Theory and History of Ontology (ontology.co) by Raul Corazzon | e-mail: rc@ontology.co

Kit Fine: annotated bibliography. Books - Papers 1970-1981

Contents

Books

1. Prior, Arthur Norman, and Fine, Kit. 1977. *World, Times and Selves*. London: Duckworth.
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"Before he died, Prior was working on a book to be entitled 'Worlds, Times and Selves'. This book was to deal, in one way or another, with the interplay between modal or tense logic, on the one hand, and quantification theory on the other. One of its main concerns was to show that modal and tense logic could stand on their own, that talk of possible worlds or instants was to be reduced to them rather than the other way round.

Unfortunately, only the first chapter was completed. There were jottings for other chapters, but they were far from complete. However, it is clear that some of Prior's recently published papers would have been incorporated into the book, though probably in considerably modified form. So what I have tried to do is to collate the published and unpublished material in such a way that the result is as close as possible to the book he had in mind.
This should explain the distribution of the unpublished material. The completed chapter appears, as it should, as the first paper of the collection. However, the other passages of unpublished material appear as supplements, in 3 and 7, to already published papers. This is because they are quite obviously expansions or elaborations of those papers. In order to avoid repetition, I have omitted some initial sections from the supplementary papers; and this accounts for their abrupt beginnings. I have also not used some other unpublished material, either because it was expository or because it was too fragmentary to be of interest.
The first paper explains in very simple terms the parallel between modal logic and quantification theory. It is a good introduction to the technical and philosophical problems that arise in the later papers.
The next three papers deal with the egocentric counterpart to ordinary tense or modal logic. They introduce the operator Q that picks out those propositions that correspond to instants, worlds or selves, as the case may be. The last sections of 2 and 4 and most of the supplement 3 are concerned with the formal development of Q or cognate notions.
The last three of Prior's papers, 5-7, deal with the problem of embedding the theory of instants or possible worlds within orthodox tense and modal logic respectively. Chapter 5 attempts to see how far the opposite view can be maintained. Chapter 6 is a particularly rich paper. It deals, among other things, with a world-calculus for the system Q, the logic of significance, and the extension of embedding results to possibilist quantifiers. The supplement elaborates further on some of these topics.
In his book, Prior would certainly have said more on this question of embedding. In the postscript, I have tried to fill this gap by discussing in detail his proposal for explaining instants and possible worlds within tense or modal logic. I had intended to write on his whole philosophy of time and modality; but, for reasons of space, I decided to stick to this more limited topic.
I should like to thank the editors of *Nous, L'Age de la Science, American Philosophical Quarterly* , and *Theoria* for permission to publish papers originally published by them. I should also like to thank Mary Prior, Anthony Kenny and Hans Kamp. They all, in their own ways, helped me to produce this collection. Tom Dimas and Mike Ferejohn prepared the indexes." (*Preface* , pp. 7-8)

2. Fine, Kit. 1985. *Reasoning with Arbitrary Objects*. Oxford: Basil Blackwell.
Contents: Preface VII; Introduction 1; 1. The General Framework 5; 2. Some Standard Systems 61; 3. Systems in General 147; 4. Non-Standard Systems 177; Bibliography 210; General Index 215; Index of Symbols 219-220.
"This book deals with certain problems in understanding natural deduction and ordinary reasoning. As is well known, there exist certain informal procedures for arguing to a universal conclusion and from an existential premiss. We may establish that all objects of a certain kind have a given property by showing that an arbitrary object of that kind has that property; and having shown that there exists an object with a given property, we feel entitled to give it a name and declare that it has the property. So we may establish that all triangles have interior angles summing to 180° by showing of an arbitrary triangle that its interior angles sum to 180°; and having established that there exists a bisector to an angle, we feel entitled to give it a name and declare that it is a bisector to the angle.
These informal procedures correspond to certain of the quantificational rules in systems of natural deduction. Corresponding to the first is the rule of universal generalization, which allows us to infer $\forall x\ \phi(x)$ from $\phi(a)$ under suitable restrictions. Corresponding to the second is the rule of existential instantiation, which allows us to infer $\exists(a)$ from $\exists x\ \phi(x)$, again under suitable restrictions.

In these inferences, certain terms play a crucial role; and it is natural to ask how they are to be understood. What role is to be attributed to the term a in the inferences from natural deduction? What is to be made of our talk of arbitrary triangles or indefinite bisectors in ordinary reasoning?

The present work is based upon the hypothesis that these critical terms refer to arbitrary or representative objects. The term a in the inferences from natural deduction functions as a name of a suitable arbitrary object. And our talk of arbitrary triangles or of indefinite bisectors is to be taken at its face value as also evincing reference to arbitrary objects.

The core of the work will be taken up with applying this hypothesis to two main systems of natural deduction: the one of Quine's *Methods of Logic* [52]; and the other of Copi [54], as amended by Kalish [67] and Prawitz [67]. In the case of each of these systems, we shall propose a generic semantics and then, by reference to that semantics, both establish soundness and motivate the restrictions on the rules.

We shall also be concerned to cover certain other topics. We develop the pure theory of arbitrary objects somewhat beyond the needs of the present application, partly because of its intrinsic interest and partly with a view to other applications. We embark on a general study of systems containing a rule of existential instantiation and prove some general results on what form satisfactory systems of this sort can take. Finally, on the basis of an alternative generic semantics, we develop certain presuppositional systems and relate them to existing systems in the literature. The book is divided into parts according to the topic treated, with the first part dealing with the pure theory, the second with the application to the systems of Copi and Quine, the third with systems in general that contain a rule of existential instantiation, and the last with the presuppositional systems.

The work here is part of a much larger project, one in which the theory of arbitrary objects is to be applied to the use of pronouns in natural language and to the use of variables in informal mathematics and programming languages. These other topics have been altogether ignored, although the perceptive reader may pick up on certain intended points of contact. The closely related topic of developing a generic semantics for the ε- and η-calculi of Hilbert and Bernays [34] and Hailperin [57] has also not been considered; and my hope is that I shall be able to deal with it thoroughly elsewhere.

The book does not need to be read from beginning to end and the first part, in particular, may be consulted according to the demands from the other parts. The reader who is having difficulties may find my 'Natural Deduction and Arbitrary Objects' [85] helpful as a somewhat gentler introduction to the subject." (*Introduction* , pp. 1-2)

References

Copi, I. 1954 *Symbolic Logic* , Macmillan: New York, First Edition.

Hailperin, T. 1957 'A Theory of Restricted Quantification', Part I, *Journal of Symbolic Logic* vol. 22, pp. 19-35, Part II, *Journal of Symbolic Logic* vol. 27, pp. 113-129.

Hilbert, D. and Bernays, P. 1934 *Grundlagen der Mathematik* Volume I, Berlin: Springer.

Kalish, D. 1967 Review, *Journal of Symbolic Logic* vol. 32, p. 254.

Prawitz, D. 1967 'A Note on Existential Instantiation', *Journal of Symbolic Logic* vol. 32, pp. 81-2.

Quine, W.V.O. 1952 *Methods of Logic* , Routledge & Kegan Paul: London.

3. ———. 2002. *The Limits of Abstraction*. New York: Oxford University Press.

Contents: Preface V-VI; Introduction IX-X; 1. Philosophical introduction 1; 2. The Context Principle 55; 3: The analysis of acceptability 101; 4. The general theory of abstraction 165, References 193; Main Index 197; Index of first occurrences of formal symbols and definitions 200-203.

"The present monograph has been written more from a sense of curiosity than commitment. I was fortunate enough to attend the Munich Conference on the Philosophy of Mathematics in the summer of 94 and to overhear a discussion of

recent work on Frege's approach to the foundations of mathematics. This led me to investigate certain technical problems connected with the approach; and these led me, in their turn, to reflect on certain philosophical aspects of the subject. I was concerned to see to what extent a Fregean theory of abstraction could be developed and used as a foundation for mathematics and to place the development of such a theory within a general framework for dealing with questions of abstraction. To my surprise, l discovered that there was a very natural way to develop a Fregean theory of abstraction and that such a theory could be used: to provide a basis for both arithmetic and analysis. Given the context principle, the logicist might then arguing that the theory was capable of yielding a philosophical foundation for mathematics, one that could account both for our reference to various mathematical objects and for our knowledge of various mathematical truths. I myself am doubtful whether the theory can legitimately be put to this use. But, all the same, there is surely considerable intrinsic interest in seeing how the theory of abstraction might be developed and whether it might be capable of embedding a significant portion of mathematics, even if the theory itself is in need of further foundation.
The monograph is in four parts. The first is devoted to philosophical matters and serves to explain the motivation for the technical work and its significance. It is centred on thee main questions: What are the correct principles of abstraction? In what sense do they serve to define the abstract with which they deal? To what extent can they provide a foundation for mathematics? The second part (omitted from the original paper) discusses the context principle, both as a general basis for setting up contextual definitions and in its particular application to numbers. The third part proposes and investigates a set of necessary and sufficient conditions for an abstraction principle to be acceptable. The acceptable principles, according to this criterion, are precisely determined and it is shown, in particular, that there is a strongest such principle. The fourth and final part attempts to develop a general theory of abstraction within the technical limitations set out by the third part; the theory is equipped with a natural class of models; and it is shown to provide a foundation for both arithmetic and analysis." (*Introduction* , pp. IX-X)

4. ———. 2005. *Modality and Tense: Philosophical Papers*. New York: Oxford University Press.
Contents: Preface; Introduction 1;
I. Issues in the Philosophy of Language.
1. Reference, Essence, and Identity (previously unpublished) 19; 2. The Problem of *De Re* Modality (1989) 40; 3. Quine on Quantifying In (1990) 105;
II. Issues in Ontology.
4. Prior on the Construction of Possible Worlds and Instants (1977) 133; 5. Plantinga on the Reduction of Possibilist Discourse (1985) 176; 6. The Problem of Possibilia (2002) 214;
III. Issues in Metaphysics.
7. The Varieties of Necessity (2002) 235; 8. Tense and Reality (2005) 261; 9. Necessity and Non-Existence (previously unpublished) 321;
IV. Reviews.
10. Review of *Conterfactuals* by David Lewis (1975) 357; 11. Review of *The Nature of Necessity* by Alvin Plantinga (1976) 366; References 371; Index 379-387.
"This volume collects together my published papers on tense and modality up to the present time. It contains two reviews, since the issues they discuss are still of interest; and it also contains a much expanded version of my paper, ‘The Reality of Tense’, now under the title ‘Tense and Reality’, and two previously unpublished papers. I have not included my technical papers on modal logic, even when they have contained philosophical material or have had an obvious bearing on philosophical questions; and nor have I included any of my philosophical or technical papers on essence, even when they have dealt with the connection between essence and modality. I have added an introduction to the volume, outlining the central content of each paper and bringing out certain issues and themes that may not be evident from the papers themselves." (From the *Preface*)

5. ———. 2007. *Semantic Relationism*. Oxford: Blackwell.
Contents: Preface VII; Introduction 1; 1. Coordination among variables 6; 2. Coordination within language 33; 3. Coordination within thought 66; 4. Coordination between speakers 86; Postscript: further work 122; Notes 133; References 141; Index 143.
"The ideas behind these lectures had their origin in the early 1980s.
There was then a great deal of excitement over the “new” theory of direct reference, but many of those who were attracted to the theory were also worried about the challenge posed by Frege’s puzzle. How could they claim, as the theory seemed to require, that the meaning of “Cicero = Tully” was the same as “Cicero = Cicero,” when the one was plainly informative and the other not?
I myself faced a similar problem over the role of variables. I had previously attempted to develop a theory of variable or arbitrary objects. According to this theory, a variable should be taken to signify a variable object, something which we might loosely identify with the variable’s meaning or abstract role. However, even though the variables x and y, when considered on their own, should be taken to signify the same variable object, they should not be taken to signify the same variable object when considered together, since otherwise we would lose the relevant distinction between x = y and x = x. It seemed clear to me that the two problems were essentially the same and that there should be a common solution to them both, even though it was not then clear to me what the solution should be.
I worried about this issue on and off for the next 15 years until it dawned on me that it could only adequately be solved by making a fundamental break with semantics as it is usually conceived. One must take account of the meaning that expressions have, not only when considered on their own but also when they are considered together; the meaning relation between them is not simply to be regarded as a product of their individual meanings. Once we embrace this liberating thought, we can then see how the usual referential view of the meaning of variables and names can be retained and yet the difficulties over Frege-type puzzles avoided.
It was, therefore, opportune when Ernie Sosa asked me to give the first Blackwell/Brown lecture for the Fall of 2002, since this provided me with an opportunity to develop these ideas, which were still in a very inchoate form, and to discuss them with a wonderful group of philosophers.
(...)
The present book is loosely based upon the lectures I gave at Brown and I have tried to keep to something like the original lecture format. This has meant that a number of topics have not been pursued, though I have given a brief account of some of the more important of these topics in the final chapter. It has also meant that scholarly allusions have been kept to a minimum. I have, in particular, made no attempt to compare my own work with the loosely related work of Almog (2006), Fiengo and May (2005), Lawlor (2005), and Lieb (1983). This is a “bare-bones” account, simply intended to convey the essential ideas; and I hope later to provide a fuller account that is both broader in its scope and much more thorough in its treatment of particular topics." (*Preface* pp. VII-VIII)
References
Almog, J. (2006) “Is A Unified Treatment of Language-and-Thought Possible?,” *Journal of Philosophy* , vol. CII, no. 10, pp. 493–531.
Fiengo, R. and May, R. (2005) *De Lingua Belief,* Cambridge: MIT Press.
Lawlor, K. (2005) “Confused Thoughts and Modes of Presentation,” *Philosophical Quarterly* , vol. 55, no. 218, pp. 137–48.
Lieb, H.-H. (1983) “ *Integrational Linguistics, vol. 1: General Outline* ”, Amsterdam; Philadelphia: Benjamins (= Current Issues in Linguistic Theory, 17).

6. ———. 2020. *Vagueness. A Global Approach*. New York: Oxford University Press.
"The material for the lectures has been extracted from a much longer booklength manuscript, which I hope to publish separately. I therefore hope that the reader will bear in mind that many topics that are discussed perfunctorily or not at all in this monograph will be discussed at much greater length in the book. This is a bare

bones account, without the usual qualifications or consideration of objections or discussion of alternative points of view.
The first lecture (Chapter 1) was intended as an introduction to a general audience with no special expertise in the topic. It is, for this reason, very sketchy and, except for the last part, not at all original. The subsequent two lectures are more substantive. The first of these (Chapter 2) presents my general account of vagueness and the second (Chapter 3) discusses its application to three topics: the sorites argument (or paradox of the "heap"); the question of luminosity (or whether we can know our own minds); and the problem of personal identity, especially in its connection to the possibility of fission." (from the Preface)

Papers 1970-1988

1. Fine, Kit. 1970. "Propositional Quantifiers in Modal Logic." *Theoria* no. 36:336-346.
"In this paper Ï shall present some of the results I have obtained on modal theories which contain quantifiers for propositions. The paper is in two parts: in the first part I consider theories whose non-quantificational part is S5; in the second part I consider theories whose non-quantificational part is weaker than or not contained in S5. Unless otherwise stated, each theory has the same language L. This consists of a countable set V of propositional variables p1, p2,, the operators v (or), ~ (not) and □ (necessarily), the universal quantifier (p), p a propositional variable, and brackets (and), The formulas of L are then defined in the usual way." (p. 336)
2. ———. 1971. "The Logics Containing S4.3." *Zeitschrift für Mathematische Logik und Grundlagen der Mathematik* no. 17:371-376.
"In this paper I prove some general results on logics containing S 4.3. In section 2 I prove that they all have the finite model property. Bull [1] has already proved thia result; but his proof is algebraic, whereas mine is semantic. In sections 3 and 4, I prove that they are all finitely axiomatizable. It follows from these results that they are all decidable. Finally, in section 5, I show that the lattice of S 4.3 logics is isomorphic to one on finite set of finite sequences of natural numbers. Needless to say, these results carry over to the extensions of the intermediate logic LC.
In a paper on logics containing K4, I shall present another semantic proof that S4.3 logics have the finite model property and thereby also establish some results on compactness." (p. 371)
(1) R. A. Bull, "That All Normal Extensions of S4.3 Have the Finite Model Property", *Zeitschrift für Mathematische Logik und Grundlagen der Mathematik* , 12, 1966, pp. 341-344.
3. ———. 1971. "Counting, Choice and Undecidability." *Manifold* no. 11:17-22.
Abbreviations: Continuum Hypothesis = CH; Axiom of Choice = AC.
"In 1900 Hilbert stated 23 problems which he considered to be of crucial iaportance. The first of these was 'prove Cantor's Continuum Hypothesis'. Gödel (1939) and Cohen (1963) have shown that the hypothesis can neither be proved nor disproved. Their proofs are expounded in:
P. J. Cohen, *Set Theory and the Continuum Hypothesis* , Benjamin 1966.
P. J. Cohen, "Independence results in set theory", in *Studies ln Logic and the Foundations of Mathematics* , North-Holland 1965, pp. 39-54.
K. Gödel, "The Consistency of the Axiom of Choice and of the Generalized Continuum Hypothesis with the axiom of set theory", 1939, 4th printing, Princeton 1966·" (p. 71)
(...)
"The question now remains: what attitude should the working mathematician take towards CH? It is important to leave AC on one side at this point because it possesses a degree of self-evidence that CH certainly lacks.

There are, I think, two main attitudes. On the one hand, one could say there is no sense in which CH is true or false and give up looking for ways of settling the question. Instead, one would develop different set theories, with or without CH, somewhat in analogy to the alternative geometries of the 19th century. On the other hand, one could say that CH Is either true or false and look for new ways of determining which.

Two main ways suggest themselves. The first is to dispense with proof and to accept that hypothesis concerning transfinite cardinals which is most fruitful in consequences. The second is to search for new self-evident axioms that might settle CH.

These new axioms might be formulated in terms of set-theoretic notions or in terms of a new notion or new notions altogether.

The adoption of non-deductive procedures or the discovery of non-set-theoretic notions would conflict with two common views about mathematics, viz. that all mathematical knowledge is based upon proof and that all mathematical notions can be given a set-theoretic definition. Although it is too early to talk of feasibility, it is worth noting that these common views are based upon an analysis of extant mathematics. There seems to be no reason, in principle, why they should be true." (p. 82)

4. ———. 1972. "In So Many Possible Worlds." *Notre Dame Journal of Formal Logic* no. 13:516-520.

"Ordinary modal logic deals with the notion of a proposition being true at least one possible world. This makes it natural to consider the notion of a proposition being true in *k* possible worlds for any non-negative integer *k.* Such a notion would stand to Tarski's numerical quantifiers as ordinary possibility stands to the existential quantifier.

In this paper (1) I present several logics for numerical possibility. First I give the syntax and semantics for a minimal such logic (sections 1 and 2); then I prove its completeness (sections 3 and 4); and finally I show how to extend this result to other logics (section 5)." (p. 516)

(1) The results of this paper are contained in my doctorate thesis, submitted to the University of Warwick in 1969. I am greatly indebted to my supervisor, the late Arthur Prior. Without his help and encouragement this paper would never have been written.

5. ———. 1972. "For So Many Individuals." *Notre Dame Journal of Formal Logic* no. 13:569-572.

"In [2], Tarski introduces the numerical quantifiers.

(...)

Because of their definability, the numerical quantifiers have rarely been considered on their own account. However, in this paper I consider a predicate logic without identity which is enriched with numerical quantifiers as primitive. In section 1, I present the syntax and semantics for this logic; and in sections 2 and 3, I establish its completeness." (p. 569)

[2] Tarski, A., *Introduction to Logic,* Oxford University Press (1946).

6. ———. 1972. "Logics Containing S4 Without the Finite Model Property." In *Conference in Mathematical Logic, London '70* , edited by Hodges, Wifrid, 98-102. Berlin: Springer Verlag.

"In [1], Harrop asked whether there were logics containing the intuitionistic logic IL which lack the finite model property [=fmp]. Jankov gave examples of such logics, but they were not finitely axiomatizable. By the Tarski-McKlnsey translation, Harrop's problem relates to the question of whether there exist extensions of the modal logic S4 without fmp. Makinson [2] showed that there are extensions of the modal logic M without fmp, but he could not extend his results to S4. In this paper, I shall exhibit logics containing both IL and S4 which lack fmp, but are finitely axiomatized and decidable." (p. 98)

(...)

"Finally, it should be noted that we can add axioms to the logics described above so as to obtain logics which are decidable, finitely axiomatized, complete for their intended interpretation, and yet without fmp." (p. 101)
[1] Harrop, R., On the existence of finite models and decision procedures, *Proceedings of the Cambridge Philosophical Society* , vol. 54 (1958), 1-16.
[2] Makinson, D., A Normal Modal Calculus Between T and S4 Without the Finite Model Property, *Journal of Symbolic Logic* , voi. 34, Number 1 (1969), 35-38.

7. ———. 1972. "Some Necessary and Sufficient Conditions for Representative Decision on Two Alternatives." *Econometrica* no. 40:1083-1090.
"A social decision rule is one that produces a social decision for each configuration of individuals' decisions. Such a rule is representative if it produces a social decision that is the result of repeatedly applying the rule of simple majority decision to decisions obtained
by that rule. We give necessary and sufficient conditions for a social decision rule for two alternatives to be representative." (p. 1083)
(...)
"The central problem of this paper is to find an alternative characterization of the representative functions. May in [1] gave an alternative characterization of the simple majority decision functions, and Murakami in [2 and 3] established that monotonicity and self-duality are necessary conditions for being a representative or indirect majority decision function. (In fact, Murakami deals with what he calls democratic functions, i.e., representative functions which are non-dictatorial; but this latter condition may be added or left out at will.) However, he was not able to establish any sufficient conditions. In this paper, I establish his conjecture that strong monotonicity with self-duality is a sufficient condition.
I use this result and a new property of not being "zigzag" to prove that monotonicity, self-duality, and not being zigzag are necessary and sufficient conditions. (2)
Finally, I show that the monotonic, self-dual, and positive functions are exactly those definable in terms of the voting and jury operators." (p. 1084)
(2) P. C. Fishburn independently solved this problem in his paper "The Theory of Representative Majority Decision," *Econometrica* , 39 (1971), pp. 273-284. However, he uses a completely different method of proof and a slightly different condition in place of "not zigzag".
References
[1] MAY, K. O.: "A Set of Independent, Necessary and Sufficient Conditions for Simple Majority Decision," *Econometrica* , 20 (1952), 680-684.
[2] MURAKAMI, Y.: "Formal Structure of Majority Decisions," *Econometrica* , 34 (1966), 709-718.
[3] MURAKAMI, Y.: *Logic and Social Choice*. London: Macmillan, and New York: Dover, 1968.

8. ———. 1973. "Conditions for the Existence of Cycles under Majority and Non-Minority Rules." *Econometrica* no. 41:889-899.
"This paper provides type I necessary and sufficient conditions for transitivity and quasi-transitivity under simple majority rule. (2) For type II conditions, a master list of orderings is acceptable if the social rule generates a "rational" (e.g., transitive) social ordering whenever the individuals select their preference orderings from the list. A list ordering may be selected any number of times, and, in particular, it may not be selected at all. For type I conditions, on the other hand, each list ordering must be selected at least once, so that the list and the configuration of individual orderings must exactly match in the kind of orderings they contain. Thus for type II conditions it is the absence of certain kinds of orderings that blocks irrational social choice, whereas for type I conditions the presence of certain kinds of orderings may also contribute toward blockage.
Type II conditions have been determined for a wide variety of rules and under several definitions of rationality. Our main interest in this paper is in type I conditions for simple majority rule with rationality defined in terms of transitivity

or quasi-transitivity. However, our method of argument will yield simple alternative proofs of some standard results on type I conditions and it will also yield the type I and type II conditions for transitivity under non-minority rule.
Section 1 lays down some relevant definitions. Section 2 proves the "min-midmax" theorem, which is the basis for all that follows. Sections 3 and 4, respectively, establish the conditions for transitivity and quasi-transitivity under majority rule. Finally, Section 5 proves the min-mid-max theorem for the non-minority rule and establishes the condition for transitivity under that rule." (p. 889)
(2) The terminology of type I and II conditions is Pattanaik's [6]. Type II conditions were first proposed by Inada [3] and type I conditions by Pattanaik [5].
References
[3] INADA, K.: "On the Simple Majority Decision Rule," *Econometrica* , 36 (1969), 490-506.
[5] PATTANAIK, P. K.: "SufficientConditions for the Existence of a Choice Set under Majority Voting," *Econometrica* , 38 (1970), 165-170.
[6] PATTANAIK, P. K.: *Voting and Collective Choice*. Cambridge: Cambridge University Press, 1971.

9. ———. 1973. "Surveys on Deontic Logic, Mathematical Logic and the Philosophy of Mathematics." In *UNESCO Survey of the Social Sciences*.

10. ———. 1974. "An Ascending Chain of S4 Logics." *Theoria* no. 40:110-116.
"This paper shows that there exists a continuum of logics containing the modal logic S4. (1) §1 contains preliminary definitions and results; §2 introduces the key notion of a frame formula; §3 establishes the main result and some consequences; and §4 establishes some further results." (p. 110)
(1) Jankov [5] has independently, and previously, proved the analogous result for intuitionistic sentential logic. His method of proof is algebraic, whereas mine is semantic.
References
[5] V. A. Jankov, On the Extension of the Intuitionist Propositional Calculus to the Classical Calculus, and the Minimal Calculus to the Intuitionist Calculus, *Journal of Symbolic Logic* 38, 1973, pp. 331-332.

11. ———. 1974. "Models for Entailment." *Journal of Philosophical Logic* no. 3:347-372.
Reprinted in: Alan Ross Anderson, Nuel D. Belnap, Jr., with contributions by J. Michael Dunn ... [et al.], *Entailment: The Logic of Relevance and Necessity,* Princeton: Princeton University Press, 1992 vol. II, pp. 208-231.
"This paper gives a modelling for Ackermann’s systems *Π'* and *Π''* , Anderson’s and Belnap’s system *E* and *R* , and several of their subsystems. The distinctive feature of this modelling is a point-shift in the evaluation of negation and entailment: the negation of a formula holds at a point if the formula itself fails to hold at a complementary point; and an entailment holds at a point if whenever its antecedent holds at a point its consequent holds at an appropriately associated point. These rules enable negations of valid formulas to hold at a point and valid formulas themselves to fail to hold at a point. They also provide a grip on certain axioms involving negation or nested entailment." (p. 347, notes omitted)
(...)
The first two sections present the deductive-semantic framework; §51.1 specifies the models, and §51.2 the logics. The following two sections establish completeness; §51.3 for a minimal logic B, and §51.4 for **Π', Π'', E** and the several subsystems. §51.5 outlines various alternative versions of the modeling. The last two sections contain applications of the modeling: §51.6 to the admissibility of modus ponens; and §51.7 to the finite model property and decidability. Many of the systems considered are shown to have these properties; see §63 for a further survey on decidability, and §65 for fundamental undecidabilily results." (pp. 208-209 of the revised reprint)

12. ———. 1974. "An Incomplete Logic Containing S4." *Theoria* no. 40:23-29.

"This paper uses the standard terminology of modal logic. It should suffice to say that: all logics contain the minimal logic *K* and are closed under necessitation, substitution and modus ponens; frames consist of a relation defined on a non-empty set of points; models consist of a frame with a valuation; and truth-at-a-point is defined and notated in an obvious way; with the formula □ *A* true at a point iff *A* is true at all accessible points. The formula *A* is true in (satisfied by) a model if it is true in all (some) points of the model; *A* is strongly verified in a model if all substitution-instances of *A* are true in the model; and *A* is valid in a frame if *A* is true in all models based upon the frame, *A* set of formulas is true, strongly verified, or valid if all of its members are. Unless otherwise stated, all logics contain S4 and all models and frames possess reflexive and transitive relations.
A logic is complete if any formula valid in all frames that validate the logic is in the logic. This paper exhibits a logic L containing S4 that is not complete." (p. 23)

13. ———. 1974. "Logics Containing K4. Part I." *Journal of Symbolic Logic* no. 39:31-42.
"There are two main lacunae in recent work on modal logic: a lack of general results and a lack of negative results. This or that logic is shown to have such and such a desirable property, but very little is known about the scope or bounds of the property. Thus there are numerous particular results on completeness, decidability, finite model property, compactness, etc., but very few general or negative results. In these papers I hope to help fill these lacunae. This first part contains a very general completeness result. Let I_n > be the axiom that says there are at most n incomparable points related to a given point. Then the result is that any logic containing K4 and I_n > is complete.
The first three sections provide background material for the rest of the papers. The fourth section shows that certain models contain no infinite ascending chains, and the fifth section shows how certain elements can be dropped from the canonical model. The sixth section brings the previous results together to establish completeness, and the seventh and last section establishes compactness, though of a weak kind. All of the results apply to the corresponding intermediate logics." (p. 31)

14. Fine, Kit, and Fine, Ben J. 1974a. "Social Choice and Individual Ranking I." *Review of Economic Studies* no. 41:303-322.
"This paper investigates social positional rules. The rules are social in that they produce a social output for any configuration of individual preference orderings. They are positional in that the output produced depends only upon the positions occupied by each alternative in the individual preference orderings. (3)
Social rules may be distinguished by the form of their output, be it a quasi-ordering, choice structure or complete ordering. For each form of output, we shall determine the class of social rules that satisfy certain desirable conditions. Part one deals with quasi ordering rules; part two will deal with the other types of rules.
Indeed, this part shows that certain desirable conditions are uniquely satisfied by the so-called positional rule. One alternative is as good as another by this rule if any individual's ranking of these cond alternative can be matched by as high a ranking of the first alternative by some possibly different individual. The individuals'rankings should be as good for the one alternative as for the other." (p. 303)
(*) Some of the results of this paper are contained in B. Fine's B.Phil. thesis, Oxford1971. We should like to thank the editor and a referee for many helpful suggestions.
(3) There have been several recent papers on positional rules. See [2], [3], [5] and [8]. However, most of the results of these papers overlap with the material of Part II (which is forthcoming in this journal) rather than Part I. Further details will be given there, but let us note that Smith [8] also has a variable number of individuals and a composition condition (his separability).
References

[1] Arrow, K. J. *Social Choice and Individual Values* (New York: Wiley, 1951; 2nd ed. 1963).
[2] Fisburn, P. C. "A Comparative Analysis of Group Decision Methods", *Behavioural Science* , 16 (1971).
[3] Fishburn, P. C. The Theory of Social Choice (Princeton UniversityPress, 1973).
[4] Gale, D. *The Theory of Linear Economic Models* (New York: McGraw-Hill, 1960).
[5] Gardenfors, P. "Positionalist Voting Functions", forthcoming in *Theory and Decision*. [September 1973, Volume 4, Issue 1, pp 1-24]
[6] Hansson, B. "On Group Preferences", *Econometrica* , 37 (1969).
[7] Sen, A. K. *Collective Choice and Social Welfare* (Holden-Day, 1970).
[8] Smith, J. H. "Aggregation of Preferences with Variable Electorate", forthcoming in *Econometrica*. [Vol. 41, No. 6 (Nov., 1973), pp. 1027-1041]

15. ———. 1974b. "Social Choice and Individual Ranking II." *Review of Economic Studies* no. 41:459-475.

"In Part I of this paper it was shown that certain appealing conditions forced any social quasi-ordering rule to include the positional rule, which is itself the intersection of all finite ranking (f.r.) rules. These conditions are slightly strengthened in the first three sections of this part, but this allows us to characterize in Section 3 the rules that also satisfy the additional properties as the intersection of some set of f.r. rules. In case a continuity property, which can be interpreted as a non-veto condition applied to groups, does not hold, the set of f.r. rules must be extended to include transfinite weightings. Section 1 finds sufficient conditions for a quasi-ordering rule to be positional. This is used in Section 2 to prove the results contained in Section 3 for the special case of a social ordering rule, when a single f.r. rule emerges. This special case is then generalized in Section 3.

In Section 4, for the first time in the paper, we analyse conditions that recognize social decision depending upon the number of alternatives. Previously, only the number of individuals has been effectively allowed to vary. Again, simple and natural properties have powerful consequences, and it is thereby shown that the Borda rule is a compelling choice for making social decision, given a veil of ignorance, that is no knowledge of the special features of the individuals and alternatives concerned. In case only a quasi-ordering rule is required, social decision is based on the intersection of a set of f.r. rules symmetrical about the Borda rule.

In Section 5 we turn to choice structureules. First a positional choice structure is defined. It is the strongest such rule containing all the f.r. rules, since an alternative in a set belongs to the choice from that set iff for some f.r. it is best in the set. This last condition is shown to be equivalent to demanding that the *HC* of that element does not belong to the convex hull of the *HC* of the other alternatives in the set. Then an outline is made for a conditions analysis of the rule: it is found to be the weakest rule satisfying certain conditions, in the sense that any other rule satisfying those conditions must be more decisive. In this, the method, results and analysis correspond to Part I's consideration of the positional quasi-ordering rule.

Section 6 is devoted to an examination of some questions concerned with the independence of conditions and Section 7 contains concluding remarks. The above only sketches the major results of thispaper. In addition,the analysis of normal social quasi ordering rules in Section 2 and Section 3 has obvious relevanceto the theory of production and utility under risk in the presence of indivisibility.

Finally, it should be noted that throughou this part, individual preferences are assumed to be antisymmetrical.Whilst the complications posed by individual indifference were overcome in Part I (Section6), a more general analysis becomes analytically cumbersome and presents more problems here. Nevertheless many of the results, especially analysis by conditions, do apply more generally, though possibly ith slight modifications." (pp. 459-460)

(*) The first part of the paper [1974a] was written up by K. Fine and the second by B. Fine. Both authors have contributed to all sections of the paper, though the first has contributed more to the material on the positional rule and the second to the material on normal social rules. Some of the resultsfor ordering rules in this paper have been independently established by Smith [Smith, J. H. "Aggregation of Preferences with Variable Electorate", *Econometrica*. Vol. 41, No. 6 (Nov., 1973), pp. 1027-1041].

16. Fine, Kit. 1975. "Vagueness, Truth and Logic." *Synthese* no. 30:265-300.
Reprinted in: Rosanna Keefe & Peter Smith, *Vagueness: A Reader,* Cambridge: MIT Press, 1996, pp. 119-150.
"My investigation of this topic began with the question "What is the correct logic of vagueness?" This led to the further question "What are the correct truth-conditions for a vague language?" And this led, in its turn, to a more general consideration of meaning and existence.
The contents of the paper are as follows. The first half contains the basic material. Section 1 expounds and criticizes one approach to the problem of specifying truth-conditions for a vague language. The approach is based upon an extension of the standard truth-tables and falls foul of something I call penumbral connection. Section 2 introduces an alternative framework, within which penumbral connection can be accommodated. The key idea is to consider not only the truth-values that sentences actually receive but also the truth-values that they might receive under different ways of making them more precise. Section 3 describes and defends the favoured account within this framework.
According to this account, as roughly stated, a vague sentence is true if and only if it is true for all ways of making it completely precise. The second half of the paper then deals with consequences, complications and comparisons of the preceding half. Section 4 considers the consequences that the rival approaches have for logic. The favoured account leads to a classical logic for vague sentences; and objections to this unpopular position are met. Section 5 studies the phenomenon of higher-order vagueness: first, in its bearing upon the truth-conditions for a language that contains a definitely-operator or a hierarchy of truth-predicates; and second, in its relation to some puzzles concerning priority and eliminability.
Some of the topics tie in with technical material. I have tried to keep this at a minimum.
But the reader must excuse me if the technical undercurrent produces an occasional unintelligible ripple upon the surface. Many of the more technical passages can be omitted without serious loss in continuity." (p. 265)

17. ———. 1975. "Normal Forms in Modal Logic." *Notre Dame Journal of Formal Logic* no. 16:229-237.
"There are two main methods of completeness proof in modal logic.
One may use maximally consistent theories or their algebraic counterparts, on the one hand, or semantic tableaux and their variants, on the other hand. The former method is elegant but not constructive, the latter method is constructive but not elegant.
Normal forms have been comparatively neglected in the study of modal sentential logic. Their champions include Carnap [3], von Wright [10], Anderson [l] and Cresswell [4]. However, normal forms can provide elegant and constructive proofs of many standard results. They can also provide proofs of results that are not readily proved by standard means.
Section 1 presents preliminaries. Sections 2 and 3 establish a reduction to normal form and a consequent construction of models. Section 4 contains a general completeness result. Finally, section 5 provides normal formings for the logics T and K4." (p. 229)
[1] Anderson, A. R., "Improved decision procedures for Lewis's calculus S4 and Van Wright's calculus M," *The Journal of Symbolic Logic,* vol. 34 (1969), pp. 253-255.
[2] Bull, R. A., "On the extension of S4 with *CLMpMLp," Notre Dame Journal of Formal Logic,* vol. VIII (1967), pp. 325-329.

[3] Carnap, R., "Modalities and quantification," *The Journal of Symbolic Logic,* vol. 11 (1946), pp. 33-64.
[4] Cresswell, M. J., "A conjunctive normal form for S3.5," *The Journal of Symbolic Logic,* vol. 34 (1969), pp. 253-255.
[10] Wright, G. H. von, *An Essay in Modal Logic,* Amsterdam (1951).

18. ———. 1975. "Review of David Lewis ' *Counterfactuals* '." *Mind* no. 84:451-458. Reprinted in: *Modality and Tense. Philosophical Papers,* as chapter 10, pp. 357-365.

"This is an excellent book. It combines shrewd philosophical sense with fine technical expertise; the statement of views is concise and forthright; and the level of argument is high." (p. 451)

(...)

"Lewis suggests that merely possible worlds are like the actual world, 'differing not in kind but only in what goes on at them'. Indeed, for him there is no absolute difference between the actual world and the others: the difference is relative to a particular possible world as point of reference. A similar view has been held about the present time, but it is hard to accept for possible worlds. On the logical construction view, the actual world is distinguished by the property that all of its propositions are true. Here 'true' is an absolute term. It is not defined as truth in the actual world but, on the contrary, truth-in-a-world is defined as set-theoretic membership." (p. 455).

19. ———. 1975. "Some Connections between Elementary and Modal Logic." In *Proceedings of the Third Scandinavian Logic Symposium* , edited by Kanger, Stig, 15-31. Amsterdam: North-Holland.

"A common way of proving completeness in modal logic is to look at the canonical frame. This paper shows that the method is applicable to any complete logic whose axioms express a XA-elementary condition or to any logic complete for a A-elementary class of frames. We also prove two mild converses to this result. (1) The first is that any finitely axiomatized logic has axioms expressing an elementary condition if it is complete for a certain class of natural subframes of the canonical frame. The second result is obtained from the first by dropping 'finitely axiomatized', and weakening 'elementary' to 'A-elementary'.

Classical logic is used in the formulation and proof of these results.

The proofs are not hard, but they do show that there may be a fruitful and non-superficial contact between modal and elementary logic. Hopefully, more work along these lines can be carried out.

§ 1 outlines some basic notions and results of modal logic. For simplicity, this is taken to be mono-modal. However, the results can be readily extended to multi-modal logics and, in particular, to tense logic.

§ 2 proves the first of the above results and a related result as well; § 3 proves the second of the above results; and finally, § 4 constructs counterexamples to some plausible looking converse results." (pp. 15-16)

(1) After writing this paper, I discovered that A.H. Lachlan had already proved the first of these 'mild converses' in [5]. His proof uses Craig's interpolation theorem, whereas mine uses the algebraic characterization of elementary classes. R.I. Goldblatt [4] independently hit upon this latter proof at about the same time as I did.

He also has a counter-example to the converse of this result. It is similar to the one in § 4.

I should like to thank Steve Thomason for the references above and for some helpful comments on the paper.

References

[4] R.I. Goldblatt, First-order definability in modal logic, [*The Journal of Symbolic Logic* , Vol. 40, No. 1 (Mar. 1975), pp. 35-40]
[5] A.H. Lachlan, A note on Thomason's refined structures for tense logic, *Theoria* , [Vol. 40, No. 2 (Aug. 1974), pp. 117–120]

20. ———. 1976. "Review of *The Nature of Necessity* ' (A. Plantinga)." *The Philosophical Review* no. 86:562-566.
Reprinted in: *Modality and Tense. Philosophical Papers,* as chapter 11, pp. 366-370.
"This book discusses several topics in the theory of modality: the *de re/de dicto* distinction, possible worlds, essences, names, possible objects, and existence. In the final two chapters, the preceding material is applied to the problem of evil and the ontological argument. In its philosophical (though not theological) parts, the book is close to Kripke's *Naming and Necessity*.
There are similar accounts of the a priori/necessary distinction, proper names, transworld identity, and the identity theory." (p. 562)

21. ———. 1976. "Completeness for the Semi-Lattice Semantics. Abstract." *Journal of Symbolic Logic* no. 41:560.

22. ———. 1976. "Completeness for the S5 analogue of E_i. Abstract." *Journal of Symbolic Logic* no. 41:559-560.

23. ———. 1977. "Properties, Propositions and Sets." *Journal of Philosophical Logic* no. 6:135-191.
"This paper presents a theory of cxtensional and intensional entities. The entities in question belong to a hierarchy that begins with individuals, sets, properties and propositions. The hierarchy extends to higher orders, both extensional and intensional. Thus it contains sets of propositions, properties of sets, properties of such properties, and, in general, it contains relations-in-intension and relations-in-extension over types of entities already in the hierarchy.
The theory does not say what a proposition or property is. Rather, a possible worlds account of these entities is taken for granted. Thus a proposition is regarded as a set of possible worlds, a property as a set of world-individual pairs, and similarly for the other intensional entities.
What the theory does is to characterize and investigate various properties of the entities in terms of possible worlds. These properties include existence, being purely general or qualitative, being logical, having an individual constituent, and being essentially modal. Thus the theory is ontological rather than linguistic. Its main concern is with the ontological status of the various entities and not with their relation to language." (p. 135)

24. ———. 1977. "Prior on the Construction of Possible Worlds and Instants." In *Worlds, Times and Selves* , 116-168. London: Duckworth.
Postscript to ' *Worlds, Times and Selves* ', by Arthur Norman Prior, reprinted in: *Modality and Tense. Philosophical Papers,* as chapter 4.
"Fundamental to Prior's conception of modality were two theses:
The ordinary modal idioms (necessarily, possibly) are primitive (1)
Only actual objects exist (2)
The first thesis might be called Modalism or Priority, in view of its nature and founder. The second thesis is sometimes called Actualism, and the two theses together I call Modal Actualism." (p. 116)
(...)
"My aim in this chapter is to carry out this programme of reconstruction, at least in outline. I have often followed the lead of Prior, much of whose later work (3) arose from this programme. However, I cannot be sure that he would have approved of all of the steps I take." (p. 118)
(1) Many references might be given. See e.g. 'Modal Logic and the Logic of Applicability' *Theoria* , 34 (1968), reprinted as Chapter 6 above.
(2) See *Papers on Time and Tense* , p. 143
(3) See the chapter of this book, Ch. XI of Papers on Time and Tense, and V of *Past, Present and Future.*

25. ———. 1978. "Model Theory for Modal Logic Part I: The ' *de re / de dicto'* Distinction." *Journal of Philosophical Logic* no. 7:125-156.

"It is an oddity of recent work on modality that the philosopher's main concern has been with quantificational logic whereas the logician's has been with sentential logic. There have, perhaps, been several reasons for this divergence of interest. One is that the area of sentential modal logic is already rich in logical problems; and another is that the semantics for quantified modal logic has been in an unsettled state. But whatever the reasons have been in the past, the time would now seem ripe for a more fruitful interaction between these two approaches to the study of modality.

My aim in these papers has been to bring the methods of model theory closer to certain common philosophical concerns in modal logic. Indeed, most of the results answer questions that arise from some definite philosophical position. In this respect, my approach differs from that of Bowen [1] and others, who attempt to extend the results of classical model theory to modal logic. Although this approach has its attractions, it also suffers from two drawbacks. The first is that most of its results are devoid of philosophical interest; and the second is that many standard results of classical model theory, such as the Interpolation Lemma, do not apply to some standard modal logics, such as quantified S5 (see my paper [5]).

The philosophical position that underlies the results of the first two parts of this paper may be called *de re* scepticism. It is the doctrine that quantification into modal contexts does not, as it stands, make sense. Call a sentence *de dicto* if, in it, the necessity operator never governs a formula that contains a free variable. Then for the *de re* sceptic, only *de dicto* sentences, or their equivalents, are legitimate." (p. 125)

References

[1] Bowen, K. A., 1975, ‘Normal Modal Model Theory’, *Journal of Philosophical Logic* 4, 2, 97–131.

[5] Fine, K., ‘Failures of the Interpolation Lemma in Modal Logic’, *Journal of Symbolic Logic* , (44), 1979, pp. 201-206.

26. ———. 1978. "Model Theory for Modal Logic Part II: The Elimination of ' *de re'* Modality." *Journal of Philosophical Logic* no. 7:277-306.

"In the first part of this paper, two philosophical positions were introduced: *de re* scepticism; and anti-Haecceitism. According to the first, quantification into modal contexts does not, as it stands, make sense; and according to the second, the identity or non-identity of individuals in distinct possible worlds is a matter of convention. It was shown that the two positions are equivalent in the sense that whatever first-order modal sentence is legitimate for the one is also legitimate for the other.

A soft and hard version of each of these positions may be distinguished. According to the soft *de re* sceptic, it is possible to make sense of *de re* modal discourse; and according to the soft anti-Haecceitist, it is possible to define coherent identity conditions for individuals across possible worlds. Both of the soft positions, then, are compromising ones in that they allow that ordinary modal discourse may be reconstructed. The hard versions of the positions, on the other hand, deny that any such reconstruction is possible.

The soft *de re* sceptic may reconstruct ordinary modal discourse in various ways. One way is to reinterpret either quantification or modality (or both) so that each *de re* sentence is equivalent to one that is *de dicto*. Although this method has been prominent in the literature, I shall deal with it only incidentally here. I hope to deal with it more fully elsewhere. Another way is to add axioms to the standard modal logic so that two conditions are satisfied. The first (eliminability) is that every *de re* sentence should have a *de dicto* equivalent relative to the resulting system. The second (conservativeness) is that no *dicto* sentence should be provable in the resulting system that is not already a theorem of standard modal logic." (p. 277)

27. ———. 1979. "Failures of the Interpolation Lemma in Quantified Modal Logic." *Journal of Symbolic Logic* no. 44:201-206.

"Beth’s Definability Theorem, and consequently the Interpolation Lemma, fail for the version of quantified S5 that is presented in Kripke’s [7]. These failures persist

when the constant domain axiom-scheme ∀x □ φ ≡□ ∀x φ is added to S5 or, indeed, to any weaker extension of quantificational *K*.
§1 reviews some standard material on quantificational modal logic. This is in contrast to quantified intermediate logics for, as Gabbay [5] has shown, the Interpolation Lemma holds for the logic CD with constant domains and for several of its extensions. §§2—4 establish the negative results for the systems based upon S5. §5 establishes a more general negative result and, finally, §6 considers some positive results and open problems. A basic knowledge of classical and modal quantificational logic is presupposed." (p. 201)
References
[5] D. Gabbay, Craig's interpolation lemma for modal logics, *Conference in Mathematical Logic* , London, 1970, *Lecture Notes in Mathematics* , no. 255, Springer-Verlag, Berlin and New York, 1972, pp. 111-127.
[7] S. Kripke, Semantical considerations on modal logic, *Acta Philosophica Fennica* , vol. 16 (1963), pp. 83-94.

28. ———. 1979. "Analytic Implication." In *Papers on Language and Logic* , edited by Dancy, Jonathan, 64-70. Keele: Keele University Library.
Reprinted in: *Notre Dame Journal of Formal Logic* , 27, 1986, pp. 169-179.
"Parry presented a system of analytic implication in [7] and [8], Dunn [2] gave an algebraic completeness proof for an extension of this system and Urquhart [10] later gave a semantic completeness proof for Dunn's system with necessity. This paper establishes completeness for Parry's original system, (*) thereby answering a question of Gödel [6], and then, on the basis of the completeness result, derives decidability; it also deals with quantificational versions and other modifications of his system.
Section 1 contains some informal remarks on the notion of analytic implication. They are not strictly relevant to the later analysis, although they may help to place it in perspective. Section 2 presents the semantics and Section 3 exhibits a system of analytic implication. Section 4 helps to demonstrate that the system is equivalent to Parry's, and Section 5 establishes completeness. Finally, Section 6 outlines the theory for some related systems." (p. 64)
(*) I mean the full system of [7] with adjunction, A14 and A15.
[1] Anderson A. R. and N. D. Belnap, Jr., "A simple treatment of truth-functions," *The Journal of Symbolic Logic,* vol. 25 (1959), pp. 301-302.
[2] Dunn, J. M., "A modification of Parry's analytic implication," *Notre Dame Journal of Formal Logic,* vol. 13, no. 2 (1972), pp. 195-205.
[3] Epstein, D., "The semantic foundations of logic," to appear.
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[10] Urquhart, A., "A semantical theory of analytical implication," *Journal of Philosophical Logic,* vol. 2 (1973), pp. 212-219.

29. ———. 1980. "First-Order Modal Theories. [II. Propositions]." *Studia Logica* no. 39:159-202.
Abstract. "This paper is part of a general programme of developing and investigating particular first-order modal theories. In the paper, a modal theory of propositions is constructed under the assumption that there are genuinely singular

propositions, ie. ones that contain individuals as constituents. Various results on decidability, axiomatizability and definability are established."

"In some recent work ([7], [8], [9], [10]), I have attempted to carry out a dual programme of developing a general model-theoretic account of first-order modal theories, on the one hand, and of studying particular theories of this sort, on the other. The two parts of the programme are meant to interact, with the second providing both motivation and application for the first. The present paper belongs to the second part of the programme and deals with the question of giving a correct essentialist account of propositions.

My approach is distinctive in two main ways, one linguistic and the other metaphysical. On the linguistic side, I have let the variables for propositions be both nominal and objectual. That is to say, the variables occupy the same position as names and are interpreted in terms of a range of objects, which, in the present case, turn out to be propositions. This approach stands in contrast to the earlier work of Prior [17], Bull [1], Fine [4], Kaplan [14] and Gabbay [12], [13], in which the variables are sentential (they occupy the same position as sentences) and are interpreted either substitutionally or in terms of a range of intensional values." (p. 159)

References

[1] R. A. Bull, On modal logic with propositional quantifiers, *Journal of Symbolic Logic* 34 (1969), pp. 257–263.

[4] K. Fine, Propositional quantifiers in modal logic, *Theoria* 36 (1970), pp. 336–346.

[7] —, Model theory for modal logic, part I, *Journal of Philosophical Logic* 7 (1978), pp. 125–156.

[8] —, Model theory for modal logic, part II — The elimination of *de re* modality, *Journal of Philosophical Logic* 7 (1978), pp. 277–306.

[9] —, First-order modal theories, part I — Modal set theory, to appear in *Nôus*. [1981]

[10] —, Model theory for modal logic, part III — Existence and predication, to appear in *Journal of Philosophical Logic*. [1981]

[12] D. M. Gabbay, Modal logic with propositional quantifiers, *Zeitschrift für Mathematische Logic und Grundlagen der Mathematik* 18 (1972), pp. 245–249

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[17] A.N. Prior, Egocentric logic, *Nôus* , vol. II, no. 3 (1968), pp. 191–207.

30. ———. 1981. "First-Order Modal Theories. I: Sets." *Noûs* no. 15:177-205.

"The aim of this paper is to formalize various metaphysical theories within a first-order modal language. The first part deals with modal set theory. The later parts will deal with propositions, possible worlds, and facts.

Such an undertaking is relevant both to logic and to metaphysics.

Its relevance to logic lies mainly in its bearing on the model theory for first-order modal languages. I have begun to develop such a theory in [8]. The consideration of particular theories can then provide both an application of and motivation for general results in this field. There is already a fruitful interaction between the proof of general results and the consideration of particular first-order theories within classical model theory; and the hope is that there should be as beneficial an interaction within modal logic.

The relevance of the undertaking to metaphysics consists mainly in the general advantages that accrue from formalizing an intuitive theory. First of all, one thereby obtains a clearer view of its primitive notions and truths. This is no small thing in a subject, such as metaphysics, that is so conspicuously lacking in proper foundations.

But once a formalization is given, one can establish results about the theory as a whole and thereby obtain that overall view of a subject that philosophers often strive for but rarely obtain." (p. 177)

(...)

"The plan of this part of the paper is as follows. §1 contains an informal discussion and justification of our axioms for modal set theory. §2 then presents the formal theories. §3 develops a proof- and a model-theory for class abstracts in modal set theory and establishes a useful result on transferring abstracts from classical set theory into a modal context. In §4, it is shown that the formal theories are equivalent in that any two of them share the same theorems in their common language. The proof of equivalence contains general result on when the possible worlds semantics for a given modal theory can be represented within that theory itself. The next section discusses the adequacy of our formalizations and shows that, in a certain sense, they capture all of the essential truths about sets as such. The last section is concerned with the identity of sets and places the problem within a general account of the identity of objects." (p. 178)

[8] Fine, K., 'Model Theory for Modal Logic I, II, III', *The Journal of Philosophical Logic* , (1978) 125-56, (1978) 277-306, and to appear. [1981, 293-307]

31. ———. 1981. "Model Theory for Modal Logic. Part III: Existence and Predication." *Journal of Philosophical Logic* no. 10:293-307.

"This paper is concerned with the technical implications of a certain view connecting existence to predication. This is the view that in no possible world is there a genuine relation among the nonexistents of that world or between the nonexistents and the existents. (1) The meaning of the term 'genuine' here may be variously explained. On an extreme interpretation, all relations are 'genuine', so that none of them are to relate non-existents.

On a milder interpretation, the genuine relations are those that are simple or primitive in some absolute sense. But even without appeal to an absolute concept of simplicity, we can require that all relations should be analyzable in terms of some suitable set of relations, relating only existents to existents.

In order to make our results applicable to the thesis, we shall suppose that the primitive non-logical predicates of our language correspond to the genuine relations, whatever they might be taken to be. Thus, the linguistic formulation of the thesis becomes that the primitive predicates of the language should only be true, in each world, of the existents of that world.

Of course, the thesis might have been given a linguistic formulation, without any reference to relations, in the first place.

The thesis is an instance of what has been called Actualism. This is the ontological doctrine that ascribes a special status to actual or existent objects. Another form of the doctrine, so-called World Actualism, says that the behaviour of nonexistents is supervenient upon the behaviour of the existents, that two possible worlds which agree in the latter respect cannot differ in the former respect. The present thesis, by contrast, might be called *Predicate Actualism*. It should be clear that Predicate Actualism implies World Actualism, at least if the predicates used to describe the world are to express 'genuine' relations; for then there are no relationships involving nonexistents by which two worlds might be distinguished. On the other hand, World Actualism does not, as it stands, imply Predicate Actualism." (p. 293)

(*) This paper is the third and final part of a series (see the references below). It was completed and submitted to the *Journal of Philosophical Logic* in 1977, at about the same time as the other parts. But because of some mishap in the mail, its publication was delayed. The present part is independent from the other parts in its results, but draws upon the terminology of Section 2 of Part I.

I should like to thank the editor, R. Thomason, for many valuable remarks on the earlier version of the paper.

(1) I have briefly discussed this thesis elsewhere. The reader may like to consult Section 7 of [11], pp. 151 and 156-160 of [2], p. 564 of [3], and Section 8 of [7b]. There has been a fair amount of recent literature on the topic. I cannot give a complete survey, but the reader may like to consult Chapters IV-V of [9], p. 86 of [8], Chapters VII-VIII of [10], and pp. 333-336 of [11].

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