Probabilistic models in food and nutrition research

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Outline

- Introduction
- Uncertainty perspective
- Methodology probabilistic analysis
  - Uncertainty and variability characterisation of inputs
  - Uncertainty and variability propagation through models
- Examples
- Conclusions

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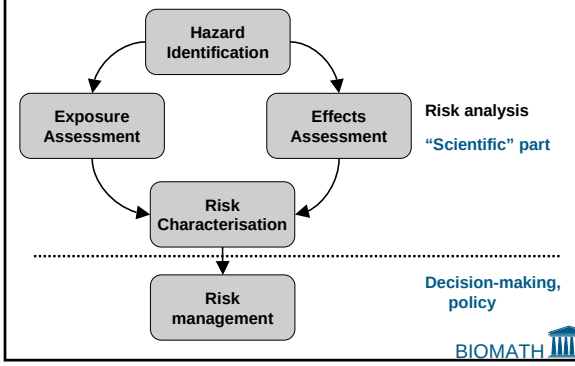
Human risk assessment



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Example exposure model

$$ADD_{life} = \frac{Conc \cdot IngR \cdot CF}{BW} \cdot \frac{D}{7} \cdot \frac{W}{52} \cdot \frac{Y}{70}$$

ADD_{life}	=	average daily dose of a chemical, averaged over a lifetime [mg/(kg*d)]
Conc	=	concentration in drinking water [mg/L]
IngR	=	ingestion rate [L/d]
CF	=	conversion factor [mg/mg] = 0,001
BW	=	body weight [kg]
D	=	number of days of exposure per week
W	=	number of weeks of exposure per year
Y	=	number of years of exposure in lifetime of 70 year

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Problem formulation

- Current approach is deterministic:
  - "point values"
  - Uncertainty -> precautionary principle -> conservatism / worst-case
- Disadvantages:
  - Not so realistic (simplification)
  - Not so transparent (unclear how conservative)

Example

Body weight = 70 kg

Example

Drinking water consumption = 2 L/day

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Problem formulation

- Classical age: appeal to magic-religious grounds
- Modern age: appeal to rational and scientific grounds

→ certainty perspective

- ? Post-modern age ?: appeal to rational and scientific grounds in uncertainty perspective

→ UNcertainty perspective

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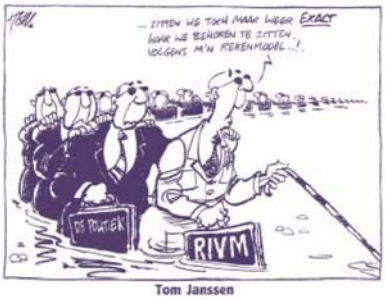
Problem formulation



Tom Janssen

The modern age

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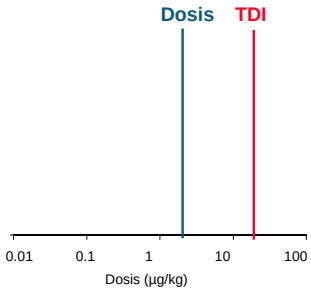
Goals

- **UNcertainty perspective in food safety**
- **How perform uncertainty analysis in food safety modelling?**



$$RisicoIndex = \sum \frac{Dosis}{TDI}$$

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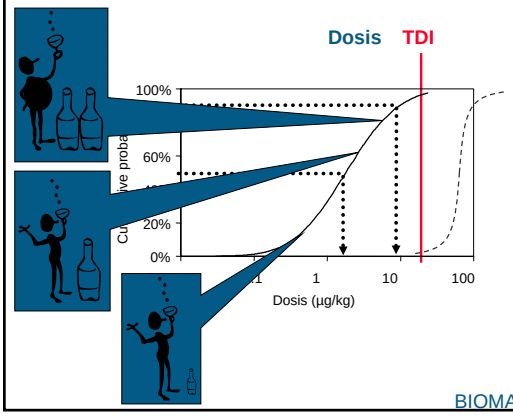

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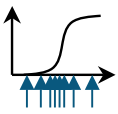
Variability and uncertainty

- **Variability:**
  - **real variations, describes the entire distribution**
  - **can not be reduced**



Forms:

- **Inter-individual:**
  - Body weight
  - Food ingestion
  - Water consumption
- **(Temporal)**
- **(Spatial)**

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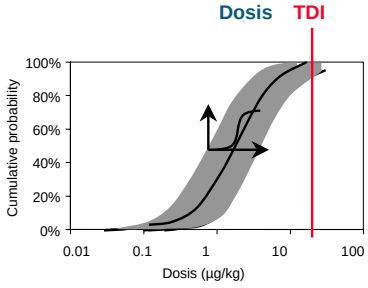

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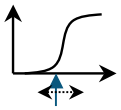
Variability and uncertainty

- **Uncertainty:**
  - **describes 1 value from the entire distribution**
  - **can be reduced by extra info**



Forms:

Quantifiable
- **"Known" ignorance:**
  - Food source contaminated?
  - Fraction absorbed
- **"Sampling" uncertainty**
- **Measurement error**

- **Model uncertainty**
- **Unknown ignorance**

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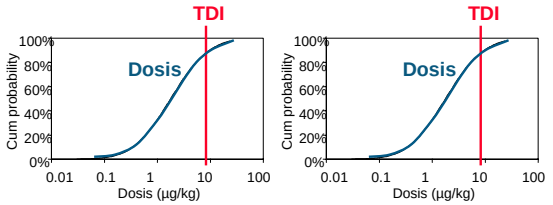
Variability <> Uncertainty



- **10% of exposure will exceed TDI**
- **10% probability that exposure exceeds TDI**

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Uncertainty and variability characterisation

- **Needed for all parameters?**

No, only the most sensitive, the key drivers suffice:
- **Sensitivity analysis**
- **Expert knowledge**

Examples:

Important can be:
- Ingestion
- Exposure duration
- …

Less important can be:
- volume fraction fat in tissue
- …

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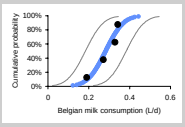
Uncertainty and variability characterisation

- **What if some parameters are uncertain AND variable?**

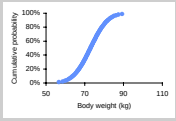
Solution:
- **Both can be modelled, but usually**
- **Mainly uncertain**
- **Mainly variable**

Examples:

Both:



Mainly variable:



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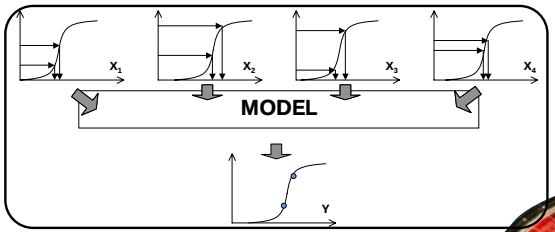
Monte Carlo analysis



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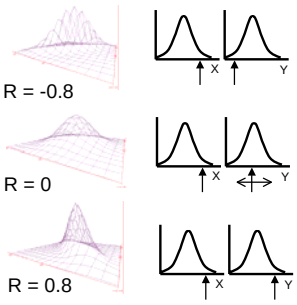
Uncertainty and variability characterisation: influence of correlations



Example:

Body weight

can be correlated with

Ingestion rate

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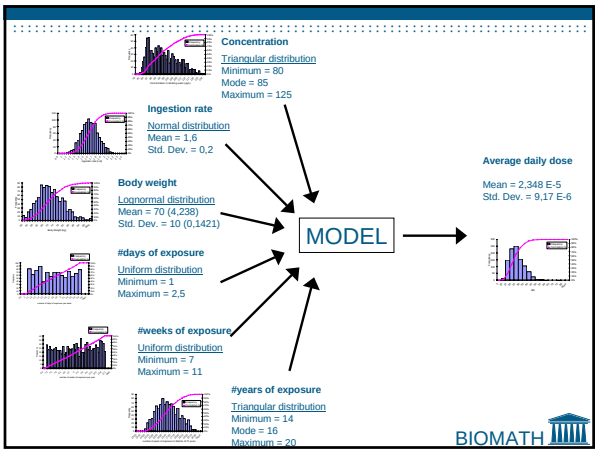
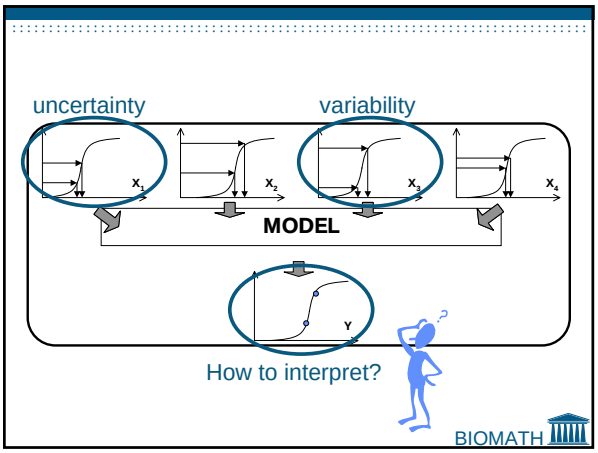
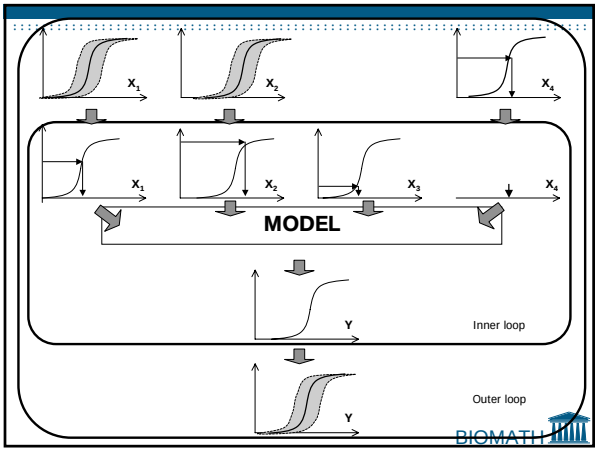
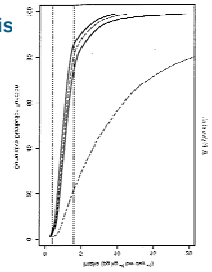






Examples

- **Probabilistic risk of dioxine-like substances in Belgian dioxine-crisis (Vrijens et al., 2002)**
  - **Variability:**
  - **food ingestion**
  - **Uncertainty:**
  - **food source: contaminated or uncontaminated farm**
  - **regression estimation uncertainty**
  - **start/end of contamination period**



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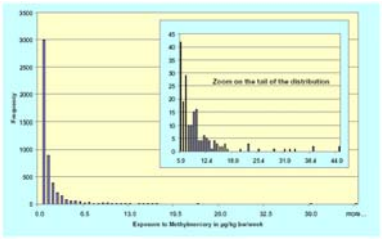
Examples

- **Probabilistic exposure to heavy metals from fish and sea products (Tressou et al., 2004)**



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Conclusions

- **Uncertainty perspective more and more important**
- **Monte Carlo analysis are useful support tools for decision-makers:**
  - **More realistic**
  - **Can avoid an unnecessary crisis**
  - **Shows degree of conservatism/uncertainty**
- **Probabilistic leads to more differentiated food risk/safety interpretations**

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