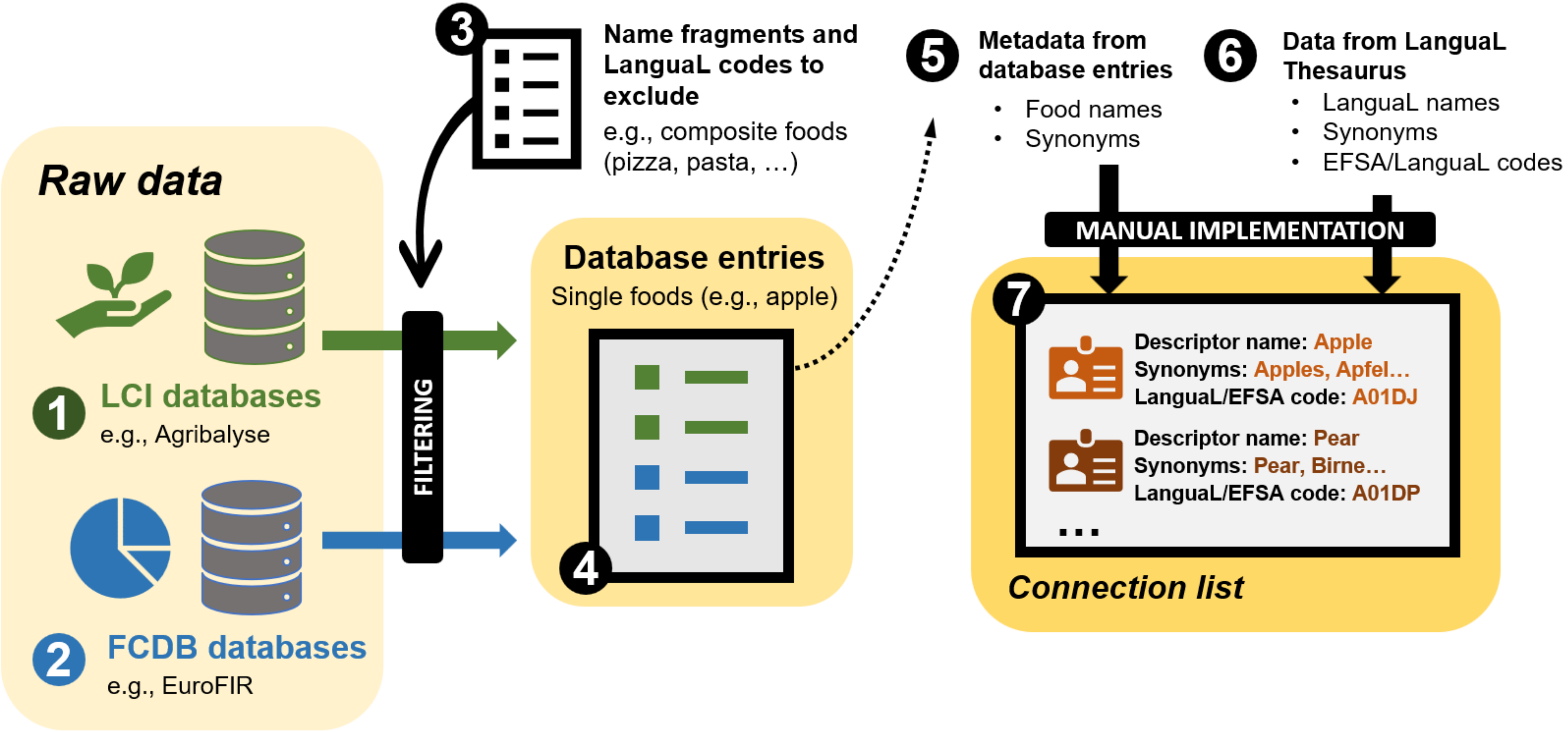
Linking environmental and nutritional data

Create entries for our nomenclature in the connection list



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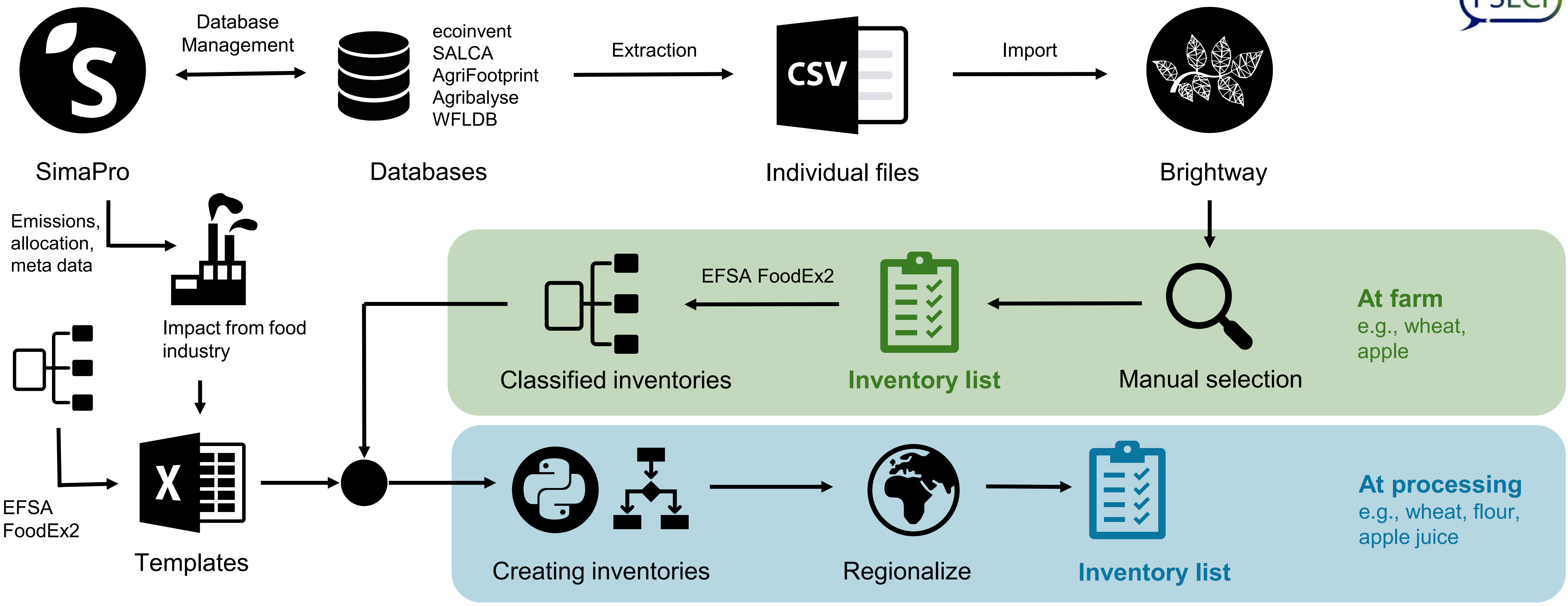
Generating harmonised LCIs
Technical workflow



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Software platform optisignfood.com

Export as PDF | Edit | Delete

Ready to eat Lentil soup chilled reusable cup 420ml

Snacks

Product information

Export as PDF | Edit | Delete

Ready to eat Lentil soup chilled reusable cup 420ml

Snacks

Product information

Ingredient list:

Water (66.81%), Brown plate lentils (7.03%), Coconut milk (7.03%), Paprika mix (5.27%), Potatoes (3.52%), Carrot cubes (3.52%), Onion pieces (3.52%), Sea salt (0.56%), Rapeseed oil (0.53%), Waxy maize starch (0.49%), Buffered vinegar (0.49%), Vegetable stock (0.42%), Garlic (0.35%), Curry powder (0.21%), Raw cane sugar (0.14%), Coriander grated (0.05%), Parsley grated (0.04%), Black pepper (0.02%)

Nutrition facts

Nutritional Values	per 100g**
Energy	KJ/ 54.00 Kcal
Total Fat	2.20 g
Saturated Fat	1.40 g
Total carbohydrate	5.80 g
Dietary Fiber	1.20 g
Sugars	0.90 g
Protein	2.20 g
Salt	0.72 g

** or mL take into consideration

Nutrition insights

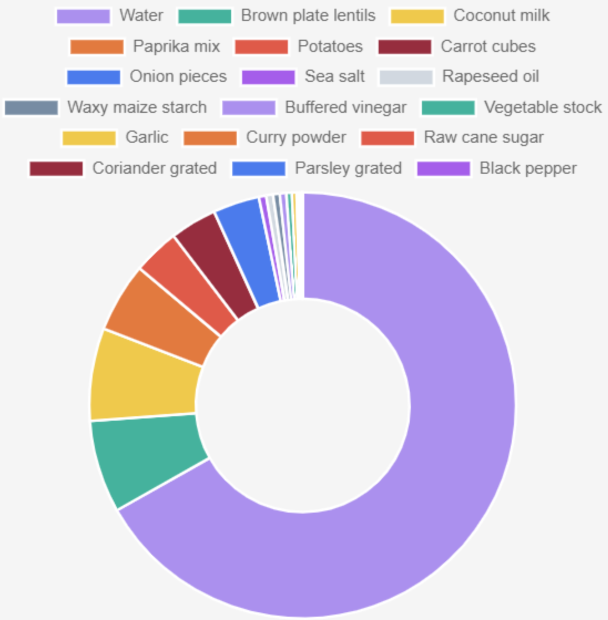
High in protein

High in protein

NUTRI-SCORE A B C D E

HENI SCORE +0.29 min

NRF9.3 INDEX 0.15



REACH US TO OPTIMIZE YOUR PRODUCT

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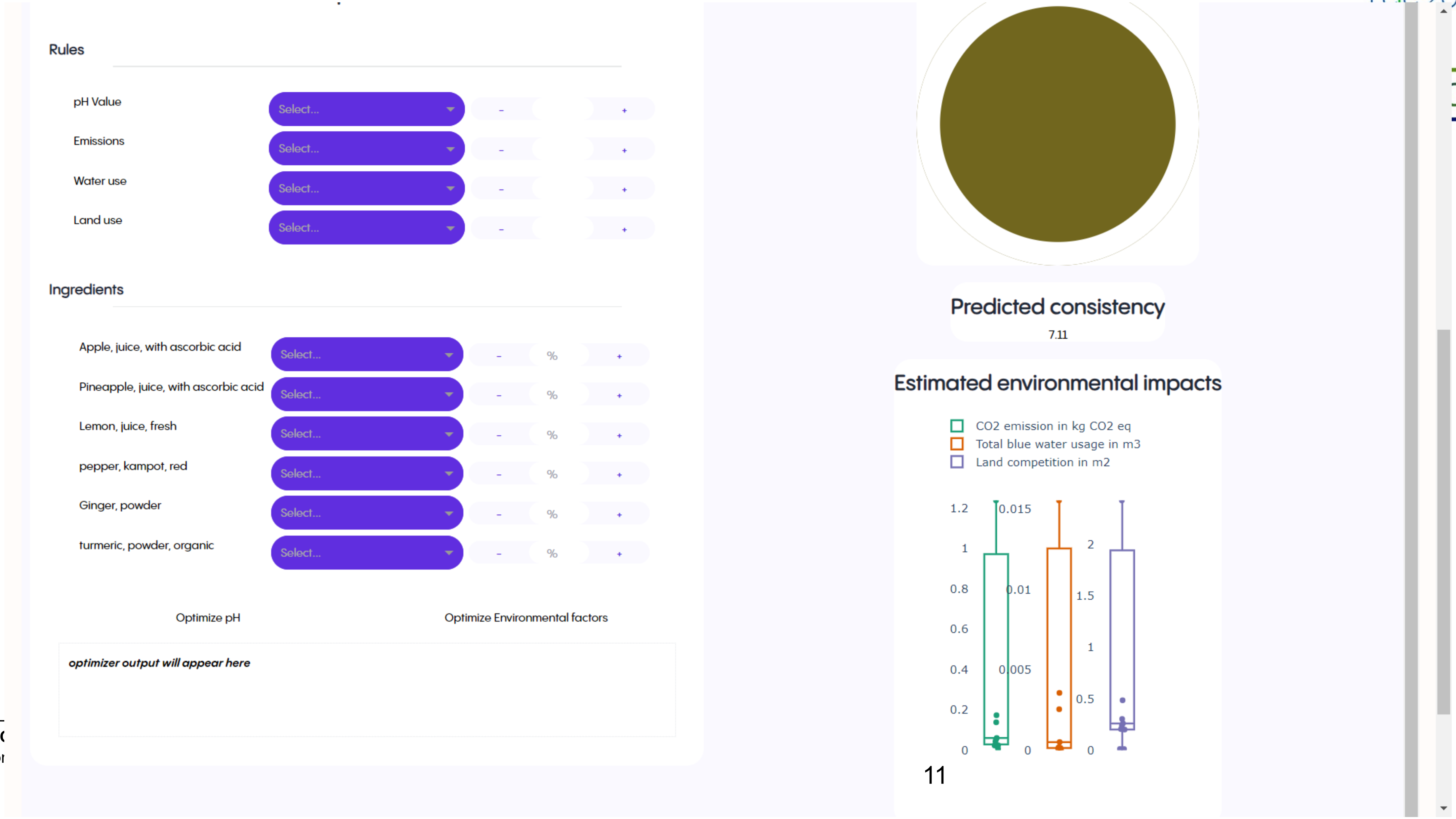

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LCI(
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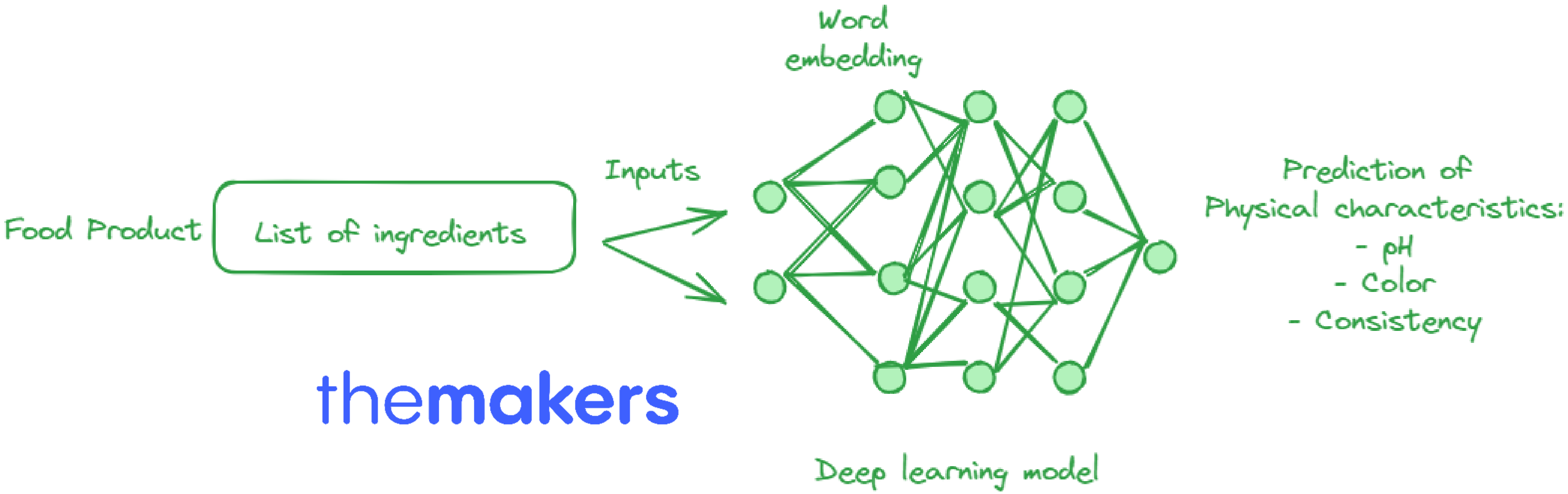
Use of AI in the project

- Extract information from scientific literature databases (HERON from Metacognis)
- Use of Artificial Neural Networks (ANN) to predict food quality parameters: pH, colour, texture
- Product pictures generated with help of AI (Midjourney tool)
- Prediction of missing values
- Matching environmental and nutritional databases



themakers

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Advancing Food Product Design with AI

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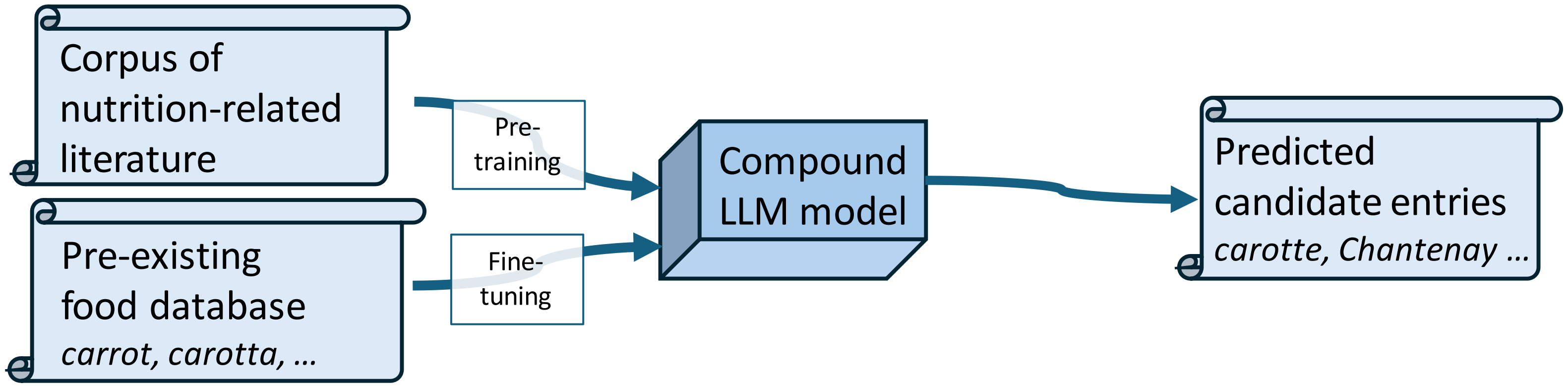
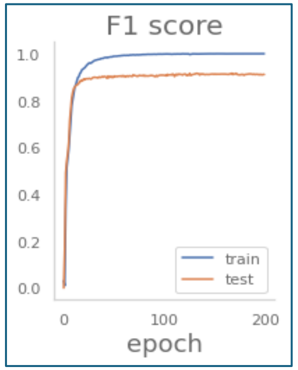
1. Context-based augmentation of food ingredient, nutrient, antinutrient & procedure databases

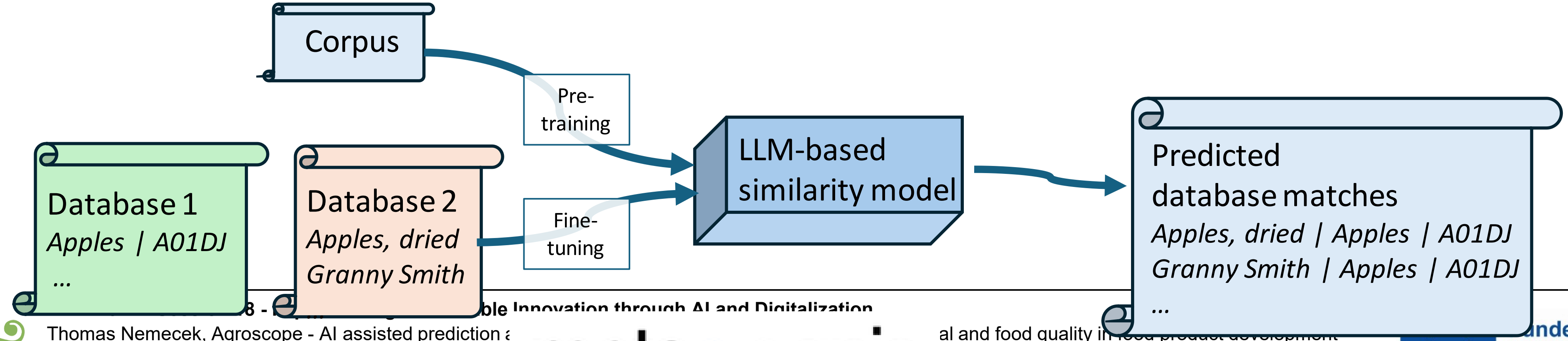
LLM augmentation based on contextual patterns in existing data: prediction of missing entities





2. Database Harmonization with transformer models

Identification and alignment of corresponding data points across disparate datasets



Contributions of OptiSignFood

- Use artificial neural networks to solve the **multidimensional optimization problem**
- **Faster** product development → respond to market and societal trends
- Food with **lower environmental impacts**
- Improved **resource efficiency**
- Higher **nutritional value**
- Show potential **trade-offs**
- Less rejected formulations and **less food waste**

Thank you for your attention

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Agroscope good food, healthy environment

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Thanks to the project team: Cédric Furrer, Alba Reguant Closa, Moritz Herrmann, Katrin Meyer, Gregoire Le Bras, Mihály Köllő

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