



Screening Methods

Elmar Plischke

Institut für Endlagerforschung

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Methods Available for Sensitivity Analysis

- **Local Methods:** Behaviour of the model about a nominal working/reference point
- **Screening Methods:** Behaviour of the system within given parameter ranges
- **Global Methods:** Behaviour under given input parameter distributions

[Badea and Bolado, 2008], [Borgonovo and Plischke, 2016]

Screening

Most methods provide a quick scan for screening out unimportant input parameters.
We have a look into

1. Tornado Diagrams
2. Sequential Bifurcation
3. Morris Screening: One-Factor-At-A-Time Elementary Effects

Tornado Diagrams

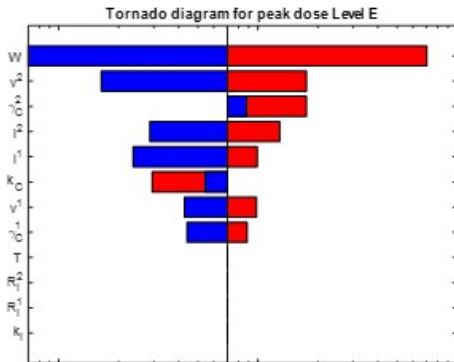
A base case, together with minimum and maximum values are required for each input parameter.

Via global One-At-a-Time sensitivity (OAT) from the base case to the extremes the deviations in the outputs are presented in a horizontal bar plot. [Eschenbach, 1992]

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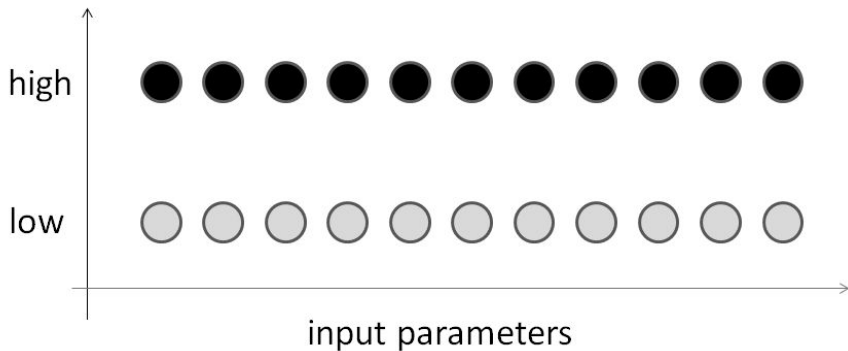
Sequential Bifurcation: A global screening method

[Bettonvil and Kleijnen, 1997]

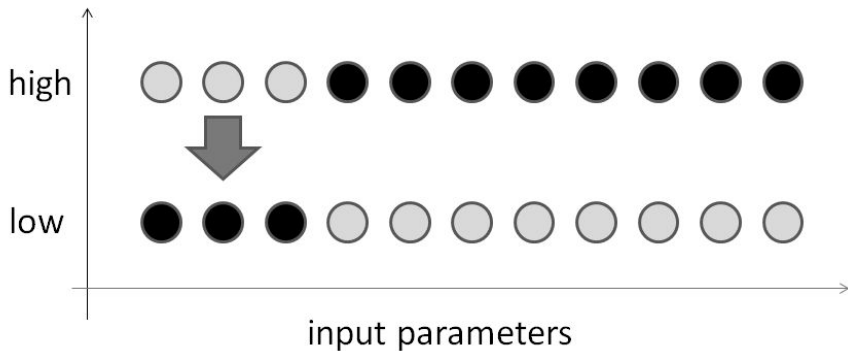
Partition the inputs into groups. Within each group assume co-monotonic behaviour. Compare the outputs related to the input design (next slide): large deviations signal an important factor in the group. Refine/bifurcate the most interesting group for more information

Define low and high values for each input factor: “Carefully chosen” extreme values

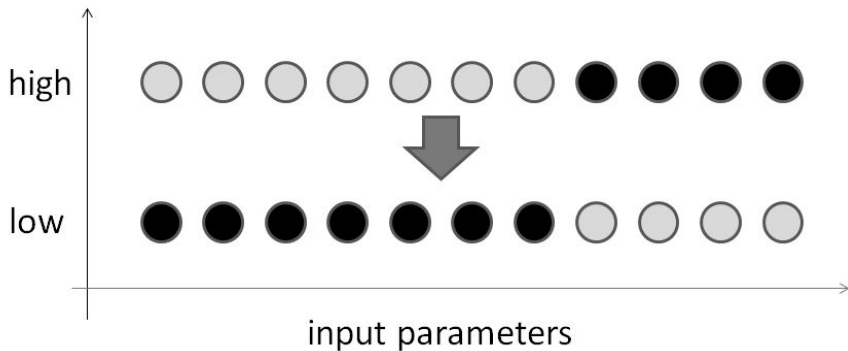
Sequential bifurcation: Input design



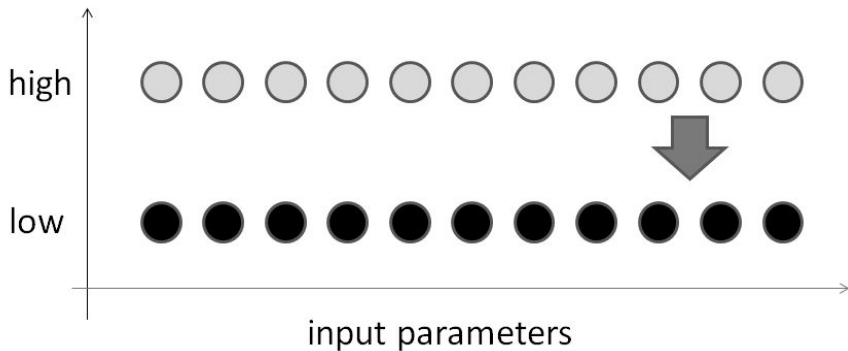
Sequential bifurcation: Input design



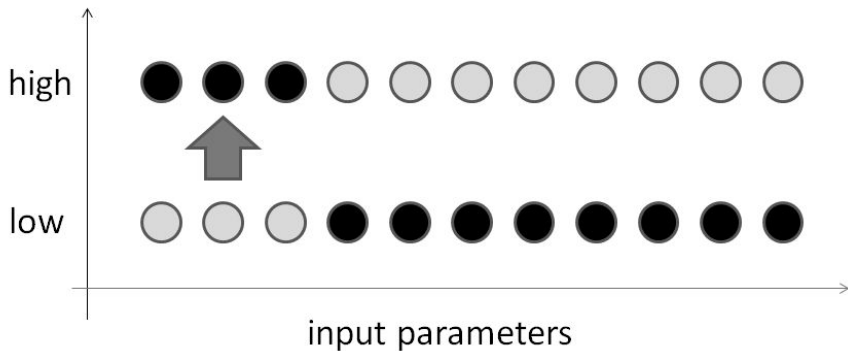
Sequential bifurcation: Input design



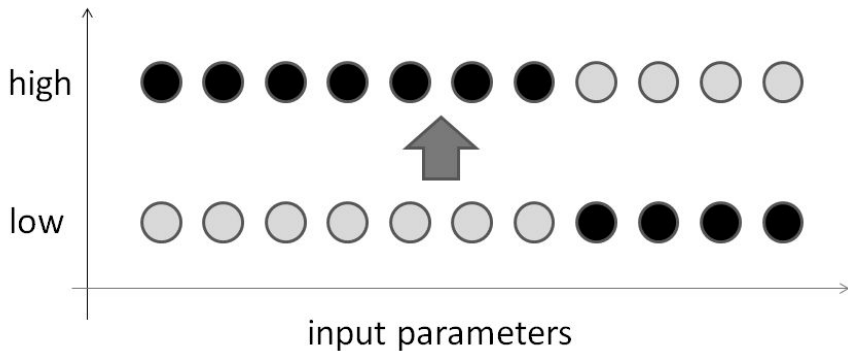
Sequential bifurcation: Input design



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Sequential bifurcation: Input design



Sequential bifurcation: Input design

Closing the circle: All “high” calculation is already available

Sequential Bifurcation: Example

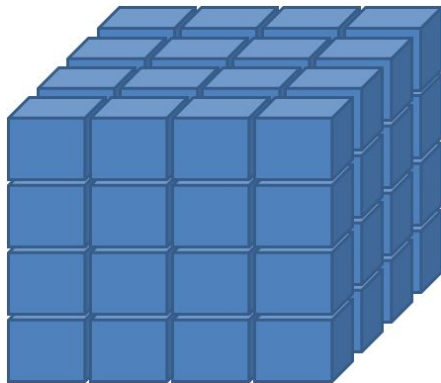
Refined until each parameter is in its own group

Original Scale	v^1	I^1	W	γ_C^1	R_I^1	I^2	R_I^2	v^2	k_I	T	k_C	γ_C^2
Log Output	W	v^1	I^1	R_I^1	γ_C^1	I^2	v^2	R_I^2	k_I	T	k_C	γ_C^2

Last two entries: null difference reported

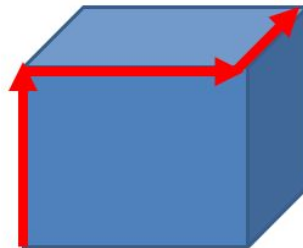
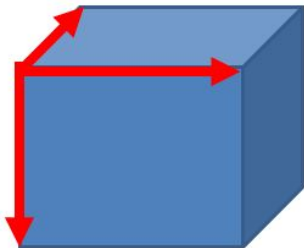
Morris OAT screening: a randomized local screening method

Partition input space into hypercubes [Morris, 1991, Campolongo et al., 2007]



Morris OAT screening

Randomly select hypercubes and compute the output with respect to a radial design or a winding stairs design



Morris OAT screening

Morris Elementary effects (radial design, R repetitions)

$$\mu_i = R^{-1} \sum_{r=1}^R \frac{g(x_r + \Delta e_i) - g(x_r)}{\Delta}$$

Avoiding cancellation effects

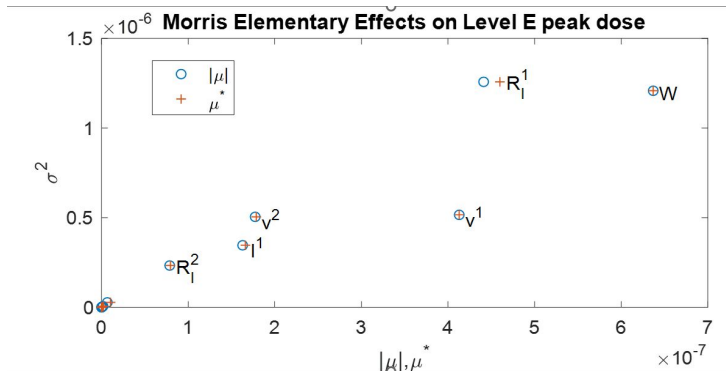
$$\mu_i^* = R^{-1} \sum_{r=1}^R \left| \frac{g(x_r + \Delta e_i) - g(x_r)}{\Delta} \right|$$

Average of difference quotients

$$\sigma_i = \sqrt{(R-1)^{-1} \sum_{r=1}^R \left(\frac{(g(x_r + \Delta e_i) - g(x_r))^2}{\Delta^2} - \mu_i^2 \right)}$$

Std. Dev. of difference quotients

Morris Screening: Same Example



Screening methods

- ad-hoc algorithms
- no deeper theory involved
- bad exploration of sample space
- correlations between input parameters are ignored
- computationally cheap (for small dimensions)
- dummy factors without any influence on the output are spotted

Thank You!

Questions, Comments

<mailto:elmar.plischke@tu-clausthal.de>

Preprints, Scripts, Stuff

<https://artefakte.rz-housing.tu-clausthal.de/epl/>

GitLab Repository

<https://gitlab.gwdg.de/elmar.plischke/global-sensitivity-analysis-collection>

References I



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