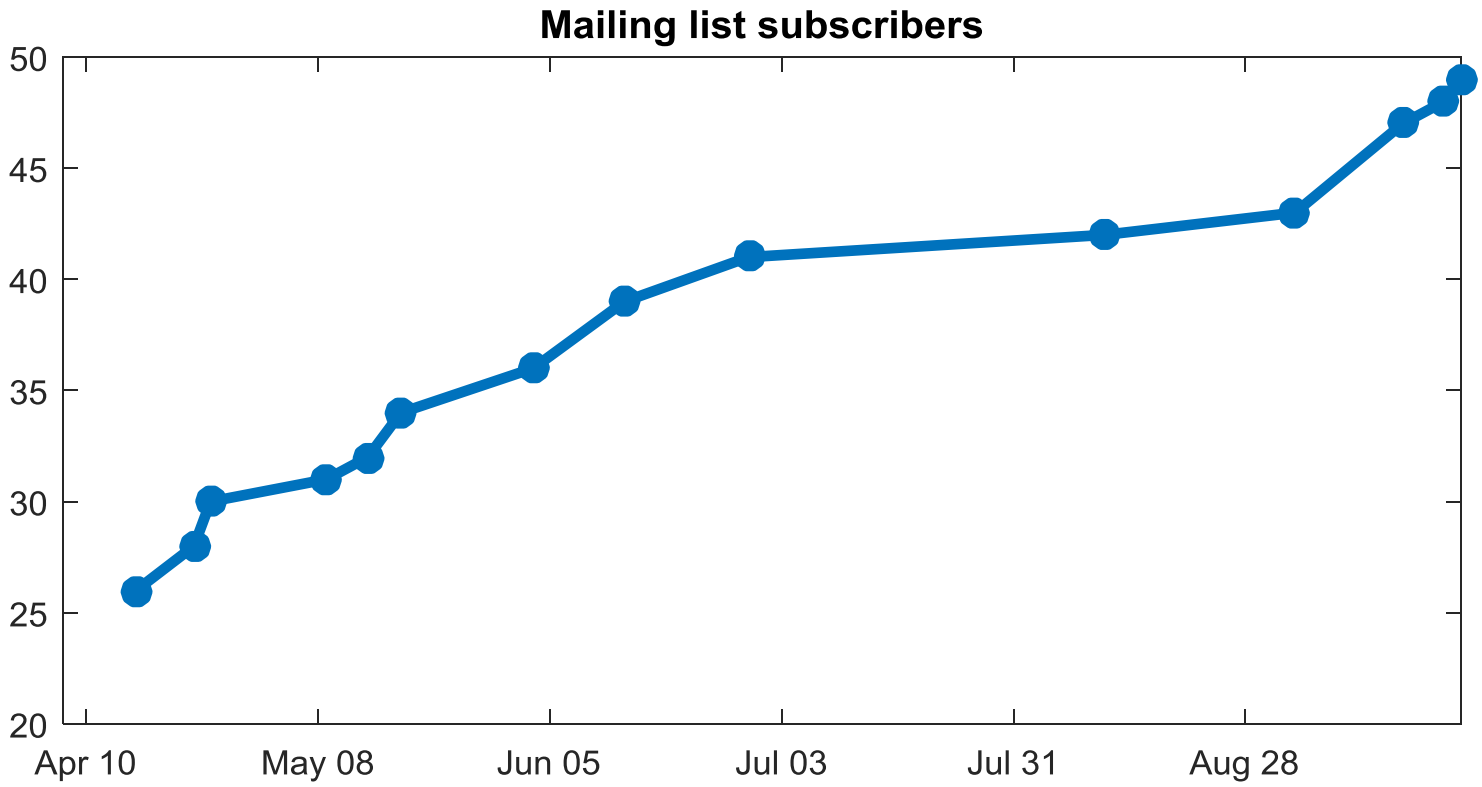
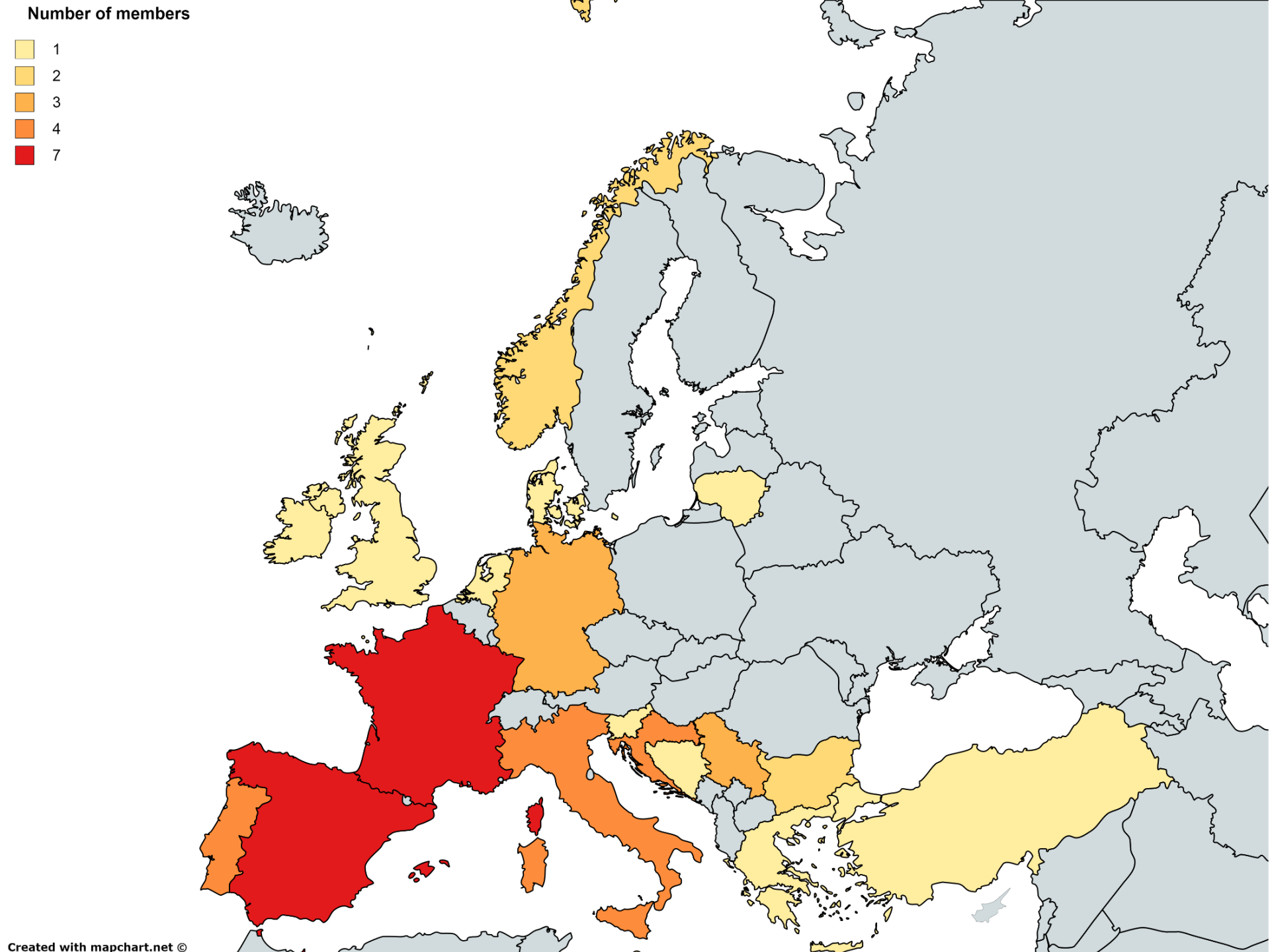
WG1: Modelling food products and food processes

Leader: Dr. Ingrid Måge, Nofima, Norway

Vice-leader: Dr. Maria Otilia Carvalho, Universidade de Lisboa, Portugal

WG1 members




Number of members
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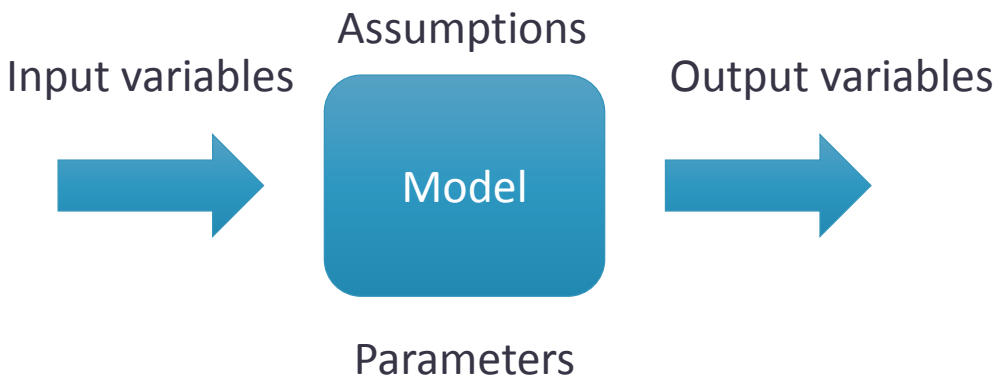
Definition of mathematical model

- A mathematical model is a description of a system using mathematical concepts and language.
- A model may help to
  - explain a system and study the effects of different components
  - make predictions about behavior



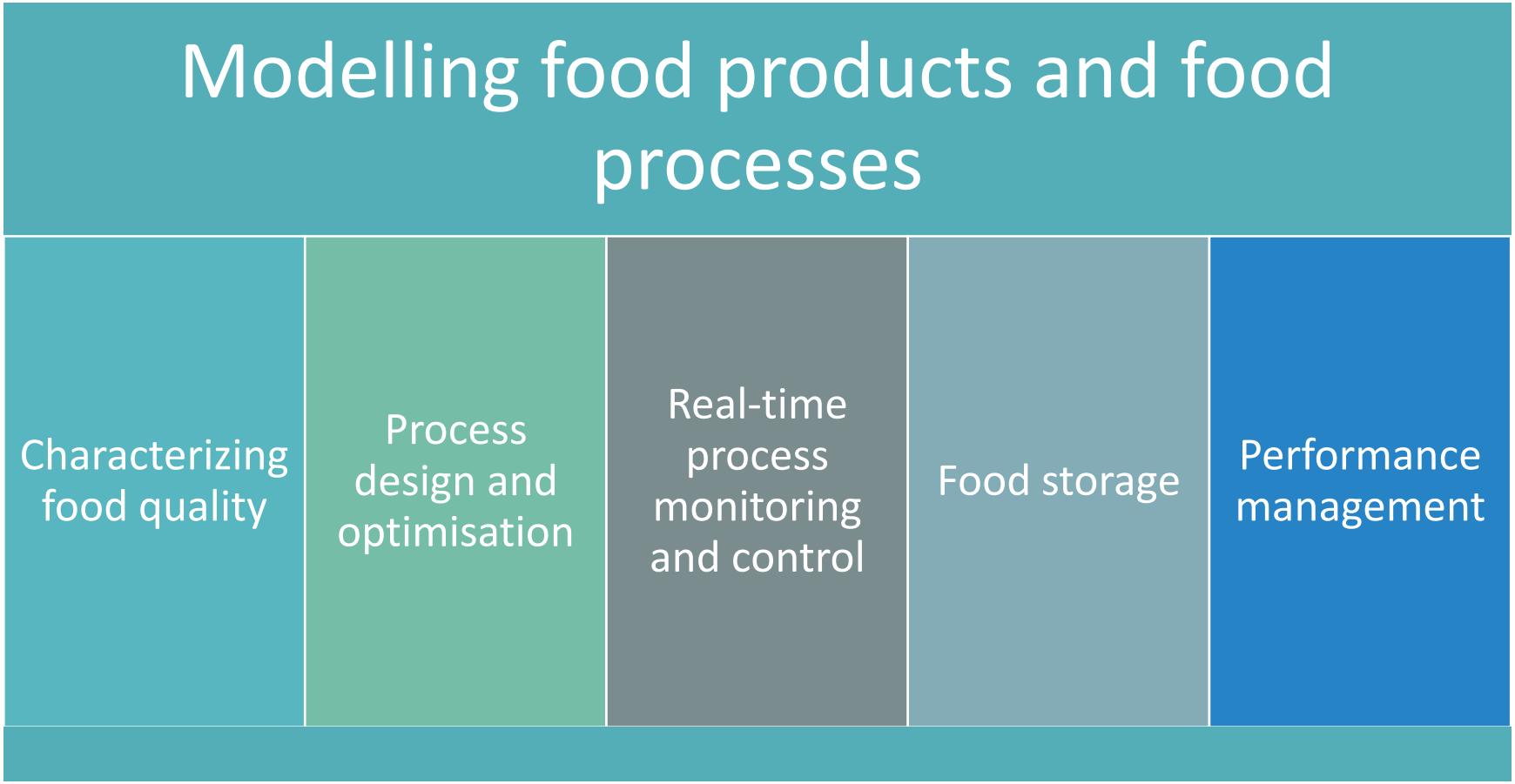
Objectives of WG1

- Common understanding of the subject
- Identify
  - Industry needs and barriers
  - Scientific challenges
- Develop knowledge
- Define benchmark case-studies

Topics for discussion in Versailles

- State of the art
- Questionnaire for the industry (with WG2)
- Identify case studies and industrial partnerships
- Deliverables
- Synergies with other national and European projects

State of the art



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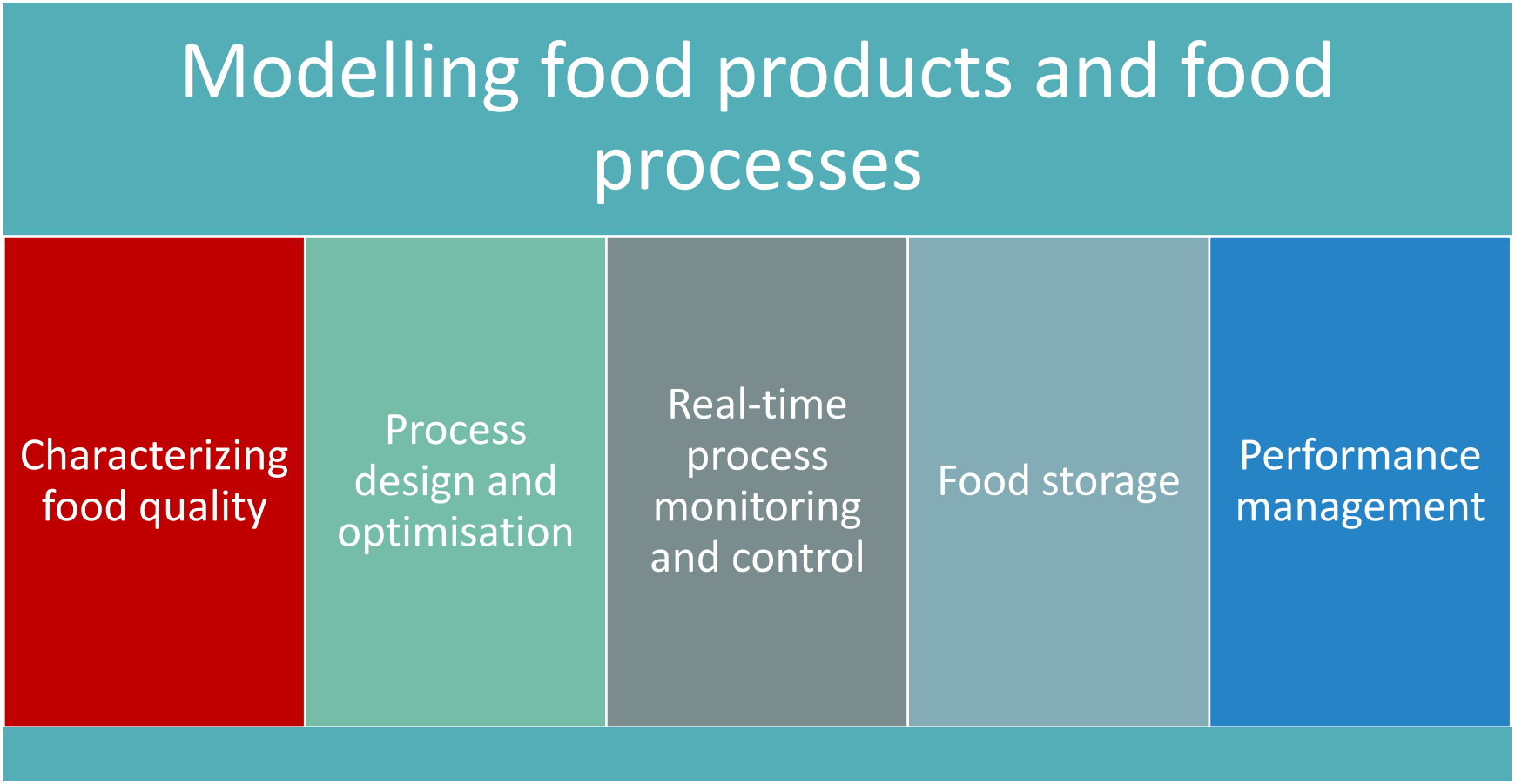
State of the art



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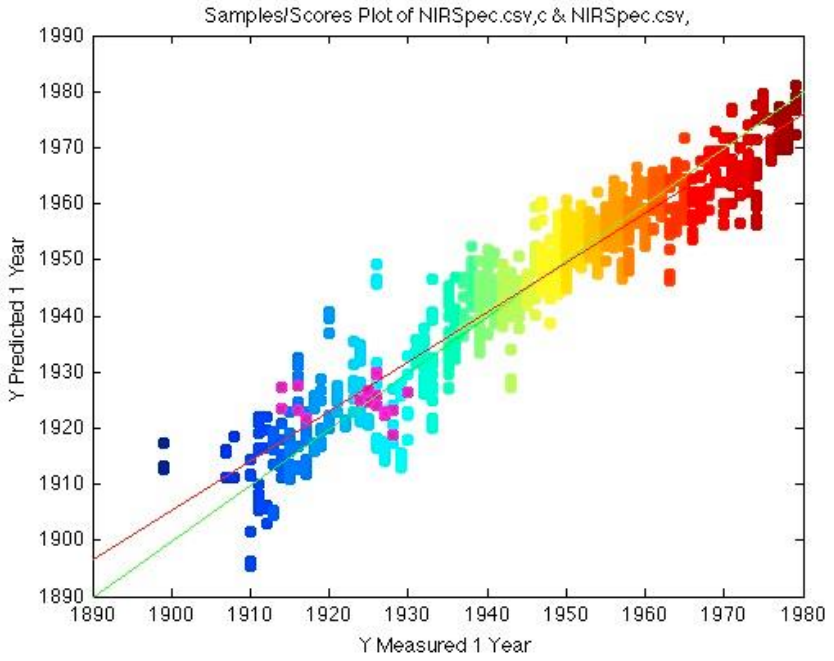
Characterizing food quality

- Multivariate calibration and classification models
- Based on multichannel sensors
  - Images
  - Spectroscopy
  - Chromatography
  - ++

- Data-driven, empirical
- Statistical models



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Multivariate calibration

- Objective
  - Predict key quality attributes
  - Fast and non-invasive measurments
- Industrial barriers
  - Need to invest in instruments
  - Instruments and models need maintainance and updates – lack of resources and competence
- Scientific challenges
  - Robust predictions
  - Calibration transfer
  - Non-causal relationships

Fat content in meat

Fat and pigment in salmon

Fatty acids in milk

Protein in cheese

Moisture in dried and salted cod

Insect fragments in wheat flour

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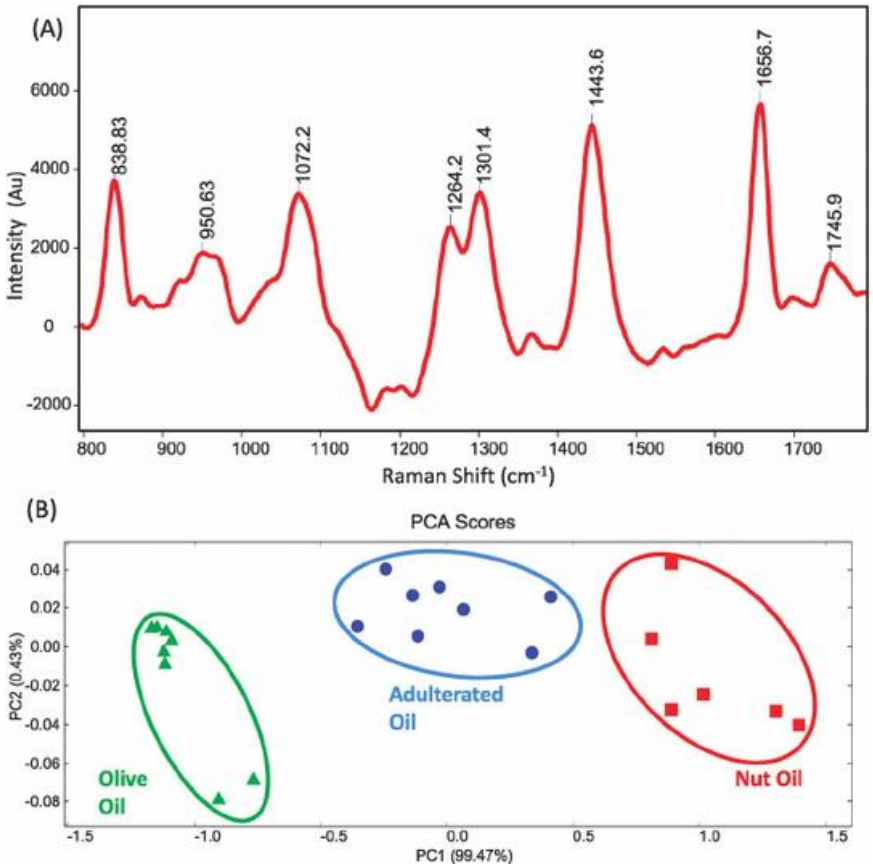
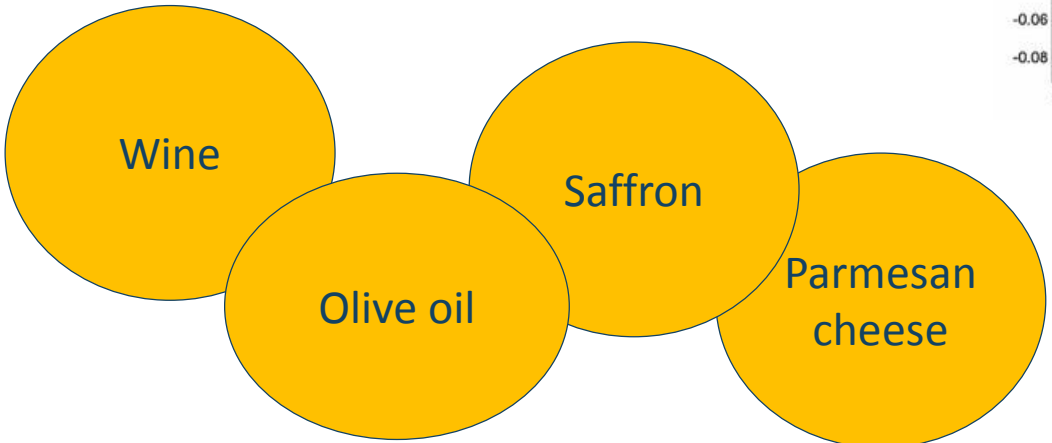
Authentication and adulteration

- Objective
  - Reassurance of origin and content
  - Often based on multichannel sensors such as chromatography, spectroscopy, DNA, etc
- Challenges
  - Accurate classifications
  - Model validation
  - ++





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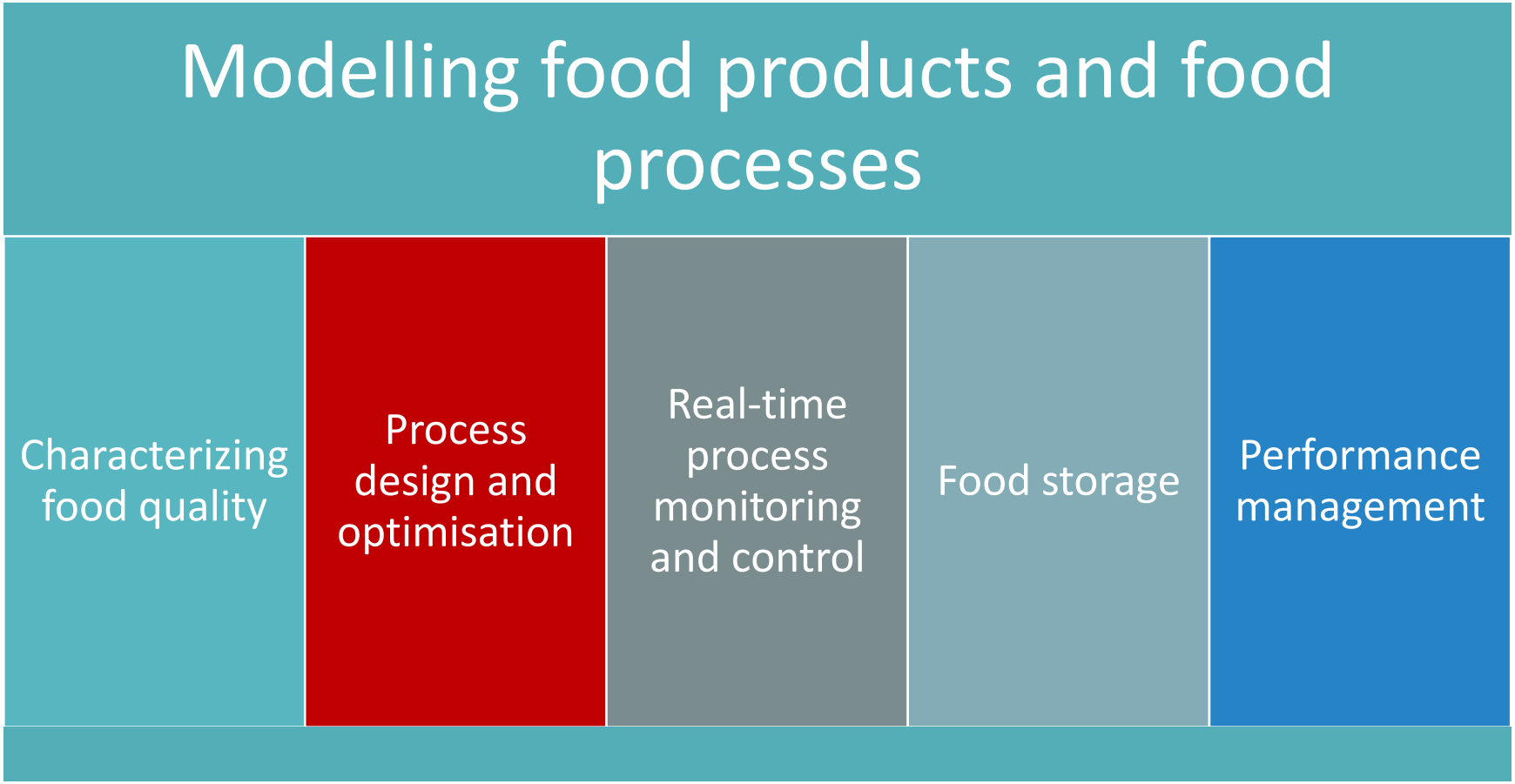

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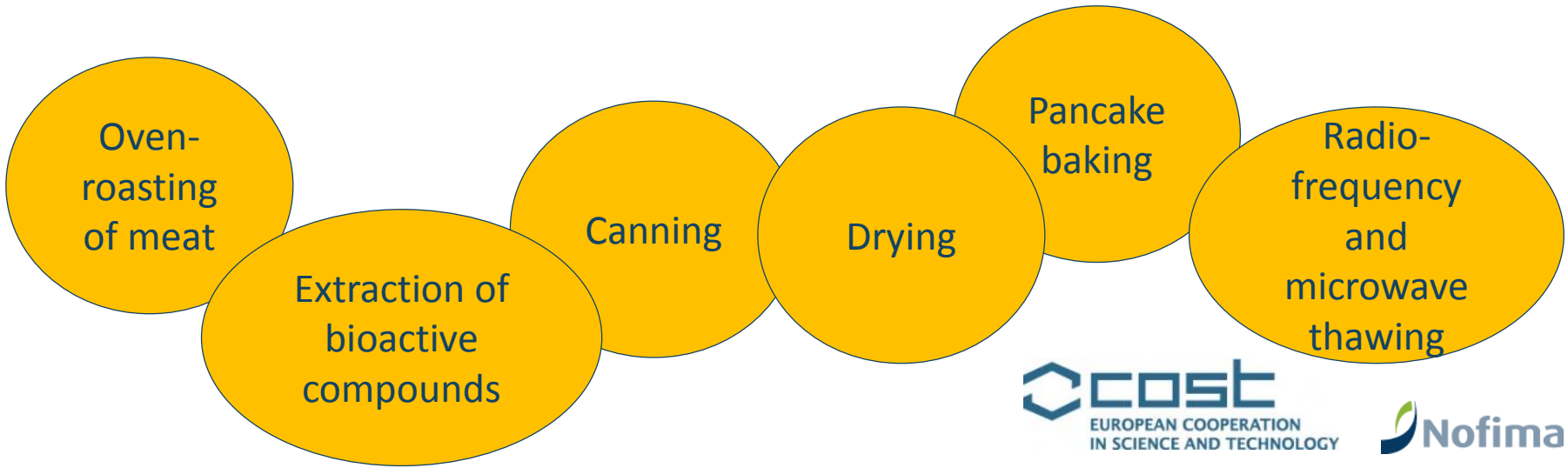
Process design and optimization

- Theory-based modelling
  - Heat and mass transfer
  - Deformation and fracture
  - Basic Knowledge Models
- Empirical modelling
  - Response surface methodology
- All with the same objective: Process and product optimization

Heat and mass transfer

- Objective
  - Design and optimize heat treatment processes with regard to product quality and energy consumption

- Industrial/scientific challenges
  - Complex processes
  - lack of data for some parameters (permeability, diffusion coefficient, thermal conductivity, etc.)
  - Lack of knowledge about link between microstructure and these parameters
  - Problems with experimental validation



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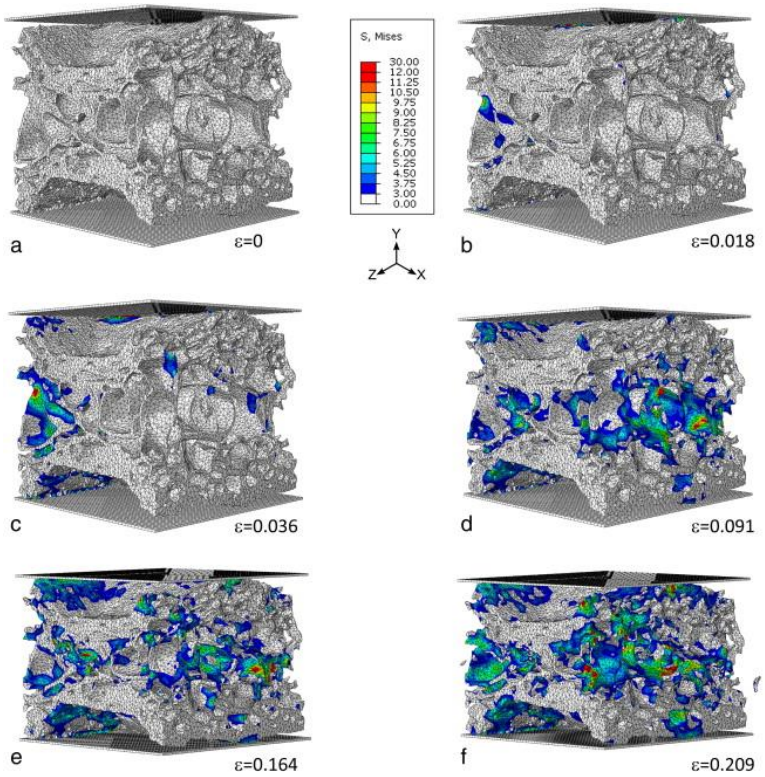
Deformation and fracture of food products

– Model deformation and fracture of food products as a function of structure and stress.

- Industrial barriers
  - Lack of modelling expertice in industry
- Scientific challenges
  - relate models to texture and perceived sensory properties during oral processing.



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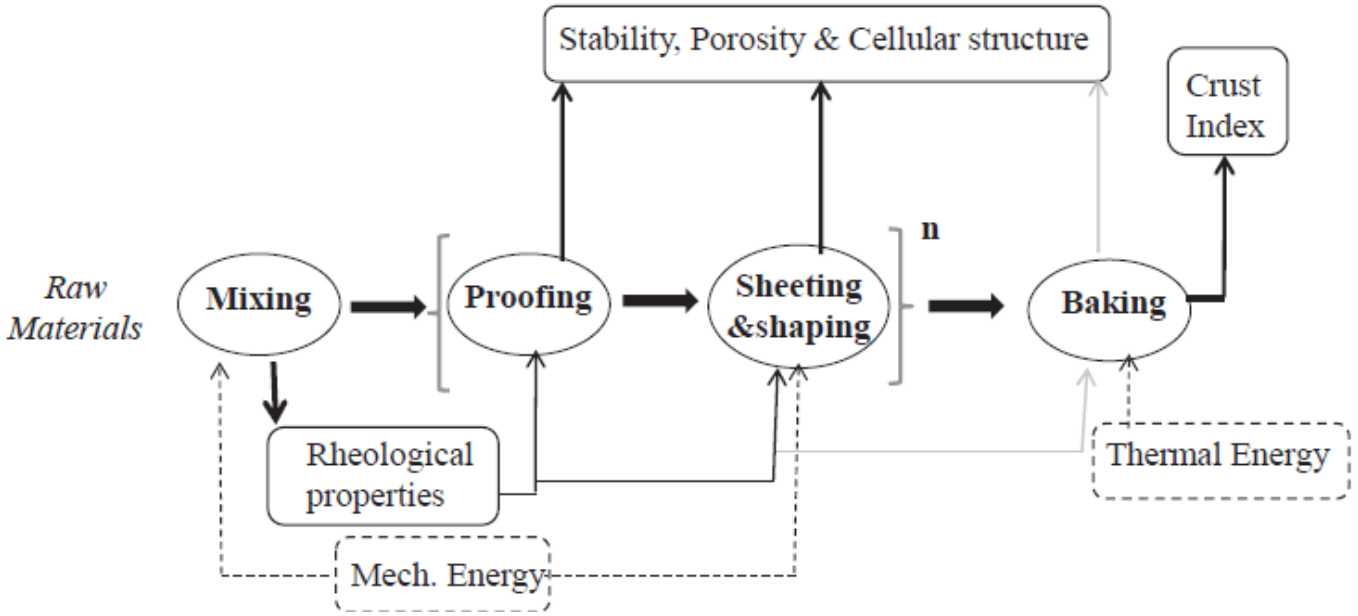
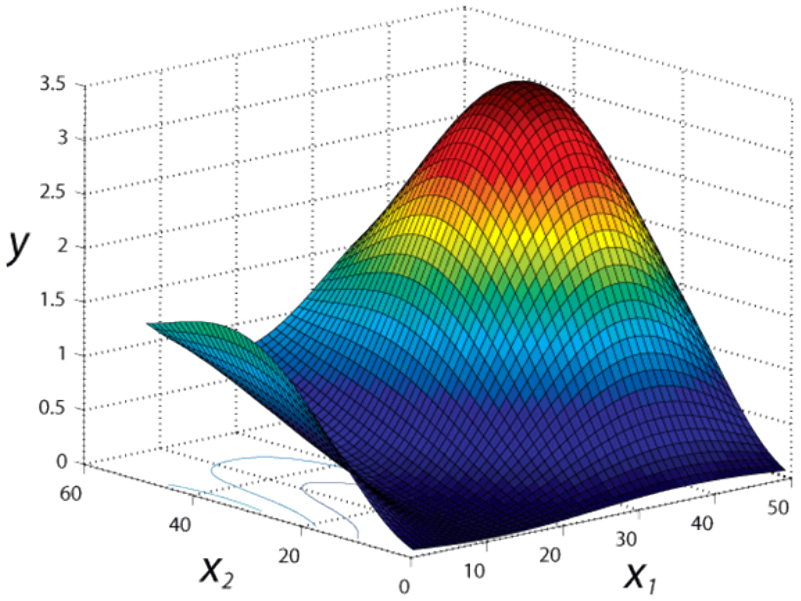
Basic Knowledge Models

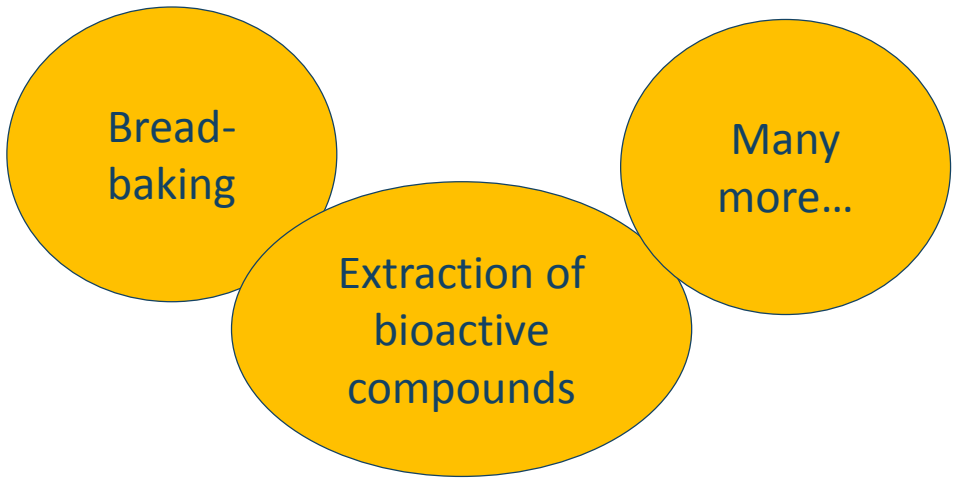
- integrate scientific and expert knowledge
- capture knowledge on the mechanisms during the different operations
- expressed under a simple mathematical form



Response surface optimisation

- Objective
  - identify optimal settings of the controllable process variables
- Industrial barriers
  - Upscaling (experiments are small scale)
  - Many variables, expensive experiments
- Scientific challenges
  - Complex response surfaces
  - Multi-response optimization
  - Dealing with uncertainty





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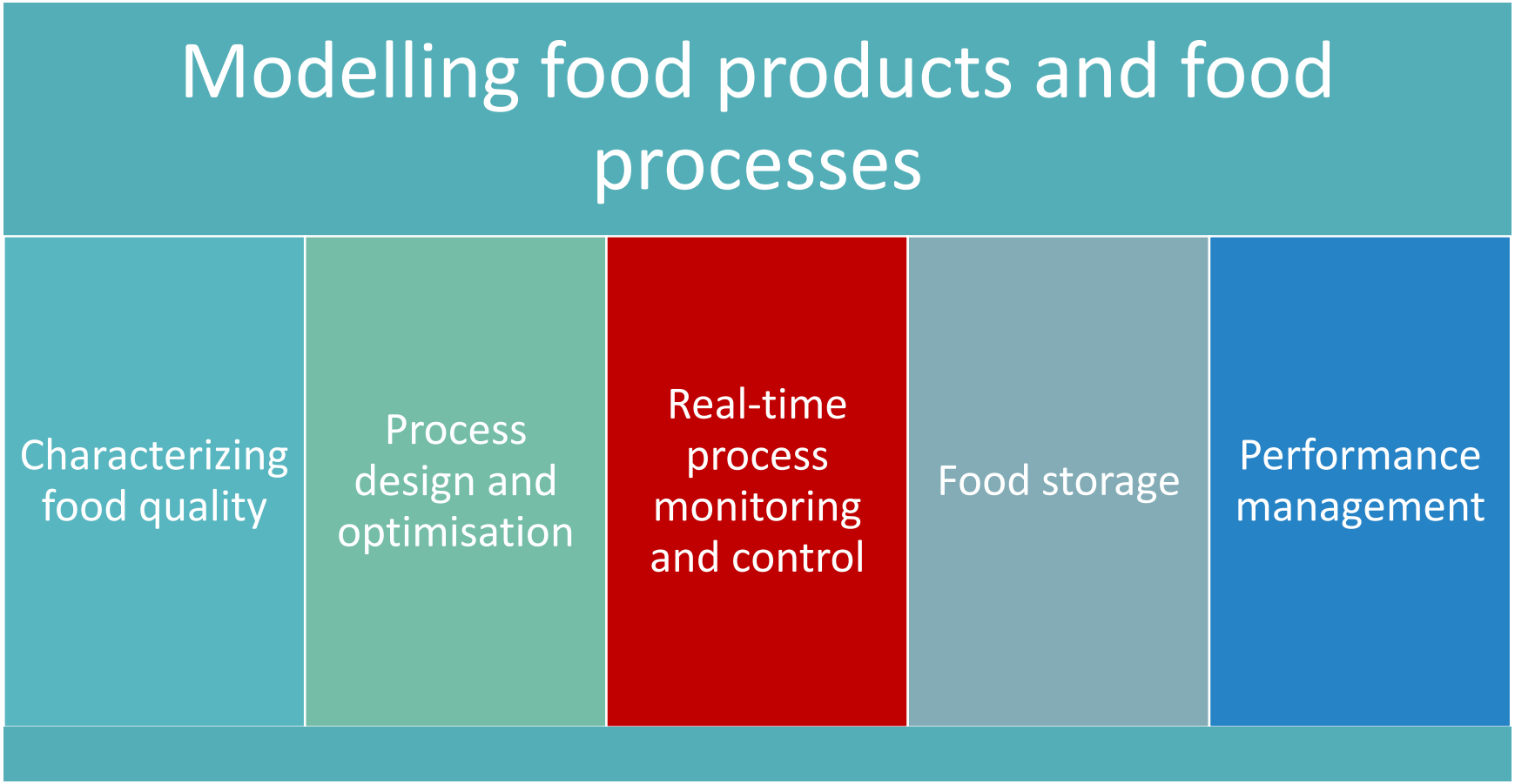
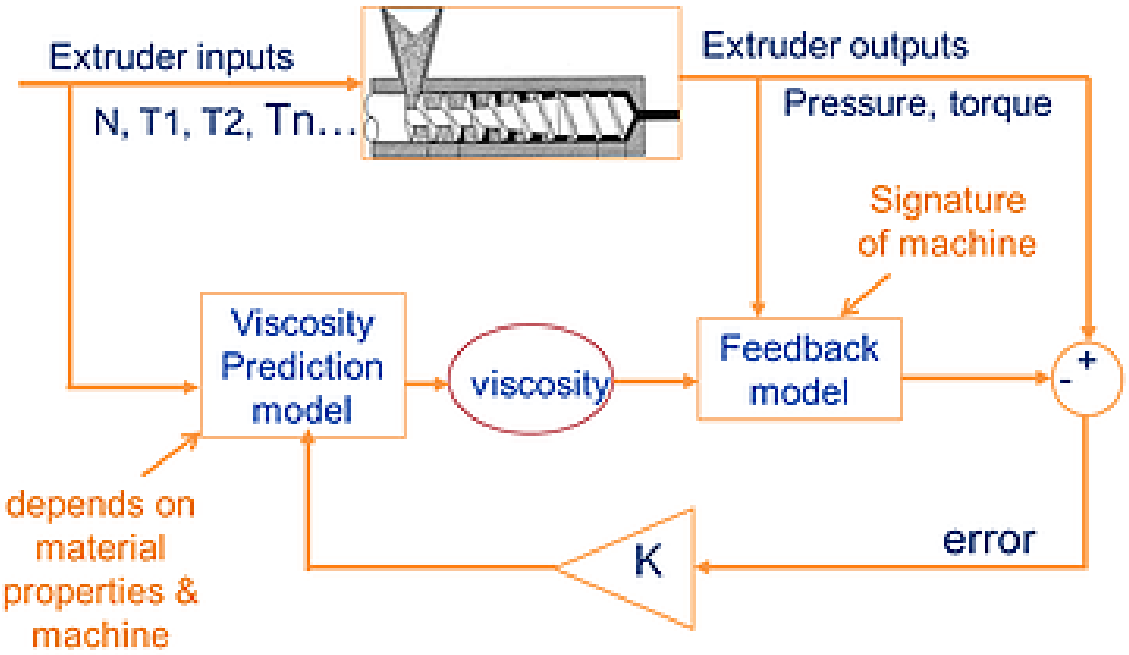


Real time process monitoring and control



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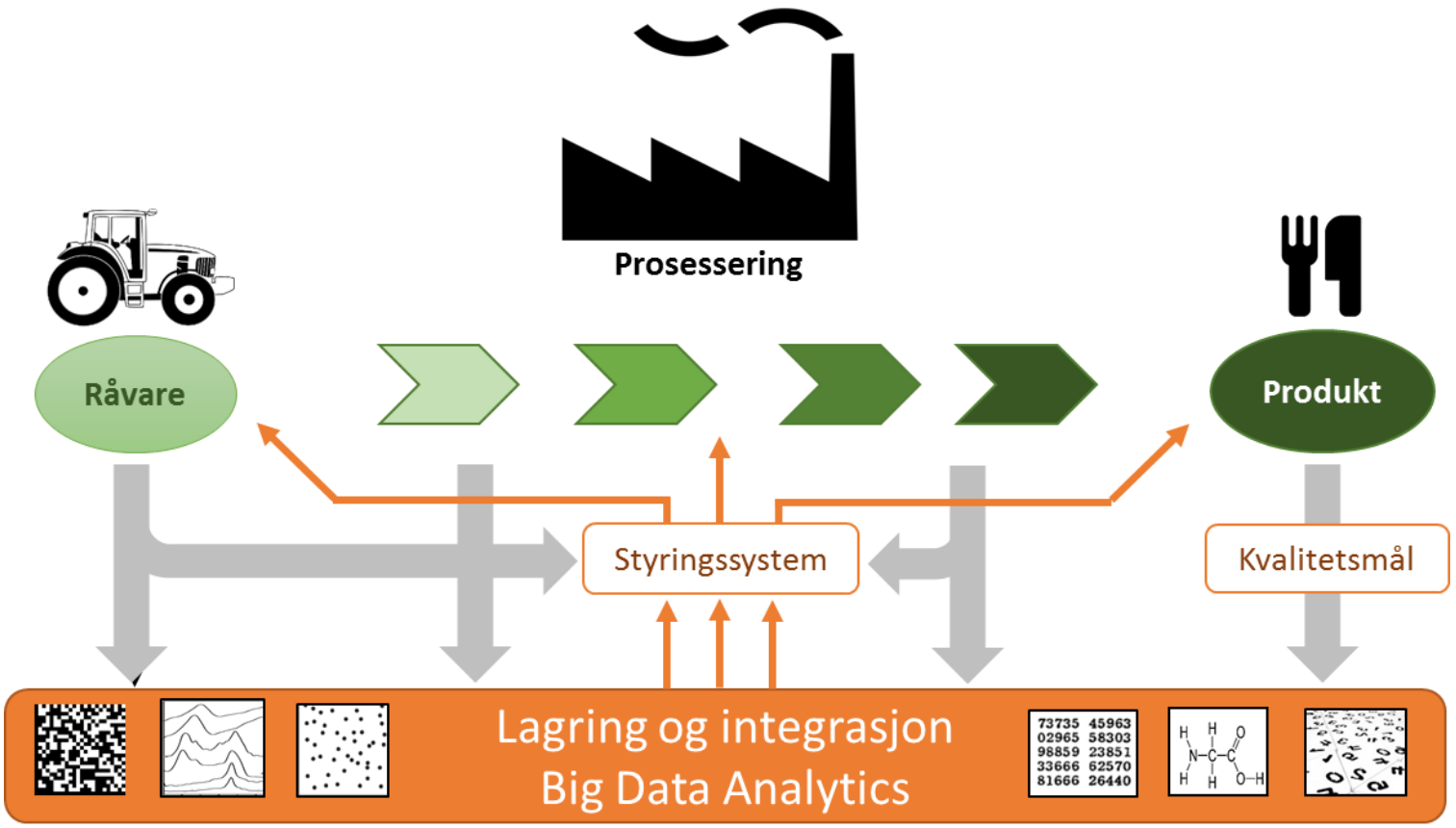

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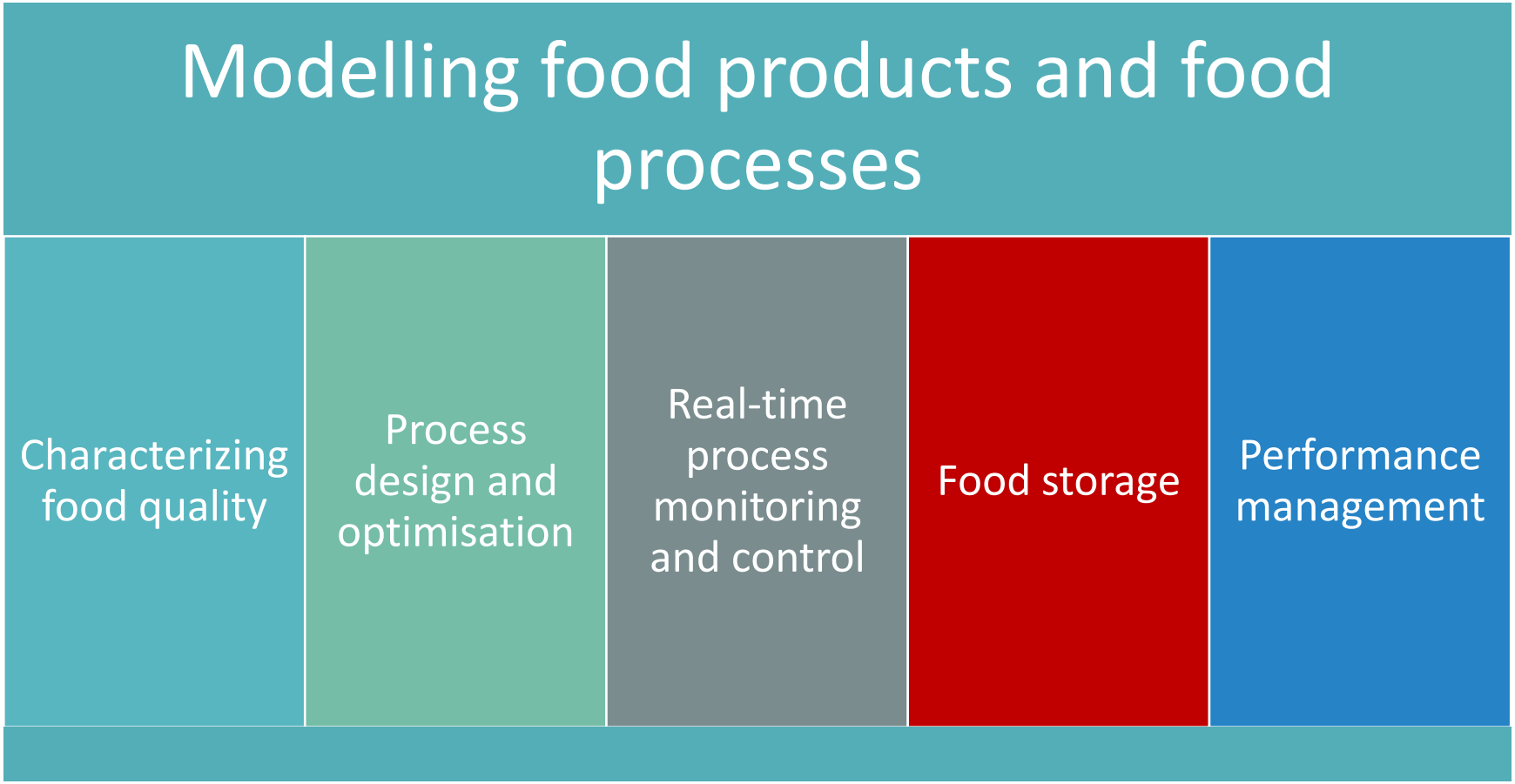

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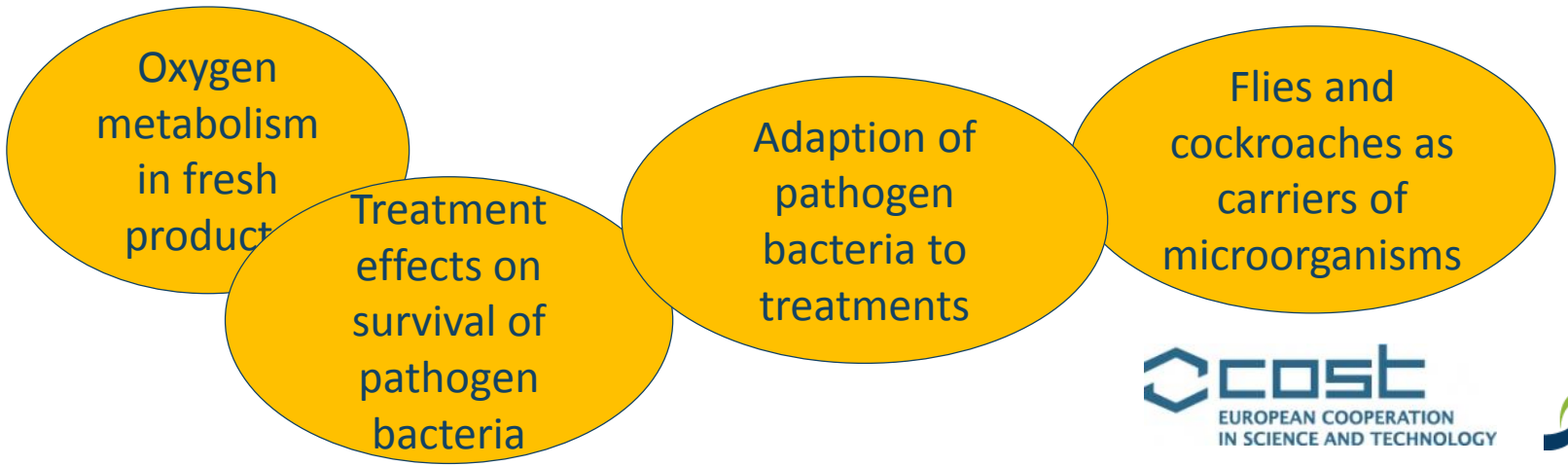
Food storage

- identify optimal packaging and storage conditions to increase shelf-life and food safety

- Challenges:
  - Expensive experiments – limited data
  - ++?



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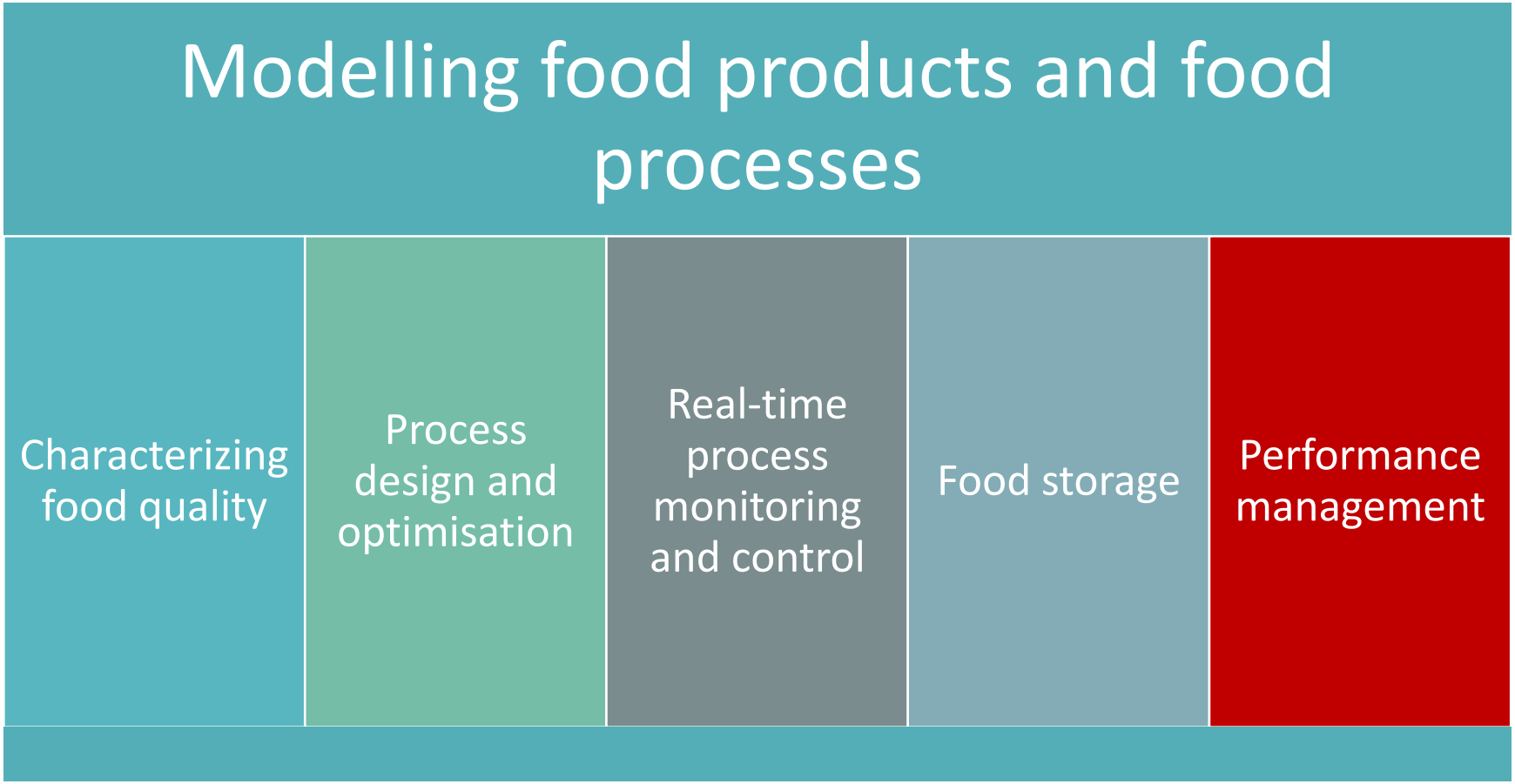
State of the art



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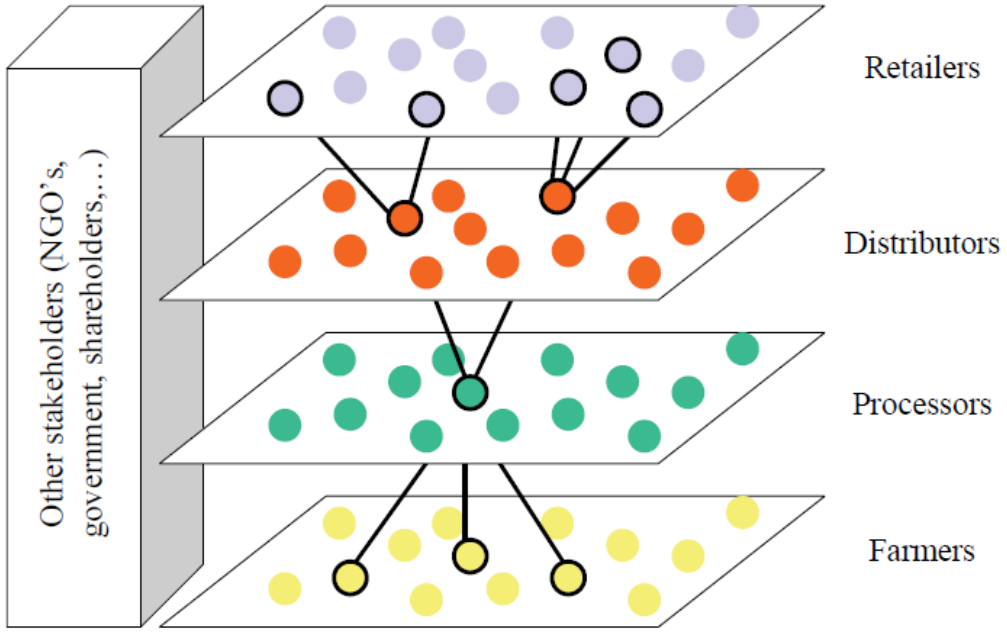
Performance management

- Valuing supply chains
- Improving manufacturing decisions
- Productivity analyses

Valuing supply chains

- Performance should be measured in terms of
  - Efficiency
  - Flexibility
  - Responsiveness
  - food quality



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Improving manufacturing decisions

- multi-criteria decision making (MCDM) techniques
- Models are easy to implement
- Specification of criteria, alternatives and weights can be based on expert knowledge or measurements
- Decision information can be fuzzy or crisp

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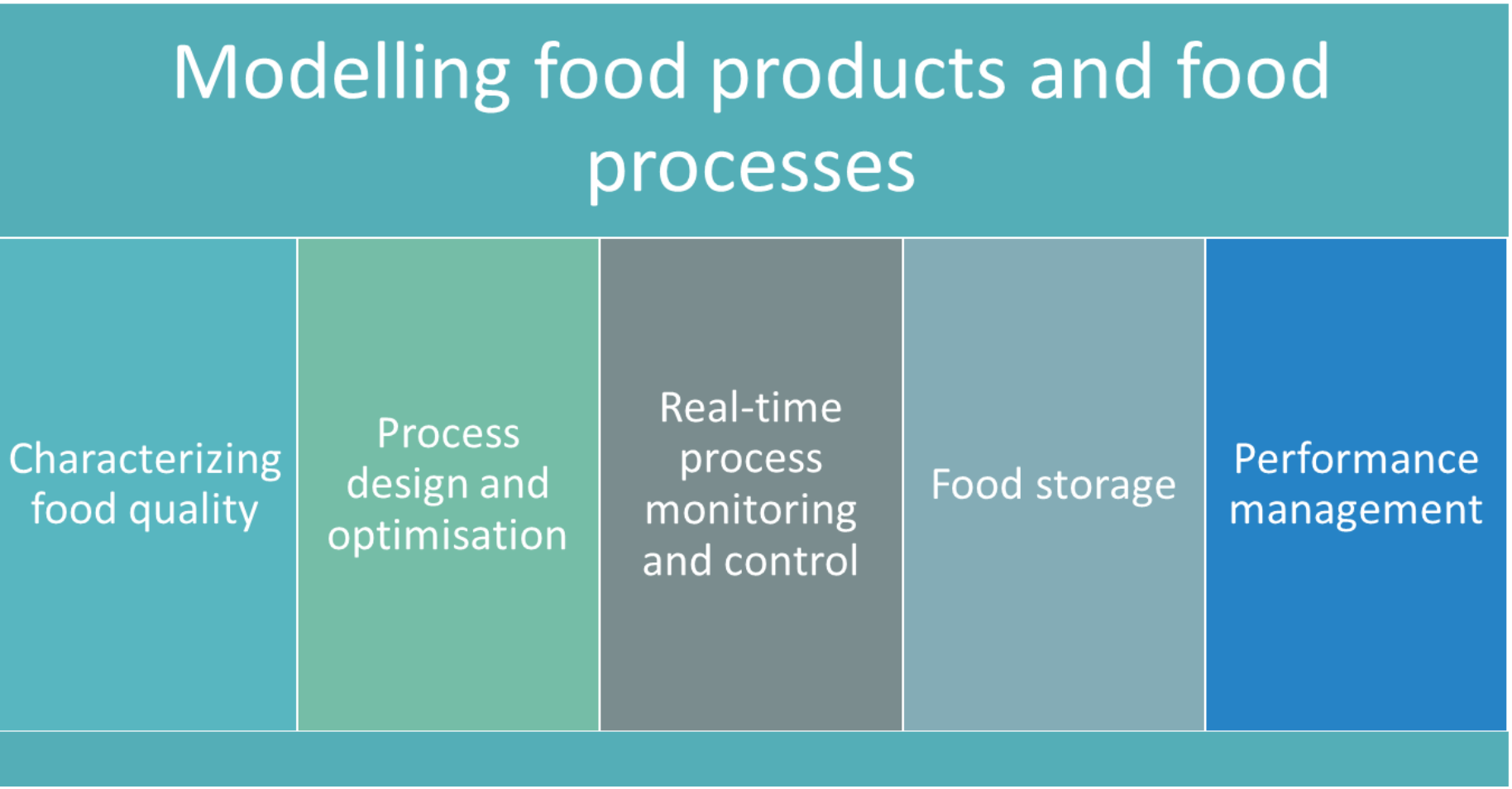
Productivity analysis

- Non-parametric or parametric techniques
- Models require extensive datasets
- Analysis of efficiency effects (contextual variables) requires even more data

How to proceed?



Minutes from the Versailles meeting

Subgroup WG1 – Modelling food products and food processes
Date: October 20th and 21st, 2016
Place: Versailles, France
Participants: approx. 40

General

WG 1 is the largest working group, with around 50 members representing 20 countries. The members of WG1 have competence in a multitude of different modelling strategies, applied on a broad range of products and processes. Some are also data providers and end-users of models.

State of the art overview

As discussed in the meeting, we have grouped the state-of-the-art according to two dimensions: "aim" (of modelling) and "scale" (of investigation). I have regrouped the google document according to "aim", but the scale information is still lacking. Scale was suggested to be divided into nano-micro-meso-macro. I think we still need to define these words in more detail. If anyone have a good definition, please share.

Publication of state of the art

It was decided that we prefer to publish in journal papers instead of a book. Preferably a special issue of an indexed journal, together with the other WGs. It still needs to be decided in which journal and the scope of the papers.

Possible case studies

The case studies were discussed together with WG2 (eco-design), since we would like to identify cases that are relevant for both groups. Three industry sectors were singled out: "Cereal", "Dairy" and "Fruits & Vegetables". In the meeting we formed subgroups that started to discuss specific case studies.

The "cereal" group was the largest. Maria Otilia Carvalho has taken the lead of this group, and is collecting e-mail addresses from those interested.

The "dairy" group identified a good case between Ilija Djekic (leader WG2, University of Belgrade) and Elisabeth Guichard (INRA), combining a large database that INRA has on cheese quality with ECO-models that Ilija has.

I do not have the minutes from the "Fruits and vegetables" group. Could any of the participant of this group please send the results of your discussion to this mailing list?

NOTE: you are free to make case studies on any industry sector, it is not restricted to the ones we discussed in the meeting.

Questionnaire for the industry

This was also discussed together with WG2, since we would like to have a joint questionnaire. The questionnaire should have few, closed, simple-to-understand questions. We should try to use questions that have been used in similar studies and have been published. This means that the questions are validated and we can compare the responses. The questionnaires should be translated to the local languages. We hope to obtain 30+ answers from each country. A draft will be circulated to all WG members soon.