Present challenges in sensitivity analysis

Andrea Saltelli

Centre for the Study of the Sciences and the Humanities (SVT) – University of Bergen (UIB)

Institut de Ciència i Tecnologia Ambientals (ICTA) – Universitat Autonoma de Barcelona (UAB)

SAMO2016 La Reunion (FR)

andrea.saltelli@uib.no
CAETERIS ARE NEVER PARIBUS

sensitivity analysis, sensitivity auditing, science for policy, impact assessment
= more material on my web site

= more material on Wikipedia
What happened since Nice 2013?
Sensitivity analysis books available on Library Genesis™
Sensitivity analysis acknowledged as necessary
Office for the Management and Budget, 2006

Environmental Protection Agency, 2009

European Commission, 2015


http://ec.europa.eu/smart-regulation/
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 **both** 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., 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?

… 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.”
“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.”
Problemsatic sensitivity analyses
Can I lie with sensitivity analysis as I can lie with statistics?

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

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

- $K=2$
- $K=3$
- $K=10$
> 1% of modelling paper have SA
< 0.1 % has global SA
Fig. 4. GSA in the different scientific domains.
Problematic quantifications in statistics
“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”

... and twenty ‘dissenting’ commentaries


See also Christie Aschwanden at http://fivethirtyeight.com/features/not-even-scientists-can-easily-explain-p-values/
A loss of craft skills in statistics?

Leek J.T., and Peng, R.D., 2015, P values are just the tip of the iceberg, Nature, 520, p. 612.
Statistical and mathematical modelling are at the hearth of science for policy; yet alarm about malpractices.

New Scientists talks of “statistical sausage factory”
A new community for science

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
Is there a crisis?
A crisis looms over the scientific enterprise. Not a day passes without news of retractions, failed replications, fraudulent peer reviews, or misinformed science-based policies.

Every day? http://www.nature.com/news/macchiarini-scandal-is-a-valuable-lesson-for-the-karolinska-institute-1.20539
Science in crisis: from the sugar scam to Brexit, our faith in experts is fading

September 27, 2016 4:43pm AEST

Unreliable research

Trouble at the lab

Scientists like to think of science as self-correcting. To an alarming degree, it is not

Oct 19th 2013 | From the print edition
The crisis has ethical, epistemological, methodological and even metaphysical dimensions;
Identified points of friction:

• paradigm of evidence-based policy

• use of science to produce implausibly precise numbers and reassuring techno-scientific imaginaries

• use of science to ‘compel’ decision by the sheer strength of ‘facts’
• Generation of new data/publications at an unprecedented rate

• Compelling evidence that the majority of these discoveries will not stand the test of time.

• Causes: failure to adhere to good scientific practice & the desperation to publish or perish.

In the book we have a different theory but … read the book!
Science/knowledge degenerates when it becomes a commodity for Ravetz (1971), Lyotard (1979) and Mirowski (2011).


In economics see the ‘Mathiness’ discussion: blogs of Paul Romer, Judith Curry and Erik Reinert’s ‘scholasticism’ paper.

See https://paulromer.net/mathiness/


http://www.andreasaltelli.eu/file/repository/Full_Circle_scholasticism_2.pdf
Institutions charged with science advice choose to ignore the crisis

Please cite this paper as:

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OECD Science, Technology and Industry Policy Papers No. 21

Scientific Advice for Policy Making

THE ROLE AND RESPONSIBILITY OF EXPERT BODIES AND INDIVIDUAL SCIENTISTS

OECD
BREXIT and the election of D. Trump have unleashed a debate on post-truth, end of expertise, and ultimately a new season of science wars.

Andrea Saltelli and Silvio Funtowicz, Science wars in the age of Trump, November 16, 2016
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.”

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
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
An old book from STS scholars Silvio Funtowicz and Jerome R. Ravetz’s

(STS=studies of science and technology)

EPILOGUE

“…Numbers, however, are still esoteric knowledge, the property of a small set of initiates […] Only when there is effective quality control of science for policy, through the management of uncertainties, will we be able to cope intelligently with the crises we face. The demystification of the mathematics of uncertainty is therefore a central part of the programme for the democratization of scientific expertise.”

Quantitative story-telling and responsible quantification
What is quantitative story telling?

• A truism: always listen more than one story

• An exhortation from philosophers

• A development from sensitivity analysis and sensitivity auditing

• A concept implicit in post-normal science’s concept of “extended peer communities”
“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.
Stories, frames / framings, narratives

Some examples
Most analyses offered as input to policy are framed as cost benefit analysis or risk analyses.

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).


Lakoff, G., 2004-2014, Don’t think of an elephant: know your values and frame the debate, Chelsea Green Publishing.
GMO treated as an issue of nutritional health safety by proponents and as an issue of power and control by opponents.

The Economist, Vermont v science, The little state that could kneecap the biotech industry, May 10th 2014
Frames as hypocognition &
Socially constructed ignorance
For Rayner (2012) “Sense-making is possible only through processes of exclusion. Storytelling is possible only because of the mass of detail that we leave out. Knowledge is possible only through the systematic ‘social construction of ignorance’ (Ravetz, 1986)”


Rayner’s (2012) strategies societies may use to deal with “uncomfortable knowledge”.

- Denial: “There isn’t a problem”
- Dismissal: “It’s a minor problem”
- Diversion: “Yes I am working on it” (In fact I am working on something that is only apparently related to the problem)
- Displacement: “Yes and the model we have developed tells us that real progress is being achieved” (The focus in now the model not the problem).

“Uncomfortable knowledge” can be used as a gauge of an institution’s health.

The larger the “uncomfortable knowledge” an institution needs to maintain, the closer it is to its ancient régime stage (Funtowicz and Ravetz, 1994).

Why frames ‘stick’

“If is difficult to get a man to understand something when his salary depends upon his not understanding it.”

Upton Sinclair
So what does quantitative story telling propose?

Instead of detailed quantification on a single[/few] frame[s] a rough quantitative appraise of a richer set of frames.

Andrea Saltelli and Mario Giampietro, The Fallacy of Evidence-Based Policy, in Benessia et al, 2016

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

…
How can sensitivity analysis play a role?

Mastering of the ‘secrets’
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.
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 [null hypothesis in modelling]

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]
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 sensitivity analysis spots it!
Remember to justify why you are using one given methods among the available zillion on methods.

= The application must drive the choice of the method.
Don’t …

… run a sensitivity analysis where each factor has a 5% uncertainty
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.
END

Twitter:
@andreiasaltelli