Logic Colloquium ’95

Since their inception, the Perspectives in Logic and Lecture Notes in Logic series have published seminal works by leading logicians. Many of the original books in the series have been unavailable for years, but they are now in print once again.

This volume, the 11th publication in the Lecture Notes in Logic series, collects the proceedings of the Annual European Summer Meeting of the Association for Symbolic Logic, held in 1995. It includes papers in the core areas of set theory, model theory, proof theory and recursion theory, as well as the more recent topics of finite model theory and non-monotonic logic. It also includes a tutorial on interactive proofs, zero-knowledge and computationally sound proofs that reported on recent developments in theoretical computer science, and three plenary lectures dedicated to the foundational and technical evolution of set theory over the past 100 years.

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LECTURE NOTES IN LOGIC

A Publication of The Association for Symbolic Logic

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LECTURE NOTES IN LOGIC 11

Logic Colloquium '95

Proceedings of the Annual European Summer Meeting of the Association of Symbolic Logic, held in Haifa, Israel, August 9–18, 1995

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Preface

The Logic Colloquium '95 is the Annual European Summer Meeting of the *Association of Symbolic Logic (ASL).* The ASL is the International Body of Logicians, both mathematical and philosophical. Its organizational center is in the US but its scope is truly international. The ASL was founded in the thirties by Alonzo Church. Since the sixties the ASL holds an annual symposium in Europe. *It is the first time that this meeting was held in Israel.* On behalf of the Organizing Committee I wish to thank the ASL, in particular Y. Moschovakis (former president of the ASL) and D. Lascar, for choosing Israel as the location of the Logic Colloquium '95 and for all its support in organizing it.

The Topics

The topics of this conference were the four classical topics of Mathematical Logic, Set Theory, Model Theory, Proof Theory and Recursion Theory, together with two topics which evolved more recently under the influence of Computer Science: Finite Model Theory and Non-monotonic Logic. A tutorial on Interactive Proofs, Zero Knowledge and Computationally Sound Proofs reported on recent developments in Theoretical Computer Science which shed new light on the nature of feasible computations.

We have added to this three plenary lectures dedicated to the foundational and technical evolution of Set Theory over the last 100 years. In this way we commemorated the 100th anniversary of the appearance in print of Cantor's fundamental paper which marks the beginning of Set Theory as a discipline.

The talks were divided into plenary lectures, special session lectures and contributed papers. The abstracts of the invited talks and contributed talks (of members of the ASL) were published in the *Bulletin of Symbolic Logic, vol. 3.1 (1997) pp. 73-147.* The contributions in this volume consists of papers and extended abstracts of the invited speakers. The papers do not necessarily coincide with the talks given. They were all submitted after the conference and were thoroughly refereed.

Logic in Israel

The fact that Israel was awarded the honour of hosting this Colloquium for the first time outside Europe is a result of the leading role that Israeli logicians play. Mathematical Logic has been a strong point in Israeli science since the beginning of modern academic activities, even before the foundation of the state. A.Fränkel, a founding father of the Hebrew University, was a true pioneer in Axiomatic Set Theory. Y.Bar-Hillel was a leading figure in the field of Philosophy of Science. A. Robinson, who together with A.Tarski initiated Model Theory, spent in the late fifties four years at the Hebrew University. H.Gaifman,

A.Levy and M.Rabin of the next generation of Israeli logicians continued this school which flourishes already in the fifth generation. In the last 40 years Mathematical Logic and the Foundations of Mathematics and Computer Science have become a focal point of research in Israel. M. Rabin left his imprint on the Theory of Computation and Theoretical Computer Science. S. Shelah has dramatically changed our perception and understanding of Model Theory and Set Theory. The program of this colloquium also bore witness to Shelah's overall impact on Mathematical Logic and we celebrated his 50th birthday together with the completion of his 600th publication with a special banquet. In the late seventies, the eminent Soviet logician B. Trakhtenbrot joined Tel Aviv University, where he founded a group which actively carries out research in Logic in Computer Science. P.Erdös, the most prolific contributor to Set Theoretic Combinatorics and laureate of the Wolf Prize, held a permanent visiting position in the Mathematics Department of the Technion. The tutorial given by S.Micali was dedicated to Interactive Proofs, an aspect of Computation theory in which Israeli researchers play a leading role. L.Babai, S.Micali C.Rackoff and two Israelis, S. Goldwasser (The Weizmann Institute) and S.Moran (Technion), received the Gödel Prize of the ACM and EATCS for their two seminal papers initiating this topic. A. Wigderson, a Technion graduate and Professor at the Hebrew University, was awarded the prestigious Nevanlinna Prize in 1994 for his overall contribution to Computation Theory.

Research in Logic is pursued very actively in all the seven institutions of higher learning in Israel. Prof. M. Rabin, laureate of the Turing Award, received the prestigious Israel Prize for his scientific and academic achievements in 1995. I have singled out only the most prominent Israeli researchers related to this conference but many others, among them the Israeli invited speakers, are worthy of similar praise. I am proud of being part of the Israeli Logic community, and I am sure all the active Israeli logicians share this feeling with me.

The Participants

This conference was truly international with over 230 participants (and over 20 contributions by title) from 34 countries and five continents:

Europe: Austria, Croatia, Czechia, Estonia, Finland, France, Germany, Great Britain, Hungary, Italy, Latvia, Lithuania, Norway, Poland, Romania, Russia, Slovakia, Spain, Sweden, Switzerland, Ukraine, Yugoslavia;
America: Brazil, Canada, Chile, USA;
Asia: China, Israel, Japan, Kasachstan, Singapore;
Oceania: Australia, New Zealand;
Africa: South Africa.

The four countries with delegations consisting of more than 10 participants are the USA, Germany, Israel, Russia and France.

The Hosting Institutions

Technion-Israel Institute of Technology is the oldest institution of higher learning in Israel and the first which adapted Hebrew as its language of instruction. Originally modeled after the German Technical Universities, it was founded in 1924. In the fifties it was expanded considerably and reorganized after the model of the American Institutes of Technology. The Mathematics Department was founded in the fifties, and the Institute of Advanced Studies in Mathematics (IASM) is attached to it. The Computer Science Departement was founded in the seventies. Logic is taught both at the Mathematics and the Computer Science Departments. Research in Mathematical Logic is more concetrated in Computer Science, but research in Set Theoretic Combinatorics is active in the Mathematics Department.

The University of Haifa was founded in the late sixties and plays an increasingly important role as the University of the North of Israel. Mathematics and Computer Science are part of the Faculty of Social and Mathematical Sciences. Logic is taught and research is active in Model Theory.

I would like to thank the Technion professors A.Solan (Senior Vice-President), N.Liron (Vice-President of Academic Affairs), M.Cwikel (Chairman IAMS), Y.Benjamini (Dean of Mathematics) and Z.Berk (former Dean of Computer Science). and the University of Haifa professors V.Harnik of the Organizing Committee, M.Schechter (Rector of the University of Haifa). and S.Waterman (Dean of the Faculty of Social and Mathematical Sciences). Their material and moral support was invaluable in the organization of the conference. In particular, I wish to thank Prof. Harnik for his part in the preparation for this conference.

Financial Support

This conference was financed through a joint financial effort of most of the Israeli Universities, the Israeli Academy of Sciences and the Ministry of Science and Arts and the Ministry of Tourism. Special thanks to the Hebrew University and the two hosting institutions. Substantial support was given by the Kurt Gödel Society and FoLLI, the European Association for Logic, Language and Information and the North Holland Publishing Company. Additionally, some of the invitations of the invited and special session speakers were supported by binational (BNSF, GIF, France-Israel) grants of Israeli researchers. All this money was used to support the invited speakers, and to subsidize the attendance of many outstanding logicians who currently suffer from the extremely poor financial conditions of their academic environment.

Furthermore, the ASL has contributed 10'000 US$ to be used for support of promising graduate students. 7500 US$ were used to support 13 applicants from America, Germany, Great Britain, Finland, France, Russia and Ukraine. 2500 US$ were used to support 10 Israeli students.

On behalf of the Organizing Committee I wish to thank all the sponsors for their support.

I wish to thank *all the participants*. The number of registrations surpassed our wildest dreams. Without them the conference would have ended in a financial disaster. I wish to thank the invited speakers who agreed to come here at their own cost and made the scientific program truly spectacular, all the special session speakers, and all those, who contributed their papers, for making the conference a truly memorable event.

Teamwork

I wish to thank the members of the Program Committee and especially Gerhard Jaeger, Menachem Magidor (chairman) and Richard Shore, who helped efficiently in choosing the invited and special session speakers. It was a pleasure to work with them.

I wish to thank the members of the Organizing Committee, who helped in raising the necessary funds. My special thanks are to V. Harnik and A. Levy.

I wish to thank the Local Organizing Staff for the enormous work they have invested in setting up the necessary framework. M.Kaminski and R.Shabalin helped in handling all the e-mail. G. Agranov provided graphics support. E.Ravve edited and compiled the abstracts distributed during the conference, Y.Sagi handled the registrations, Z.Keisari and her team from the External Studies Department of the Technion and the TANDU Travel Agency were in charge of organizing accommodation, meals and daily transportation. Last but not least, I wish to thank my wife M.N.Yelenevskaya, for her understanding and her enduring all kinds of deprivations while I was pursuing the preparations of this event.

János Makowsky

Since the holding of the
Logic Colloquium'95 four
logicians have passed away
to whom the colloquium was
indebted in one way or another:

Alonzo Church, 1903-1995, the founder of the ASL,
George Boolos, 1940-1996, then acting president of the ASL,
Paul Erdös, 1913-1996, who had a second home in Haifa, and
Laura Mayer, 1957-1997 who did attend and read a paper.

We shall remember them as colleagues and through their work.

Plenary sessions

Tutorials

- K. Compton (University of Michigan, USA)
  0-1 laws and finite model theory
- D. Marker (University of Illinois at Chicago, USA)
  Strongly minimal sets and geometry
- S. Micali (MIT, Cambridge Mass)
  Interactive proofs, zero knowledge and computationally sound proofs
- T. Slaman (University of Chicago, USA)
  Recent developments in recursion theory

Plenary addresses

- H.Becker (University of S. Carolina, USA)
  Path-connectedness, simple connectedness and descriptive set theory
- Z. Chatzidakis (Universite Paris 7, France)
  Model theory of finite fields
  Published as: Z. Chatzidakis, Model theory of finite and pseudo-finite fields, to appear in the Annals of Pure and Applied Logic, special issue of the Proceedings of the AILA-KGS conference.
- B. Cooper (University of Leeds, England)
  Beyond Goedel's theorem - the failure to capture information content
  Published as: S. Barry Cooper, 'Beyond Godel's Theorem: The failure to capture information content' in 'Complexity, Logic and Recursion Theory' (ed. A. Sorbi), Lecture Notes in Pure and Applied Mathematics no. 187, Marcel Dekker, 1997, pp. 93-122.
- A. Dawar (University of Swansea, Wales)
  Model theoretic methods for complexity theory
- R. Downey (Victoria University, New Zealand)
  On the low_2 recursively enumerable degrees
- I. Herzog (University of Illinois at Chicago, USA)
  Model theory of modules
- E. Hrushovski (Hebrew University, Israel)
  Stability and its heirs
- A. Kanamori (Boston University, USA)
  The evolution of techniques in set theory
- J. Krajicek (Mathematical Institute of CAS, Czechia)
  Propositional proofs, proofs of membership in polynomial ideals, and their complexity
- J. Lynch (Clarkson University, USA)
  On beyond zero-one laws
- P. Maddy (University of California at Irvine, USA)
  Justifying the axioms (V=L and maximize)

- M. Makkai (McGill University, Canada)
  Results in categorical model theory
- D.A. Martin (University of California at Los Angeles, USA)
  Recent work on large cardinals and determinacy
- A. Nies (Heidelberg University, Germany)
  Coding in distributive structures
- M. Pentus (Moscow University, Russia)
  Lambek calculus and formal languages
- A. Pillay (Notre Dame University, USA)
  Lecture 1: Superstable differential fields
  Lecture 2: S. Shelah's work in model theory
- Y. Peterzil (Haifa University, Israel)
  Zilber's trichotomy and o-minimal structures
- W. Pohlers (Universitaet Muenster, Germany)
  Subsystems of set theory vs. subsystems of second order number theory.
- M. Rathjen (Universitaet Muenster, Germany)
  The higher infinite in proof theory
- S. Shelah (Hebrew University, Israel)
  An iterated forcing for the continuum
- L. Soukup (Mathematical Institute HAS, Hungary)
  Combinatorial principles from adding Cohen reals
- A. Stolbushkin (UCLA, USA),
  Monotonicity in feasible models
- S. Wainer (University of Leeds, England)
  The proof theoretic complexity of recursion

Abstracts of all the lectures are published in the Bulletin of Symbolic Logic, vol. 3.1 (1997), pp. 73-147

Special sessions

Finite model theory and computer science

Coordinated by E. Grädel and J.A. Makowsky.

- J. Baldwin (University of Illinois at Chicago, USA)
- B. Courcelle (Bordeaux University, France)
- R. Downey (Victoria University, New Zealand)
- S. Lifsches (Hebrew University, Israel)
- M. Otto (Technical University Aachen, Germany)
- L. Pacholski (Wroclaw, Poland)
- E. Rosen (University of Pennsylvania, USA)
- M. Taitslin (Tver University, Russia)

A special issue of the *Archive for Mathematical Logic* will be dedicated to papers resulting from this session. It should contain the following papers:

- E. Graedel and A. Malmstroem, 0-1 Laws for Recursive Structures
- M. Otto, Bounded Variable Logic: Two, three, more,
- A. Stolbushkin and M. Taitslin, Normailzable orders and generic computations in finite models
- R. Downey and M. Fellows, Index sets and parametric reductions
- Eric Rosen, An existential fragment of second order logic,
- E. Graedel, M. Otto and E. Rosen, Undecidability results on two-variable logics,
- S. Lifsches and S. Shelah Random Graphs in the Monadic Theory of Order
- J. Nurmonen and L. Hella Vectorization hierarchies for some graph quantifiers

Model theory

Coordinated by E. Bouscaren and E. Hrushovski.

- O. Belegradek (Kemerovo, Russia)
- B. Herwig (Freiburg University, Germany)
- M. Junker (Universite de Paris 7, France)
- A. Khelif (Universite Paris 7, France)
- L. Newelski (Mathematical Institute of the Polish Academy of Sciences, Wroclav, Poland)
- E. Rabinovich (Ben Gurion University, Israel)
- Z. Sokolovic (McMaster University, Canada)

Three papers of this session will appear in the *Israel Journal of Mathematics*:

- B. Herwig, Extending partial isomorphisms for the small index property for many ω-categorical structures.
- L. Newelski, M-gap conjecture and m-normal theories.
- M. Junker, Completeness of Zariski groups.

Set theory

Coordinated by M. Magidor and J.A. Makowsky

- N. Brunner (Vienna University, Austria)
- L. Bukovsky (University of Kosice, Slovakia)
- J. Cummings (Hebrew University, Jerusalem, Israel)
- M. Foreman (UCI, Irvine, USA)
- S. Friedman (MIT, USA)
- M. Goldstern (TU Wien, Austria)
- T. Jech (Penn State University, USA)
- I. Juhasz (Math.Inst. of the Academy of Sciences, Budapest, Hungary)
- V. Kanovei (Moscow Transport Institute, Russia)
- P. Koepke (Universitaet Bonn, Germany)
- P. Komjath (Math.Inst. of the Academy of Sciences, Budapest, Hungary)
- L. Stanley (Lehigh University, Betlehem PA, USA)
- P. Vojtas (Slovac Academy of Sciences, Kosice, Slovakia)

A special issue of *Fundamenta Mathematicae* was dedicated to papers originating in this special session, edited by Akihiro Kanamori (Guest Editor), Alexander Kechris and Leszek Pacholski. The contents of this issue, volume 154, Number 2 (1997), consists of

- N. Brunner, P.Howard and J.E.Rubin, Choice principles in W/eglorz' models
- A.Dow and I.Juhász, Are initially ω_1-compact separable regular spaces compact?
- S.D.Friedman, Σ^* the approach to the fine structure of L
- S.Fuchino and L.Soukup, More set-theory around the weak Freese-Nation property
- W.Just and P.Vojtáš, On matrix rapid filters
- V.Kanovei, Two dichotomy theorems on colourability of non-analytic graphs
- P.Komjáth, A strongly non-Ramsey uncountable graph 2

Recursion theory

- M. Arslanov (Kazan, Russia)
- P. Cholak (University of Notre Dame, USA)
- C.T. Chong (Singapore)
- P. Fejer (University of Mass., Boston, USA)
- S. Goncharov (Novosibirsk, Russia)
- M. Groszek (Dartmouth College, Hannover, USA)
- V. Harizanov (George Washington University, USA)
- E. Herrman (Humboldt University Berlin, Germany)
- J. Knight, (Notre Dame University, USA)
- M. Kummer (University of Karlsruhe, Germany)
- M. Lerman (University of Connecticut, USA)

A special issue of *Annals of Pure and Applied Logic* was dedicated to papers originating in this special session, edited by R. Shore (Guest Editor). The contents of this issue, volume 87.2, (1997) consists of

- C.T. Chong and Y. Yang, Σ_2 induction and infinite injury arguments, Part II: Tame Σ_2 coding and the jump operator
- M.J. Groszek and T.A. Slaman, Π^0_1 classes and minimal degrees
- E. Herrmann, Boolean pairs formed by Δ^0_n sets
- C.J. Ash and J.F. Knight, Possible degrees and recursive copies II
- S. Lempp and M. lerman, A finite lattice without critical triple that cannot be embedded into the enumerable Turing degrees.

Proof theory

Coordinated by G. Jäger and S. Wainer.

- A. Avron (Tel Aviv University, Israel)
- L. Beklemishev (Steklov Mathematical Institute, Moscow, Russia)
- G. Bellin (Universite Paris 7, Paris, France)
- V. Danos (Universite Paris 7, Paris, France)
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- U. Kohlenbach (Frankfurt University, Germany)
- G. Mints (Stanford University, USA)
- W. Pohlers (Universitaet Muenster, Germany)
- T. Strahm (Universitaet Bern, Switzerland))
- A. Weiermann (Universitaet Muenster, Germany)

A special issue of the *Archive for Mathematical Logic* is being prepared with papers resulting from this session.

Non-monotonic and non-classical logic

Coordinated by D. Lehmann and W. Marek.

- G. Amati (Fondazione Ugo Bordoni, Roma, Italy)
- R. Ben-Eliyahu (Techion-Israel Institute of Technology, Israel)
- Tim Fernando (University of Stuttgart, Germany)
- M. Gelfond (University of Texas, USA)
- G. Gottlob (Technical University of Vienna, Austria)
- H. Herre (Universitaet Leipzig, Germany)
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