



## Abstract

Voodoo decision theories have a number of major advantages over scientific theories. It is not surprising therefore that they can become very popular in scientific circles, including refereed journals. For this and other reasons it is very important and useful to acquire basic skills to identify such theories. In this presentation I provide some practical tips for the identification of Voodoo decision theories, especially theories that are designed for [robust decision-making in the face of severe uncertainty](#). I illustrate these tips in action by a formal, rigorous, mathematical analysis of [Info-Gap decision theory](#).

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## Program

- How do you make **robust** decisions in the face of **severe** uncertainty?
  - Severe Uncertainty
  - Voodoo Decision Theories
  - Info-Gap Decision Theory
  - Classical Decision Theory
  - Australian perspective
  - My Info-Gap Campaign
- Collaboration
- Site visit: [decision-making.moshe-online.com](http://decision-making.moshe-online.com)
- FAQs

# Admin

This is a

Math Classification G

presentation.

Math Classification MA +18

versions can be found at

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## Severe Uncertainty

### Working Assumption

$$|\text{Estimate} - \text{True Value}| \gg \varepsilon > 0$$

The estimate we have is

- A wild **guess**.
- A **poor** indication of the true value.
- Likely to be **substantially wrong**.

### Difficulty

**Results** obtained in the neighborhood of the **estimate** are likely to be **substantially wrong** in the neighborhood of the **true** value.

## Severe uncertainty

### Region of Severe Uncertainty

true value



poor estimate



### Uncertainty Models for Severe Uncertainty

- Non-probabilistic
- Likelihood-free

## AU Perspective

What is the most popular methodology for  
robust decision-making under severe uncertainty  
in a number of prestigious research organizations in  
Australia

?



# Example

## Decision-Making Under **Severe** Uncertainty



bio-security

homeland-security



# Example

A new reliable technical indicator for predicting financial markets



## Example

### Planning for robust reserve networks using uncertainty analysis

... In summary, we recommend **info-gap uncertainty analysis** as a **standard practice** in computational reserve planning. The need for **robust** reserve plans may change the way biological data are interpreted. It also may change the way reserve selection results are evaluated, interpreted and communicated. **Information-gap decision theory** provides a standardized methodological framework in which implementing reserve selection uncertainty analyses is relatively straightforward. We believe that alternative planning methods that consider **robustness** to model and data error should be preferred whenever models are based on uncertain data, which is probably the case with nearly **all** data sets used in reserve planning ...

Ecological Modelling, 199, pp. 115-124, 2006  
Finland (1), USA (3), Australia (3), Israel (2)

# AU Perspective: Example

# αεδα

**Applied Environmental Decision Analysis**  
A Commonwealth Environment Research Facility  
*smart science for wise decisions*

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## Events & Workshops

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### UP & COMING ...

15 - 19 Sept, 2008	<a href="#">Info-Gap Applications in Ecological Decision Making</a> (5 Day workshop with Prof. Yakov Ben-Haim).
6 - 10 Oct, 2008	Multispecies Management Workshop, Brisbane, Queensland

# AU Perspective

## New Secret Weapon Against Severe Uncertainty

$$\hat{\alpha}(q) := \max\{\alpha \geq 0 : r \leq R(q, u), \forall u \in U(\alpha, \tilde{u})\}, q \in \mathcal{Q}$$

Known as

## Info-Gap Robustness Model

Ben-Haim (1996, 2001, 2006)

Very popular in a number of research organizations in Australia



# Voodoo Decision Theory



# Voodoo Decision Theory

## Encarta online Encyclopedia

### **Voodoo** n

- ① A religion practiced throughout Caribbean countries, especially Haiti, that is a combination of Roman Catholic rituals and animistic beliefs of Dahomean enslaved laborers, involving magic communication with ancestors.
- ② Somebody who practices voodoo.
- ③ A charm, spell, or fetish regarded by those who practice voodoo as having magical powers.
- ④ A belief, theory, or method that lacks sufficient evidence or proof.

# Voodoo Decision Theory



# Voodoo Decision Theory





# Voodoo Decision Theory



# Voodoo Decision Theory



# Good Company

- Voodoo economics
- Voodoo science
- Voodoo mathematics
- Voodoo Decision-making

# Voodoo Decision Theory

Apparently very popular,

## Example

The behavior of Kropotkin's cooperators is something like that of decision makers using Jeffrey expected utility model in the Max and Moritz situation. Are ground **squirrels** and **vampires** using **voodoo decision theory**?

Brian Skyrms

*Evolution of the Social Contract*

Cambridge University Press, 1996.

Issue:

Evidential **dependence**, but causal **independence**.

## Voodoo Decision-Making vs Scientific decision-making

### Major Obstacles to Progress in Scientific Decision-Making

- Garbage In – Garbage Out
- The results of an analysis can be only as good as the estimates on which it is based.
- Beware of the distinction between local and global analysis.
- Thou shalt not contradict thyself!

They do not hinder progress in Voodoo Decision-making!

## Example: The legend

An old **legend** has it that an ancient **treasure** is hidden in an Asian-Pacific **island**.



**You** are in charge of the treasure hunt. How would **you** plan the operation?

# The legend

Main issue: location, location, location!

## Terminology



Certainty



Risk



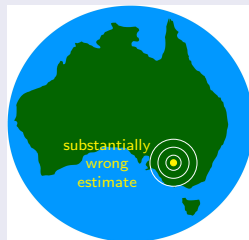
Severe  
Uncertainty

# Voodooism

## The Fundamental Theorem of Voodoo Decision Making



$\approx$



Severe Uncertainty

### 1.2.3 Recipe

- ① Ignore the severity of the uncertainty.
- ② Focus on the substantially wrong estimate you have.
- ③ Conduct the analysis in the immediate neighborhood of this estimate.



# Voodooism

## Voodoo Decision-Making

Region of Severe Uncertainty

poor estimate



# Voodooism

## Conventional Decision Theory

GI  $\rightarrow$  **Model**  $\rightarrow$  GO

Wrong  $\rightarrow$  **Model**  $\rightarrow$  Wrong

The robustness of any decision and the risk incurred in making that decision is **only as good as the estimates on which it is based**. Making estimation even more challenging, virtually all estimates that affect decisions are uncertain. Uncertainty can not be eliminated, but it can be managed.

Top Ten Challenges for Making Robust Decisions

The Decision Expert Newsletter, Volume 1; Issue 2

<http://www.robustdecisions.com/newsletter0102.php>

# Voodooism

Decision Theory

GI



GO

Wrong



Wrong

# Voodooism

## Voodoo Decision Theory

*garbage*

*GI*



**Model**



*gold*

*GO*

**Wrong**



**Model**



**Right**

**Alchemy**

## Question

What is the most popular **Voodoo Decision Theory** for robust decision-making under severe uncertainty in a number of research centers in

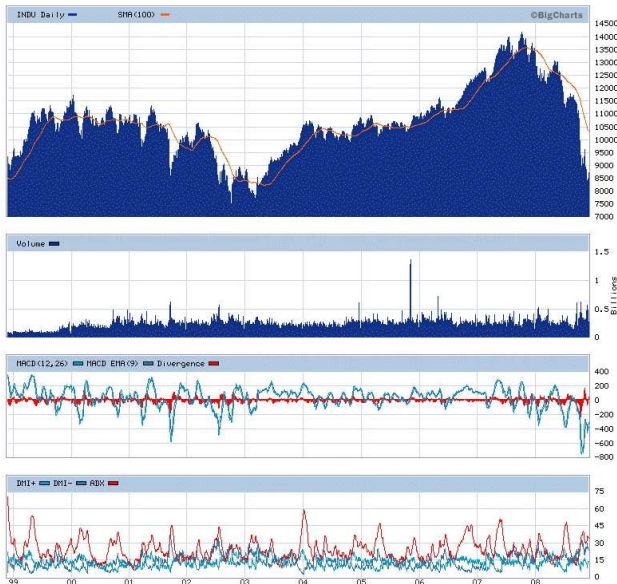
# Australia

?



# Example

A new reliable technical indicator for predicting financial markets



## Example

### Applied ecology and conservation biology



# This seminar

## Objective of this seminar

- Overview of Voodoo Decision-Making (5000 BC – )
- Tips for identifying Voodoo Decision Theories
- Overview of Info-Gap Decision Theory (1996 – )
- Progress report on my Info-Gap Campaign (2006 – )
- Raise/Answer questions



The Spin Stops Here!



# This seminar

## Why bother about Voodoo Decision Theories?

- Party
- Refereeing
- Reviewing research proposals
- Examining PhD Theses
- Assessing financial investment strategies
- Medical equipment/treatment
- Evaluating your very own models and theories

## This seminar

### Tips for recognizing Voodoo Decision Theories

- Clear the fog, **spin**, rhetoric
- Check the **assumptions**
- Ask yourself: isn't it **too good** to be true?
- Check the GIGO Axiom
- Double-check: are we **reinventing** the (square) wheel?
- Apply your **mathematical** skills!
- Check the **10 Natural Laws** of Operations Analysis
- Consult books such as  
**Fashionable Nonsense**: Postmodern Intellectuals' Abuse of Science (Alan Sokal, Jean Bricmont, 1999)  
**Voodoo Science**: The Road from Foolishness to Fraud (Robert Park, 2001)



## Info-Gap Revisited

### Impressive Self-Portrait

Info-gap decision theory is **radically different** from **all** current theories of decision under uncertainty. The difference originates in the modelling of uncertainty as an information gap rather than as a **probability**. The need for info-gap modeling and management of uncertainty arises in dealing with **severe lack of information and highly unstructured uncertainty**.

Ben-Haim [2006, p. xii]

In this book we concentrate on the fairly **new** concept of information-gap uncertainty, whose differences from more classical approaches to uncertainty are **real** and **deep**.

Ben-Haim [2006, p. 11]

# Info-Gap

## Obvious Questions

- ① Does Info-Gap **substantiate** these very strong claims?
- ② Are these claims **valid**?

## Not So Obvious Answers

- ① **No**, it does not.
- ② Certainly **not**.

It is therefore important to subject Info-Gap to a formal analysis – that actually should have been done seven years ago:

Info-Gap  
Formal vs Analysis  
Classical Decision Theory

Good news: should take no more than 5-10 minutes!

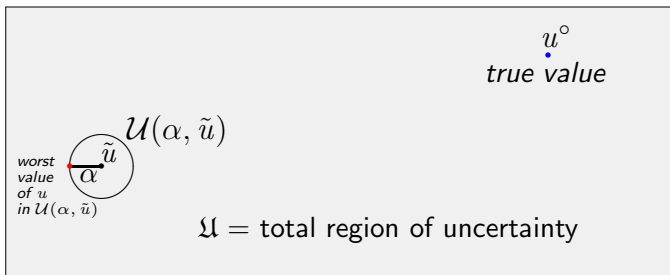
# Info-Gap Decision Theory

## Complete Generic Robustness Model

$$\hat{\alpha}(r_c) := \max_{q \in \mathbb{Q}} \max \{ \alpha \geq 0 : r_c \leq R(q, u), \forall u \in \mathcal{U}(\alpha, \tilde{u}) \}$$

$$\mathcal{U}(\alpha, \tilde{u}) \subseteq \mathcal{U}(\alpha + \varepsilon, \tilde{u}), \forall \varepsilon > 0$$

## Region of Severe Uncertainty, $\mathfrak{U}$



# Info-Gap Decision Theory

## Complete Generic Robustness Model

$$\hat{\alpha}(r_c) := \max_{q \in \mathbb{Q}} \max \{ \alpha \geq 0 : r_c \leq R(q, u), \forall u \in \mathcal{U}(\alpha, \tilde{u}) \}$$

## Fundamental FAQs

- |   |                                      |                 |
|---|--------------------------------------|-----------------|
| ① | Is this <b>new</b> ?                 | Definitely not! |
| ② | Is this radically <b>different</b> ? | Definitely not! |
| ③ | Does it make <b>sense</b> ?          | Definitely not! |

So what is all this **hype** about Info-Gap ?!

Good question!

# Info-Gap Decision Theory

## First Impression

### Complete Generic Robustness Model

$$\hat{\alpha}(r_c) := \max_{q \in \mathbb{Q}} \max \{ \alpha \geq 0 : r_c \leq R(q, u) \forall u \in \mathcal{U}(\alpha, \tilde{u}) \}$$

### Observations

- This model **does not deal** with severe uncertainty, it simply and unceremoniously **ignores** it.
- The analysis is **invariant** with  $\mathfrak{U}$ : the **same solution** for all  $\mathfrak{U}$  such that  $\mathcal{U}(\hat{\alpha}(r_c), \tilde{u}) \subseteq \mathfrak{U}$ .
- This model is **fundamentally flawed**.
- This model advocates **Voodoo** decision-making.



# Info-Gap Decision Theory

## First Impression

### Fool-Proof Recipe

Step 1: *Ignore* the severe uncertainty.

Step 2: Focus instead on the *poor estimate* and its immediate neighborhood.

### Region of Severe Uncertainty



# Info-Gap Decision Theory

## First Impression

Region of Severe Uncertainty



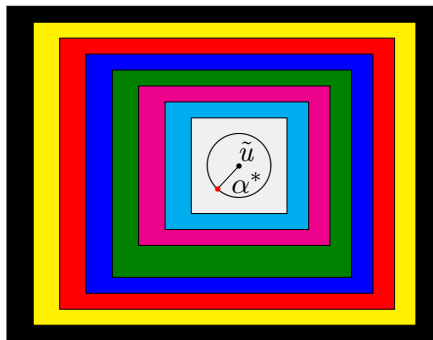
Recall that this is **voodoo** decision making!

# Info-Gap Decision Theory

## Complete Generic Robustness Model

$$\alpha^* := \max_{q \in \mathbb{Q}} \max \{ \alpha \geq 0 : r_c \leq R(q, u), \forall u \in \mathcal{U}(\alpha, \tilde{u}) \}$$

## Fundamental Flaw



# Info-Gap Decision Theory

More formally

## Invariance Theorem (Sniedovich, 2007)

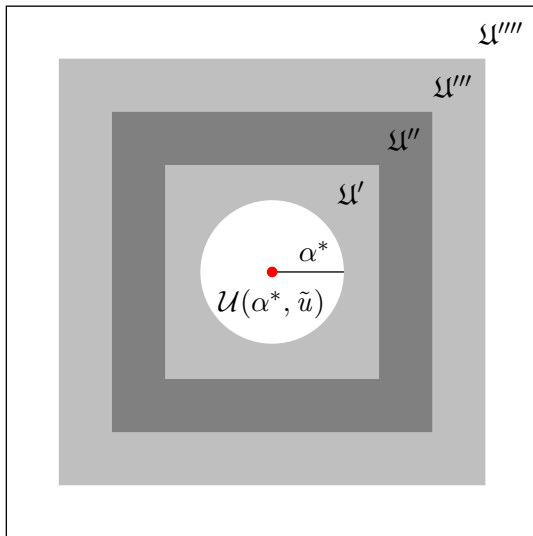
Info-Gap's robustness model is invariant to the size of the total region of uncertainty  $\mathfrak{U}$  for all  $\mathfrak{U}$  larger than  $\mathcal{U}(\alpha^*, \tilde{u})$ , where  $\alpha^* := \hat{\alpha}(r_c)$ .

That is, the model yields the same results for all  $\mathfrak{U}$  such that

$$\mathcal{U}(\alpha^* + \varepsilon, \tilde{u}) \subseteq \mathfrak{U}, \quad \varepsilon > 0$$

# Info-Gap Decision Theory

## Info-Gap's Invariance Property



# Info-Gap Decision Theory

## Maximin Theorem (Sniedovich 2007, 2008)

Info-Gap's robustness model is a simple instance of **Wald's Maximin model** (circa 1940). Specifically,

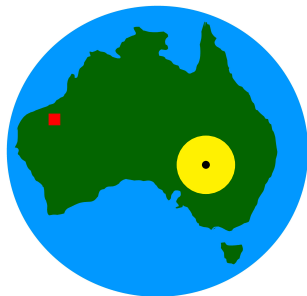
$$\begin{aligned}\alpha(q) &:= \max_{\alpha \geq 0} \{ \alpha : r_c \leq R(q, u), \forall u \in \mathcal{U}(\alpha, \tilde{u}) \} \quad , \quad q \in \mathbb{Q} \\ &= \max_{\alpha \geq 0} \min_{u \in \mathcal{U}(\alpha, \tilde{u})} \psi(q, \alpha, u)\end{aligned}$$

where

$$\psi(q, \alpha, u) := \begin{cases} \alpha & , \quad r_c \leq R(q, u) \\ 0 & , \quad r_c > R(q, u) \end{cases} \quad , \quad \alpha \geq 0, q \in \mathbb{Q}, u \in \mathcal{U}(\alpha, \tilde{u})$$

## Info-Gap: Typical misconception

### Treasure Hunt



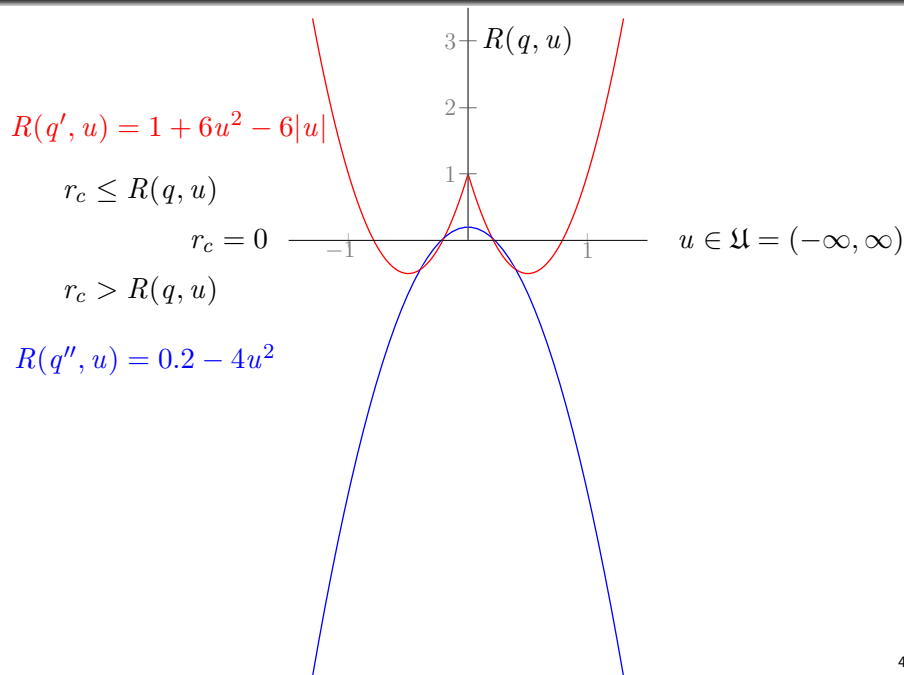
### Myth:

#### How wrong can I be, yet be safe?

- Region of uncertainty.
- Estimate of the location.
- Region affecting Info-Gap's analysis.
- True (unknown) location.

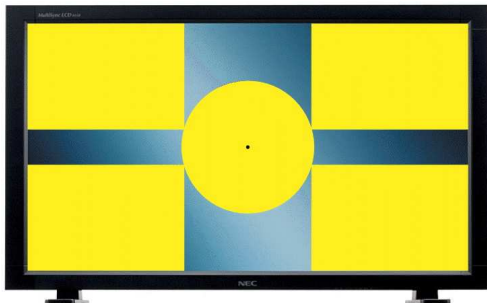
### Fact:

Info-gap may conduct its robustness analysis in the vicinity of **Brisbane** (QLD), whereas for all we know the true location of the treasure may be somewhere in the middle of the **Simpson desert** or perhaps in down town **Melbourne** (VIC). Perhaps.





# Local vs Global Robustness



"Yellow" Device  
Very powerful.  
Covers most of the screen.



"Green" Device.  
Very weak. Effective only  
in the middle of the screen.

**The Winner!!!!**  
(a la Info-Gap)

## Quiz on Info-Gap:

### Recognizing Voodoo Decision Theories

- Fog, spin, rhetoric
- Assumptions
- Too good to be true!
- Violation of the GIGO Axiom
- Reinvention of a square wheel
- Local vs Global
- Contradiction
- 10 Natural Laws of Operations Analysis

# Info-Gap Decision Theory

## Bottom Line

### Fool-Proof Recipe

Step 1: *Ignore* the severe uncertainty.

Step 2: Focus instead on the *poor estimate* and its immediate neighborhood.

### Region of Severe Uncertainty

Neighborhood of a Wild guess



True value



Local Maximin Analysis

# Australian Perspective



# Why am I here?

## Issues

- Refereed Publications
- Research Grants
- PhD Theses
- Keynote Lectures
- Workshops

## Voodoo decision theories are not good for

- Decision-Making
- Mathematics
- Science
- Australia
- .

## Conclusions

- Decision-making under severe uncertainty is **difficult**.
- It is a **thriving** area of research/practice.
- The **Robust Optimization** literature is extremely relevant.
- The **Decision Theory** literature is extremely relevant.
- The **Operations Research** literature is very relevant.
- Beware of Voodoo decision theories.
- **Info-Gap** decision theory is a **Voodoo** decision theory.
- **Info-Gap** decision theory is a **square** wheel.

Join my campaign!




## The Ten Natural Laws of Operations Analysis

- ① Ignore the problem and go immediately to the solution, that is where the profit lies.
- ② There are no small problems only small budgets.
- ③ Names are control variables.
- ④ Clarity of presentation leads to aptness of critique.
- ⑤ Invention of the wheel is always on the direct path of a cost plus contract.
- ⑥ Undesirable results stem only from bad analysis.
- ⑦ It is better to extend an error than to admit to a mistake.
- ⑧ Progress is a function of the assumed reference system.
- ⑨ Rigorous solutions to assumed problems are easier to sell than assumed solutions to rigorous problems.
- ⑩ In desperation address the problem.

Bob Bedow, *Interfaces* 7(3), p. 122, 1979.

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# Decision-Making Under Severe Uncertainty

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- Voodoo Decision-Making
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- Severe Uncertainty
- Maximin
- Info-Gap Decision Theory
- Satisficing vs Optimizing
- Too Good to be True!
- Reinventing a Square Wheel
- Black Swans
- New Nostradamuses
- Alchemy
- The Spin Stops Here!








# FAQs?










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