Uncertainty calculation for LCI data - reasons for, against, and an efficient and flexible approach for doing it

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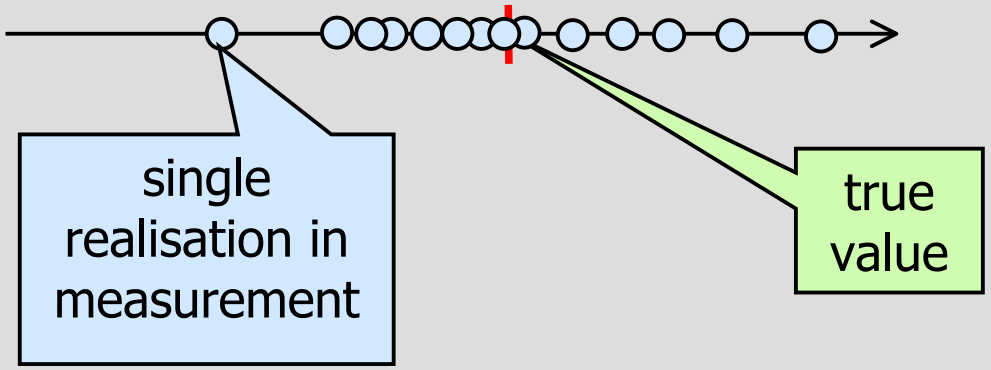
Andreas Ciroth

greendeltaTC
TOOLS CONSULTING


single
realisation in
measurement
true
value

3 reasons for,

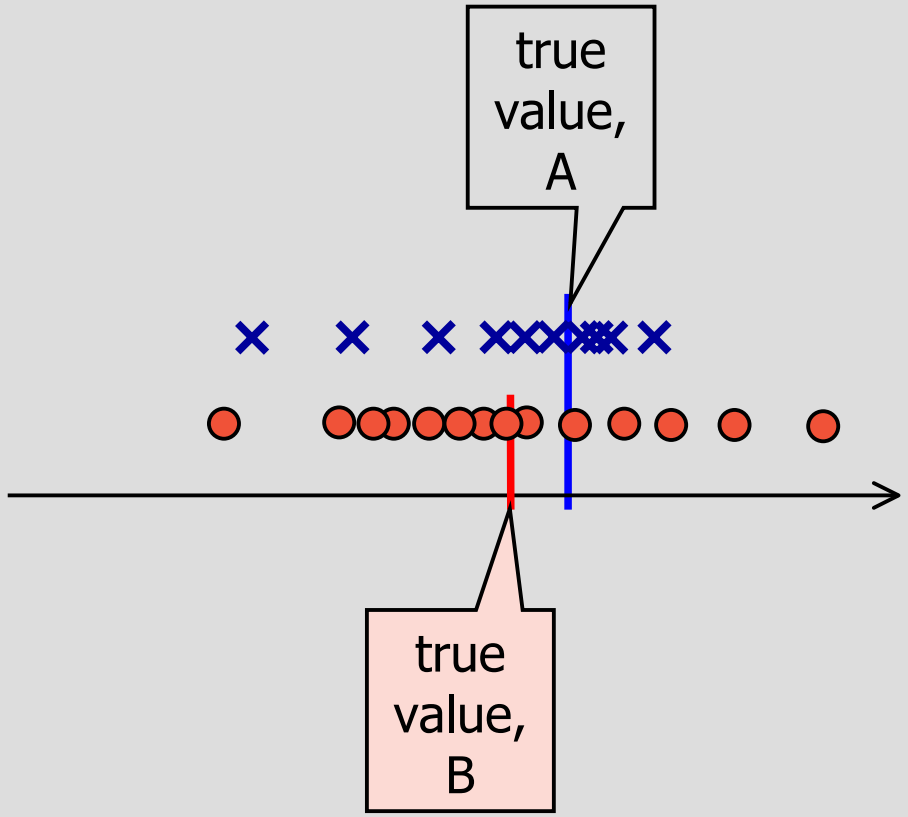
and 4 reasons against,

a quantitative uncertainty assessment

Uncertainty assessment in LCA -

Reasons for	Reasons against
Needed for decision support	Human nature
Transparency	Additional effort
Quality competition	Lack of appropriate methods
	Additional errors possible

1st pro: better decision support



1st pro: better decision support

- Result may completely change if additional uncertainty information is considered;
- Decision maker's risk awareness can be accounted for;
- Vital information for setting thresholds, e.g. on optimal recycling rates

2nd pro: Transparency

- How uncertain are single elements of the LCI?
- Where does uncertainty mainly come from?
- In a comparative study, which alternative is less uncertain?

3rd pro: Quality competition

A plight to provide uncertainty information serves as incentive for providing less uncertain data.

- For practitioners, when performing case studies;
- For data providers;
- Needs: Accredited, accepted framework for uncertainty assessment & calculation.

1st against: Human nature

- "What you don't know won't hurt you"
  (Was ich nicht weiß macht mich nicht heiß)

- Tendency to give more credits to single values, esp. in case of high uncertainty

→ For data providers with highly uncertain data: Motivation to not state the uncertainty! Hiding uncertainty may work!

2nd against: Effort

Collecting uncertainty information,
and calculating, and managing uncertainty explicitly,
means additional effort for data collection,
and standard LC calculation may prove difficult.

3rd against: Lack of methods

„The quantitative analysis of uncertainties arising from the influence of data quality on LCA results is still very much in its infancy“,
Ross et al., Int J LCA 7 (1) 2002

4th against: Additional errors

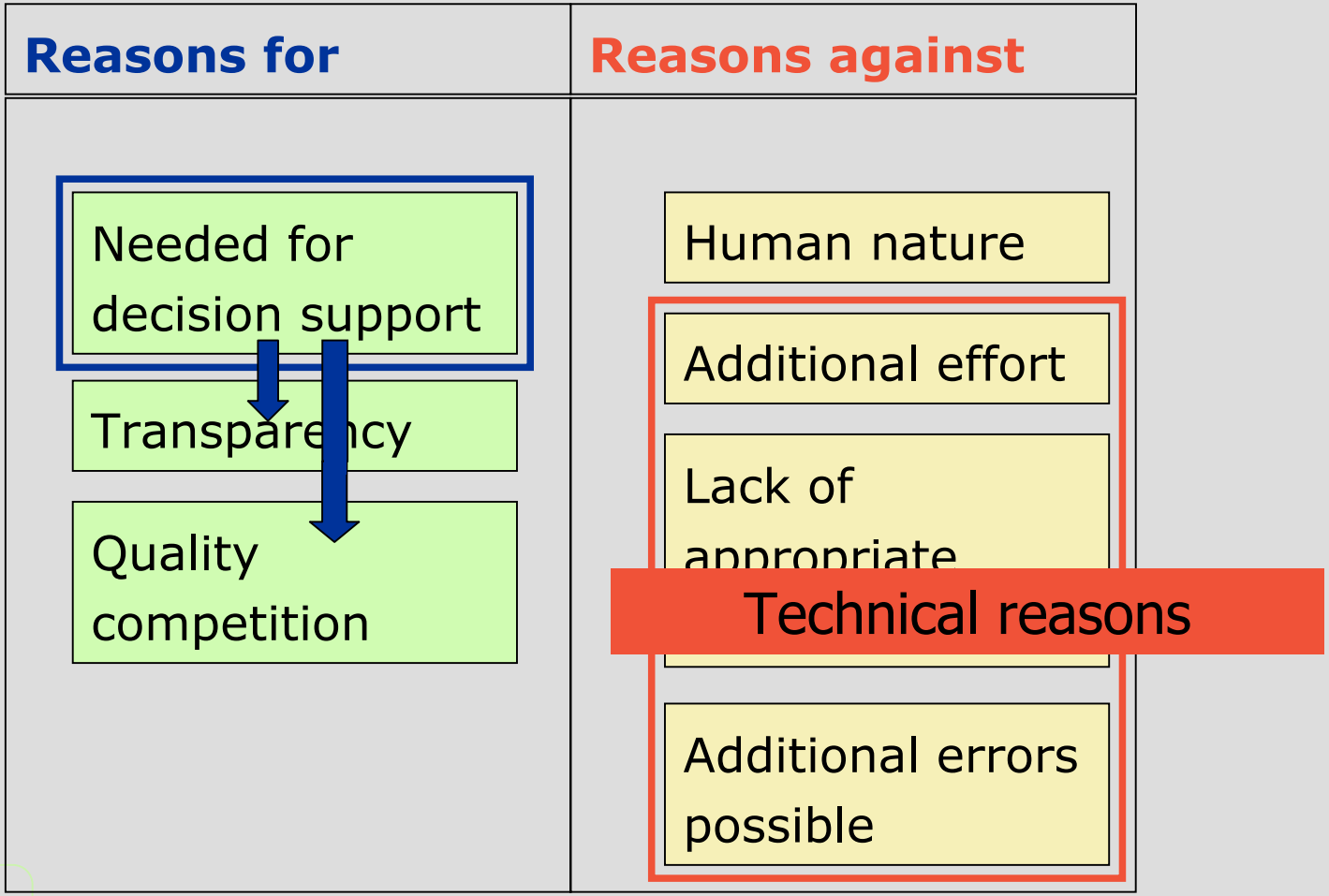
Considering uncertainty explicitly

=

Model sophistication

→ Needs validated methods.

Uncertainty assessment in LCA -



→ Requirements for the calculation of uncertainties in LCI / LCA

→Basic rule:
Be aware of human tendency to not consider uncertainty if it is not mentioned.

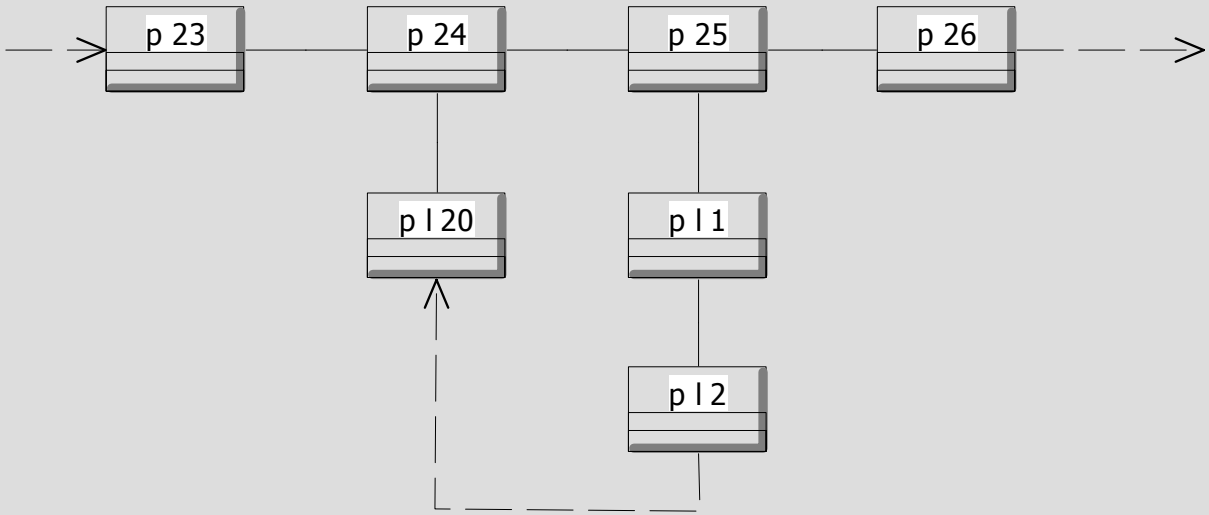
→Allay lack of methods, esp. reliable, efficient methods for adequately represent uncertainty in the result

→→ Introducing a method for calculating uncertainties in LCI

- Combination of approximation formulas and Monte Carlo Simulation, best of both worlds
- Model-validated thresholds for applying the approx. formulas
- Sources:

Ciroth, A.: Fehlerrechnung in Ökobilanzen, Dissertation TU Berlin 2001, http://edocs.tu-berlin.de/diss/2001/ciroth_andreas.htm;
Ciroth, A., et al. : Uncertainty calculation in Life Cycle Assessments: why and how?, submitted to Int. J. LCA, 2003.

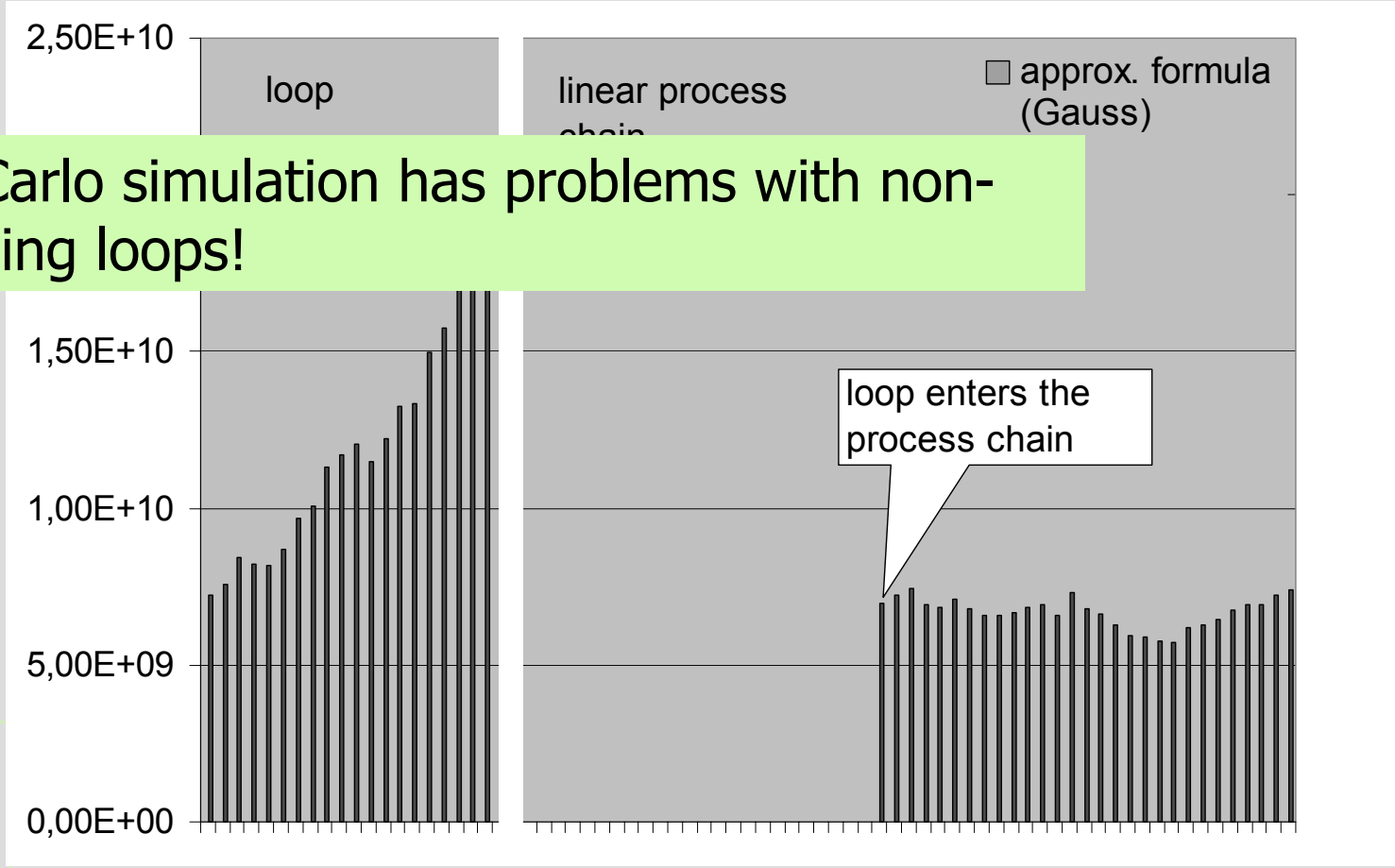
Example: Loops, and their effect on the calculation of process scaling factors



→Calculated uncertainty,

Initial scaling factor of each process in the loop 0.99,

uncertainty in exchanges of 0.05.

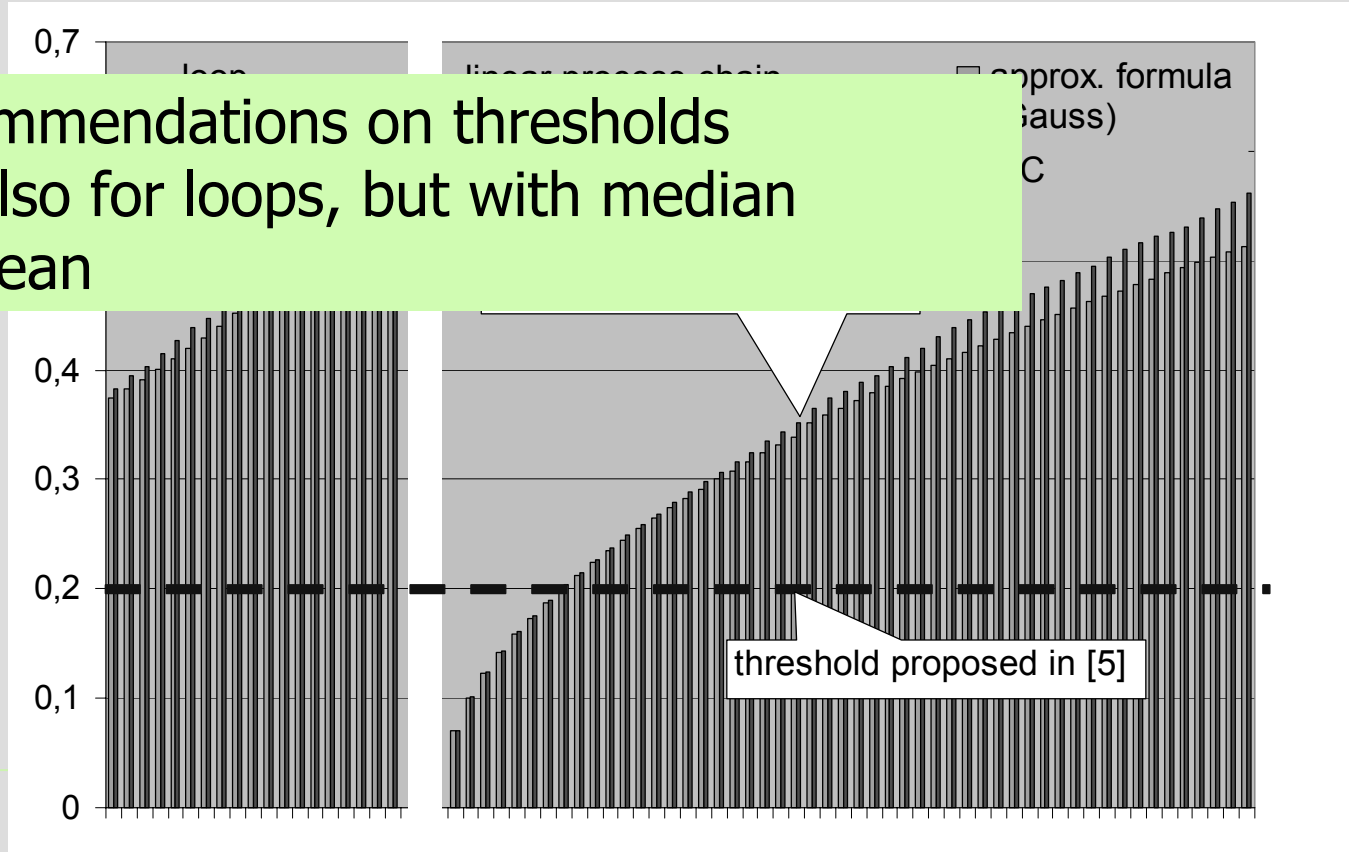


Monte Carlo simulation has problems with non-converging loops!

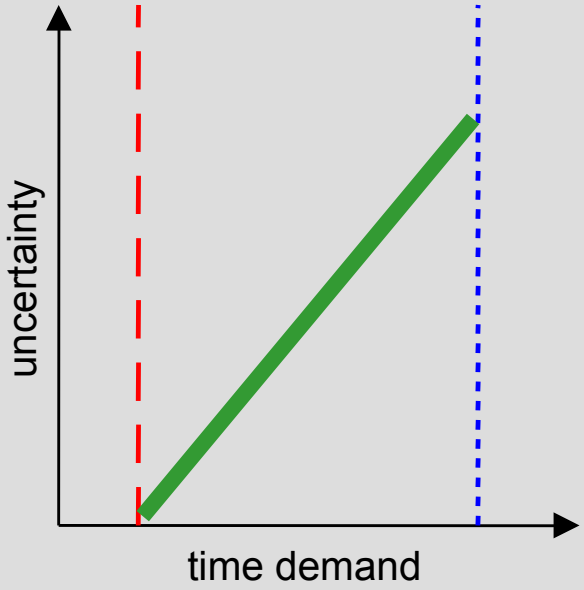
→ Approximation formulas and simulation results:

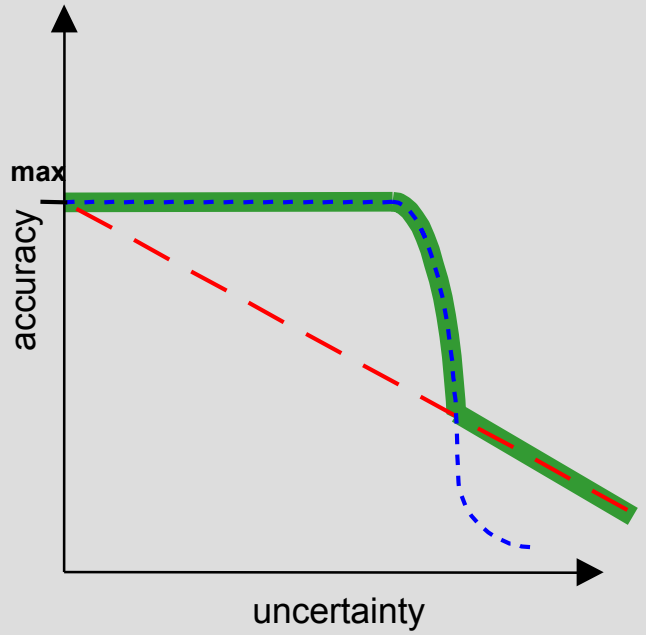
Initial scaling factor of each process in the loop 0.90,
uncertainty in exchanges of 0.05.

Former recommendations on thresholds confirmed, also for loops, but with median instead of mean



Benefits of the combination





approx. formula

combined approach

Monte Carlo Simulation

→Conclusions

- Quantitative uncertainty assessment is vital for sound decision support, transparency, and quality control, …

- …provided there are efficient and reliable ways for collecting uncertainty information, calculating propagated uncertainty, and for dealing with uncertainty in the result.

- We presented a method for calculating uncertainties by combining approximation formulas and Monte Carlo Simulation, validated in a model.

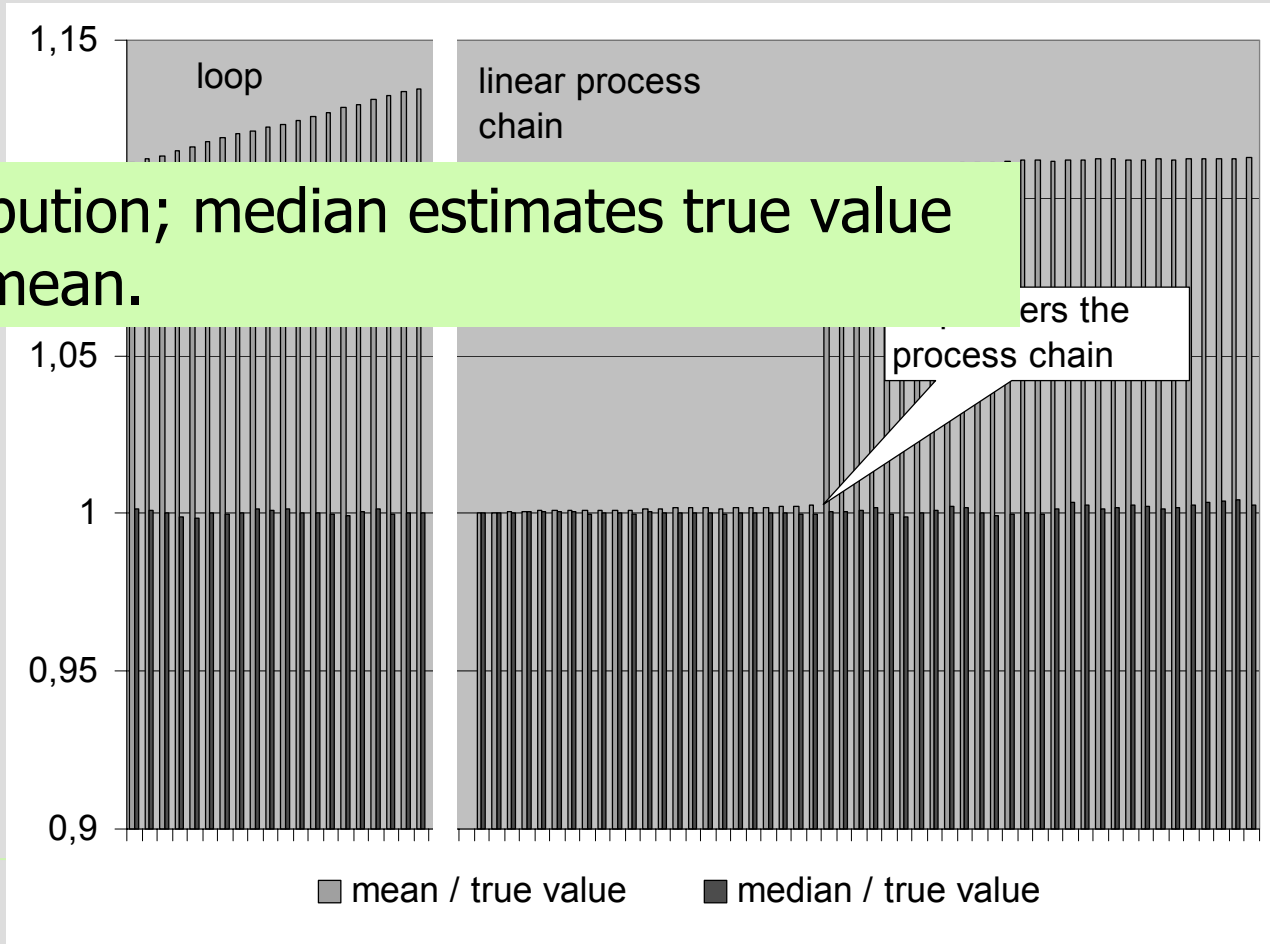
- Further research necessary on
  - *implementing the approach in software
  - *coordinating ways to collect uncertainty information
  - *finding ways for dealing with uncertainty in the result

  AND finally for reducing the uncertainty in the result!

→ Mean, median, true value

Initial scaling factor of each process in the loop 0.99,

uncertainty in exchanges of 0.01.



Biased distribution; median estimates true value better than mean.