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Agroscope

OptiSignFood: software platform for an optimised product development in the food sector

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Swiss Food Research IG Digitalisation – 5.12.24

www.agroscope.ch | good food, healthy environment

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the European Union



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

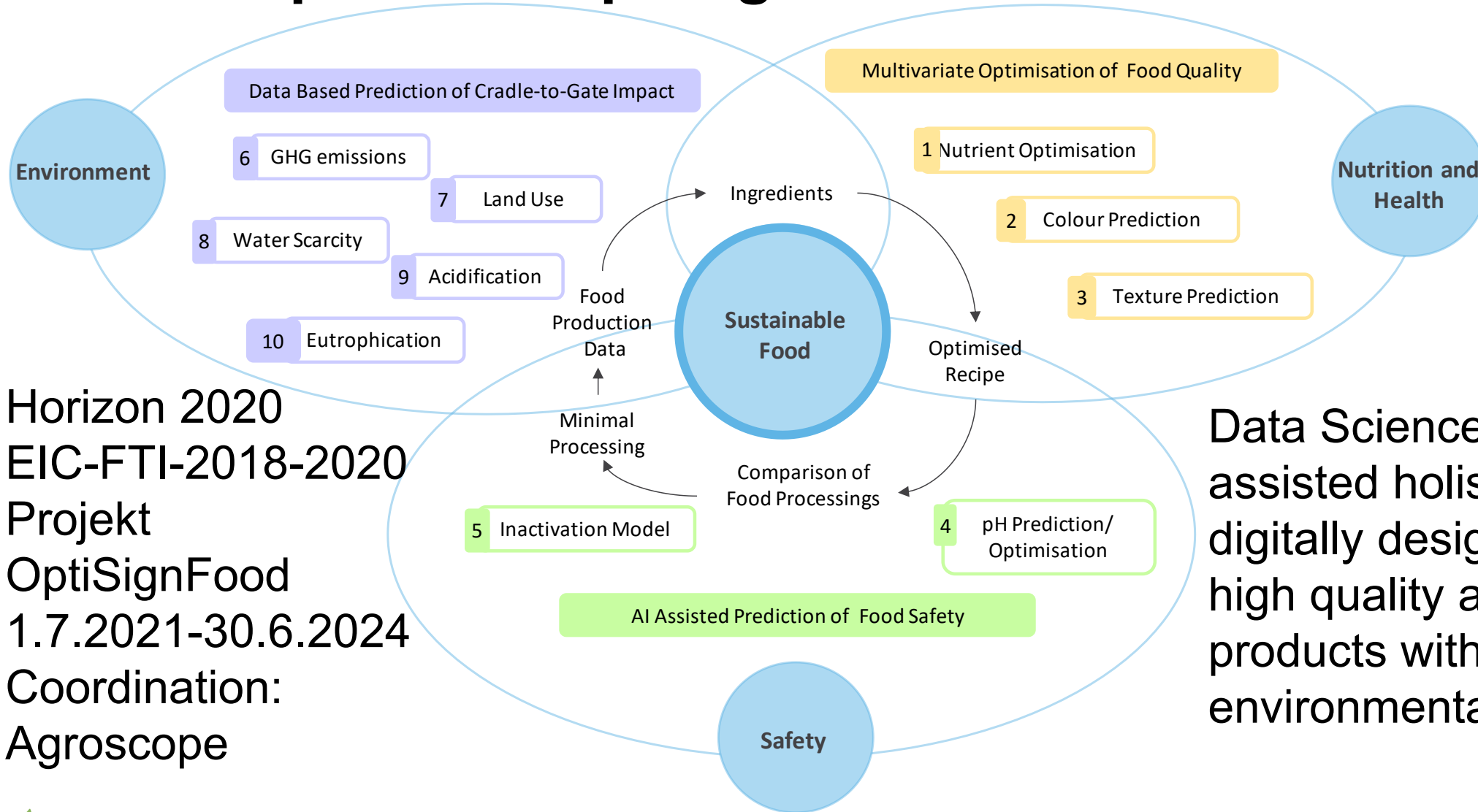
Challenges:

- 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.



Concept of the OptiSignFood tool



- Horizon 2020
EIC-FTI-2018-2020
- Projekt
OptiSignFood
- 1.7.2021-30.6.2024
- Coordination:
Agroscope

Data Science and AI assisted holistic software to digitally design optimized high quality and safe food products with minor environmental impact



OptiSignFood Partner

- **Agroscope**
 - Coordination of the EU project
 - Life Cycle Inventory databases
 - Nutritional databases and indices
- **Mia & Ben Organic GmbH → The Makers Food GmbH**
 - Innovative, science-based food manufacturing company
 - Startup with main focus on baby food
- **Metacognis Limited**
 - Scientific data analysis
 - Heron, AI-based tool for data mining
- **Pascal Processing**
 - Service provider for High-pressure processing (HPP)
 - Food processing technology and food product development



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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:

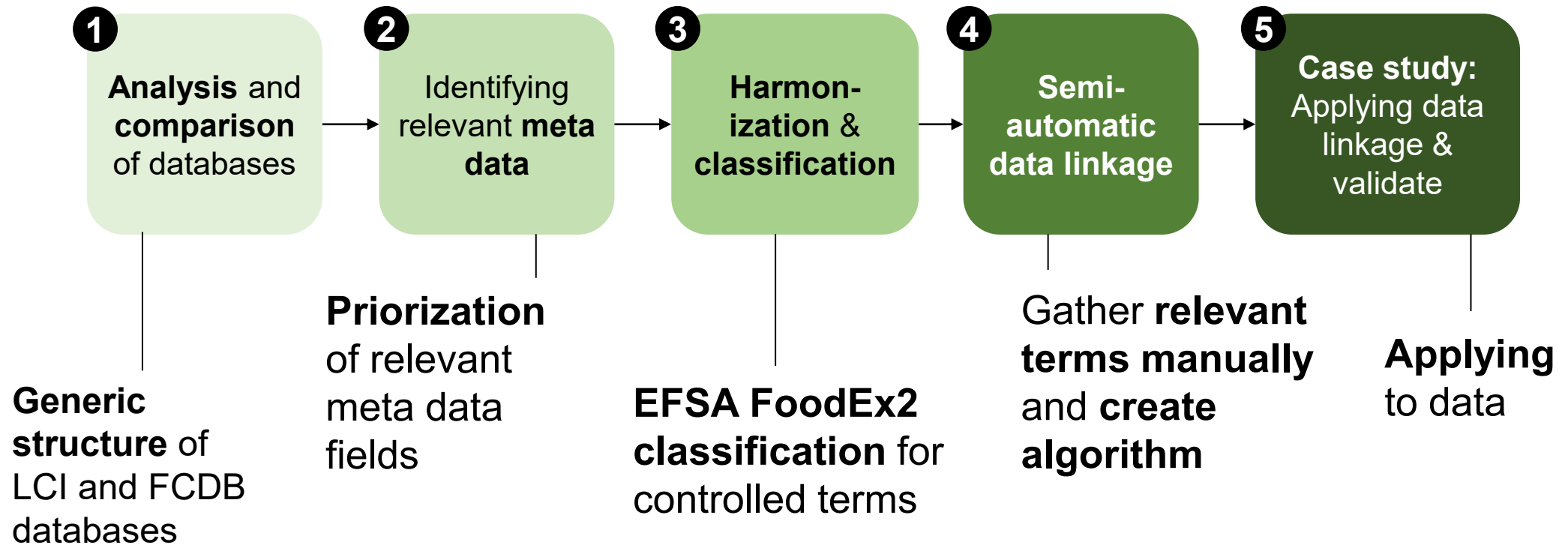
- ~50 indicators: midpoint impacts and inventory indicators
- First version for users: limited to 3 indicators
- GWP100 (IPCC 2021)
- Water scarcity (AWARE)
- Land occupation





Linking environmental and nutritional data Methods

Relevant research areas for database interlinkage considered in this study



Linking environmental and nutritional data

Standardising nomenclature using available meta data

Name
e.g., Apple

→ Describes **basic ingredient** without any further specification

Default
Not applicable

Specification
e.g., Juice

→ Describes a food in **more detail**

Default
None

Treatment
e.g., pasteurized

→ Any further **procedures** applied to the food

Default
Raw

Production System
e.g., Organic

→ Describes **how** the food is produced

Default
Conventional





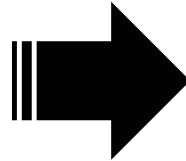
Linking environmental and nutritional data

Standardising nomenclature: example

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

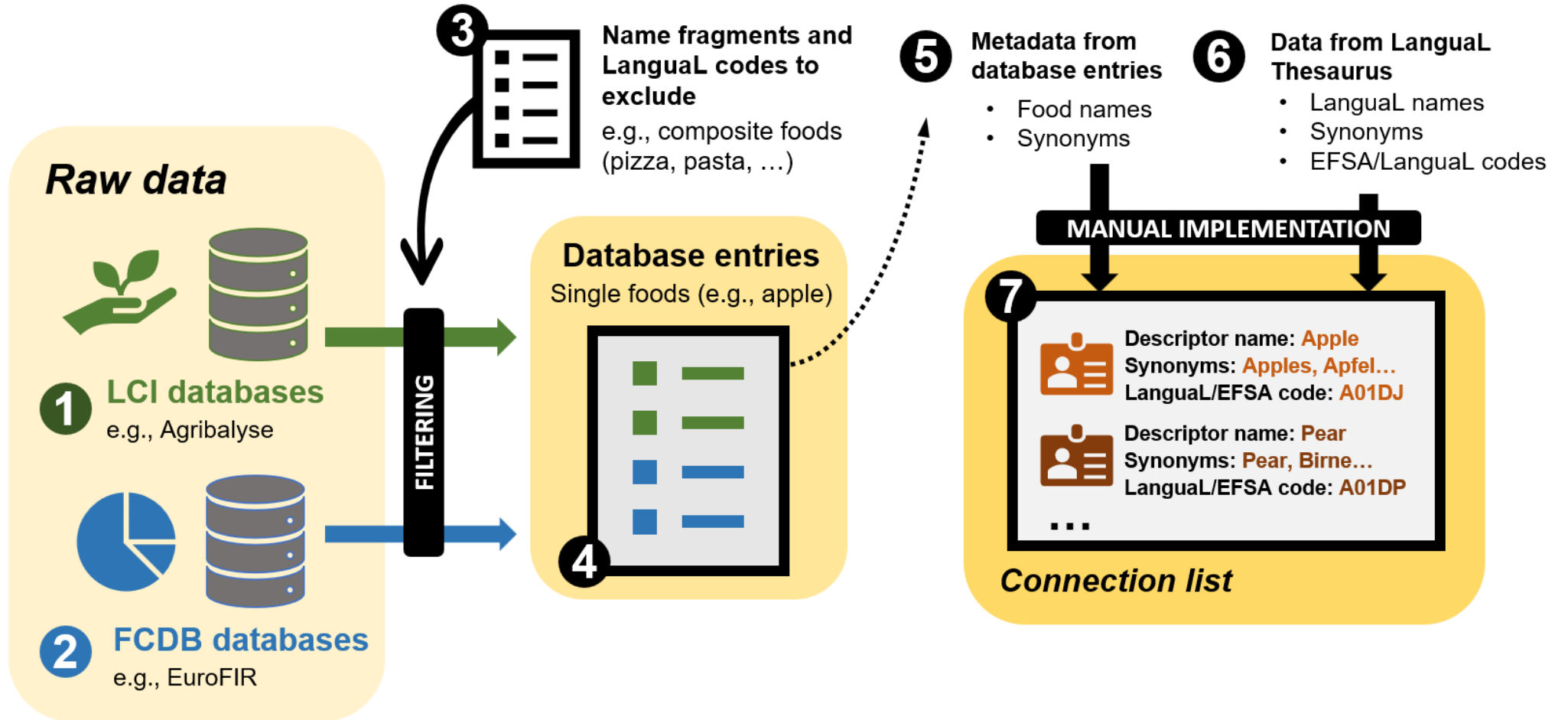
- Apple juice | **integrated production** | unspecified | **{CH}** | Unit process
- Apple juice | **conventional production** | unspecified | **{IT}** | Unit process
- Apple juice | **conventional production** | unspecified | **{ZA}** | Unit process
- Apple juice | **conventional production** | unspecified | **{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





Linking environmental and nutritional data

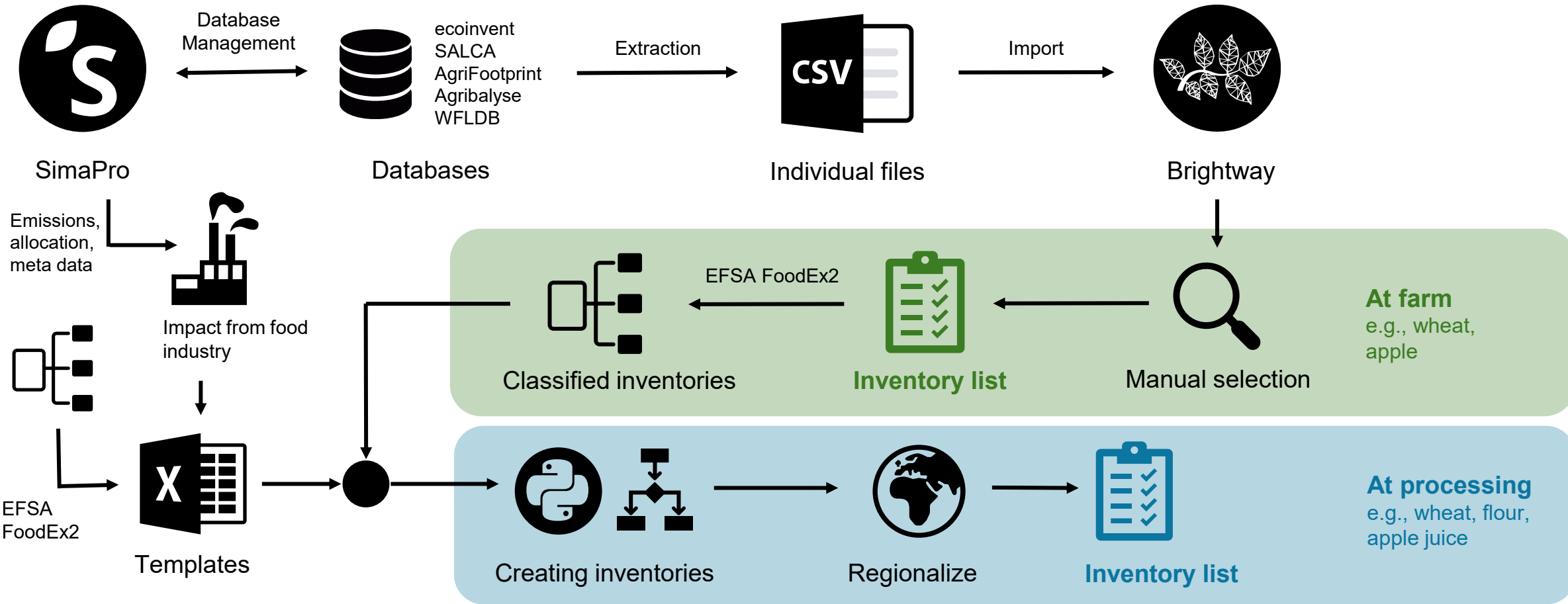
Create entries for our nomenclature in the connection list





Generating harmonised LCIs

Technical workflow





Indices for nutrition and health

Table: Group classification of nutritional/health indices

Group classification		Characteristics	Examples
Nutrient/food quantity based	Group A	Ratio between nutrient content and reference amount (e.g. DRI) for qualifying and disqualifying nutrients and/or foods	<ul style="list-style-type: none"> Nutrient rich food indices (NRF) Nutrient Balance Concept (NBC)
		Simplified ranking of foods for consumer interpretation/understanding	<ul style="list-style-type: none"> Nutri-Score Health star rating system
Guideline based	Group B	Based on the adherence to specific guidelines on healthy eating	<ul style="list-style-type: none"> Healthy eating Index (HEI) Mediterranean Eating index (MEI)
Diversity based	Group C	Based on nutrients/food group diversity	<ul style="list-style-type: none"> Rao's Quadratic Entropy Dietary Diversity Score (DDS)
Nutrient-quality based	Group D	Considers nutrient quality characteristics specific to one or more nutrients (bioavailability, digestibility, etc.)	<ul style="list-style-type: none"> Digestible Indispensable Amino Acid Score (DIAAS)
Health based	Group E	It accounts for health impacts of foods and diets based on dietary risk factors	<ul style="list-style-type: none"> Health Nutritional Index (HENI)





Indices for nutrition and health: Examples

Table: Description of selected nutritional/health indices for analysis

Indices	Characteristics	Nutrients included Qualifying 😊 / Disqualifying ☹️
Nutrient Rich Food (NRF9.3) Group A1	Nutrient rich food score based on nutrients to encourage and to limit in reference to recommended daily intakes.	Protein, iron, fiber, vitamin A, Vit. C, Vit. E, Ca, Mg, Fe, K, saturated fats, added sugars, sodium.
Nutrient Balance Concept (NBC) Group A1	Algorithm considering qualifying and disqualifying nutrients standardized to energy content (2000kcal)	Fiber, protein, linoleic acid, α-linolenic acid, choline, folate, niacin, riboflavin, thiamin, pantothenic acid, Vit. A, Vit. B12, Vit B6, Vit C, Vit D, Vit E, Vit K, Ca, Cu, Fe, Mg, Mn, P, K, Se, Zn, total fat, saturated fat, trans fat, cholesterol, total sugar, sodium
Nutri-Score Group A2	Algorithm that considers nutrient content and food groups. Ranks foods in a scale letters and colours to facilitate comprehension of the message to the consumer	Fruit, vegetables, fiber, protein, energy, sugar, saturated fatty acids, sodium
Health Nutritional Index (HENI) Group E	Algorithm considering health impacts of foods based on the Global Burden of Disease study. It considers 15 dietary risk factors including nutrients, food groups and foods	Seafood omega-3, calcium, nuts and seeds, fibre, polyunsaturated fatty acids, whole grains, legumes, fibre, fruits, vegetables, milk, sugar-sweetened beverages, red meat, processed meat, trans fatty acids, sodium, saturated fatty acids



Software platform optisignfood.com



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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

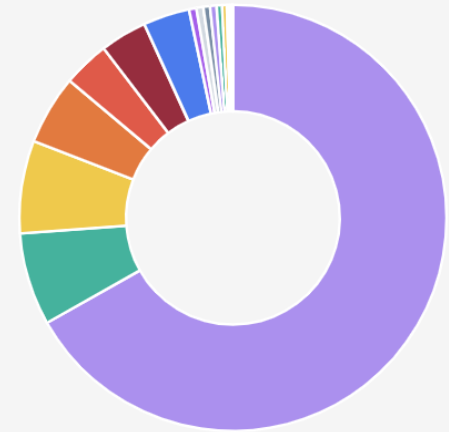
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Ready to eat Lentil soup chilled reusable cup 420ml

Snacks

Product information

High in protein



REACH US TO OPTIMIZE YOUR PRODUCT



Software platform optisignfood.com

Rules

pH Value	Select...	-	+
Emissions	Select...	-	+
Water use	Select...	-	+
Land use	Select...	-	+

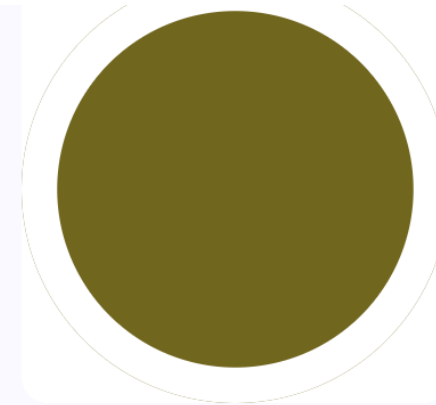
Ingredients

Apple, juice, with ascorbic acid	Select...	-	%	+
Pineapple, juice, with ascorbic acid	Select...	-	%	+
Lemon, juice, fresh	Select...	-	%	+
pepper, kampot, red	Select...	-	%	+
Ginger, powder	Select...	-	%	+
turmeric, powder, organic	Select...	-	%	+

Optimize pH

Optimize Environmental factors

optimizer output will appear here

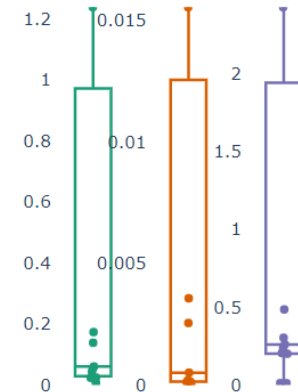


Predicted consistency

7.11

Estimated environmental impacts

- CO2 emission in kg CO2 eq
- Total blue water usage in m3
- Land competition in m2



User friendliness



- Because of the complexity of the individual steps of food development process user friendliness was a key challenge during the project



- Our first solutions were too complex and customers struggled with usability. We also tried to solve too many problems at the same time



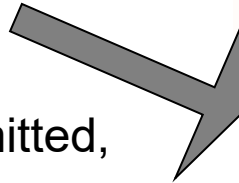
- As our initial attempts were too technical, we were only relevant to food development teams which is a rather small group with little purchasing power





Results: All information for the customer in one place

- Solution: we created a free version which gives customers the **overview** of their existing **product portfolio** plus **environmental impact** and **nutrition score** for all products.
- Customers can ask to **improve** aspects of **product** and start a new development round. they can also ask for the additions to their portfolio.
- Once development request is submitted, The Makers team member uses our **inhouse developed tools to optimize the products**. In a **semi automated process** the results are constantly shared with the customers interface and iterations round added to their portfolio

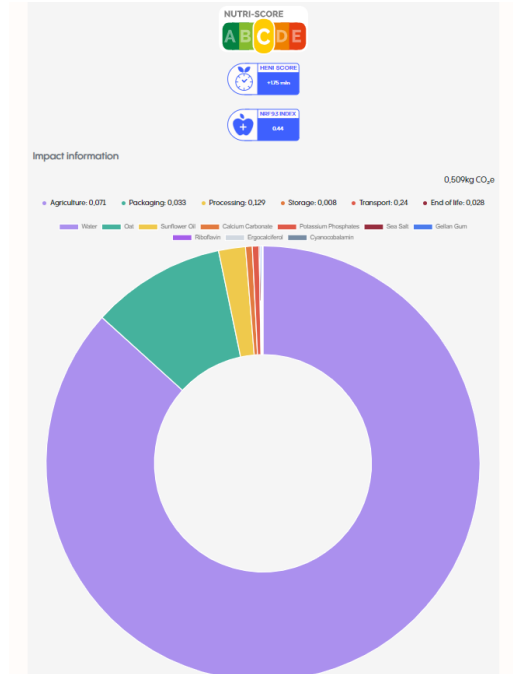


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Plant Drink Oat Barista Fortified Tetra Pak 1 l

REACH US TO OPTIMIZE YOUR PRODUCT

Optimize/Contact us: If you want to improve your product regarding nutritional parameters, impact scores, quality parameters and certifications, contact us.



Product information

Ingredient list:
Water (86,70%), Oat (10,00%), Sunflower Oil (2,00%), Calcium Carbonate (0,50%), Potassium Phosphates (0,50%), Sea Salt (0,10%), Gellan Gum (0,10%), Riboflavin (0,03%), Ergocalciferol (0,03%), Cyanocobalamin (0,03%)

Nutrition facts

Nutritional Values	per 100g**
Energy	221,75 KJ/ 53,00 Kcal
Total Fat	3,00 g
Saturated Fat	0,40 g
Total carbohydrate	5,40 g
Dietary Fiber	0,50 g
Sugars	2,60 g
Protein	0,80 g
Salt	0,13 g

** or mL take into consideration

Nutrition insights
Fortified with riboflavin, vitamin D, vitamin B12 (each 15% of recommended daily intake)



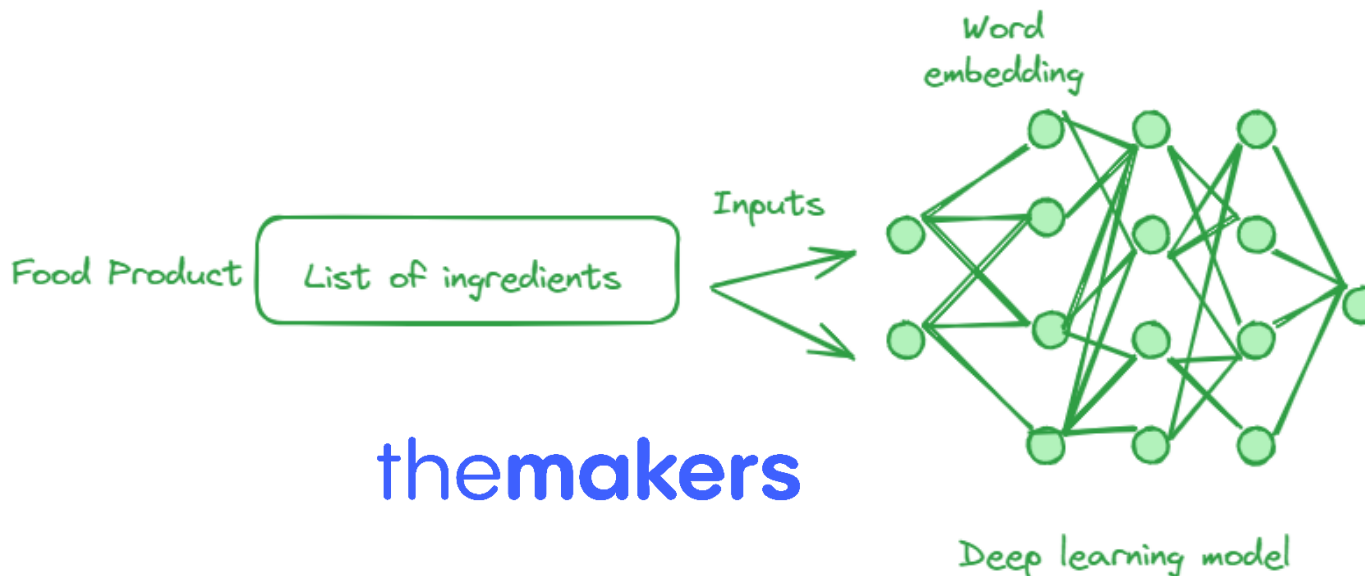
OptiSignFood: software platform for an optimised product development in the food sector
Thomas Nemecek, Agroscope





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



Prediction of Physical characteristics:

- pH
- Color
- Consistency

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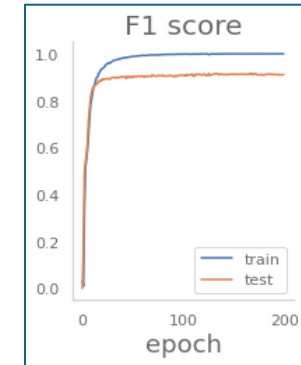
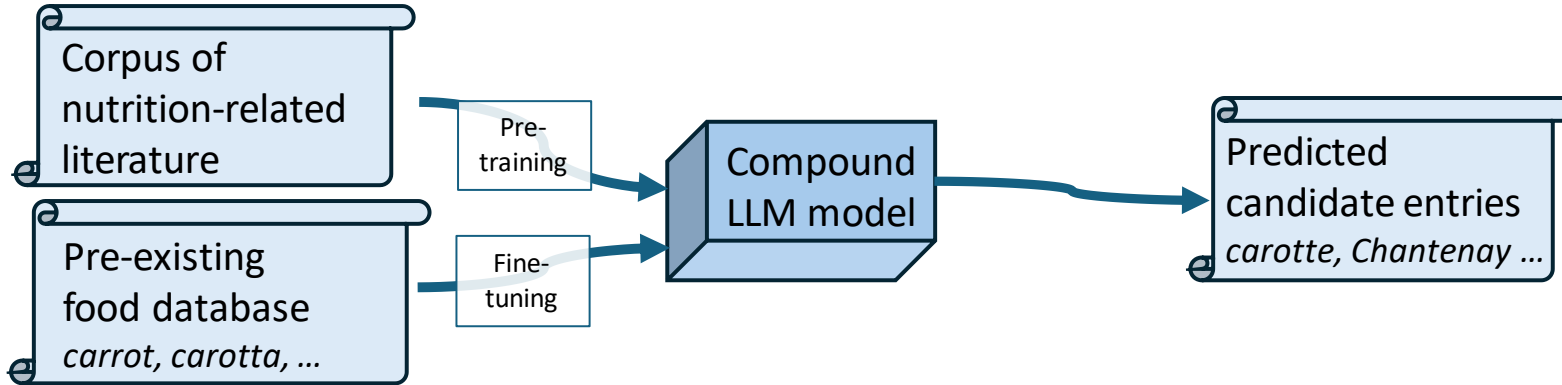




Advancing Food Product Design with AI

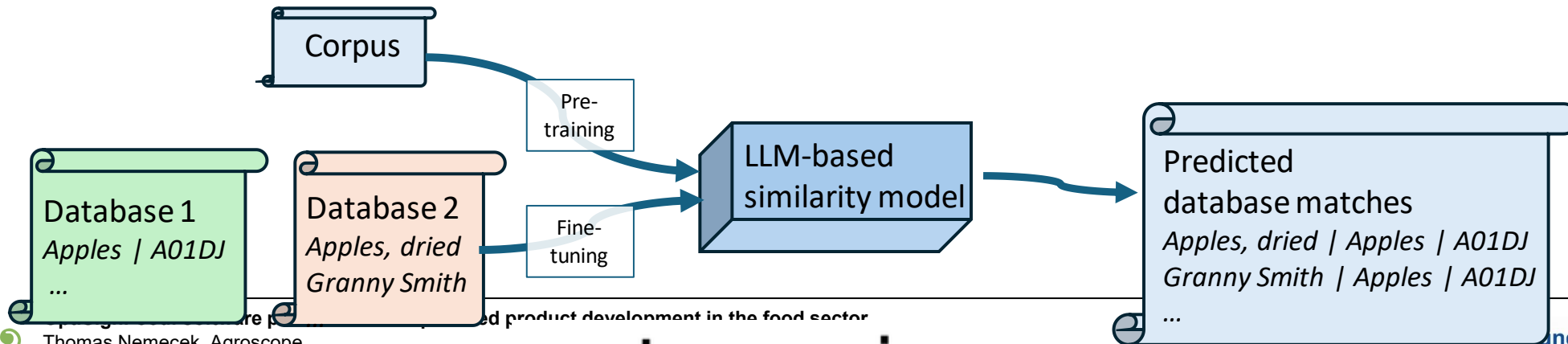
1. Context-based augmentation of food ingredient, nutrient, antinutrient & procedure databases

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



(Future) Challenges

- Building the software & database category by category excludes certain customers that we can only onboard over time
- Data: Finding more data is an ongoing challenge; cost of licenses for database usage very high
- Elements we are missing, for example price
- Macro environment:
 - Tight budgets for brands - therefore we designed a leaner package for customers
 - Funding for further development of the software / adding more commercial uses

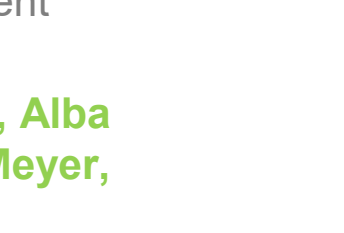
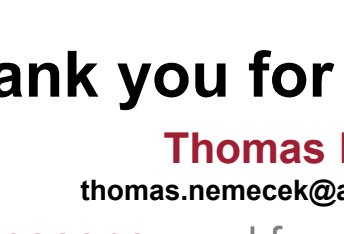




Contributions of OptiSignFood

- 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

www.agroscope.admin.ch

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

