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The 30th Anniversary Conference of the Australasian Association for Logic was held at the University of New England (Armidale, New South Wales), from June 30 through July 3, 1995. Organisers were Lesley Roberts, Graham Priest, and Fred D'Agostino. The program included a session on the history of logic in Australia. In 1965 an Honours Masters Course in logic started in Armidale, the first such course in Australia or New Zealand. This influenced a number of people, including the Chair of the ASL Committee on Logic in Australia, to become interested in logic. The Conference also commemorated the first AAL Conference, also held in Armidale.

Abstracts of contributed talks given (in person or by title) follow.

For the ASL Committee on Logic in Australia
MARTIN BUNDER, CHAIR

Abstracts of contributed talks

▶ ROSS T. BRADY, *Simple Gentzenizations for the normal formulae of contraction-less logics*.
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We develop an innovative method, which makes essential use of a restriction to normality, to establish two simple Gentzenizations for the normal formulae of the logic B, and then extend the method to other sentential contraction-less logics. To obtain the first of these Gentzenizations, for the logics B and DW, we remove the two branching rules $(F\&)$ and (Tv), together with the structural connective ',', to simplify the elimination of the inversion rules and 't'. We then eliminate the rules $(T\&)$ and (Fv), thus reducing the Gentzen system to one containing only '$\sim$' and '$\rightarrow$' and their four associated rules, and reduce the remaining types of structures to four simple finite types. Subsequently, we re-introduce $(T\&)$ and (Fv), and also $(F\&)$ and (Tv), to obtain the second Gentzenization, which contains ',' but no structural rules. The procedure varies somewhat for the contraction-less logics TW, EW, RW and RWK, since the inversion rules do not appear eliminable for TW and EW, 't' does not appear eliminable for EW, and the four simple types of structure are not available for TW, EW, RW and RWK. Unfortunately, this rather specialized method does not extend to quantifiers or to logics with intensional contraction of any kind.

▶ MARTIN BUNDER, *The computer generation of proofs in classical propositional logics*.
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The full classical propositional logic can be based on the axioms:

B: $(P \to Q) \to (R \to P) \to R \to Q$.
C: $(P \to Q \to R) \to Q \to P \to R$.
K: $P \to Q \to P$.
fe: $f \to P$.
P: $((P \to Q) \to P) \to P$.

and the definitions

$$\begin{aligned} \neg P &= P \to f \\ P \text{ or } Q &= \neg P \to \\ P \text{ and } Q &= \neg(P \to \neg Q). \end{aligned}$$

We show that any proof of a classical theorem A can be transformed into a BCK proof of $(f \to A) \to A$ from the hypotheses $((f \to A) \to A) \to p_1, \ldots, ((f \to A) \to A) \to p_n$, where $p_1, \ldots, p_n$ are the propositional variables in A. (These hypotheses may be used zero or more times each.)

Such a BCK proof is easily generated by the Ben_Yelles or a related algorithm (a computer implementation of this already exists) and the proof of the classical theorem A follows using one *fe* and at most n P steps.

We apply similar techniques to sublogics such as *BCKP*, *BCKfe*, etc.

► JOSHUA COLE, *Foundations for mathematics and the foundations of category theory*.
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What are we to make of the extravagant claims that have come from some category theorists that category theory presents as a suitable foundation for mathematics? In this paper I set out what foundations are and what foundations there are. I conclude that there are at least two types of foundations—explanatory and operational—and that category-theoretic foundations for mathematics are best seen as foundations in an operational sense. The extent to which they are good operational foundations should determine the extent to which we should modify or replace our best explanatory foundations to properly accommodate them.

► MIC DETLEFSEN, *Powers of reflection, frames of mind: $L = F6b's$ theorem and the mechanization of human reasoning*.
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In the paper I argue that $L = F6b's$ Theorem implies a limitation on our knowledge of mechanism.

► JAMES FRANKLIN, *Topological structure in logical spaces*.
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If one analyses counterfactuals in terms of what happens in possible worlds similar, or close, to this one, one relies on a notion of similarity between worlds. But what is similarity or distance in abstract spaces, like the space of possible worlds? Or the space of perceived colours? Similar (sic) problems arise in the "slippery slope" arguments, which exist because of the possibility of a continuous transition in some logical space. Legal and moral arguments on "where do you draw the line?" seem to suppose that a position is to be found in some space of logical possibilities, on the basis of a balance of considerations which may vary continuously. People conduct reasoning of these kinds with some measure of intersubjective agreement, but traditional logic with its commitment to discrete symbol processing has avoided them. It is argued that an analysis of these notions is necessary, but that the obvious candidate analyses are wrong.

► RODERIC GIRLE, *Diagrams, taxonomy, and ternary semantics*.
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The possible worlds semantics for standard modal logics have a binary accessibility relation. One of the major ways of distinguishing one logic from another is to refer to the properties of the accessibility relation, e.g., $S4$ has a reflexive and transitive relation, while Br has a reflexive and symmetric relation. The standard properties of binary relations are well understood and useful in a wide variety of contexts (not only in modal logic semantics). The typical possible worlds semantics for relevant logics have a ternary accessibility relation. It is also the case that the properties of the ternary can be used to distinguish one logic from another. The accessibility relation for the positive logic, $B+$, has the property $R0ii$. But there is no taxonomy of the properties for ternary relations.

In this paper there is a discussion of the possibility of generating a taxonomy for ternary relations which is analogous to the binary relation taxonomy. There will be a discussion of the "postulates" for ternary semantics, and what help they might be in generating the taxonomy. Two and three dimensional diagrams will also be used. Difficulties (of an apparently insuperable kind) will be discussed.

► A.P. HAZEN, *Reduction to a dyadic predicate revisited*.
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Quine showed that an arbitrary first-order theory could be faithfully interpreted in a theory formulated with a single, dyadic, predicate, at the expense of some added ontology. A technique of Rabin and Scott allows the same reduction with a more conservative additional ontology, and with an interpreting theory which, unlike Quine's, is always interpretable (multi-dimensionally) in the original theory. The Rabin and Scott technique can be seen as suggested by a metaphysics of tropes (though there is no evidence that it was so suggested historically) and is similar to the technique used by Peirce for a reduction, satisfying additional constraints, to ternary predicates.

► WILLIAM JAMES, *Sheaf theory for logicians*.
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We move on to some new constructions of sheaves and sheaf spaces defined over the closed sets of a topological space. In that sheaves are routinely and usefully defined over the open sets of topological spaces, the interesting properties of lattices of closed sets as paraconsistent algebras and their effect on the logic built into the sheaf structure has been overlooked. In particular, we announce that the logic of toposes, and so, in some sense, of mathematics, previously understood to be Intuitionist is revealed as having an extra paraconsistent character.

► CHUCHANG LIU, *A temporal logic language with time granulation*.
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An important activity in computer science is the invention, analysis and application of formally defined *logics* which are designed to specify, reason about and represent algorithms, programs and systems. Recently, there is a substantial interest in temporal logic which has been widely used as a formalism for program specification and verification, reasoning about time and modelling temporal databases.

Chronolog [2] is an extension of logic programming. Its underlying logic is a linear-time temporal logic [1] which refers to a natural extension of a standard first-order logic language. In Chronolog, the set of natural numbers models the collection of moments in time with an unbounded future.

In this talk, we present an extension of Chronolog by introducing multiple granularity of time, i.e., defining local clocks associated with predicates. The global time is always modeled by the set of natural numbers. We define that the global clock is the base clock, i.e., the strictly increasing sequence of all natural numbers $(0, 1, 2, 3, 4, \dots)$, and a local clock is a strictly increasing sequence of natural numbers $(a_0, a_1, a_2, \dots)$ where a_k and a_{k-1} are not necessarily consecutive. For each predicate, there is a local clock associated with it.

In the framework, we investigate the axiom system of the extended temporal logic and its semantics, and discuss its model theory framework. Also, we show that the extended temporal logic language can be applied to the specification of concurrent systems.

[1] R. Goldblatt, *Logics of time and computation*, ***Lecture Notes***, no. 7, Center for the Study of Language and Information, Stanford University, 1987.

[2] M. A. Mehmet and W. W. Wadge, *Theory and practice of temporal logic programming*, ***Intensional logics for programming*** (L. Fariñas del Cerro and M. Penttonen, editors), Oxford University Press, 1992, pp. 23–50.

► PETER MENZIES, *Ramsey-test conditionals and Adam's thesis*.
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The Ramsey-test conditionals are those conditionals whose acceptability is assessed in accordance with Ramsey's test: first, add the antecedent (hypothetically) to your stock of beliefs; second, make whatever adjustments are required to maintain consistency; and finally, consider how acceptable the consequent is on the basis of this revised body of beliefs. How is the belief-revision process involved in this test to be modelled probabilistically? Most philosophers think that the belief-revision process is accurately modelled by conditionalisation; and so, endorse Adam's thesis that the acceptability of Ramsey-test conditionals (more strictly, of indicative conditionals) goes by conditional probability. I argue that Adam's thesis is not, in general, true of Ramsey-test conditionals and that the belief-revision process involved in Ramsey's test is better modelled by imaging rather than conditionalisation. I claim that the acceptability of such conditionals goes by imaged probability, and not conditional probability. I explain how the two kinds of probability coincide for the most part, diverging only under special circumstances. I claim, nonetheless, that there are significant explanatory advantages to the hypothesis that the acceptability of Ramsey-test conditionals goes by imaged probability.

► DOUGLAS J. H. MOORE, *Totality theory, first classness and relative types*.
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This paper introduces the author's work on Totality Theory. The Theory is based on the fact that Totality is subject to the most draconian constraint imaginable—it must be absolutely free of all constraints. Three key concepts are involved in the formalisation: the logical necessity of temporality, all entities must be "first class," and every aspect of the formalisation must be totally relativistic. This leads to a Theory of Relative Types which, unlike Russell's theory of types, is totally devoid of any absolute hierarchy or scale. Totality Theory is also a theory of generic language and offers new insights into the nature of the genetic code. It claims that this relativistic mathematics will also provide the missing unification of superstring theory in Quantum Mechanics. Totality Theory also has profound implications in understanding the concept of Self in psychology and religions. Classical scientific theories explain the literal in terms of the non-literal. Literals and non-literals can be considered as *types* pertaining to entities. These types can also be treated as entities in their own right. This idea—a concept that one can trace back to the Stoics—is quite commonplace in certain computer programming languages. Totality Theory exploits this parity between literal and non-literal types and turns it into a theory which has a radically new epistemology. The theory spans both sides of the relationship. This is achieved by abandoning the absolute typing that characterise traditional science and mathematics, and basing all difference on relative types.

In this way, it is possible to formalise a system which avoids any absolute criteria of exteriority and interiority. Everything is included in the theory including the theory of the theory. This is why it is called Totality Theory as there is nothing "left out." It is the theory of relative types—the theory of relativity pure.

Classical relativity theory is based on applying nonrelativistic mathematics to physics where relativity has been patched into the physics and is not inherent in the mathematics. Although the mathematical models differ, there is no fundamental difference between the underlying logic of relativistic and nonrelativistic physics (Quantum Mechanics excepted). In Totality Theory, the relativity is built into the logic of the mathematics. As will be shown in this paper, the logical basis of the mathematics is founded on a totally revamped version of the ancient logical system developed by the Stoics and formalised using a modern "arrow theoretic" approach, similar in many respects to that used in mathematical Category Theory.

This paper provides a nontechnical introduction to how Totality Theory achieves this complete relativisation of all its structures and hence poses itself as the most generic of all sciences. It will also outline some of the potential applications and implications of Totality Theory.

▶ CHRIS MORTENSEN, *The Leibniz continuity condition, inconsistency and quantum dynamics*.

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The Leibniz continuity condition (LCC) has recently been put to philosophical use by Priest. This paper analyses the LCC and proposes an alternative application, which has a bearing on the dynamics of quantum systems.

▶ DANIEL NOLAN, *Expressive completeness without possible worlds: The Hazen cases*.

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In a well-known paper, Allen Hazen has argued that there are some claims that can be translated into the language of quantification over possible worlds, but defy translation into the logic of modal operators. In this paper, I show that the ordinary-language modal claims which Hazen considers can be translated as effectively into modal-operator logic as into the language of quantification over possible worlds, and argue that some claims of the same kind as Hazen's examples cannot be translated simply with the resources of his logic of quantification over possible worlds, but do receive adequate translations in the modal-operator logic I will discuss. My modal-operator translations differ from the ones sometimes advanced to translate the Hazen cases in the literature in that those translations rely on an infinite number of modal operators, whereas mine rely only on the usual handful.

► GRAHAM PRIEST, *Finite models of arithmetic*.
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Let A be the set of truths of the standard model of first-order arithmetic. A is well-known to have nonstandard classical (consistent) first order models. A also has many nonclassical inconsistent models (see, e.g., [1]). Some of these are particularly interesting, since they are finite. This paper provides a complete taxonomy of the structure of such models.

[1] R. MEYER and C. MORTENSEN, *Relevant arithmetic*, ***Journal of Symbolic Logic***, vol. 49 (1984), pp. 917–29.

► GREG RESTALL, *Negation in relevant logics: How I stopped worrying and learned to love the Routley Star*.
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Negation has always been an issue for any *semantic* account of relevant logics. There are at least three different issues to be faced by any theorist who sees a place for relevant logic in giving an account of entailment and negation.

1. How is one to understand the 'Routley star'? In the frame semantics for relevant logics, we have $x \models A$ if and only if $x^* \not\models A$. What is the meaning of the star operation?
2. For relevant logics, the entailment $A \wedge (\sim A \vee B) \rightarrow B$ fails. Is there any sense in which the argument from $A \wedge (\sim A \vee B)$ to B (*disjunctive syllogism*) is valid?
3. Is there a place for *boolean negation* in relevant logics? Meyer [4] has argued that boolean negation '$-$' (satisfying $\vdash A \wedge -A \rightarrow B$ and $\vdash A \rightarrow B \vee -B$, as well as disjunctive syllogism) deserves a place in relevant logics along with the original de Morgan negation. Is this correct?

In this paper I sketch an interpretation of the Routley-Meyer frame semantics of relevant logics which provides principled answers to each of these questions. The answers when taken together define a new position in the philosophy of relevant logic. I will argue for the following answers to our questions.

1. Against Copeland [1], I argue that the frame semantics for relevant logics is (when properly interpreted) an *applied semantics*, not merely a *pure* one. In particular, sense can be made of the interpretation of negation, and the Routley star function.
2. Against the relevantist of Belnap and Dunn [3], I argue that in an important sense, disjunctive syllogism is valid.
3. Finally, against Meyer [4], I argue that under the intended interpretation of relevant logics, *real* negation turns out to be de Morgan negation (or something very much like it) and *not* Boolean negation.

These answers together stem from a reading of the Routley-Meyer semantics, partly inspired by Dunn's work on the semantics of negation [2], and by my work connecting the semantics of relevant logic with work on information flow and situation semantics.

[1] B. J. COPELAND, *On when a semantics is not a semantics: some reasons for disliking the Routley-Meyer semantics for relevance logic*, ***Journal of Philosophical Logic***, vol. 8 (1979), pp. 399–413.

[2] J. MICHAEL DUNN, *Star and perp: Two treatments of negation*, ***Philosophical Perspectives*** (James E. Tomberlin, editor), vol. 7, Ridgeview Publishing Company, Atascadero, California, 1994.

[3] N. D. Belnap Jr. and J. M. Dunn, *Entailment and the disjunctive syllogism*, ***Philosophy of Language/Philosophical Logic*** (F. Fløistad and G. H. von Wright, editors), Martinus Nijhoff, The Hague, 1981, pp. 337–366.

[4] Robert K. Meyer, *New axiomatics for relevant logics—I*, ***Journal of Philosophical Logic***, vol. 3 (1974), pp. 53–86.

▶ HARTLEY SLATER, *Mereological sets*.
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This paper investigates the possibility of reading standard set-abstraction expressions as plural terms designating the members of sets, those sets being then formed as the mereological sums of their members (not the unit sets of their members, as with David Lewis, and Harry Bunt). There are many grammatical facts which support this identification; thus, for example, we read '$n\{x \mid Ax\} = 5$' as 'the number of A's (sic) is 5,' and '$y \in \{x \mid Ax\}$' as 'y is one of the A's.' Sets with different members can then have the same extensions, in the sense that the totality formed from their members may be the same: thus twenty suits of clothes may form the same totality as sixty pieces of clothing. The basic grammatical point was noted by Frege, namely that number words are attributive adjectives, thus the same object which is one copse may be five trees (*The foundations of arithmetic*, Oxford, Blackwell, 1968, pp. 28–9, translated by J. L. Austin). The resulting set theory is a combination of Mereology with that portion of Quine's *Set Theory and its Logic* before he starts to treat set abstraction expressions as singular terms. Russell's Paradox is therefore immediately avoided; but the Power Set Axiom cannot be retained in its current form. The power set of a set is the set itself merely partitioned in a different way, into overlapping cells.

▶ TIMOTHY SURENDONK, *The strong completeness of intensional logics*.
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In 1974 David Lewis showed that every intensional logic without iterative axioms has the finite model property and so is decidable. (An intensional logic without iterative axioms is a logic which has an axiomatisation where the axioms have no intensional operators within the scope of other intensional operators.) In effect, Lewis showed that such logics are weakly complete; each non-thesis having a counter-frame. In an unpublished paper Roy A. Benton conjectured that it should be possible to extend Lewis's result to show that all such logics are strongly complete, in that every consistent set of formulae can be realised in some frame, possibly even a canonical frame. In this paper we will show that Lewis's method can be reinterpreted and augmented to provide a positive answer to this question.

▶ RICHARD SYLVAN AND JAIR ABE, *General annotated logics, with an introduction to full accounting logi*.
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We first survey annotation and like methods—subscripting, labelling, contextualizing—in logic. While present day annotated logics are not intended to cover all these, those that are covered are not covered adequately. Critical assessment of these logics reveals that they fall down conspicuously on advocated motivational bases, notably paraconsistency. To cater properly for paraconsistency as regards complex formulae, we couple annotated logics with "general logics," a clever relevant expansion of mainstream natural deduction logics using associated subscripting methods. We show the adequacy of certain general annotated logics. Then we explain how these structures include other annotated systems recently advanced, such as labelled deductive systems and display logics. Further generalizing and relaxing these frameworks, to encompass other applications, such as to abductive and inductive logics, to dialogic and polylogic logics, leads us to a grander integration: that of logic with spreadsheet accounting. In this way too we can begin to take due account of much of what logic has hitherto left out, and has been properly criticised for neglecting.

► RICHARD SYLVAN AND JACK COPELAND, *Heresies of computability*.
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The so-called Church-Turing thesis, apparently universally accepted among logicians, computer and cognitive scientists, and philosophers of mind, purports to draw a borderline between computability and noncomputability. It is the claim that the class of well-defined computations is identical to the class of computations that can be carried out by Turing machines. In point of fact Turing himself nowhere endorses, nor even states, this thesis (nor does Church). Moreover the thesis is false. We describe a number of notional analogue machines that can compute more than a universal Turing machine. Some of the functions that such machines compute cannot even be approximated by a Turing machine. Nothing known at present rules out the actual construction of such devices.

Abstract presented by title

► STAN J. SURMA, *Towards an abstract theory of Lindenbaum operators*.
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This paper is concerned with the problem of axiomatisation of an abstract idea of extension articulated as a primitive operator **Ln** from the power set $P(S)$ of some set S to the power set of the power set $P(P(S))$ of that set. One example of the S is the set of all sentences of some object-language. In this case an intuitive paradigm example of an operator **Ln** is a correlation with each set of sentences of some object-language, whether consistent or inconsistent, of the family of all its maximal consistent extensions, Lindenbaum-style. With this example in mind, I call the operators Lindenbaum operators.

The discussion of Lindenbaum operators is carried out in two stages. At the first, absolute stage the focus is on set-theoretic or absolute properties of Lindenbaum operators, i.e., properties totally independent of the "inner" structure of S. For our paradigm example this means that the object-language in question is treated, at this stage, simply as a non-empty set of sentences of unspecified structure. By the axiomatisation suggested in the paper, a Lindenbaum operator **Ln** is characterised as a nontrivial, extensive, inclusive and antimonotonic operator from $P(S)$ to $P(P(S))$. The relation of the **Ln**-based methodology to the standard deductive methodology is discussed at some length. Also proved in this part of the paper is a relative consistency of the theory of **Ln**.

At the second, relative stage, the discussion involves properties of Lindenbaum operators that depend on the "structure" of S. For our intuitive example that means that the underlying language is treated as a structured language whose compound sentences can be seen as built up of simpler sentences using some specified logical operators. For the sake of simplicity, I only consider one "structural" operator #, i.e., a n-ary mapping # from S to S. For our intuitive example that means that # is n-ary sentential connective. In this part of the paper I define the following two, arguably useful, concepts: "**Ln** is (#)-saturated" and "# is in the **Ln**-normal form" and prove that each regular Lindenbaum operator **Ln** is (#)-saturated iff

is in the **Ln**-normal form.

The explicit definitions of some of the terms involved in this paper are as follows. $X \in 2_Y$ iff $Y \subseteq X$ for any $X, Y \subseteq S$. X is #-*complete* iff the fact that $(\#A_a A_2 \ldots A_n) \in X$ is equivalent to the fact that $\#^*(A_1 \in X)(A_2 \in X) \ldots (A_n \in X)$, for any $A_1, A_2, \ldots, A_n$ where $\#^*$ is the metalanguage-correlate of (the object-linguistic) #. For instance, taking # to be $\rightarrow$ we get this: X is $(\rightarrow)$-*complete* iff the fact that $(A \rightarrow B) \in X$ is equivalent to the fact that $(A \in X) \rightarrow^* (B \in X)$, i.e., is equivalent to the fact that if $A \in X$ then $B \in X$, for any A and B.

We say that **Ln** is *nontrivial* iff $\mathbf{Ln}(S) = \emptyset$. **Ln** is *extensive* iff $\mathbf{Ln}(X) \subseteq 2_X$ for any X. **Ln** is *inclusive* iff $\mathbf{Ln}(\emptyset) \cap 2_X \subseteq \mathbf{Ln}(X)$ for any X. **Ln** is *antimonotonic* iff the fact that $X \subseteq Y$ implies that $\mathbf{Ln}(Y) \subseteq \mathbf{Ln}(X)$. **Ln** is *regular* iff $X = Y$ for any $X \in \mathbf{Ln}(\emptyset)$ and any $Y \in \mathbf{Ln}(X)$. **Ln** is #-*saturated* iff X is (#)-complete for any $X \in \mathbf{Ln}(\emptyset)$.