

a brief history of the
institute for logic, language
and computation
people, ideas & practices

Johan van Benthem
Martin Stokhof

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foreword

This booklet presents a short history of the ILLC up to 2021 as seen by two of its founders, with a focus on the early years, from the 1970s until the 1990s. We have chosen a light narrative emphasizing trends and people, leaving a deeper historical assessment in the safe hands of the generation after us. Even so, we hope that the inevitable selections made in producing a text like this have been fair and informative.

Many colleagues and friends of the ILLC have generously contributed material, from text passages and vignettes to photographs and other illustrations. We are grateful for all the support we have received in the long process of preparation. In particular, we thank Peter van Ormondt without whose help the realisation of this booklet would have been impossible.

a brief history of logic in Amsterdam

The University of Amsterdam has a remarkable academic tradition in logic, broadly conceived as including connections with philosophy, mathematics, computer science and other fields - with the Institute for Logic, Language and Computation (ILLC) as its platform since 1991.

This booklet presents a brief history of this institute, and of the ideas, the people, and the circumstances that shaped it.



Logic in Amsterdam

In the decades around 1900, the Netherlands once more became a vibrant presence on the international scene, with remarkable contributions to the arts, sciences, and industrial innovation that are still with us today. This period saw Nobel prizes in physics, chemistry, and biology awarded to Lorentz, Van 't Hoff, and De Vries, significant contributions to painting, architecture and design by artists such as Van Gogh, Mondriaan, and Rietveld, and the rise of major industrial corporations such as Unilever, Philips, and Shell. The time of these creative activities has been heralded as 'The Second Dutch Golden Age'.

Logic and mathematics

In this period, modern logic, too, became an area of specialised research in the Netherlands – though Simon Stevin's book *Dialectike ofte Bewysconst* from 1585 may well be the first logic textbook published in a vernacular European language. The first innovative voice in Dutch logic sounded in the area of foundations of mathematics. Luitzen E. J. Brouwer (1881-1966) was one of the leading mathematicians at the time, reflecting on what it is that makes mathematics, the key to all of the exact sciences, so precise and secure. He made important contributions to the emerging field of topology, where the Brouwer Fixed Point Theorem is still a

landmark. But it was his broader foundational perspective of intuitionism that gave a wholly new analysis of the mental activity of mathematics as constructing ever new objects and at the same time proving their properties in an ongoing infinite creative process. These ideas by a prominent mathematician, fuelled by a remarkable philosophical sensitivity, were radical in that they broke with laws of classical logic that had held sway for millennia in mathematics and elsewhere.

The stamp that the Dutch postal service dedicated to Brouwer in 2008 shows this rejection: intuitionistic logic does not accept the famous Law of Excluded Middle, 'A or not-A', coming to us from Antiqui-

| <i>Valid</i> | <i>Invalid</i> |
|--|---|
| (1) $(x) [P(x) \rightarrow \overline{M(x)}]$ | (3) $(\exists z) [S(z) \& \overline{P(z)}]$ |
| (2) $(\exists y) [S(y) \& M(y)]$ | (8) $S(a) \& P(a)$ |
| (4) $S(a) \& \overline{M(a)}$ | (9) $\overline{P(a)}$ (5) and (8) |
| (5) $S(a)$ | (12) $M(a)$ (11) |
| (6) $\overline{M(a)}$ (4) | |
| (7) $P(a) \rightarrow \overline{M(a)}$ (1) | |
| (10) $P(a)$ (9) | |
| (11) $\overline{M(a)}$ (7) and (10) | |

Beth would have been very pleased and proud to see that logic, – for him so central to human intellectual endeavour –, has become part of the study of human thought in so many ways, and that in no small measure through the achievements of what started as his institute.

Hans Kamp

ty, because mathematical statements are not always true or false at a particular stage of mathematical inquiry.

Over time, Brouwer's ideas unfolded their true content. Intuitionistic reasoning does not just reject old principles, it has a deep structure of its own that was brought to light by Arend Heyting (1898-1980), who was Brouwer's student around 1930 and later became his colleague, and by several generations of Dutch and foreign researchers after him. In the hands of an international community and pursued by modern techniques from proof theory and category theory, the intuitionistic research program is still very much alive. In particular, its combination of construc-

tion and proof goes to the heart of understanding computation, and thus to modern computer science.

Logic and philosophy

The next major voice in logic in Amsterdam was that of Evert Willem Beth (1908-1964). Trained as a philosopher, Beth's interests were broad, ranging from the history of philosophy to the foundations of mathematics and the empirical sciences. Beth made major contributions to pure logic, such as his Definability Theorem that explained the balance between reasoning and the expressive power of the language that the reasoning is couched in. And his method of semantic tableaux for

testing validity, which was based, characteristically, on an analysis of broad styles of reasoning in the history of mathematics and of philosophy, was one of the first instances of an automated deduction system that could be programmed and run on computers, a technical paradigm that is still active today in computer science and artificial intelligence.

Beth saw a broad intellectual role for mathematical logic in combination with philosophy, an interface on which he wrote extensively, for instance, in his studies of Kant's notion of analyticity, of reasoning with modal expressions of necessity and possibility, and in his pioneering analysis of the structure of



the empirical sciences as a paradigm for the philosophy of science.

In line with these interests, Beth was one of the founding fathers of the ‘Centrale Interfaculteit’, an academic entity the core of which was constituted by strong, independent philosophy departments. And in line with that, Beth was also open to connections with the emerging formal linguistics of his day, in particular Chomsky’s work in transformational generative grammar, and with the developmental psychology of Jean Piaget, with whom he co-authored a book. Beth was an influential teacher, and many of his students, among whom Joop Doorman, Frits Staal, Pieter Seuren, Dick de Jongh

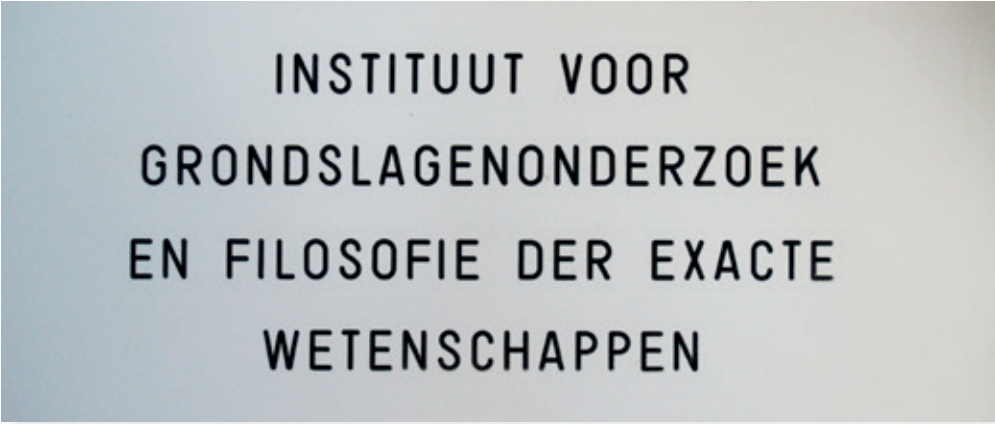
and Hans Kamp, later became leading academics in their own right in the fields of logic, philosophy and linguistics. Beth was also a prolific author, who published in Dutch, English, French and German, and he created a style of pursuing philosophy that has persisted until today, aiming at making conceptual finesse, mathematical precision and erudition go hand in hand.

The IGLO

Beth’s relatively short academic career was remarkable, not just for his research and teaching, but also for his many organisational activities. The collegial collaboration of the Amsterdam logicians in the

departments of mathematics and philosophy created a stable environment for students and visitors. Attempts were made early on to organise these activities in an independent institutional setting.

In 1952, Beth founded the ‘Institute for Foundational Research and Methodology of the Exact Sciences’ (or ‘IGLO’, which is the acronym of the Dutch name), initially by partitioning his own office and asking a secretary to sit in the front, thus creating an illusion of space and grandeur. From the start, this environment had an international orientation, and in the 1960s, it was the base for a EURATOM project, which aimed to develop perhaps the earliest automated deduction system



INSTITUUT VOOR
GRONDSLAGENONDERZOEK
EN FILOSOFIE DER EXACTE
WETENSCHAPPEN

for big data in science, in this case the then emerging nuclear facilities of the European Community. Together with Heyting in Amsterdam, and in collaboration with his friend Alfred Tarski in Berkeley, Beth was also instrumental in creating the famous book series *Studies in Logic and the Foundations of Mathematics*, that has done much to shape logic as a field, and in creating the Division of Logic, Methodology and Philosophy of Science of the International Union of History and Philosophy of Science and Technology, which organised conferences where colleagues from all continents and political systems met and that are still major international venues for logic in its widest sense.

After Beth's death in 1963, an interregnum followed with famous temporary successors, including some of the most resounding names of the field in the United States: Dana Scott, Richard Montague, and Haskell Curry. Frits Staal continued to play an important role and inspired a further generation, among whom Henk Verkuyl, Simon Dik, and Jan Kooij, who became leaders in the linguistics community.

In 1971, the chair passed to Martin Löb, a proof theorist whose famous work on provability in arithmetic extended that of Gödel in significant ways. In this period, the IGLO disappeared as a separate entity, mostly because of a revised academic statute, adopted after the student revolu-

tion of the late 1960s, reflecting entirely new attitudes and matching new democratic organisational structures.

What remained was the 'Interfacultaire Vakgroep Logica' ('Interfaculty Logic Section'), a collaborative forum of logicians, philosophers and mathematicians, which functioned as a point of contact for the Faculty of Mathematics and Computer Science and the Faculty of Philosophy.

Logic and computation

The 1970s were a period of academic ferment for logic in Amsterdam. One important influence was the emergence of computer science (or in the perhaps more felicitous European term, 'informatics')

as a separate discipline with its own agenda beyond just being a handmaiden of automation and ICT, where Dutch scientists played an important role. Notable figures at the time were Edsger Dijkstra (a later Turing Award winner) and Adriaan van Wijngaarden, the director of the Mathematisch Centrum (‘Mathematical Centre’), a nationally funded research institute. These were the heydays of structured programming and procedural programming languages. In these developments, logic played an important role. Logical notions and methods were prominent in the specification and verification of programs, the design of programming languages, the study of algorithms and complexity theory, and other themes that were making large-scale computation both practically feasible and theoretically solid and that forged strong connections between theoretical computer science and mathematics. At the same time, ideas from logic pervaded the closely connected field of artificial intelligence. These close connections have persisted until today, and information and computation have become major themes for logicians in Amsterdam as well.

Logic and linguistics

The second major development was the rise of modern linguistics in the mathematical style of Chomsky and his generation. While earlier philosophers and

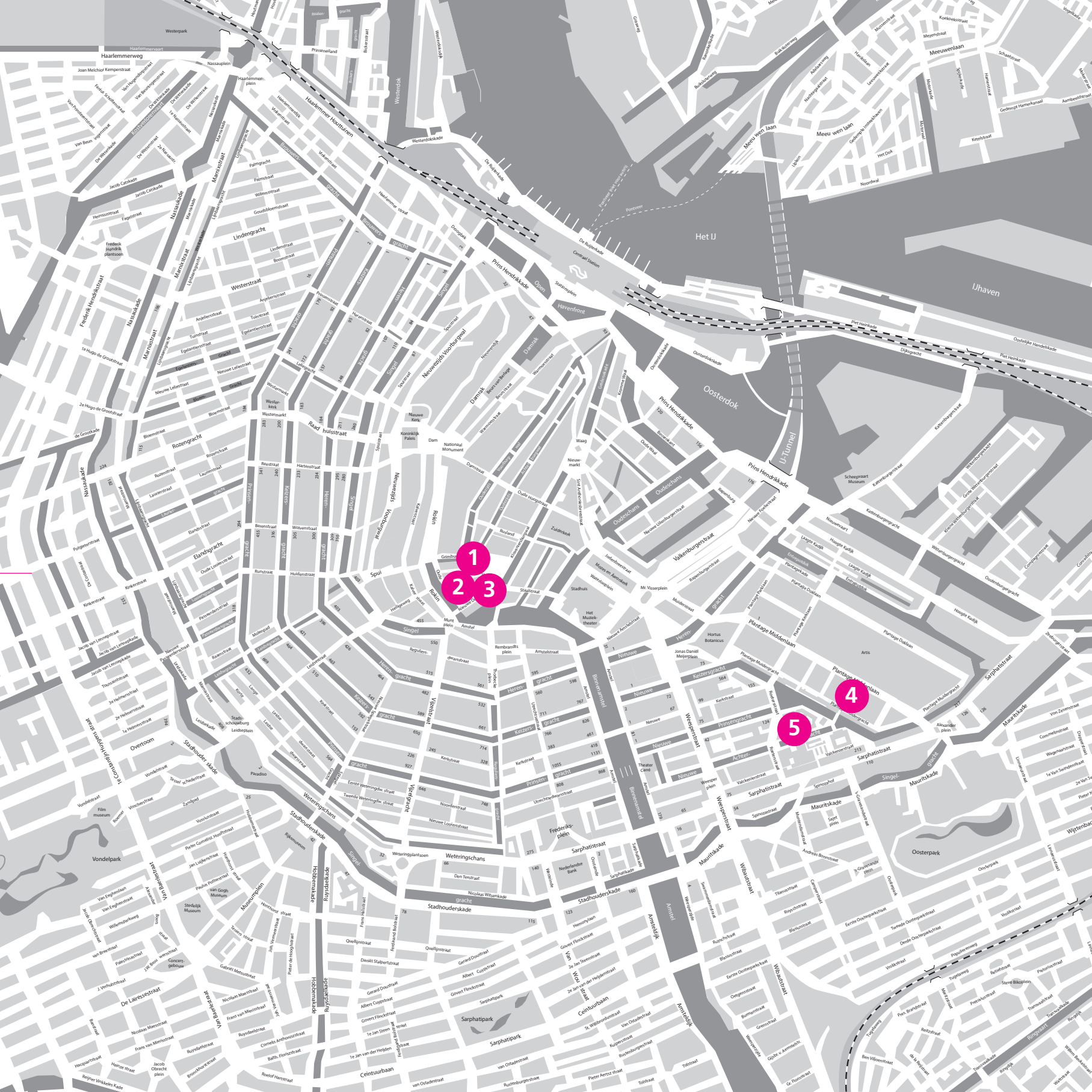
logicians, following the warnings of Frege, Russell and Carnap, might have been wary of natural language as unsystematic and vague, if not downright misleading, and hence in need of correction by specifically designed formal languages, the idea now gained ground that natural language has its own structure, serving its own purposes very well. A famous representative of this new perspective was Frits Staal (1930-2012), who studied mathematics, physics and philosophy, later became an eminent scholar of Sanskrit and Indian culture, and who was the holder of the chair in general and comparative philosophy until his departure to UC Berkeley in 1968.

Again, a connection with logic turned out important here, enshrined in the view expressed in Montague’s famous dictum that there is no difference in methodological principle between the natural languages of the linguists and the formal languages of the logicians. This contact, too, has persisted, and modern areas of formal linguistics such as formal semantics and formal pragmatics are unimaginable without the close collaboration with logic.

In this climate of old strengths and new interdisciplinary themes, a generation of students and professors grew up who recognised this constellation as their natural habitat.







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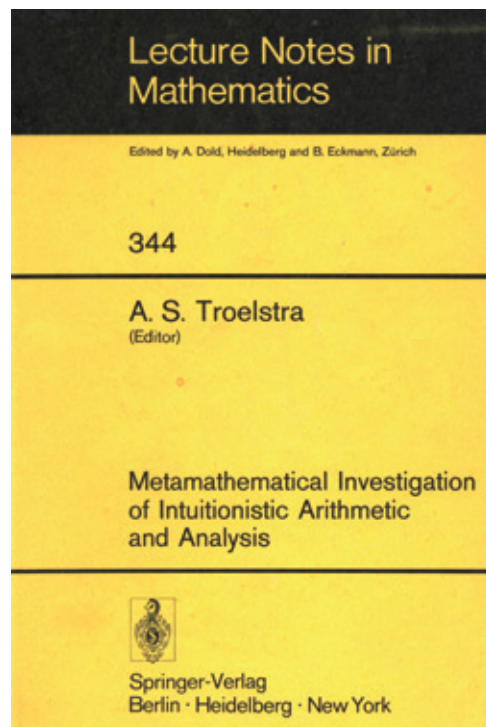
Past and present locations of the ILLC

1. Binnengasthuisterrein
2. Oude Turfmarkt
3. Turfdraagsterpad 9
4. Plantage Muidergracht 24
5. Roetersstraat 15
6. Science Park 107
7. Science Park 904



the seventies: a broad community forms

The 1970s saw the emergence of a new generation of faculty and, very importantly, also of students who crossed easily between topics, lectures, and seminars in different academic environments and who made the newly emerging areas their home base. Building on work done by previous generations, they took things a step further and created new areas of research, exploring both old and new questions with new formal methods and conceptual frameworks from a variety of sources.



Logic

In logic, Anne Troelstra, appointed as Heyting's successor in 1970, expanded the field of constructive mathematics with a study of new intuitionistic objects such as lawless sequences. Moreover, in a series of influential publications, he began to systematise the realm of constructive mathematical theories. Interestingly, this meta-theory was often pursued by means of techniques from classical logic, and so earlier ideological quarrels were replaced by more relaxed and successful collaboration. Troelstra's colleague Martin Löb added classical proof-theoretic themes to this environment, and with the arrival of Dick de Jongh after his PhD studies with

Kleene in Wisconsin, Löb's work created a research program in 'provability logic', the study of properties of provability in major mathematical theories, which has been a highlight of logic in Amsterdam and other Dutch universities ever since. Provability logic creates a link between the foundations of mathematics and techniques from modal logic, a field that originated in philosophy as a study of necessity, possibility, and entailment. In this same spirit of seeking connections, Johan van Benthem, appointed in 1972 as an assistant professor of philosophical logic, wrote a thesis on modal correspondence theory, a model-theoretic study of modal logic from a mathematical point of view, which proposed the invariance notion of

bisimulation as a key to understanding modal languages. This work brought out deep analogies between modal logic and classical first- and second-order logic, leading to a working style combining both, a hallmark of what is now called the 'Amsterdam School' in modal logic. Another important connection created at the time was that between intuitionistic logic, modal logic and universal algebra, which was pioneered by Wim Blok. Of course, more standard topics from mathematical logic were there, too: for many years, Kees Doets taught model theory and set theory as indispensable tools to a broad community.

$$\Box(\Box p \rightarrow p) \rightarrow \Box p$$



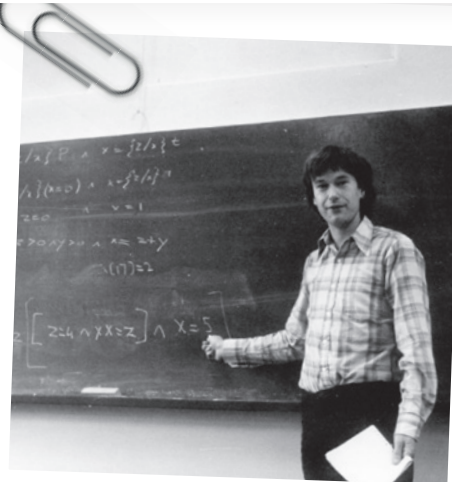
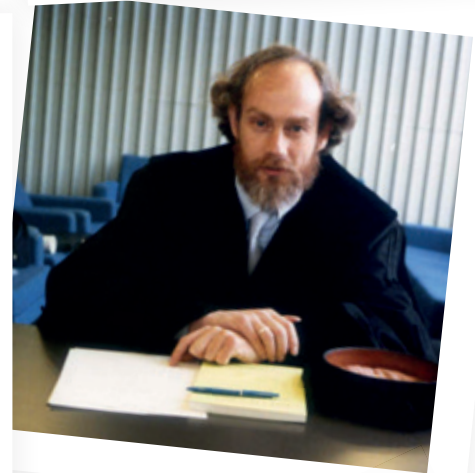
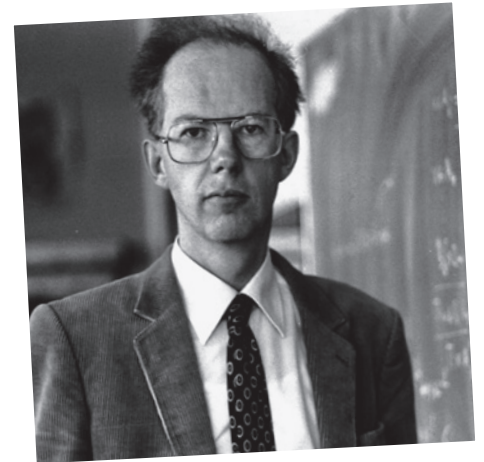
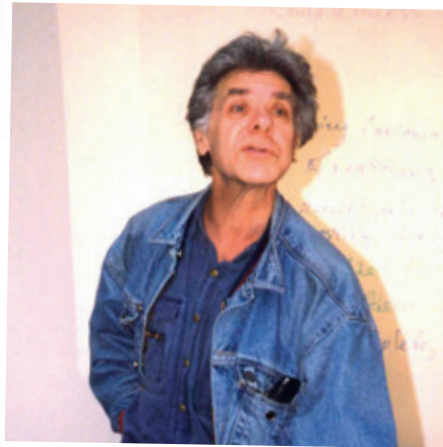
More broadly, philosophical logic and mathematical logic kept interacting in Amsterdam as they had in Beth's days, as exemplified in the work and highly influential teaching of Else Barth (later a professor of logic and analytical philosophy in Utrecht and, subsequently, Groningen) on the history of philosophy and on dialogical foundations of logic. A generation of students formed around this interface, such as Erik Krabbe, who would become a pioneer connecting logic and argumentation theory, Theo Kuipers, who connected logic with the philosophy of science in a dissertation on Carnap's inductive logic, and, later on, Frank Veltman, who worked on conditional logic and became an assistant professor

of philosophical logic at the University of Amsterdam in 1978.

Language

Once insights from Chomskyan linguistics were coupled with conceptual frameworks from analytic philosophy and then explored using methods from formal logic, a new field of formal semantics of natural language emerged. Originally, this occurred primarily in the US and Germany. But very soon Amsterdam added a signature of its own. Montague had presented his original ideas in Amsterdam while being a visiting professor earlier on, but it was the appointment of Renate Bartsch on Staal's chair in 1974 that really jumpstarted

the Amsterdam formal semantics scene. The broader local scene was conducive to that, with a special role for Simon Dik, a professor in general linguistics who would later develop his own framework of functional grammar. He coached a number of active students, including Jeroen Groenendijk, Alice ter Meulen, and Martin Stokhof, who wanted to explore the relationships between linguistic theory and philosophy of language. Another congenial and supportive colleague in the faculty of humanities was Teun van Dijk, an expert on text linguistics and literary theory.



The founders

First row

Johan van Benthem

Dick de Jongh

Anne Troelstra

Second row

Martin Stokhof

Jeroen Groenendijk

Peter van Emde Boas

Third row

Renate Bartsch

Theo Janssen

Frank Veltman

The 1970s saw the rise of Montague Grammar. We sensed its importance, but Montague's papers were not easily accessible. The diversity of expertise present in the ILLC proved to be crucial. Jeroen Groenendijk

Upon her arrival, Bartsch brought many state-of-the-art themes and an extensive academic network, and introduced the members of the Amsterdam community to the international scene. Through the 1970s, the group was continually strengthened by new graduate students, a talented group including Paul Dekker, Herman Hendriks, Fred Landman, Ieke Moerdijk, Piet Rodenburg, and Henk Zeevat. An early initiative of the initial group was the first international Montague Colloquium (1975), a landmark event in the development of formal semantics that started a tradition and a community, and became a milestone in many organisational developments that were to follow in the decades to come.

Computation

A third environment in the mix of influences at the time was the Mathematical Centre in Amsterdam where Peter van Emde Boas, appointed as a lecturer in 1977, and originally an expert on complexity theory, formal language theory and automata, was developing a strong interest in formal semantics. Together with his student Theo Janssen, he found several striking parallels between central phenomena in the semantics of programming languages, such as intensionality and anaphora, and their counterparts in natural language. Hence, the two quickly joined the semantics circle, and added a characteristic flavour, different from most

places abroad, with an open window to influences from computer science. Montague's Thesis could now also be said to cover a third realm: not just logic and linguistics, but also computer science. The formal semantics group that thus emerged was characterised by its multidisciplinaryity: all members had a background in at least two disciplines: philosophy, linguistics, computer science. What bound them was their interest in natural language semantics and their conviction that logic, in a broad sense, provided the most suitable methodology.

Epistemic logic was transformed from an exotic theme in philosophical logic into a central topic in computer science. The ILLC was both an instigator and a core participant in this transformation.

Peter van Emde Boas

Cross-connections

Merges and cross-overs were highly characteristic of this formative period. People took each other's classes, seminars were attended by a wide range of students and professors from different fields, dissertations by members of the founding group were co-supervised by staff from different departments (many are available on the ILLC website) and there were several joint appointments, such as De Jongh in philosophy and mathematics and Janssen in philosophy and computer science. Moreover, given the thin boundaries between fields, research in semantics ran over seamlessly into that on philosophical logic, making the work of Veltman on logics of condi-

tionals fit in from the start. And there were also early notable joint projects. The L.T.F. Gamut two-volume textbook *Logic, Language and Meaning*, written around 1980 by Van Benthem, Groenendijk, De Jongh, Stokhof, and Verkuyl, is still in print in several languages today.

Why? It is hard to say what exactly made all this happen. There was definitely a feeling in the air, perhaps because of the academic revolution around 1970, that a new world was in the making, disregarding old dogmas and boundaries, and the same seemed true academically. What also played a role was the appointment of a generation of young professors whose interests matched and provided the right

complementarity, and who got on together well at a personal level. And finally, there was a continuous influx of young talented students in philosophy, mathematics, linguistics, computer science, and elsewhere.

These people retained their attitudes of openness and mutual exchange over the years, even though they might change fields every now and then. They would become the people who created the ILLC.





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the eighties: consolidation

The time was now ripe for more structured organisation. The interests of the community forming around 1980 were not accidental, they formed a natural kind. The interface of philosophy, mathematics, computer science, and linguistics continually attracted a wide group of new students for whom this was a natural combination, rather than an interdisciplinary fad. Accordingly, a further degree of organisation made sense, and new more sustained initiatives sprung up.



I first attended the Amsterdam Colloquium in 1980. It was the most inspiring and most demanding environment imaginable, and for at least a decade, it was where I presented my main new work. *Barbara H. Partee*

There were now lively, long-running research seminars where people from different departments would discuss papers of shared interest, ranging from linguistics to logic and computation, and discover and expand commonalities leading to joint publications and dissertation projects. Talking to one's colleagues became the natural thing to do. There were more and more courses teaching students from different backgrounds the basic necessities for participation, thus broadening the base of the community.

Moreover, the bi-annual Montague Colloquium became a regular international event with widely read proceedings, that documented the latest advances in the

logical study of natural language and on related topics in philosophical logic. These proceedings later turned into the GRASS series (which appeared with Foris Publications in Dordrecht, and later with De Gruyter in Berlin), which also reflected the lively interactions with a like-minded community at the University of Groningen, including Frank Heny, Frans Zwarts and their students and colleagues, where Van Benthem had moved in 1977 to join the departments of philosophy and mathematics.

New appointments

Through the 1980s, new appointments were made. Van Benthem returned to

Amsterdam from Groningen in 1986 as the successor to Löb on Beth's chair, an appointment supported by the three departments represented in the community as a way of having a central logic chair dedicated to the integrated environment that was emerging. New students joined him, such as Reinhard Muskens, Maarten de Rijke, Victor Sanchez, and Yde Venema, later on well-known names in the history of the ILLC.

Another important development was the appointment in 1988 of Remko Scha to the chair of computational linguistics, who brought hands-on experience with computational linguistics and its interfaces to industry (Philips Electrologica, Philips NatLab, BBN Laboratories in Boston).

The Amsterdam school in modal logic?
Correspondence Theory, the third pillar
of modal wisdom: thinking about graphs
and how we can talk about them with
simple languages.

Patrick Blackburn

Leen Torenvliet joined the theoretical computer science group, and so did, at a later stage, Paul Vitányi, who worked on Kolmogorov complexity and information theory, and Krzysztof Apt, who worked on logic programming. Vitányi and Apt joined on part-time appointments, having their main affiliations at the Centrum voor Wiskunde en Informatica (National Research Institute for Mathematics and Computer Science, CWI), the successor of the former Mathematisch Centrum. This group was an important part of the community, both through its interactions with the logicians, philosophers and linguists, but also by linking up with developments within computer science more broadly. This proved of vital importance as connec-

tions between logic and computational linguistics, artificial intelligence and cognitive science became more robust in the 1980s. In this lively atmosphere, the initial interests of the 1970s community gradually coalesced and transformed, forming lines with a recognisable thematic signature and increasing international recognition and influence.

Foundations of mathematics

Logic and the foundations of mathematics continued its strengths in intuitionism, culminating in the monograph *Constructivism in Mathematics* by Troelstra and Dirk van Dalen, the definitive text in the field. It shows how further perspectives

Mathematical logic in the ILLC is
pursued in a wide variety of contexts,
but remains exciting in itself
because of the simplicity and beauty
of ever arising new mathematical
ideas.

Dick de Jongh

entered constructivist research, coming from classical proof theory and category theory. Several of Troelstra's PhD students, among whom Ieke Moerdijk, would become leaders in these areas. In parallel, the foundational agenda was enriched as De Jongh and Albert Visser kept extending provability logic, where ideas from philosophical logic, viz., Veltman's conditional logic, turned out useful in the study of relations between mathematical theories.

Modal logic

At the same time, through the 1980s, the mathematical approach to modal logic and its philosophical applications, pioneered

It was fascinating that natural language meaning could be conceived of, not as timeless and ideal, but as alive and real, and still admit of rigorous, logical characterisation. Paul Dekker

$$(\exists x\varphi \wedge \psi) \leftrightarrow \exists x(\varphi \wedge \psi)$$

by Kripke, Kamp, Fine, Gabbay, Goldblatt, Blok, and many others, kept flourishing in a highly recognisable style, witness Van Benthem's books *The Logic of Time* (1983), *Modal Logic and Classical Logic* (1985), Veltman's *Logics for Conditionals* (1985), and a further stream of publications by De Jongh.

Later, in the 1980s, this program was to receive new impetus through connections with computer science and algebraic logic, and become the Amsterdam School in its current shape, with trademark features such as fruitful connections between modal and classical logics through correspondence theory, and the balance between expressive power of rich modal formalisms and desirable computational simplicity. These were notably different from the purely philo-

sophical or mathematical approaches to the field found elsewhere.

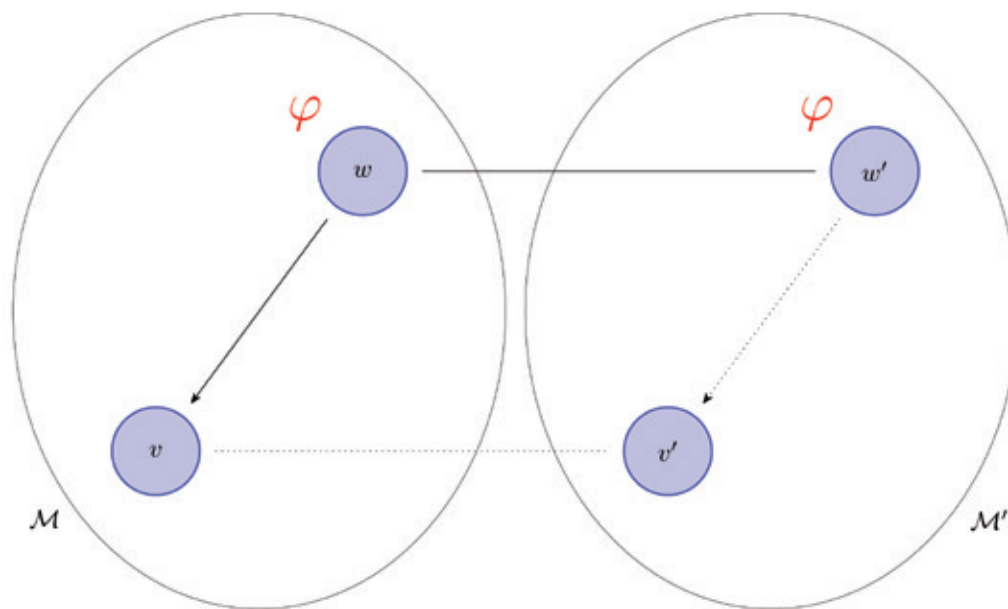
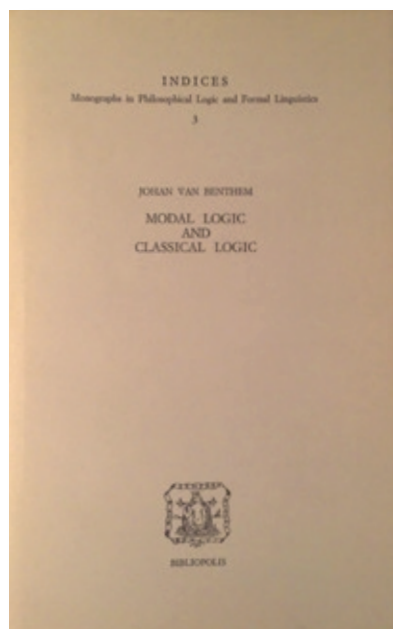
In this new guise, over the years, modal logic turned out to be a core calculus for both epistemic logic, the study of information and knowledge, and dynamic logic, the study of computation and action in general.

Dynamic semantics

A third striking development in the 1980s was the emergence of a new approach to semantics emphasising the role of information and information exchange. The *ILLC* approach is related to earlier theories of Hans Kamp and Irene Heim, but significantly different in major respects. Dynamic semantics, developed by Groenendijk and Stokhof for anaphora and discourse

coherence, and in an independent version by Veltman for information update, became one more international trademark of the Amsterdam environment.

Dynamic semantics combines ideas from Montague semantics, philosophical logic, and computer science to provide an account of meaning that is rooted in the dynamics of communication between linguistic agents. Its core idea is that the meaning of an expression is tied to its potential for modifying information states of speakers and hearers in a systematic manner. It quickly became clear that, from this new starting point, a novel perspective arises on much of formal semantics and the philosophy of language. The dynamic, information-oriented turn is of course a direct reflection of the many-sided nature of the



Amsterdam community as it had formed at that time. Dynamic semantics in the Amsterdam fashion proved to be a lasting influence in formal semantics throughout the 1990s up to the present-day, and turned into a well-known and acknowledged framework for exploring a large range of aspects of natural language meaning.

And more

The above list is not exhaustive. Logic and philosophy at Amsterdam also included connections with the formal philosophy of the empirical sciences in Beth's spirit, though this seed eventually did not become a major focus in its own right. What did attract international attention were some fur-

ther research lines generated by the Amsterdam logic and language milieu. In particular, Van Benthem and his PhD students Jan van Eijck, Víctor Sánchez and Michael Moortgat, together with congenial colleagues elsewhere such as Frans Zwarts and Dag Westerståhl, developed the theory of generalised quantifiers, a topic in both linguistics and mathematical logic that is now part of the heartland of formal semantics.

This work in its turn led to a lively interest in categorial grammar, a mathematical-linguistic paradigm for natural language based on a calculus of resource management that is closely related to lambda calculus, proof theory, category theory, and algebraic logic. For at least a decade, this last line put the ILLC in close touch with

an active international community, from Poland to the US, with colleagues such as Wojciech Buszkowski, Mark Steedman, Emmon Bach and Dick Oehrle.

Agenda setting

By the mid 1980s, the Amsterdam group with its overlapping strengths in the areas of mathematical proof and computation, philosophical modality, information flow and language use had acquired an international reputation for doing cutting edge research in various fields. Research agendas were being set right here. As a prominent visitor once put it: 'You had to go to Amsterdam to see where things were heading.'

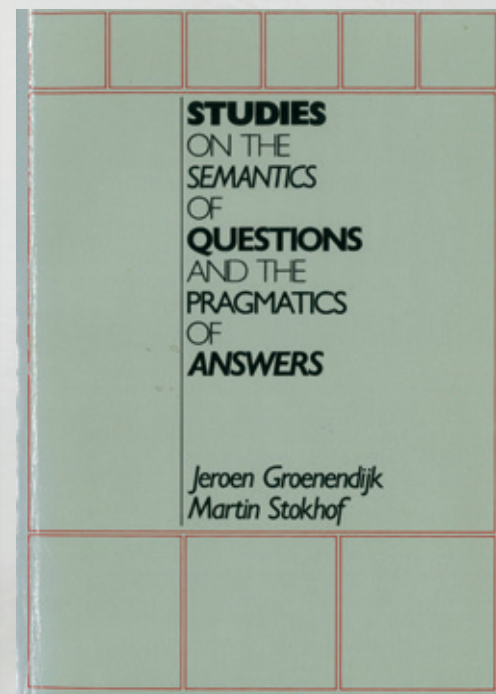
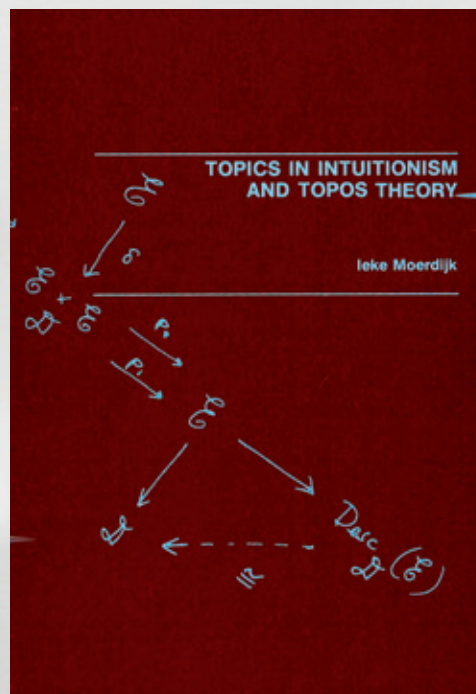
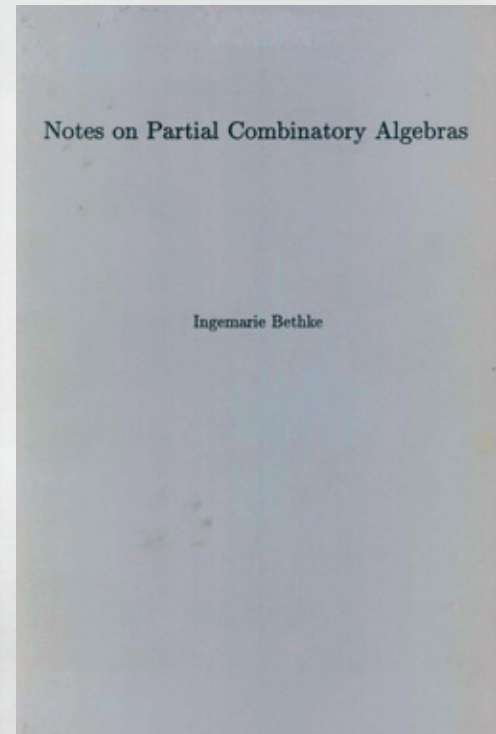
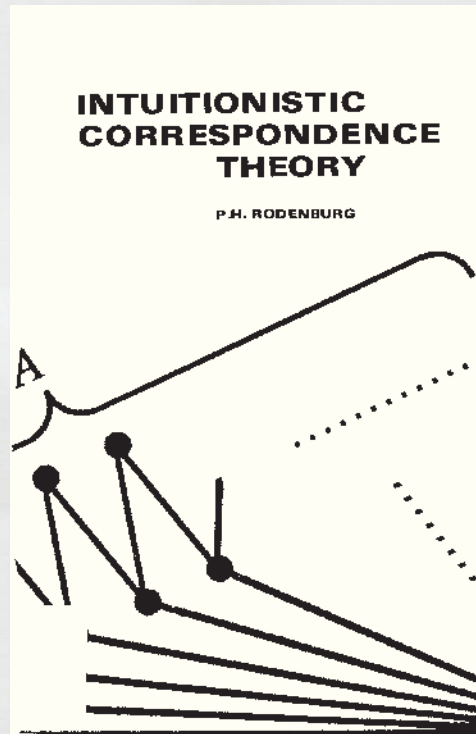
Ten early dissertations

First row:

Piet Rodenburg, Ingemarie Bethke, Kees Doets,
Gerard Renardel de Lavalette, Frank Veltman

Second row:

Ieke Moerdijk, Jeroen Groenendijk & Martin
Stokhof, Michiel van Lambalgen, Theo Janssen,
Leen Torenvliet



COMPLETENESS AND DEFINABILITY

*applications of the Ehrenfeucht game
in second-order and intensional logic*

Kees Doets

THEORIES WITH TYPE-FREE APPLICATION
AND EXTENDED BAR INDUCTION

$$\underline{T}(\underline{\neg}) \geq \underline{T}$$

$$\underline{APP} + \underline{EAC} \succ \underline{HA}$$

$$\underline{EL} + \underline{EBI} \equiv_{ar} \underline{ID}_1$$

Gerard R. Renardel de Lavalette

Frank Veltman
LOGICS FOR CONDITIONALS

RANDOM SEQUENCES

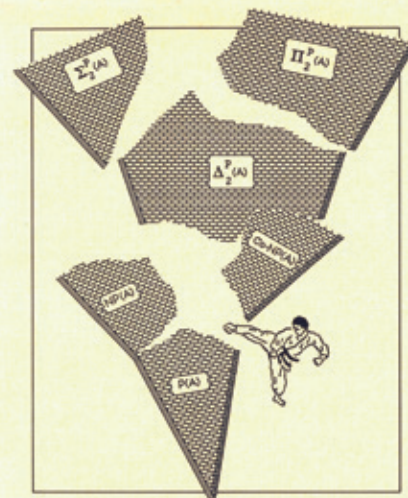
M. van LAMBALGEN



FOUNDATIONS AND APPLICATIONS OF MONTAGUE GRAMMAR



THEO M.V. JANSSEN



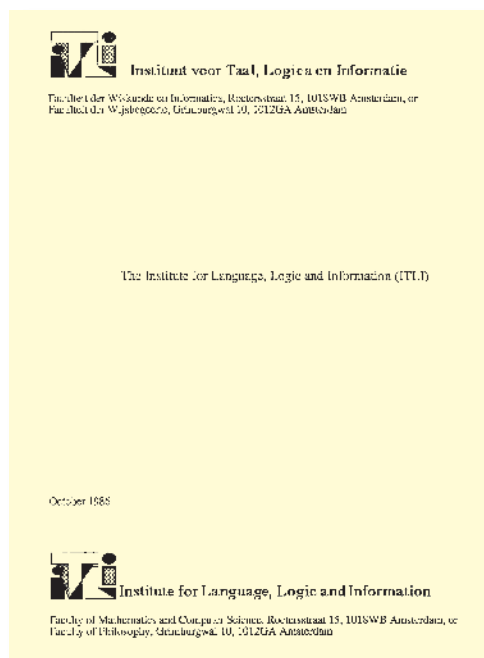
Structural Concepts in Relativised Hierarchies

Leen Torenvliet

the birth of the ILLC



Now that the broader intellectual environment worked, both in research and teaching, the issue of institutionalisation arose.



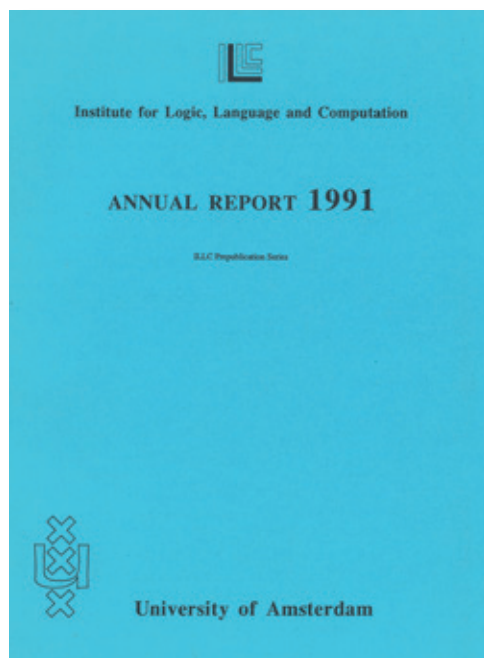
While the bottom-up growth since the 1970s ensured personal commitment and support from colleagues in a range of departments (philosophy, mathematics, computer science), both in teaching and research, it seemed time to create a more stable institutional setting that could protect these developments, and serve as a platform for broader ambitions and outreach. Ideas like this were floated many times in the early 1980s, e.g., by Peter van Emde Boas, that were partly inspired by the creation of a department of computer science at the time, which showed that new organisational forms were possible. Before ‘marriage’, however, came ‘engagement’.

The ITLI

In 1986, following Beth’s lead when starting the IGLO in the 1950s, a voluntary association was formed calling itself the ‘Instituut voor Taal, Logica en Informatie’ (ITLI, ‘Institute for Language, Logic and Information’), without official sanction or status, but based on a coherent group of staff in various ranks and their students who shared a number of goals. Mindful of Lenin’s adage that a political party is a mob with a newspaper, the ITLI produced a founding document, signed by Johan van Benthem and Martin Stokhof.

This text outlined several major goals, including: creating a stable research environment, running a teaching program in close connection with the research, setting up a graduate program, establishing a series of research reports, participating in major international publications, organising regular high-profile international events, and engaging in fund raising from national and European sources.

In the next five years, the ITLI functioned on all these fronts, as can be seen from five annual reports documenting its activities. Inside, organisation was minimal and informal, with an internal democracy



based on gatherings of the whole group. Some bureaucratic stability was provided by funds acquired from the Dutch national Network for Logic, Language and Information, subsidised by the Ministry of Education for setting up a national graduate program in logic. Jan Bergstra, a professor of programming research in the computer science department, and Martin Stokhof jointly defined the framework and conducted the negotiations with colleagues in Groningen, Nijmegen and Utrecht. For four years, the network organised and coordinated post-graduate teaching and research in semantics, logic, and theoretical computer science.

Establishing the ILLC

In 1991, the University of Amsterdam decided on a restructuring whereby departments lost a lot of their traditional powers. Henceforth, research was to be organised in dedicated research institutes, cutting across departments where useful, while parallel dedicated teaching institutes administered both traditional curricula and new interdisciplinary ones. These institutes would be evaluated on a five-year basis to keep structures flexible and let people decide freely, at regular intervals, where they thought they fit best.

This provided an opportunity for the ILLI community, which applied successfully for formal institute status. (In fact, the ILLC was the first institute at the University of Amsterdam that was established under the new regime.) With the support of the departments of philosophy, mathematics, and computer science, the *Institute for Logic, Language and Computation* started its activities, now officially recognised.

The name-change from ‘Information’ to ‘Computation’ reflected the accession of two new groups, the Programming Research group led by Jan Bergstra from computer science, and the Computational



Six former directors of the ILLC

from left to right:

Jeroen Groenendijk (2009)

Martin Stokhof (1998-2004)

Frank Veltman (2004-2009)

Yde Venema (2011-2016)

Leen Torenvliet (2009-2011)

Johan van Benthem (1991-1998)

Logo-image of the Institute



INSTITUTE FOR LOGIC, LANGUAGE AND COMPUTATION

Linguistics group led by Remko Scha from the humanities. Except for a few fluctuations in its participating groups, mainly due to external organisational changes, the current ILLC is this same institute, now into its 30th year of existence.

The aims of the ILLC were largely those of the ITLI, as can be seen in its founding documents. But it provided a more effective platform, partly through the greater autonomy of the institute format. Under a succession of directors, the institute has expanded considerably in terms of staff and students, with its international visibility and influence growing as well, by conducting research that continued to have

considerable impact and enjoy international visibility and recognition, but also by taking the lead in large international projects and organisations.

The structures put in place back then are still functioning today. They will be explained below, in tandem with the intellectual trajectory of the institute over the next almost three decades.

Setting up a university-wide institute between two big faculties, the Faculty of Science and the Faculty of Humanities, was not as easy as the preceding may suggest, given the remarkably resilient traditional divisions and attitudes in a university. In a way, structures like the ILLC defy

the laws of academic entropy, and there is a constant danger that things and people will return to their original, divergent locations, with various surrounding departments eager for a ‘Polish partition’. What helped in keeping the ILLC together were various factors. There was the coherence of the research program, there was the collegial cohesion of internal democracy, and also, the institute has always been appreciated as an important asset by successive presidents and rectors of the University of Amsterdam.

The ITLI was primarily an organisational entity, and the ILLC was like that in its early days, but that changed in 1999, when

The ILLC recipe: Take strong local tradition. Generously add camaraderie at global scale. Stir. Put in ability to ride the winds of change in university politics. Mix. Add dash of community spirit. Taste notes: vivid, crisp, success!

Erik-Jan van der Linden

the then newly established Faculty of Science was organised in terms of institutes that were given budget responsibility. This was a major change. Institutes now had to make annual budgets, for academic and non-academic staff, office costs, computers, web access and other infrastructure, and later on, also for housing. They were now responsible for long-term personnel planning, within general constraints set at the faculty level.

Growth became a much more tangible affair, it being the result of attracting external funding, optimising the participation in various teaching programmes, and so on. In the following years the ILLC used this opportunity to structure its internal opera-

tions more clearly and to increase its visibility to the outside world. It took a while for the Faculty of Science and its institutes to settle into the new structure, but the ILLC thrived in the new setting. Being one of very few university-wide research institutes is an honour, but it also carries its burdens. Institutional independence only occurred in the Faculty of Science: up to the present day the ILLC budget in the Faculty of Humanities is managed at the faculty's own central level. This has created an imbalance in teaching requirements and other working conditions between researchers at the ILLC appointed in the Faculty of Science, and those who belong to the Faculty of Humanities. Another consequence is that

the ILLC has less room to develop a long-term strategy for new appointments for its programs in the Faculty of Humanities. The task of running the ILLC on a day-to-day basis in two different organisational cultures makes the life of an ILLC scientific director definitely challenging, but also uniquely interesting.

A clear test, and a proven stumbling block for many interdisciplinary institutes, is the problem of the founding generation. Once the initial movers retire, what happens next? The ILLC has been exceptionally lucky in finding ever new administrative talent for its leadership, sometimes coming from researchers who might have thought they did not have it in them.

The ILLC's PhD community
is cohesive and vibrant whilst
allowing each candidate to
pursue their specific research
interests. Luca Incurvati

The list of directors illustrates that this rejuvenation has taken place, and it shows no sign of letting up: Johan van Benthem started in 1991, Martin Stokhof, who already functioned as deputy director when Van Benthem spent the spring quarters in Stanford, took over in 1998 and passed the baton to Frank Veltman in 2004, who was in charge until 2009, followed by Jeroen Groenendijk for a short period, and then by Leen Torenvliet, who was succeeded by Yde Venema in 2011, who in 2016 saw Sonja Smets take over.

One long sentence, one long sequence of dedicated scientific directors who have been fortunate to lead an institute that has left its mark.

But in a way this list is misleading. The ILLC has many other crucial positions in its research and teaching programs described below, all of them filled competently and energetically, first by members of the founding generation, and gradually also by the next generation appointed after them.

This may be a good place for making a point that some academics, who see all organisation and administration as an unnecessary evil, do not always appreciate. The success of the Amsterdam logic environment rests obviously on the quality of people and dynamics of their ideas. But its consolidation and progress also had a lot to do with choosing the right organisa-

tional structures to protect and foster these individuals and their ideas. The same point has been made about general intellectual history: universities are not just loose collections of individuals, they are also creative and historically remarkably resilient and successful, creative social inventions.



research organisation at the ILLC

The way in which research at the ILLC is organised reflects a bottom-up perspective: it is the internal developments within the relevant disciplines that set the agenda and that determine the organisational structure. This means a high degree of autonomy for researchers to define their projects and it requires an institutional structure that is sufficiently flexible to accommodate and facilitate changes.

This model is particularly suited for the kind of theoretical research at which the ILLC excels, even when less effective for governance of more applied research. And an additional advantage is that it does not attempt to define the remit of the ILLC. Such definitions tend to proceed in terms of ‘core’ and ‘periphery’. The identity of the ILLC, however, is not like that: it resembles a doughnut. When asked whether they felt that their kind of research was central within the ILLC, the large majority of all the PhD students that were asked that question during one of the annual rounds of interviews said ‘No’.

Programmes

Research at the ILLC is structured into three main programmes: *Logic and Language*, *Logic and Computation*, and *Language and Computation*. Within these programmes, individual researchers find their habitat, including professors with their PhD students. And they also are the home of various larger groups, often organised around grants that run for a number of years.

Although the scope of the programmes is wide, they are more than just administrative umbrellas. The various projects that constitute a programme have clear connections in terms of research questions and methodologies. They can be complementary in some respects, while overlap-

ping in others. These commonalities are explored and fostered through a variety of activities, from joint papers to shared supervision of Master students and PhD students. Also, the programmes run various colloquia in which ILLC researchers as well as researchers from elsewhere present their latest results. The exchanges that are facilitated by these colloquia serve an important role in establishing and maintaining the shared identity of the programme.

Themes

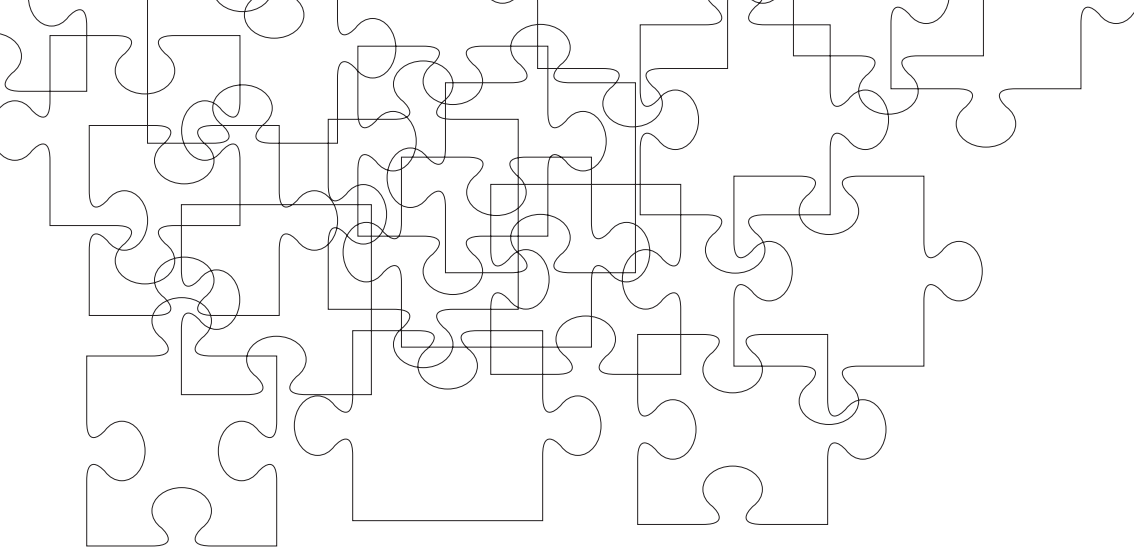
To create additional flexibility, topics of broad contemporary importance in the institute are organised into special themes that unite researchers from different programs for a period of time. Examples of such themes over time have been: *Games*, *Learning* and *Cognition*. The creation of these themes is the outcome of a bottom-up process anchored in actual research activities and emerging concerns in scientific communities. The games theme was a natural extension of results in natural language semantics and epistemic logic to interactive multi-agent scenarios, while games also played an important role in the mathematical logic research. Likewise, learning had turned out to be a shared concern in many parts of the ILLC, a central question being how formal systems come into actual effective use. And finally, the cognition theme reflected a growing awareness in the theoretical ILLC commu-

nity that actual data about human performance do not represent an irrelevant ‘comedy of errors’, but speak to the heart of what logic as a relevant study of reasoning should be concerned with.

Themes can also be fuelled by a desire to establish new outreach of the ILLC: in the case of games the connection is with game theory in mathematics and the social sciences, in the case of learning with the information sciences and statistics. And sometimes there is the practical motive of wanting to be where the action is: the cognition theme definitely also had something to do with the exciting new developments in modern cognitive science.

From a high-level conceptual point of view many commonalities can be defined that link research projects carried out in the three programmes. But it is only when there is an actual need from within a number of projects to investigate a shared set of issues that it makes sense to create a research theme and devote resources to it.

In some cases, such as the *Games* and *Learning* themes, the primary need to start investigating them came from within the ILLC community, since these topics were emerging spontaneously within several programmes, and merited sustained attention. In the case of *Cognition*, it was a perceived opportunity to further develop links with disciplines outside the ILLC,



By defying traditional university divisions, the ILLC has fostered fresh, sometimes unexpected connections and infused new life into research agendas of established disciplines. Krzysztof Apt

and a fascination that even theorists can feel for engaging with empirical facts, that provided the initial impetus.

Collaborative research

The style of research at the ILLC also reflects some major changes that have been taking place over the years. While the basic skills for research still involve individual thinking and scholarship, projects came to involve larger groups, as reflected in a fast-increasing number of co-authored papers emanating from the institute. These are journal papers, contributions to books, and in some cases chapters of dissertations. Research is increasingly becoming a social endeavour, and the institute functions as a

guild where students learn from experts and work in what may be compared to ateliers of established artists.

External funding

Collaborative research is conducted in multi-person, multi-annual research projects. These are externally funded, by national and European funding organisations. ILLC researchers were early beneficiaries of the funding mechanisms that were put in place on national and European levels since the 1980s. In the Netherlands, the national research funding organisation NWO initiated a re-organisation of its funding portfolio under the slogan ‘focus and mass’. The

goal was to introduce and facilitate collaborative research projects, which were already mainstream in the natural sciences and life sciences, also in the social sciences and humanities, and in those natural sciences disciplines, such as mathematics and theoretical computer science, which hitherto had also been of a rather individual nature. This required a fundamental change in mind-set and research practices in these areas, one that took a while to be accomplished.

But it harmonised very well with the ILLC culture of cross-disciplinary collaboration, a fact which gave ILLC researchers a definite competitive advantage.

As information processing has become the domain of computing machinery, Turing machines, algorithmics and quantum computing have become central to ILLC research.

Leen Torenvliet

The policy change at NWO followed the introduction of collaborative project funding schemes at the European level that started in the 1980s. Initially these European funding schemes had ample opportunities for basic research, though later the emphasis was increasingly on applied research. Opportunities at NWO increased when it started the ‘Vernieuwingsimpuls’ funding scheme in 2000. And when the European Research Council was launched in 2007, ILLC researchers were well-prepared to apply there.

Over the years ILLC researchers have been very successful in the acquisition of external funding made possible by these new realities at national and international levels.

The next chapter provides some concrete examples of how these new funding streams have enriched the ILLC: it describes four projects that have played an important role in shaping the ILLC’s research environment in its first two decades.





four key projects



Many smaller- and larger-scale research projects have been important to the ILLC over the years, and it is impossible to do justice to them all. In this chapter we describe the main characteristics of four projects that have been of particular importance for the development of the institute in the early years.



DYANA came with *consortium partners*, *site managers*, *allocation of person months*, *risk analysis*, and lots of *deliverables*.

Back then all of this was unheard of in the humanities.

Frank Veltman

The DYANA-project Adding a European dimension 1989-1995

The DYANA-project ran in two phases: one from 1989 to 1992, and a follow-up from 1992 to 1995. DYANA was funded by the European Union as an Esprit Basic Research Action. It was a large project, with seven partner institutes: The Centre for Cognitive Science, Edinburgh; the Institut für maschinelle Sprachverarbeitung, Stuttgart; the Seminar für Sprachwissenschaft, Tübingen; the Centrum für Informations- und Sprachforschung, München; the Research Institute for Language and Speech, Utrecht; the Department of Linguistics and Philosophy, Oslo; and the ILLC,

Amsterdam. Frank Veltman was the ILLC's site manager during the first phase of DYANA, and its project leader in the second phase.

DYANA was the first large-scale collaborative research project in the area of natural language semantics in which researchers of the ILLC took part. It provided them with unprecedented opportunities to collaborate extensively with researchers in other major centres in Europe and to attract talented PhD students and post-docs. It also increased international visibility. The distinct influence of Amsterdam-style dynamic semantics is definitely also due to the opportunities provided by DYANA, and so are the sus-

tained coalitions with European institutes in follow-up initiatives beyond DYANA.

Dynamic semantics was the core contribution of the ILLC to the DYANA-project, notably through the contributions of Veltman, Groenendijk, Stokhof, Beaver, and Dekker. The further development of the dynamic perspective and its formalisation formed the core of their work, along with applications to such central empirical topics as quantification and anaphora, presuppositions, default reasoning, and so on. DYANA also triggered a number of related research lines: important work was done on categorial grammar and type theory, discourse coherence, epistemic modalities, tense and aspect. This work



Linguists and philosophers learned about programming and computer scientists about pronominal reference and generalised quantifiers. It was structured interdisciplinary action. Jan van Eijck

includes contributions by local associates such as Herman Hendriks and Jaap van der Does, and international visitors such as Gennaro Chierchia, Friederike Moltmann, Anastasia Giannakidou and Craige Roberts.

The cooperation with researchers in Edinburgh and other centres formed the nucleus of a number of other types of cooperative endeavours, notably the *Foundation for Logic, Language and Information* (FoLLI), the *European Summer Schools in Logic, Language and Information* (ESSLLI), and the *Journal of Logic, Language and Information*. More about these structures and the role of the ILLC in them can be found in the next chapter.

The Parallels-project Increasing interdisciplinary connections 1991-1995

The PARALLELS project, fully titled ‘Semantic Parallels in Natural Language and Computation’, was led by Jan van Eijck, and was funded by the Nationale Facilititeit Informatica (National Informatics Facility) as a way of boosting fundamental research in the information sciences.

This project started from the idea, developed at the ILLC over a decade by then, that the many striking syntactic, semantic, and even pragmatic parallels between the structure and functioning of natural languages and designed computer languages

justified further research, and indeed joint development. PARALLELS was administered at the ILLC, but also involved other sites nation-wide, in particular, the University of Utrecht (Albert Visser, Michael Moortgat). It employed 2 postdocs and 2 PhD students, and equally importantly, it had an exceptionally generous budget for inviting foreign visitors, all of which resulted in a large number of (joint) publications and international scientific events.

The PARALLELS project played an important role in putting several interfaces between natural and formal languages on the map. One strand were analogies between dynamic semantics of natural language, logics of information flow, and the

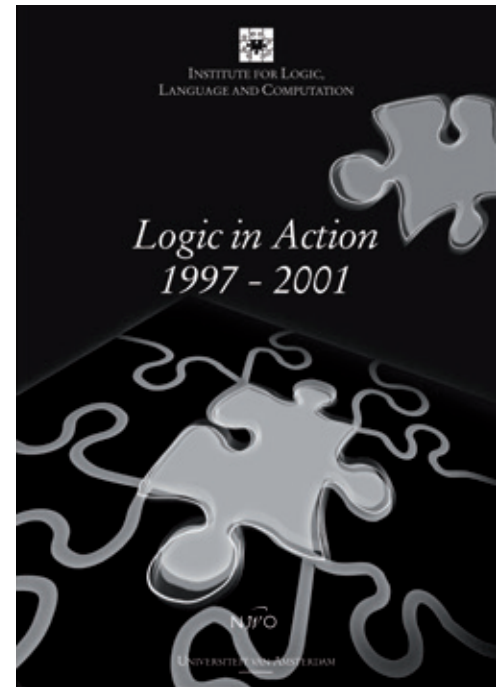
At the time I greatly admired the generosity of Johan van Benthem who provided his Spinoza prize money for widening the scope of the institute and offering new opportunities for younger colleagues and students. Sijbolt Noorda

semantics of imperative programming languages, which turned out to be expressible in new logical and algebraic frameworks including connections with dynamic logic and process algebra, which were already well-established parts of theoretical computer science.

Another important line in the project was the study of the categorial structure of natural language, both in general and for the special category of linguistic quantifiers, in tandem with type theories used in the foundations of mathematics and computation. The project contributed actively to the development of so-called ‘resource logics’ that merge proof-theoretic and computational considerations, which fed

into the still flourishing area of substructural logics, but also led to the study of new decidable fragments of existing logical formalisms.

The project had a distinctly international flavour, leading to collaborations with colleagues in London (Dov Gabbay), Budapest (Hajnal Andréka and István Németi) and the US (Vaughan Pratt, Dexter Kozen), many of which have persisted until today.



The Spinoza-project ‘Logic in Action’ **Adding new research lines** **1996-2001**

A third key project, and a boost to the ILLC, had a different origin, namely, the Spinoza Award for Johan van Benthem. The Spinoza Awards are the highest awards in the Dutch science system, as a recognition of a lifetime oeuvre. Van Benthem used the award to start the project Logic in Action, that ran from 1996 to 2001, and that helped extend the range of ILLC research to include connections between logic and game theory, computational logic, and the design of new logic courses.



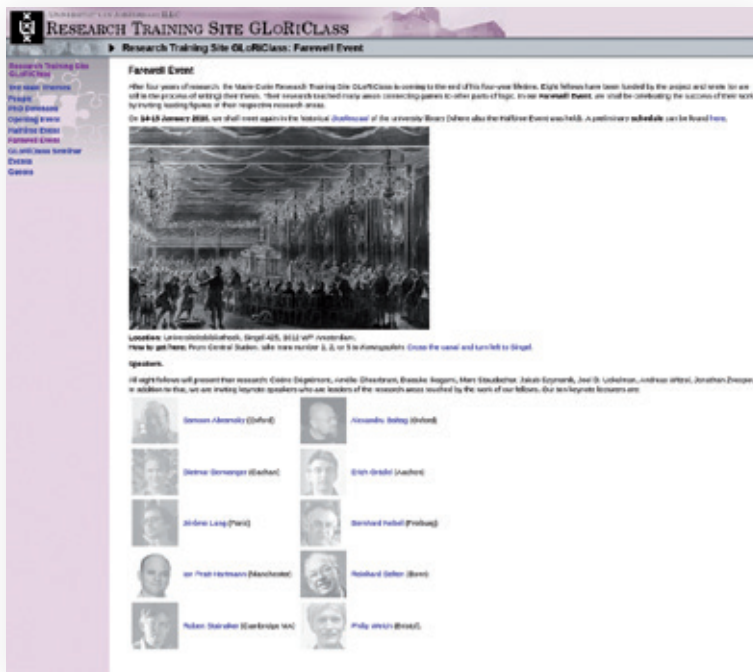
Logic in Action introduced two new research lines to the ILLC. One was interfaces between logic and games, a continuation of the dynamics research at the ILLC to include social interactions between agents that process information, pursue goals, take decisions, and act in the presence of others doing those same things. This new line, led by Paul Dekker and Yde Venema, led to lasting contacts with game theorists in economics, but also with linguists and computer scientists, since games are also a natural extension of the traditional notions of communication and computation.



A second new theme, led by Maarten de Rijke, was computational logic, the implementation of logical systems as working computer systems, and the design of new languages and algorithms for general computational tasks inspired by state-of-the-art ideas from logic.

Finally, a third project, led by Jan van Eijck, focused on didactic innovation, resulting eventually in the internet course 'Logic in Action' (cf., <http://www.logic-in-action.org>) developed in Amsterdam and used in many places worldwide, including Beijing and Stanford.

A lasting legacy of the SPINOZA project was the granting of permanent positions to its project leaders, thanks to the generosity and vision of the Faculty of Science and the Faculty of Humanities.



GLoRiClass produced researchers who were equally conversant in the basic dialects of game-based reasoning: model theory, computational complexity, language evolution, and social choice. Benedikt Löwe

The GLoRiClass-project Training a new generation 2006-2010

A fourth important large project at the ILLC was based on a new opportunity provided by the European Union in the Marie Skłodowska-Curie programme as an Early Stage Research Training Host Fellowship (MEST-CT-2005-020841). The heart of the GLoRiClass-project, initiated and led by Benedikt Löwe, which ran from 2006 to 2010, was a group of eighteen fellows and associated fellows who explored the ILLC-wide theme of games in many directions. This remarka-

ble set of young talents, whose names can be found at <http://projects.illc.uva.nl/GLoRiClass/>, co-supervised by various ILLC professors and international colleagues, considerably pushed the boundary of the interface between logic, game theory, computer science, and other fields. The resulting dissertations explored new logics for reasoning about games and analysing fundamental game-theoretic results and extended the role of games in set theory and hence the foundations of mathematics. In addition, these projects developed new theories about games as a generalised form of interactive computation, explored

new uses of games in understanding the communicative function of natural language, and also created links with empirical fields such as cognitive science and computer games.







the ILLC as an organisational force

A striking feature of the ILLC right from the start was its role as initiator and participant in larger national and international organisational ventures. This reflects not only the scientific standing of the institute, but also a strong belief that cooperation and dissemination are key factors in making academic fields thrive and progress. The ILLC recognised the importance of this already at an early stage.

ONDERZOEKSSCHOOL VOOR EEN HOOGST INDIVIDUEEL VAK

OOK LOGICI ETEN MET MES EN VORK

Het is een heet leed en pijnlijk schoon kamertje in het wiskundegebouw van de Universiteit van Amsterdam. Er ligt vijfvel geen papierje. Twee Appletjes staan op standby, hun schermpjes gloeiend maar gevend om op ieder moment wakker te springen. Typisch een werkvertrek van iemand die zich geld gevind aan het systematisch ordenen van de grens. En dat klopt, want het beschreven onderzoek is de commandobrug van de landelijke Onderzoekschool Logica, een samenwerkingsverband van vier universiteiten dat het vaandel van L. E. J. Brouwer en de andere grote Nederlandse logici verder moet dragen. Deze week vrijdag wordt, met een kring, een drankje en enkele hoge gasten in het Roetersexpansiecomplex de officiële aftrap gegeven voor de school, die informeel al een tijdje draait.

JAAK PRIESTER

"Zakelijk manager strategie secretaria," is het beroep van dr. E. J. van der Linden (32), die noch wiskunde, noch informatica is maar computerlogica en daarom de persoon bij uitstek om zich bezig te houden met de introductie van de Nederlandse logica. Het vakgebied heeft immers van de computerrevolutie een snelle opkikker gekregen. Van der Linden beweegt zich in de wereld van het *Intuition for Logic, Language and Computation* en de *European Foundation for Logic, Language and Information*, organisaties die sinds de laatste benamingen gewoos aan de Plaatsje Mathematische gevestigd zijn, in het hoofd van kamertje. Het boekje aan samenwerkingsovereenkomsten, dat, van der Linden is coördinerend aan onder zijn hoede heeft, wordt deze week aangevuld met iets dat in het verleden ontvond Onderzoekschool Logica later.

Kinderchooristen
Onderzoekschool, men weet het, zijn instituten die assistentie in opleiding begeleiden naar hun promotie. In de regel zijn het samenwerkingsverbanden tussen meerdere universiteiten, soms aangevuld met een halvervoortzette instellingen. Onderzoekschool staan eigenlijk nog in de kinderschoenen. Twee maanden geleden heeft de Koninklijke Nederlandse Akademie van Wetenschappen, de plechtstatige instelling aan de Amsterdamsche Kerkensingel die over dat soort dingen gaat, er voor het eerst een aantal verleid. Zo'n erkenning geldt voor vijf jaar en werd aan signatuur van de twaalf aangevuld verleid. Alleen een onderzoekschool voor materieleonderzoek in Groningen viel niet in de prijzen. Voor drie van de erkende onderzoekschool is de Universiteit van Amsterdam de 'bevoordel'. Behalve de

Onderzoekschool Logica gaat het om het Amsterdamse *Lodewijk Janmaat* voor Informatica en de *Onderzoekschool Bouwman* Amsterdam. De EVA participeert ook in onderzoekschool voor natuurwetenschappen en voor astronomie. De erkenning door de akademie is vooral een papieren operatie; de minister zoekt er, tot idetovelling van veel bezwaarden, voorafslag geen special geld voor uit. De onderzoekschool, of leerer de samenkomsten die de onderzoekschool vormen, dienen voortloop zelf hun financiële hoeden te deppen. Het brengt met zich mee dat het nog wel even zal duren voordat er voor een onderzoekschool een profiel zal worden overgenomen, met een portier en een concierge. Onderzoekschool blijven voortloop samenwerkingsverbanden, gevrijd over de deelnemende universiteiten.

Verdergaand
De Onderzoekschool Logica is nu'n samenwerkingverband van vier universiteiten. Behalve de EVA zijn dat de universiteiten in Groningen, Nijmegen en Utrecht. Ook het in Amsterdam gevestigde Centrum voor Wiskunde en Informatica werkt mee. Verdergaand wordt de samenwerking tussen de ver-

schillende instellingen is dat er ook wordt samenwerking tussen verschillende faculteiten. Logica is immers een samenwerking van wiskunde, informatica, wijsbegeerte en letteren. De overbrugging, kortom, van de oude kloven tussen alle, beta en gamma.
Dat laatste is een van de grote charmes van logica voor prof. dr. J. F. A. K. van Benthem (43), hoogleraar wiskundige logica en wijsbegeerte der wiskunde aan de Universiteit van Amsterdam. Genetijk vader van de onderzoekschool, en daarmee eigenlijk ook van logica als afzonderlijke discipline, met zo'n credent wil hij zich niet laten aanspreken. Maar hij is wel goedvoerd als directeur van de school. "Niet moeilijk," docert hij, terwijl er diepe denkrimpels in zijn hoge wiskundevoetbedel verschijnen, "in logica een exact wet in de zin dat dezelfde precieze wordt suggererend die je ook in de wiskunde of de natuurwetenschappen aantreft. Maar het is niet typisch beta omdat het niet over typische beta-onderwerpen gaat, maar over menselijk redeneren, respecties van taal. Dat is wel een van de aantrekkelijkere kanten van logica."

Ook al begint de Onderzoekschool Logica pas deze week vrijdag aan zijn officiële bestaan, er werken nu al zo'n zeventig aan 'em' ('niet-universitaire aan''). Het grootste deel van hen is afkomstig van de Universiteit van Amsterdam, die met belangrijke hoogleraren als L. E. J. Brouwer en E. W. Beth in het verleden een niet min te verwaant stemmel heeft gedrukt op het vakgebied - wij Johan van Benthem in alle beschouwend grag 'bestaadraken' - ralla met steeds doet. Weliswaar naar Brouwer (1881-1966) te boek als wiskundige en Beth (1908-1964) als filosoof, maar ze waren toch in de eerste plaats logici. "Van de laatste decennia wordt logica als zelfstandige discipline gezien," zegt Van Benthem. "Die ontwikkeling is nog gaande en je kunt de oprichting van de school zien als een stap daarin. Ik denk dat de meeste logici nog niet zouden durven beweren dat hun vakgebied gelijkwaardig is aan wiskunde of wijsbegeerte, maar de inhoud van het vak wordt steeds breder, evenals toepassingsgebied. Logica is zo langzaamhand een grote vis in het academisch landschap."

De toepassingen zijn vooral te vinden waar menselijke taal, menselijk redeneren en de computer elkaar raken. Moderne overtuigingen zoals kunstmatige intelligentie zijn meer scherplichtig

aan de logica en hebben het vakgebied ook verlost van het sinter abstracte imago. Niet langer doet de logica zich circulerend voor als een bibliotheek van dikke boekwerken waarin op noodgrondelijke wijze en met veel ondoel van formules wordt beweerd dat 1+1 gelijk is aan twee, maar er zijn zelfs verkoopbare producten op de markt op basis van logica: geavanceerde 'expert-systemen' voor de computer, en maar een te noemen.

De producten zijn er vooral gekomen omdat de logica zich de laatste decennia interesseert voor een domein dat bij uitstek aan de afkantschouwer 'menselijke taal'. Er blijkt aan taal veel meer exact te bevesteren dan de traditionele taal-onderzoekende benadering. Computeringetiek, alle-informatie en aanverwante vakken zijn er de kinderen van. Het wat proficiënten als de letterkundigen van signatuur zijn er op het eerste gezicht met als wiskundige verhandelingen: formules, symbolen, *Reflexie* met taal, kortom.

Reflectie
Logica levert reflectie op, een soort algemene instructies over het soort werkvoegen dat door andere vakken worden gebruikt. Dat kunnen soms direct overbreken anderen zijn, maar de filosofie ook heel algemeen zijn. Neem die beroemde stelling van Gödel: die in het reusbaar van logisch nadenken over wat wiskundig bewezen is en ontdekken wat daarvan de mogelijkheden en onmogelijkheden zijn. Logica levert allerlei modellen en begrippen die in andere



Van Benthem (links) en Van der Linden: 'Janken over doden...'

GESCHENK
Een van de gasten die de Onderzoekschool Logica bij haar openingsoffice op vrijdag 20 november ontmoet, is de Russische logicus prof. dr. S. Artamonov. Hij zal onder andere spreken over de problemen waarmee het wiskundig bewijs ontstaat in de voorwaarde 'aanpak'. Uite te kampen heeft. Goede opmerkingen treden weg, en er is groot geluk aan Brouwer en andere hulpverleners. De onderzoekschool zal, samen met wiskundige afgevoerd van Dierstra en Kluwer, Artamonov daarom voor enkele duizenden gelden aan boeken aangevuld met de Mathematische Instituut. 'Meestal bring je een geschied bij een openingsoffice,' zegt Erik Jan van der Linden van de Onderzoekschool Logica. 'Wij vonden het leuk om een geschied weg te geven.'

Vervolg op pagina 10

SYMBOLISCHE LOGICA

Logica, het is op de meest onverwachte plekken te vinden, vaak in de vorm van een jauntje. Ergens in de officiële erkenningsovereenkomst van de Onderzoekschool Logica duikt bijvoorbeeld het volgende tabelletje op van de monochromatische de doelmakende instellingen in het samenwerkingsverband willen stellen.

1992-1993
LIDEN VAN DE SCHOOL

| | | | | | |
|---------------|------------|------------|------------|-----------|-----------|
| CHW | 1,6 | 1,1 | 1,5 | 8 | 15 |
| Witteveen | 1,5 | 1,1 | 1,7 | 5 | 8 |
| Stroomer | 1,4 | 1,1 | 1,8 | 5 | 15 |
| Brecht | 1,3 | 1,8 | 1,2 | 5 | 11 |
| Ind | 1,5 | 1,8 | 1,4 | 2 | 10 |
| TOTAAL | 7,4 | 4,9 | 6,8 | 17 | 70 |

Het is het soort tabelletje dat in vroege universitaire notities staat en waar veelal gewoon overheen wordt gelopen. Maar als je het goed bekijkt is de onbetrouwbare conclusie: dit tabelletje klopt helemaal niet! De totale stemmen niet in de vroege vroege overeen met de optelling van de getallen die er boven staan! Nadere bestudering leert dat er een dwarsmaat is gemaakt, die toch typisch logisch is. Wie de lijst niet moet aangevuld voor een zinrijke bij de Onderzoekschool Logica... De oplossing staat op pagina 17.

Folia 14 - 20 november 1992 - pagina 9

National AIO-network and research school

In 1987, the Dutch Ministry of Education, acknowledging an increasing need for collaboration between Dutch universities, especially in areas that locally were rather small, announced funding for national networks for PhD-training. As described before, the ITLI jumped at the chance and started setting up such a network and organising the support from other universities.

The efforts resulted in the 'AIO-Netwerk voor Taal, Logica, en Informatie' ('PhD Network for Language, Logic, and Information'), which was recognised and funded by the Dutch Ministry of Education for



a 4-year period (1988-1992). During that time the network organised and coordinated post-graduate teaching and research in semantics, logic, and theoretical computer science. The ILLC administered the network and provided the director.

The temporary PhD-networks were precursors of what was intended as a more permanent way of organising post-graduate training and research, in so-called Landelijke Onderzoekscholen ('National Research Schools'). The framework for these schools was developed by the *Dutch Royal Academy of Sciences* (KNAW), which was also in charge of the accreditation of the schools and of their periodic evaluation. The ILLC took the lead to transform the

successful PhD-network into a research school. The *Dutch Research School in Logic* (OZSL) was accredited by the Dutch Royal Academy of Sciences in 1992. It was the first national research school in the humanities.

These organisational activities not only served the field internally, they also made it visible to the rest of the academic world: university boards, academies, and the Ministry of Education took notice and recognised the strong position of Dutch logic, nationally and internationally. This kind of recognition is only won by academic achievements in tandem with organisational and administrative exploits such as these, and for that reason the ILLC has

always been a driving force behind such initiatives, at the national level, but also internationally, as the following shows.

European FoLLI and ESSLLI

During the 1980s, scientific contacts between researchers at the ILLC and their counterparts in various other centres, in Europe and beyond, were intensified, and the ILLC became involved with all kinds of exchanges, from individual research visits to joint PhD supervision, workshops and conferences. Over time, this loosely knit community felt the need for a more formal organisation that would increase its visibility and influence.



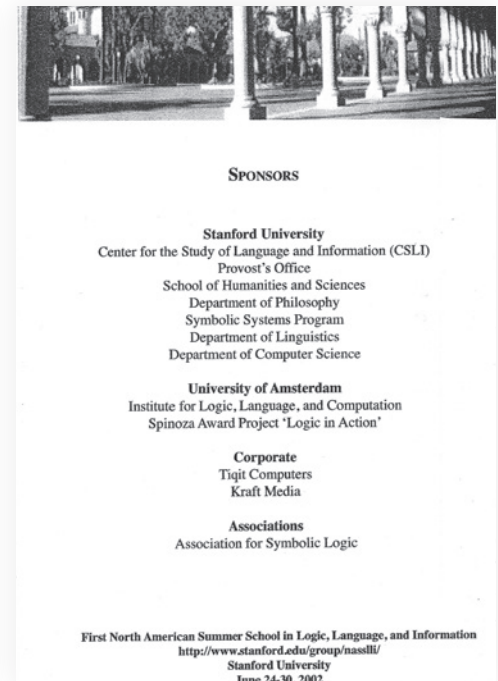
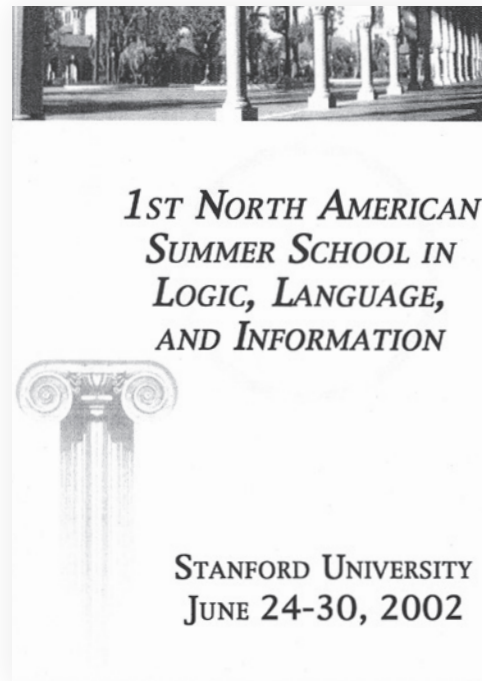
Initially, the move to set up a container of the various activities was instigated by the desire to make sure that at the European administrative level the interdisciplinary nature of logical research would be recognised.

To that end, a number of key researchers and research institutes from all across Europe joined forces in creating the *Foundation for Logic, Language, and Information* (FOLLI). This foundation was to be a platform for training and dissemination, and for representing logic in the ILLC-spirit as a distinct field of research. It aimed to do so by coalescing existing activities, and by initiating and stimulating new ones. FOLLI started with a wide portfolio of activities including a series of outreach

conferences on logic, language and information, held in Autrans, 1992, and Espinho, 1995, which were funded by the European Science Foundation. An important initiative was the establishment of a new journal: in 1992, FOLLI initiated the *Journal of Logic, Language and Information*, with Peter Gärdenfors as its first editor-in-chief. The journal quickly became an important voice and is today regarded as one of the leading journals for interdisciplinary research in the field of logic.

A FOLLI book series was started, as well as a ‘clearing house’ for logic publications that was to turn later into Dov Gabbay’s well-known College Publications publish-

ing service to the international logical community. But FOLLI’s most important and most lasting activity is its adoption of an initiative by Frans Zwarts, who organised a summer school in Groningen in 1989. This proved an immediate success and showed that there was a community of international students and teachers for whom logic, language and information was a natural niche. The yearly *European Summer School in Logic, Language and Information* (ESSLLI) has travelled all over Europe, and has consistently engaged a large number of participants, also from outside Europe. The summer schools consist of a mix of courses at various levels, workshops, and lectures. They provide graduate and



post-graduate students with unique opportunities to get basic instruction in fields that are new to them, and be updated with the latest trends and developments in their field of specialisation. The instructors get valuable feedback on the materials that they present from an engaged and high-level audience. And students and teachers can battle it out in a soccer match...

For many students at the ILLC these summer schools are an integral part of their socialisation into the international community.

Researchers from the ILLC have played a key role in shaping ESSLLI and setting up FOLLI. From its inception in 1991 to 2004 the FOLLI secretariat was located at the ILLC, and ILLC-researchers have consistently been present at the FOLLI-board.

Many of them have given courses and workshops at various ESSLLI-instalments, and they have played a key role in the organisation of the summer schools: Paul Dekker chaired the standing committee of ESSLLI from 2007 to 2017.

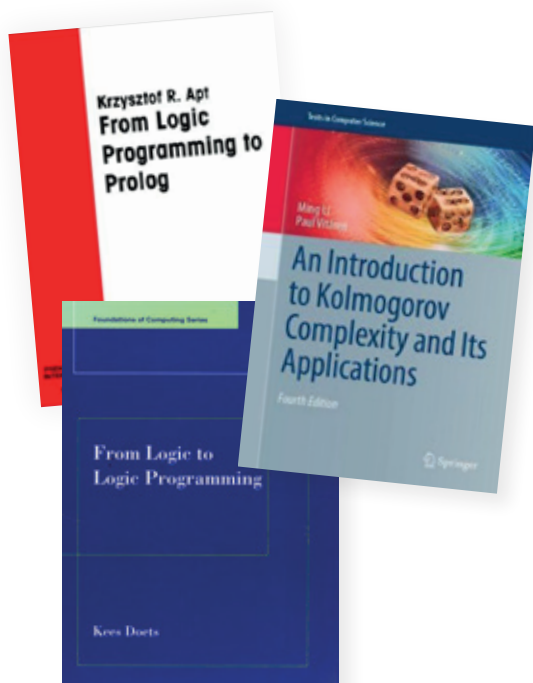
And wider NASSLLI, EASLLC

The success of the ESSLLI summer schools has spurred similar events in other parts of the world. The bi-annual *North American Summer School in Logic, Language, and Information* (NASSLLI) started at Stanford in 2002, with a similar goal and similar structure as ESSLLI. Since 2010, NASSLLI is organised under the auspices of FOLLI.

The *East-Asian School on Logic, Language and Computation* (EASLLC) started in 2010, and it, too, is organised under the FOLLI-umbrella.

research trends in the 1990s

Research themes following the founding of the ILLC were a consolidation and extension of what had worked well in the 1980s, with new approaches arising in various areas as well.



Logic, mathematics and computation

In the foundations of mathematics, linear logic entered as a new approach to constructivism, with broader links to substructural logics in the analysis of categorial grammars.

Provability logic continued to expand in an extensive cooperation with Georgian and Russian colleagues, drawing in new local students who would later fan out over academia, such as Rineke Verbrugge. Another new influence was more general proof theory, not necessarily oriented toward intuitionistic logic, which would culminate in Troelstra's book *Basic Proof Theory* with Helmut Schwichtenberg.



Research in modal logic considerably extended its agenda by incorporating interfaces with algebraic logic in the work of Yde Venema, Maarten Marx, and others, in a long-standing cooperation with colleagues in London and Budapest. It also acquired new interfaces with computer science in the work of Maarten de Rijke on richer modal formalisms for applications, the work of Edith Spaan on complexity of modal logics, and that of Van Eijck, Van Benthem and other colleagues on contacts with programming languages and process algebra.

But newer interfaces of logic and computer science emerged also during this period. The ILLC saw an active collaboration

on the foundations of logic programming between Krzysztof Apt and Kees Doets, witness their companion books *From Logic to Logic Programming* and *From Logic Programming to Prolog*. There was also a vigorous development of structural complexity theory in the work of Leen Torenvliet, and of the broad field of Kolmogorov complexity in the work of Paul Vitányi, including connections with information theory. The latter line led to one of the most widely cited ILLC publications over the last decades: *An Introduction to Kolmogorov Complexity and its Applications* by Paul Vitányi and Ming Li. This work also fit very well with the foundational interests in information, computation and learning introduced by Pieter

Being a PhD student at the ILLC was like a long ESSLLI but with exams: intense, demanding, diverse, engendering joy and pride in belonging to an exciting, interdisciplinary community. Maarten Marx



Adriaans, entrepreneur and graduate student, who would later become a professor of Learning Systems. A final landmark from this period is Michiel van Lambalgen's philosophical and logical analysis of algorithmic randomness, resulting in some of the basic tools of this field of research in between computability theory and probability theory.

Logic and language

Intensive work was done on a wide range of topics in the Logic and Language project of the ILLC in 1990s, including traditional strengths from the 1980s such as categorial grammar, now linked more closely to algebraic logic and substructur-

al logics. Two lines with a significant influence today, both within the ILLC and elsewhere, are dynamic semantics and data-oriented parsing.

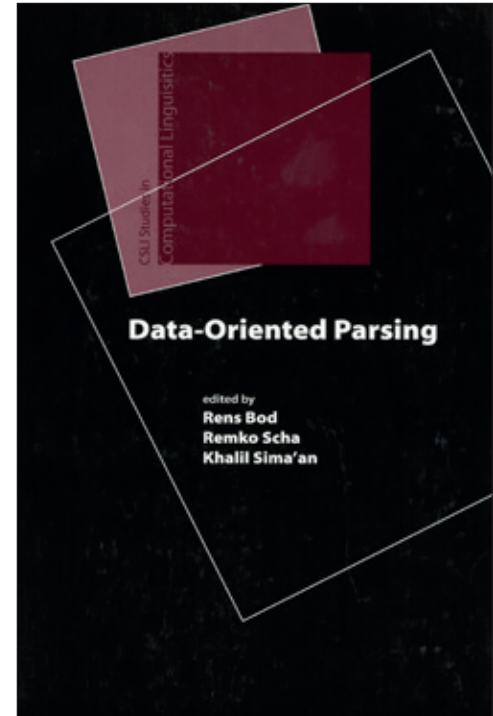
Dynamic semantics

Veltman, Groenendijk, Stokhof and Dekker, along with a number of PhD-students and postdocs (Aloni, Mastop), worked throughout the 1990s on the further development of dynamic semantics as a new way of thinking about natural language meaning, bringing together the initially different strands of information update and dynamic predicate logic. Dynamic semantics turned out to have repercussions, not just at a theoretical-conceptual level, but also from an empiri-

cal-descriptive point of view. Integrating elements of semantics and pragmatics as traditionally conceived in its conception of meaning as conveying information, the main function of natural language use, it showed that logic provides adequate tools to deal with a wide range of phenomena in natural language in an integrated way. This perspective bridged discourse and conversation studies on the one hand, and logics of social interaction on the other.

After the DYANA-project, the ILLC-research in dynamic semantics continued in the project 'Sources and Streams of Information: Towards a Logical Analysis of the Dynamics of Discourse'. It was funded

Based on hierarchically structured representations in the brain, DOP inspired work in statistical language processing, but also in computational musicology, and other digital humanities. Rens Bod



by the Dutch Science Foundation (NWO), and had as its partners the Department of Philosophy, Utrecht University (Albert Visser and Cees Vermeulen) and the Department of Linguistics, Katholieke Universiteit Brabant (Reinhard Muskens). The programme employed various post-docs (among whom David Beaver) and PhD students, and ran from 1997-2001. It was the first large scale project in the humanities ever to be funded by NWO, and served as a model for the development of the NWO funding portfolio in this area.

But semantics research at the ILLC also contained other internationally influential strands. The categorial grammar and natural language tradition from the 1980s was continued by Victor Sánchez Valencia

in the program of developing a ‘natural logic’ for reasoning directly with linguistic forms, and by Herman Hendriks on flexible categorial semantics and type theory. Another prominent line, then and now, is the central methodological role of compositionality in designing semantics for natural and formal languages, championed at the ILLC by Theo Janssen, and returning in ever new settings.

Data-oriented parsing

A major innovative feature of logic and language research at the ILLC in the 1990s was the development of data-oriented parsing (DOP). This was one of the first approaches in computational linguistics that abandoned the then prevailing rule-based paradigm, where computational

linguists basically implemented and tweaked the kind of grammars that linguists produced in their study of natural languages. Although that paradigm had produced interesting results and applications, it faced a fundamental problem of scaling.

The DOP-approach was radically different: instead of taking rules as basic elements of a computational natural language system, it proposed to analyse linguistic material in terms of the probabilities of words and phrases co-occurring, where traditional grammatical tree structures played an auxiliary role in setting up the data structures. Those probabilities can be determined only on the basis of a large amount of data, of actual linguistic material.



This puts large corpora at the centre of natural language processing. But there is also an important more cognitive interpretation of the DOP-paradigm shift. Expert language users do not just use rules anew every time, but can first, or simultaneously, do memory-based pattern recognition: that is, their past experience is as important as their skills in current rules or strategies. This memory-based perspective applies widely, not just to language: reasoning seems to work this way as well, and when all is said and done, so do the professional practices of logic researchers...

DOP was originally developed by Scha. Further development was taken up and continued by Rens Bod, Khalil Sima'an and others. It has played a major role in

changing the nature of research in computational linguistics, opening up new interfaces between logic and probability, which over time have become a major presence at the ILLC, where research had been more purely qualitatively-oriented before. Core elements of the DOP-approach were also applied in the analysis of music, and in modelling expert cognitive practices.

Social themes

Another new development in the 1990s with later repercussions was the joining of the ILLC by the group of Michael Masuch and Rob Mokken (the author of a classic graph-theoretic study of social power networks in the Netherlands) from the Faculty of Behavioural and Social Sciences,

which studied the high-level principles of behaviour of social organisations such as firms with tools from logic. While this project ended in 2004 with the retirement of Masuch, it brought in a number of excellent staff with a new kind of background, such as Maarten Marx and Jeroen Bruggeman, and Jaap Kamps, who still represents this topic at the ILLC. Together with the game-theoretic interests that were put on the map in Van Benthem's SPINOZA-project, it prepared the ground for the developing social, multi-agent interests in research at the ILLC.





education

The background is composed of several large, overlapping triangles. The top section features shades of green, from light to dark. The middle section is dominated by a large black triangle, flanked by dark grey and dark blue triangles. The bottom section consists of various shades of blue and purple, ranging from light lavender to deep navy.

Research at the ILLC has always been pursued in tandem with teaching, the way things go in all good university environments. As it developed, the ILLC expanded the regular courses taught by its staff, but also developed a number of new initiatives along with its research development.

**'ANYONE WHO IS INTERESTED IN LOGIC
WILL KNOW WHY I CHOSE AMSTERDAM'**



everywhere, but coming here was absolutely necessary to discuss everything else and everything else.

As the moment I carry out a PhD project within the Department of philosophy called "Space-time and modality". The project focuses on topics in the philosophy of time within the context of the Special Theory of Relativity, as well as on the logic of time in the light of this theory. For example, what can the notion "future" or the term "will" mean when a future event from one point of view can be a past one from another?

How are some of the reasons why I wanted to pursue my studies in Amsterdam. You are surrounded by amazing people here all the time. As some I can no longer share my life with the director of the institute I was not aware when I was talking to. Because he happened not to be an old man with a long white beard. Besides, the reason I like a multidisciplinary setting, there is a lot of openness for new people and their projects, and also special attention to research students. Furthermore, it offers the amazing number of colleges, seminars, conferences and guest lectures abroad.

The city of Amsterdam looks like an university I should probably see this the other way round, but this was the reason of my coming there, it is a university.

multinational, it is open to new people and their ways of living, the number of cultural happenings is amazing, and on occasions are usually young, the meaning which is a safe one. The only problem is accommodation. The city is quite crowded and one needs to go to find a decent and affordable place to live. This is the only part of a stay in Amsterdam that has to be planned well in advance.

How can one get in touch with Dutch people more so, depend on the country one is from. The more so the south one's country is, the less open it appears to be. But the multiculturalism of Amsterdam and the large number of guests constantly present at the university gives everybody an opportunity to find their own social network.

Research and PhD training in the field of Logic and its applications at the University van Amsterdam is central to within the Institute for Logic, Language and Computation (ILLC). It also contains mathematics, linguistics, computer science and philosophy are open, with logic as a red thread. ILLC has recently created the possibility to obtain the degree Master of Logic. The one year Programme Master of Logic consists of courses in English and a Master's thesis approved by one of ILLC's staff members. Furthermore, all other facilities at ILLC (Diverse series, Master classes, computer and library facilities) are open to Master's students.

A brochure with all information is available, send an E-mail message with your postal address to illic@uva.nl, or use the reply coupon.

MASTER OF LOGIC

Send me the brochure with general information including an application form.

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UvA DE UNIVERSITEIT VAN AMSTERDAM.

At ILLC research and educational mission are closely intertwined, witness the Master of Logic programme: a seemingly inexhaustible source of new ideas and talent. Ulle Endriss

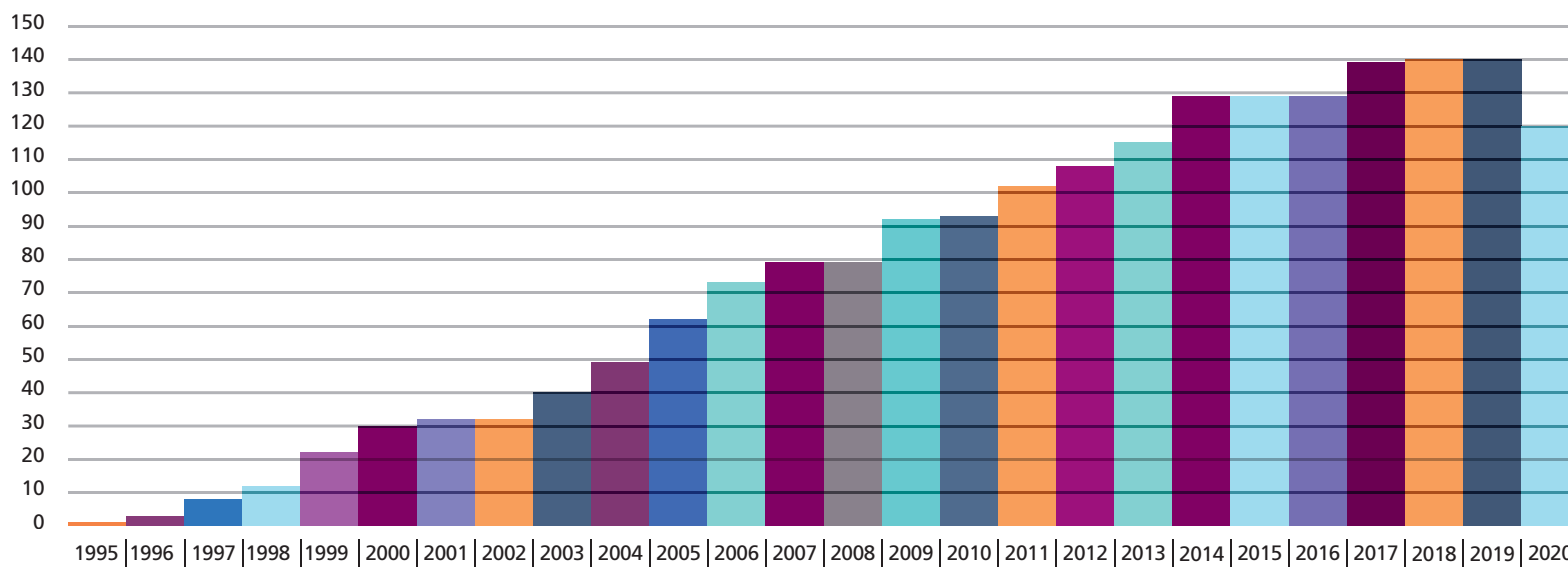
The Master of Logic programme

Traditionally, logic has been, and still is, part of regular graduate and undergraduate programmes in philosophy, linguistics, mathematics, computer science, and artificial intelligence. But its impact in those disciplinary teaching programmes is limited, both quantitatively, i.e., in terms of the amount of logic that these programmes can accommodate, as well as qualitatively: the focus is on the interactions with, and the relevance for, one particular other discipline, which means that all kinds of important cross-connections remain under-represented.

The initiative to start a dedicated programme as the master's level in logic was motivated by these concerns and was coupled with the realisation that the opportunity to study logic in the broad sense in which it is conceived at the ILLC might be attractive, especially for international students.

Thus 1996 saw the start of a one-year master programme in logic. Its first director was Dick de Jongh, who would continue to play that role until the summer of 2004, with Ingrid van Loon in charge of the administration. Later directors were Benedikt Löwe (2004-2010), Ulle Endriss (2010-2015), Maria Aloni (2015-2020), and Paul Dekker (2020-present), with

Tanja Kassenaar fulfilling the important role of administrator of the programme. The first years attracted a modest number of students. The programme continued to grow over the years, and thus an international community started to form of students coming from all over the world to Amsterdam to study logic 'ILLC-style'. Initially, the Master of Logic (MoL) programme awarded an MSc degree that was recognised separately by the University of Amsterdam. With the implementation of the Bologna agreements, under which master programmes in the natural sciences all had to become two-year programmes, the MoL-programme also had to be re-conceived. The transition, which was



executed in 2003, turned out to be a success: enrollment grew further and has been steady over the last years at 35-40 students per year on average.

The MoL-programme consists of a number of core courses that introduce the students to the broad view on logic that forms the identity of the ILLC and that also give them an opportunity to get in touch, right from the start of the programme, with the research that is being conducted and with the people who carry it out. After this introduction students specialise in one of four streams: *Logic & Computation*, *Logic & Language*, *Logic & Mathematics*, *Logic & Philosophy*.

Each track has two or three core courses

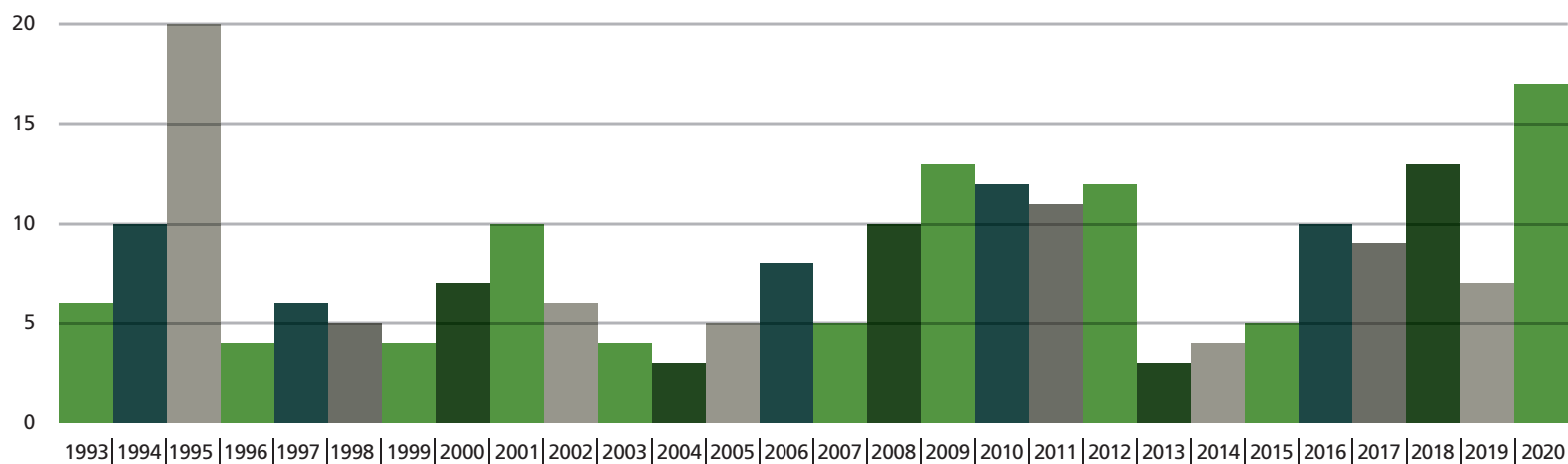
which define its special nature. These core courses are required for students who are in that track, but they are also open as electives for students from other tracks. Via the choice of electives and through individual, small-scale research projects, students can pursue all kinds of cross-connections.

The MoL-programme is demanding, but a remarkable number of students complete the programme in a timely manner. The quality of the programme has been recognised by a sequence of independent evaluation committees. It received one of the highest grades of all programmes across all disciplines in the country in the 2008 formal accreditation procedure. And in

2014 the MoL-programme was awarded the qualification ‘excellent’, the highest qualification a study programme in the Netherlands can earn, which is given only very rarely: only two master-programmes in the Netherlands obtained this distinction.

PhD training and PhD supervision

As was, and to some extent still is, customary in humanities disciplines, but also in such areas as mathematics and theoretical computer science, PhD training at the ILLC for a long time was a highly individual affair. In the early years PhD projects were often tuned to the specific profile of the students, and so was their



training, which usually consisted of a few courses to fill in specific deficits, and for the rest was mostly ‘training on the job’. This was the ‘master-apprentice’ model that only gradually gave way to a more structured PhD programme.

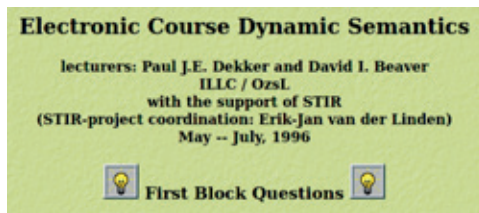
From the 1990s onwards a PhD training model emerged that consists of a mix of courses in a national (OZSL) and international (ESSLI) context, combined with university-wide compulsory skills-courses, and training focussed on the specifics of the PhD project. This change co-occurred with a shift from purely individual PhD projects to projects that are part of larger, externally funded projects,

such as those supported by NWO and the ERC. Less customary, but very characteristic of the ILLC-environment has been the fact that, almost right from the beginning, joint PhD-supervision has been the rule rather than the exception. This reflects the nature of the research that was being conducted: investigating problems at the interface of different disciplines and approaches. The model has been very successful and continues to be the norm.

One thing that many students note in evaluations is that an essential part of their PhD training at the ILLC comes from their peers. This involvement of PhD students reflects a community bond that is

characteristic for the ILLC and that is of great value at all sort of levels.

Another element of the PhD environment that the ILLC offers is monitoring of both the progress made by the PhD students and the quality of the supervision, in order to signal problems at an early stage and help address them. This monitoring is done on a yearly basis by an independent committee, the ‘Promotievoortgangscommissie’ (‘PhD progress committee’, PVC), that interviews PhD students, talks to supervisors when it deems it relevant to do so, and writes a report with its findings and recommendations that is presented to the ILLC scientific director and distributed



within the ILLC-community. The work of the PVC has been vital for maintaining the quality of PhD supervision.

The ILLC PhD program has consistently pursued a broad international outlook, training researchers for the world. This shows in the many collaborations with external colleagues on thesis committees, joint dissertations between the ILLC and universities elsewhere, and in recent years, the establishment of joint graduate programs with the University of St. Andrews and Tsinghua University.

Further Educational Activities

Besides the Master of Logic programme and PhD training, members of the ILLC are active participants in other regular teaching programmes. They contribute to curricula in computer science, artificial intelligence, mathematics, linguistics, philosophy and cognitive science on a structural basis, and incidentally they also teach in other programmes.

Apart from regular teaching, staff have been frequent contributors of courses and lectures to the international ESSLLI, NASSLLI, and EASLLC summer schools, occasionally also to the summer schools

The ILLC has given us the Master of Logic programme, and since then teaching is something to look forward to. *Michiel van Lambalgen*

of research schools in linguistics and philosophy; they have given tutorials and seminars in the context of conferences such as EACL, ACL, and so on.

As for broader outreach, as early as 1996, the ILLC offered an internet course on dynamic semantics which was designed by Paul Dekker. Well before the age of video-conferencing and social media, it used email and chatrooms to simultaneously teach students on three different continents. A more recent outreach effort is the internet course 'Logic in Action', whose development was subsidised by the Dutch Ministry of Economic Affairs as part of a national infrastructure initia-





tive. Developed around 2010 by Van Eijck, Jaspars, Van Ditmarsch and Van Benthem, it has come into use at Tsinghua Beijing, Stanford, and other universities worldwide.

But also, in more traditional style, some widely used textbooks in university curricula were written at the ILLC. These include the two-volume Gamut *Logic, Language and Meaning* (Introduction to Logic and Montague Grammar); Stokhof's *Taal en Betekenis* ('Language and Meaning'), a widely-used Dutch language textbook on philosophy of language; *Logic for Informatics* by Van Benthem and Van Ditmarsch;

Modal Logic by Blackburn, De Rijke and Venema. And there was also outreach beyond academia: Van Eijck, Jaspars and Visser wrote books on proofs and computation in mathematics and logic that target high school students.

from upstart to role model

Stability must be won and re-won...

Organisation is important, but it does not provide a safe haven once and for all.

What strikes a science policymaker, is the strong integration within the ILLC: alpha, beta and gamma disciplines, students and researchers, men and women, Dutch and internationals. Politicians talk about it, the ILLC does it!

Eva Hoogland

The professionalisation of the ILLC as an institute around 2000 called for yearly planning and internal evaluation cycles, and forced the scientific director and the management to regularly explain to outside administrators, such as faculty deans and the university board, why such an administrative outlier – a research institute that crossed faculty borders – needed to exist. This was not just a challenge, it also helped forge a strong sense of identity and an awareness of accountability to the outside world.

Throughout, the ILLC operated, as it still does, in between two large organisations: the Faculty of Science and the Faculty of Humanities. And even worse, for a while this balancing act involved three major

partners: the research group of Masuch and Mokken, which was part of the ILLC between 1996 and 2004, belonged to the Faculty of Behavioural and Social Sciences.

And these faculties themselves were not always stable, continuous entities: over time the ILLC has witnessed many reorganisations at university and faculty levels and has had to maintain its position through various administrative and financial changes.

That the ILLC has managed to do so successfully is due to several factors. First of all, there is content and visible output. The research dynamics of the ILLC community remained strong, with high levels

of publications, large numbers of successful PhD projects, and there was also the success of the Master of Logic programme, in terms of both numbers and average completion time.

Internal organisation also played a role. The flexibility and planning cycles of the ILLC research programmes allowed the institute to take advantages of new opportunities, which manifested itself in increasing acquisition of external funding.

And the human factor is important in running an institute as well. A series of highly competent managers has supported the scientific directors from the start: Erik-Jan van der Linden, Peter Blok, Ingrid van



Loon, and Jenny Batson. They have been essential factors in the ILLC's long-term success by providing continuity and focus internally, by representing the institute in a plethora of external administrative processes, and by supporting the ongoing professionalisation of the ILLC.

Quality assessments

The quality of research, teaching and management at the ILLC has been subjected to various external evaluations over the years. The Master of Logic programme is evaluated separately, and the results have already been mentioned.

Research, including PhD training, at Dutch universities has known external evaluation since 1993, in a five, later six year cycle. These evaluations are carried out by an independent committee of mostly foreign experts and run by a professional organisation. Initially, the different parts of the ILLC were evaluated on a disciplinary- and/or faculty-defined basis. The researchers based in the Faculty of Humanities in the period 1994-1998 obtained a grade of excellence as part of a national philosophy research evaluation. The researchers based in the Faculty of Sciences in the period 1996-2001 also obtained that grade in a national evaluation of computer science research.

As an institute in its own right, the ILLC had already organised a critical look at itself in 1996 by inviting a number of researchers from outside to visit and evaluate its results. Officially, the institute was first externally evaluated in 2006, covering the period 2000-2005. This evaluation recognised the special position of the ILLC, the high level of the research carried out there, and the quality of the management: on each of the parameters quality, productivity and relevance, the ILLC was given the highest mark.

The success was repeated in 2012, and then again in 2019: in each case the performance of the ILLC was rated as

General managers of the ILLC

from left to right:

Jenny Batson (2011-present)

Ingrid van Loon (2001-2011)

Peter Blok (1998-2001)

Erik-Jan van der Linden (1992-1998)

The distinctive ILLC-style has had an indelible cross-disciplinary influence in the US, – from modal logic to the ‘dynamic turn’ –, and for American logicians spending time at the ILLC is a rite of passage. *Thomas Icard*



excellent, in terms of quality, output and management.

The committee that performed the 2012 evaluation made a special note of the efficient and successful way in which the ILLC had achieved the transition from the ‘founder generation’ to the next one: a feat unthinkable without the strong and effective support of the management.

These assessments of the ILLC have also influenced the way in which it is perceived and valued within the University of Amsterdam. From an unusual and provocative upstart, it has become something of a role model. For example, in the Faculty of Humanities, the ILLC has inspired the genesis of a number of institutes. But

outside the University of Amsterdam, too, one may discern traces of the ILLC philosophy at work, either by distant example or through explicit alliances. And in various places institutes have been started that have followed the ILLC in some respects. All this shows that in order to be a success a research institute needs to have not only great research but also high levels of managerial competence and strategic talent to operate in different administrative cultures.

International alliances

Stanford

One long-standing collaboration for the ILLC has been that with the Center for the Study of Language and Information (CSLI)

at Stanford University. Founded a bit earlier than the ITLI by a group of renowned researchers including the logician Jon Barwise, the philosopher John Perry and the linguist Stanley Peters, CSLI brought and brings together researchers at the interface of linguistics, logic, philosophy, computer science, and in recent years increasingly also cognitive science.

Over the years, contacts with CSLI, and with Stanford University more generally, have been close in terms of working visits by professors and students, workshop series, and publications. The contact was



Following the Chinese saying ‘Keep the company of good people and you shall be of their number’ we have created a joint research centre to introduce new ideas from the ILLC to China. Liu Fenrong

and is embodied in the appointment of Van Benthem as a tenured professor, and the two institutes form a natural coalition as research themes and opportunities keep mutating. Along this channel also, several ILLC alumni, such as Martin van den Berg and Balder ten Cate, have found their way into the vibrant industrial world of Silicon Valley.

Tsinghua

A recent offshoot of the ILLC approach is the Joint Research Center in Logic (JRC) at Tsinghua University in Beijing. This centre, a first of its kind, is co-directed by Van Benthem and Fenrong Liu and brings together Chinese researchers with colleagues from the ILLC and elsewhere.

They cooperate on a number of research projects in logic, philosophy, computation and social agency, and also generate new research lines such as the history of logical thought in China.

Through various outreach efforts in events and publications, the centre is becoming a force for logic in China and East Asia, building on its historical connection to Jin Yuelin, the founder of modern logic in China. The centre is still expanding, and a recent development is another first, viz., the institution by Tsinghua University of the Jin Yuelin chair in Logic, held jointly by a group of four international colleagues, including Van Benthem and Stokhof from the ILLC.

topics and trends since 2000

Chopping up history into fixed periods is of course just a form of bookkeeping: things need not change when entering a new decade, or even a new century. So, the distinction between ‘the ILLC prior to and after 2000’ is artificial to some extent.

$$Q_2(f) \geq \widetilde{\deg}(f)/2$$

Contemporary formal semantics at ILLC combines experimental and computational techniques with the rigor of logic and philosophy to address core descriptive and foundational issues. Maria Aloni

Even so, looking back one can discern certain research trends that started in the late nineties come to fruition from 2000 onwards. However, as the ILLC expanded fast in this period qua themes and participants, a few lines must suffice, since there is no historical distance yet for a grand narrative.

Research lines

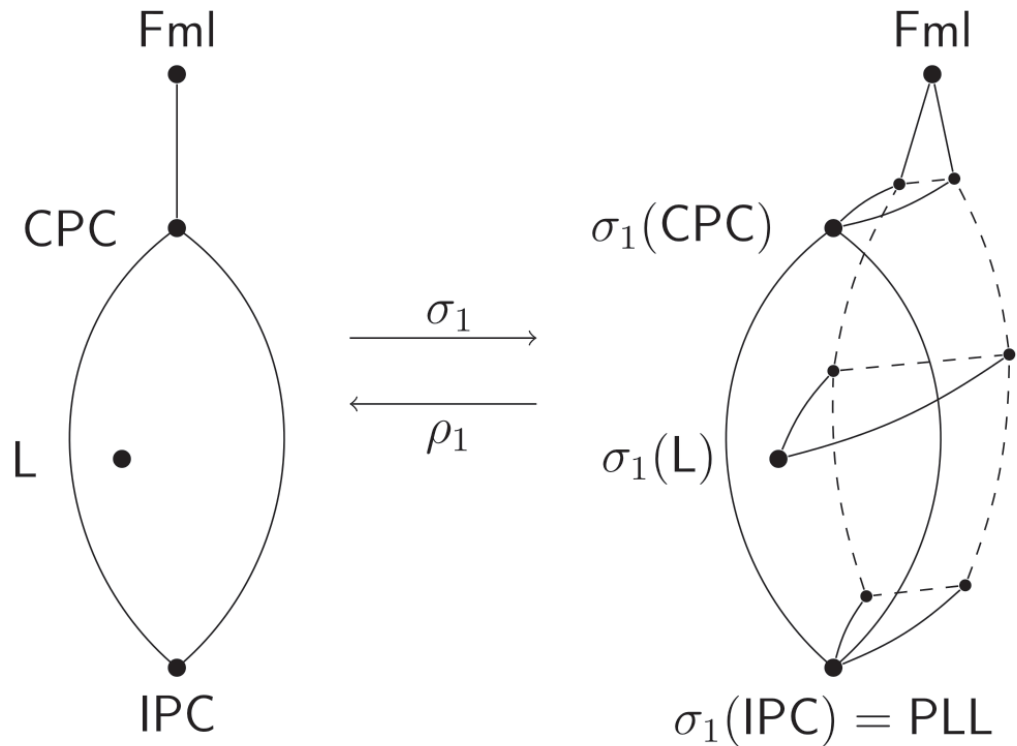
As the ILLC kept growing in terms of academic personnel, its intellectual span extended apace. Research in the decades since 2000 has partly followed earlier programs, though with a great variety of new themes. Mathematical logic fanned out from its strengths in constructivism to proof theory

and category theory, consolidated with the appointment of Benno van den Berg. Entirely new lines sprung up as well, such as the research on descriptive set theory by Benedikt Löwe, and on generalised quantifiers and game techniques by Jouko Väänänen, who also initiated a fundamental study of the logic of dependency, a crucial notion across mathematics, game theory, probability and, increasingly, artificial intelligence.

Likewise, the modal logic agenda at the ILLC became much broader. Under the leadership of Yde Venema, it came to include new connections with computer science in the work on fixed-point logics of computation and their game semantics, but also with co-algebra, a new paradigm

for finite and infinite computations rethinking the mathematical foundations of computing. At the same time, new connections with algebraic logic and topology have emerged, accelerated by the appointment of Nick Bezhanishvili, while modal techniques are also used increasingly in the study of weak logics and ‘deep inference’ by Dick de Jongh and his collaborators.

Conspicuous in many of these developments was the same sort of entanglement of logic and computation that had already been so characteristic for ILLC research in the 1980s. Maarten de Rijke opened up new interfaces of logic and information retrieval, theorem proving, and other applied themes.



These research topics eventually moved to the Institute of Informatics when de Rijke became a full professor there.

A more theoretical instance of the entanglement with computation is the research on dynamic-epistemic logic by Alexandru Baltag, Johan van Benthem and Sonja Smets and their students which combined ideas from philosophical and computational logic to develop a broad theory of information flow, communication and information and goal-driven agency under the heading of logical dynamics, a program for putting actions and events at centre stage in designing logical systems. Dynamic-epistemic logic in a variety of formats, and applied to philosophy, multi-agent sys-

tems, game theory, and social network theory, has become one more ILLC trademark research line.

At the interface of logic and language, too, the ILLC has seen seminal new developments. Traditional strengths in the semantics of intensional predication and quantification continued in the work of Maria Aloni and Paul Dekker. In addition, Frank Veltman kept broadening the scope of his update semantics to also include generic expressions, and default reasoning in artificial intelligence.

The agenda also broadened to include several new descriptive areas, such as the study of epistemic modals, intensional quantification, vagueness, and of exhaus-

tive meanings in natural language.

The period since 2000 was also one of methodological innovation. Jeroen Groenendijk and Floris Roelofsen developed dynamic semantics into a new paradigm, called ‘inquisitive semantics’, that highlights the role of questions and issues in directing discourse, and explores its repercussions in linguistics, philosophy, and even the foundations of logic itself. Other new methodologies were the use of signalling games by Robert van Rooij to throw new light on the genesis of language and fundamental issues in pragmatics.

A conspicuous new trend in recent years has been the causal paradigm for natural language developed by Van Rooij and

The ILLC provides a fertile ground for developing a computational semantics and pragmatics that integrates formal semantics with empirical methods from psycholinguistics and machine learning techniques from AI. Raquel Fernández

Katrin Schulz, which connects up with both classical themes in the philosophy of science and current developments in artificial intelligence, while introducing probabilistic methods at the heart of semantics.

On the more applied side, the ILLC saw a fast expansion into the realm of computational linguistics. In the hands of Khalil Sima'an, Raquel Fernández, Ivan Titov and others, ideas from the 1990s now became available on an applicable scale: for parsing, but also for discourse interpretation and discourse pragmatics.

Beyond the bounds of already existing themes and trends, the two decades of the ILLC since 2000 have also opened up new

interfaces with several disciplines, increasing the outreach of the institute.

Quantum computing has become a major research line, in the work of Harry Buhrman on quantum algorithms and complexity of quantum computations, and later also by Christian Schaffner on quantum cryptography, all in collaboration with the CWI and the Institute of Physics and the Korteweg de Vries Institute for Mathematics in Amsterdam.

Another noticeable interface is that with cognitive science. Research into natural language processing has come to include general cognition in the work of Rens Bod, and music entered as an independent research theme with the appointment of Henkjan Honing. Close collaborations



with cognitive scientists are also much in evidence in the ongoing work of Michiel van Lambalgen on the psychology of reasoning pursued with the help of logic programming methods, and in that of Jakub Szymanik on learnability of linguistic expressions and logical inference patterns. Finally, cognitive research on semantics and discourse reaching out to newer machine learning and other data-processing techniques in AI has started flourishing in the groups of Jelle Zuidema and Raquel Fernández.

A third new interface in the ILLC today is with the social sciences. Supported by an ERC Starting grant, Sonja Smets and collaborators created a group studying infor-

$$[\alpha]\Box_a\mathbf{P} \Leftrightarrow pre_\alpha \rightarrow \bigwedge_{\beta >_a \alpha} K_a[\beta]\mathbf{P} \wedge \bigwedge_{\gamma \simeq_a \alpha} \Box_a[\gamma]\mathbf{P}$$

Like energy, meaning is transformed from one form to another. Physics studies how energy is preserved during a transformation. In machine translation our primary task is to develop models for how meaning is preserved in human translation. Khalil Sima'an

mation flow and opinion dynamics in multi-agent settings, bordering on both the logical analysis of games and the theory of dynamical systems. Concurrently, Ulle Endriss started a research group on computational social choice, an interface area in between computer science, logic, and the social sciences. This group is now supported by Endriss' Vici-grant.

A final interface is an old one. Modern logic started out close to mathematics but also to philosophy. Interestingly, a growing group of researchers at the ILLC and their students have started working on forging new connections between logic and philosophy, including such topics as the philosophy of Ludwig Wittgenstein (Stokhof and his students), formal episte-

mology (Sonja Smets, Alexandru Baltag and others), metaphysics (Franz Berto), philosophy of mathematics (Luca Incurvati), history of logic (Arianna Betti), methodology and philosophy of the social sciences (Federica Russo), and the logical reconstruction of Kant's epistemology (Michiel van Lambalgen).

This return is not surprising. Research is dynamic, and old friends can easily become new ones. But unlike in the old days, this philosophy-oriented research, too, is now a collaborative effort, often carried out in large, thematic, externally funded projects.

Internal growth, outside orientation

This all too brief summary of current research lines and the people involved in them is by no means complete. New appointments are extending and transforming the landscape of research on logic, language and computation at the ILLC at an increasing pace, as befits a large institution with its own dynamics. Given this ongoing transformation and scale-up a set of aggregated facts probably does more justice to what is going on now than a narrative constructed without proper temporal distance. A list of permanent appointments at the ILLC throughout its history is included at the end of this

$$\arg \max_{\theta} p(\theta|x) = \arg \max_{\theta} \int p(\theta, z|x) dz$$

Formal epistemology, epistemic logic, and learning theory are merging and ILLC researchers take the lead, combining different methodologies and systematic investigations with a focus on social group dynamics. Alexandru Baltag

booklet, along with a number of other quantitative data sets that illustrate the growth, and the growth rate, of the institute. In line with these new realities some 30 years after its founding, the ILLC community is currently engaged in a broad reappraisal of its internal organizational structure, adjusting it to current research interests and needs for the years to come.

In its process of internal growth, the ILLC maintains its traditional external outlook and keeps interacting with its international environment. Its researchers are continuously involved in new initiatives for publications and conferences. Another testimony to this international activity is the involvement of ILLC researchers in the

compilation of prestigious handbooks that consolidated communities formed one or two decades earlier, witness Van Benthem's co-editorship of the *Handbook of Logic and Language*, 1997 with Alice ter Meulen; the *Handbook of Modal Logic*, 2006, with Patrick Blackburn and Frank Wolter; the *Handbook of Spatial Logics*, 2008, with Marco Aiello and Ian Pratt-Hartmann; and the *Handbook of the Philosophy of Information*, 2009, with Pieter Adriaans. Other notable examples of such enterprises are the *Handbook of Formal Semantics*, 2016, edited by Maria Aloni and Paul Dekker, and the *Handbook of Computational Social Choice*, 2016, co-edited by Ulle Endriss.

More institutionally, the ILLC also takes a lead as the opportunity arises. The GLoRiClass project was a typical example in the 2000s, and later on, the institute also took the lead in new kinds of projects. The ILLC played a key role in designing and executing the LOGICCC program ('Modelling Intelligent Interaction: Logic in the Humanities, Social and Computational Sciences, 2008-2011), a EuroCores programme of the European Science Foundation, which brought together researchers in logic, computer science, and the social sciences from across a broad academic and geographical spectrum. Currently, the ILLC is a founding node in the national Zwaartekracht project 'Language in



Interaction' (2013-2023), in collaboration with psychologists, linguists and neuroscientists.

New challenges

Despite its expansion and continued influence, the ILLC today operates in a changing environment, which also brings major new intellectual challenges. Logic is definitely not the only game in town in many of the areas where the institute operates, and there are major paradigms that are either neutral or even active competitors. Probability is a major alternative methodology in many fields, and its mathematical connections to logic raise fundamental questions. Non-representational paradigms like

neural networks and machine learning bypass basic assumptions of logical approaches to information and knowledge. Cognitive psychology has brought to light the limitations of logical reasoning by actual human agents. And finally, big data pose yet other challenges, replacing philosophical intuition and mathematical finesse by pattern matching and sheer weight of accumulated facts.

While none of these developments threaten the viability, content and elegance of logic in the broad sense pursued at the ILLC, they do pose serious questions to an institute that wants to be avant-garde. The new challenges raise new deep issues for fundamental research, but also offer opportunities for making logic, language

and computation in the Amsterdam style relevant in new ways in current areas like cognition and artificial intelligence that are transforming our world. It will be exciting to see where the current young ILLC community will move in the decades to come.

$$\exists x \forall y \exists z (=(z, y) \wedge \neg z = x)$$

Logic in Action
Overview of the Logic Open Course Project 2009-2011

Logic in Action is an educational project which aims at the development of 'open' web-oriented courses on logic and a wide range of applications in fields such as mathematics, philosophy, computer science, linguistics and cognitive science.

The project has been set up by the Logic Education Group based at the Institute for Logic, Language and Computation (ILLC) at the University of Amsterdam in the Netherlands.

The *Logic Education Group* originates from earlier education projects in the Netherlands. An overview of earlier activities can be found at the [site](#) of this group (in Dutch). The people involved are

| | | | |
|--|---|---|---|
|  |  |  |  |
| Johan van Benthem Univ of Amsterdam, NL, and Stanford University CA, US | Jan van Eijck Centre for Mathematics and Comp Science, Amsterdam and Univ of Utrecht, NL | Hans van Ditmarsch Univ of Seville, SP | Jan Jaspars Free Lance Logician, Amsterdam, NL |

Public Outreach

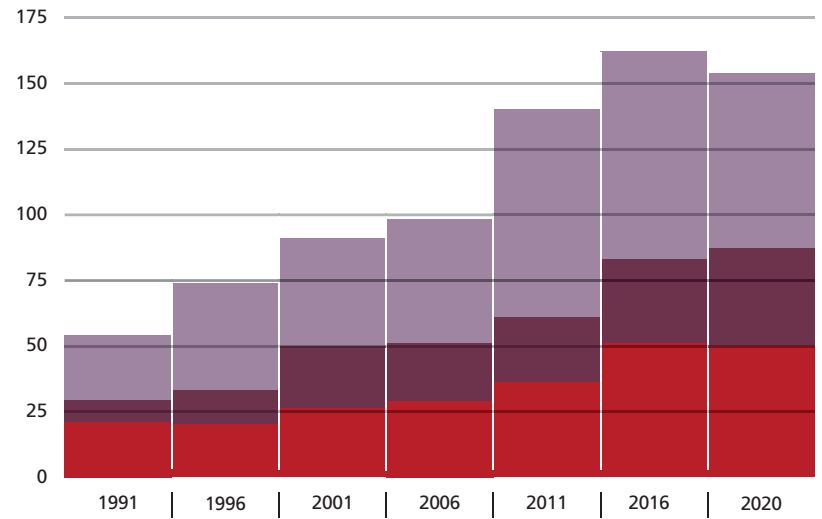
One more thing that has changed is public scrutiny. The ILLC has always been an institute for experts, appreciated by an international elite of colleagues and visiting committees. What it is all about is much harder to see for a broader audience, which, of course, has a perfect right to insist on transparency and accountability.

The institute is showing awareness of this by undertaking new outreach initiatives toward high schools, offering master classes to both students and teachers. And at another level, it has been the home base for highly visible public outreach in the work of Rens Bod on a global history of

the humanities across cultures, and that of Henkjan Honing on the origins of musicality. Here, too, it will be interesting to see what public voices will be heard from the ILLC community in the years to come.

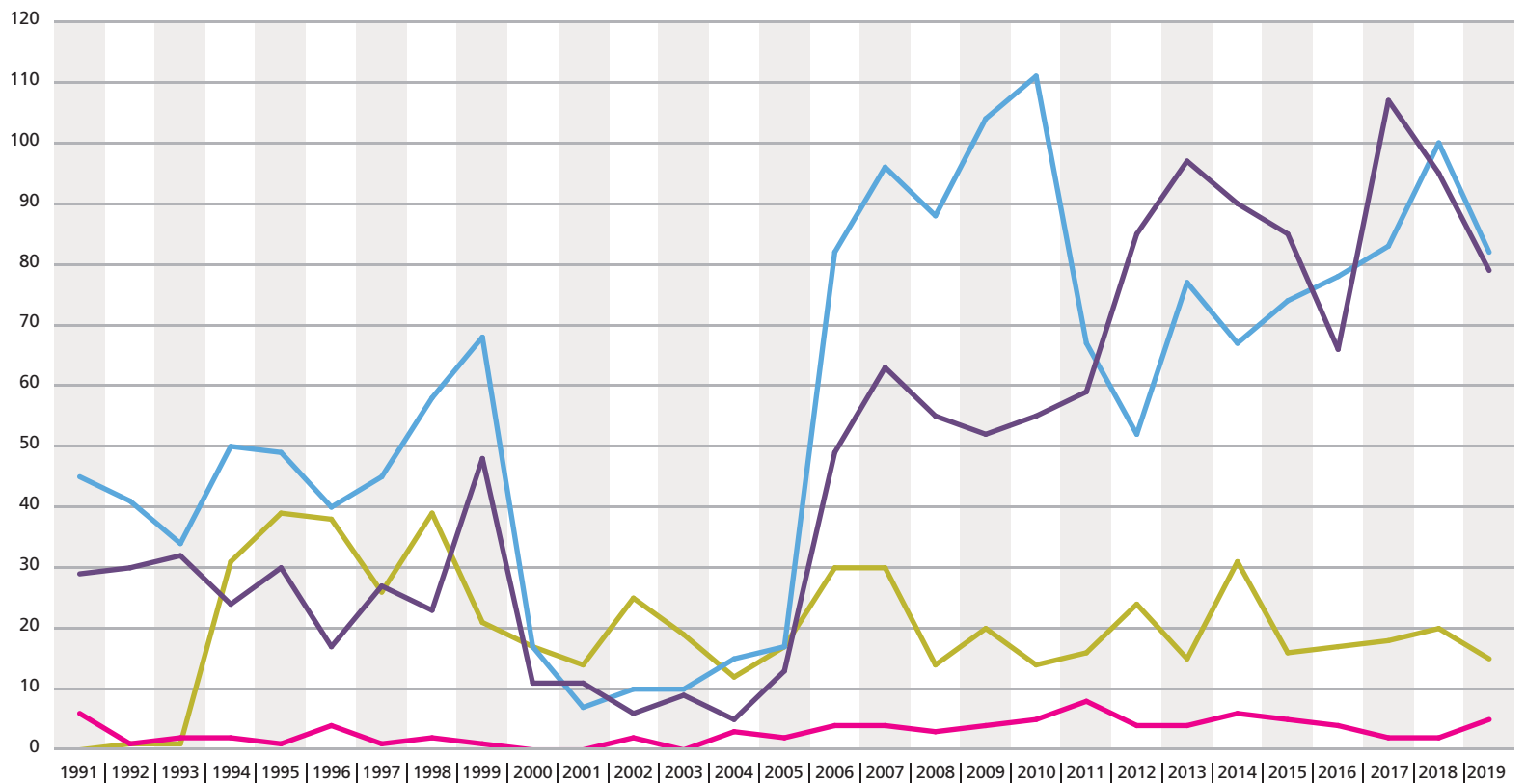
Researchers at the ILLC 1991-2020

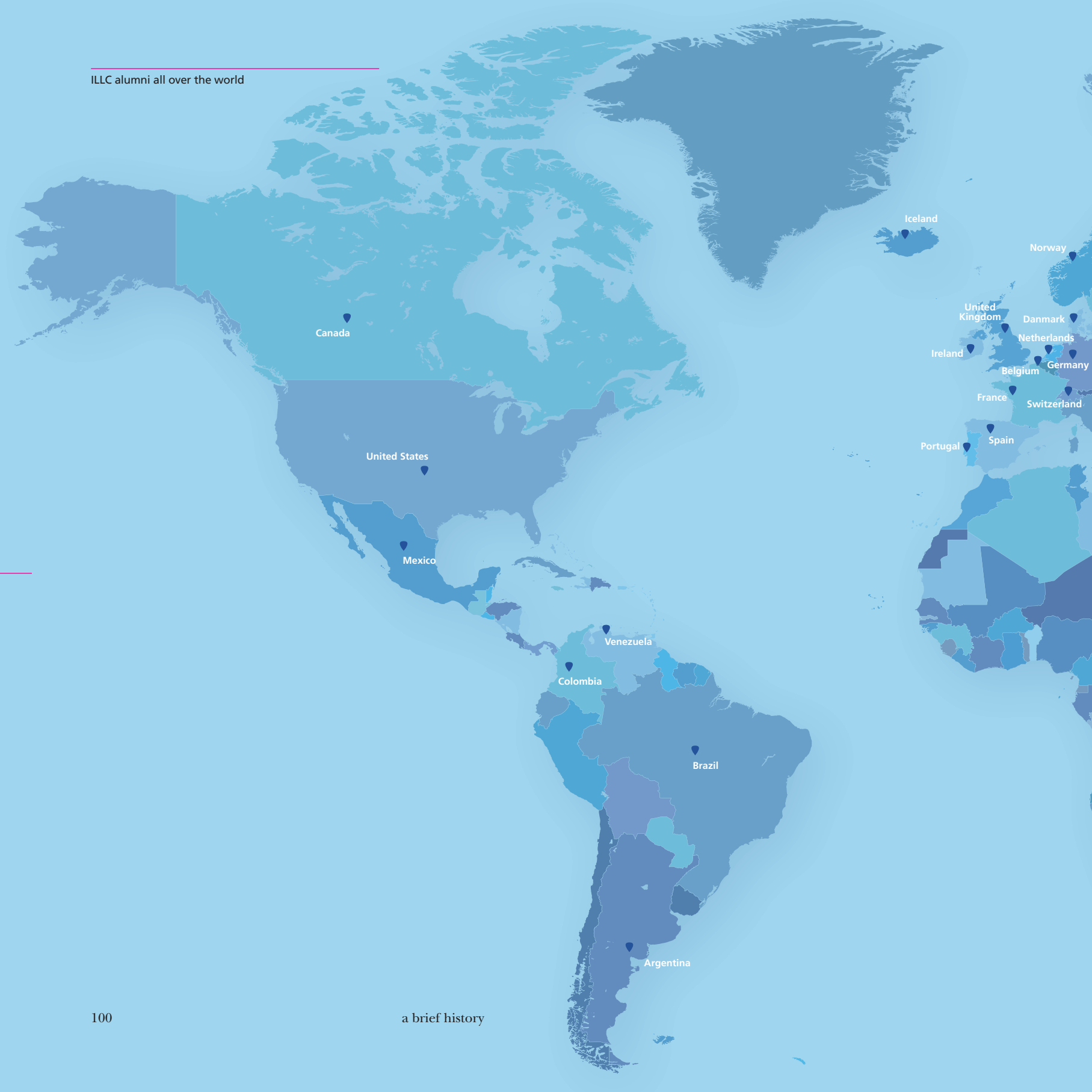
- PhD
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- tenured staff

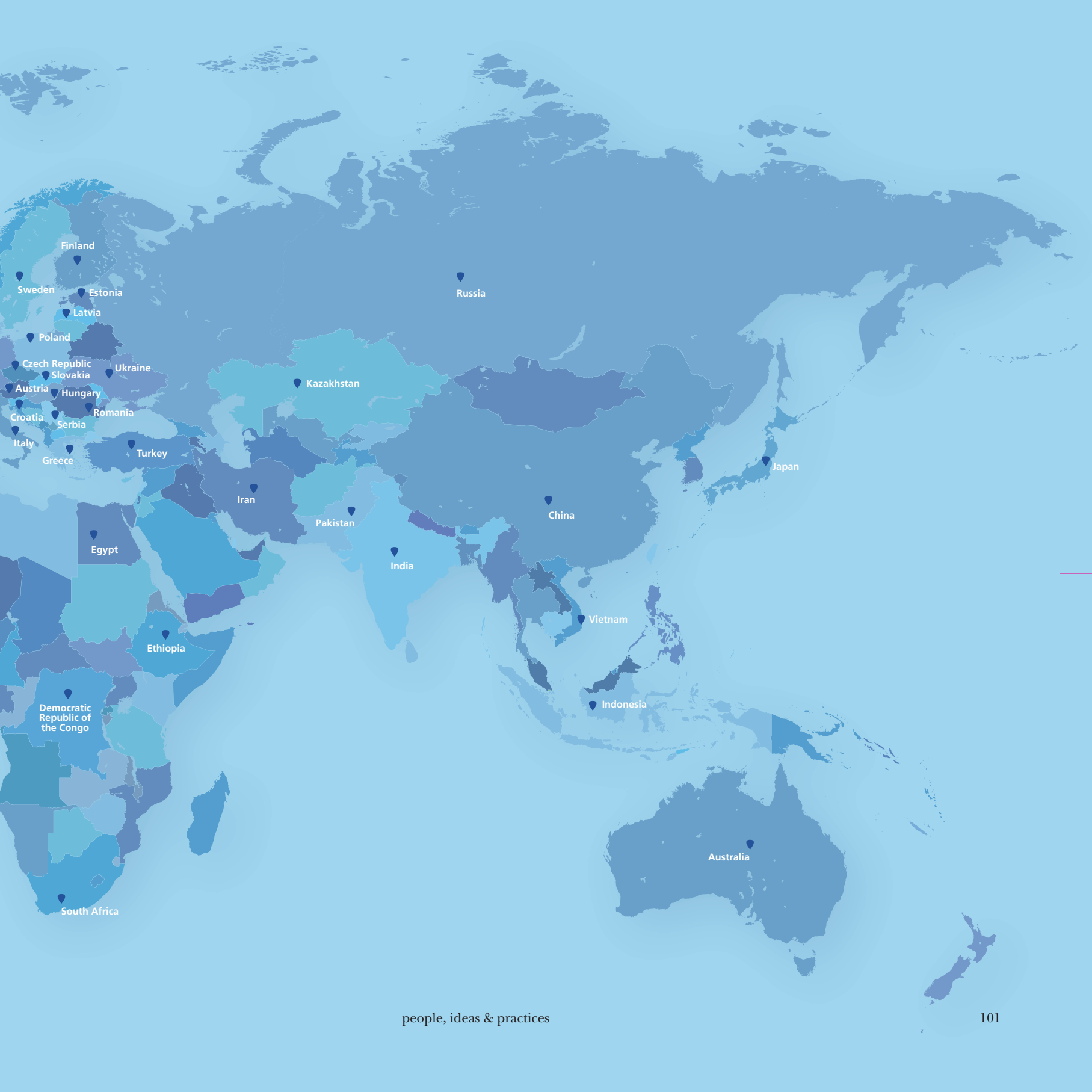


Publications 1991-2019 (below)

- books / monographs
- articles in journals
- articles in conference proceedings
- chapter in book







conclusion



The ILLC started out as a grassroots association of congenial researchers and students interested in logic, language, information, and communication.

As this short history has shown, from these beginnings a large and diverse institute has sprung up, with its own organisational structures and practices.

Keeping the humanities and sciences together at the ILLC comes naturally. We attract logicians who are active in epistemology and artificial intelligence, computer scientists who write poetry, philosophers who work in linguistics and game theory, and mathematicians who love philosophy. This is just who we are and how we work. Sonja Smets

There are also some features that have remained unchanged from the start. The ILLC is still a research community that serves as a factory of new ideas. Those ideas come from a broad range of disciplines but they fit and cohere, and researchers grow up in an atmosphere of mutual respect. Moreover, the community continues to strive to be agenda-setting, and, while doing so, the ILLC still provides an intellectual home for academic free spirits, from professors to new generations of students. In fact, its students, and their skills and attitudes, are a major product of the ILLC as much as its ideas and publications, and by now, ILLC alum-

ni form a dense and influential network around the globe.

Of course, as any living organisation, the ILLC faces its challenges. Its culture of coherence and cross-fertilisation is not a given once and for all, it needs careful cultivation drawing on its tradition of integrating perspectives from mathematics, philosophy, linguistics, and other fields. The agenda-setting role of the ILLC can only flourish by keeping its sights at the cross-roads of major new developments, for instance, from AI and cognitive science. Also, the ILLC is currently working toward broader responsibilities to-

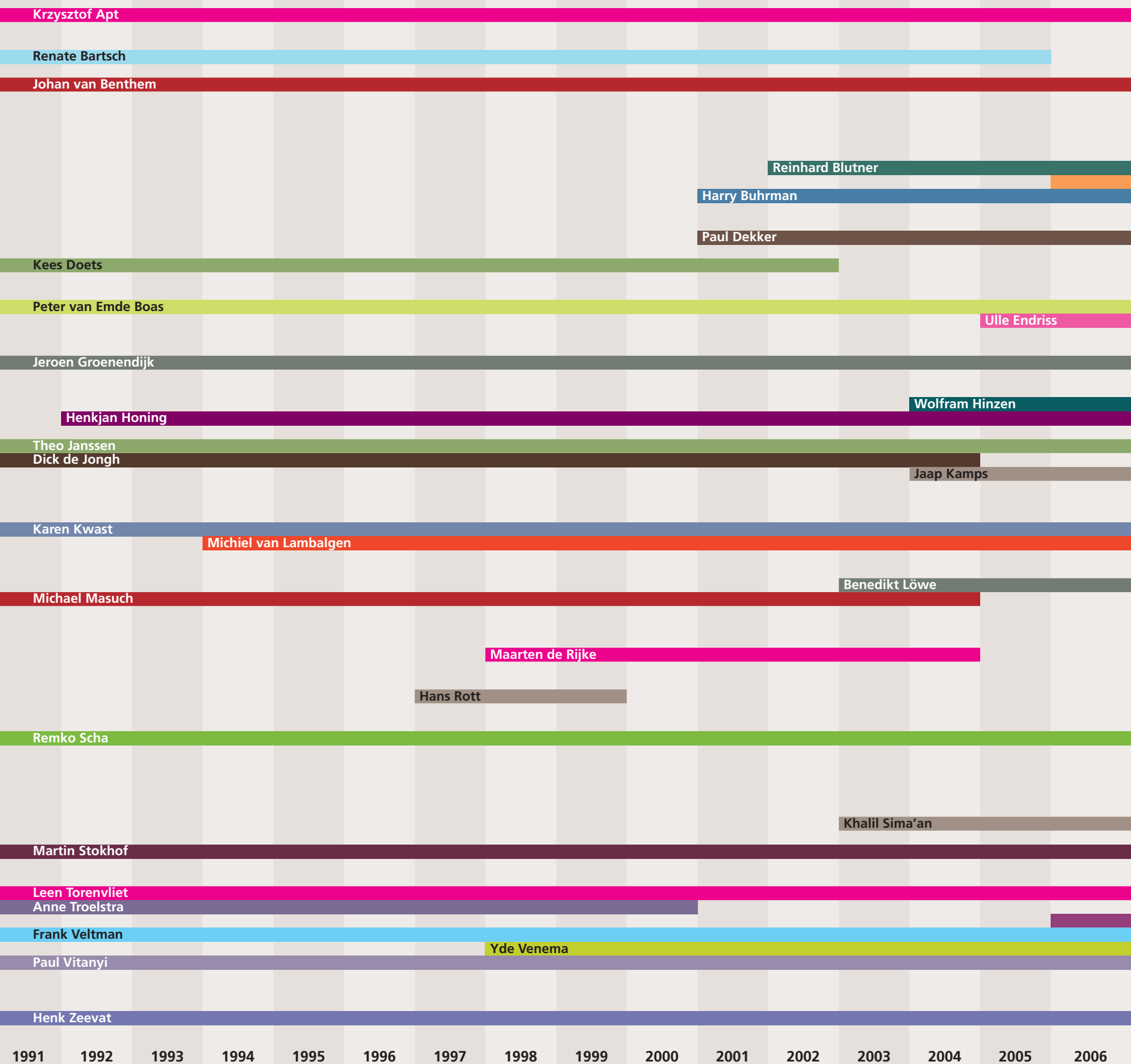
ward society. It offers pilot master classes for students and teachers from high schools, and its internet course offerings, too, offer ample scope for greater ambition and expansion.

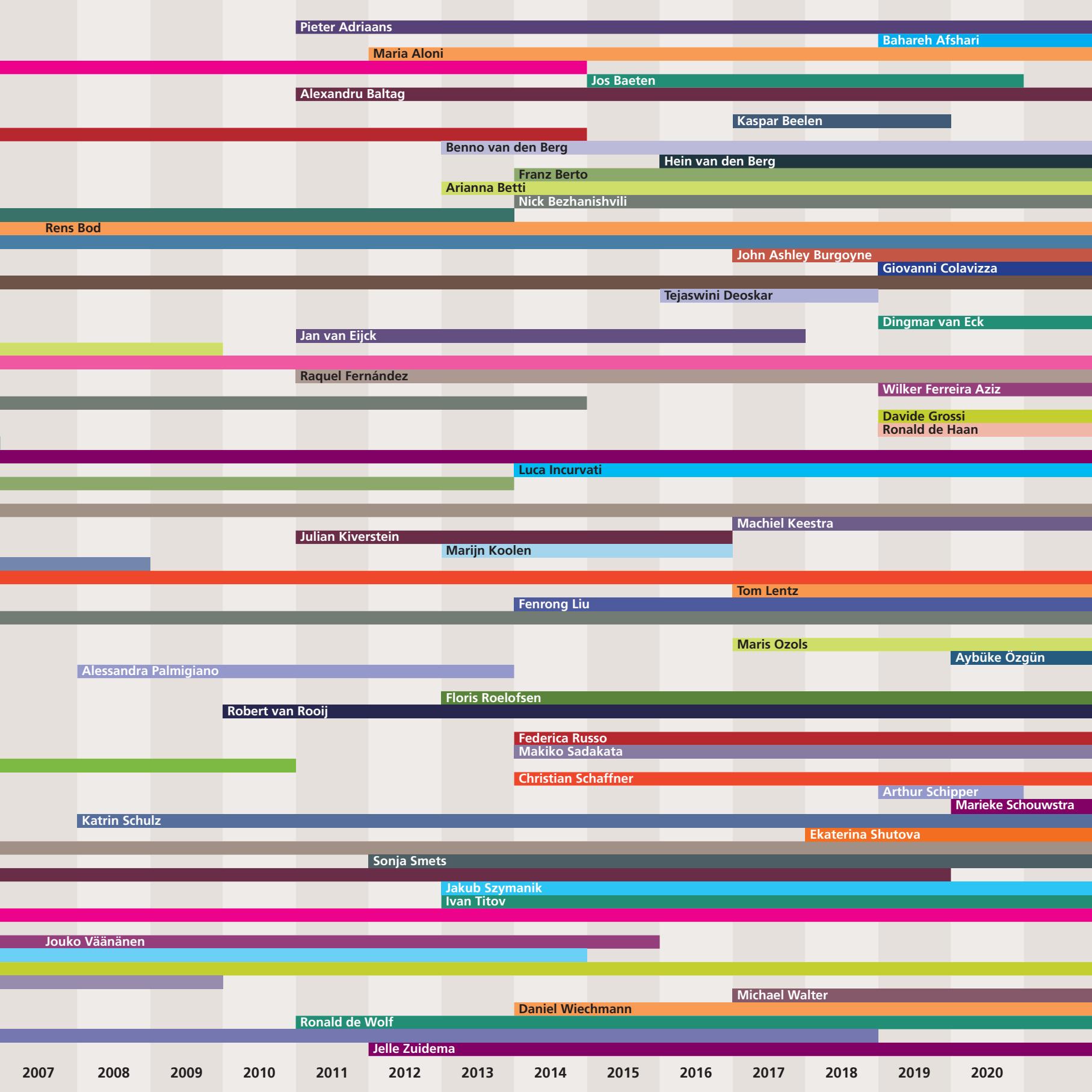
Finally, the ILLC is still mostly a place for connoisseurs, one of the hot-spots of the profession worldwide. It is not well-known to a general public with intellectual interests, and its visibility with university administrators needs constant care. The crown jewel is seldom on display. The institute is aware of this, and is trying to make 'spreading the word' broadly a habit to be engrained in its staff and students.

Whether in its historical achievements or its current position at the university, the ILLC is a remarkable place and its success defies easy mono-causal explanations. In this booklet we have sketched in broad strokes what has happened and identified some the many factors (including that most important one of all: a bit of luck...) that have resulted in a unique institution that has served and will continue to serve its academic community, the university, and the public at large.



staff 1991-2020





new
generation



Marieke Schouwstra



Giovanni Colavizza



Hein van den Berg



Nick Bezhaniashvili



Ulle Endriss



Jelle Zuidema



Davide Grossi



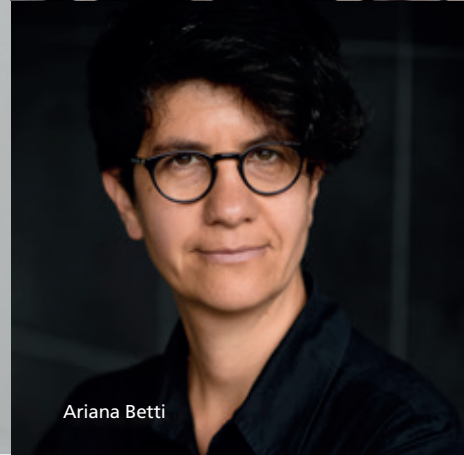
Aybüke Özgün



Sonja Smets



Floris Roelofsen



Ariana Betti



Katrin Schulz



Maris Ozols



Makiko Sadakata



Ronald de Wolf



Bahareh Afshari



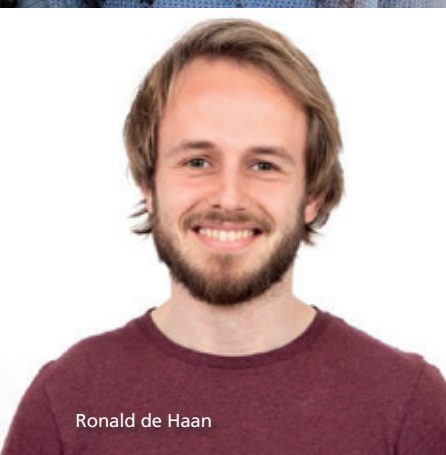
Wilker Ferreira Aziz



Benno van den Berg



Maria Aloni



Ronald de Haan



Robert van Rooij



Federica Russo



Raquel Fernández



Luca Incurvati



Daniel Wiechmann



Ekatarina Shutova



Jakub Szymanik



Ivan Titov



Christian Schaffner



Ashley Burgoyne



Alexandru Baltag



Left: Vendelstraat, right: new building LAB24





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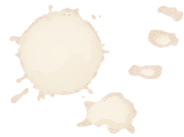
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people, ideas & practices





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The ILLC is a research institute in the interdisciplinary area between the humanities, the behavioural and the natural sciences.



UNIVERSITY OF AMSTERDAM
Institute for Logic, Language and Computation