

Oral Examination Abstract

ON THE INDUCTIVE STRUCTURE OF WORKS OF ART

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The purpose of this dissertation is to specify the meaning and consequences of the following proposition:

A great work of art is an inductive game.

I do not offer an argument for the truth of the proposition, but rather, as a mathematician who specifies an axiom system and develops its consequences without arguing for the truth or falsity of its axioms, I specify its meaning, so that, if true, its structural consequences will be apparent to the working artist.

I consider three axioms: the first states what an accurate induction is; the second asserts that the essential activity of a human organism is making accurate inductions; and the third asserts that a work of art is an inductive game which exercises the deepest habitual responses of the organism. Since the meaning of the latter two axioms

depends upon the meaning of the first, I begin by constructing a formal logic of induction and illustrating its application to an inductive situation. I then specify the meaning of the latter two axioms. Lastly, I discuss and illustrate the structural consequences of the axioms with respect to the traditional formal canons of the arts, distinguishing between narrative and non-narrative arts.

Assume, for purposes of clarity of exposition, that the meaning of the first axiom is given. The meanings of the second and third axioms can then be specified briefly as follows:

A human organism at each moment of its existence encounters complex temporal events, some of which are conducive to the furthering of its well-being and some of which are not. To insure its self-preservation, the organism must seek the former and avoid the latter, and do so with maximum efficiency (since its resources are limited).

Achieving the^fabove goal with maximum efficiency, however, requires that the inductive range of the conscious thought of the organism be kept to a minimum, for, if the limited though superior discriminating powers of the logical and memory faculties of the intellect are to be used to greatest effect, they must be concentrated upon those aspects of the complex temporal events encountered which are least redundant to the previous experiences of the organism. At each moment of its existence, therefore, the organism is not only involved in consciously predicting aspects of the future consequences of present situations, but is simultaneously involved in the task of converting conscious patterns of inference which have proven successful in the past

into unconscious habits of reaction by which to predict such consequences in the future without conscious effort, thereby freeing its intellect for concentration on novel or more subtle predictive aspects, and hence increasing its organismic efficiency.

Habits, therefore, are responses which have become automatic. Their very automaticity signifies the organism's fullest confidence in their ability to function efficiently to preserve its well-being. It is not surprising, therefore, that the momentary failure of an habitual response should effect a more pervasive physiological shock to the organism than the momentary failure of a conscious and hence non-habitual choice, for the effectiveness of its most trusted mechanism for self-preservation has been questioned. Such a pervasive shock causes a physiological reaction within the organism which is called an emotion.

Emotional responses, however, fall along a continuum which divides into two distinct halves, for a momentary failure of the organism's habitual response structure to anticipate accurately may either result in the expected danger to the well-being of the organism which, as the emotional reaction indicates, it fears, or it may result unexpectedly in its increased well-being. If the former, the emotions of anger, fear, terror, etc., occur. If the latter, the emotions of relief, joy, gaiety, etc., occur. And if the emotional response of the organism is itself so pervasive as to threaten the well-being of the organism, the physiological mechanism of the organism asserts control, shutting off momentarily the organism's capacity for motivated activity in a flush of tears and helplessness.

The essential features of a human organism's existence, therefore,

are dependent upon its capacity to make accurate habitual inductions.

By asserting that a work of art is an inductive game, I mean that a work of art is a tool whereby a human organism is able to make habitual inductions as if its well-being depended upon their accuracy, without an actual threat being present. Since no actual threat is present, the emotional responses which result from the thwarting of an habitual induction made in response to a work of art have a peculiar detachment and gentleness, indicative of the fact that the habit has been exercised in a non-threatening context. For example, I recall vividly finishing a first reading of Tolstoy's Anna Karenina with tears in my eyes, knowing well that the rare presence of tears indicated neither that I had encountered nor escaped a threat to my well-being, but rather that, having been led by Tolstoy's words thru a long and subtle sequence of hoping, caring, guessing, being proven wrong and being proven right, I had emerged from an experience in which my most deeply conditioned responses had been exercised. Long dormant habitual reactions had been tested, re-assessed, and refined. And I had emerged as a generally more sensitive person (i.e. as a more subtly-skillful inductive organism), even though the experience had presented no actual threats to my well-being.

Human organisms, of course, engage in a diversity of other inductive games (eg. tennis, golf, chess, bridge, etc.). Works of art differ from the above only in that

- (a) the pervasiveness of the habitual reactions which they exercise is much greater; and

(b) the exercise is finer (i.e. more subtle).

The experience one has in playing a game of chess or tennis, therefore, is not qualitatively dissimilar from one's experience in listening to Bach or reading Proust, but rather quantitatively so. In the former, one's inductions are often consciously made and unique to the immediate situation; in the latter, they are unconscious and general.

The task of specifying the meaning of the first axiom, however, involves a complex formalization of which only a sketch can be given here. The formalism firstly specifies the meaning of 'accurate induction' with respect to a set of precisely defined machines, and then secondly specifies the sense in which human organisms can be considered to be such machines.

A proposition is defined to be anything which asserts that the number of elements in the intersection of two sets, a subject set and a predicate set, lies within an upper and lower numerical bound. If the cardinality of the intersection of the two sets indeed lies within the asserted limits, then the proposition is taken to be true (with suitable restrictions to avoid the Paradox of the Liar). Given the above, the truth-functions of the propositional calculus are defined in the customary way, with the assertion that p implies q being taken to be simply the assertion that the conditional of q given p is true.

A set of objects, called Θ -machines, is then introduced. Such machines are objects each of which is programmed to act as if each of a given set of propositions were true. Each machine is said to believe

each proposition of its program; and, if a believed proposition is indeed true, then the machine is said to know the proposition.

Probabilities are then specified to be rational numbers which are assigned unambiguously with respect to a given Θ -machine to propositions asserting that a proposition p implies a proposition q . (I abbreviate 'the Θ -probability of the truth of the conditional of q given p equals k ' by the symbol

$$\vdash_{\Theta} (p \rightarrow q) = k \quad .)$$

The number assigned to a given implication proposition with respect to a given Θ -machine depends upon the knowledge of the Θ -machine; it is, therefore, subjective with respect to that machine. Since, however, the machine's knowledge depends upon the truth of the propositions it believes, it is objective with respect to the world.

The procedure for assigning the probabilities contains many formal subtleties designed to elude the various objectionable features of previous inductive logics. (Eg. The grue-paradox of Nelson Goodman is thereby avoided, as explained in an appendix to the dissertation.) But, essentially, the procedure involves assigning a code number to each element of that set P of propositions which Θ knows to contain only one true proposition (but doesn't know which) and which is such that Θ knows that each element implies proposition p . The ratio of the sum of the code numbers of that subset Q of P , each element of which Θ knows to imply q , to the sum of the code numbers of P is the probability with respect to Θ that p implies q ; i.e.

$$\vdash_{\Theta} (p \rightarrow q) .$$

(Thruout the remainder of this abstract, I shall assume that Θ is given, and hence shall omit its symbol from all formulae.)

The fundamental theorems of the probability calculus are then derived in the system. including all of the following:

$$\begin{aligned}
 0 &\leq \text{Pr}(p \rightarrow q) \leq 1; \\
 \text{Pr}(p \rightarrow \bar{q}) &= 1 - \text{Pr}(p \rightarrow q); \\
 \text{Pr}(pq \rightarrow r) &= \text{Pr}[p \rightarrow (q \rightarrow r)]; \\
 \text{Pr}(pq \rightarrow r) &= \frac{\text{Pr}(p \rightarrow qr)}{\text{Pr}(p \rightarrow q)}; \\
 \text{Pr}[p \rightarrow (q \vee r)] &= \text{Pr}(p \rightarrow q) + \text{Pr}(p \rightarrow r) - \text{Pr}(p \rightarrow qr); \\
 \text{Pr}(pq \rightarrow \omega_a) &= \frac{\text{Pr}(p \rightarrow \omega_a) \times \text{Pr}(p\omega_a \rightarrow q)}{\sum_{t=1}^m [\text{Pr}(p \rightarrow \omega_t) \times \text{Pr}(p\omega_t \rightarrow q)]}.
 \end{aligned}$$

The last equation is Bayes's Theorem (1763).

Applying the theorems of the probability calculus as specified in the formalism to an illustrative inductive situation in which I, as a Θ -machine, know that each element of a set E is either white or black, and that some particular subset S of E having s elements contains exactly t black elements, I prove that the probability with respect to myself as Θ that any particular other element of E is black is

$$\frac{t+1}{s+2}.$$

This is formally similar to Laplace's Law of Succession (1774); but whereas Laplace's law leads to inductive inconsistencies, the restrictions imposed by the formalism of my system avoid them. (An ambiguity

in the Laplacean notion of 'sampled object' is also avoided by a complex specification detailed in the dissertation.)

Having formally specified and illustrated the procedure of assigning probabilities to assertions of implication with respect to Θ - machines, I assume that an induction is a decision made by a machine in an inductive situation to act as if certain relevant propositions were true and the remainder false, based upon its calculation of the respective probabilities of the relevant propositions with respect to the evidence. The three axioms may then be explicitly summarized as:

- I. The most accurate induction which a human organism could make in a given inductive situation is that which a Θ - machine having an identical program would have made in the same situation, assuming that if
 - (a) $\vdash \Theta \vdash (p \rightarrow q) > \frac{1}{2}$; and
 - (b) Θ knows proposition p ; then
 - (c) Θ believes proposition q (i.e. is prepared to act as if q were true).
- II. The essential activity of a human organism is making accurate inductions.
- III. A work of art is an inductive game which exercises the deepest habitual responses of the organism.

But the point of all this is to elicit more clearly the structural features of great works of art. How does a great work of art differ structurally from a mediocre one? Since, as previously noted, a work of art is a deeper and more finely wrought sporting event, I look to the world of golf for evidence 'writ large': How does a great golf course differ structurally from a mediocre one?

Every golfer in the course of a round is involved in a sequence

of situations each of which forces him to make choices such as

- (a) Ought I to go over the water, or to the side?;
- (b) Which club should I choose?;
- (c) Ought I to move my rear foot inward?;
- (d) Ought I to pitch-and-run, or wedge?;
- (e) Can I drive past that bunker?; etc.

His evaluation of the situation facing him, dependent for its accuracy upon the strength of his concentration now and in the past, and hence on the strength of his memory, leads him to disregard certain factors as irrelevant to the success of his forthcoming shot, and to weigh the relative importance of the remainder. Simply put, on the basis of his skill, he finds a theme, and on the basis of this theme he makes an induction and acts upon its. By acting upon the induction, he assumes as an hypothesis the relevance to the situation at hand of the theme chosen on the basis of his skill, and puts it to the test. The accuracy or inaccuracy of the induction depends upon the relevance of the chosen theme. If he guesses inaccurately, he may yet succeed in making the shot; if he guesses accurately, he may yet fail. But, at best, a golf course ought in general

- (a) to reward more accurate inductions and penalize less accurate ones;
- (b) to reward few redundant inductions; and
- (c) to satisfy conditions (a) and (b) without respect to the relative skillfulness of the players involved.

(By condition (b), I mean that a golf course ought to present as few situations as possible which would permit a player to proceed success-

fully by exercising exactly the same set of habitual responses which were exercised with success at an earlier stage of the game.) Conditions (a), (b), and (c) have clear structural implications for the golf course architect. And since they say nothing of the ^{depth} of the mechanisms of the organism involved in making the inductions, nor of the particular nature of the skills involved, they are directly applicable to works of art. A great work of art, thus, differs structurally from a mediocre one to the extent that it succeeds more efficiently in rewarding non-redundant accurate inductions and penalizing inaccurate ones, without respect to the relative skillfulness of the players involved.

But, in greater detail, what do conditions (a), (b), and (c) entail structurally in a great work of art? On a golf course, to reward an accurate induction is to put the player in such a position that he can proceed along the course with less physiological effort than had he guessed inaccurately; to penalize an inaccurate induction is to put the player in such a position that he can proceed only with greater physiological effort than had he guessed accurately. Similarly, to reward an accurate induction by a player perceiving a work of art is to put the player in such a position that he can proceed to the next element of the work with less physiological effort than had he guessed inaccurately; to penalize an inaccurate induction is to put the player in such a position that he can proceed to the next element of the work only with a greater physiological effort than had he guessed accurately.

By such considerations, I show that conditions (a) and (b) entail that, at best, each experienced element of a work of art

- (a') be consistent with those habitual inductions accurately based upon the previously experienced elements; and
- (b') be necessary, at some succeeding point in the experience of the work, if an accurate habitual induction is to be made.

The player of a work of art, at any moment of his experience, is constructing an inductive proof; i.e. he is making an induction based upon his memory of the previous information and the subtlety of his habitual responses. The latter is not a function of the work of art, but rather of the player's skillfulness. The former is a function of both, however, for given the particular degree of skillfulness in concentration and memory of the player, the amount of previous information he has retained is a function of its mode of presentation (i.e. a function of the structure of the work of art). By extending the notion of structural simplicity for valid deductive proofs, it is shown that a structural condition sufficient to guarantee the satisfaction of condition (c) for accurate inductive proofs is that each element of the proof occur no sooner than needed in the proof; i.e. that, at best, each element of the work of art

- (c') be experienced as shortly before the 'succeeding point' of (b') as possible.

The greatness of a work of art, therefore, is not to be found in the complexity of its inference structure, but rather in the subtlety and richness of the structured elements (i.e. in their ability simultaneously to reinforce accurate inductions of varying degrees of skill). A complex inductive puzzle, hence, is not equivalent to a work of art.

The remainder of the dissertation consists in showing that works of art constructed in accordance with the structural conditions (a'), (b'), and (c') (hereafter called 'the Trinity') would, in general, conform to those traditional descriptive canons of the arts which, although having proven to be descriptively true of finished works of art, have proven in larger part to be compositionally useless.

Of those works of art whose principal structural dimension is temporal, I consider first the narrative. The experience of a narrative work of art has been described with general accuracy for centuries as consisting of three parts:

- (1) an Exposition;
- (2) a Development; and
- (3) an Obligatory Scene-Climax-Dénouement;

in roughly that order. Consider part (1). The expectations of a playgoer at any moment of his experience of a drama are inductively determined by his current understanding of the motivations of the characters and their existential (i.e. situational) context. Imagine, then, a narrative work of art based upon a set of principal characters and conforming to the Trinity. Since an accurate understanding of the principal characters is necessary to an accurate understanding of the bulk of the remaining elements of the work (or they would not be principal charac-

ters), satisfaction of the Trinity would require that the principal characters be experienced and adequately understood by the player of the work of art prior to his experience of the bulk of the remaining elements of the work. Hence, a narrative work of art conforming to the Trinity would entail structurally that the earliest part of the player's experience be an exposition of the principal characters, in accordance with the traditional descriptive canons.

Consider now part (3). Since condition (b') entails that each experienced element of a work of art be necessary to the player at some succeeding point in his experience of the work if he is to make an accurate induction, it follows, assuming that a work of art is finite, that at least one element of the work must be an inductively necessary condition of each of the preceding elements: namely, the last element experienced. But since condition (c') entails that less complex inductions be experienced before more complex ones, in effect it structurally prohibits anticlimaxes. The satisfaction of the Trinity by any work of art, therefore, entails structurally that a player's experience of the work, given inductive accuracy, will contain a single climax at or near the end of his experience, in accordance with the traditional canons.

Returning now to part (2), it is usually held that the plot is therein developed (where the work 'plot' refers to an outline of the dramatic action). The dramatic action at any moment in a playgoer's experience is inductively determined by his current understanding of the principal characters and their existential context. Given a drama whose principal themes are characters and which satisfies the Trinity, since the bulk of the elements of the drama are determined by the

activities of the principal characters, their existential context at any moment in a playgoer's experience of the drama has been largely determined by their previous activities. Since, therefore, the members of the Trinity entail that the structural development of the drama follow the development of the playgoer's understanding of the principal characters, it follows that the structure of the drama will also conform to the traditional canons of the plot.

In general, therefore, narrative works of art structured in accordance with the Trinity would conform to the traditional tri-partite descriptive canons of narrative art.

By similar reasoning extended, it is then shown that the most natural structure for a drama satisfying the Trinity whose principal theme is a single principal character would conform to the traditional canons of the Tragedy; and, conversely, that the most natural structure for such a drama whose principal theme is a single developing existential situation would conform to the traditional canons of the Comedy.

The most pervasive non-narrative descriptive form for temporally based works of art is the sonata form, which consists of

- (1) an Exposition;
- (2) a Development; and
- (3) a Recapitulation (with or without coda);

in that order. Not surprisingly, therefore, by arguments parallel to those given for narrative works of art, it is shown that works of musical art constructed in accordance with the Trinity would tend, in general, to conform to all or part of the traditional sonata form. But since the context of habitual responses built-up within a musical work of art is

so thematically integrated and fragile, in comparison to the thematic strength of the habitual responses to narrative characters and situations, sustained structural concentration on either its melodic or its harmonic themes would weaken the other so much that its habitual context would be destroyed. It is due to their intrinsic abstractness, therefore, that musical works of art have given rise to no traditional descriptive canons corresponding to those of the Tragedy and Comedy of the narrative genre.

Lastly, of those works of art having no principal temporal dimension, I consider non-representational paintings. Since nowhere in our culture do there exist generally applicable traditional descriptive canons of the structures of great paintings (eg. comparable to the sonata form in music), I cannot argue that paintings which conform to the Trinity will conform also to the traditional descriptive canons of the art, since the latter do not exist. Rather, I attempt to indicate in a general way how a painting can be said to conform to the Trinity, and hence in what sense the experience of a painting is an inductive exercise.

Roughly, the notion is that each color point in a painting is surrounded by a color field exerting an attractive vector potential on each other color point which is inversely proportional to the product of their colormetrical differences and to the square of their spatial distance apart. A painting, being a finite group of color points, is surrounded by a complex color field which has a single spatial point at which the vector potential of the field is strongest. The latter is the climax of the painting.

A player experiencing a painting is engaged in determining the position of the climax with ever greater precision by making successive inductions accurately based upon his increasing awareness of the structural subtleties of the color field of the painting.

In conclusion, the notion of a great work of art as an inductive game answers many of the vague puzzles over which aestheticians have pondered since Aristotle: eg. How can the players emotions be evoked, and yet the work remain at a 'psychical distance'?; How can the elements of a work be essential yet ambiguous?; How can a great work of art have an aura of universality, and yet be experienced as being both natural and intimate? But, more importantly, if a great work of art is an inductive game, then this fact has structural implications which are of general use to the artist engaged in the chores of composition - a feature uncommon to general aesthetic speculations.

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