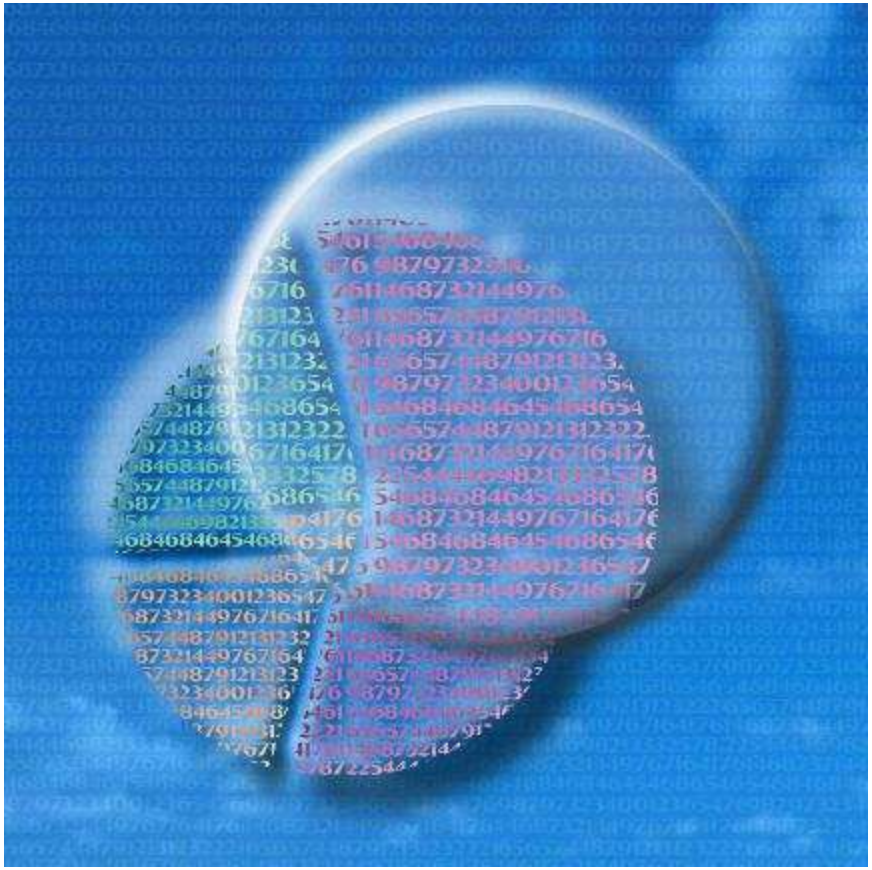

Present challenges in sensitivity analysis

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Uncertainty quantification seminar, Trondheim, January 18, 2017

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Additional material: www.andreasaltelli.eu

sensitivity analysis, sensitivity auditing, science for policy, impact assessment

Sensitivity analysis acknowledged as necessary

Office for the Management and Budget, 2006

Environmental Protection Agency, 2009

European Commission, 2015

EPA, 2009, March. Guidance on the Development, Evaluation, and Application of Environmental Models. Technical Report EPA/100/K-09/003. Office of the Science Advisor, Council for Regulatory Environmental Modeling, http://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1003E4R.PDF, Last accessed December 2015.

EUROPEAN COMMISSION, Better regulation toolbox, appendix to the Better Regulation Guidelines, Strasbourg, 19.5.2015, SWD(2015) 111 final, COM(2015) 215 final, http://ec.europa.eu/smart-regulation/guidelines/docs/swd_br_guidelines_en.pdf.

OMB, Proposed risk assessment bulletin, Technical report, The Office of Management and Budget's – Office of Information and Regulatory Affairs (OIRA), January 2006, https://www.whitehouse.gov/sites/default/files/omb/assets/omb/inforeg/proposed_risk_assessment_bulletin_010906.pdf, pp. 16–17, accessed December 2015.

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

EUROPEAN COMMISSION

Better Regulation "Toolbox"

4. SENSITIVITY AND UNCERTAINTY ANALYSES

Page 391

- Six steps for a global SA:
  1. Select one output of interest;
  2. Participatory step: discuss which input may matter;
  3. Participatory step (extended peer review): define distributions;
  4. Sample from the distributions;
  5. Run (=evaluate) the model for the sampled values;
  6. Obtain in this way bot the uncertainty of the prediction and the relative importance of variables.

Sensitivity auditing also acknowledged

Sensitivity auditing

- Originates from uncertainty & sensitivity analysis
- Addresses model-based evidence used for policy

Saltelli, A., Guimarães Pereira, Â., Van der Sluijs, J.P. and Funtowicz, S., 2013, What do I make of your latinorum? Sensitivity auditing of mathematical modelling, Int. J. Foresight and Innovation Policy, 9, 2/3/4, 213–234.

Saltelli, A., Funtowicz, S., 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.
http://issues.org/30-2/andrea/

EC guidelines:
what do they about sensitivity auditing ?

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

p. 392

… 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.

p. 393

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.

p. 393

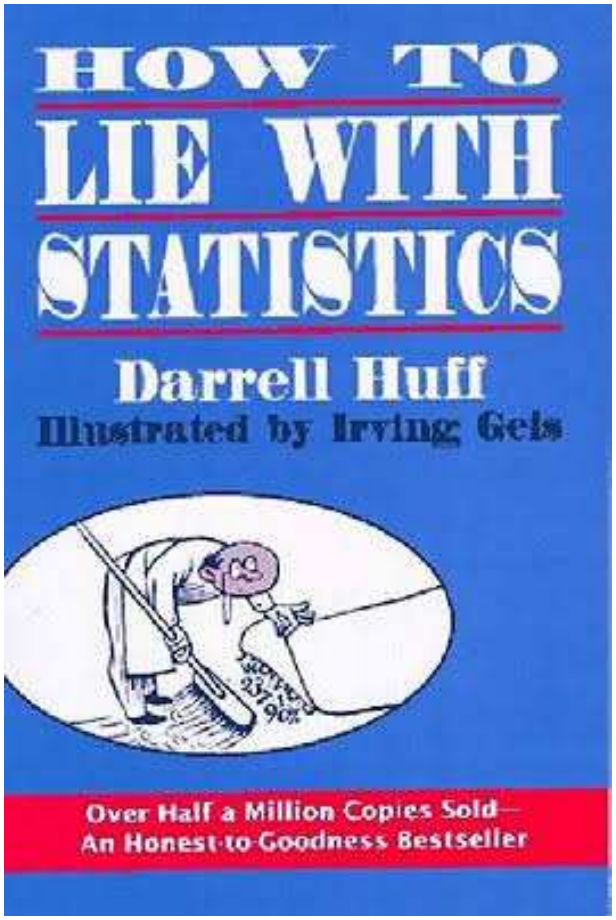
“In general sensitivity auditing stresses the idea of honestly communicating the extent to which model results can be trusted, taking into account as much as possible all forms of potential uncertainty, and to anticipate criticism by third parties.”

p. 393

“In particular, one should avoid giving the impression of false confidence by “quantification at all costs”. In some cases there is simply not enough data, or the process is too complex, to give a meaningful quantitative prediction.”

Problematic sensitivity analyses

Can I lie with sensitivity analysis as I can lie with statistics?



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

OAT is still the most used technique. Out of every 100 papers with SA only 4 are 'global' (non-OAT)

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Trends in sensitivity analysis practice in the last decade

Federico Ferretti [a,*], Andrea Saltelli [b,d], Stefano Tarantola [c]

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[b] Centre for the Study of the Sciences and the Humanities (SVT), University of Bergen (UIB), Spain
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[d] Institut de Ciència i Tecnologia Ambientals (ICTA), Universitat Autonoma de Barcelona, Spain

Ferretti, F., Saltelli A., Tarantola, S., 2016, Trends in Sensitivity Analysis practice in the last decade, Science of the Total Environment, http://dx.doi.org/10.1016/j.scitotenv.2016.02.133

OAT in 10 dimensions puts zero points in a portion of the input space equal to 99.75% of the input space

Problematic quantifications in statistics

IN FOCUS NEWS

REPRODUCIBILITY

Statisticians issue warning on *P* values

Statement aims to halt missteps in the quest for certainty.

"Misuse of the P value — a common test for judging the strength of scientific evidence — is contributing to the number of research findings that cannot be reproduced"

Baker, M., 2016, Statisticians issue warning on P values, Nature, 531, 151

AMERICAN STATISTICAL ASSOCIATION RELEASES STATEMENT ON STATISTICAL SIGNIFICANCE AND *P*-VALUES

Provides Principles to Improve the Conduct and Interpretation of Quantitative Science

March 7, 2016

… and twenty 'dissenting' commentaries

Wasserstein, R.L. and Lazar, N.A., 2016. 'The ASA's statement on p-values: context, process, and purpose', The American Statistician, DOI:10.1080/00031305.2016.1154108.

See also Christie Aschwanden at http://fivethirtyeight.com/features/not-even-scientists-can-easily-explain-p-values/

Statistical and mathematical modelling are at the hearth of science for policy; yet alarm about malpractices.

New Scientists talks of "statistical sausage factory"

FEATURE 13 April 2016

Why so much science research is flawed – and what to do about it

Dodgy results are fuelling flawed policy decisions and undermining medical advances. They could even make us lose faith in science. **New Scientist** investigates

An alarming amount of research is flawed
Brett Ryder

LEADER 13 April 2016

Science isn't as solid as it should be – but science can fix it

Unconscious biases and data-torturing are weakening our knowledge base – but unlike politicians and bankers, scientists aren't covering up their failings

New Scientist

A new community for science

New Scientist

From Andrea Saltelli, Jerome R. Ravetz and Silvio Funtowicz

We would like to complement your analysis of a crisis in science relating to studies that can't be replicated (16 April, p 5 and p 38). One of us, Jerome Ravetz, predicted in 1971 in his book *Scientific* Knowledge and its Social Problems that the system of internal quality control of science would not easily withstand the evolution toward big science.

Quality in science depends on the existence of a community of scholars linked by norms and standards, and willing to stand by these. The historian Philip Mirowski in Science-Mart (2011), fills in the blanks of Ravetz's analysis with details of how science's internal quality control system stalled when "market" replaced "community" as a unifying principle, driven by firms funding research.

The crisis has deep significance, since the contract between science and power is a basis of modernity. Science offers legitimacy to power via its guarantee of "truth". If trust collapses within the research sector, how can public trust be maintained for the many policy-relevant functions of science?

Reform will depend on the emergence of a new "polity" of science including citizen scientists who take responsibility for rooting out corruption of all sorts, scientist-citizens working primarily in the policy arena and concerned journalists and teachers. Issues of ethics and quality, previously largely restricted to coffee-time grumbles, now attract public debates and activist campaigns.

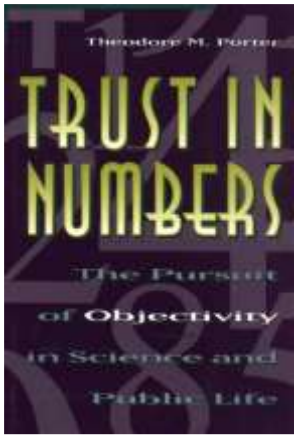
Bergen, Norway; Barcelona, Spain; and Oxford, UK

June 26, 2016
https://www.newscientist.com/letter/mg23030791-600-7-a-new-community-for-science/

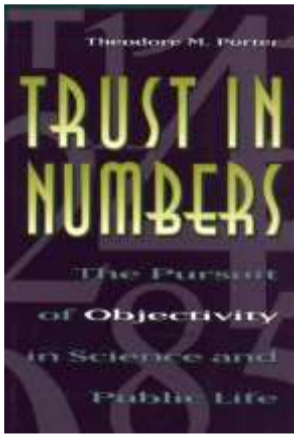
Quantification and trust

p. 8: “The appeal of numbers is especially compelling to bureaucratic officials who lack the mandate of a popular election, or divine right. Arbitrariness and bias are the most usual grounds upon which such officials are criticized. A decision made by the numbers (or by explicit rules of some other sort) has at least the appearance of being fair and impersonal.”

Theodor M. Porter



Theodore M. Porter, Trust in Numbers, The Pursuit of Objectivity in Science and Public Life, Princeton 1995



p. 8: “Scientific objectivity thus provides an answer to a moral demand for impartiality and fairness. Quantification is a way of making decisions without seeming to decide. Objectivity lends authority to officials who have very little of their own.”

Trust, authority and styles of quantification: two different stories

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US Army Corps of Engineers®

Porter's story: Quantification needs judgment which in turn needs trust …without trust quantification becomes mechanical, a system, and 'systems can be played'.

Can sensitivity analysis and auditing play a role in all this?

Demystifying the mathematics of uncertainty

As a critical tool for extended peer communities,
e.g. to deconstruct spoof evidence

Opening up of frames

Saltelli, A., Giampietro, M., Ravetz, J.R., 2016, Decalogue of the diligent quantifier. A Pledge.

Excerpts:

Don't quantify at gun point; My license to quantify is also a license not to quantify

Mind frames; mind motivations and power relations

Don’t swipe assumptions under the carpet

Each measure need a stable external referent

…

While sensitivity analysis enjoys universal recognition its use is scarce or deficient.

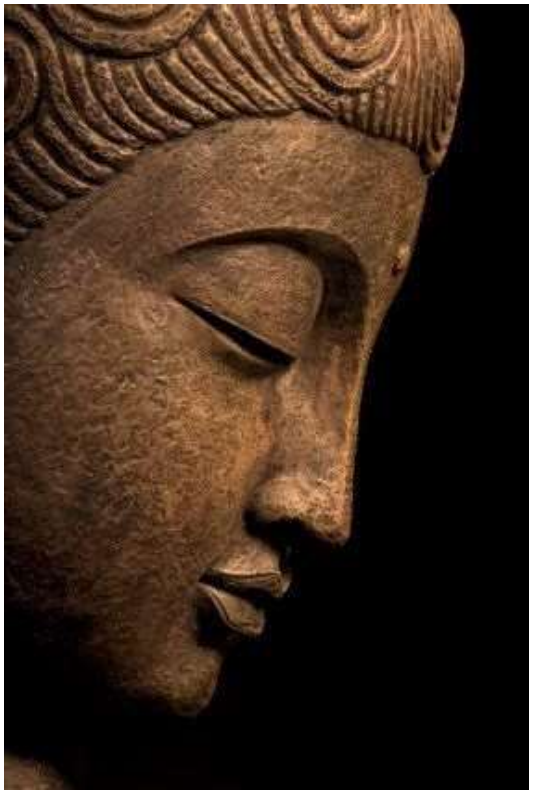
A general malaise? Loss of craft skills? A wider crisis of science's quality control apparatus?

Quantification and trust are linked. High responsibility of the quantifier.

Can sensitivity analysis and auditing help? To demystify spoof evidence, and fight hypocognition? A few SA-specific 'secrets' to help in this direction.

The problem, the cause, the solution, the way

What can be done?



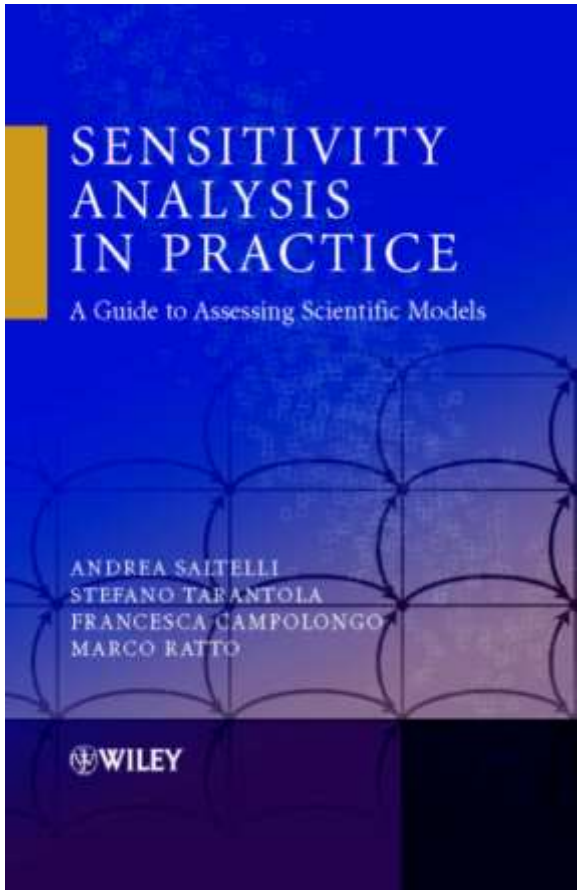
Short of a Reformation (!) practitioners can engage in upholding good practices in the discipline

Martin Luther and Johann Tetzel

COST action DM-SAMO

- Resolve fragmentation (e.g. see US 'Verification, Validation and Uncertainty Quantification' (VVUQ))
- Mainstream the discipline (have it taught in syllabuses)
  - Develop syllabuses
  - Prepare a MOOC
- Identify and consolidate practices in relevant problem settings
  - E.g. Taxonomies of settings; prepare a repertoire of exemplary industrial applications; ...
  - A new handbook

Sensitivity analysis books available on Library Genesis



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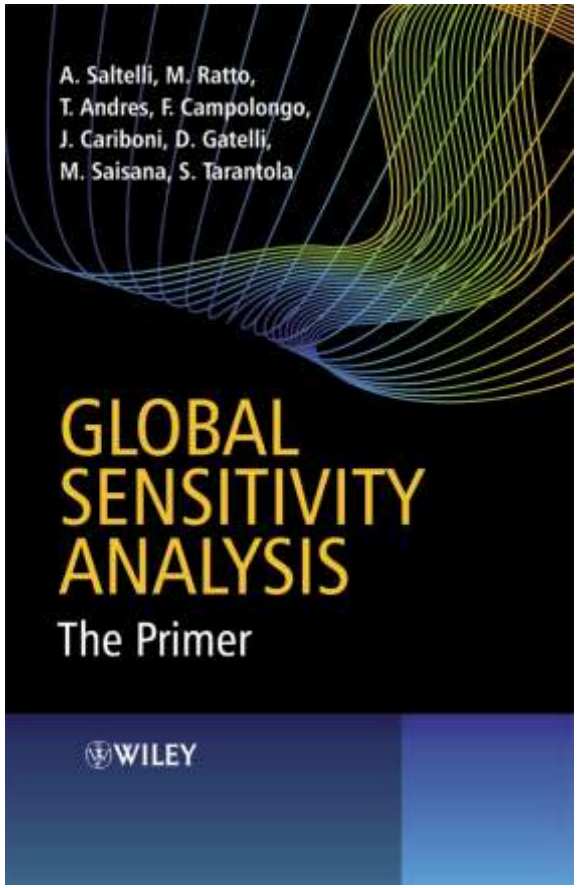

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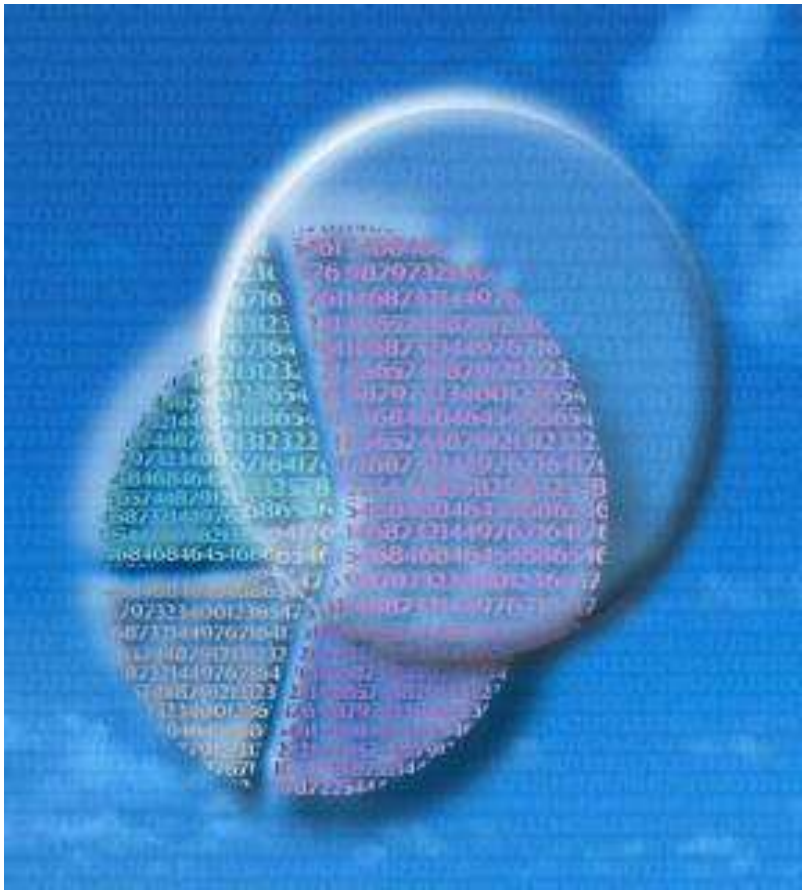
COST action DM-SAMO

- Students exchange programs
- Consolidate the SAMO series of conferences and summer schools
- Reach out to other discipline including social scientists, e.g. via the bridges such as sensitivity analysis ➔sensitivity auditing ➔ quantitative storytelling ➔ ethics of quantification ➔ epistemology ➔ science and technology studies (STS) …



END

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