

Why so many published sensitivity analyses are false: a systematic review of sensitivity analysis practices

Andrea Saltelli, Ksenia Aleksankina, William Becker, Pamela Fennell, Federico Ferretti, Niels Holst, Qiongli Wu

Ninth International Conference of Sensitivity analysis #SAMO_2019, Barcelona, Castelldefels, October 28-30 2019

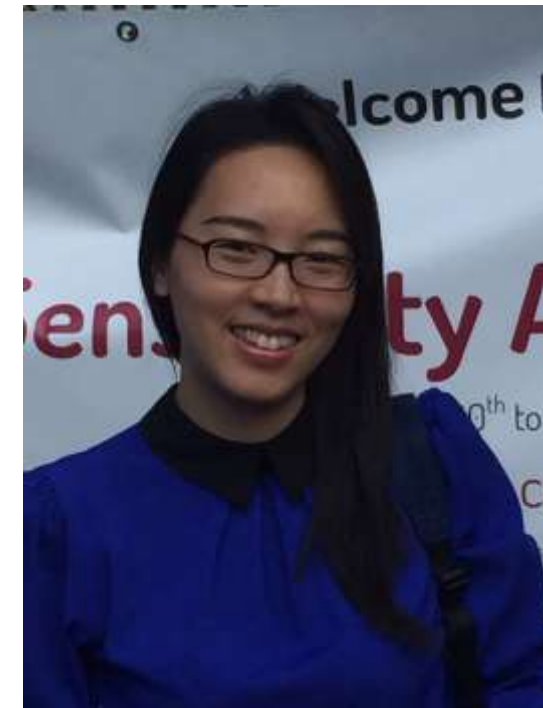
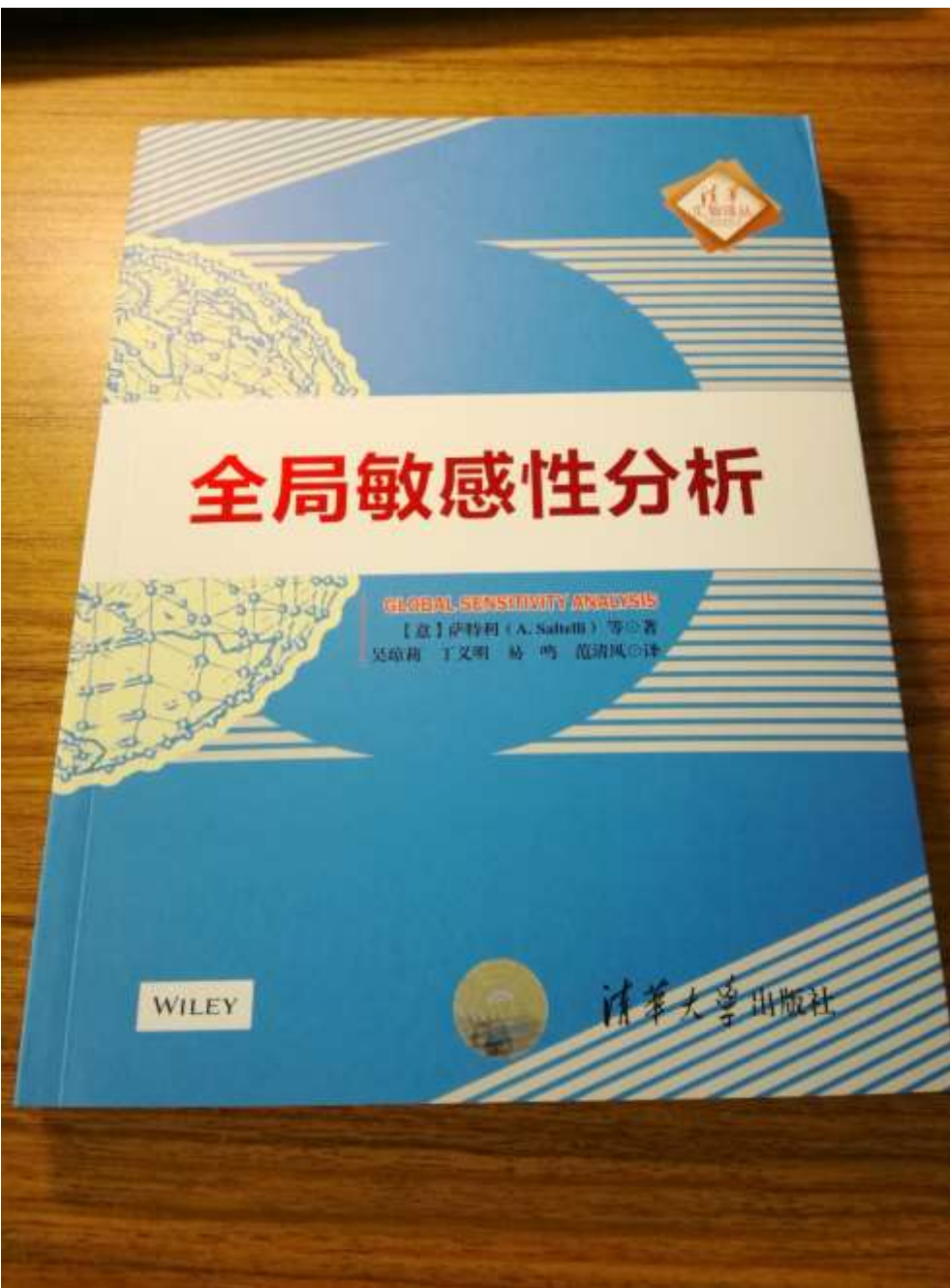


A. Saltelli, M. Ratto,
T. Andres, F. Campolongo,
J. Cariboni, D. Gatelli,
M. Saisana, S. Tarantola

GLOBAL SENSITIVITY ANALYSIS

The Primer

 WILEY



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Environmental Modelling & Software

Volume 114, April 2019, Pages 29-39



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Andrea Saltelli ^{a, b}  , Ksenia Aleksankina ^c, William Becker ^d, Pamela Fennell ^e, Federico Ferretti ^d, Niels Holst ^f, Sushan Li ^g, Qiongli Wu ^h

Why false?

Environmental Modelling & Software 25 (2010) 1508–1517



ELSEVIER

Contents lists available at ScienceDirect

Environmental Modelling & Software

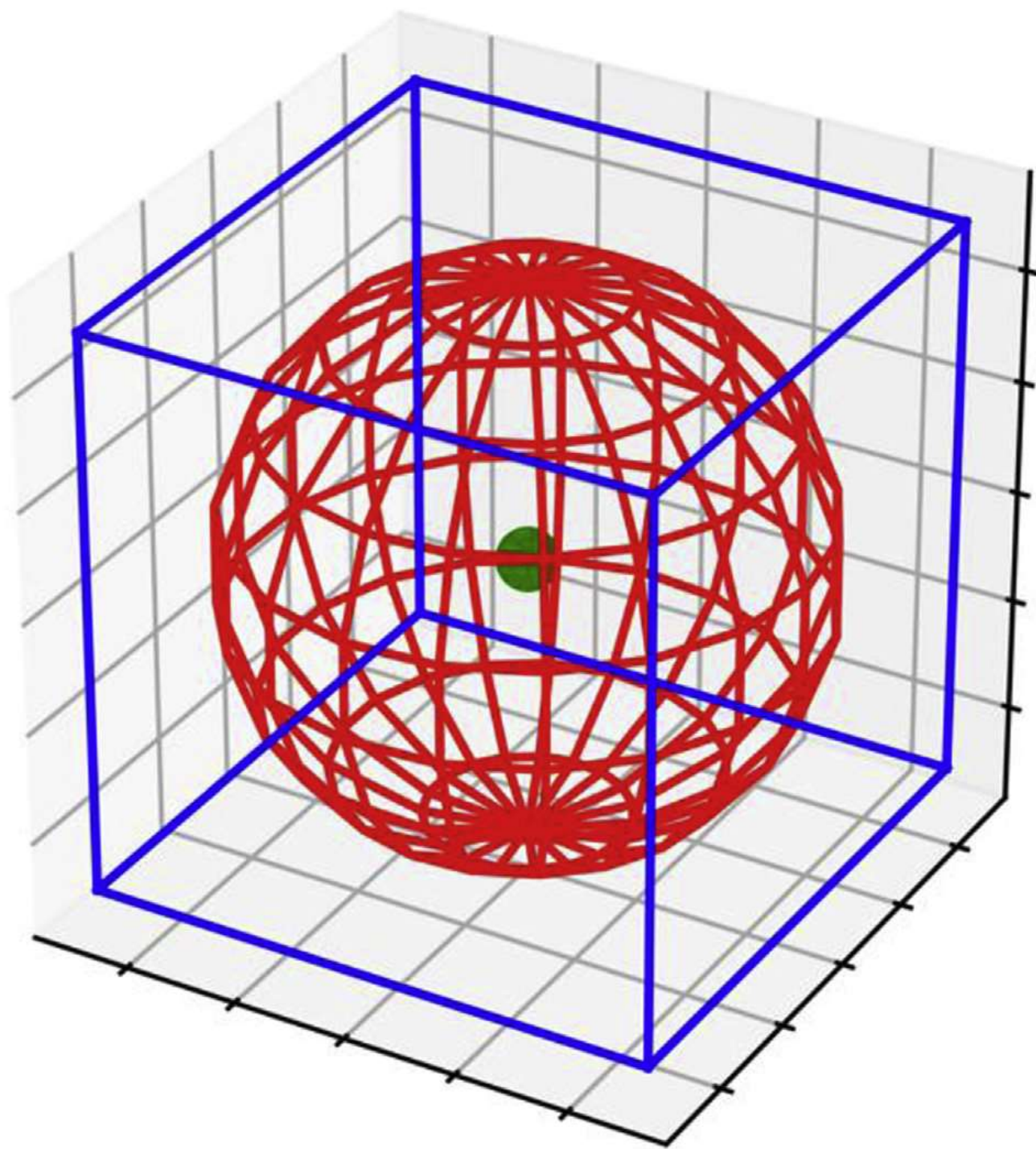
journal homepage: www.elsevier.com/locate/envsoft



How to avoid a perfunctory sensitivity analysis

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A sphere included in a cube (three-dimensional case) and tangent to its faces. The volume of the sphere divided that of the cube is roughly $1/2$

If the dimension were ten instead of three the same ratio would be 0.0025





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Literature search in Scopus

Query: “sensitivity analysis” & “model/modelling”
& “uncertainty”; years 2012–2017; journal
articles; in English

→ 6000 articles

- AgrBioSci (Agricultural and Biological Sciences)
- BiochemGenMBio (Biochemistry, Genetics and Molecular Biology)
- BusManAcc (Business, Management and Accounting)
- Chemi (Chemistry)
- ChemEng (Chemical Engineering)
- CompSci (Computer Science)
- DecSci (Decisional Science)
- EarthSci (Earth and Planetary Sciences)
- EconFin (Economy and Finance)
- Energy (Energy)
- Engineering (Engineering)
- EnvSci (Environmental Science)
- ImmunMicrobio (Immunology and Microbiology)
- MatSci (Material Science)
- Math (Math)
- Medicine (Medicine)
- PharTox (Pharmacology and Toxicology)
- PhysAstro (Physics and Astronomy)
- SocSci (Social Science)

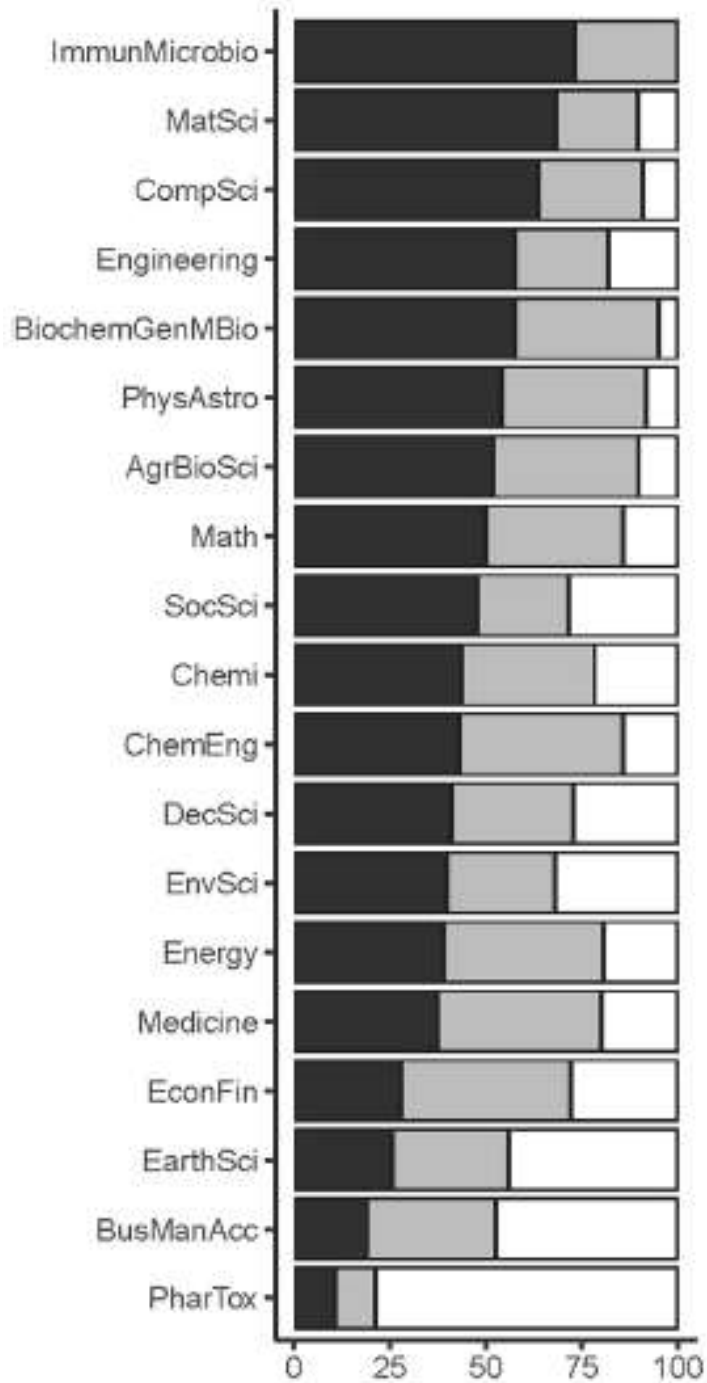
Limit subject areas to those with >100 articles (19 areas)

Taking the top twenty most-cited papers in each subject area:

→ 324 articles, divided among authors

Cleansing manually irrelevant articles:

→ 280 articles



SA method



Global



OAT



None/Unclear

Still many papers
apply an OAT SA:
65%

What if the model is truly linear?

Linear	7%
Nonlinear	61%
Unclear	32%

Linear	7%
Nonlinear	61%
Unclear	32%

65% highly cited articles are OAT

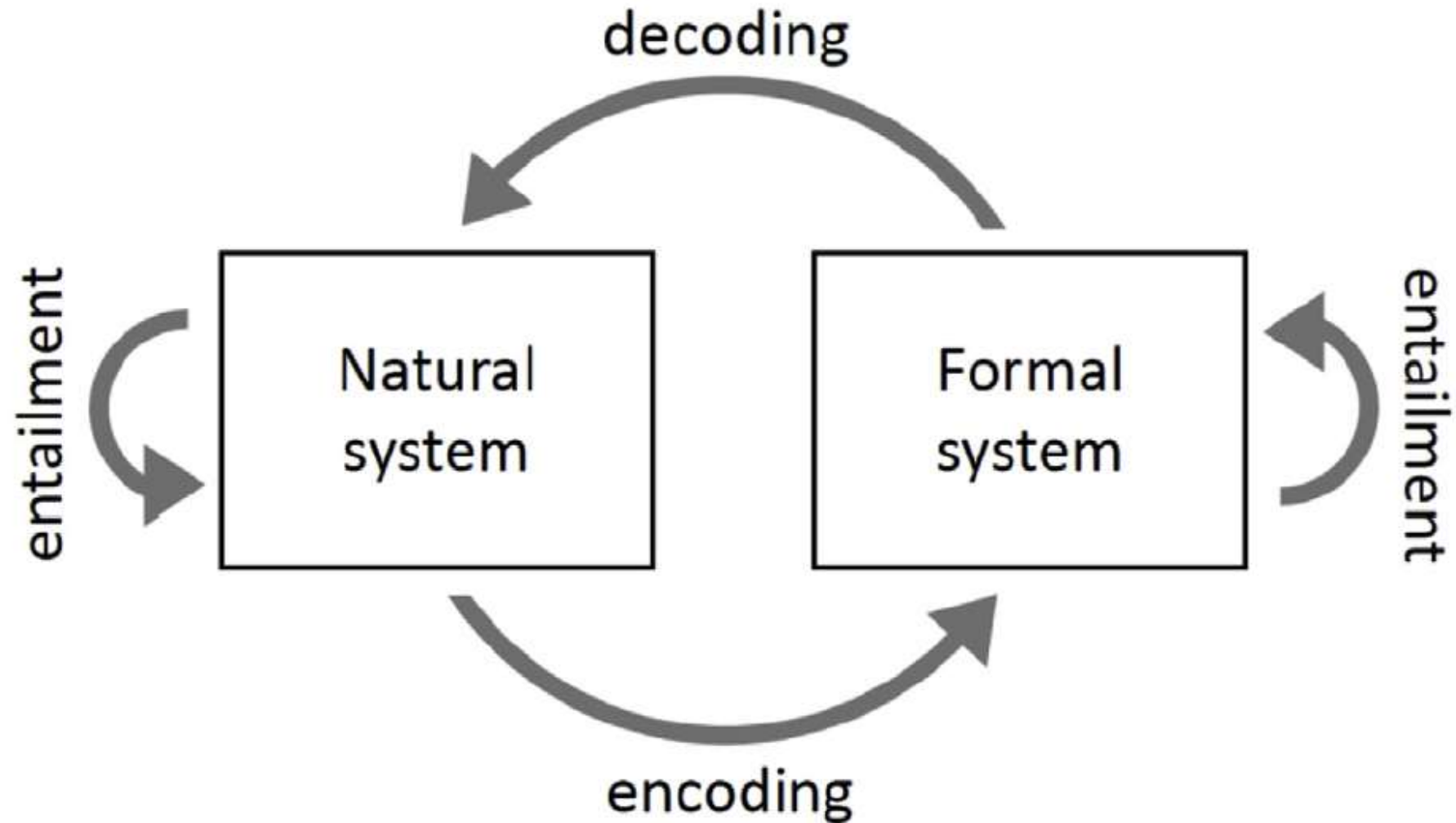
Taking all 'unclear' as 'linear' →
still over 20% of papers wrong
(OAT & non-linear model)

Why?

Discussion

Reasons for bad practice

Why? → 1. Modelling as a craft



Why? → 2. Each discipline going about modelling on its own separate way; pockets of SA practitioners (out of our 280 papers, 35 were methodological, of which 24 suggest global SA)

Why? → 3. Good practices require training in statistics

Why? → 4. More time is needed; though mature global sensitivity analysis methods around for more than 25 years researchers tend to emulate methods found in highly cited papers assuming that they are best practice

Why? → 5. Strategic reasons: global SA is bad if one wants to play the uncertainty game, inflating or deflating uncertainties instrumentally (see sensitivity auditing)



When All Models Are Wrong

BY ANDREA SALTELLI, SILVIO FUNTOWICZ

Sensitivity auditing

EC guidelines on impact assessment 2015, and
SAPEA report 2019



Interested? Come to our ‘Numbers for policy’ school in November 18–20, here in Castelldefels

<https://www.uib.no/en/svt/127988/numbers-policy-practical-problems-quantification>

with Samuele Lo Piano, Jeroen van der Sluijs and myself.

Solutions? 1. Statistics as a discipline
takes responsibility for statistical
methods for
model validation and verification

Example: who can authoritatively suggest
to modellers not to overinterpret results
from multi-model ensembles?

ISSUES

IN SCIENCE AND TECHNOLOGY

◀ VOL. XXXI, NO. 3, SPRING 2015

Climate Models as Economic Guides: Scientific Challenge or Quixotic Quest?

BY [ANDREA SALTELLI](#), [PHILIP B. STARK](#), [WILLIAM BECKER](#), [PAWEL STANO](#)

Climate Models as Economic
Guides: Scientific Challenge or
Quixotic Quest?

BY ANDREA SALTELLI, PHILIP B. STARK, WILLIAM BECKER, PAWEŁ STANO

A plea against audacious risk or cost-benefit analyses running over centennial time scales; example: crime rate as modified by climate change in US at the level of the county in 2100

Solutions? 2. Learn from what happens in statistics where the p-test crisis is being tackled head on

... mathematical modelling cannot do this:



**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

Wasserstein, R.L. and Lazar, N.A., 2016. 'The ASA's statement on p-values: context, process, and purpose', *The American Statistician*, Volume 70, 2016 – Issue 2, Pages 129–133.



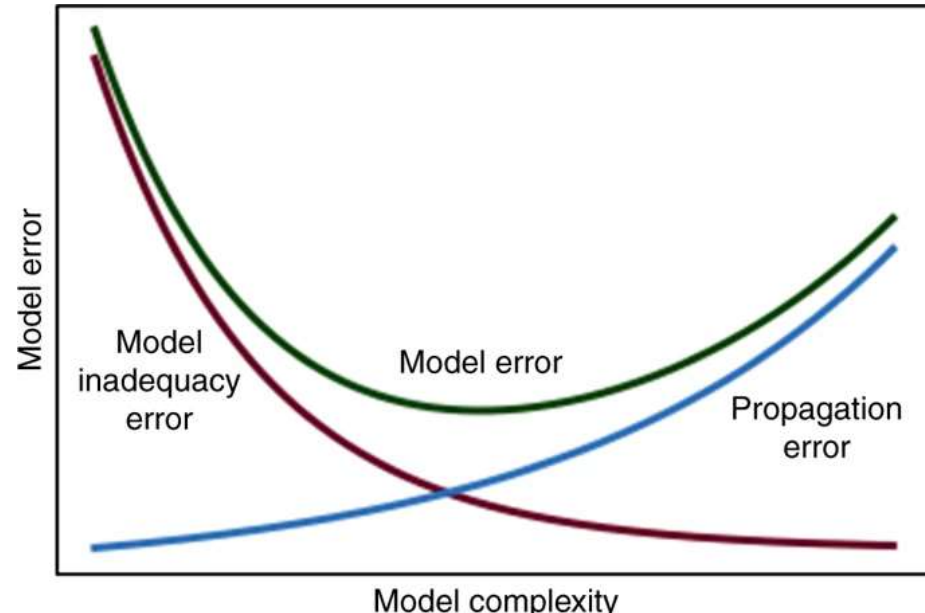
Cargo-cult statistics and scientific crisis

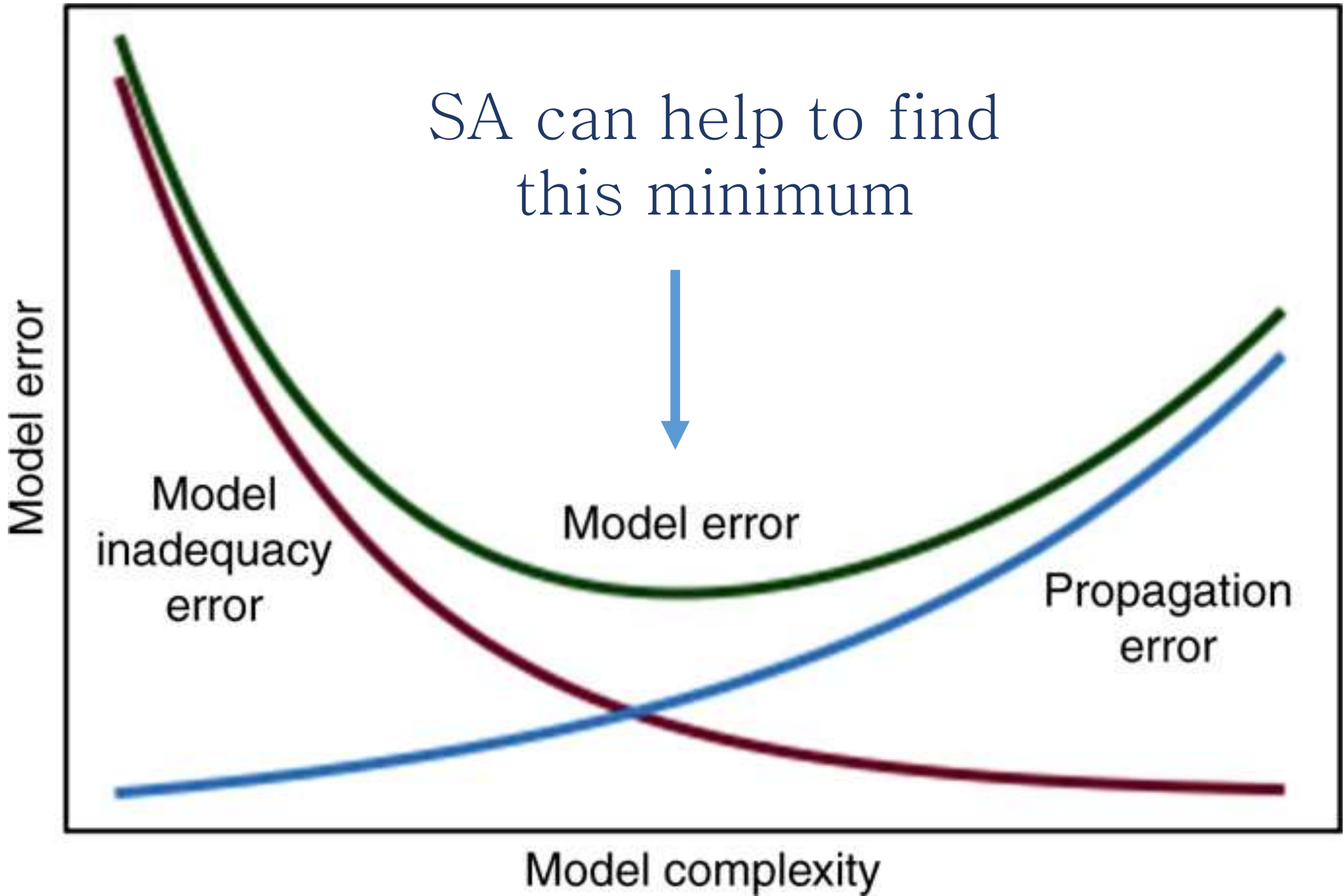
The mechanical, ritualistic application of statistics is contributing to a crisis in science. Education, software and peer review have encouraged poor practice – and it is time for statisticians to fight back. By **Philip B. Stark** and **Andrea Saltelli**

Lessons for sensitivity analysis

- Global SA
- UA and SA coupled
- Purpose- & context-specific
- The map is not the territory

- Memento







Comment

Open Access

Published: 27 August 2019

A short comment on statistical versus mathematical modelling

Andrea Saltelli 

The author's name, Andrea Saltelli, followed by a blue square icon containing a white envelope symbol, indicating an email contact.

The End

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