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Bounded awareness, heuristics and the Precautionary Principle

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ABSTRACT

The Precautionary Principle has been proposed as a basis for making decisions about environmental issues but remains controversial. Using a model of inductively justified propositions about awareness, this paper shows how the Precautionary Principle may be interpreted as a heuristic guide for boundedly rational decision-makers faced with the possibility of unfavorable surprises.

1. Introduction

The Precautionary Principle, most commonly presented as a guide to environmental policy decisions, is widely used, controversial and hard to define precisely. While no exact formulation of the principle has achieved unanimous support, the Precautionary Principle has been widely advocated. The version adopted by the Wingspread Conference (1998) is fairly representative:

> Where an activity raises threats of harm to the environment or human health, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context the proponent of an activity, rather than the public, bears the burden of proof.

Considered as a generic rule, this formulation of the principle could be read as a simple requirement to take risks into account, even if they are unproven, a prescription that is embodied in all mainstream approaches to the theory of decision under uncertainty. This is the interpretation given by Gollier et al. (2000), who focus on the option value associated with waiting for further information. Since a complete risk analysis should incorporate option values, this defence of the Precautionary Principle amounts to the claim that, in practice, risk analyses are usually incomplete, and that this error can be corrected by adoption of the Precautionary Principle.

On the other hand, as critics have pointed out, stronger formulations of the principle appear to rule out all courses of action that may have adverse consequences, which would potentially give rise to situations where every possible action was

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rejected. For example, Sunstein (2003, p. 1003) argues that, since no course of action can be risk-free, strong versions of the Precautionary Principle are incoherent:

> I aim to challenge the Precautionary Principle here, not because it leads in bad directions, but because read for all that it is worth, it leads in no direction at all. The principle threatens to be paralyzing, forbidding regulation, inaction, and every step in between.

Sunstein goes on to claim that operationalizing the Precautionary Principle requires ignoring some risks and that the application of standard principles of risk analysis will yield better outcomes on average.

As these examples show, most discussion of the Precautionary Principle, both favorable and unfavorable, has taken place on the basis of an assumption that decision-makers can and should take all possible contingencies into account. That is, although decisions may be subject to uncertainty, they are taken on the basis of an evaluation of all possible contingencies, and the associated outcomes of particular courses of action.

In this paper we consider a more fundamental objection to a policy of exclusive reliance on benefit–cost analysis, leading to an alternative interpretation of the Precautionary Principle. Given the bounded rationality of human agents, it is impossible to enumerate and consider all relevant possibilities. This point is sometimes expressed with reference to 'unknown unknowns', that is, relevant possibilities of which we are unaware (Rumsfeld, 2002). It follows that benefit–cost analysis can never encompass all relevant possibilities. For some decisions, involving courses of action similar to those undertaken on many previous occasions, and for which there exists a well-developed theoretical framework, the set of possibilities considered may be sufficiently detailed and accurate to yield an analysis that may be regarded for practical purposes as complete. For other decisions, the role of 'unknown unknowns' may be critical.

It is one thing to observe that human decisions are commonly subject to unforeseen and unconsidered contingencies. A more difficult problem is to reason about decision problems involving such contingencies and to prescribe appropriate actions.

The first difficulty is to formulate a logical framework in which statements such as 'there exist possibilities of which I am unaware' make sense. In recent years a variety of different approaches to the problem have been explored (Heifetz et al., 2006, 2009; Halpern and Rêgo, 2006, 2008, 2009, 2011). In this paper, we will focus on the idea that induction from past experience permits decision-makers to make judgments about whether they are, or are not, aware of all relevant contingencies in particular problems (Grant and Quiggin, 2013; Walker, 2013).

An even more difficult problem is to offer guidance to decision-makers in such situations. The central problem of decision-making with bounded awareness is evident in the terminology of 'unknown unknowns'. How can a decision-maker take account of her own bounded awareness, given that, by definition, the contingencies of which she is unaware are unknown to her? Grant and Quiggin (2013) propose the adoption of 'awareness-based heuristics', that is, decision rules that can be implemented based on the decision-makers' perception of the game or decision problem they are facing, combined with an inductively derived judgment as to whether there exist relevant contingencies of which they are unaware.

The central problem with such heuristics is that, unless they judge themselves to be aware of all relevant contingencies associated with a given decision problem, decision-makers cannot, *ex ante*, evaluate the expected payoff to the adoption of an awareness-based heuristic in a given situation. Evaluated on the basis of a formal model of the contingencies under consideration, the adoption of a non-trivial heuristic (that is, one that differs from the prescription 'choose the course of action that maximizes expected utility') can never increase (perceived)welfare and may reduce it. Thus, the adoption of an awareness-based heuristic by an individual makes sense only on the basis of an inductively justified conclusion that there exist unconsidered possibilities relevant to the outcome.

The expected return to the adoption of a heuristic can be evaluated from the perspective of an outside observer who is aware of all relevant contingencies. One interpretation of an awareness-based heuristic, therefore, is that it might represent advice that could be given by a fully aware external adviser to a boundedly rational decision-maker who is capable of adopting and implementing the heuristic, but not of understanding and solving the full game (or decision problem).

An alternative approach to the evaluation of heuristics is based on the idea of 'ecological rationality' proposed by Goldstein and Gigerenzer (2002). Goldstein and Gigerenzer suggest a concept of ecological rationality for heuristics, explained as 'the capacity of the heuristic to exploit the structure of the information in natural environments'. In this paper, we will show how this concept can be applied to awareness-based heuristics.

The heuristic interpretation of the Precautionary Principle proposed in this paper arises when a decision-maker is faced with a choice between alternatives, one of which leads to consequences for which the relevant elements of the state space are well-understood and the other which leads to consequences that depend to a significant extent on 'unknown unknowns'.

If most surprises are unpleasant, a risk analysis based only on known risks will underestimate the costs of choices of the second kind. That is, standard risk analysis leads to a bias in favor of taking chances on poorly-understood risks. The Precautionary Principle may be seen as a rule designed to offset such biases. Our primary aim in this paper is to show how the Precautionary Principle may be understood as an ecologically rationally heuristic constraint on decisions and strategies for individuals who are unaware of relevant contingencies and understand this to be the case.

The paper is organized as follows. In Section 2, we develop a formal model of reasoning and decision-making for an individual who is, in general, unaware of some relevant possibilities, but understands that she may become aware of new possibilities over time. This model is derived from that of Grant and Quiggin (2013), simplified to apply to the special case of individual decisions. Readers interested in a more detailed exposition of the modal-logical and game-theoretic aspects of the