

SYNOPSIS

The following brief summaries, arranged here alphabetically, provide an introduction to each of the papers in this volume.

1. *Duhem on Maxwell: A Case-Study in the Interrelations of History of Science and Philosophy of Science.* Roger Ariew and Peter Barker. We examine Duhem's critique of Maxwell, especially Duhem's complaints that Maxwell's theory is too bold or not systematic enough, that it is too dependent on models, and that its concepts are not continuous with those of the past. We argue that these complaints are connected by Duhem's historical criterion for the evaluation of physical theories. We briefly compare Duhem's criterion of historical continuity with similar criteria developed by "historicists" like Kuhn and Lakatos. We argue that Duhem's rejection of theoretical pluralism was a primary factor preventing him from recognizing Maxwell's work as an autonomous tradition.

2. *Leibniz on Continuity.* Richard T.W. Arthur. In this paper I attempt to throw new light on Leibniz's apparently conflicting remarks concerning the continuity of matter. He says that matter is "discrete" yet "actually divided to infinity" and (thus dense), and moreover that it fills (continuous) space. I defend Leibniz from the charge of inconsistency by examining the historical development of his views on continuity in their physical and mathematical context, and also by pointing up the striking similarities of his construal of continuity to the approach taken by 20th century Combinatorial Topology.

3. *What Happens to Accounts of Mind-Brain Relations If We Forego An Architecture of Rules and Representations?* William Bechtel. The notion that the mind is a physical symbol system (Newell) with a determinate functional architecture (Pylyshyn) provides a compelling conception of the relation of cognitive inquiry to neuroscience inquiry: cognitive inquiry explores the activity within the symbol system while neuroscience explains how the symbol system is realized in the brain. However, the view that the mind is a physical symbol system is being challenged today by researchers in artificial intelligence who propose that the mind is a connectionist system and not simply a rule processing system. I describe this challenge and offer evidence that indicates the challenge may be well motivated. I then turn to the question of how such changes in the conception of the activity of the mind will affect our understanding of the relation of neuroscience to cognitive inquiry and sketch a framework in which the cognitive system consists of several levels and in which both neuroscience and cognitive science can make contributions at several of these levels.

4. *The Revolutionary General.* John R. Bosworth. In response to a claim that the philosopher has little or nothing to add to our understanding of crucial events in the history of science, it is proposed that Johannes Kepler's work on planetary motion puts him at one with the interest of the philosopher in the "good". Where the historical record is apparently blank, in Kepler's thinking about his third law of motion, its "logic" and "rationale" is seen as based on the formation of a binding relation between astronomers. They are seen as

standing together in defense of the truth, and standing accordingly in service to the "good".

5. *Metaphorical Models and Scientific Realism*. M. Elaine Botha. Theories developed on the basis of metaphorical modes and tested and corroborated in confrontation with empirical reality, provide a realistic approximation of reality. This is argued over and against the position of Mary Hesse who sees theorizing as the metaphorical redescription of the domain of the expanandum yet opts for an anti-realist or moderate realist position because of her rejection of the existence of universals, natural kinds and essences. It will be argued that the maintenance of a realist stance requires a rejection of the traditional (or absolute) theory of universals and a different construal or reformulation of such a theory in order to escape the relativistic and anti-realist consequences which Hesse's position entails. A realist approach to the metaphorical account of scientific theorizing requires a theory of meaning oriented to and supplemented by a modified theory of universals which recognizes the fact that the underlying classificatory system on which metaphorical reference is based represents more than sociologically determined semantic reality.

6. *Towards a Theory of Theoretical Objects*. Gordon G. Brittan, Jr. Traditional accounts stress certain features of theoretical objects such as their alleged imperceptibility, that are taken to raise epistemological difficulties. But these accounts do not show how theoretical objects, rightly understood, either differ in kind from more ordinary sorts of objects or make science possible. I sketch a new account that focuses on the underdetermination and similarity of theoretical objects, features closely connected to the explanatory roles they play, and construes them on an algebraic model.

7. *Fitness As a Function*. Henry Byerly. Fitness in the sense of actual rate of increase of genotypes, commonly used in population genetics, is contrasted with fitness in the ordinary sense (and Darwin's) of adaptedness of organisms. Fitness as actual reproductive success is interpreted as a function of variables representing intrinsic adaptive capacities and environmental properties. Adaptive capacities causally contribute to fitness as actual reproductive success which in turn, as relative increase of genotypes, determines evolutionary change. The propensity interpretation of fitness is shown not to play a role in evolutionary explanation.

8. *Instrumental Evaluation in Scientific Knowledge*. F. John Clendinnen. The normative nature of scientific rationality is sometimes accounted for by the thesis that having theories which meet the criteria we apply is valuable to us in itself rather than as a means to an end. But given the experiential input to our beliefs and their practical role, it is apparent that we must evaluate the criteria to be used as rational means of pursuing predictive success. So we must seek a practical justification, in spite of the threat of circularity. There is hope of achieving this via an exploration of options which may show that there is no reasonable alternative to the principles we use.

9. *Probabilistic Reasoning in Expert Systems Reconstructed in Probability Semantics*. Roger M. Cooke. Los's probability semantics are used to identify the appropriate probability conditional for use in

probabilistic explanations. This conditional is shown to have applications to probabilistic reasoning in expert systems. The reasoning scheme of the system MYCIN is shown to be probabilistically invalid; however, it is shown to be "close" to a probabilistically valid inference scheme.

10. *Causality as an Overarching Principle in Physics.* James T. Cushing. Many factors are operative in the scientific enterprise to provide the epistemic warrant which finally convinces people to accept a scientific theory. The methods, goals and meanings of terms do not remain fixed, but evolve over time. This paper concentrates on one aspect of this shifting pattern of scientific practice - the role and meaning of causality in modern physics.

11. *Causal Processes and Causal Interactions.* Douglas Ehring. Wesley Salmon has developed a theory of causation which makes use of the concepts of a "causal process" and a "causal interaction." Roughly, a causal process is a process which transmits its own structure, and a causal interaction is an intersection of processes which transforms the character of these processes. The cause-effect relation is analyzed as a causal interaction followed by a causal process which terminates in a further causal interaction. In this paper I present a series of problem cases which run "counter" to Salmon's account.

12. *Judgment and Reasoning in the Evaluation of Theories.* Maurice A. Finocchiaro. In an attempt to clarify and strengthen the thesis that theory choice is a form of value judgment, I elaborate a central point advanced by Kuhn and McMullin and defend it from what appears to be a criticism by Laudan. I explore some aspects of the process by giving several realistic examples, by reconstructing some of the underlying reasoning, and by discussing several kinds of agreement and disagreement that result. Despite the considerable work that remains to be done, there seems to be no doubt that theory choice is simultaneously a form of evaluation, of judgment, and of reasoning.

13. *Niels Bohr, Complementarity, and Realism.* Henry J. Folse. Although it is, often considered a form of anti-realism, here it is argued that Bohr's complementarity viewpoint must accept entity realism based on its analysis of the causal interaction involved in observation. However, because Bohr accepts the quantum postulate he must reject the view that the goal of theory is to represent the independently existing object apart from observation. Thus he abandons the spectator account of knowledge and with it the correspondence theory of truth. In this respect his view is parallel to the positions held by Hacking, Cartwright, and Ellis.

14. *Unification and Scientific Realism Revisited.* Malcolm R. Forster. Van Fraassen has argued that quantum mechanics does not conform to the pattern of common cause explanation used by Salmon as a precise formulation of Smart's 'cosmic coincidence' argument for scientific realism. This paper adds to this list some common examples from classical physics that also do not conform to Salmon's explanatory schema. This is bad news and good news for the realist. The bad news is that Salmon's argument for realism does not work; the good news is that realism need not demand hidden variables in quantum mechanics if they are not used in classical mechanics. Many correlations in physics

are explained in terms of property identity (contra Salmon). This leads to a new argument against van Fraassen because the unified version of the theory obtained by identifying theoretical properties is always less empirically adequate.

15. *Sober's Use of Unanimity in the Units of Selection Problem.* Fred Gifford. Sober argues that the units of selection problem in evolutionary biology is to be understood and solved by applying the general analysis of what it means for C to cause E in a population. The account he utilizes is the unanimity account, according to which C causes E in a population when C raises the probability of E in each causal context. I argue that he does not succeed here, both because the unanimity account is not well grounded in the general case, and because there are important differences between cases of population causation which do involve selection and those which do not.

16. *How Scientists reach Agreement about new Observations.* David Gooding. I outline a pragmatic view of scientists' use of observation which draws attention to non-discursive, instrumental and social contexts of observation, in order to explain scientists' agreement about the appearance and significance of new phenomena. I argue that: observation is embedded in a network of activities, techniques, and interests; that experimentalists make construals of new phenomena which enable them communicate exploratory techniques and their outcomes, and that empirical enquiry consists of communicative, exploratory and predictive strategies whose interdependence ensures that, notwithstanding the constructedness of representations and the empirical underdetermination of theories, observations contain information about the natural world.

17. *A Case Study in the Application of Mathematics to Physics: Descartes' Principles of Philosophy, Part II.* Emily R. Grosholz. The question of how and why mathematics can be applied to physical reality should be approached through the history of science, as a series of case studies which may reveal both generalizable patterns and salient differences in the grounds and nature of that application from era to era. The present examination of Descartes' Principles of Philosophy Part II, reveals a deep ambiguity in the relation of Euclidean geometry to res extensa, and a tension between geometrical form and 'common motion of parts' as principles of individuation for matter in Cartesian physics.

18. *Popper versus Lorenz: An Exploration Into the Nature of Evolutionary Epistemology.* Kai Hahlweg. This paper expounds the central tenets of the Austro-German school of evolutionary epistemology and points out that it conflicts in important aspects with Popper's. The conflict arises because some of the members of the above-mentioned school consider induction to be an absolutely central feature of any evolutionary epistemology. Thus the question arises if Poppers 'method of trial-and-error' is still to be considered to be the evolutionary method. The present author suggests that what is being selected for during scientific evolution is our capacity to apply induction appropriately. We learn when to use induction reliably and when to resort to the most elementary of all methods, the method of trial-and-error.

19. *Objective Homogeneity Relativized*. Joseph F. Hanna. In his recent book Scientific Explanation and the Causal Structure of the World Wesley Salmon provides a detailed explanation of objective homogeneity, a concept which is central to his S-R model of explanation. I propose a modification of Salmon's definition which both simplifies and (in minor ways) corrects it, while at the same time generalizes it by including an important temporal factor that is missing from the original. I argue that if the world is irreducibly stochastic, then objective probabilities (determined by objective homogeneous reference classes) must be temporally relativized. We can speak coherently of the objective probability of a particular event relative to a given point in time, but not of the objective probability of the event simpliciter. I briefly explore the consequences, of the temporal relativity of objective homogeneity for Salmon's attempt to secure an objective (nonepistemic, nonpragmatic) S-R basis for causal explanation.

20. *Sociobiology and the Semantic View of Theories*. Barbara L. Horan. The semantic view of scientific theories has been defended as more adequate than the "received" view, especially with respect to biological theories. However, the semantic view has not been evaluated on its own terms. In this paper it is first shown how the theory of sociobiology propounded by E.O. Wilson can be understood on the semantic approach. The criticism that Wilson's theory is beset by the problem of unreliable generalizations is discussed. It is suggested that this problem results from the use of the model-building strategy in theory construction. The author concludes that the problem is pressing enough to impugn the semantic view as an adequate account of sociobiological theory.

21. *Causal Modeling and the Statistical Analyses of Causation*. Gurol Irzik. Recent philosophical studies of probabilistic causation and statistical explanation have opened up the possibility of unifying philosophical approaches with causal modeling as practiced in the social and biological sciences. This unification rests upon the statistical tools employed, the principle of common cause, the irreducibility of causation to statistics, and the idea of causal process as a suitable framework for understanding causal relationships. These four areas of contact are discussed with emphasis on the relevant aspects of causal modeling.

22. *Abduction by Classification and Assembly*. John R. Josephson; B. Chandrasekaran; Jack W. Smith, Jr.; and Michael C. Tanner. Red-2 is a computer program for red-cell antibody identification, a piece of "normal science". Abstracting from Red-2, a general problem solving mechanism is described that is especially suited for performing a form of abductive inference or best explanation finding. A problem solver embodying this mechanism synthesizes composite hypotheses by combining hypothesis parts. This is a common task of intelligence, and a component of scientific reasoning. The work addresses the question, 'How is science possible?' by showing how a simple but powerful form of hypothesis synthesis is computationally feasible.

23. *How The Laws Of Physics Don't Even Fib*. A. David Kline and Carl A. Matheson. The most recent challenge to the covering-law model of explanation (N. Cartwright, How the laws of Physics Lie) charges that the fundamental explanatory laws are not true. In fact explanation and

truth are alleged to pull in different directions. We hold that this gets its force from confusing issues about the truth of the laws in the explanation and the precision with which those laws can yield an exact description of the event to be explained. In defending this we look at Cartwright's major case studies and sketch an amended covering-law model of explanation.

24. *Anthropic Explanations in Cosmology.* John Leslie. Cosmologists using the Anthropic Principle claim that if our universe had been much different then nobody would exist to observe it. This may become explanatory when one accepts the actual existence of multiple "universes": gigantic, largely or entirely separate systems having very varied properties. Ian Hacking has urged, though, that an Inverse Gambler's Fallacy is committed during many attempts to formulate anthropic explanations. Besides disagreeing with him, the paper makes several further points in support of such explanations, in particular against the background of the Inflationary Universe.

25. *Evaluation of Evidence in Group Selection Debates.* Elisabeth A. Lloyd. I address the controversy in evolutionary biology concerning which levels of biological entity (units) can and do undergo natural selection. I refine a definition of the unit of selection, first presented by William Wimsatt, that is grounded in the structure of natural selection models. I examine Elliott Sober's objection to this structural definition, the "homogeneous populations" problem; I find that neither the proposed definition nor Sober's own causal account can solve the problem. Sober, in his solution using his causal view, imports precisely the information needed to make the structural definition effective. Finally, I indicate how the proposed definition can clarify which sorts of evidence could be brought to bear on the controversial case of the Myxoma virus.

26. *Truth, Epistemic Ideals and the Psychology of Categorization.* Robert N. McCauley. Recent theoretical work on the psychology of categorization emphasizes the role cognitive constructs play in perception and categorization. This approach supports Putnam's rejection of metaphysical realism. However, the experimental findings concerning basic level categories, in particular, suggest that robust stabilities among our systems of empirical concepts persist in the face of considerable theoretical diversity and change. These stabilities undermine Putnam's strongest negative conclusions concerning the correspondence theory of truth (once it is uncoupled from metaphysical realism). The centrality of a correspondence criterion of truth (in a larger theory of truth) is psychologically inescapable, rationally indispensable, and (therefore) epistemologically fundamental.

27. *Quantum Disjunctive Facts.* James H. McGrath. A reformulation of the Kochen and Specker Theorem is used to show how quantum disjunctive facts have presented an insurmountable obstacle to mainstream attempts to motivate quantum logic. The failure of these attempts represents a progressive retrenchment of the program of connecting quantum logic to quantum theory. However, a recent program proposed by Allen Stairs gives those who embrace a realist ontology of quantum "facts" reason to believe quantum logic may yet be read off quantum theory.

28. *What is Wrong with Strict Bayesianism?* Patrick Maher. Bayesian decision theory, in its classical or strict form, requires agents to have a determinate probability function. In recent years many decision theorists have come to think that this requirement should be weakened to allow for cases in which the agent makes indeterminate probability judgments. It has been claimed that this weakening makes the theory more realistic, and that it makes the theory more tenable as a normative ideal. This paper shows that the usual technique for weakening strict Bayesianism has neither of these claimed advantages.

29. *Problems in the Development of Cognitive Neuroscience: Effective Communication between Scientific Domains.* Edward Manier. This is one of a series of reports of a case study of the convergence of molecular neurobiology and cognitive studies of Pavlovian conditioning. Here, I examine a fundamental disagreement between major centers of research representing each of these two domains and analyze it in terms of a hybrid historical, sociological, and philosophical concept of effective scientific communication. The specific example considered is found to fall short of the criteria for effective communication because of the absence of explicit, published reciprocity in the exchange of critical appraisal of results and in requests for reformulation of investigative priorities, research designs, and criteria of scientific adequacy. The situation is dramatized and a remedy proposed by means of an imaginary dialogue linking the two research centers. The paper raises a number of key issues. (1) means for appraising the epistemic status of explanations putatively linking domains in the absence of effective scientific communication; (2) the influence of socially contingent features of the cognitive perspectives of the relatively small number of scientific translators responsible for such communication between domains; and (3) the status of dialogues of the sort presented here, e.g., as idealized philosophical critique or conjectural history of the future of science.

30. *The Constitution of Domains in Science: A Linguistic Approach.* Paul Mattick. The logical empiricist assumption that scientific thought could be adequately represented by a logical system had the advantage of offering the possibility of precision in the analysis of meaning relationships and patterns of reasoning. More recent studies of science in terms of such concepts as that of "domain", while leading to valuable work, depend on the semantic intuitions of the researcher in the specification of domain boundaries and the relations between methods, concepts, and data within them. This paper suggests the relevance to such issues of an analysis of the "syntax of science" based not on logic but on linguistic structures characteristic of scientific texts, by sketching the principles of such an analysis and the results of its application to the case of immunology.

31. *Cartwright, Causality and Coincidence.* Deborah G. Mayo. Cartwright argues for being a realist about theoretical entities but non-realist about theoretical laws. Her reason is that while the former involves causal explanation, the latter involves theoretical explanation; and inferences to causes, unlike inferences to theories, can avoid the redundancy objection--that one cannot rule out alternatives that explain the phenomena equally well. I sketch Cartwright's argument for inferring the most probable cause, focusing on Perrin's inference to molecular collisions as the cause of Brownian

motion. I argue that either the inference she describes fails to be a genuinely causal one, or else it too is open to the redundancy objection. However, I claim there is a way to sustain Cartwright's main insight: that it is possible to avoid the redundancy objection in certain cases of causal inference from experiments (e.g., Perrin). But, contrary to Cartwright, I argue that in those cases one is able to infer causes only by inferring some theoretical laws about how they produce experimental effects.

32. *Observation and Growth in Scientific Knowledge.* Robert Nola. In the writings of scientists we find claim to the effect that we can observe items such as pulsars, gravity waves, quarks, electrons, etc. An epistemological theory, originally developed by Dretske and modified by Jackson, is used to give an account of such claims and the extent to which they may be deemed correct. The theory eschews talk of the theory-ladenness of observation while giving an account of how our observation reports may evolve with growth in scientific knowledge. The theory is partially linked to Shapere's recent account of observation in science.

33. *Reichenbach, Causation, and Explanation.* Richard Otte. This paper investigates the differences between two conceptions of causation which are claimed to amount for causation in indeterministic situations. Recent analyses of indeterministic causation have been based upon mark transmission, and upon probability relations. Both types of analyses were proposed by Reichenbach, who claimed that they were extensionally equivalent. I demonstrate that they are not equivalent, and discuss some implications of this for models of scientific explanation.

34. *Naturalized Philosophy of Science, History of Science, and the Internal/External Debate.* Bonnie Tamarkin Paller. The paper begins with a discussion of the significance of the naturalized turn for the philosophy of science. Two points are argued for. One, the naturalized turn requires a new understanding of the projects and relations between history of science and philosophy of science. Two, given the naturalized turn, it is unlikely that a purely internalist account of theory development will be found adequate. I specifically discuss Lakatos' and Shapere's accounts. Using the case of Newton's posit of active principles in nature, I argue that an adequate account of theory development will trace both internal and external reasons.

35. *The Paradox of Instrumentalism.* David Papineau. Instrumentalism seems less plausible than realism, yet at the same time to be logically weaker. This paper explores the possibility of resolving this apparent paradox by switching to an anti-Humean view of laws. Although in the end this suggestion turns out to be only a part of the solution, it does help to clarify what is at issue in the debate about instrumentalism.

36. *The Character of Galilean Evidence.* Joseph C. Pitt. We examine Galileo's theory of evidence as presented in his Dialogue on the Two Chief World Systems. It is argued that for Galileo evidence not only had to be tied to the senses, but, that for purposes of evidential relevance, epistemologically significant experience is only of terrestrial objects and events. This account forms the first part of an argument for understanding Galileo as an instrumentalist. The second

part of the argument consists in examining Galileo's views on the limits of knowledge. Given his conviction that we cannot know everything and his requirement that evidence be tied to terrestrial phenomena, claims for instrumentalism seem warranted.

37. *The Modal View and Defending Microeconomics*. Steven Rappaport. What Daniel Hausman has called 'the simple criticism of economic theory' affirms that neoclassical microeconomic models include false statements, and therefore economists cannot rationally accept such models. Hausman considers, but rejects, the modal view of economic models as a defense of neoclassical theory against the simple criticism. I attempt to show that, on the contrary, the modal view can be used to defend neoclassical micro theory. The modal view distinguishes theoretical from applied economic models. Theoretical models afford true descriptions of hypothetical economic agents, whereas applied models contain true or false statements about some real world situation. Relying on the modal view, I argue that the simple criticism is not well-founded, whether it concerns theoretical or applied models.

38. *The Universality of Laws in Space and Time*. Robert Rynasiewicz. A number of writers have suggested that laws of nature must be universal in space and time. Just what this claim amounts to is the focus of the present study. I consider and compare a number of interpretations of the requirement, with especial reference to an example by Tooley which seems paradigmatic of the antithesis of universality in space and time. I also sketch a number of other concepts of "local", "global", and "universal", each of which should be kept distinct from "universality in space and time". I leave open the issue whether or not laws must satisfy any of the requirements.

39. *An Assessment of the Scientific Standing of Economics*. Margaret Schabas. Economists are still very much in the grip of both operationalism and a reverence for classical mechanics as the science to emulate. Those who have exposed the weaknesses of this approach tend also to dismiss neo-classical economics as devoid of empirical and/or ideological-free content, a move which seems to have been counter-productive. This paper attempts to follow up on the more modest assessment of economics put forth by Allan Gibbard and Hal Varian. Their perspective on economic models suggests that economists might better establish the scientific status of their discipline by adopting the Hempelian case for history.

40. *How Not to Identify Innate Behaviors*. Dennis M. Senchuk. Despite the biological turn of recent discussions of behavior, insufficient attention has been paid to methodological-philosophical issues about the experimental basis for talk of instincts, social or otherwise. This paper examines the credentials of one standard technique, the deprivation experiment, exploited by the ethologists in their efforts to provide an inventory of species-specific, innate behaviors. It is argued that, given some hypothetical facts and plausible theoretical assumptions (of D.S. Lehrman, Kurt Koffka, and others) about the role of environmental factors in the development of behavioral repertoires, the ethologists' efforts to identify innate behaviors on the basis of the deprivation technique are not just futile but misguided.

41. *Selectivity and Theory Choice*. Matti Sintonen. Several writers have maintained that the Kuhnian revolution in philosophy of science amounts, in part, to an increased appreciation of the role of value judgments and decisions in theory appraisal. This paper argues that, Laudan's recent skeptical remarks notwithstanding, recourse to subjective criteria in the application and weighing of shared choice criteria makes good sense. The paper also shows how the structuralist theory-notion, which should be congenial to Kuhn on independent grounds, helps to locate and explicate some vague and ambiguous values, such as simplicity.

42. *Null Hypotheses in Ecology: Towards the Dissolution of a Controversy*. Peter B. Sloep. Ever since ecology's inception, the concept of competition has generated discussion. Recent discussions have focused on the role of interspecific competition in shaping the structure of ecological communities. More in particular, ecologists are split up over the validity of a method that is currently in vogue to discredit explanations of community structure in terms of competition theory. An analysis of this controversy is presented which attempts to show that the discussions so far have focused on the wrong issues. Not the method's ability to generate alternative explanations should be questioned, but its ability to generate superior explanations. The impact of Popperian philosophy of science on the dispute is briefly discussed.

43. *Metatrickles and Ratificationism*. Jordan Howard Sobel. It is shown that even if a process of ideal evidential deliberation that paid attention to its own progress would in every case lead to credences that made things probabilistically independent of actions of which they were believed to be causally independent; it would not in every case lead to agreement in the ultimate dictates of evidential and causal decision theories. This point is made by a decision problem in which the action prescribed by causal decision theory is not (as it is in Newcomb's Problem) a dominant action. It is also shown that such non-dominance problems provide decisive objections to Ratificationism.

44. *Internal Realism, Truth and Understanding*. Gordon Steinhoff. Putnam presents a Peircean characterization of truth in an attempt to avoid relativism, which he argues is incoherent. I argue that Putnam has not avoided relativism. According to Putnam's theory of understanding, we must understand all claims concerning a Peircean community in terms of our own experiences and in terms of our own standards of rational assertability. Truth simply collapses into warranted assertability. At this point Putnam appeals to the objectivity of our standards of assertability. But Putnam's notion of "objectivity for us" is a notion of objectivity which the relativist can happily adopt. Putnam's failure to provide more than a superficial distinction between internal realism and relativism means that internal realism faces the same problems which Putnam directs at "self-refuting" relativism.

45. *Synthesis, Sensibility and Kant's Philosophy of Mathematics*. Carol A. Van Kirk. This paper presents an interpretation of Kant's analytic/ synthetic distinction and of the capacity he terms "sensibility" in order to offer a new account of Kant's claim that mathematics consists primarily of synthetic judgments which involve

intuition. In Section 1, it is argued that the analytic/synthetic distinction is based upon a theory of concepts going back to Aristotle which sees these as organizable into genus/species hierarchies. Analytic judgments are those whose predicates are genus-related to the subject while synthetic judgments do not exhibit a genus/species relation between the predicate and the subject of the judgment. Section 2 considers the nature of sensibility which is argued to involve the discernment of mereological relations. Mathematics is then seen to involve the formation of concepts of these relations.

46. *Probabilistic Causality, Randomization and Mixtures.* Jan von Plato. A formulation of probabilistic causality is given in terms of the theory of abstract dynamical systems. Causal factors are identified as invariants of motion of a system. Repetition of an experiment leads to the notion of stationarity, and causal factors yield a decomposition of the stationary probability law of the experiment into ergodic components. In these, statistical behaviour is uniform. Control of identified causal factors leads to a corresponding statistical law for the events, which is offered as a notion of probabilistic causality. After a suggestion by Feller, randomization is identified as mixing, formulated in above terms.

47. *Taking Analogical Inference Seriously: Darwin's Argument From Artificial Selection.* C. Kenneth Waters. Although historians have carefully examined exactly what role the analogy between artificial and natural selection might have played in Charles Darwin's discovery of natural selection, philosophers have not devoted much attention to the way Darwin employed the analogy to justify his theory. I suggest that philosophers tend to belittle the role that analogies play in the justification of scientific theories because they don't understand the special nature of analogical inference. I present a novel account of analogical argument developed by Julian Weitzenfeld and then use it to carry out an in-depth analysis of Darwin's argument from artificial selection.

48. *Decisions in Dynamic Settings.* Paul Weirich. In a decision problem with a dynamic setting there is at least one option whose realization would change the expected utilities of options by changing the probability or utility function with respect to which the expected utilities of options are computed. A familiar example is Newcomb's problem. William Harper proposes a generalization of causal decision theory intended to cover all decision problems with dynamic settings, not just Newcomb's problem. His generalization uses Richard Jeffrey's ideas on ratifiability, and material from game theory on mixed strategies. Harper's proposal has two drawbacks, however. One concerns the mechanism for choosing among ratifiable options. The other concerns the proposal's reliance upon mixed strategies. Here I make another proposal that eliminates these two drawbacks.

49. *The Logical Skeleton of Darwin's Historical Methodology.* Mary B. Williams. Narrative explanations in evolutionary biology have seemed fundamentally different from other scientific explanations, and similar to historical explanations. This investigation of the structure of narrative explanations in evolutionary biology reveals that narrative explanations do have a deductive-nomological base, but that their structure contains two significant additional elements as well. The

additional elements are: the multidimensional recursive connection between the different sub-explanations in a narrative explanation; and a set of generic explanations which make possible the integration of multiple co-existing processes.

50. *Bootstrapping in Un-Natural Sciences: Archaeological Theory Testing*. Alison Wylie. Several difficulties have been raised concerning applicability of Glymour's model to developing and "un-natural" sciences, those contexts in which he claims it should be most clearly instantiated. An analysis of testing in such a field, archaeology, indicates that while bootstrapping may be realized in general outline practice necessarily departs from the ideal in at least three important respects 1) testing is not strictly theory contained, 2) the theory-mediated inference from evidence to test hypothesis is not exclusively deductive and, 3) structural considerations do not displace or take precedence over substantive considerations. These points of divergence reflect the fact that bootstrapping in developing and exploratory sciences is as much a process of theory construction as of theory testing.