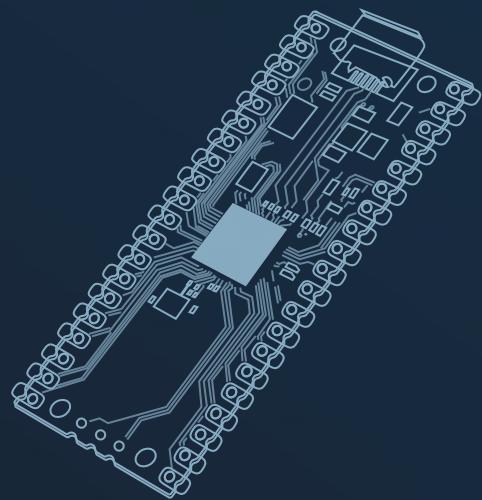
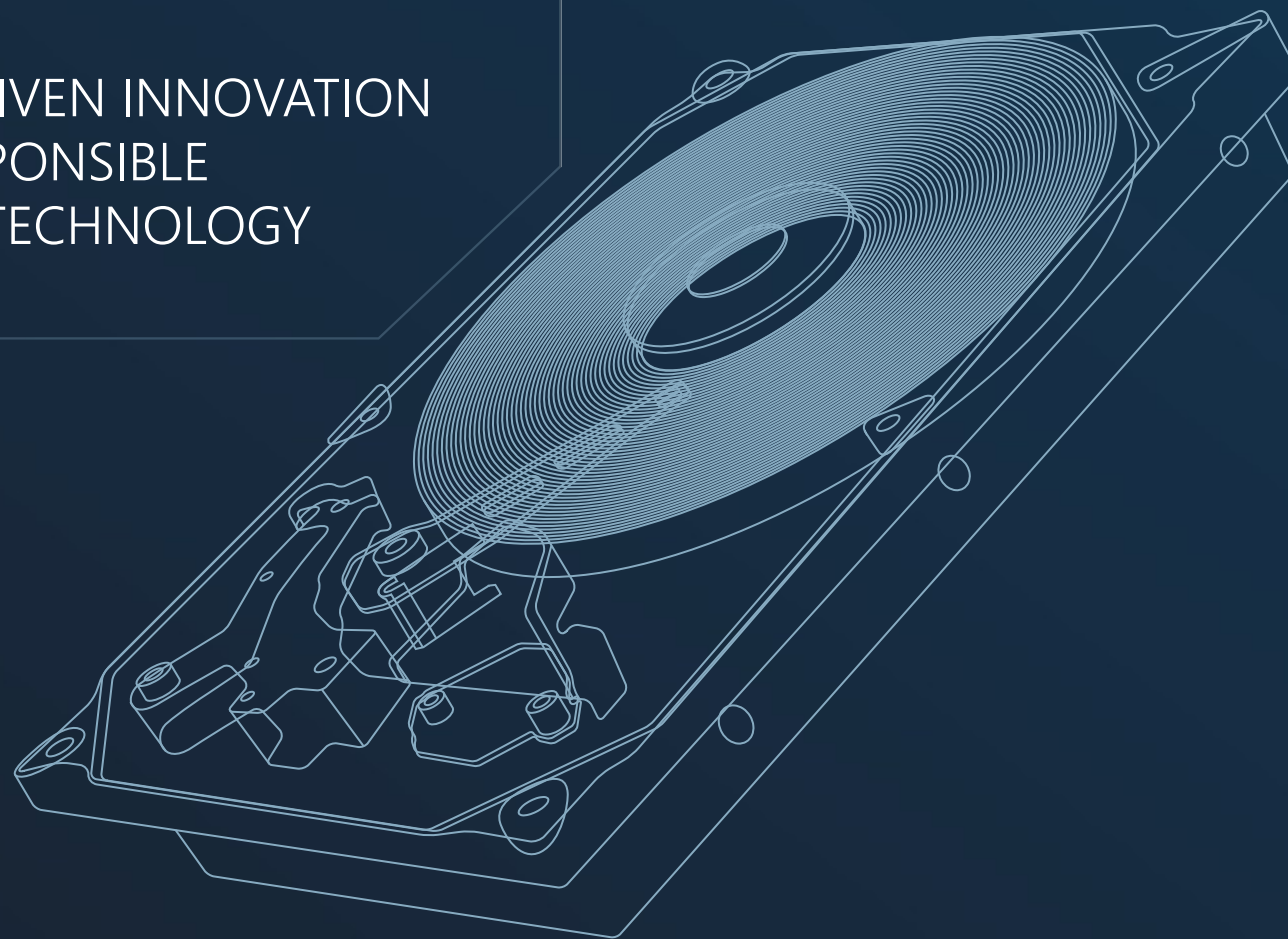
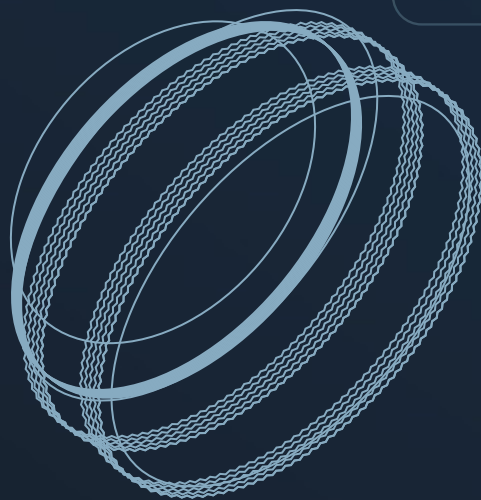
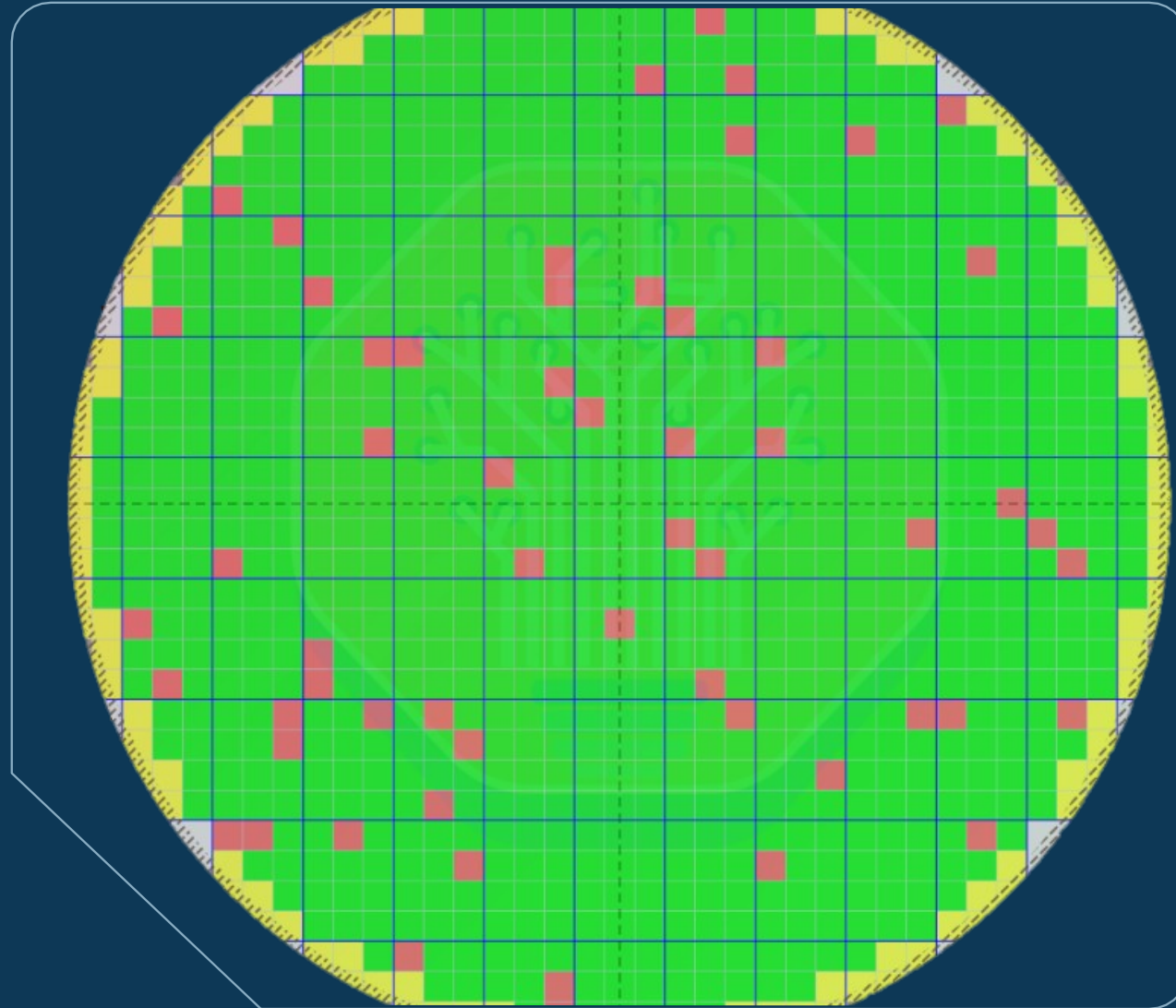




DATA-DRIVEN INNOVATION
FOR RESPONSIBLE
DIGITAL TECHNOLOGY



UNCERTAINTIES IN LCA – SPECIFICITIES FOR THE DIGITAL COMPONENTS



UNCERTAINTIES IN LCA – SPECIFICITIES FOR THE DIGITAL COMPONENTS



Uncertainties are a well-documented topic in LCA. From the sensitivity analyses to the Monte-Carlo analyses, many methods aim at controlling, reducing or managing uncertainties.

However, the digital sector leads to specific issues regarding data quality and availabilities. This presentation introduces those issues, their impacts on result variations, and the approaches used to reduce them.

1. What are uncertainties in LCA?
2. Application to the digital sector – What specificities?
3. How to deal with them?

1. WHAT ARE UNCERTAINTIES IN LCA?

Takeaway message:

- No standard definition of uncertainty
- What matters is to be able to draw a conclusion

Definition of uncertainties



Merriam-Webster

No definition in the LCA standards

"The quality or state of being uncertain"
Uncertain: "not known beyond doubt, not constant, not certain to occur, not reliable"

In LCA context

→ Variability of LCA results due to the cumulated effects of the assessment imprecision, the input uncertainty and data variability

This result variability can lead to doubts on LCA conclusions

→ It must be determined, managed and reduced

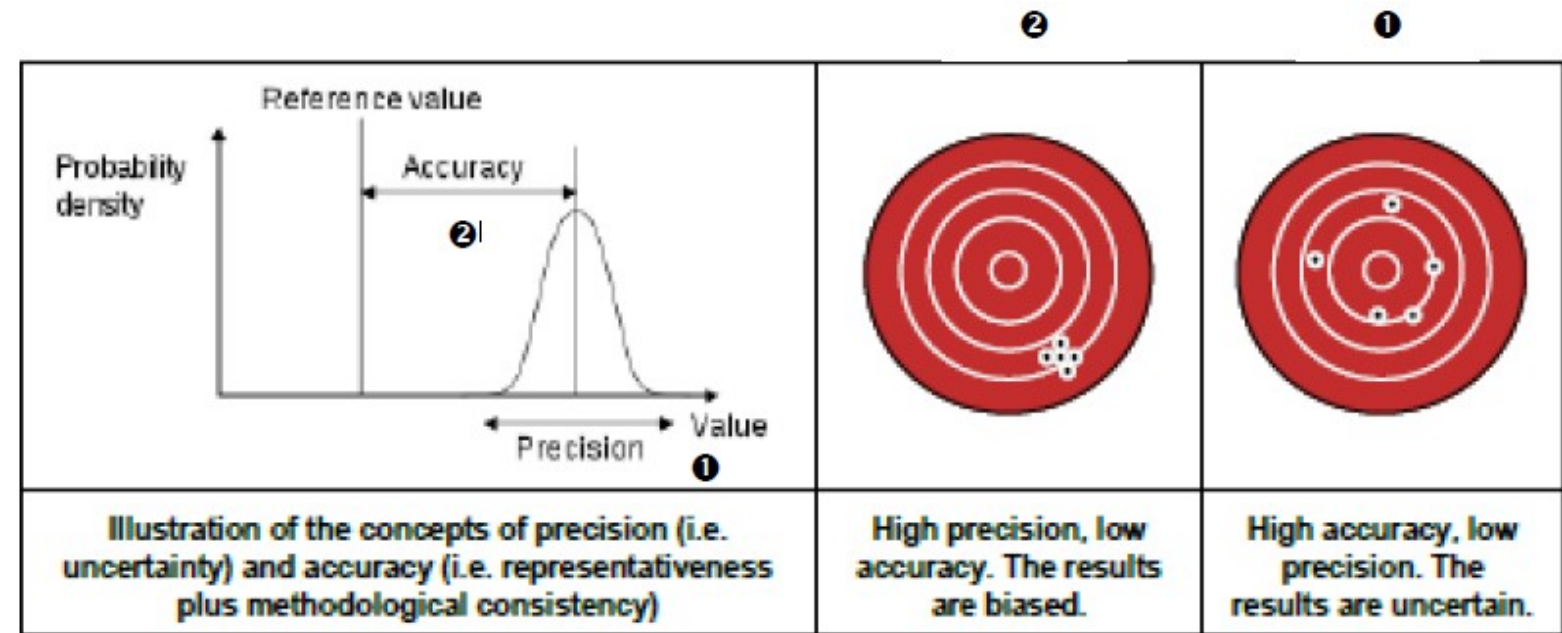
→ Within physics, there are uncertainties! LCA must reflect that fact

1. WHAT ARE UNCERTAINTIES IN LCA?

Takeaway message:

- A good precision can lead to a false sense of truth
- « It is better to be roughly right than precisely wrong »

Precision vs accuracy



Source : ILCD Handbook, General Guide for Life Cycle Assessment
– Detailed guidance, figure 28 p 326

There often is confusion between precision and accuracy

1. WHAT ARE UNCERTAINTIES IN LCA?

Types of data

2 types of data

Collection data / activity data

Related to the physical assessment of the system under study
→ It is a number and/or a type of material / component / substance

Inventory data

Related to the adequation between the collection data and environmental data set / databases

Takeaway message:

- Uncertainty can come from collection and inventory data

1. WHAT ARE UNCERTAINTIES IN LCA?

Takeaway message:

- Primary data are preferred, but more complex to have
- Primary data can be uncertain too, and secondary data can sometimes be more accurate

Types of data

Primary / specific data

Directly extracted from the system studied (mass, volume, quantity, nature of materials, flows, etc.)

Secondary / generic data

Gathered from literature, methodological rules, product category rules, databases, etc.

1. WHAT ARE UNCERTAINTIES IN LCA?

Takeaway message:

- Dealing with data quality is a way to limit the uncertainty
- But it is not enough

Data quality

The link between uncertainties and data quality is strong

The quality of data influences the variation between real impacts and their determination with LCA. This variation is an uncertainty

But the uncertainty also comes from other sources (impact indicators notably).

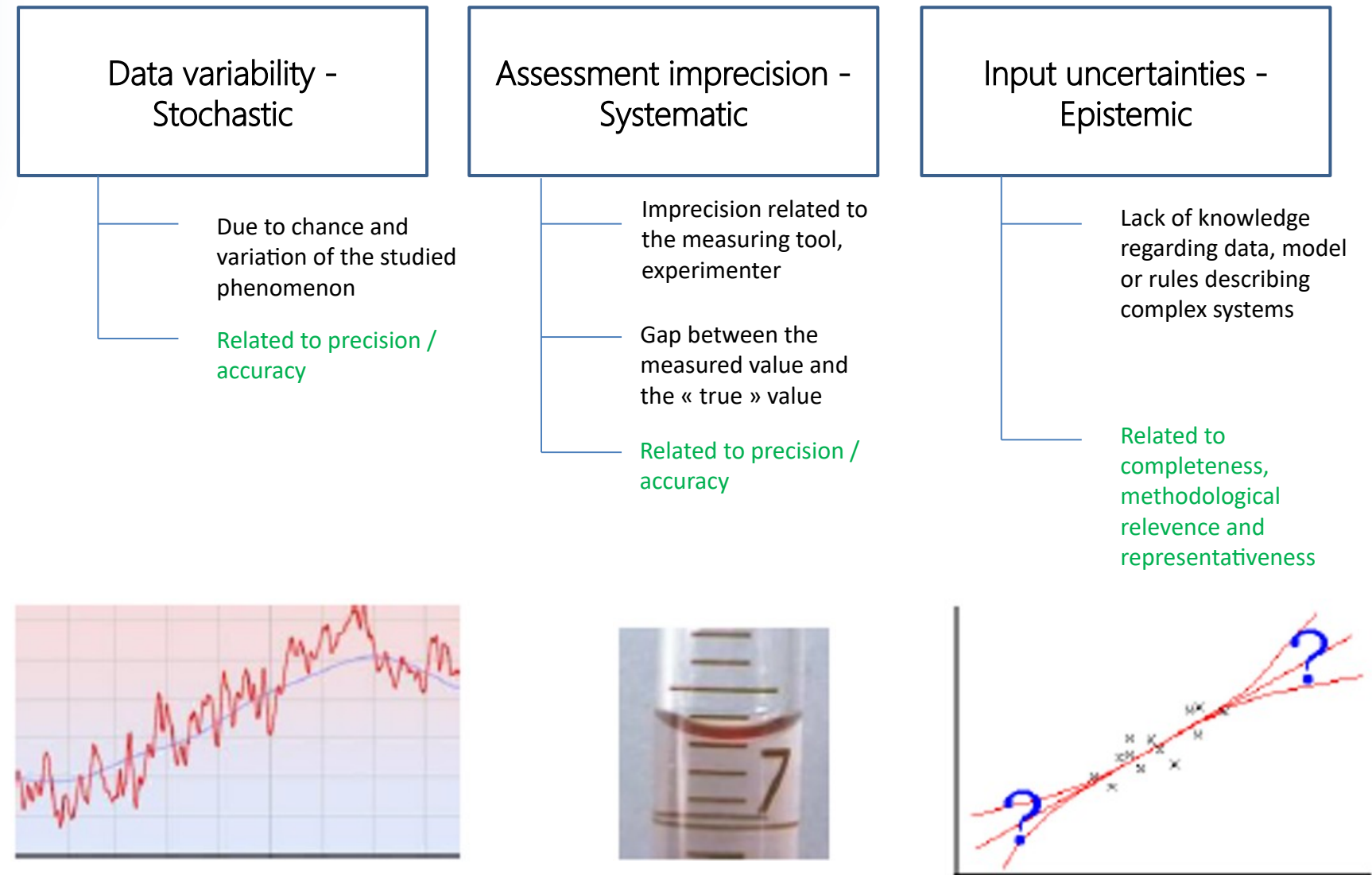
Controlling the quality means reducing the uncertainties, and evaluating the quality is partially knowing the uncertainties.

1. WHAT ARE UNCERTAINTIES IN LCA?

Takeaway message:

- There are multiple types of uncertainty, all must be considered

Types of uncertainties

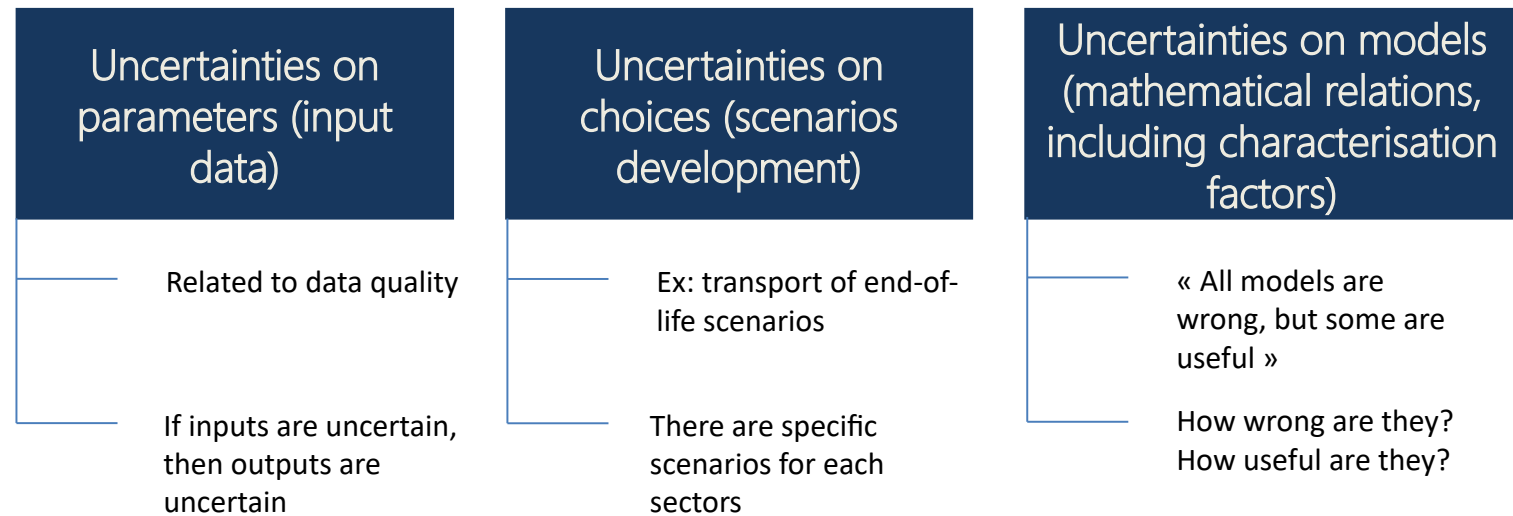


1. WHAT ARE UNCERTAINTIES IN LCA?

Sources of uncertainties

Takeaway message:

- There are multiple sources of uncertainty, all must be considered
- But only uncertainties on parameters are generally covered

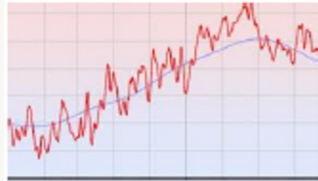
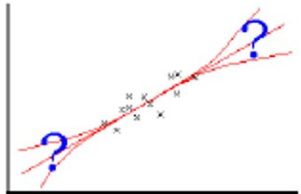


2. APPLICATION TO THE DIGITAL SECTOR

Takeaway message:

- There are specificities for the digital sector

Type and sources of uncertainties applied to the digital sector

Application to the digital sector – creation of an RAM chip		Types of uncertainties		
Sources of uncertainties	Uncertainties on parameters (input data)	Data variability – Stochastic 	Assessment imprecision – Systematic 	Input uncertainties – Epistemic 
	Uncertainties on choices (scenarios development)	Different models of RAM can have different materials	Measure of the amount of materials within the component	Some materials are not detected by the material analysis
	Uncertainties on models	Choice of the average production country	Choice of purity of materials within the component	Choice of the wafer yield model (Murphy, Poisson...)
		Allocation of impacts to the revenue of chips - Variation of RAM prices over time	Allocation of impacts to the surface of chip – surface measurement uncertainty	Allocation of impacts to the surface of chip – surface deduced with the memory density

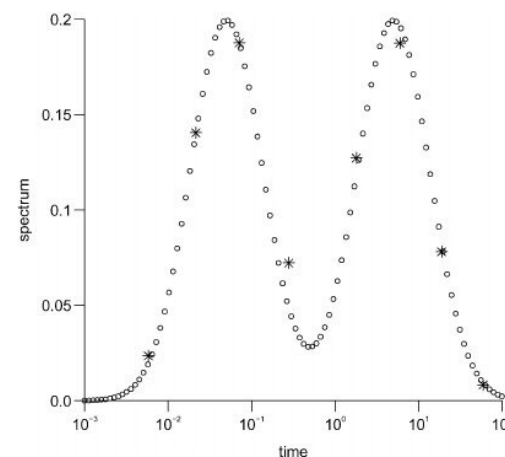
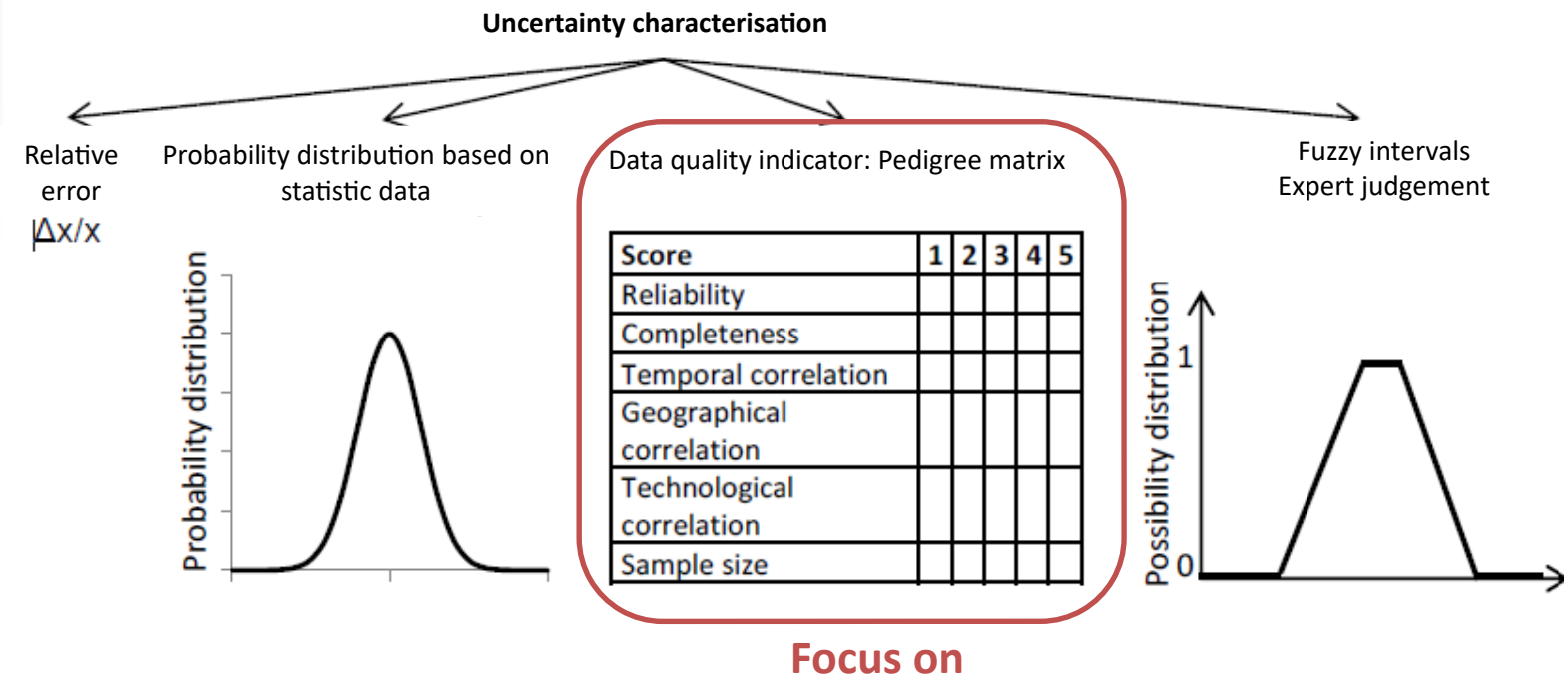
3. HOW TO DEAL WITH THEM?



Takeaway message:

- Many methods exist, depending on the need, the resources and the availability of information
- None is perfect

Uncertainty characterisation



Sometimes the probability distribution is more complex

3. HOW TO DEAL WITH THEM?



Takeaway message:

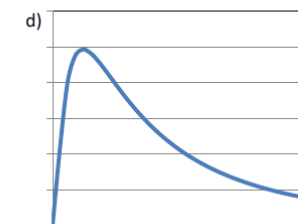
- The tools are there, but their application for the digital sector is lacking

Data quality

Score	Reliability	Completeness	Temporal correlation	Geographical correlation	Further technological correlation
1 (Highest quality)	Verified data based on measurements	Representative data from all sites relevant for the market considered, over an adequate period to even out normal fluctuations	Less than 3 years of difference to the time period of the dataset	Data from area under study (i.e., UK for this study)	Data from enterprises, processes and materials under study
2	Verified data partly based on assumptions or non-verified data based on measurements	Representative data from > 50% of the sites relevant for the market considered, over an adequate period to even out normal fluctuations	Less than 6 years of difference to the time period of the data set	Average data from larger area in which the area under study is included (i.e., Europe or global for this study)	Data from processes and materials under study (i.e., identical technology) but from different enterprises
3	Non-verified data partly based on qualified estimates	Representative data from only some sites (< 50%) relevant for the market considered or > 50% of sites but from shorter periods	Less than 10 years of difference to the time period of the data set	Data from area with similar production conditions (i.e., Switzerland and USA for this study)	Data from processes and materials under study but from different technology
4	Qualified estimate (e.g. by industrial expert)	Representative data from only one site relevant for the market considered or some sites but from shorter periods	Less than 15 years of difference to the time period of the data set	Data from area with slightly similar production conditions	Data on related processes or materials
5 (Lowest quality)	Non-qualified estimates	Representativeness unknown or data from a small number of sites and from shorter periods	Age of data unknown or more than 15 years of difference to the time period of the data set	Data from unknown or distinctly different area (North America instead of Middle East, OECD-Europe instead of Russia)	Data on related processes on laboratory scale or from different technology

Indicator score	1	2	3	4	5
Reliability	0.000	0.0006	0.002	0.008	0.04
Completeness	0.000	0.0001	0.0006	0.002	0.008
Temporal correlation	0.000	0.0002	0.002	0.008	0.04
Geographical correlation	0.000	2.5e-5	0.0001	0.0006	0.002
Further technological correlation	0.000	0.0006	0.008	0.04	0.12

$$SD_g = \exp \sqrt{[\ln(U_1)]^2 + [\ln(U_2)]^2 + [\ln(U_3)]^2 + [\ln(U_4)]^2 + [\ln(U_5)]^2 + [\ln(U_6)]^2 + [\ln(U_7)]^2}$$



Log-normal distribution

Are they the good values?

Conclusions

- There are uncertainties in the digital sector, all the more so as it is a complex sector, with many parameters and data confidentiality
 - Tools and methods exist to manage the uncertainty, through data quality management and impact variation results
 - But those tools are to be adapted to the digital sector
- There is a need for updated methods
- Then to apply them to the digital sector to manage quality and uncertainties

LET'S BUILD THIS TOGETHER!



How can we promote and enable **eco-design** throughout the **digital** value chain:

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