Sensitivity analysis, sensitivity auditing and quantitative story telling. Hints for use in the Adverse Outcome Pathways model

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The Wellcome Collection

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Where to find this talk: www.andreasaltelli.eu

Sensitivity analysis book available on LibGen
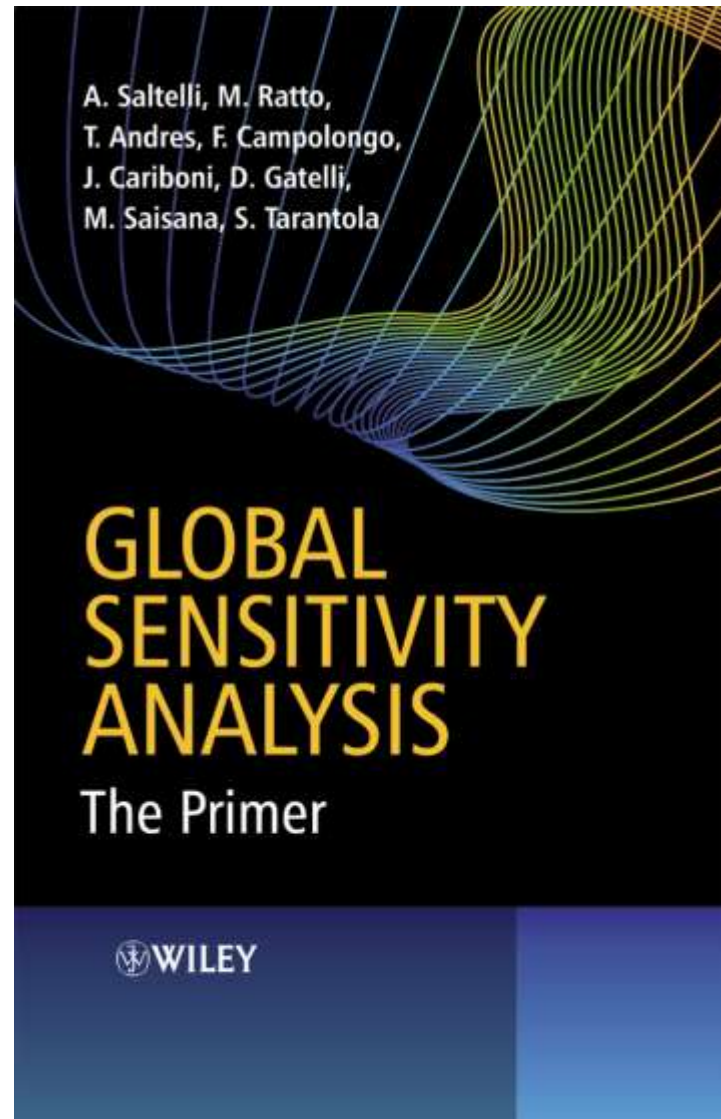
Sensitivity analysis

Saltelli, A., Annoni, P., 2010, How to avoid a perfunctory sensitivity analysis, Environmental Modeling and Software, 25, 1508–1517.
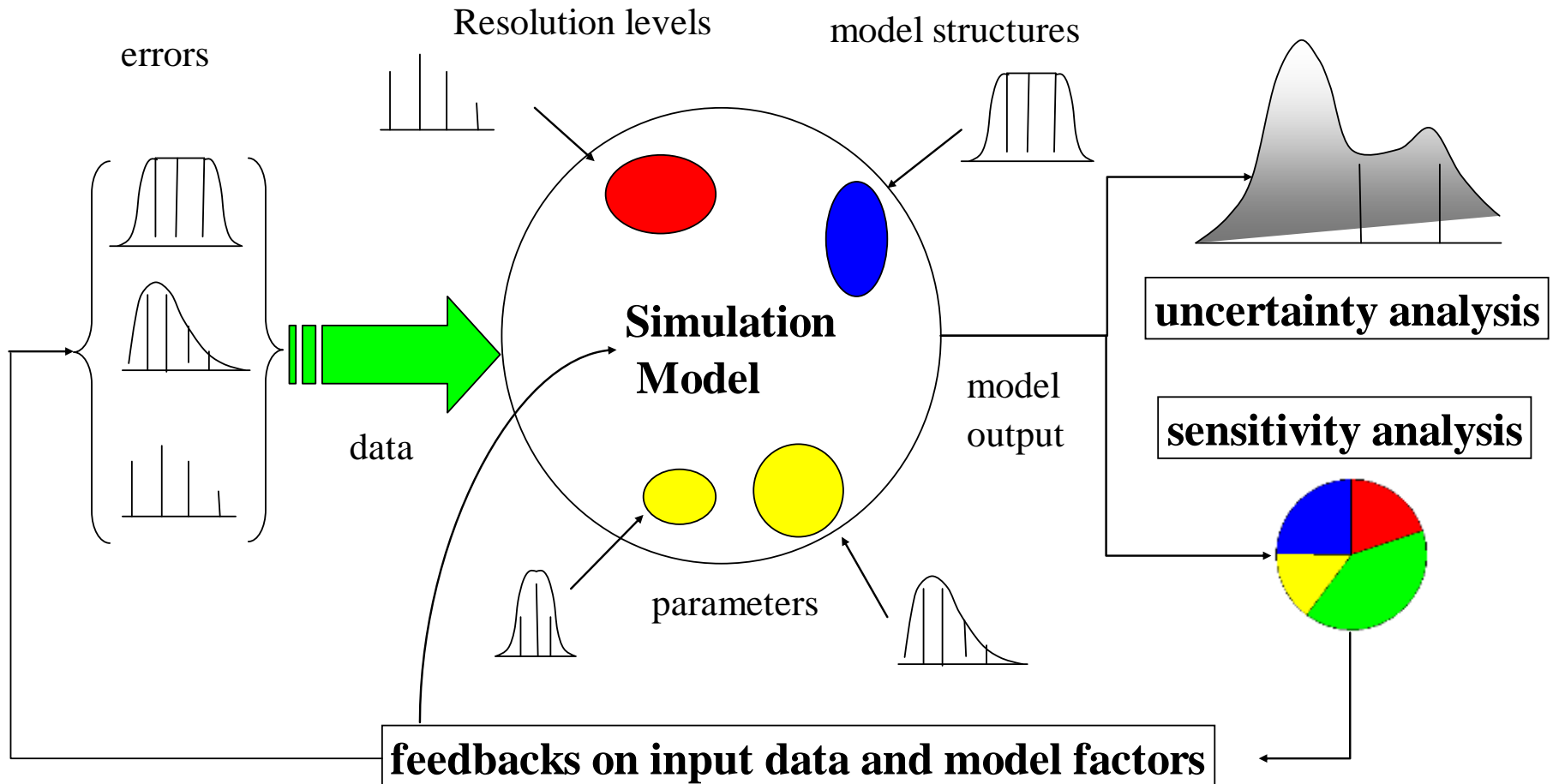
Sensitivity auditing

Saltelli, A., Funtowicz, S., 2014, When all models are wrong: More stringent quality criteria are needed for models used at the science-policy interface, Issues in Science and Technology, Winter 2014, 79–85.

Quantitative storytelling

Andrea Saltelli, Mario Giampietro, 2017, What is wrong with evidence based policy, and how can it be improved? Futures, DOI: http://dx.doi.org/doi:10.1016/j.futures.2016.11.012.

An engineer's vision of UA, SA

errors

Resolution levels

model structures

Simulation Model

data

model output

parameters

uncertainty analysis

sensitivity analysis
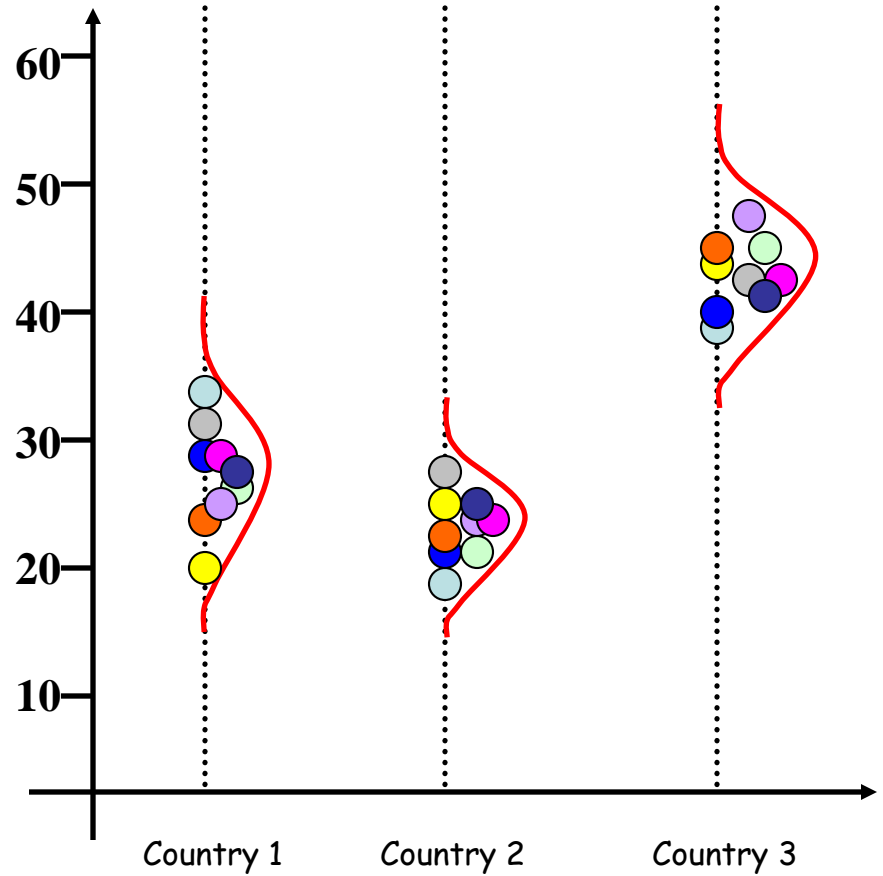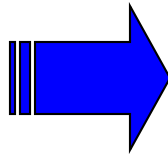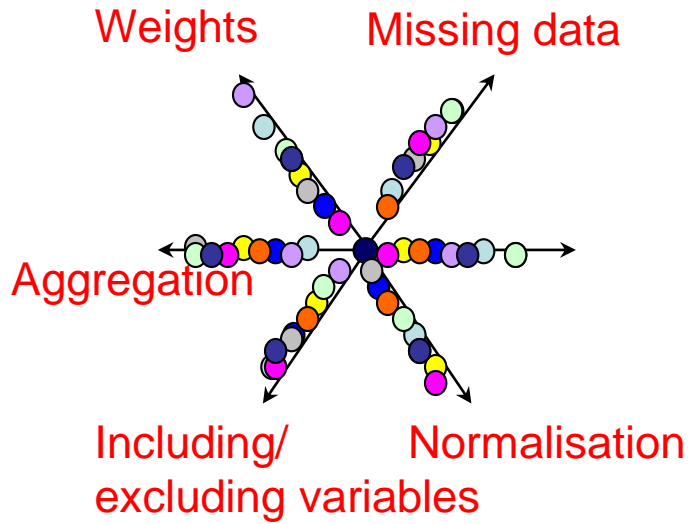
feedbacks on input data and model factors

One can sample more than just factors

One can sample modelling assumptions

Example: The output is a composite indicator

Assumption	Alternatives
Number of indicators	▪ all six indicators included or one-at-time excluded (6 options)
Weighting method	▪ original set of weights, ▪ factor analysis, ▪ equal weighting, ▪ data envelopment analysis
Aggregation rule	▪ additive, ▪ multiplicative, ▪ Borda multi-criterion

Space of alternatives

Weights   Missing data

Aggregation

Including/
excluding variables   Normalisation

Country 1   Country 2   Country 3

http://ec.europa.eu/smart-regulation/

Source: IA Toolbox, p. 391

EUROPEAN COMMISSION

Better Regulation "Toolbox"

Secrets of sensitivity analysis

First secret: The most important question is the question.

Corollary 1: Sensitivity analysis is not "run" on a model but on a model once applied to a question.

First secret: The most important question is the question.

Corollary 2: The best setting for a sensitivity analysis is one when one wants to prove that a question cannot be answered given the model

It is better to be in a setting of falsification than in one of confirmation (Oreskes et al., 1994).

[Normally the opposite is the case]

Verification, Validation, and Confirmation of Numerical Models in the Earth Sciences, Naomi Oreskes, Kristin Shrader-Frechette, Kenneth Belitz, Science, New Series, Vol. 263, No. 5147 (Feb. 4, 1994), pp. 641-646.

Second secret: Sensitivity analysis should not be used to hide assumptions [it often is]

Third secret: If sensitivity analysis shows that a question cannot be answered by the model one should find another question/model which can be treated meaningfully.

[Often the love for the model prevails]

Badly kept secret:

There is always one more bug!

(Lubarsky's Law of Cybernetic Entomology)

And of course please don't …

… run a sensitivity analysis where each factors has a 5% uncertainty

Sensitivity auditing

EC impact assessment guidelines: what do they say about sensitivity auditing ?

http://ec.europa.eu/smart-regulation/guidelines/docs/br_toolbox_en.pdf

⋯ where there is a major disagreement among stakeholders about the nature of the problem, ⋯ then sensitivity auditing is more suitable but sensitivity analysis is still advisable as one of the steps of sensitivity auditing.

Sensitivity auditing, [⋯] is a wider consideration of the effect of all types of uncertainty, including structural assumptions embedded in the model, and subjective decisions taken in the framing of the problem.
[⋯]
The ultimate aim is to communicate openly and honestly the extent to which particular models can be used to support policy decisions and what their limitations are.

"In general sensitivity auditing stresses the idea of honestly communicating the extent to which model results can be trusted, taking into account as much as possible all forms of potential uncertainty, and to anticipate criticism by third parties."

Quantitative story-telling

"There is only a perspective seeing, only a perspective "knowing"; and the more affects we allow to speak about one thing, the more eyes, different eyes, we can use to observe one thing, the more complete will our "concept" of this thing, our "objectivity", be."

Friedrich Nietzsche, Genealogy of Morals, Third Essay.

Frames

The expression 'tax relief' is apparently innocuous but it suggests that tax is a burden, as opposed to what pays for road, hospitals, education and other infrastructures of modern life (Lakoff, 2004).

George Lakoff

Lakoff, G., 2010, Why it Matters How We Frame the Environment, Environmental Communication: A Journal of Nature and Culture, 4:1, 70-81.

Lakoff, G., 2004-2014, Don't think of an elephant: know your values and frame the debate, Chelsea Green Publishing.

Frames
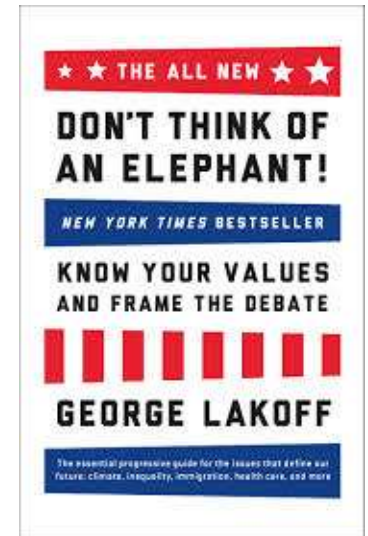
Why Free Markets Make Fools of Us

Cass R. Sunstein

Phishing for Phools: The Economics of Manipulation and Deception
by George A. Akerlof and Robert J. Shiller
Princeton University Press, 272 pp., $24.95

The Rolls-Royce Silver Cloud — $13,995

"At 60 miles an hour the loudest noise in this
new Rolls-Royce comes from the electric clock"

An advertisement for Rolls-Royce from the late 1950s

Frames

For Akerlof and Shiller - against what the 'invisible hand' would contend - economic actors have no choice but to exploit frames to 'phish' people into practices which benefit the actors not the subject phished.
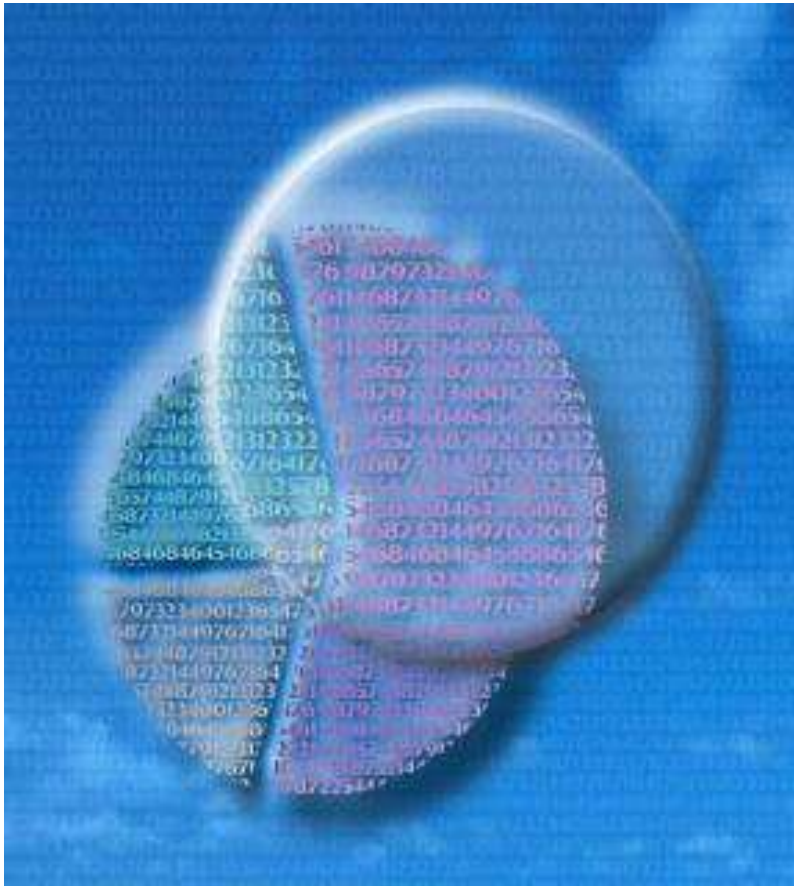
George Akerlof

Robert R. Shiller

Instead of Evidence-based policy: robust policy:

Test for:

- feasibility (compatibility with processes outside human control);
- viability (compatibility with processes under human control, in relation to both the economic and technical dimensions); and
- desirability (compatibility with a multitude of normative considerations relevant to a plurality of actors).

END

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