

THE
JOURNAL
OF
SYMBOLIC LOGIC

EDITED BY

PETER ACZEL

MATTHEW FOREMAN

MICHAEL MAKKAÏ

GEORGE BOOLOS

SY D. FRIEDMAN

ANDRE SCEDROV

WILFRIED BUCHHOLZ

GERHARD JÄGER

PHILIP SCOWCROFT

JOHN P. BURGESS

JULIA KNIGHT

JOHN VAN BENTHEM

HERBERT B. ENDERTON

STEFFEN LEMPP

ALBERT VISSER

VOLUME 59

1994

PUBLISHED QUARTERLY BY THE ASSOCIATION FOR SYMBOLIC LOGIC, INC. WITH
SUPPORT FROM ICSU AND FROM INSTITUTIONAL AND CORPORATE MEMBERS

The four numbers of Volume 59 were issued at the following dates:

Number 1, pages 1–352, March 21, 1994

Number 2, pages 353–736, June 2, 1994

Number 3, pages 737–1120, September 19, 1994

Number 4, pages 1121–1496, December 6, 1994

Numbers 1–4 of this volume are copyrighted © 1994 by the Association for Symbolic Logic, Inc. Reproduction of copyrighted numbers of the JOURNAL by photostat, photoprint, microfilm, or like process is forbidden, except by written permission, to be obtained from the Secretary of the Association, C. Ward Henson, Department of Mathematics, University of Illinois, 1409 W. Green St., Urbana, IL 61801.

The paper used in this JOURNAL is acid-free and falls within the guidelines established to ensure permanence and durability. This JOURNAL has been registered with the Copyright Clearance Center, Inc. The appearance of a code at the bottom of the first page of an article indicates the copyright owner's consent for copying beyond that permitted by Sections 107 or 108 of the U. S. Copyright Law, provided that the per-copy fee stated in the code is paid directly to Copyright Clearance Center, Inc., 222 Rosewood Drive, Danvers, MA 01923. This consent does not extend to copying for general distribution, for advertising or promotion purposes, for creating new collective works, or for resale. Specific written permission for such copying must be obtained from the Association.

CONTENTS OF VOLUME 59

SURVEY PAPERS

BUSS, SAMUEL R. On Gödel's theorems on lengths of proofs I: Number of lines and speedup for arithmetics	737
MAZUR, B. Questions of decidability and undecidability in Number Theory	353

RESEARCH PAPERS

ABRAMSKY, SAMSON and JAGADEESAN, RADHA. Games and full completeness for multiplicative linear logic	543
ANDRÉKA, H., KURUCZ, Á., and NÉMETI, I. Connections between axioms of set theory and basic theorems of universal algebra	912
———, GIVANT, STEVEN, and NÉMETI, ISTVÁN. The lattice of varieties of representable relation algebras	631
ARTĚMOV, SERGEI and MONTAGNA, FRANCO. On first-order theories with provability operator	1139
ASH, C. J. On countable fractions from an elementary class	1410
——— and KNIGHT, J. F. Mixed systems	1383
BALIGA, GANESH, CASE, JOHN, JAIN, SANJAY, and SURAJ, MANDAYAM. Machine learning of higher-order programs	486
BARBACK, JOSEPH. Torre models in the isols	140
BECKER, HOWARD. The topological Vaught's conjecture and minimal counterexamples	757
BEKKALI, M. Chains and antichains in interval algebras	860
BÉLAIR, LUC and DURET, JEAN-LOUIS. Indécidabilité des corps de courbe réelle	87
BOROVIK, ALEXANDRE V. and NESIN, ALI. Schur-Zassenhaus theorem revisited	283
BOUSCAREN, E. and HRUSHOVSKI, E. On one-based theories	579
CASE, JOHN. See BALIGA, GANESH	
CHOWDHURY, AMBAR. On the number of nonisomorphic models of size $ T $	41
——— and PILLAY, ANAND. On the number of models of uncountable theories	1285
CUMMINGS, JAMES. Possible behaviours for the Mitchell ordering II	1196
DAMNJANOVIC, ZLATAN. Strictly primitive recursive realizability, I	1210
DOWNEY, ROD and CHRISTINE HAUGHT. Embedding lattices into the wtt -degrees below $0'$	1360
DURET, JEAN-LOUIS. See BÉLAIR, LUC	
FAGIN, RONALD. A quantitative analysis of modal logic	209
FENNER, STEPHEN A. Almost weakly 2-generic sets	868
FERNANDO, TIM. Bisimulations and predicate logic	924
FERREIRA, FERNANDO. A feasible theory for analysis	1001
FRIEDMAN, SY D. Jensen's Σ^* theory and the combinatorial content of $V = L$	1096
———. The genericity conjecture	606
FUCHINO, SAKAÉ. Some remarks on openly generated Boolean algebras ...	302
FULLER, MARK. Normality of a filter over a space of partitions	529
GAO, SU. The degrees of conditional problems	166

GITIK, MOTI and MAGIDOR, MENACHEM. Extender based forcings	445
GIVANT, STEVEN. See ANDRÉKA, HAJNAL	
GOODE, JOHN B. Accessible telephone directories	92
GORDEEV, L. A modified sentence unprovable in PA	1154
GRAINGER, ARTHUR D. Flat sets	1012
GROSZEK, MARCIA. ω_1^* as an initial segment of the c -degrees	956
HALBEISEN, LORENZ and SHELAH, SAHARON. Consequences of arithmetic for set theory	30
HAMKINS, JOEL. Fragile measurability	262
HANSSON, SVEN OVE. Kernel contraction	845
HAUGHT, CHRISTINE. See DOWNEY, ROD	
HERRMANN, EBERHARD and KUMMER, MARTIN. Diagonals and \mathcal{D} -maximal sets	60
HÖSLI, BRIGITTE and JÄGER, GERHARD. About some symmetries of negation	473
HRUSHOVSKI, EHUD. Finitely axiomatizable \aleph_1 categorical theories	838
———. See BOUSCAREN, E.	
HUMMEL, TAMARA LAKINS. Effective versions of Ramsey's Theorem: Avoid- ing the cone above \mathcal{O}'	1301
HYTTINEN, TAPANI and SHELAH, SAHARON. Constructing strongly equivalent nonisomorphic models for unsuperstable theories, Part A	984
IGNJATOVIĆ, ALEKSANDAR. Hilbert's program and the omega-rule	322
JAGADEESAN, RADHA. See ABRAMSKY, SAMSON	
JÄGER, GERHARD. See HÖSLI, BRIGITTE	
JAIN, SANJAY. See BALIGA, GANESH	
JECH, THOMAS and WITZANY, JIŘÍ. Full reflection at a measurable cardinal	615
JIN, RENLING and SHELAH, SAHARON. The strength of the isomorphism prop- erty	292
JOCKUSCH, CARL G., JR. and SOARE, ROBERT I. Boolean algebras, Stone spaces, and the iterated Turing jump	1121
KAFKOULIS, GEORGE. The consistency strength of an infinitary Ramsey prop- erty	1158
KANAI, YASUO. On A generalization of distributivity	1055
KIKYO, HIROTAKA and TSUBOI, AKITO. On reduction properties	900
KNIGHT, JULIA F. Nonarithmetical \aleph_0 -categorical theories with recursive models	106
———. See ASH, C. J.	
KOTLARSKI, HENRYK. On the incompleteness theorems	1414
KRAJÍČEK, JAN. Lower bounds to the size of constant-depth propositional proofs	73
KUMABE, MASAHIRO. Minimal upper bounds for arithmetical degrees	516
KUMMER, MARTIN. See HERRMANN, EBERHARD	
KURUCZ, Á. See ANDRÉKA, H.	
LACHLAN, ALISTAIR H. and SOARE, ROBERT I. Models of arithmetic and upper bounds for arithmetic sets	977
LATKA, BRENDA J. Finitely constrained classes of homogeneous directed graphs	124
LIU, NIANZHENG. Semilinear cell decomposition	199

TABLE OF CONTENTS

v

LOW, LEE FONG. Lattice of algebraically closed sets in one-based theories. 311

MADDUX, ROGER D. Undecidable semiassociative relation algebras. 398

MAGIDOR, MENACHEM. See GITIK, MOTI

MALHAS, OTHMAN QASIM. Abacus logic: The lattice of quantum propositions as the poset of a theory. 501

MARKER, DAVID and STEINHORN, CHARLES I. Definable types in \mathcal{O} -minimal theories. 185

MARTINI, SIMONE and MASINI, ANDREA. A modal view of linear logic. 888

MASINI, ANDREA. See MARTINI, SIMONE

McGEE, VANN. On the degrees of unsolvability of modal predicate logics of provability. 253

MELLES, GARVIN. Natural internal forcing schemata extending ZFC: Truth in the universe? 461

MONTAGNA, FRANCO. See ARTĚMOV, SERGEI

MOSCHOVAKIS, JOAN RAND. More about relatively lawless sequences. 813

MUNDICI, DANIELE. A constructive proof of McNaughton's theorem in infinite-valued logic. 596

NADEL, MARK E. Scott heights of abelian groups. 1351

NĚMETI, ISTVÁN. See ANDRĚKA, H.

———. See ANDRĚKA, HAJNAL

NESIN, ALI. See BOROVIK, ALEXANDRE V.

PHEIDAS, THANASES. Extensions of Hilbert's tenth problem. 372

PILLAY, ANAND. Definability of types, and pairs of O-minimal structures. . 1400

———. Some remarks on nonmultidimensional superstable theories. 151

———. See CHOWDHURY, AMBAR

PLEWIK, SZYMON. Ideals of nowhere Ramsey sets are isomorphic. 662

PRATI, N. A partial model of NF with E. 1245

ROORDA, DIRK. Interpolation in fragments of classical linear logic. 419

SCHEEPERS, MARION. Meager nowhere-dense games (IV): n -tactics (continued). 603

SCHLINDWEIN, CHAZ. Consistency of Suslin's hypothesis, a nonspecial Aronszajn tree, and GCH. 1

SHARP, JAMES D. Combinatorics on ideals and axiom A. 997

SHEARD, MICHAEL. A guide to truth predicates in the modern era. 1032

SHELAH, SAHARON. See HALBEISEN, LORENZ

———. See HYTTINEN, TAPANI

———. See JIN, RENLING

SHLAPENTOKH, ALEXANDRA. Diophantine equivalence and countable rings. 1068

SIMPSON, STEPHEN G. On the strength of König's duality theorem for countable bipartite graphs. 113

SOARE, ROBERT I. See JOCKUSCH, CARL G., JR.

———. See LACHLAN, ALISTAIR H.

SOLECKI, SŁAWOMIR. Covering analytic sets by families of closed sets. 1022

STEINHORN, CHARLES I. See MARKER, DAVID

STERN, ALAN S. and ŚWIERCZKOWSKI, STANISŁAW S. A class of connected theories of order. 534

SURAJ, MANDAYAM. See BALIGA, GANESH	
ŚWIERCZKOWSKI, STANISŁAW S. See STERN, ALAN S.	
TAKANO, MITIO. Subformula property in many-valued modal logics	1263
TAKEUTI, GAISI. Grzegorczyk's hierarchy and $Iep\Sigma_1$	1274
———. The critical number of a variable in a function	1228
TSUBOI, AKITO. See KIKYO, HIROTAKA	
VERBRUGGE, RINEKE and VISSER, ALBERT. A small reflection principle for bounded arithmetic	785
VISSER, ALBERT. See VERBRUGGE, RINEKE	
WAGNER, FRANK O. A note on defining groups in stable structures	575
WEBER, FRANK P. Initial segments of the lattice of ideals of r.e. degrees . . .	1326
WEIERMANN, ANDREAS. A functorial property of the Aczel-Buchholz- Feferman function	945
WELCH, P. D. Characterising subsets of ω_1 constructible from a real	1420
WILKIE, A. J. On defining C^∞	344
WILLARD, ROSS. Hereditary undecidability of some theories of finite struc- tures	1254
WITZANY, JIŘÍ. See JECH, THOMAS	
YING, MINGSHENG. A logic for approximate reasoning	830
ZHANG, SHU-GUO. Stationary reflection and ideals	182

REVIEWS

Reviews	668
Reviews	1105
Reviews	1433

MEETINGS OF THE ASSOCIATION

Annual Meeting of the Association for Symbolic Logic, Notre Dame, 1993	696
Spring Meeting of the Association for Symbolic Logic, Toronto, 1993 . . .	346
Winter meeting of the Association for Symbolic Logic, San Antonio, 1993	720

MEETINGS SPONSORED BY THE ASSOCIATION

1993 Annual Meeting of the Australasian Association for Logic, Adelaide	1443
Conference on Mathematical Logic, Paris, 1992	345
IX Latin American Symposium on Mathematical Logic, Bahía Blanca, 1992	682
Logic and Linguistics Meeting, Columbus, 1993	1115
The European Association for Logic, Language, and Computation, Lisbon, 1993	1116
The Fifth Asian Logic Conference, Singapore, 1993	730

NOTICES

Notices	350
Notices	733
Notices	1117
Notices	1493

OFFICERS AND MEMBERS

List of officers and members of the Association for Symbolic Logic	1450
--	------

ERRATA

VOLUME 58

Page 481. In the paper *Extending the first-order theory of combinators with self-referential truth* by A. Cantini, the independence conditions 1.9 should be completed as follows:

- (i) If $L_1, L_2 \in LOG_1 := \{NAT, NEG, TR, ALL\}$, then $CL \vdash L_1x = L_2y \rightarrow L_1 = L_2 \wedge x = y$;
- (ii) if $G_1, G_2 \in LOG_2 := \{ID, AND\}$, then $CL \vdash G_1xy = G_2x'y' \rightarrow G_2 = G_1 \wedge x = x' \wedge y = y'$;
- (iii) if $L_1 \in LOG_1, L_2 \in LOG_2$, then $CL \vdash \neg L_1x = L_2yz$; if L_1, L_2 are distinct elements of $LOG_1 \cup LOG_2$, then $CL \vdash \neg L_1 = L_2$.

(Verification is by pairing axioms and β -conversion.)

Page 488. The definition of *EXT*, as it stands, does not give the injectivity that is implicitly used in the proof of 3.5.1. We remedy this by making *EXT* somewhat redundant; indeed, we redefine *EXT* as the property $\{x : x = x \wedge EXT x\}$, that is, as the term satisfying the equation $EXT = \lambda x. AND(ID_{xx})(EXT x)$. Then we have $\mathcal{M} \models EXT a = EXT b \rightarrow a = b$. We accordingly change the definition of $X(EXT)$ (see 3.5):

$$X(EXT) := \{\mathcal{M}(EXT a) : a \in P\} \cup \{\mathcal{M}([a = a]) : a \in X\}.$$

Page 490. Definition 3.8 should consequently be changed as follows:

$$D(X) := UP(\{\mathcal{M}(EXT a) : a \in P\} \cup \{\mathcal{M}(\neg EXT a) : a \notin P\} \cup \{\mathcal{M}([a = a]) : a \in X\}).$$

The proofs and the basic claims are left unchanged.

Page 1055, line 9 from below, should be replaced by «PROPOSITION 5. If $MA + \neg CH$ hold, then there is an element $f \in {}^{\omega_1}\omega_1$ such that».

Pages 1054, 1056, 1058, 1060, 1062, 1064, 1066, 1068, and 1070, running head. For the fourth word, read «JOUKO».

VOLUME 59

Page 199. Insert the following footnote. «The author hereby expresses his gratitude to his advisor Professor L. Lipshitz for all the guidance and help on this work. Thanks are due to Professor A. Pillay for the helpful discussions through e-mail during the course of this work. Thanks are also due to the referee for valuable suggestions.»

Pages 575–578. Frank O. Wagner has recently learned that the main theorem in his *A note on defining groups in stable structures* has previously been proved by Ludomir Newelski and has been published as Theorem 3.1 in his article *On type definable subgroups of a stable group*, *Notre Dame journal of formal logic*, vol. 32 (1991), pp. 173–187. He wishes to apologize to Professor Newelski for being unaware of his article.

Continued from inside front cover

Institutional membership in the Association is available to any academic institution or department. Annual institutional dues are \$375 for 1994. Membership privileges include choices of current subscriptions, of back volumes, and of student memberships. A detailed description of institutional and corporate membership is available from the Secretary-Treasurer of the Association.

Information on microfiche and microfilm editions of the JOURNAL can be obtained from *University Microfilms, 300 North Zeeb Road, Ann Arbor, MI 48106, U.S.A.*

Back volumes of the JOURNAL are available. Prices per volume in paper form are as follows: \$60 for Volumes 1–13; \$120 for Volumes 14–30; \$140 for Volumes 31–45; \$180 for Volumes 46–47; \$235 for Volumes 48–49; \$205 for Volumes 50–52; \$235 for Volumes 53–54, and \$265 for Volume 55–58. Volume 26 is an index for Volumes 1–26 and Number 4 of Volume 45 is an index for Volumes 27–45. Number 4 of Volume 55 is a cumulative index for Volume 27 through Volume 55 (it includes the index published in Volume 45, Number 4, except for listings of reviews by subject, which has been discontinued). The indexes through Volume 45 may be purchased together for \$155, and the cumulative index for Volumes 27–55 may be purchased as a single issue for \$65. Members of the Association may purchase back volumes for their personal use at a 50% discount. A revised edition of *A Bibliography of Symbolic Logic* by Alonzo Church may be purchased separately; the price is \$15 for members and \$30 for nonmembers.

Requests for information, applications for membership, orders for back volumes, business correspondence, and notices and announcements for publication in the JOURNAL should be sent to the Secretary-Treasurer of the Association, *C. Ward Henson, ASL, Department of Mathematics, University of Illinois, 1409 W. Green Street, Urbana, IL 61801, U.S.A.* The Internet address of the Association's business office is *asl@math.uiuc.edu*.

Notices of change of address, dues, and subscriptions to the JOURNAL should be sent to the *Association for Symbolic Logic, Journals Division UIP, 1325 South Oak Street, Champaign, IL 61820, U.S.A.* All orders must be accompanied by payment in dollars; Visa and Master Card are accepted. To receive a replacement copy of the JOURNAL, please report damaged, defective, or missing issues within nine months of the date of publication.

Books for review in the JOURNAL should be sent to *Herbert Enderton, The Journal of Symbolic Logic, U.C.L.A., Los Angeles, CA 90024, U.S.A.* The other editors of reviews are *George Boolos, Matthew Foreman, Gerhard Jäger, and Philip Scowcroft.*

Articles being submitted for publication in the JOURNAL should be sent in duplicate to one of the following editors: *Peter Aczel, Departments of Computer Science and Mathematics, Manchester University, Manchester M13 9PL, England;* or *Wilfried Buchholz, Mathematisches Institut, Universität München, Theresienstrasse 39, D-8000 München 2, Germany;* or *Sy D. Friedman, Department of Mathematics, Massachusetts Institute of Technology, Cambridge, MA 02139, U.S.A.;* or *Julia Knight, Department of Mathematics, University of Notre Dame, Notre Dame, IN 46556 U.S.A.;* or *Steffen Lempp, Department of Mathematics, University of Wisconsin, Madison, WI 53706, U.S.A.;* or *Andre Scedrov, Department of Mathematics, University of Pennsylvania, 209 South 33rd Street, Philadelphia, PA 19104-6395, U.S.A.;* or *Johan van Benthem, Faculty of Mathematics and Computer Science, Universiteit van Amsterdam, Plantage Muidergracht 24, Amsterdam 1018 TV, The Netherlands.* The editor in charge of survey and expository articles is *John P. Burgess, Department of Philosophy, Princeton University, Princeton, NJ 08544, U.S.A.*

Each manuscript should be typewritten with wide margins and with double spacing between the lines. Footnotes should be numbered consecutively and should also be typed with wide margins and double spacing, preferably on a separate sheet. Two copies of the manuscript should be sent to the editor, and the author should also keep a complete copy. Fifty offprints of each article are supplied at no charge, and additional offprints may be purchased if desired.

The JOURNAL invites submission of (1) original technical papers in the field of symbolic logic, (2) expository papers in this field, (3) papers whose main point is philosophical and which either bear upon logic or make use of its methods, and (4) studies in the history of logic in which modern technical developments are taken into account.

This JOURNAL has been registered with the Copyright Clearance Center, Inc. The appearance of a code at the bottom of the first page of an article indicates the copyright owner's consent for copying beyond that permitted by Sections 107 or 108 of the U. S. Copyright Law, provided that the per-copy fee stated in the code is paid directly to *Copyright Clearance Center, Inc., 222 Rosewood Drive, Danvers, MA 01923, U.S.A.* This consent does not extend to copying for general distribution, for advertising or promotion purposes, for creating new collective works, or for resale. Specific written permission for such copying must be obtained from the Association.