Severe uncertainty and info-gap decision theory: a perspective from the Land of the Black Swan

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For almost ten years now, I have been engaged in numerous discussions with applied ecologists and conservation biologists about info-gap decision theory (IGDT). As a matter of fact, evidence of this can be found in this magazine. For instance, in Issue 24 (2008, p. 10), I issued a *Call for the reassessment of info-gap decision theory*, suggesting the following, among other things:

> 'So, what is needed now is not another workshop on Info-Gap Applications, but something more along the lines of a half-day forum on "What Exactly is Wrong With Info-Gap Decision Theory and Why knowing this Matters?". This is long overdue.'

What prompted me to issue this call from the pages of this magazine, was statements, such as the following, attesting to the vigorous promotion of IGDT in Australia by individual scholars, and by government supported centers (e.g AEDA, ACERA) and to the resulting enthusiastic embrace of this theory by applied ecologists and conservation biologists in the *Land of the Black Swan* (Decision Point, Issue 16, 2008, p. 5):

> "In cases where a decision is required in conditions of severe uncertainty it's possible to use a technique as info-gap analysis. For example suppose you wanted to evaluate the optimal spacing between reserves but you only have a best guess for the dispersal distance of the species you want to conserve and this best guess is highly uncertain by an unknown amount.
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> Info-gap theory approaches uncertainty analysis from the opposite direction as probabilistic methods. Rather than specifying the extent of uncertainty in parameters at the outset, info-gap theory takes the position that the best management strategy is the one that gives us an outcome that is acceptable under the greatest level of unfavorable uncertainty. That is, we choose a strategy that maximizes the reliability of an adequate outcome.
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> Yakov Ben-Haim, one of the AEDA chief investigators based in Israel, is the inventor of Info-gap theory and has helped many AEDA members to understand and use this novel concept."

Note that, as I point out below, far from being novel, the concept "info-gap robustness", which is the central pillar of IGDT, is in fact a reinvention of a staple measure of local robustness/stability, that is used extensively in many fields, and is known universally as *radius of stability* (circa 1960). Also, the concept "reliability" does not exist in IGDT, indeed, it is completely exogenous to it. This means that the theory cannot possibly maximize the "reliability of an adequate outcome".

The objective of this short note is to advise readers of this magazine that I recently issued a *Third and* **Final** *Call for The Reassessment of the Use and Promotion of Info-Gap Decision Theory in Australia*[1].

By making this a **final** call, I want to give notice that my campaign to convince leading applied ecologists and conservation biologist in Australia that IGDT is egregiously flawed and that this fact ought to be discussed, in the open, preferably in peer-reviewed ecology journals, is now drawing to a close because it clearly begins to bear fruit.

To illustrate, consider the following extracts from the most comprehensive peer-reviewed assessment of IGDT to-date, entitled *Severe uncertainty and info-gap decision theory*, by Hayes et al. (2013), published in *Methods in Ecology and Evolution*:

[1] See http://info-gap.moshe-online.com/third_call_2013.html

> "Ecologists and managers contemplating the use of IGDT should carefully consider its strengths and weaknesses, reviewed here, and not turn to it as a default approach in situations of severe uncertainty, irrespective of how this term is defined. We identify four areas of concern for IGDT in practice: sensitivity to initial estimates, localized nature of the analysis, arbitrary error model parameterisation and the ad hoc introduction of notions of plausibility.
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> Sniedovich (2008) bases his arguments on mathematical proofs that may not be accessible to many ecologists but the impact of his analysis is profound. It states that IGDT provides no protection against severe uncertainty and that the use of the method to provide this protection is therefore invalid.
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> The literature and discussion presented in this paper demonstrate that the results of Ben-Haim (2006) are not uncontested. Mathematical work by Sniedovich (2008, 2010a) identifies significant limitations to the analysis. Our analysis highlights a number of other important practical problems that can arise. It is important that future applications of the technique do not simply claim that it deals with severe and unbounded uncertainty but provide logical arguments addressing why the technique would be expected to provide insightful solutions in their particular situation.
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> Plausibility is being evoked within IGDT in an ad hoc manner, and it is incompatible with the theory's core premise, hence any subsequent claims about the wisdom of a particular analysis have no logical foundation. It is therefore difficult to see how they could survive significant scrutiny in real-world problems. In addition, cluttering the discussion of uncertainty analysis techniques with ad hoc methods should be resisted."

I should also call attention to the article *Fooled by local robustness: an applied ecology perspective* (Sniedovich 2012), published in *Ecological Applications*. While Hayes et al.'s (2013) assessment focuses on IGDT's mistreatment of severe uncertainty, Sniedovich (2012) gives a broader characterization and assessment of IGDT. The main points it makes are these:

- IGDT's robustness model is a reinvention of the radius of stability model (circa 1960).
- IGDT's robustness model is a very simple maximin model. More accurately, relative to other models deriving from Wald's famous maximin paradigm (1960), IGDT's robustness model is an extremely simple model.
- IGDT's robustness model is a model of **local** robustness, meaning that IGDT is a theory of **local** robustness.
- IGDT is therefore utterly unsuitable for the treatment of the severe uncertainty that it postulates.

To illustrate the last point, contrary to what is proposed in Wintle et al. (2010), the point made in Sniedovich (2012) is that IGDT most definitely is ill-equipped to deal with the challenges posed by Taleb's *Black Swans*, let alone ... *Unknown Unknowns*.

Applied ecologists and conservation biologists using IGDT, as well as those who contemplate using it, would do well to consult Sniedovich (2012) and Hayes et al. (2013) to appreciate the implications of these points for their projects.

An important lesson learned from the IGDT experience in Australia over the past ten years is that it is important to keep in mind that the revered peer-review process is

not infallible, meaning that it is always good practice to ascertain whether theories, even those that are being advocated from the pages of well established peer-reviewed journals, are too good to be true, for as we know, they often are!

More information: `http://info-gap.moshe-online.com/DecisionPoint`

References

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