LIÈGE université
Gembloux
Agro-Bio Tech

Prof. Hélène Soyeurt
Dr. Anthony Tedde

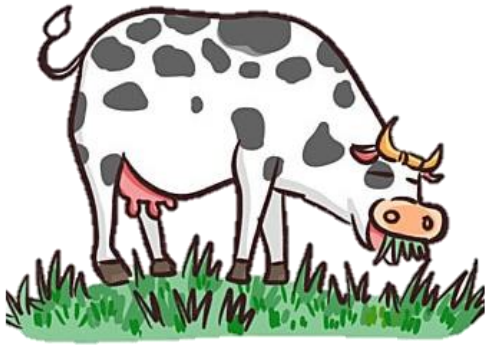
Predictions of dairy related phenotypes using milk mid infrared spectral data

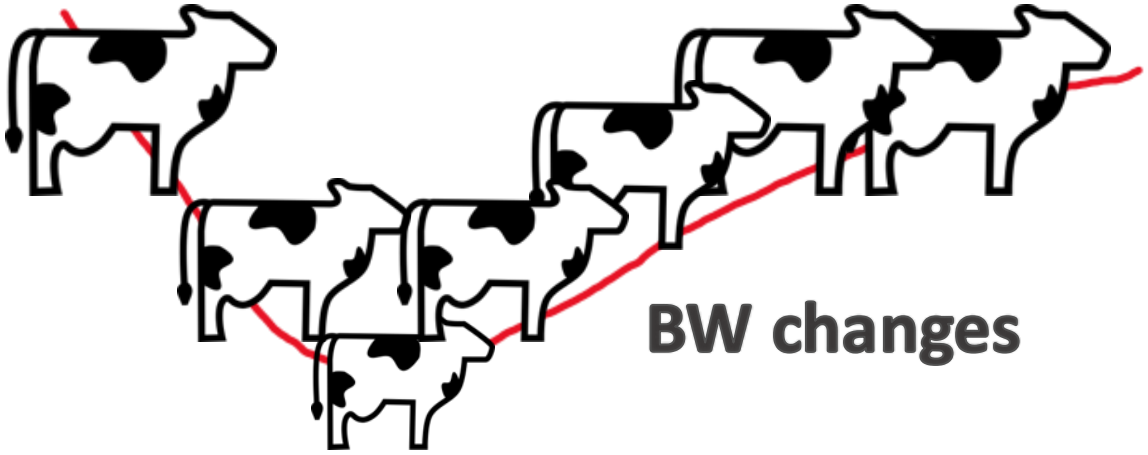
SimBa workshop – 12 May 2023

Body Weight - BW

Dry matter intake - DMI

Grazing probability



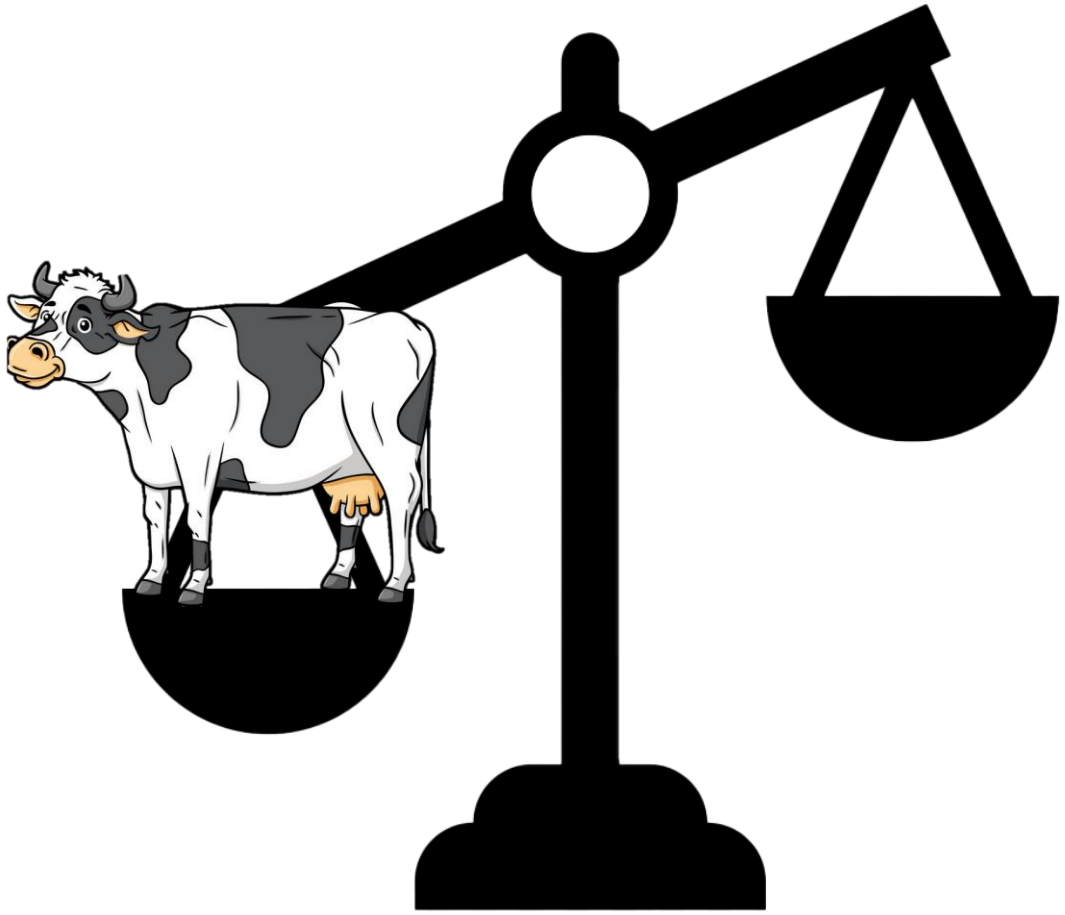


BW changes

Intensification level

Dalcq *et al.* (2020), PhD thesis

Body weight



Farm management (Thorup *et al.*, 2012),

Disease detection (Berry *et al.*, 2007),

Reproduction performance (Van Straten *et al.*, 2009) ,

Methane production (Herd *et al.*, 2014)

Dry matter intake (National Research Council, 2001)

Dry matter intake

- **Methane production** (Blaxter and Clapperton,1965; Pelchen and Peters, 1998)
- **Feeding efficiency**
- **Farm management**
- **Body weight** (National Research Council, 2001)

Grazing probability

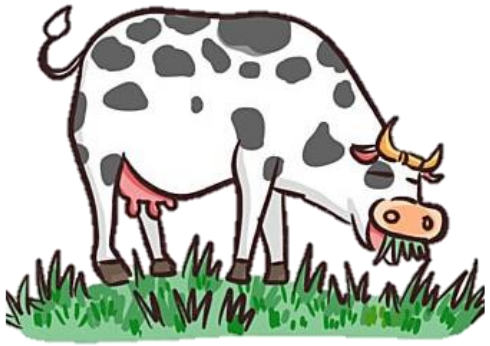
- **Farm management**
- **Feeding efficiency**
- **Body weight**
- **Label for Protected Product**
- **Consumer’s health**

Degree of production intensification

- Decision tool
- Simulation tool
- **Grazing**
- **Economic indicateur**
  - market
  - Milk quality
- **Farm resilience**

Dry matter intake

Grazing probability



Direct measure

Precision

Cost

Limited scale

Time

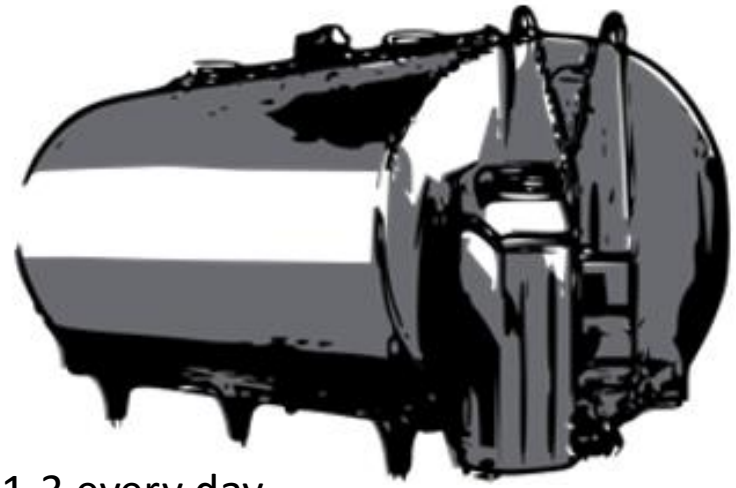
Not standardized

Dalcq *et al.* (2020), PhD thesis

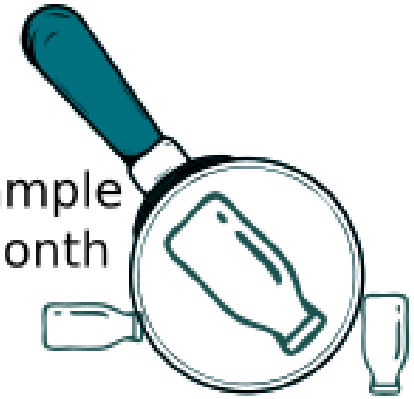
Degree of production intensification

Fast and Cheap Measurements

Milk infrared spectrometry

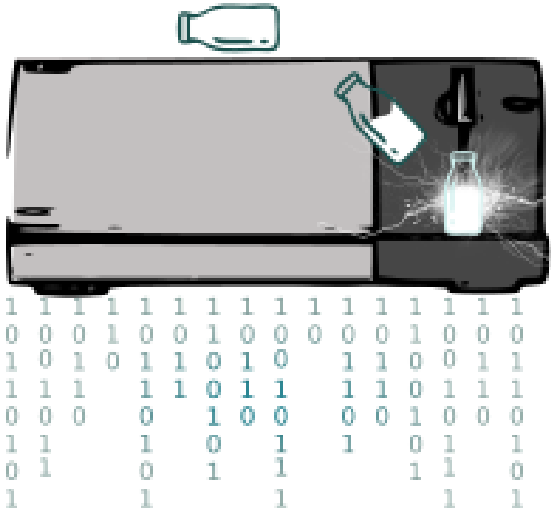


1-3 every day

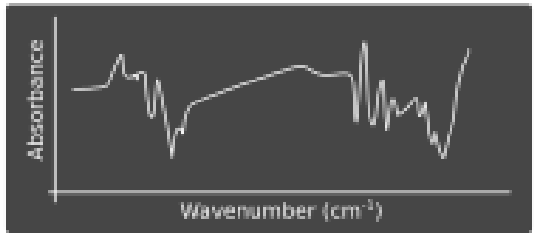


Milk sample
~1 / month

Milk analysis

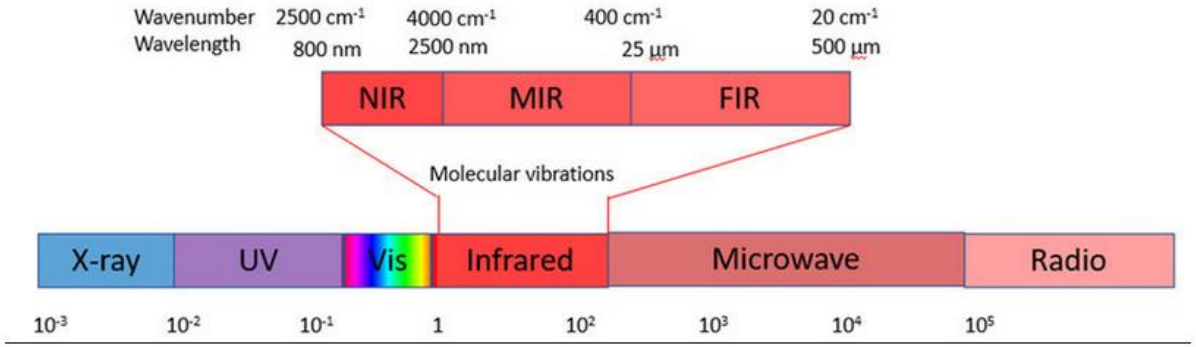


Mid infrared spectrum data



Milk Analysis

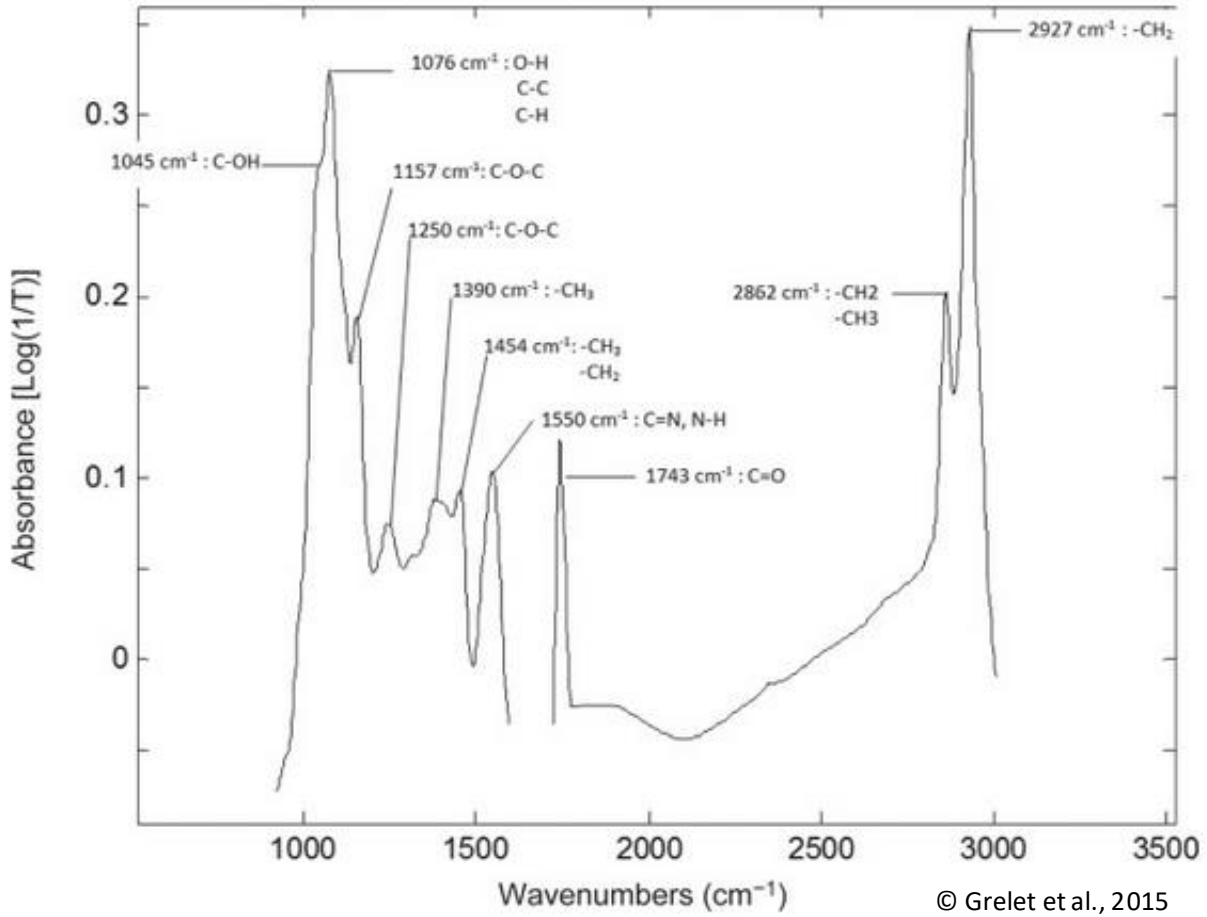
©Avelino Calvar Martinez



Milk MIR spectrum

=

Absorption of infrared ray at frequencies related to the vibrations of specific chemical bounds in milk

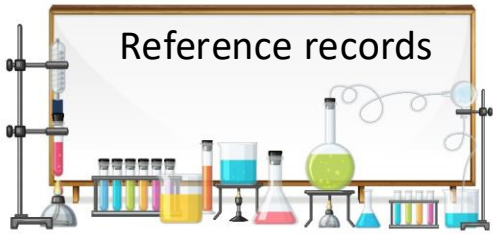


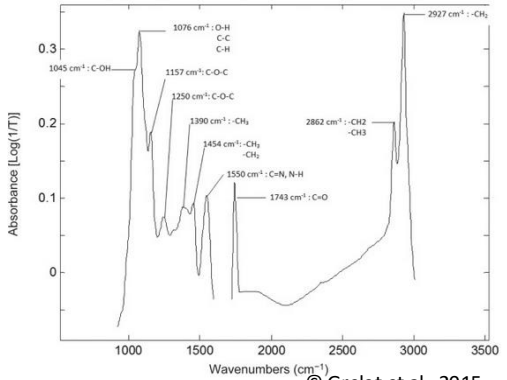
© Grelet et al., 2015

Milk Analysis

Milk samples

Milk FT-MIR





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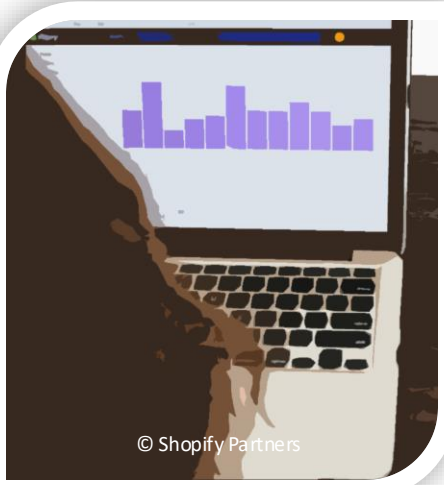


Predictive model = Equation

What exists ?

Nutritional quality

Fat, protein, lactose, fatty acids, Ca, lactoferrin,…

Technological properties

Cheese yield, yoghurt yield, butter yield, spreadability …

Animal Health

Na, lactoferrin, Energy balance, acetone, BHB, citrate …

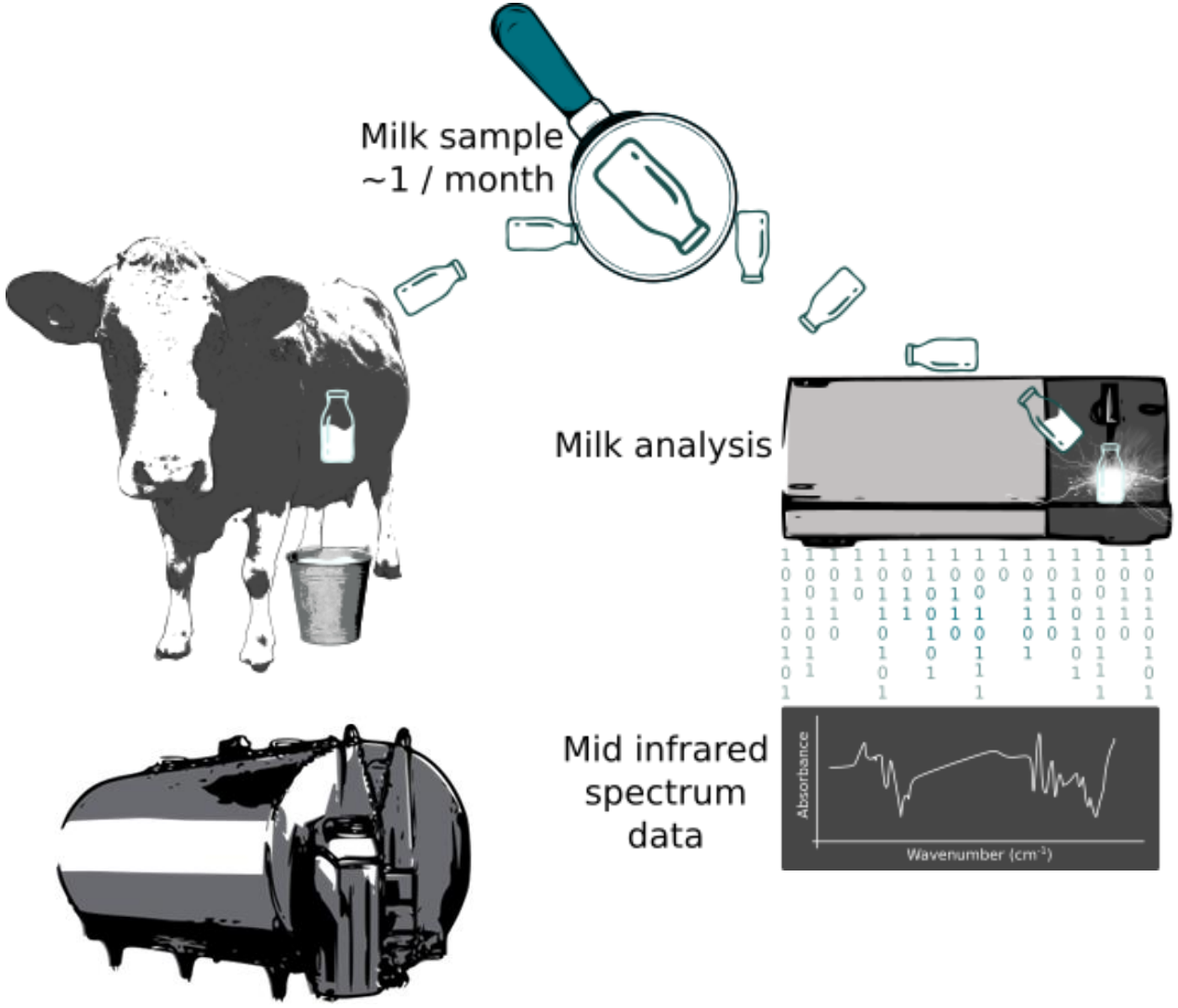
Environmental fingerprint

Methane, P, urea …

Sustainability

Consumption index, nitrogen efficiency …

Abnormal milk samples



Cheap

Routine

Historical data

Large scale

Indirect measure

Precision

Milk Analysis

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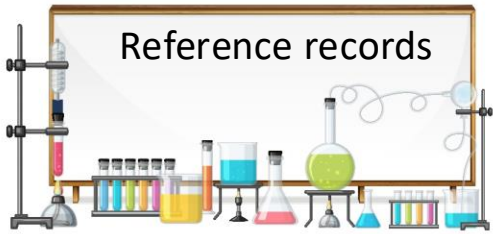
Milk samples

©Foss

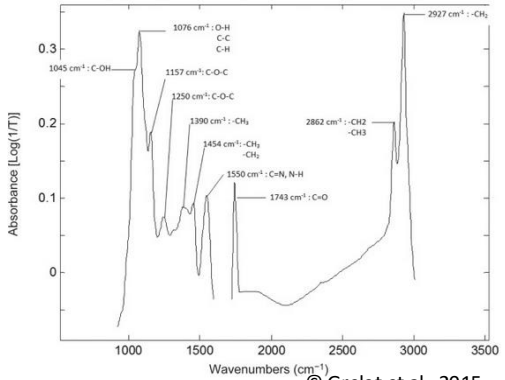
Milk FT-MIR

Additional traits = new equations !



Reference records

© vecteezy



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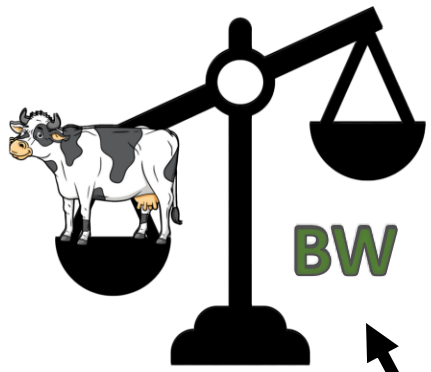
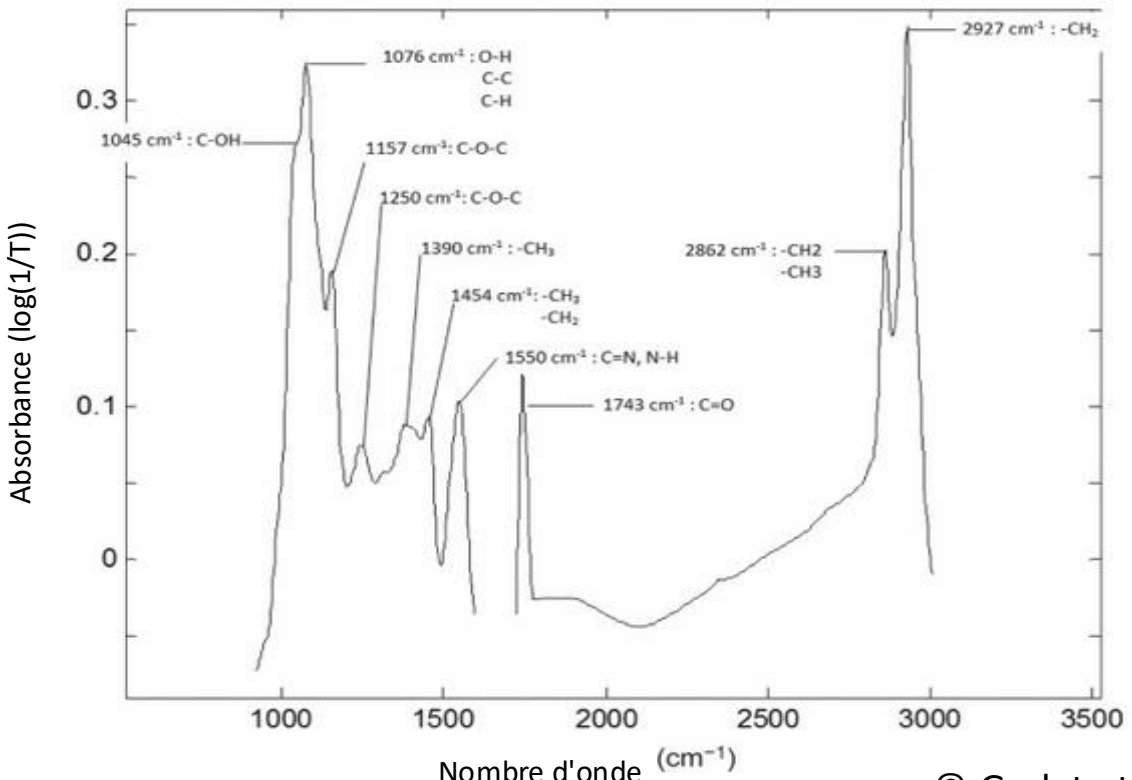
Predictive model = Equation



Dry matter intake



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Grazing probability

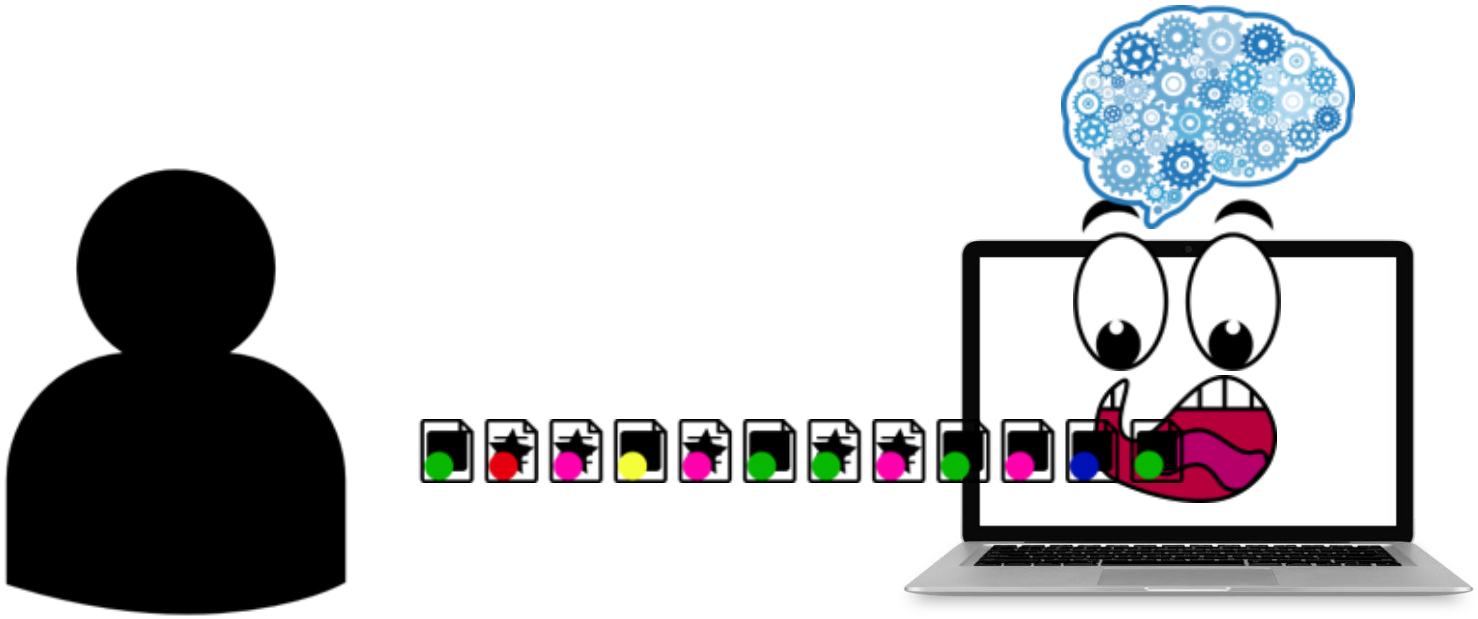
Degree of production intensification

Create new equations

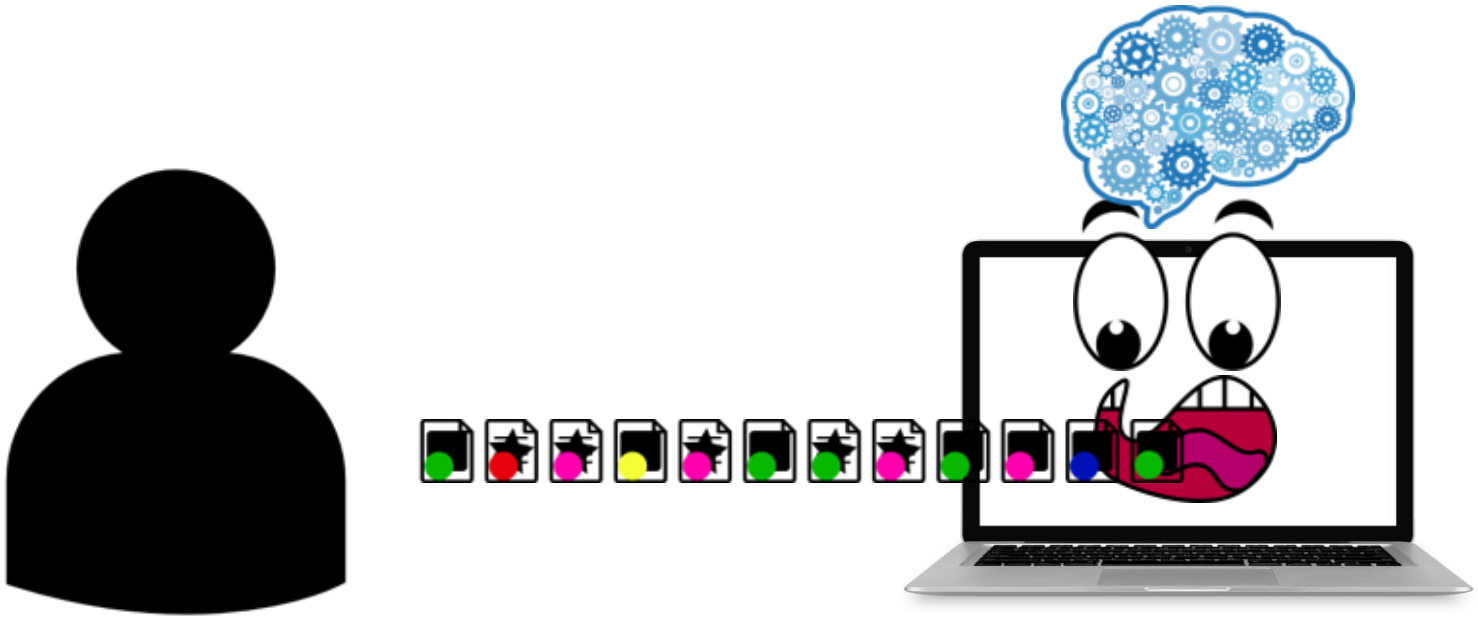
Prediction: automatic learning

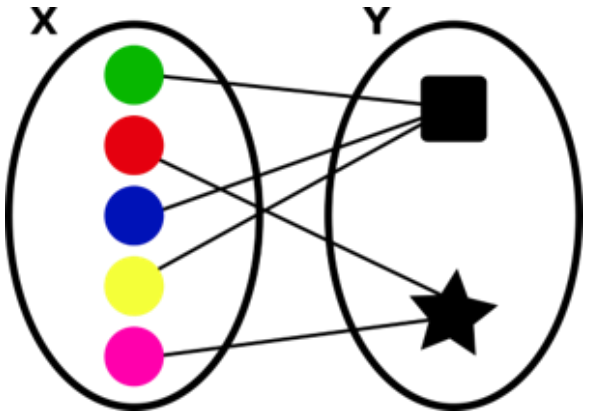
If A or B then Y

Prediction: automatic learning

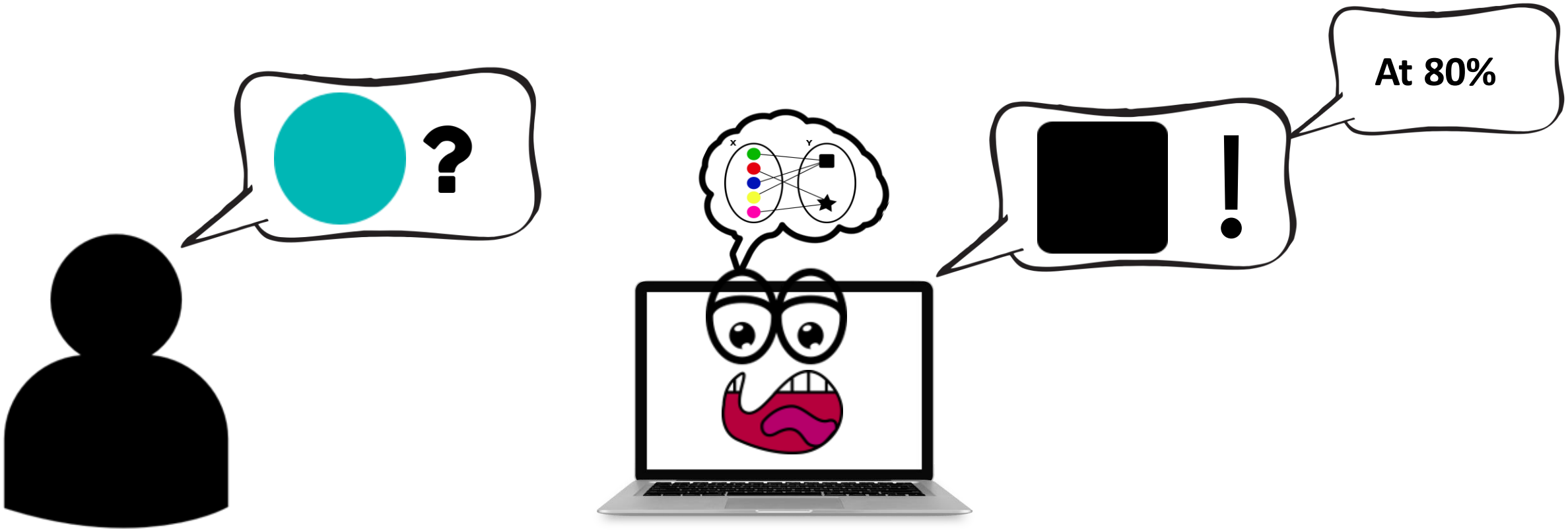


Prediction: automatic learning

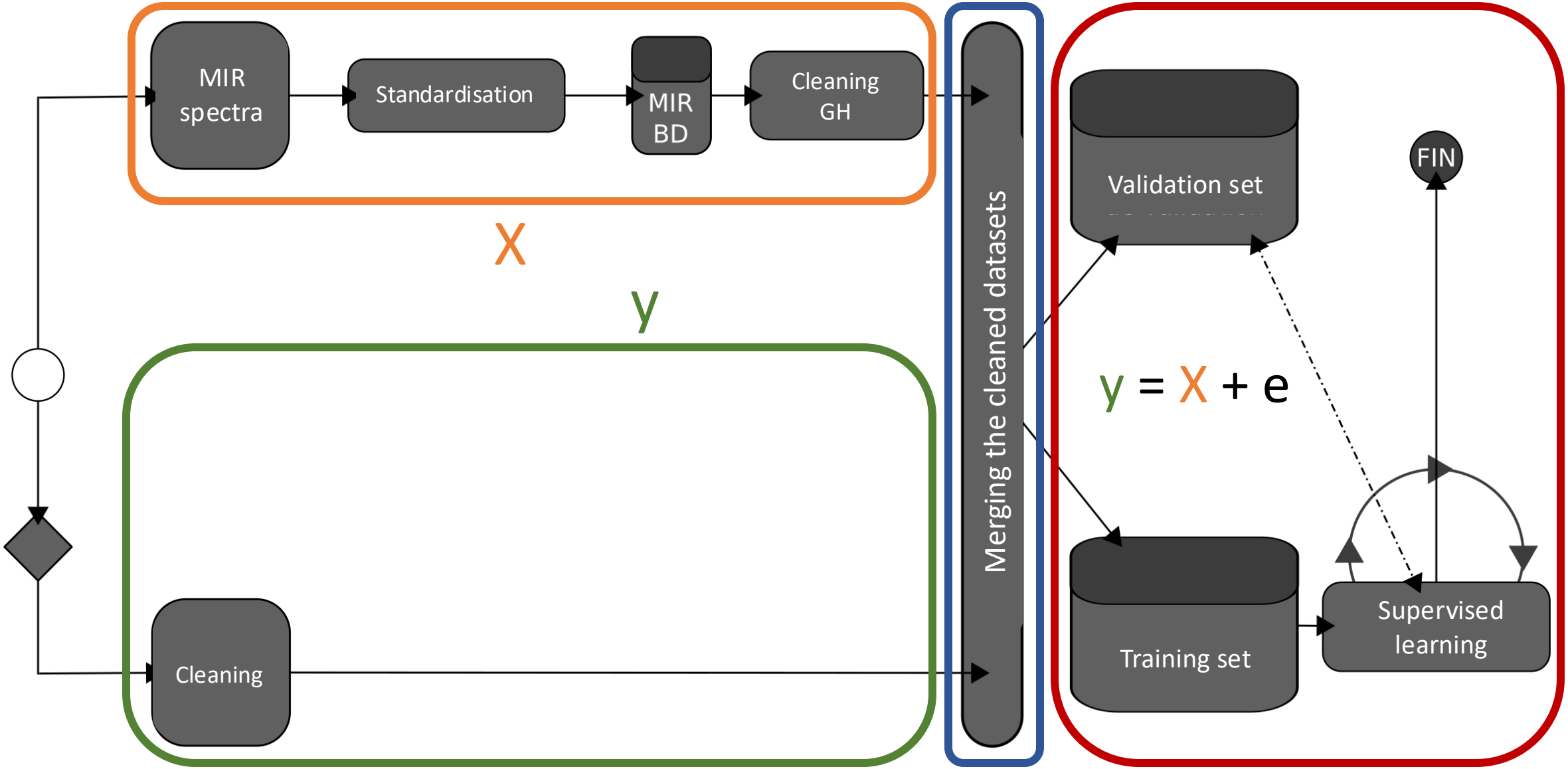




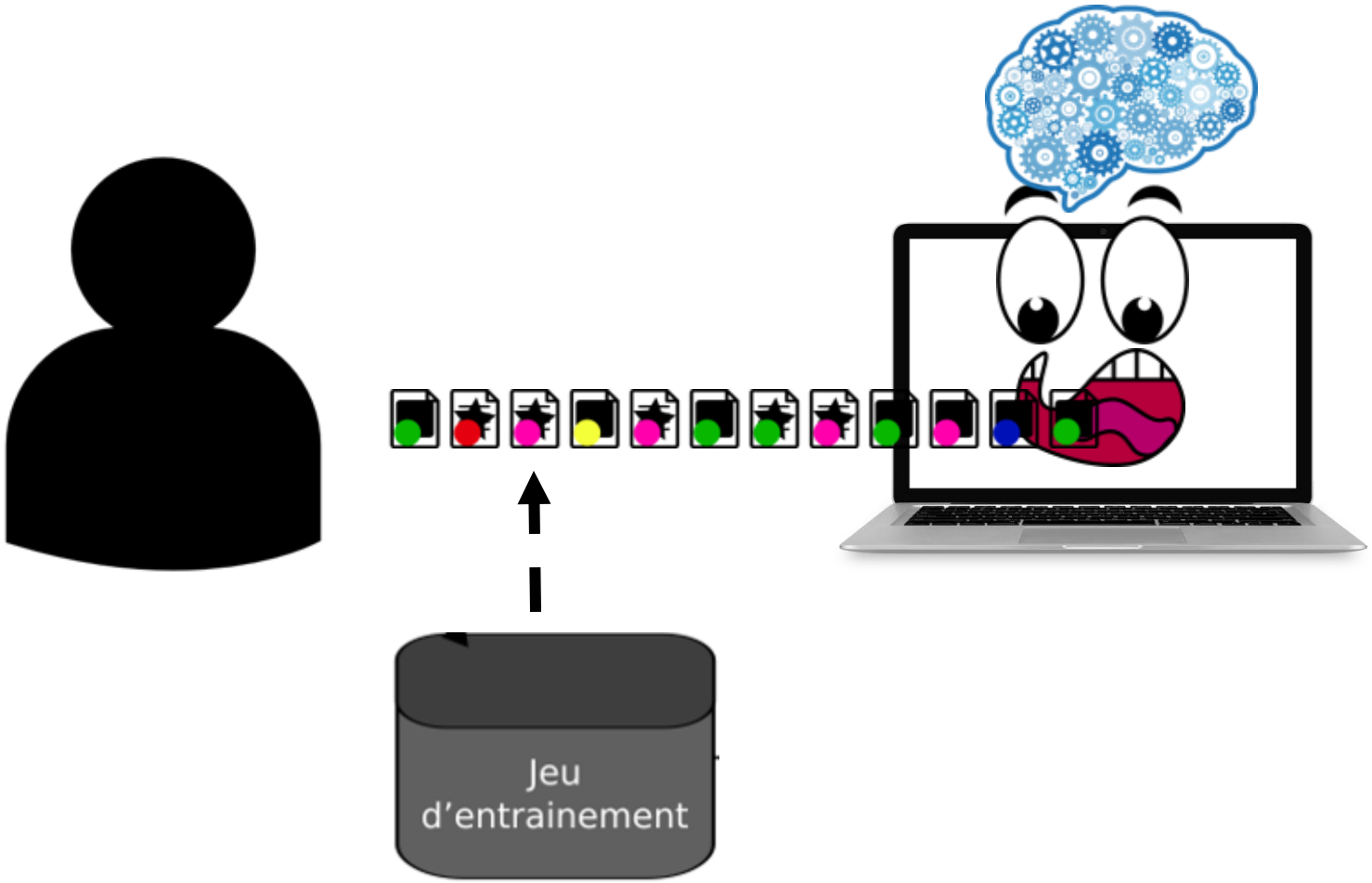
Prediction: automatic learning



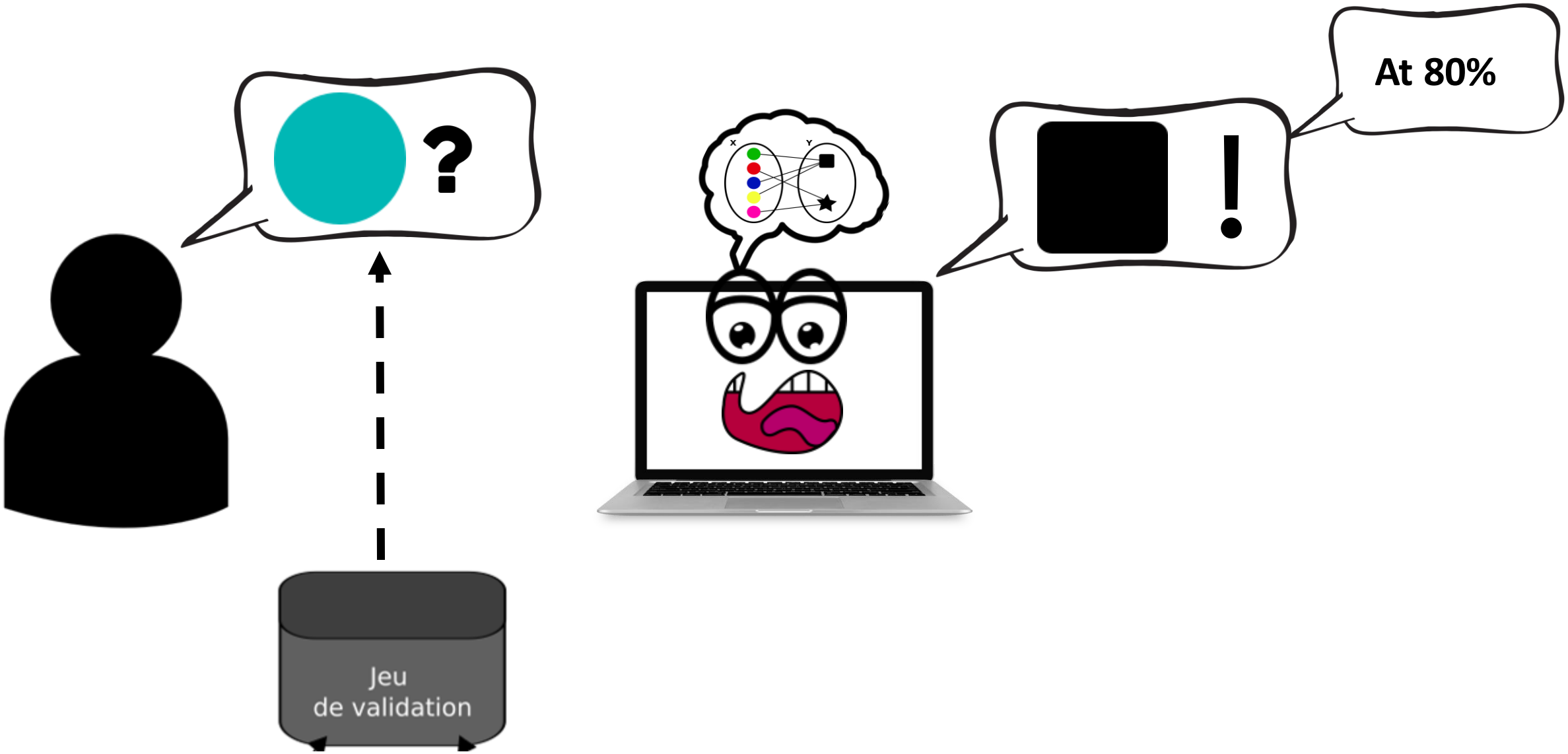
Modeling : Usual practises



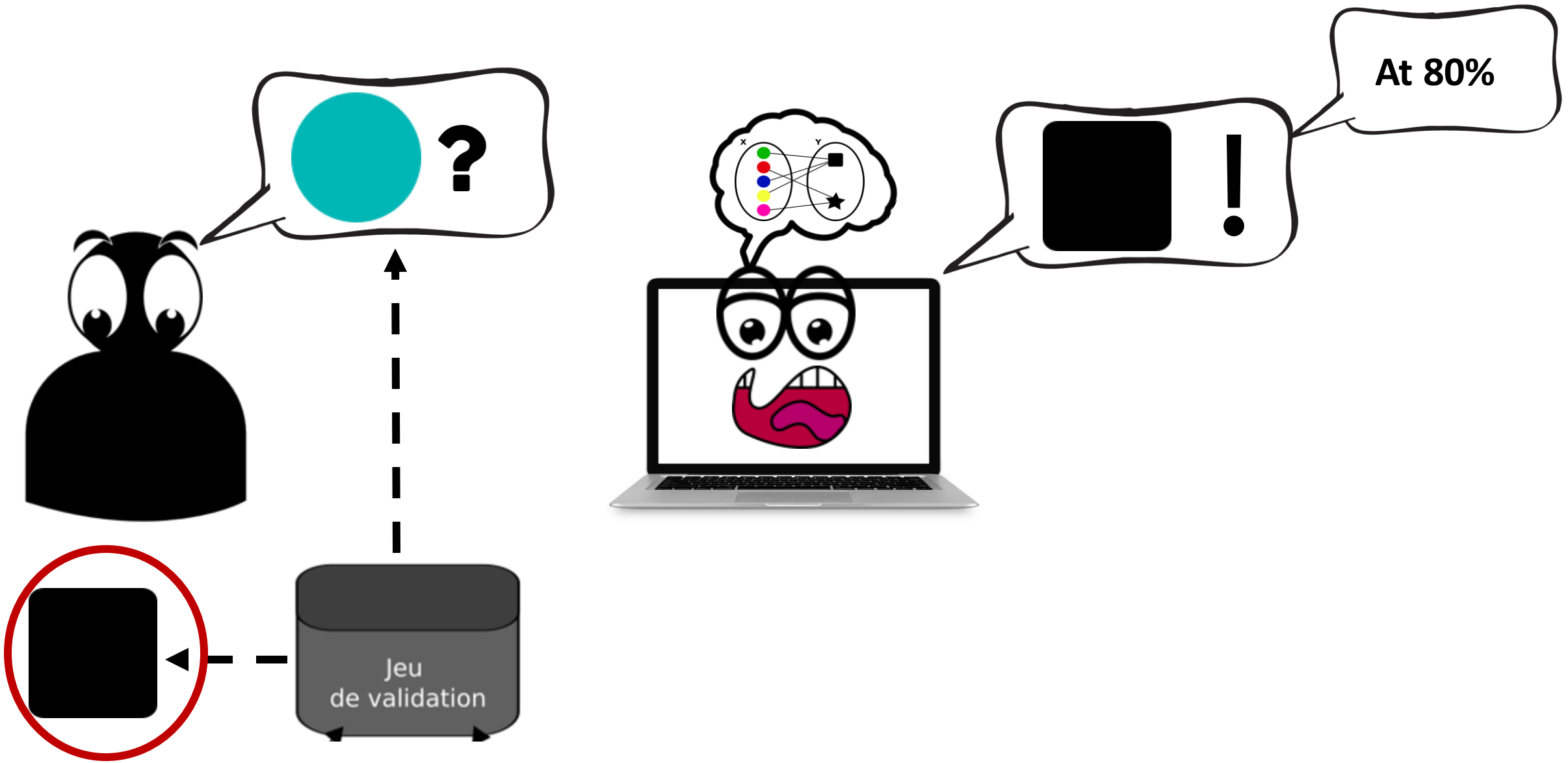
Prediction: automatic learning



Prediction: automatic learning



Prediction: automatic learning



Same idea, for instance …

Milk Analysis

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Milk samples

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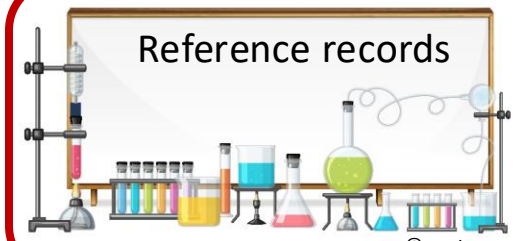
Milk FT-MIR

Additional traits = new equations !



Reference records

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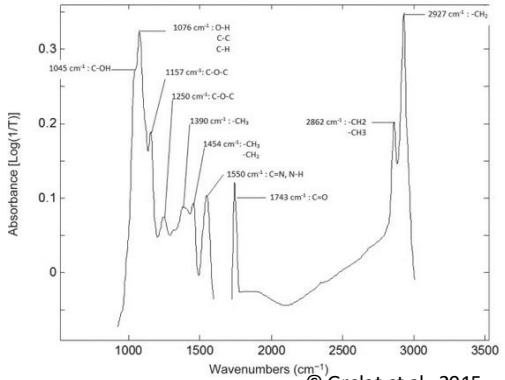

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Predictive model = Equation

Information level : 3 cases in the SimBa project

Complete references

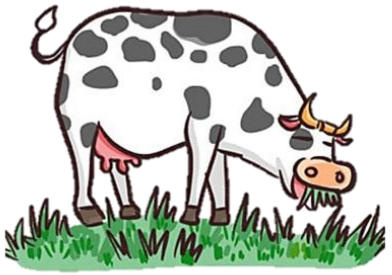
Spectra MIR + Reference

Dry matter intake

No reference values

Spectra MIR +

Grazing probability



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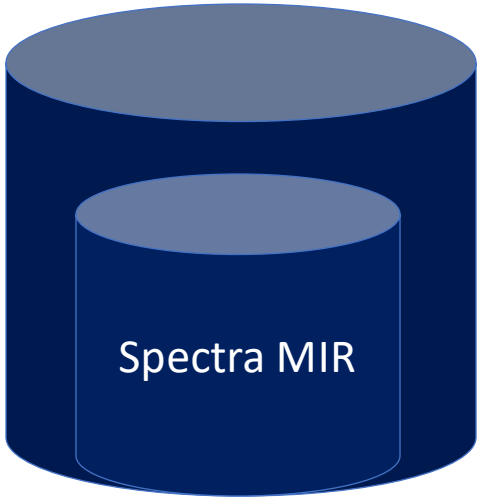
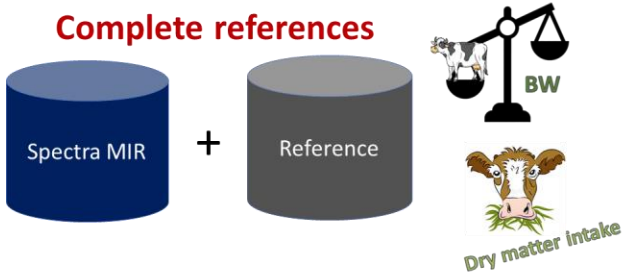


+ Reference

Degree of production intensification

Complete references



Strength

Many different methodologies

Opportunity

Improving existing equations

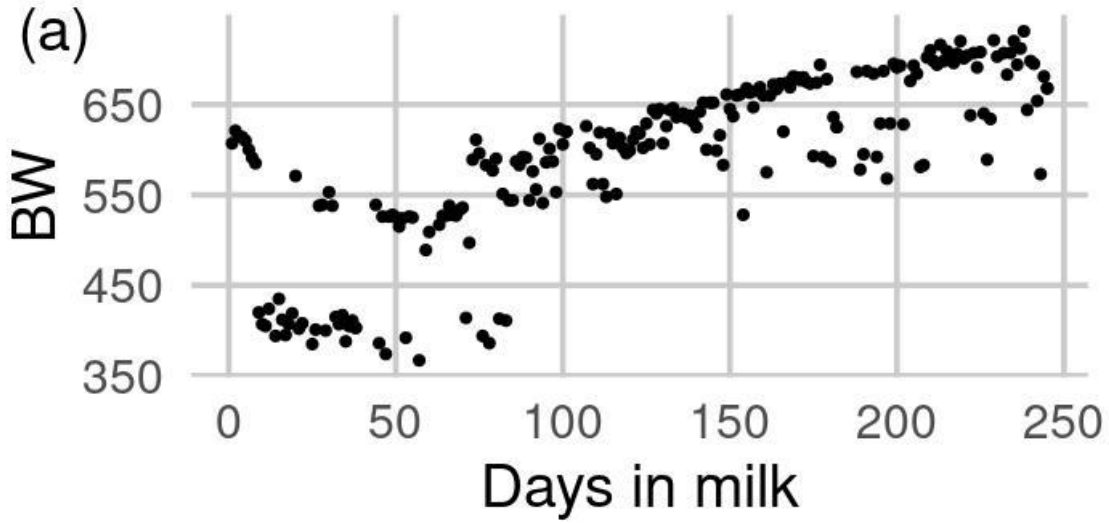
Weakness

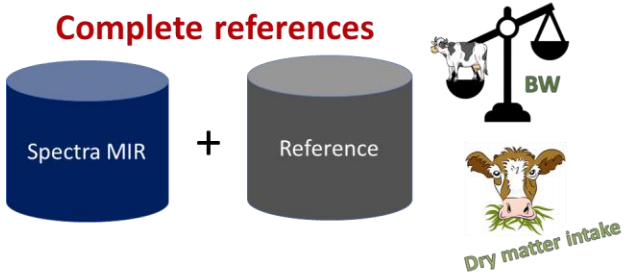
Fiability of reference values

Threat

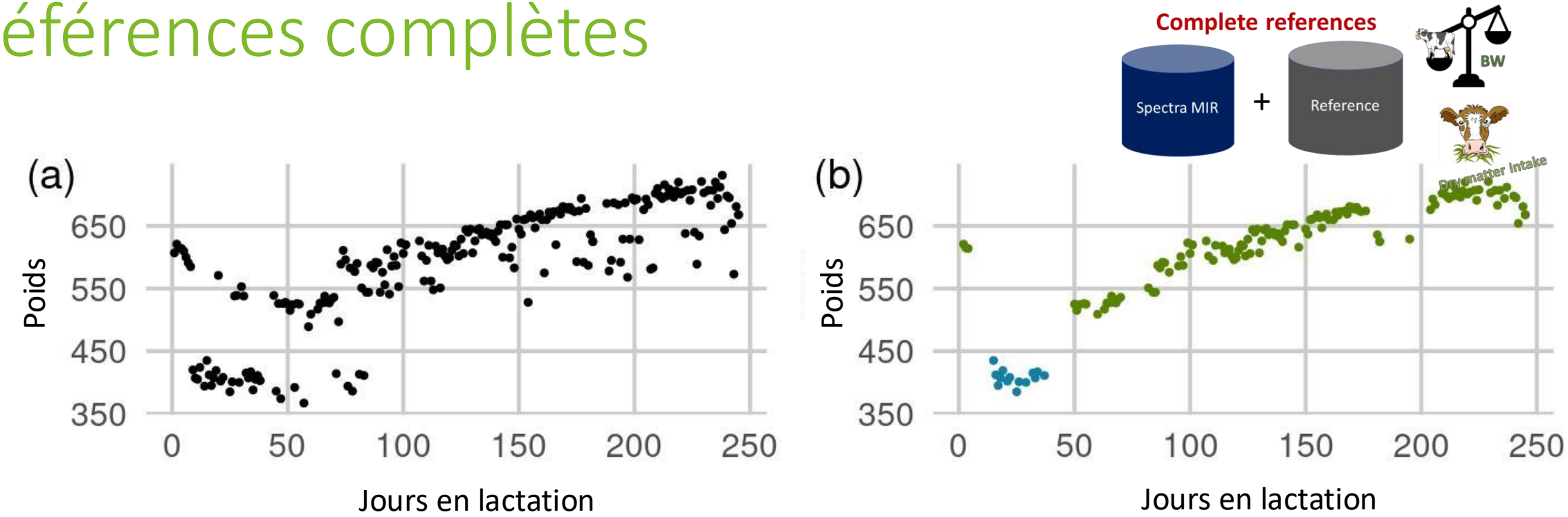
- Lack of explanatory analysis
- Over-confidence

Complete references

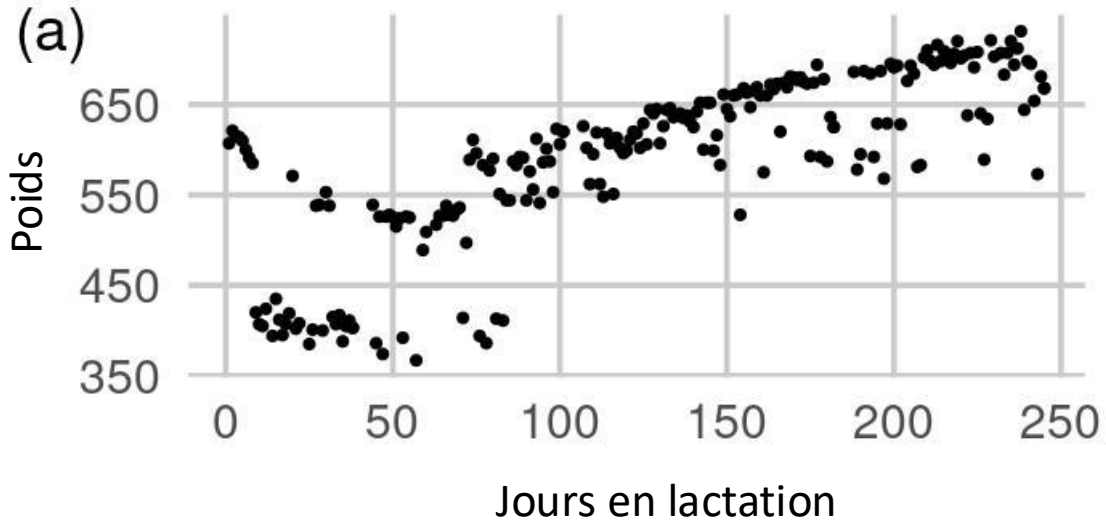


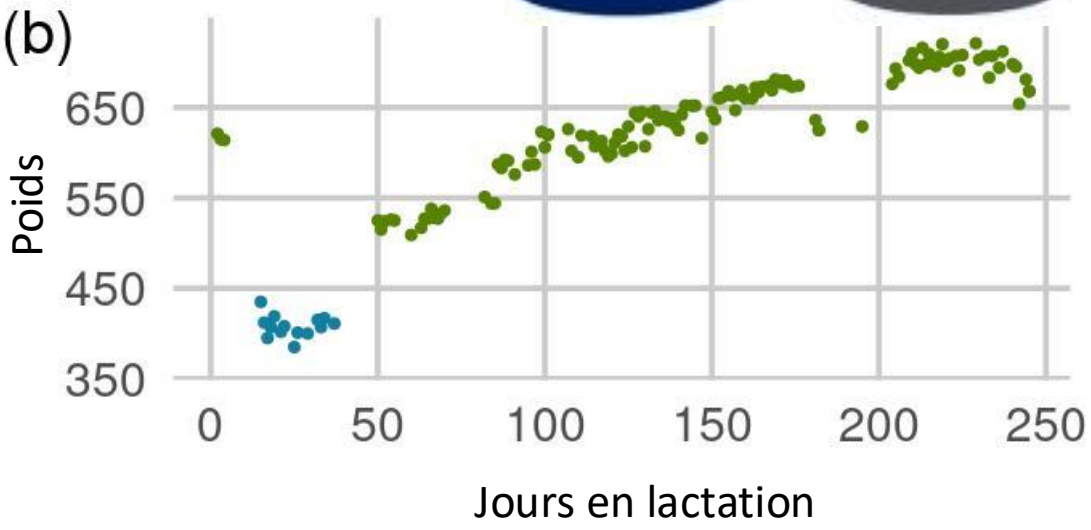


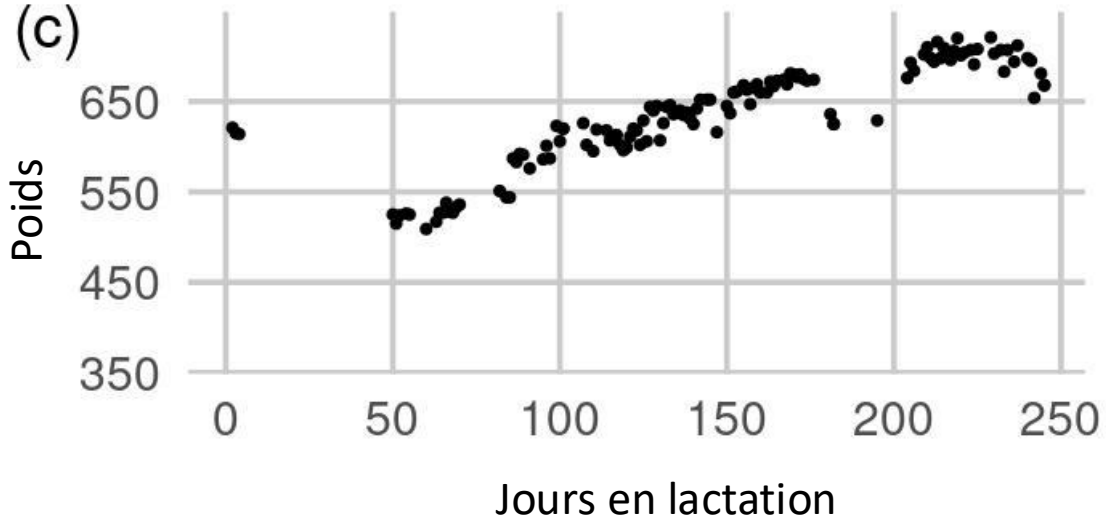
Références complètes



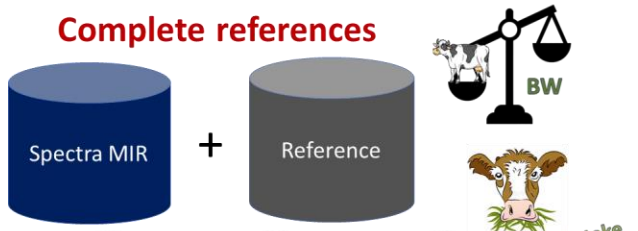
Références complètes

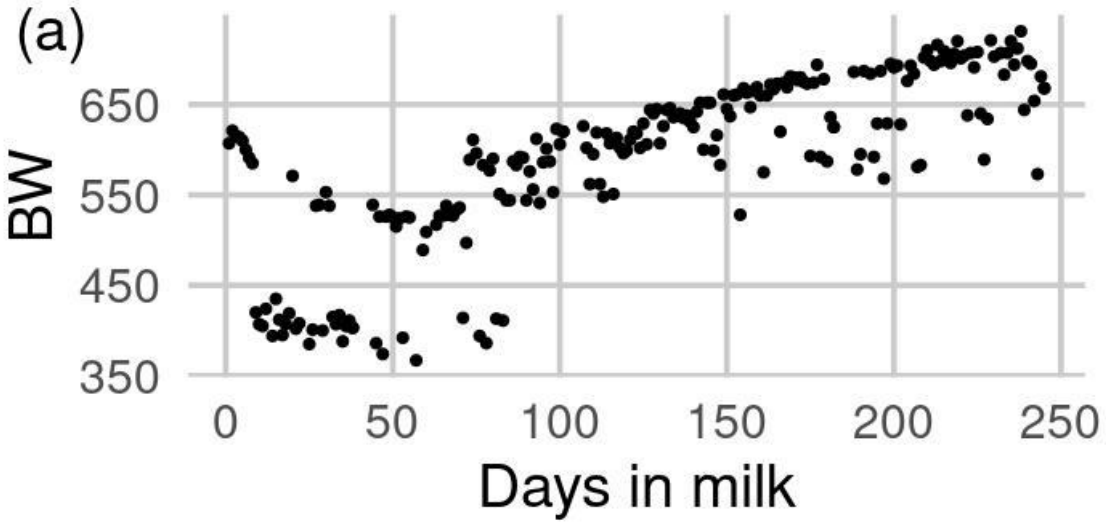


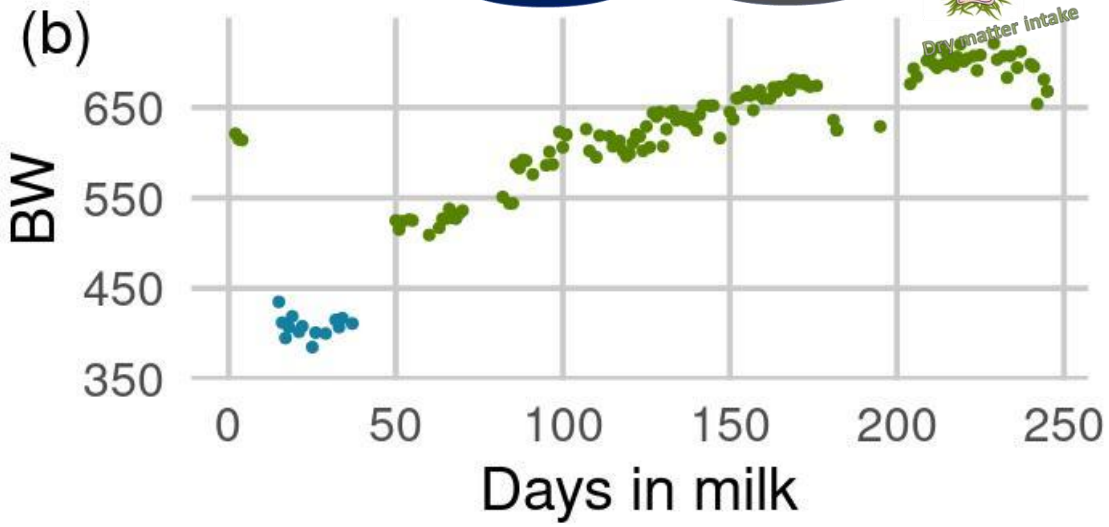


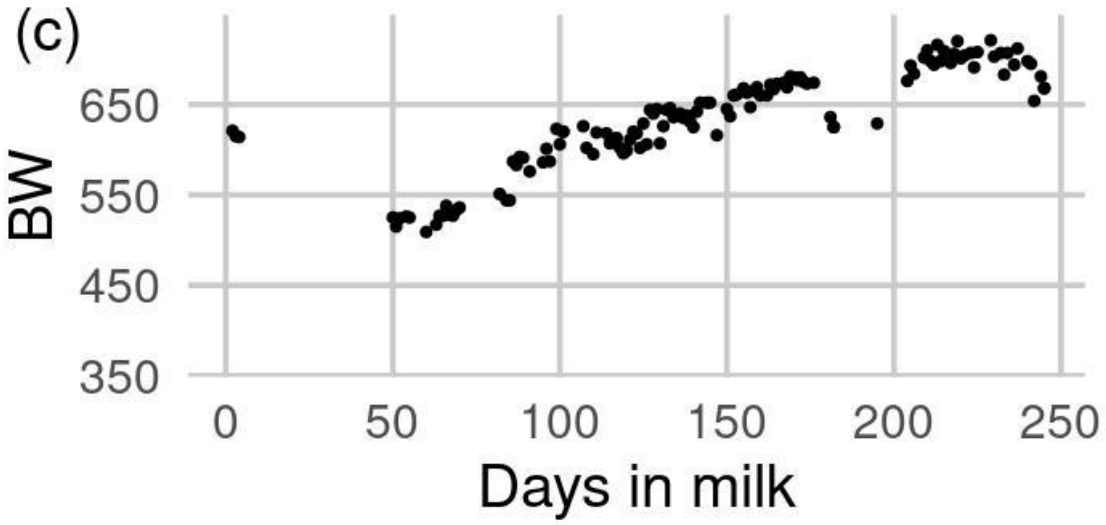


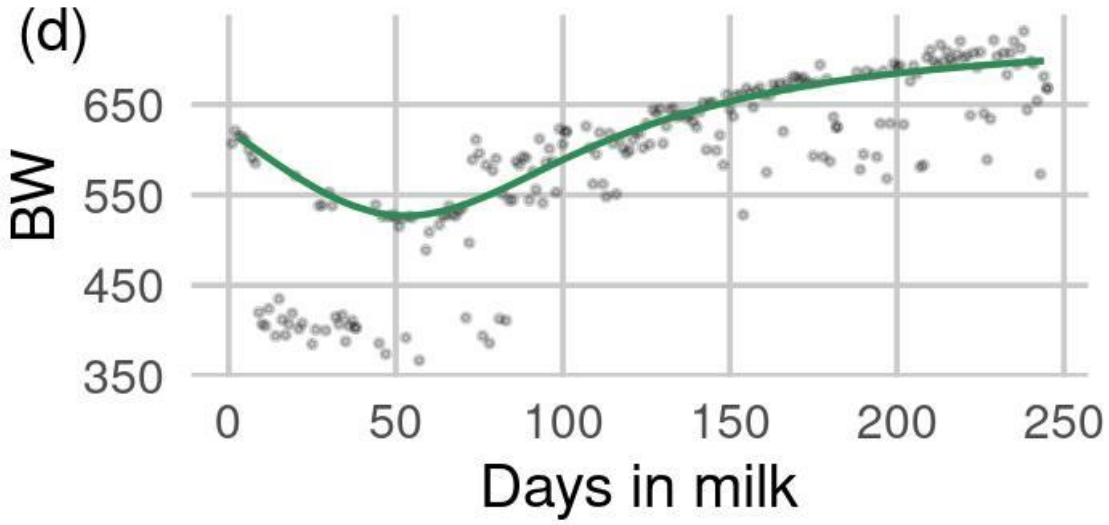
BW is a good example



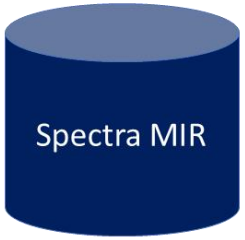








No reference values



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Grazing probability

Spectra MIR

~~Grazing day~~

Grazing probability

Spectra MIR

Fat

Urea

Fatty acids

Casein

β-HydroxyButyrate

Milk yield

Protein

~~Grazing day~~

Test date → Month selection

Lessire et al. (2019)

July

August

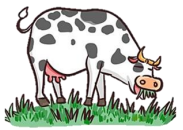
January

February

No reference values

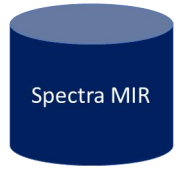
+

Grazing probability



Complete references

No reference values



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Grazing probability

Strength

- Strongly dependent of the studied population
- Need to a data structure

Opportunity

Creation of new phenotypes

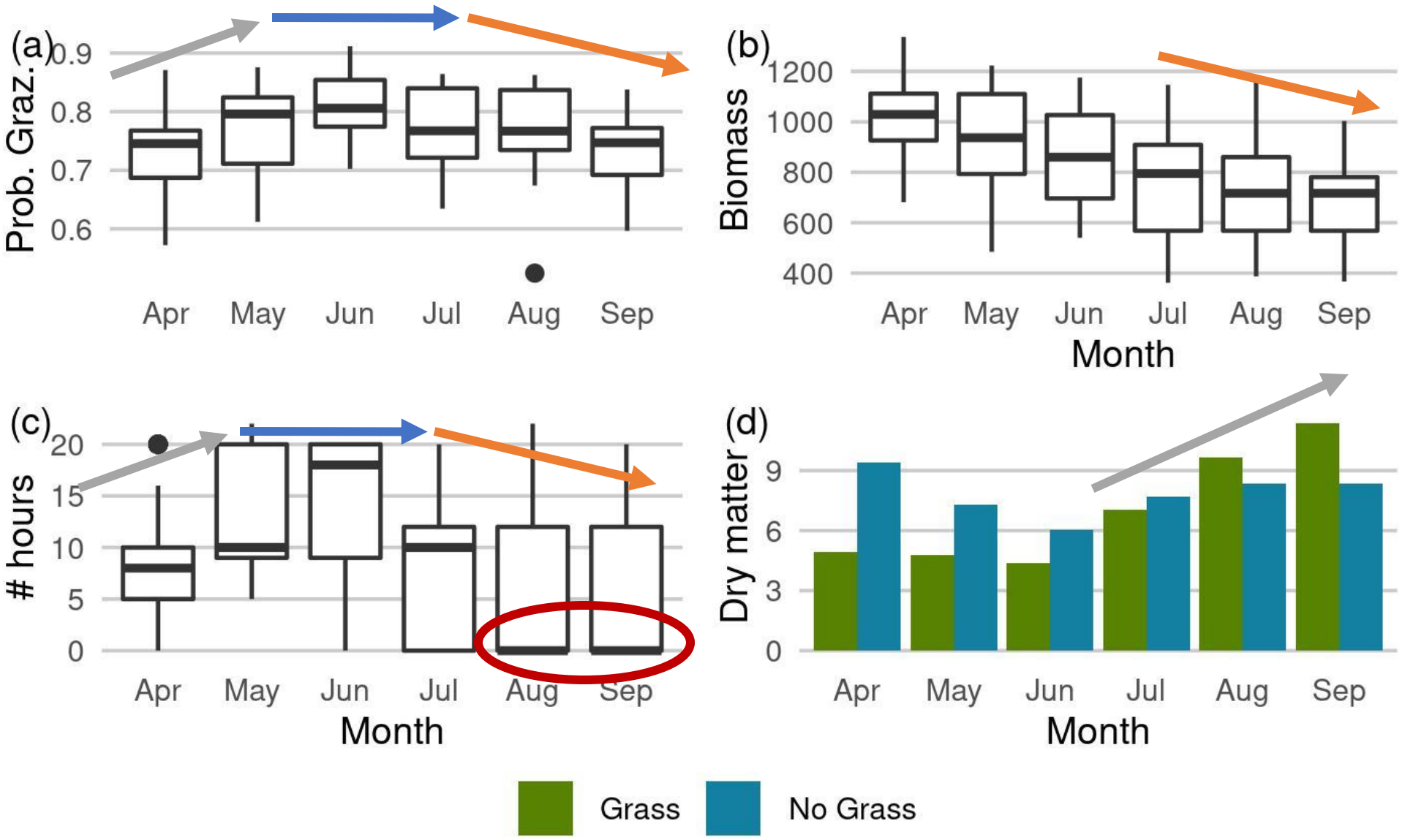
Weakness

- Wrong references
- Bias can be present

Threat

Model having a weak generalisation

A validation is highly needed



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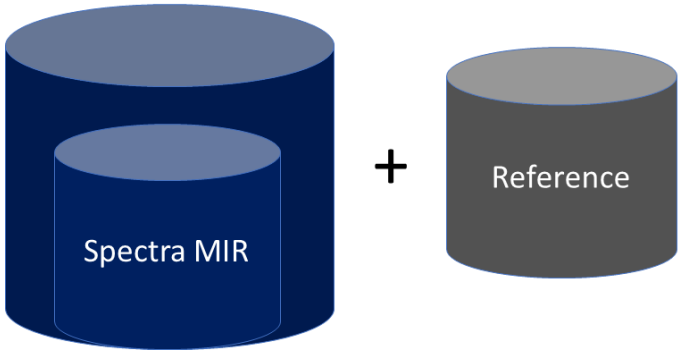
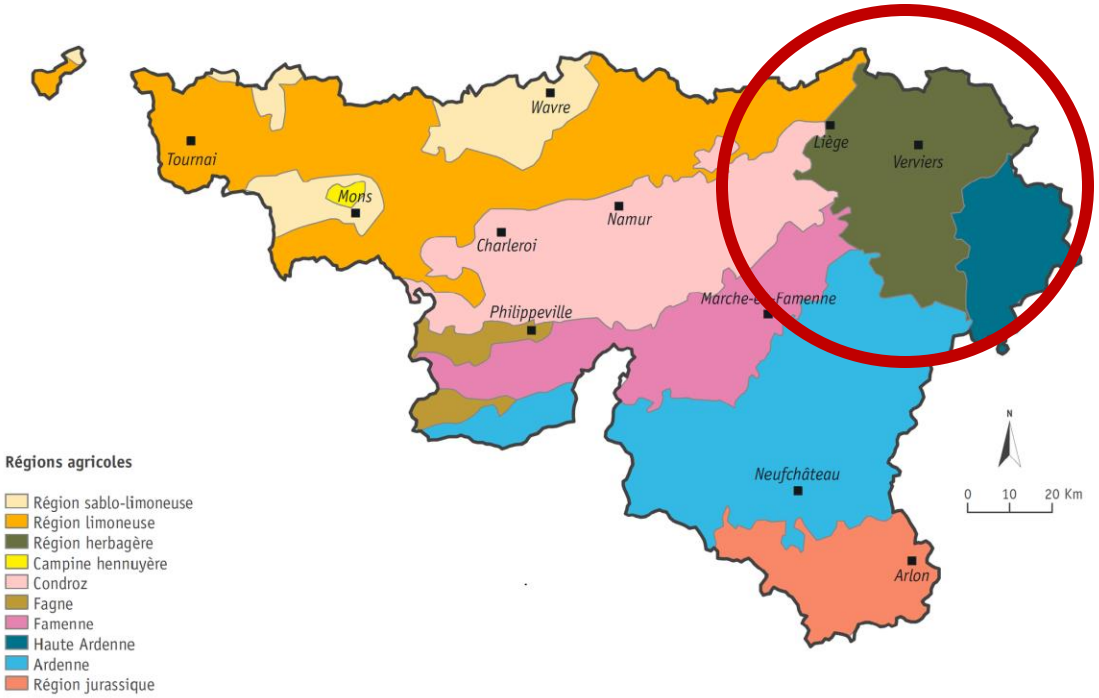


Degree of production intensification



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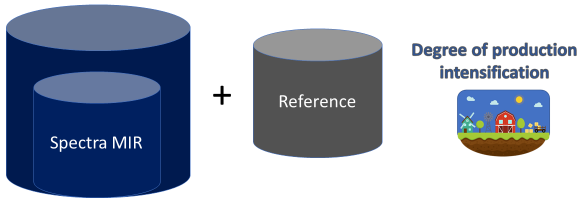
Extensive farm

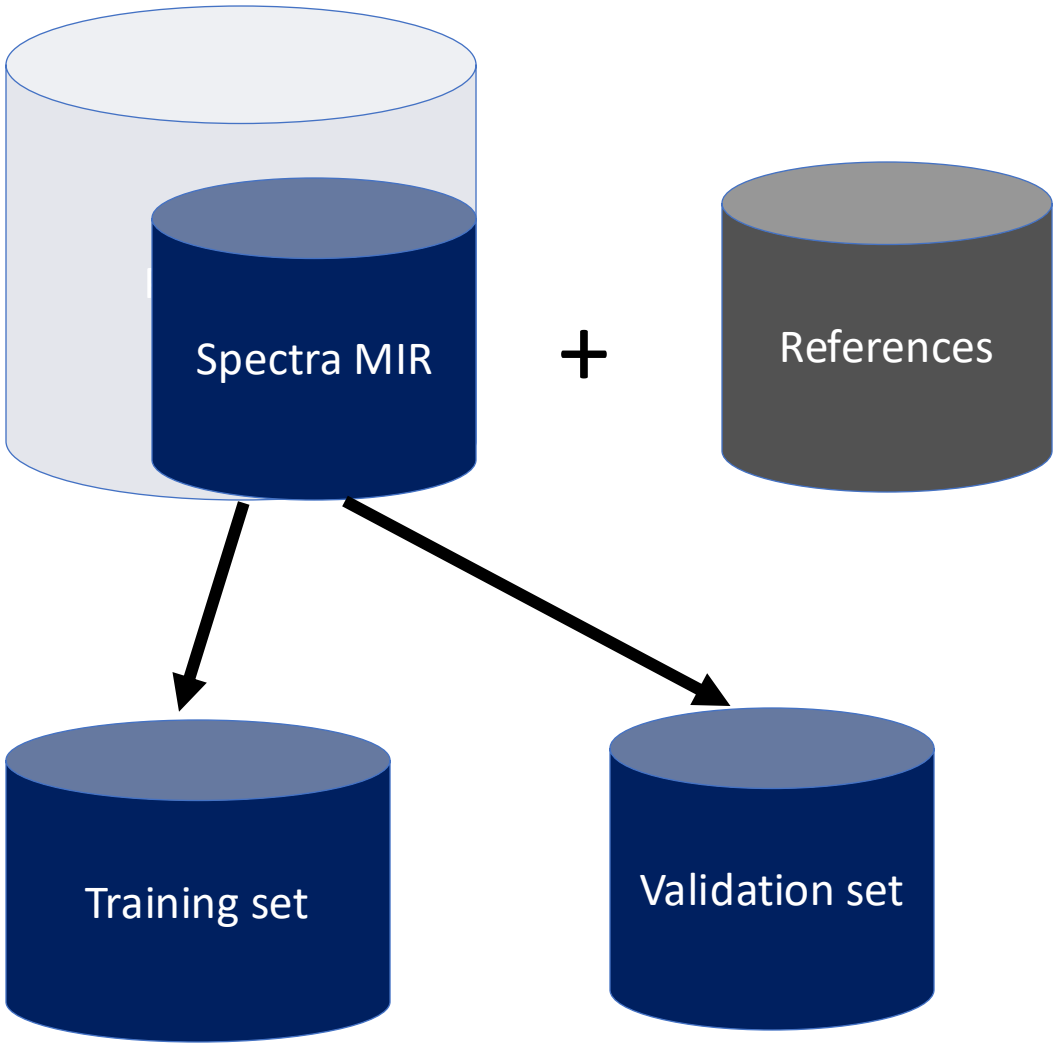
Dalcq *et al.* (2020), PhD thesis

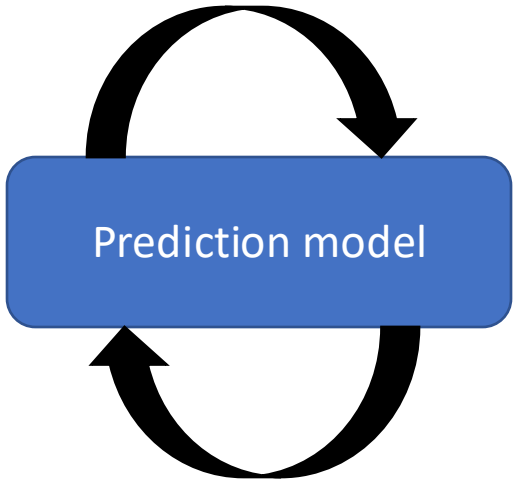
Intensive farm

Prediction of Intensification using economic data

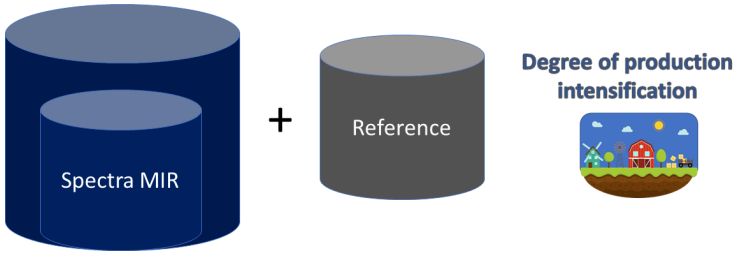
Semi-complete references

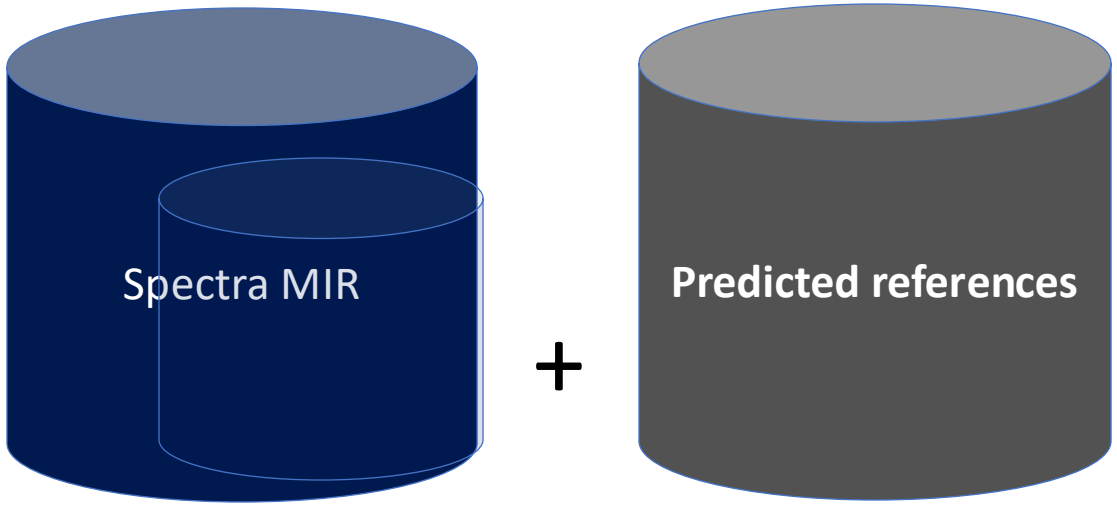


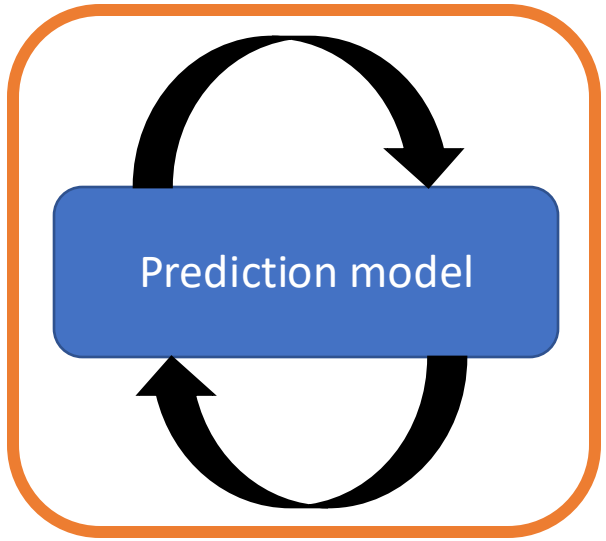


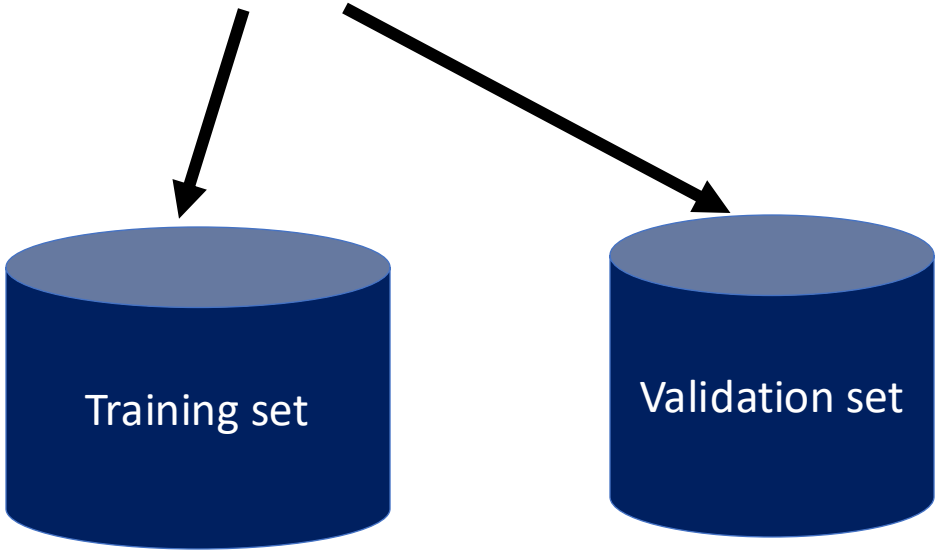


Semi-complete references









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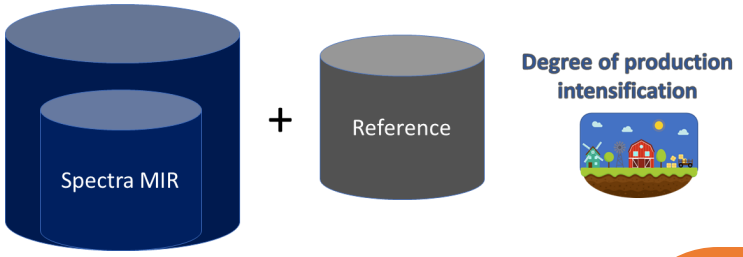
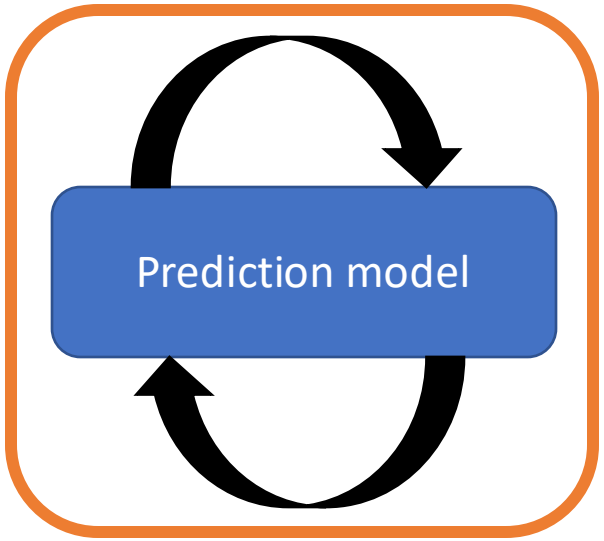
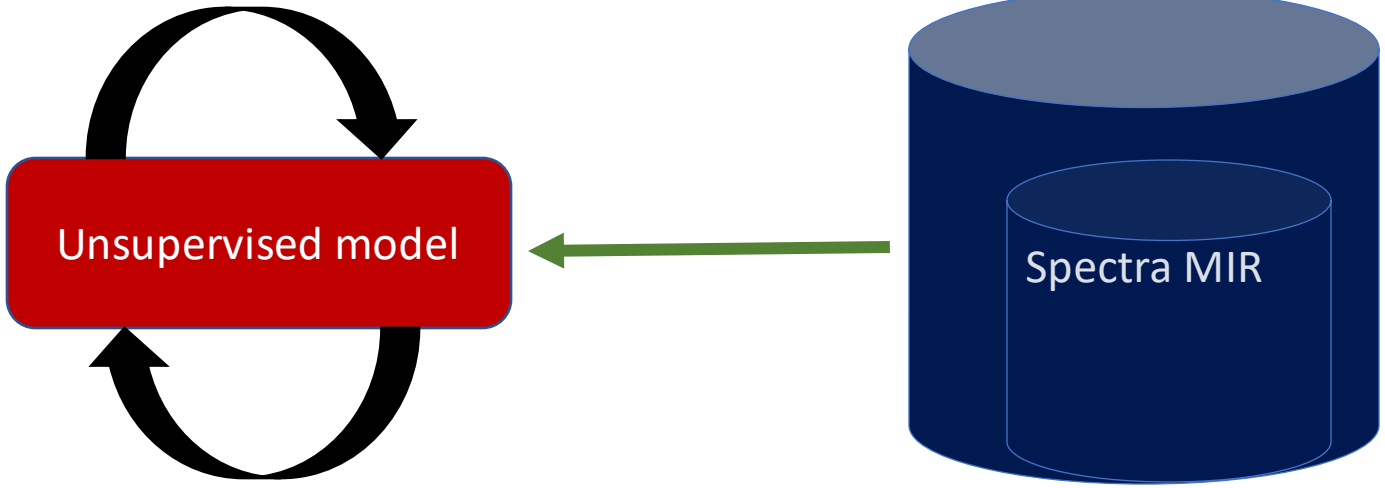




Extraction of knowledge:

C10:0 (Autumn and winter),
C12:0 (Autumn and winter),
C18:2 cis 9 cis 12 (Autumn),
Glucose in blood (Autumn and winter),
K20 (Winter),
Lactalbumin (Winter),
acetone (Winter),
glucose in milk (Winter),
IGF-1 (Autumn and winter),
BHB (Winter),
and **C18:1 trans total** (Summer)



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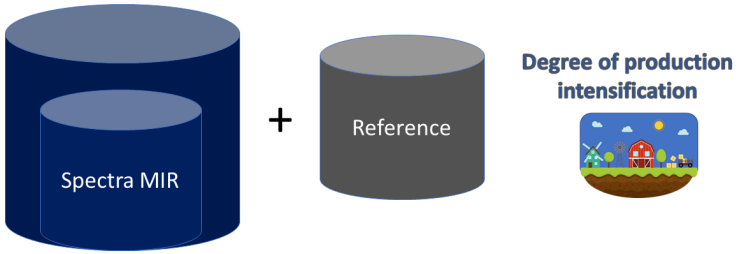

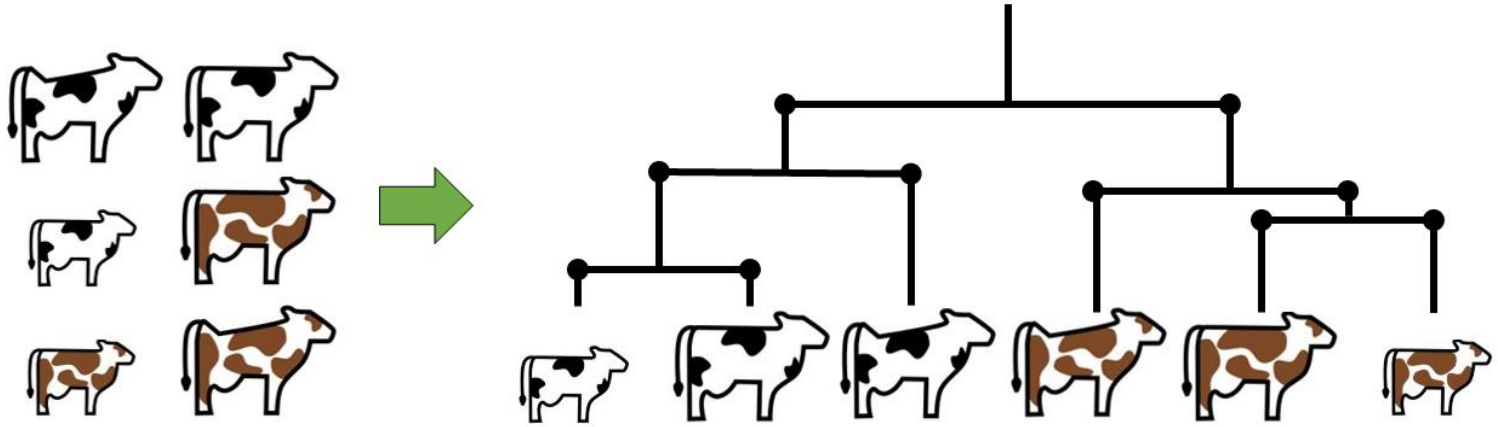

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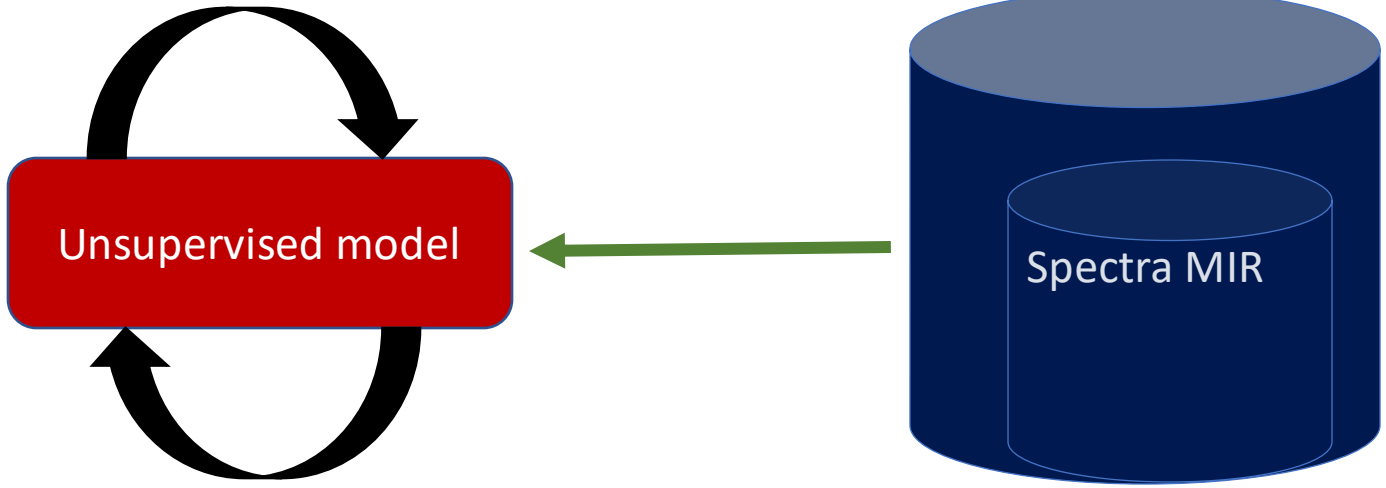

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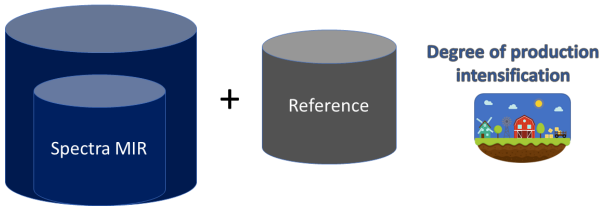
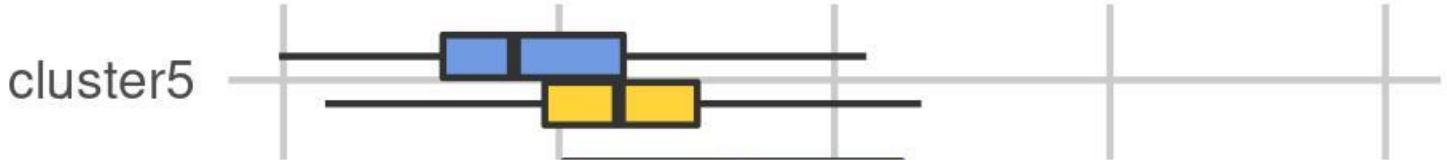
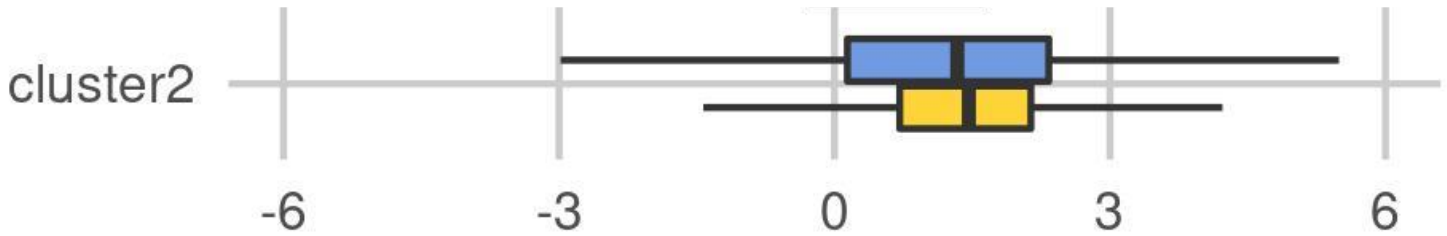
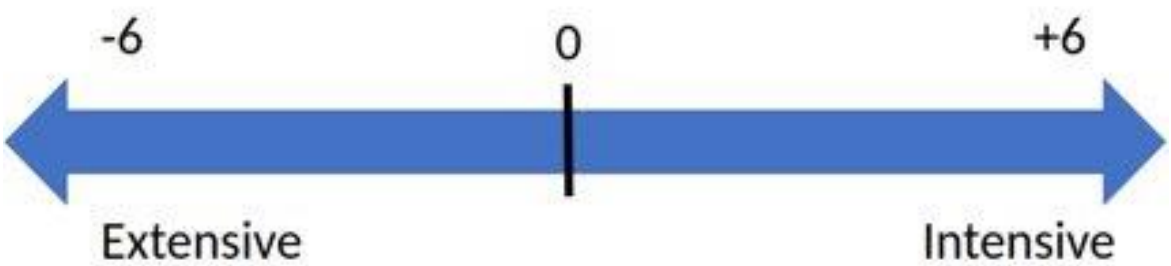






Prediction from large DB

Prediction from small DB



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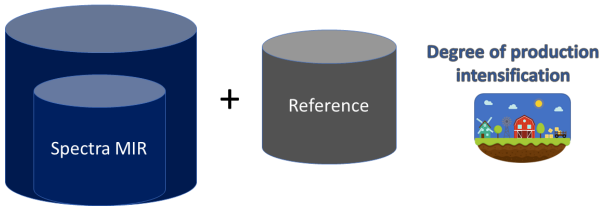
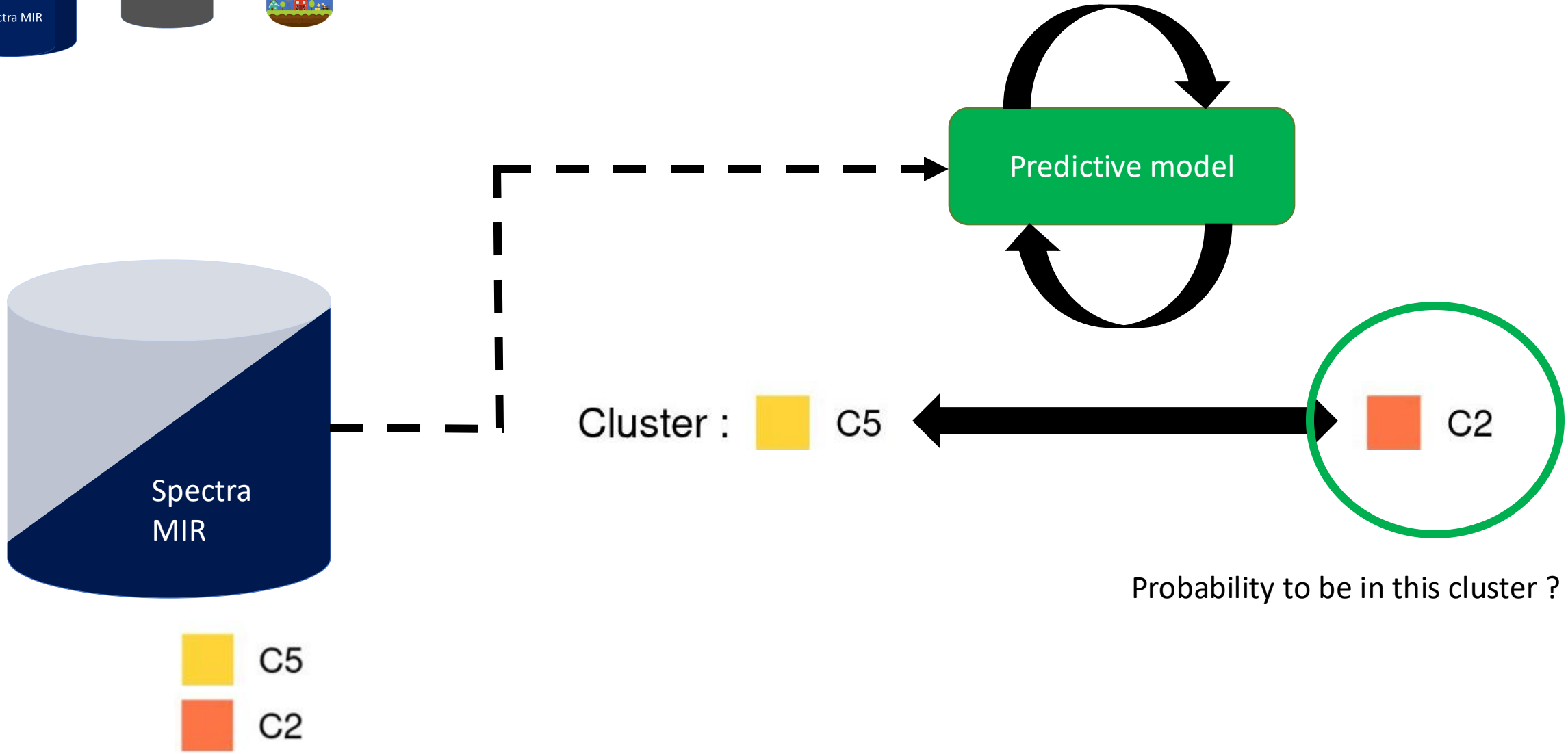
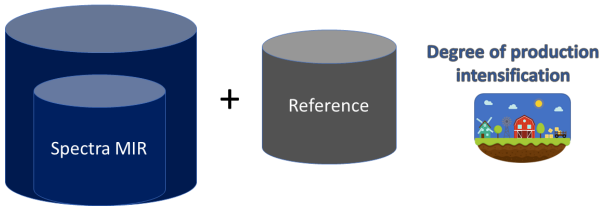




Semi-complete references



Strength

A limited reference database exists

Opportunity

Extraction of knowledge (features) from the limited database

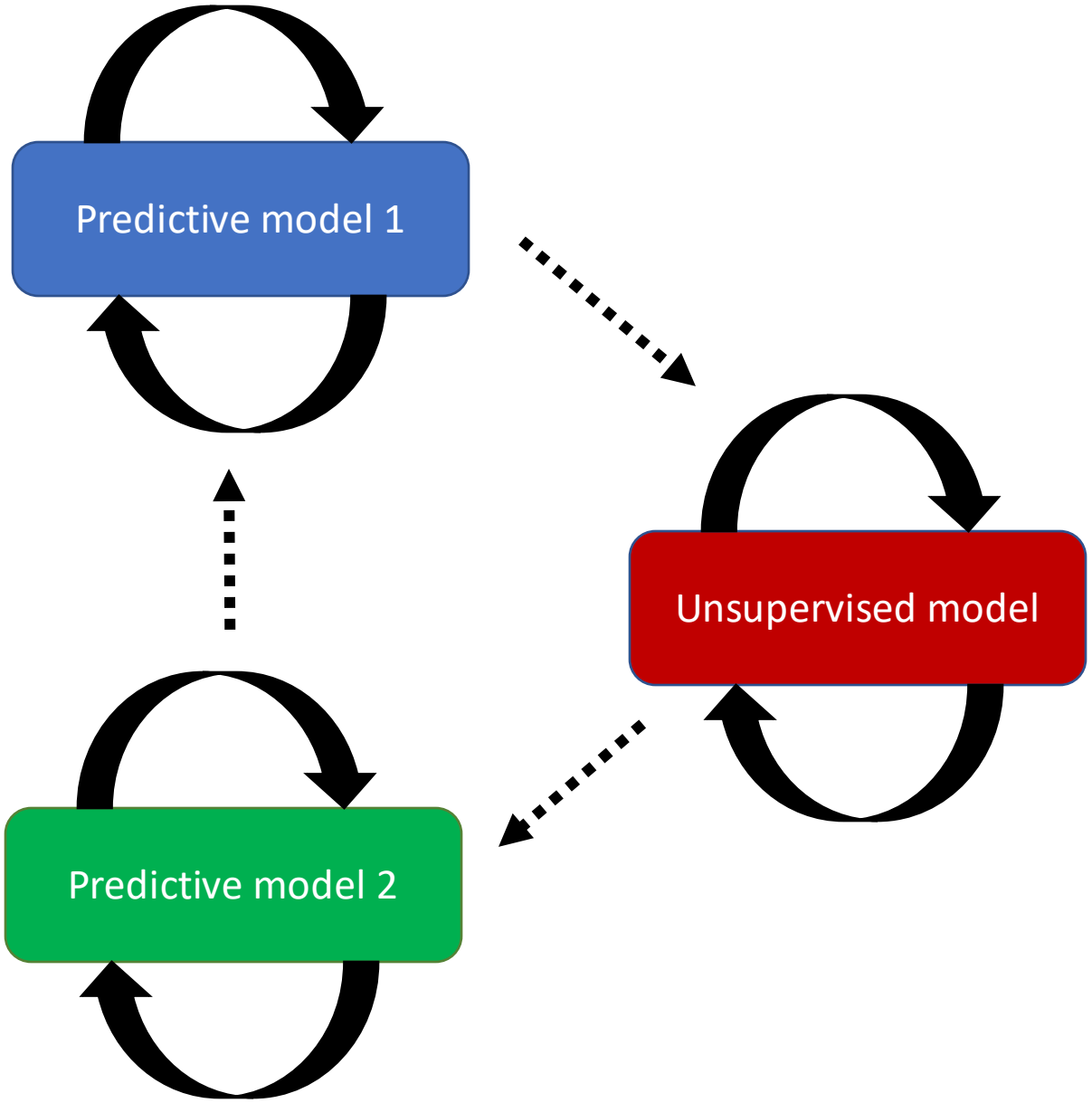
Weakness

Potential under-representation of records

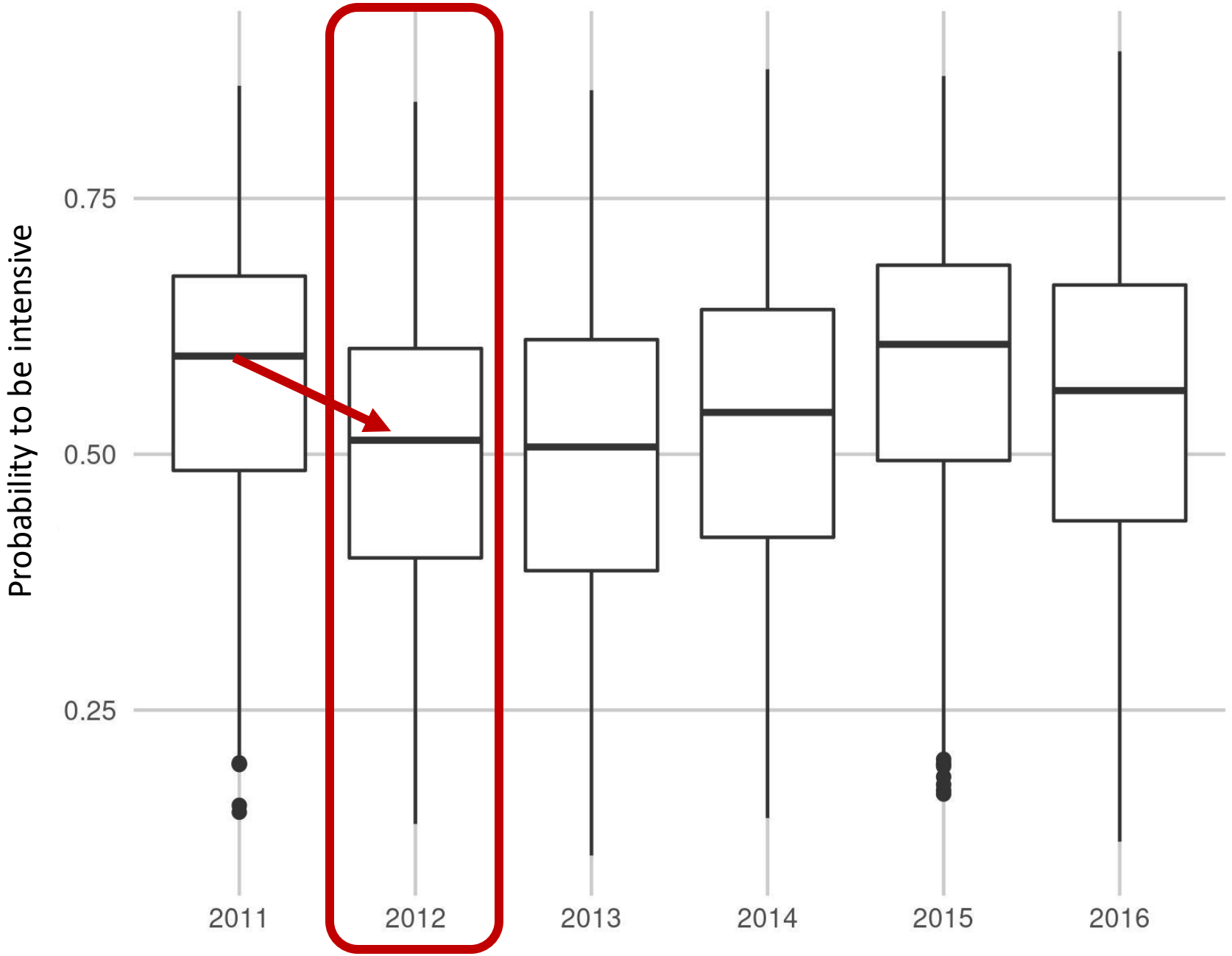
Threat

Potential circular validation

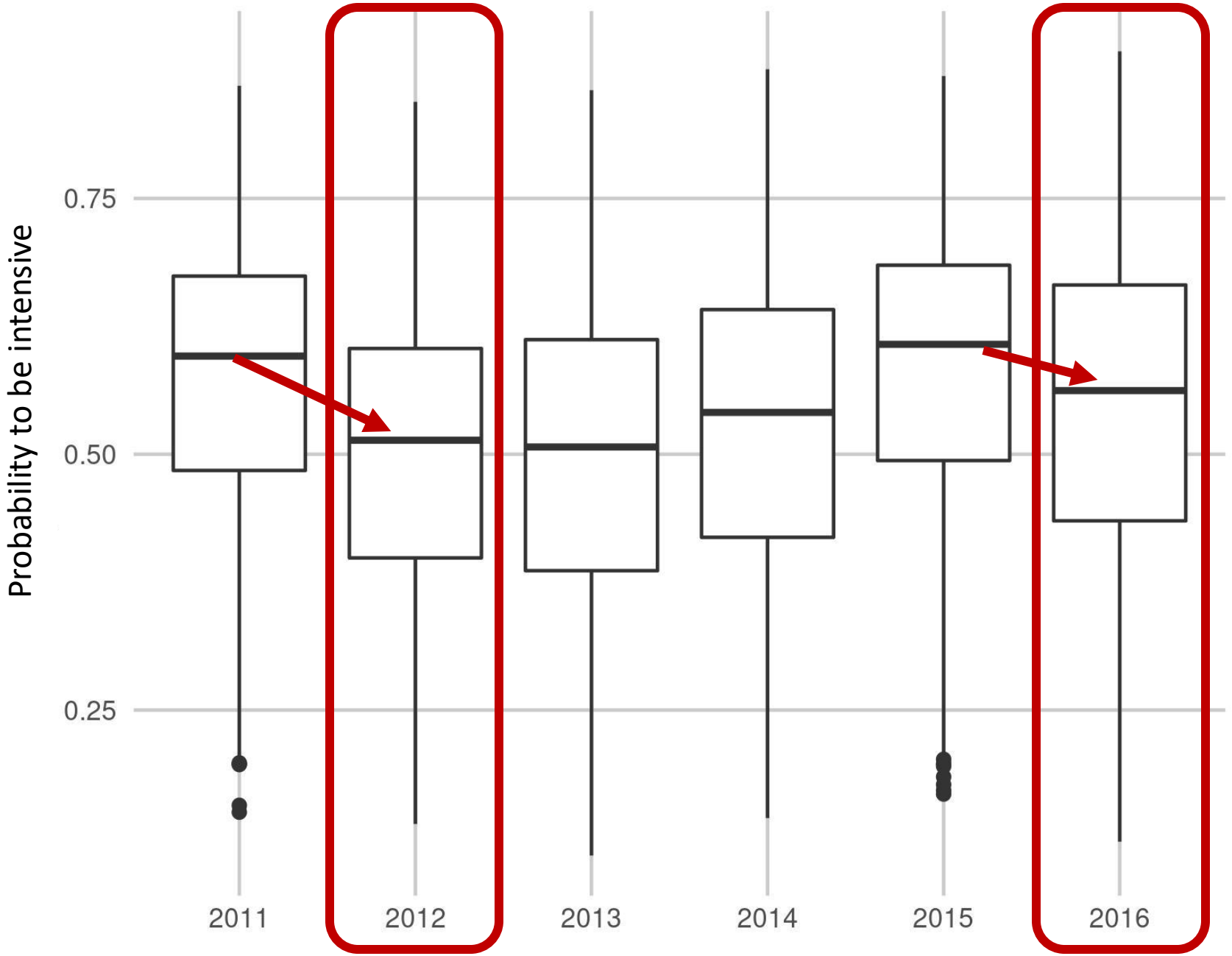
Circular validation



External validation based on historical events

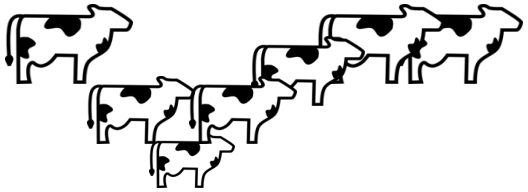

Probability to be intensive
0.75
0.50
0.25
2011
2012
2013
2014
2015
2016

- Crisis ?


Probability to be intensive
0.75
0.50
0.25
2011
2012
2013
2014
2015
2016

- Crisis ?

Concrete applications of the developed model

	Reference value	From existing equations	Can be used on field ?	Can be used in simulation studies?
			50 kg	
			Yes if more records	
			5 kg	
Grazing probability 			+/- 90%	
Degree of production intensification 			+/- 90%	

Thank you !


fnrs
LA LIBERTÉ DE CHERCHER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recherche
CRA-W


LA TROBE
UNIVERSITY

LIÈGE université
Gembloux
Agro-Bio Tech

Prof. Hélène Soyeurt
Dr. Anthony Tedde

Predictions of dairy related phenotypes using milk mid infrared spectral data

hsoyeurt@uliege.be

SimBa workshop – 12 May 2023