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UNIVERSITY OF APPLIED SCIENCES

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Development of a fuzzybased model for the evaluation of measurement uncertainties using high voltage arcs as an example

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Motivation/Objective

Motivation:

- How reliable are the results?
- How is the impact of uncertainty on the results?
- Getting certainty about the uncertainty

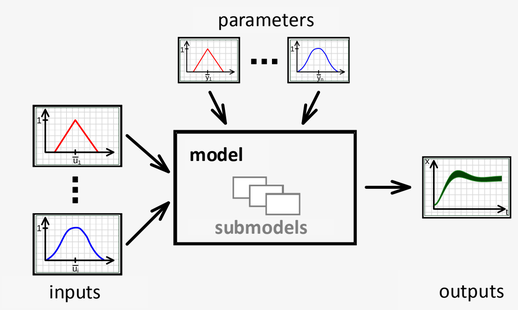


Figure: model with fuzzy input and output data

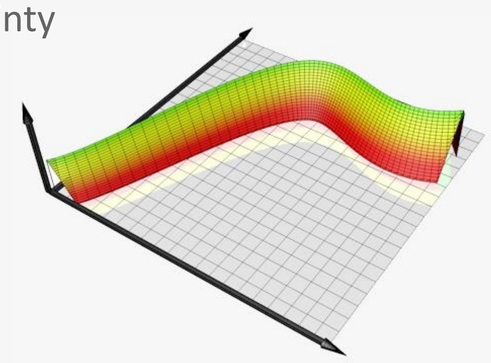


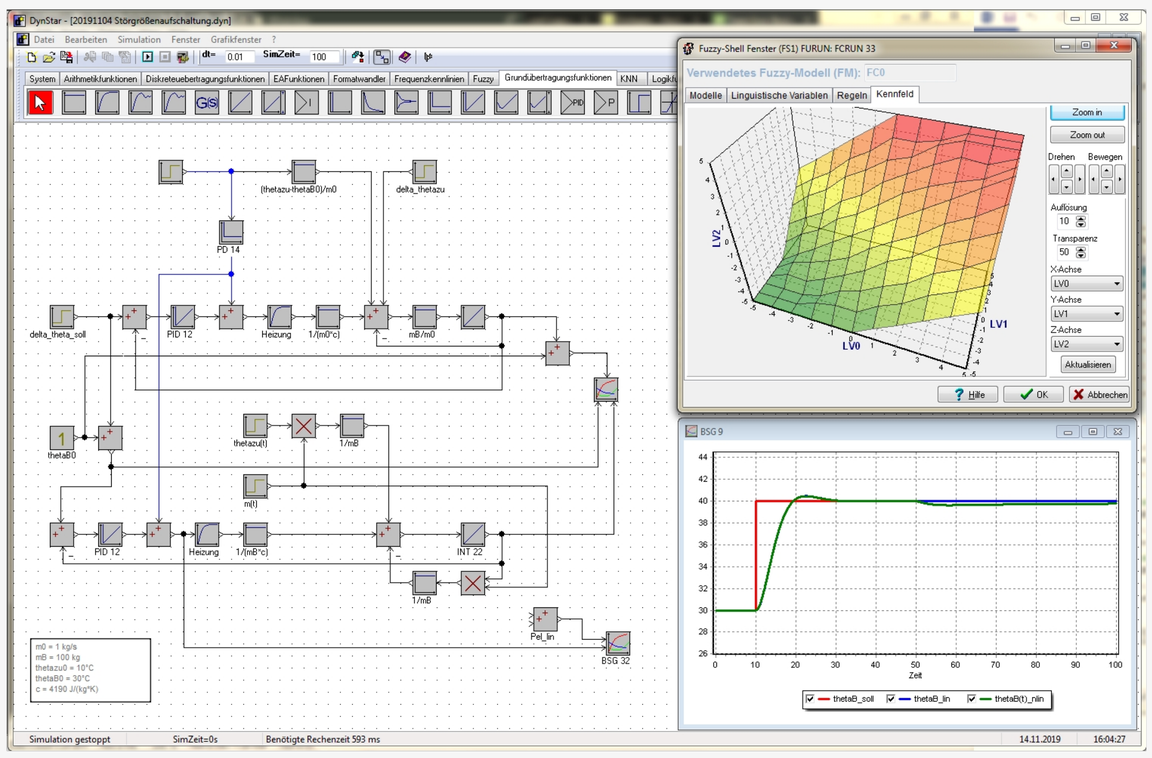
Figure: model with temporally fuzzy output data

Objectives:

- Consideration of aleatory and epistemic uncertainties in dynamic simulations as fuzzy quantities
- Further development and integration of methods and procedures into the simulation system "DynStar“
- Example Process: surface temperature of insulation material during high voltage arc test

DynStar:

- the institute's own simulation tool for static and dynamic processes
- the easy way to get fast results
- powerful simulation system for the realization of simple controlled loops up to complex systems
- has a OPC, fuzzy and a neural network library and is extensible



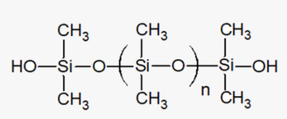
Application/Model

Uncertainty evaluation using the example of the high-voltage arc test:

- Low current arc between 2 needle electrodes (range 10mA - 40mA)
- Essentially thermal stress of the test specimen
- Evaluation criterion: time to specimen failure (conductive path)

material parameters:

- heat capacity
- thermal conductivity
- enthalpy of reaction (heat of decomposition)

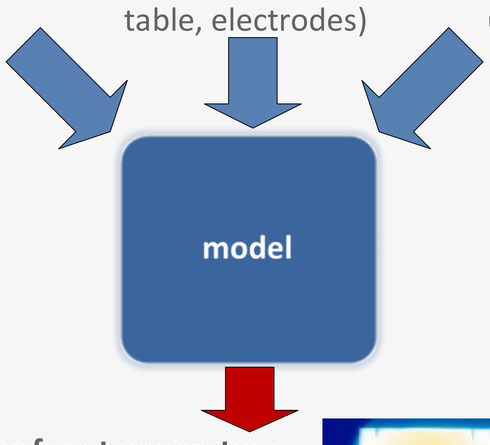


further parameters:

- environmental conditions
- heat sinks (e.g. test table, electrodes)

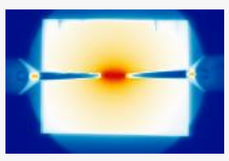
discharge parameters

- type of voltage
- V-C-characteristic
- electrical power loss
- temperature (distribution + absolute values)



surface temperature

- local and temporal distribution T(x,t)

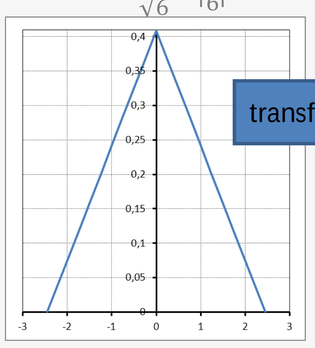


Mathematical framework

- three ways to describe uncertainties mathematically
  - ➢probability densities
  - ➢Fuzzy numbers (fuzzy set theory)
  - ➢intervals

probability densities

$$p(x) = \frac{1}{\sqrt{6}} - \left|\frac{x}{6}\right|$$

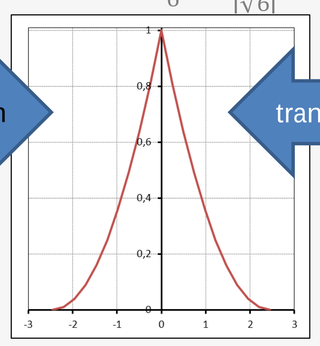


measure of probability

transformation

Fuzzy numbers (fuzzy set theory)

$$\mu(x) = 1 + \frac{x^2}{6} - 2\left|\frac{x}{\sqrt{6}}\right|$$

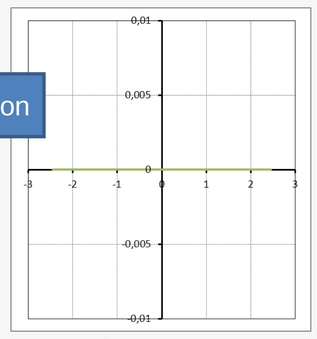


measure of possibility (expressed by membership function)

transformation

intervalls

$$[-\sqrt{6}, +\sqrt{6}]$$



interval

- the way is a unified mathematical framework
- Using of exisiting mathematical transfomation in fuzzy numbers

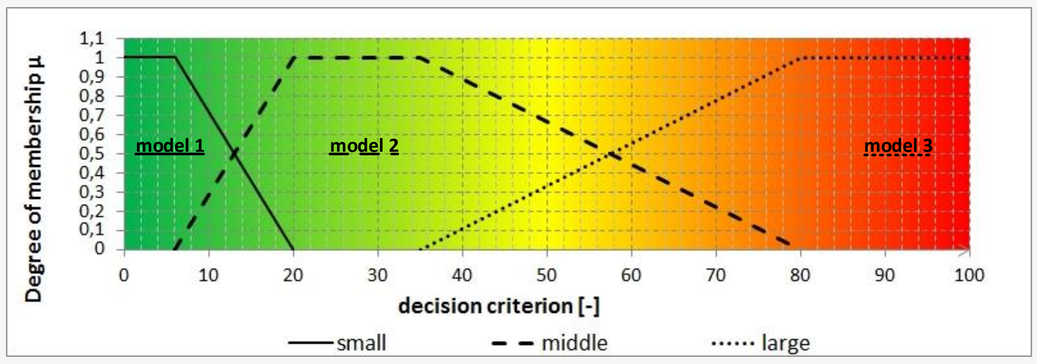


Figure: general example for the consideration of model uncertainties

→ fuzzy set theory allows ***model*** and ***parameter uncertainties*** to be taken into account

The steps to sucess

- model implementation
- Uncertainty analysis for interesting parameters
- Dynamic simulation with model and parameter uncertainties
- Evaluation of the results
- Validation/Optimization
- Integration of Methods in DynStar

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