

To IG or not to IG? – that is the question

Decision-making under uncertainty

By David Fox

I found the article by Sniedovich (2008) interesting, challenging and illuminating. Mark Burgman's (2008) response was equally informative and, in a somewhat more genteel way, equally provocative. I would like to share some observations/insights as someone who has spent a career working with uncertainty and all its manifestations.

More recently I, like some others at the University of Melbourne have been exposed to Yakov Ben Haim's Info Gap (IG) theory. Indeed I have jointly published a paper on an IG approach to power and sample size estimation (Fox et al. 2007). I believe Yakov has done us a great service if for no other reason than getting us to think a lot more about how we make decisions – the underlying theory, processes, models, and metrics.

However, given the current level of interest and some openly expressed reservations, perhaps it's time to open this up for wider input from mathematicians and operations research scientists as alluded to by Burgman (2008). IG provides us with one way of assessing the impact on a measure of utility or performance when there is uncertainty in the parameters of the performance model. There are of course numerous other strategies embodied in classical decision theory, frequentist and Bayesian statistics. What I would find useful is a comparative study with some general advice – for example, about the similarities and differences in approaches, the strengths and weaknesses, and under what (if any) conditions would a particular strategy be preferred?

I believe the recent exchange of views in the last two editions of Decision Point raises another uncertainty, and that is: what actually constitutes decision-making? Of course the trite response is decision-making is about

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Info-gap and uncertainty

Editor's note: Moshe Sniedovich's article in Decision Point #22 on Info-gap analysis sparked a passionate response from some readers (see Burgman, 2008). Here we run another view point on the topic of decision making under uncertainty from David Fox. The breakout box presents a short note from Moshe Sniedovich calling for a re-examination of info gap.

making decisions. I suspect part of the debate stems from a lack of clear delineation between an estimation problem and a decision-making problem. I appreciate that these are not mutually exclusive and in many instances decisions will be made on the basis of what we estimate (for example, the decision about how much water to return to a river as an environmental flow is predicated on a reliable estimate of the current flow).

There are other times, where we simply wish to quantify something because the estimate has intrinsic interest (it may be used by others for making decisions, but the original and primary objective was to simply estimate an unknown and use this as a proxy for a fact – for example, 1 in 4 Australian children are obese). Sniedovich's (2008)

map of Australia illustration prompted me to think of the problem this way: one person is asking “how far away from the camp fire can I be and still be warm?”; while the other is asking “where's the camp fire?”.

Returning to one of my lingering concerns with IG theory and it concerns the term ‘robustness’. Robustness is the largest horizon of uncertainty for which specified minimal requirements are always satisfied (Ben-Haim 2006, p38). But beyond the mathematical definition how does one

A call for the reassessment of Info-Gap Decision Theory

In this short note I re-iterate what I have been arguing over the past three years: that the use/promotion of info-gap in Australia should be reassessed. This is long overdue.

This reflects my position that it is time to face up to the sharp differences between two conflicting evaluations of info-gap decision theory. On one hand, the view that info-gap decision theory is a novel approach to decision-making under severe uncertainty that is well suited for the treatment of a variety of practical problems in ecology and conservation biology. On the other, the position that a formal examination of info-gap decision theory reveals that this theory is a “voodoo” decision theory par excellence in the sense that not only does it lack sufficient evidence or proof, but also that its treatment of severe uncertainty is fundamentally flawed and its assessment of its role and place in decision theory is mistaken.

The reasons for a reassessment of the use and promotion of info-gap decision theory in Australia are compelling.

My extensive experience in explaining the failings of info-gap decision theory to info-gap users has been that their understanding of these flaws has enhanced their appreciation of the challenges encountered in the formulation, modeling and treatment of severe uncertainty.

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.

And as a final note, I should stress that I harbor no illusions about the challenges faced by this Call. As I mentioned above, I have been active on this front for more than three years now and I am fully aware of how difficult it is to move info-gap users from their position. Still, a reevaluation of this position is of the essence, and the sooner this is done the better.

More details on this subject can be found on my website at www.moshe-online.com.

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interpret and use robustness since its numerical value is context-specific? Thus, a robustness of 6, say in one problem is not comparable to a robustness of 6 for a different problem. It is for precisely these reasons that we quote a correlation coefficient to convey something about the strength of a (linear) relationship between two variables rather than their covariance.

Perhaps robustness was never meant to be used in this manner, but I think the concept invites such comparisons. In any event, if we restrict our attention to a single decision-making problem that is multi-parameter, we find ourselves contemplating essentially the same question. For example, in the paper on power analysis (Fox et al. 2007), we assumed the same numerical robustness value for each of the parameters σ ; effect size; and the pdf. In doing this we were allowing the same relative error in all three quantities, although it's not clear how a relative error of α in σ say, compares to a relative error of α in the pdf. For me, this frailty of the IG theory introduces a form of 'linguistic uncertainty' (Burgman 2005, Ben-Haim 2006) – brought about by the adoption of a broadly used, everyday term to describe a narrowly-defined mathematical construct. Thus my notion of a 'robust' decision may be different to yours but the discrepancy is not removed by appealing to the IG definition of robustness.

Finally, I would like to see some comparative analysis of various decision-making strategies – including IG. The goal would be to assess strengths and weaknesses and offer some general advice regarding situations in which one approach might be expected to be better suited than another. There are parallels here with the historical schism between Bayesian and frequentist statistics. The statistical

profession spent many years and devoted many journal pages to the debate over the legitimacy of the Bayesian paradigm.

Thankfully the old divisions between the two statistical camps have largely given way to a more pragmatic approach that accommodates multiple modes of statistical inference with the choice increasingly based on the notion of 'fit-for-purpose' rather than ideological or pedagogical constructs. I believe the decision-maker should have a number of decision-making tools in the tool kit and be prepared to use them depending on the circumstances at hand. As they say, if all you've got is a hammer, then the whole world's a nail!

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