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## DECISION: FOUNDATION & PRACTICE II

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### 1 BACKGROUND

- 1.1 Our overall objective is to create man-computer symbiotic systems for decision-making that utilize the full capabilities of all the sub-systems involved.
- 1.2 To do this involves both practical work on actual decision-making systems and foundational work on the logics and system theories underlying decision making.
- 1.3 We see a strong convergence between theories based on Spencer Brown's (1969) calculus of distinctions and practice based on Kelly's (1955) personal construct theory.
- 1.4 The following notes are an outline of some salient points. We assume the availability of last year's papers (Gaines 1978a, Shaw 1978).

### 2 KNOWLEDGE & DECISION

- 2.1 Hume's argument against the possibility of knowledge creates fundamental problems for any theory of decision that takes knowledge as a primitive.
- 2.2 Taking decision itself as a primitive, however, one introduces notions of value that are not explicit in a theory of knowledge alone.
- 2.3 Values are the presuppositions necessary to make action possible.
- 2.4 Humean knowledge then becomes decisions valued according to the accuracy of predictions about the future.
- 2.5 However, to establish this definition requires notions of 'prediction' and the 'future' which are themselves problematic.
- 2.6 Hume's argument can be shown to be inherent in these problematic definitions and derived tautologically from effective definitions of the direction of time such as those of Reichenbach.
- 2.7 This still leaves time itself as a problem !

### 3 PRACTICE & DECISION

- 3.1 We contrast prediction as the use of information for passively establishing the future with action as the use of information for actively establishing the future.
- 3.2 The equivalent of passive 'knowledge' is then active 'power'.
- 3.3 Knowledge and power may be treated within a formal framework of decision making that makes little distinction between them.
- 3.4 Thus we can see 'technology' as a means of changing the world to make prediction, and hence 'science', easier.
- 3.5 There is then mutual feedback between science and technology that leads both towards a world that is both more predictable and more controllable.

### 4 THE ROLE OF THE COMPUTER

- 4.1 We see the computer as an 'emancipatory' tool enabling people to cope with the complexity of decision-making required in modern society (Shaw & Gaines 1979).
- 4.2 We have noted that, "we can envision the computer as helping the individual in a number of different ways:
- (1) Modelling of data within a given framework (confirmation);
  - (2) Indication of search strategy for data most likely to cause a change of model (falsification);
  - (3) Indication of the effects of actions on the state of the model (simulation);
  - (4) Indication of actions most likely to lead to desired model or state of model (decision);
  - (5) Indication of presuppositions underlying the above four processes (paradigm)."

(Shaw & Gaines 1979 p.137)

- 4.3 So far we have implemented programs for (1) (Gaines 1977) and (5) (Shaw 1979), and our current work is concerned with amalgamating these and extending them to cover (2) through (4).
- 4.4 We have recently (Shaw & Gaines 1980) put the work on (5) within the framework of fuzzy semantics.
- 4.5 This allows the on-line analysis and feedback of results to be couched in the same terminology as the construct elicitation so that a true dialogue is possible.

- 4.6 The user can query the analysis and propose alternatives, and the system can explain from what data the queried analysis arises, or what data prevents the proposed analysis being correct.
- 4.7 One important development of the FOCUS construct analysis program arising from this is that it has been extended to derive an entailment structure for constructs rather than just to cluster them.
- 4.8 We see this work as leading to a 'database' system that satisfies a far wider range of user requirements than do current systems (Gaines 1979).

## 5 DIALECTICS

- 5.1 We have noted the desirability of going beyond (5) above to:
  - "(5') Indication of a change in presuppositions that would greatly improve applications (1) through (4) (paradigm shift)." (Shaw & Gaines 1979 p.138).
- 5.2 Kelly's constructive alternativism encourages this, but it is most actively developed in Hegel's dialectical method (Lenin 1914).
- 5.3 Hegel goes from the concept of a general negation to that of a specific negation that has the connotations of 'an opposite'. The specific negation of a thesis is its antithesis. The thesis and antithesis together may be regarded as forming the poles of a construct and it is this construct which is the synthesis.
- 5.4 We have developed the semantics of this concept of 'opposite' within a fuzzy relevance logic that gives foundations for both Kelly's construct theory and Hegel's dialectics (Shaw & Gaines 1980).
- 5.5 In this context it is significant to note that White (1979) has now proved the conjecture made in Gaines (1976) that the axiom of comprehension in set theory is consistent if quantified Lukasiewicz logic is used rather than classical predicate calculus.
- 5.6 Since the axiom of comprehension, that every predicate defines a set, is so natural to human reasoning this lends support to the conjecture that fuzzy logic may provide an adequate model of human reasoning. It also strengthens the status of formal systems based on Lukasiewicz logic.

## 6 CONFLICTS, P INDIVIDUALS AND POSSIBLE WORLDS

- 6.1 Theories of decision making with insufficient information are far better developed than those for decision making with too much information. Yet in real-life the conflict of over-determination is more common than the uncertainty of under-determination.
- 6.2 The difficulty with over-determination is that it involves contradiction between information or objectives and this leads to the breakdown of classical logic.

- 6.3 Multi-sorted modal logics can be used to represent conflicts adequately, and it is now possible to deal with these formally. However, the computational complexity of such systems is formidable and seems to rule them out as adequate models of human reasoning in conflict situations.
- 6.4 We are using decision-making under conflict as a rationale for the formation of multiple P Individuals (Pask 1975) in the same M Individual. Each P Individual uses a system of constructs that leads to a consistent logic for its reasoning processes. P Individuals may have differing types of overlap provided each is internally self-consistent.
- 6.5 If we look at a population of M Individuals then we may find them supporting a number of isomorphic P Individuals. The construct system common to one such P individual defines a "world" which has all the characteristics of Popper's "third world" (Popper 1974).
- 6.6 In this context we may see Popper's emphasis on the ontological status of a "third world" as being justified in terms of its role in creating a particular form of P Individual across a population.
- 6.7 Thus a 'mathematician' is a P Individual who has entered 'the world of mathematics' through the literature of mathematics.
- 6.8 Combining this with Wolff's (1976) evocative terminology in Surrender and Catch we can define a P Individual as one who constructs a particular "construct system" by which to "surrender" himself to a particular "third world" in order to "catch" its essence.

## 7 FOUNDATIONS BASED ON THE CALCULUS OF DISTINCTIONS

We are attempting to found our whole enterprise on propositions that are clearly acceptable and which may be translated into formal operational theory. The following section is the initial sequence of a theory based on Brown's "Calculus of Distinctions" up to the point where we introduce the notion of a decision.

- 0 We will discuss distinctions, systems, hierarchies, valuations, decisions, practice, knowledge, power.
- 0.1 We presuppose that discussion is possible.
- 0.2 We use words that yet have no meaning.
- 1 "Making a distinction" is a primitive act.
- 1.1 There is a logic of making distinctions.
- 1.2 Distinction making alone is form alone.
- 1.3 We call the logic of making distinctions alone a syntax of distinctions.
- 2 Distinctions may be made amongst distinctions.

- 2.0.1 We call the logic of making distinctions that takes account of "distinctions amongst distinctions" a semantics of distinctions.
- 2.1 The distinction between distinctions alone and "distinctions amongst distinctions" generates levels of distinction.
  - 2.1.1 We say that a "distinction amongst distinctions" is at a level 'above' the distinctions themselves which are conversely at a level 'below' the "distinctions amongst distinctions".
- 2.2 We create the levels when we make this distinction.
- 2.3 Distinctions may be made amongst "distinctions amongst distinctions".
  - 2.3.1 This creates a further level of distinctions.
- 2.4 The distinction between levels of distinctions generates a hierarchy of distinctions.
- 2.5 We create the hierarchy when we make this distinction.
- 2.6 The logic of making distinctions within a hierarchy we call a hierarchic semantics for distinctions.
- 3 We may make a distinction between distinctions that ascribes some distinctions to a system.
  - 3.1 We create a system when we make this distinction.
  - 3.2 We may make distinctions between systems.
  - 3.3 Systems form a hierarchy.
  - 3.4 The logic of making distinctions within a system we call a systemic semantics for distinctions.
- 4 We may make a distinction amongst "distinctions amongst distinctions" that describes some as valuations.
  - 4.0.1 We might distinguish "more succesful" from "less succesful" distinctions, or "more acceptable" from "less acceptable" distinctions.
  - 4.1 We create a valuation when we make this distinction.
  - 4.2 Valuations form a system.
  - 4.3 Valuations form a hierarchy.
  - 4.4 The logic of making distinctions within a valuation we call a value semantics for distinctions.
- 5 A decision is a distinction to which a valuation may be applied.
  - 5.0.1 A valuation is a distinction amongst decisions.

5.1 Without the distinction between "the distinction which is a decision" and "the distinction which is a valuation" decision making is form alone.

5.2 We create decision making when we make this distinction.

5.3 The logic of making distinctions that are decisions we call a decision-making semantics for distinctions.

## 8 CONCLUSIONS

The approach taken in the work outlined here may seem far removed from classical decision making. However, we believe that theories of probability, statistical estimation, and so on, may be derived within it by using appropriate presuppositions and have already indicated how Lukasiewicz and probability logics are closely linked (Gaines 1978b) and how probabilistic modelling may be derived from complexity/approximation theory (Gaines 1977). In our work on personal construct elicitation (Shaw & Gaines 1980) and on conflict resolution through the co-existence of partially compatible P Individuals (Shaw & McKnight 1980) we are developing "semantic information theories" that tackle the problems of meaning and relevance that have no place in the formal methodology of classical decision theory, although their immense practical importance is always informally emphasized. We believe that the axiomatic approach through the calculus of distinctions will pay off because it is very directly assimilable by people and can be made operational in computer-based decision aids. It also leads very naturally into the theoretical foundations we have previously proposed.

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