Handbook of the
First World Congress and School on
Universal Logic

UNILOG'05

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Edited by
Jean-Yves Beziau and Alexandre Costa-Leite

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1.1 Organizing Committee of UNILOG'05

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  Institute of Logic - University of Neuchâtel - Switzerland
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1.2 Supporting Organizers During UNILOG'05

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2 What is Universal Logic?

In the same way that universal algebra is a general theory of algebraic structures, universal logic is a general theory of logical structures. During the 20th century, numerous logics have been created: intuitionistic logic, modal logic, many-valued logic, relevant logic, paraconsistent logic, non monotonic logic, etc. Universal logic is not a new logic, it is a way of unifying this multiplicity of logics by developing general tools and concepts that can be applied to all logics.

One aim of universal logic is to determine the domain of validity of such and such metatheorem (e.g. the completeness theorem) and to give general formulations of metatheorems. This is very useful for applications and helps to make the distinction between what is really essential to a particular logic and what is not, and thus gives a better understanding of this particular logic. Universal logic can also be seen as a toolkit for producing a specific logic required for a given situation, e.g. a paraconsistent deontic temporal logic.

Universal logic helps to clarify basic concepts explaining what is an extension and what is a deviation of a given logic, what does it mean for a logic to be equivalent or translatable into another one. It allows to give precise definitions of notions often discussed by philosophers: truth-functionality, extensionality, logical form, etc.

3 First World School on Universal Logic

3.1 Aim of the School

The school is intended to complement some very successful interdisciplinary summer schools which have been organized in Europe and the USA in recent years: The ESSLLI (European Summer School on Logic, Language and Information) in Europe and the NASSLLI (North American Summer School on Logic, Language and Information) - this last one has been launched recently by one of us (Darko Sarenac).

The difference is that our school will be more focused on logic, there will be fewer students (these events gather several hundreds of students) and a better interaction between advanced students and researchers through the combination of the school and the congress. We also decided to schedule our event in Spring in order not to overlap with these big events.

This school is on universal logic. Basically this means that tutorials will present general techniques useful for a comprehensive study of the numerous existing systems of logic and useful also for building and developing new ones.

For PhD students, postdoctoral students and young researchers interested in logic, artificial intelligence, mathematics, philosophy, linguistics and related fields, this will be a unique opportunity to get a solid background for their future researches.

3.2 Tutorials

3.2.1 Adaptive Logics

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Adaptive logics provide a unified framework for the formal study of reasoning patterns that are dynamic (inconsistency-handling, compatibility, inductive generalization, abduction, diagnosis, default reasoning...). Most, but not all, of the corresponding inference relations are non-monotonic. A standard format for adaptive logics has been designed that covers all currently available adaptive logics. This format delivers, for each adaptive logic, a (dynamical) proof theory as well as a provably sound and complete semantics. It also provides criteria for the combination of several adaptive logics (which is necessary for many applications).

The first session will be devoted to (i) dynamic reasoning patterns (examples; absence of a positive test for derivability) and to (ii) inconsistency-adaptive logics. In the second session, we shall (i) present the standard format (lower limit logic, upper limit logic, set of abnormalities; dynamic proof theory, derivability at a stage, final derivability; adaptive semantics) and (ii) discuss the mechanisms for combining different adaptive logics. The final session will be devoted to (i) tableau-methods, (ii) block semantics and (iii) applications (from commonsense reasoning as well as from scientific contexts).

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3.2.2 Introduction to Universal Logic

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The main philosophical ideas behind universal logic will be discussed: the analogy and difference with universal algebra, the key role of the notion of structure, the rejection of axioms and so on. We will explain in particular what is the difference between this approach and the traditional one.

We will describe various kinds of logical structures through a historical survey (Tarski's consequence operator, Hertz's Satzsysteme, etc). Completeness will be given as an example of general theorem that can be re-presented by cleary making the distinction between the particular and the universal.

We will present the main mathematical challenges raised by universal logic and its philosophical import through some central problems such as combination of logics, translation and equivalence between logics.

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J.-Y.Beziau (ed), *Logica Universalis* , Birkhaueser, Basel, 2005.

3.2.3 Combining Logics

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Combined logics are essential for reasoning about complex phenomena. Different aspects of a given phenomenon may be adequately dealt with using different logics, but a unique logic encompassing all these aspects and catering to the various ways they can possibly interact is certainly a goal to pursue. The motivations for this work come not only from practical problems, namely in the fields of knowledge representation, software engineering, or linguistics, but also from well-known examples (eg. multimodal logics).

We adopt a methodological abstract viewpoint that is concerned with general universal mechanisms for combining logics. Rather than focusing on the specific details of the combination of particular logics, we aim at rigorously defining a logic combination mechanism at the adequate level of abstraction and then establishing meaningful transference results that may be used in many situations.

The typical questions to be asked and answered are: (i) When does it make sense to combine two given logics and what is the result? (ii) If two logics with property P are combined does the resulting logic inherit the property P? The course introduces the topic of logic combination and its main difficulties, starting from the very concept of logic.

We adopt a category-theoretic approach, formulating combination mechanisms as universal constructions. We concentrate on the detailed theory of the powerful mechanism of fibring (originally proposed by Dov Gabbay) and its recent extension, cryptofibring. We analyze relevant transference results and examples, focusing on soundness and completeness preservation, in various contexts, including also logics with non-truth-functional semantics.

Finally, we overview the "collapsing problem" for fibring, and show how it can be solved by adopting cryptofibring. Along the way, several open research problems are identified. The course is based on recent and ongoing work by the lecturer and close colleagues. The corresponding track of publications can be found in the web page of the project FibLog.

3.2.4 Many-Valued Semantics

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Many-valued semantics, besides providing a natural semantical interpretation for several non-classical logics, constitute a very sharp tool for investigating and understanding meta-logical properties in general. Although open to debates from the philosophical perspective, seen from the mathematical viewpoint many-valued matrices and algebras are perfectly well-defined mathematical objects with several attractive properties. This tutorial intends to review the main results, techniques and methods concerning the application of the many-valued approach to logic as a whole.
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3.2.5 Games and Logic

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Game Theory is a very efficient tool for describing and analyzing many logical problems. The evaluation of a formula in a given model, the con-

struction of homomorphisms between models, and even the description of computational complexity classes can all be described in a very natural way in terms of games. This short lecture presents the basic notions of Game Theory, from strategies to determinacy, and its applications to the ongoing "gamification" of logic.

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3.2.6 Abstract Algebraic Logic

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Abstract algebraic logic (AAL) deals with the algebraic study of logics in a way that views both terms "algebraic" and "logic" under a general perspective. It studies different abstract processes of assigning a class of algebras to a given logic, and the general properties of these processes, their limitations and their different variants or enhancements, instead of focusing on the resulting class of algebras for a particular logic. AAL crystalized in the eighties and nineties as an evolution from the so-called "Polish"-style general approach to sentential logics with algebraic means, after the fundamental contributions of researchers such as Czelakowski, Blok, Pigozzi, Herrmann, Font, Jansana and Verdú.

The clarification of the different ways in which a logic can be algebraized has thrown light on the behaviour of several logical systems that are not amenable to the standard settings, but it has also clarified the deep roots of the algebraic properties of classical logic. In its recent developments AAL has proven useful for the study of non-monotonic and substructural logics, and of other Gentzen-style systems formulated with hypersequents or many-sided sequents. It does also provide definite criteria to clarify in which sense a logic is said to correspond to a given class of algebras, and it has stimulated a reflection on the issue of what a logic is.

This tutorial is conceived as a reading guide of the available scholarly material. AAL is a mathematical theory, and by now it is deep and technically involved, with several ramifications and its own terminology and notation. A 3-session tutorial can only show the essentials, that is, the "what" and the "why", but not much of the "how". An effort will be made to provide enough examples of logics and of classes of algebras and of their treatment under several of the AAL paradigms.

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References 3 and 5 are survey-like and contain more extensive bibliographies.

3.2.7 Abstract Model Theory

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Abstract model theory is a field that arose in the seventies after Lindström's model-theoretic characterization of first-order logic. Logics started to be studied and compared in terms of their model theoretic properties -in opposition to extended model theory, which studies logics in terms of their expressive power. This optic gave rise to the search of new logics capable of exhibiting a certain combination of model-theoretic properties. So, to the generalizations of infinitary logics Lkl, Lindstrom himself (following the path started by Mostowsky in the late fifties) added extensions of first-order logic by generalized quantifiers, corresponding to an arbitrary class of models associated with an abstract sentence -i.e. without a specific syntax.

This tutorial tries to give a general overview of the developments of abstract model theory, from the beginnings till its actual scenario, as far as classification of logics is concerned. After an introduction to the main concepts of the field, we describe the extensions of first-order logic and state Lindstrom's theorem. Secondly, we describe back-and-forth systems, which are a main tool in the field, particularly in the proofs of Lindstrom's and interpolation theorems. We then present the generalizations of these concepts through, among others, Barwise's, Caicedo's, Lindstrom's and Shelah-Väänänen's results for Lindstrom's and interpolation theorems in several logics. We finish with a schematic presentation of compactness and the relation between generalized interpolation and definability theorems in abstract logics, as studied by Makowsky, Shelah and Stavi.

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3.2.8 Universal Algebra for Logics

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In the middle of the nineteenth century two new fields - universal algebra and formal logic - came into being. They both originated in George Boole's ideas. The quickest development and the most remarkable features of the reunion of algebra and logic took place in the 1930s due to discoveries of Birkhoff, Tarski and Lindenbaum. Nowadays, universal algebra is one of the most important tools used in logical investigations. The aim of this tutorial is to present some important notions and theorems of universal algebra and their applications to formal logic. In the first part we explain basic notions of universal algebra, like an algebraic structure, a set of generators, homomorphisms, products, congruences, varieties and free algebras. In the second part we present the elements of lattice theory which are especially useful in description of algebras of different types of logics.

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3.2.9 Fuzzy Logics

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Mathematical fuzzy logic or fuzzy logic in the narrow sense is symbolic many-valued logic with a comparative notion of truth. Best understood systems are t-norm based, i.e. using continuous t-norms on the interval [0,1] as standard semantics of conjunction and their residua as standard semantics of implication. General algebras of truth functions are so-called BL-algebras (MTL algebras). The corresponding logic BL - basic fuzzy logic, both propositional and predicate calculus - is elaborated in Hajek's monograph [5], including axiomatization, completeness and incomplete-

ness results, results on complexity etc. The more general logic MTL was introduced in [1]. The results show that these logics have very good properties. Some of many new results on them will be presented.

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3.2.10 Tableaux Systems

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Tableaux systems are together with resolution procedures and sequent systems the main methods for automation of reasoning. They can be used both to construct proofs and to build models. Given a formula or a set thereof, a tableaux system uses a set of rules in order to build trees (or more generally graphs). Closure being defined as inconsistency in some

node, a formula is inconsistent if all possible tableaux are closed. For many logics there have been designed strategies which combine the rules in a way such that termination is guaranteed. For these logics construction of tableaux can be used as a decision procedure. Recently tableaux have found wide application as optimal decision procedures for description logics.

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3.2.11 Universal Computation

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The course explores the notion of formal systems, from a completely abstract point of view. First, the intuitive concept of computability is introduced via examples, which will be used as evidence of the fundamental properties shared by all computing systems. The concept of Abstract Families of Algorithms (AFA) is introduced, as a group of algorithms with a certain computing power. The possibility of isomorphically transforming an AFA into another by means of algorithms in the families themselves is used to strongly support the Church-Turing thesis. Finally, an abstract version of Goedel's Incompleteness Theorem is presented.

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3.2.12 Nonmonotonic Logics

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Too often, nonmonotonic logic is presented as a mysterious and esoteric affair. In fact the basic ideas are very straightforward. Almost any consequence relation may be taken as a base on which to build stronger nonmonotonic ones. In the tutorial we will describe the three main ways of doing this, give an overview of the families of systems that emerge when we take classical consequence as our initial base, and outline salient aspects of their behaviour.
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3.2.13 Multiple-Conclusion Logics

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Logic is about what-follows-from-what. The idea that an argument is to sanction the derivation of *one* conclusion from a *set* of premises is just as intuitive as, unfortunately, technically wanting. A more generous and

more symmetric account of consequence and entailment should in fact allow for the derivation of a *set* of alternatives as the conclusion of the argument. As it has been argued by universal logicians, the right choice of framework is important from a methodological, a philosophical, and a mathematical point of view. And that choice is nothing but fundamental if logic is to deserve a distinguished place at an updated Bourbakian architecture of mathematics.

The aim of this tutorial is to present the advantages and purview of a multiple-conclusion approach to logic and metalogic. Such an approach helps not only to eliminate any still existing bias towards *truth* (when *falsity* is just as respectable), but also to help expressing and comparing different kinds of logical systems. The very basic, though lamentably still insufficiently well-known, general issues and techniques related to *multiple-conclusion reasoning* will be presented in the tutorial.

The first lecture will compare the single-conclusion and multiple-conclusion approaches, for a motivation, and will survey some standard approximations to the very concept of logic. The second lecture will investigate what happens in such an environment with the general metalogical tools and concepts, both from an abstract and a semantical standpoints. The third lecture will deal with specific applications, further illustrations, and more esoteric results.

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3.2.14 Logics for Semistructured Data

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We present logical methods for querying semistructured data, in particular XML documents. Models for such documents are finite node labeled sibling ordered trees. Several logics are useful to query such data, and in fact the logical core of the W3C standard XPath is nothing but a modal logic. We discuss temporal logic, PDL and Kozen's Kleene algebras with tests as formalisms for reasoning and querying these kind of trees. The primary focus will be on techniques for obtaining expressivity and complexity results. No background on XML is needed. Some logical background is required, that is familiarity with first order logic and preferably the basics of modal logic. This course is intended for people who like to see logics in action, and who are interested in designing logical systems for a particular problem.

3.2.15 Substructural Logics

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Substructural logics owe their name to the fact that an especially immediate way to introduce them is by means of sequent calculi la Gentzen where one or more of the structural rules (weakening, contraction, exchange) are suitably restricted or even left out. Quite independently of

the proof-theoretical framework within which they are presented, however, substructural logics differ from classical logic in that they offer a more fine-grained analysis of logical constants: e.g. while classical logic has a single conjunction and a single (inclusive) disjunction, substructural logics can distinguish between a lattice and a group version for each of the two connectives. The topic of substructural logics links up nicely with research streams in universal algebra (e.g. the theory of residuated lattices), theoretical computer science (e.g. the study of parallelism), theoretical linguistics (e.g. type-theoretical grammars). The aim of this tutorial is to present the main ideas of substructural logics.

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3.2.16 Abstract Proof Theory

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The precise definition of formal proofs and the study of their structural properties are central issues in General (Structural) Proof Theory. On the other hand, Reductive (Interpretational) Proof Theory is mainly interested in the analysis of mathematical theories through their proofs and syntactical interpretation between them. General and Reductive studies is the classical division of Proof Theory. Cut elimination in sequent calculus and normalization theorems in natural deduction systems are fundamental results in general proof theory and are applied, for exam-

ple, to decidability problems and to problems related to the complexity and identity of proofs. An important set of problems in reductive proof theory includes consistency problems, functional interpretations, ordinal analysis and translations between logics and theories. Although we have some very general and abstract results both in structural proof theory and in interpretational proof theory, an "Abstract Proof Theory" where one would be interested in very general and abstract conditions for structural/interpretational proof-theoretical analysis of formal systems still does not officially exist. The main purpose of this tutorial is to present some old and new proof-theoretical results in an abstract setting.

Basic proof theoretical methods will be presented from an abstract standpoint and four central topics will be discussed in details:

(1) A general strategy for cut elimination in the following sense: suppose that the rules of a certain sequent system S satisfy some very general conditions. Define rewriting rules for proof transformation. Then, one can prove that S satisfies cut elimination.

(2) A general normalization procedure for the abstract introduction and elimination rules due to P. Schröder-Heister.

(3) The general idea of ordinal analysis for a theory T.

(4) The relation between translation among logical systems and normalization procedures.

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3.2.17 Category Theory and Logic

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Category Theory (CT) is a branch of mathematics regarded by its proponents either as an alternative to or as a profoundly revised and generalized version of the Set theory in its role of unifying conceptual framework for mathematics. Relationships between CT and logic are twofold. On the one hand, CT may be used as a powerful algebraic tool for combining logical systems and studying relations between logical systems. From this point of view applications of CT in Universal Logic are natural and straightforward. On the other hand, CT allows for an "internal" reconstruction of basic logical notions (truth-values, connectives, quantifiers) through a category-theoretic construction of topos. Since topos may be regarded as a generalized domain of discourse as well as a generalized geometrical space, this latter approach reveals new deep links between logic and geometry (topology). The two approaches in the categorical logic are not formally incompatible but prima facie they assume different attitudes towards the following philosophical dilemma: Whether any mathematical theory needs certain logical foundations (to be made explicit through some formal logical system) or the formal logic itself is nothing but a particular application of mathematics, so one should build logic on a mathematical background rather than the other way round? CT sheds a new light on this old controversy, and allows for a substantial revision of its terms. In this introductory tutorial we will give the basic notions of CT, briefly sketch both approaches in categorical logic, and consider the issue of Universal Logic from a category-theoretic point of view.
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3.2.18 Kripke Structures

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Relational semantics has gained the place of one of the mainstay semantics for exploring mathematical properties of various formal languages. The foremost class of languages explored is the class of modal languages. These include alethic (truth, possibility, contingency, necessity, etc), epistemic (knowledge), temporal and spatial, to name just a few in the endless array of modalities studied using relational semantics. The usefulness of modal languages and closely related classes of languages lies in good part in their computational properties. It was shown that modal logics the semantics of which can be represented in the so-called guarded fragment of first-order are all decidable. Usefulness of relational structures does not end with modal operators, however. Various propositional connectives have been studied via relational structures (e.g. intuitionistic, relevant, causal, paraconsistent implication, various negations, etc). In this tutorial we will emphasize the mathematical versatility of applications of this semantics.

The aim of this tutorial is to introduce the basics of relational semantics and give participants a taste of the plethora of its uses in modern logic. As we will see, the semantics and its related languages are used across the fields of AI, computer science, linguistic, mathematics and philosophy. We will emphasize its flexibility and capacity to model intentional phenomena, as well as the intuitiveness of this variable-free kind of quan-

tification. The semantics will be viewed as a logical toolbox, much in the spirit of the so-called Amsterdam school. First, we will give a general intro into relational semantics and modal and other germane languages. Then, we will explore the relational structures as a means for modelling propositional languages, and finally, we look at the place of this semantics in the general landscape of tools for logical modelling, that is, its connection to classical and other logics of interest.

References

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History: A nice summary of the development of Kripke semantics (and on why perhaps it shouldnt be called Kripke semantics): Mathematical modal logic: a view of its evolution, by Rob Goldblatt, Journal of Applied Logic, Volume 1 , Issue 5-6 (October 2003) Two seminal papers on Kripke semantics by the man himself: S. Kripke, Semantical analysis of modal logic i, Zeitschr. f. math. Logik und Grund. d. Mathematik 9 (1963), 67-96. Semantical analysis of intuitionistic logic i,pp.92-130, In Formal Systems and Recursive Functions, Amsterdam, North-Holland, 1965.

3.2.19 Labelled Deductive Systems

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Non-classical logics such as modal, temporal or substructural logics

are extensions or restrictions of classical logic that provide languages for reasoning about knowledge, belief, time, space, resources, and other dynamic 'state oriented' properties. As such, they are increasingly finding applications in various fields of computer science, artificial intelligence, cognitive science and computational linguistics. Driven in part by the rising demands of practitioners, there has been an explosion of research in non-classical logics and the development of new application-driven logics. However, developing such logics is a specialized activity that is largely restricted to experts: each new logic demands, at a minimum, a semantics, a deduction system, and metatheorems connecting the two together. This is non-trivial and there is often an *ad hoc* nature to the entire enterprise where one is forced to find new ways of extending old results or even to start from scratch. Labelled deduction systems (e.g. natural deduction, sequent and tableaux systems), on the other hand, exploit additional information of a semantic or proof-theoretic nature to provide a means of formalizing and implementing non-classical logics in a uniform, modular and 'natural' way.

The course is organized in three modules. In the first module, I briefly introduce non-classical logics (their syntax and semantics, and their applications), and then present various labelled deduction systems for them, focusing in particular on modal and substructural logics. I also briefly present implementations of these systems in a typical logical framework such as **Isabelle** or the **Edinburgh LF**. In the second module, I discuss the proof-theory and semantics of labelled deduction systems, focusing on completeness and normalization results. I also discuss proof-theoretical and semantical limitations of the systems (i.e. what one cannot do with them), especially in comparison with standard approaches, such as Hilbert-style axiomatizations, 'unlabelled' natural deduction, and semantics-based translations. In the final module, I show how labelled deduction systems provide a basis for the combination and fibring of logics. I also show how to establish (un)decidability and complexity results for non-classical logics by means of a proof-theoretical analysis of the corresponding labelled deduction systems.

References

The course is based on recent and ongoing work by the lecturer and colleagues. Some relevant publications can be found on my webpage at

http://www.inf.ethz.ch/personal/vigano/:
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3.2.20 Combinatory Logic and Lambda Calculus

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Combinatory Logic started in 1924 with a paper by Moses Schnfinkel. The aim was an elimination of variables and a reduction of the primitive notions of logic. This work was continued by H.B. Curry who introduced the term of combinatory logic. At about the same time, Church introduced his lambda calculus as a new way to study the concept of rule. Originally his purpose was to provide a foundation for mathematics. Combinatory logic and lambda calculus, in their type-free version, proved to generate essentially the same algebraic and logic structures.

This tutorial is intended as a short introduction to both fields of combinatory logic and lambda calculus. In the first part, the historical context and the underlying conceptual problems are presented for both cases. Especially the Kleene-Rosser paradox is discussed, which shows the inconsistency of Churchs first system, hence the failure of his foundational claim. In the second part we will present some of the essential properties of theses theories, briefly discuss their typed versions and also give a few examples of more recent developments.
References

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3.2.21 Consequence Operators

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We develop a basic theory of logical systems. Our aim is to provide elementary concepts and methods used for the study of propositional logics. We focus on the notion of completeness in both its aspects: global and local. "Global means here reference to the set all correct and reliable schemata of argumentation. This approach impels such formal variants of the notion as Post-completeness or structural completeness. In the local view we have to do with the notion of truth relative to given semantices such as logical matrices or Kripke models. We keep to Hilbert-style formalization of logical system. The basic concept is that of consequence operator due to Alfred Tarski. In the first part of our tutorial, we introduce concept and results central for the further study of the lattice of consequence operators. Logical matrices, and their variants, are discussed in the second part. They are regarded as propositional semantices and used for characterization of logical systems. Then we concentrate on different variants of the notion of completeness. Some methods and results used in the study of propositional systems are developed and briefly discussed there.
References

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4 First World Congress on Universal Logic

4.1 Aim of the Congress

Up to now no such congress has been held. Many conferences have been organized on specific techniques (combination of logics, labelled deductive systems, tableaux, etc.) or on some specific classes of logics (nonmonotonic logics, many-valued logics, paraconsistent logics, etc.).

The idea of this event is to put together these various activities in order to promote interaction and to provide access of these different fields to the non specialist.

This event is intended to be a major event in logic, providing a platform for future research guidelines. Such an event is of interest for all people dealing with logic in one way or another: pure logicians, mathematicians, computer scientists, AI researchers, linguists, psychologists, philosophers, etc.

4.2 Call for Papers

All papers dealing with general aspects of logic are welcome, in particular those falling into the following categories:

General tools and techniques for logics
- Theory of the consequence operator
- Abstract logic
- Multiple-conclusion logic
- Labelled deductive systems
- Kripke structures
- Many-valued matrices
- Tableaux
- Game semantics
- Category theory
- Universal algebra
- Combination of logic
- Bivaluations

Study of some classes of logics
- Non monotonic logics
- Modal logics
- Substructural logics
- Paraconsistent and paracomplete logics
- Linear logics
- Relevant logics
- Abstract model theory
- Fuzzy logics

Scope of validity / domain of application of fundamental theorems
- Interpolation (Craig)
- Definability (Beth)
- Deduction
- Compactness
- Completeness
- Cut-elimination

Incompleteness
Undecidability
Lindenbaum extension

History and Philosophy
Principles, axioms, laws of logic
Leibniz and logic as lingua universalis
Pluralism in logic
Square of oppositions
Truth and fallacies

4.3 Invited Speakers

4.3.1 Arnon Avron

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Non-deterministic Matrices and Modular Semantics of Rules
We introduce multi-valued structures (called Nmatrices) where the value assigned by a valuation to a complex formula can be chosen non-deterministica lly out of a certain nonempty set of options. The use of finite structures of this sort has the benefit of preserving all the advantages of logics with ordinary finitely valued semantics (in particular: decidability and compactness), while it is applicable to a much larger family of logics. Moreover: it allows for a modular semantics of rules of inference. We demonstrate this with two examples. In the first we provide modular semantics for any canonical Gentzen-type propositional rule, and use it to establish strong connection between the admissibility of the cut rule in canonical Gentzen-type propositional systems, non-triviality of such systems, and the existence of sound and complete non-deterministic two-valued semantics for them. In the second example we modularly provide effective semantics for a family of 32 paraconsistent logics resulting from the most basic logic of formal inconsistency (LFI) by the addition of some combination of 5 basic rules considered by the Brazilian school of paraconsistency.

4.3.2 Diderik Batens

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The Standard Format for Adaptive Logics as a Step towards Universal Logic
As the multiplicity of adaptive logics grew, it became the aim of the programme to characterize, in a formally precise way, consequence relations for which there is no positive test (ranging from handling inconsistency to inductive generalization). The standard format allowed for the sys-

tematization of the multiplicity. It characterizes an adaptive logic as a triple: a lower limit logic (usually a monotonic and compact logic), a set of abnormalities (defined by a possibly restricted logical form), and an adaptive strategy. It will be shown that the standard format (in itself) equips an adaptive logic with dynamic proofs, including the definition of final derivability, and with a (preferential) semantics. Moreover, nearly all desirable formal properties of an adaptive logic in standard format are provable in terms of this format alone, without relying on specific properties of the logic. Examples: soundness and completeness of final derivability with respect to the semantics, proof invariance, strict reliability (stopperedness, smoothness), criteria for final derivability, the relation between the adaptive logic, the lower limit logic, and the upper limit logic (that presupposes all abnormalities to be false), etc. A fascinating aspect is that adaptive logics can be combined and superimposed without loss of the advantages endowed by the standard format.

4.3.3 Janusz Czelakowski

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Infinitistic methods in the theory of definition
The focus is on three basic infinitistic ways of defining objects:

(1) the method of fixed-points,
(2) the transfinite recursion method,
(3) the method of algebraic completions of posets.

An important feature of many definitions is that they are inherently *infinitistic*. Definitions of this type make reference to infinite methods and constructions either by applying to the notion of a limit or by making use of properties of certain infinite sets or classes as e.g. the classes of ordinal numbers or well-founded relations. The definitions of the limit of a sequence, the limit of a function at a point, the derivative of a function or the Riemann integral of a function are examples of such definitions.

The treatment of infinitistic definitions based on the algebraic completions of posets seems to be not recognized in the literature (though

the concepts of an algebraic poset and semantic domains, relevant to that method, are due to Dana Scott, are well known). The notions of a directed-complete partially ordered set and of the algebraic completion of a poset play a key role in this approach. A poset Q is directed-complete if every directed subset has a supremum in Q. Every poset P possesses a unique, up to isomorphism, algebraic completion in which P coincides with the set of non-zero compact elements of this completion. Moreover, every monotone mapping F_0 from P into an arbitrary directed-complete poset Q has a unique order-continuous extension F from the algebraic completion of P to Q. The extension F of F_0 is defined in a certain canonical way.

The above, simple observations give rise to a certain general scheme of infinitistic definitions. This scheme is briefly defined as follows. At the outset there is a directed poset P_0 and a monotone mapping F_0 defined on P_0 with values in a directed-complete poset Q. The elements of the image $F_0[P_0]$ are called approximations to the defined concept. As P_0 is directed, the unique algebraic completion P of P_0 has a greatest element 1. After the identification of the poset P_0 with the set of non-zero compact elements of the completion P, the mapping F_0 uniquely extends to an order-continuous mapping F from P to Q. Then the limit value $F(1)$, belonging to Q, defines the infinitistic object approximated by the values $F_0[P_0]$.

The above scheme is anchored in the theory of order, and it does not refer to primitive concepts, having a distinct quantitative character, like numbers or sets of numbers. This scheme encompasses the definitions rooted in calculus which make use of the notion of a limit, as e.g. the limit of a sequence, the Riemann integral, or the Jordan measure. The scope of this method is examined by providing a list of useful applications and instances of the method.

4.3.4 Kosta Dosen

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Coherence in General Proof Theory
Coherence problems are completeness and axiomatizability problems studied in category theory since the 1960s, when Mac Lane solved a major problem of that kind for monoidal and symmetric monoidal categories. These problems are of general mathematical interest, but they are interesting in particular for general proof theory. There they appear in the program to find a criterion of identity of proofs in the notion of generality of proofs. This program yielded in [1] a nontrivial notion of identity of proof for classical propositional logic, in accordance with normalization procedures in the style of Gentzen. This was usually considered to be something unattainable.
Reference
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4.3.5 Michael Dunn

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Steps towards a Symmetric Gaggle Theory:
The Ubiquity of the Inequation $a \circ (b + c) \leq (a \circ b) + c$
In Dunn and Hardegree (2001) there are several ideas relevant to "universal logic." One of these is the notion of a "gaggle." I introduced gaggle theory in a series of papers as a general framework for studying algebras closely related to various logics. A second idea is "symmetric consequence" (derived from Gentzen's calculus LK and previously studied by Kneale, Scott, Shoesmith and Smiley, etc.). A third idea, which Hardegree and I related to the second idea, is that of a "hemi-distributoid." On this occasion I shall be relating the second idea to the first by way of the third.

The proto-typical case of a binary gaggle is a (distributive lattice-ordered) residuated groupoid with its characteristic law:

$$a \leq c \longleftarrow b \quad iff \quad a \circ b \leq c \quad iff \quad b \leq a \longrightarrow c$$

There is also its dual gaggle satisfying:

$$a \geq c \leftharpoonup b \quad iff \quad a + b \geq c \quad iff \quad b \geq a \rightharpoonup c$$

On this occasion I explore "gluing" these together into a single "symmetric gaggle." But how should $\circ$ and $+$ interact? It turns out that the hemi-distribution law

$$a \circ (b + c) \leq (a \circ b) + c$$

and its three symmetric variants are the key.

Reference

J. M. Dunn and G. Hardegree (2001), *Algebraic Methods in Philosophical Logic,* Oxford University Press.

4.3.6 Dov Gabbay and John Woods

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The role of mechanisms in universal logic

We view universal logic as the collection of logical modules at the disposal of an active interactive evolving cognitive agent. To analyse these modules we have embarked on a series of books entitled *A Practical Logic of Cognitive Systems.*

The first two *Agenda Relevance: A Study in Formal Pragmatics* and *Reach of Abduction: Insight and Trial*, have been published by Elsevier. Each book analyses in depth one of the mechanisms available to the agent.

The third book, coming next in line, analyses the fallacies. In our view, these are correct reasoning moves applied in the wrong context, maybe even deliberately by the reasoning agent.

4.3.7 Ramon Jansana

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Selfextensional logics and algebraizable logics
A logic SSS is said to be selfextensional if its interderivability relation is a congruence of the algebra of formulas. A finitary logic SSS is finitely algebraizable if there is a finite translation of formulas into equations and a finite translation of equations into formulas such that they establish an equivalence between the logic SSS and the quasiequational theory of its canonical class of algebras Alg(SSS). One of the important results of the theory of algebraizable logics says that if a finitary logic is finitely algebraizable then is class of algebras Alg(SSS) is a quasivariety. The result cannot be improved since there are finitely algebraizable logics whose class of algebras is not a variety. One example is BCK-logic. Many of the most well-known finitely algebtraizable logics have a variety as its class of algebras. An important problem in the theory of the algebraizable logics is to find an explanation of this fact. In the talk we will provide a partial explanation of that fact. We will use the theory of selfextensional logics to provide an explanation for a family of finitely algebraizable logics with conjunction which includes most of the well-known cases. To this purpose we will survey the theory of selfextensional logics with conjunction and show that these logics have a variety as their class of algebras. Then we will associate to every finitely algebraizable logic SSS of the family a selfextensional companion with conjunction $SSS^{\leq}$ with the same class of algebras, obtaining as am immediate consequence that Alg(SSS) must be a variety.

4.3.8 Arnold Koslow

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Structural Logic: Implications, Inferences, and Consequences
There ought to be a way of recognizing the variety and depth of logic with-

out making it hostage to narrow conceptions of proof theory or to broad conceptions of semantics; one that does not make logic hostage to epistemological and metaphysical theories, even though such philosophical considerations have sometimes played a role in the development of logic. The subject should also accommodate both the topic neutrality of some logic and not exclude logics that have dedicated subject matter. Historical versions of intuitionism due to Becker, Kolmogorov, and Heyting ought to count as logic, but on many accounts they do not. There are relations between pictures, between mental states, and between ethical statements, that could easily count as logical, but dont. We will look at the possible unification and insight that a structuralist approach to logic can offer.

4.3.9 István Németi and András Simon

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Universal algebraic logic, new perspectives in the Tarskian school

What is logic? What is a logic? (Two different questions, cf. [1],[2] for answers.) Why algebraize? Algebraization of logics as a method for putting all kinds of logics into a unifying, mathematically streamlined perspective [3],[4]. Duality theory between the world of logics and the world of (classes of) algebras. Characterization of domains of validity of fundamental theorems of logic, like interpolation (Craig), definability (Beth), deduction, compactness, ..., undecidability. The approach of Tarski's school (still active, presently expanding) to these and related issues [5],[6].

Algebraizing the semantic/model theoretic aspects leads to algebras of sets of sequences, i.e. of relations. Hence a central unifying tool for all the above is provided by theories of algebras of relations of various ranks: cylindric algebras, polyadic algebras of relations and their variants. Rel-

ativization is used as a tool for turning negative results to positive [7],[8]. This leads to positive results for the guarded fragment and bounded fragment of FOL as well as for logics of the dynamic (or arrow) trend, for relational semantics in general, and for making the finite variable hierarchy of FOL behave well. Definitional equivalence of many-sorted first-order theories as a step toward defining equivalence of logics [9].

Broadening the scope of applicability of logic: logic foundation of space-time theories (two-way connections). Cosmologic. The Gödel-Einstein collaboration. The unity of Tarski's approaches to (i) logic, (ii) universal algebra, (iii) algebraic logic, and (iv) geometry (space-time). Convergence of major schools: Tarski, Quine, van Benthem & Goldblatt.

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[9] Madarász: Logic and Relativity, section 4.3, 2002. Many of the above works are available at http://www.math-inst.hu/pub/algebraic-logic/Contents.html

4.3.10 Valeria de Paiva

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Equivalence of Logics:
the categorical proof theory perspective
The categorical proof theory approach to logic has been around since at least the early sixties (cf. the pioneering work of Lambek and Lawvere) and it has been very successful. As evidence, consider the number of practioners, the quality of international research projects (e.g. CLiCS I and II, Types, APPSEM I and II) and the sheer amount of research, papers, theses, monographs, software, etc generated.

The picture is less rosy, however, if you consider the impact it has had on logic itself.

In this 'propaganda' talk I will describe the basic ideas of categorical proof theory, some of its successes and some of its possibilities as far as applications back in logic are concerned. Thus I hope to explain the identity criteria that we arrive at, when confronted with the problem of deciding when two logical systems should be taken as "the same", using the perspective of categorical proof theory. As a paradigmatic example I will be discussing (mostly intuitionistic) Linear Logic, the main source of my intuitions.

4.3.11 Krister Segerberg

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This thing called deontic logic
In spite of the fact that deontic logic in its modern form has been around for more than fifty years, there is still ever so often a book or paper with a title such as "new foundations for deontic logic". In stead of providing yet another instance of this phenomenon, in this talk I will offer some reflections on why this is so and discuss what might reasonably be expected of a deontic logic worth its name.

4.3.12 Jouko Väänänen

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Abstract model theory without negation

Abstract model theory tries to systematize the study of the various extensions of first order logic, such as higher order logics, infinitary logics and logics with generalized quantifiers.

The study of such extensions was originally carried out in the context of infinite first order structures but there are more and more examples also in the context of finite structures. Some extensions do not have a negation in the classical sense, e.g. the Independence Friendly logic, and some infinitary logics with long game quantifiers. In the finite context the question whether existential second order logic is closed under negation is a famous open problem.

There is in principle no reason why this study could not be extended to non-classical logics permitting a semantic treatment. We give an overview of old and new results in abstract model theory with and without negation.

This is partly joint work with Saharon Shelah and partly joint work with Marta García-Matos.

4.3.13 Vladimir Vasyukov

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Structuring the Universe of Universal Logics

The usual definition of universal logic as a general theory of logical structures means under a structure an object of the following type S = <T, i >, where T is the domain of the structure (it is just the set) and i is the type of the structure which is the sequence of relations defined on the domain (it includes functions and not only relations between elements of the domain, but relations between parts of the domain, etc.). This gives

us an opportunity to clarify what does it mean for a logic to be equivalent or translatable into another one. Moreover, the last notion enable us to collect the structures into the category whose arrows are the translations of structures. It turns out, that such category has its own structure allowing us to consider the products and the co-products of the logical structures as well as the co-exponentials of those.

4.3.14 Yde Venema

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Algebra and coalgebra: mathematical environments of modal logic

If one studies modal logics from a mathematical angle, one is immediately drawn to the links with neighboring fields like model theory, universal algebra, or the theory of finite automata. An exploration and further fortification of these links naturally leads to a more abstract perspective on modal logic, and thus facilitates the import of more general ideas to the field. Recent years have also witnessed an information flow in the opposite direction. Ideas from modal logic, when properly generalized and perhaps translated, have turned out to carry over to a much wider setting. In the talk we will discuss two examples of this: the property of canonicity, and the concept of a bisimulation. These examples also illustrate how modal logic provides an extremely interesting interface between the areas of universal algebra and universal coalgebra.

4.3.15 Secret Speaker

Nobody knows who he is, but he will be there !

4.4 Contest: How to Define Identity Between Logics?

4.4.1 The Problem

Obviously a logic, such as classical propositional logic (or the modal logic S5), is not a structure, but a class of equivalent or identical structures, since it can be presented in many different ways (choice of primitive connectives, consequence relation vs tautologies, etc.) .

The problem is to find a good definition of equivalence or identity between logics which is reasonable and applies to a wide range of particular cases. The standard definition, "to have a common expansion by definition up to isomorphism", does not apply straightforwardly, as pointed by Beziau et al. (2001). Proposals such that one of Pollard (1998) or Pelletier and Urquhart (2003) apply only to some special situations.

So this fundamental problem is still open and we hope that someone will present a satisfactory solution in Montreux.

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4.4.2 The Competitors

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`Equipollent logical systems`

When can we say that two distinct logical systems are, neverthe less, essentially the *same*? In this paper we discuss the notion of *sameness* between logical systems, bearing in mind the expressive power of their associated spaces of theories, but without neglecting their syntactical dimension. Departing from a categorial analysis of the question, we in-

troduce the new notion of equipollence between logical systems. We use several examples to illustrate our proposal and to support its comparison to other proposals in the literature, namely homeomorphisms, and translational equivalence (or synonymity.)

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`What is a Logic?`
This paper builds on the theory of institutions, a version of abstract model theory that emerged in computer science studies of software specification and semantics. To handle proof theory, our institutions use an extension of traditional categorical logic with sets of sentences as objects instead of single sentences, and with morphisms representing proofs as usual. A natural equivalence relation on institutions is defined such that its equivalence classes are logics. Several invariants are defined for this equivalence, including a Lindenbaum algebra construction, its generalization to a Lindenbaum category construction that includes proofs, and model cardinality spectra; these are used in some examples to show logics inequivalent. Generalizations of familiar results from first order to arbitrary logics are also discussed, including Craig interpolation and Beth definability.

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`A Topological Approach to Universal Logic: Model-Theoretical Abstract Logics`
I present a model-theoretical approach to the development of a general theory of logics. An abstract logic is a triple consisting of a set of expressions, a class of interpretations and a satisfaction relation. The main idea is to use the observation that there exists a kind of pre-topological structure on the set of expressions and on a set of equivalence classes

on the interpretations. Properties of the logic are reflected in topological properties on these structures. I define different concepts of logic-homomorphisms by means of topological terms. All these concepts lead to the same concept of logic-isomorphism, a mapping that preserves all structural properties of a logic. Furthermore, I show that abstract logics together with a strong form of logic-homomorphisms (or some other relationships) give rise to the well-known notion of an Institution.

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`Relating algebraic models of predicate logic`

The Soundness and completeness theorem for a logic does not uniquely determine its class of models. For example, as complete models of intuitionistic predicate logic we have the class of models based on complete Heyting algebras on the algebraic side and that of models based on Lawvere's hyperdoctrines on the categorical side.

After organizing each kind of models into a category we prove that only hyperdoctrines have theories of intuitionistic predicate logic as their internal language, after relating the two categories via a categorical adjunction.

Moreover, we note that the internal language theorem does uniquely determine a category of models up to a categorical equivalence.

The same can be said for classical predicate logic with respect to models based on complete boolean algebras and those based on hyperdoctrines.

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`What is a logic, and what is a proof ?`

The two fundamental problems of how to define identity between logics and how to define identity between proofs are discussed. For the first, a solution is presented, and for the second a possible direction of research is proposed.

4.4.3 The Jury

The President of the Jury is Gerhard Jäger, President of the Swiss Society of Logic and Philosophy of Sciences. The two other members of the Jury are Vladimir Vasyukov form the Russian Academy of Sciences and Edward Hermann Haeusler from the Catholic University of Rio de Janeiro.

4.4.4 The Prize

The prize will be offered by Birkhäuser Verlag, who is sponsoring the contest.

4.5 Contributed Talks

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`Logic without self deductibility`

Self deductibility is the Stoic version of the law of identity: if A then A. In his Algebra of logic, Peirce argues that it "justifies our continuing to hold what we have held, though we may, for instance, forget how we were originally justified in holding it". Accordingly, the desire of keeping track of old proofs implies some restriction on the scope of self deductibility. In the "proofs as functions" paradigm, this leads to the fact that proofs should be injective and not surjective. Self deductible propositions correspond to Dedekind-infinite sets.

Building on this idea, we propose a simple model for a logic without self deductibility - not a category since identities do not exist. It suggests a natural system of logical axioms and rules. The most unexpected rule is: if A entails A and A entails B, then B entails B; in this context it is a form of Booleanness.

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`The Theoretical Framework and a Preliminary Implementation of Universal Logics`

This paper first analyzes the contribution and limitation of classical Mathematical Logics, which is called the Rigid logic while in real world, many problems have both intrinsic contradictions and extrinsic uncertainties. They need the mathematical dialectic logics, which will be referred as the flexible logic. Then it proposes the universal logics, a theoretical framework to cover most modern logics. The ultimate goal of the universal logic is to study the general principles of logics from the highest level, and to establish a universal and open theoretical framework for the logics, so as to normalize and guide the modern logics research and achieve the flexibility in mathematical logic. The key for achieving this goal is to introduce the flexible mechanism into the mathematical logic to make it capable

to handle contradictions and uncertainties. And then it also proposes a preliminary implementation of universal logics, the flexible propositional logics, finally applications of propositional universal logics is discussed.

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`From Logical Complementarity and Pluralism to Super-logic`

Paying attention to the relations between logic and linguistics, and the reference of logic to a possible world, this paper begins with emphasizing on i) main formal differences between logic and mathematics; and ii) the role of syntax, semantics, pragmatics, intuition and empirical knowledge in determining the truth / falsity of a sentence and the validity of an inference.

Then the paper puts under observation a) the fact that logic has not been able to cover all sorts of sentences of a typical language; b) the invention of different logics on the basis of various approaches / purposes / applications, in company with different implicit / explicit philosophical presuppositions on the one hand, and due to taking into consideration a kind of word-groups that has been disregarded by former logic(s) on the other hand. So, some changes bring about an endless sequence of rival logics: from changes happening in the realm of logical concerns, changes occurring in human understanding, to those occurring in some parts of a typical language. The occurrence of these processes is confirmed by history of linguistics, history of logic and philosophical analyzes.

So, we always confront a multiplicity of logics, in which the number of logics is potentially / actually increasing. Some of these invented logics- if they are logics at all- are contradictory to each other in some respects, and some of them are complementary. In this paper the complementarity would be underscored. Then it will be shown that a / the general theory of logics could not be a / the universal logic in the sense that it would encompass all logics. A / the universal logic, in this sense, may be of three sorts: 1) in the first sort it would be a set of common elements of so many rival logics; in this case it has no considerable number of members; it may be an empty set; furthermore, it, as a collection of different elements of endless sequence of logics, would be so sophisticated that it may be impossible to construct such a logic; 2) in the second sort it, as a formal

complex structure, may have a collection of parameters, called metric, so that the set of its variations could give the set of all possible logics; 3) in the third sort it would be a / the universal super-logic that could play the role of every possible logic, so that there would be no need for any possible particular logic.

In each case we would have a / the universal logic only if i) it could be constructed with such a structure that could include all possible logics; ii) it could be constructed with such features that it would be considered as the substitute for every possible logic. In each case, our universal logic must reflect all actual and potential possibilities of all languages in all possible worlds.

The author defends some principle of complementarity and, accordingly, encourages a) the invention of various new necessary logics, and b) the extension of various existing logics. In this way, firstly, each of the existing logics would be refined, and, secondly, a wider range of reality and language would be covered. Afterwards, it would be possible to go towards some better complementary standard logics, each of which would be faithful to reality and typical language in possible worlds on the one hand, and would be ready to be reconciled to other logics on the other hand. After this stage, some of the complementary standard logics would be able to go towards more and more generalizations and mutual competition for being, probably, a / the standard super-logic.

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`An analysis of first-order completeness from a computer-checked proof of Goedel's completeness theorem`

Goedel's completeness theorem for first-order logic has been recently mechanically checked. An advantage of a computer-checked proof is level of detail: because a computer does not refer to ideas or have mathematical intuitions, the steps in a proof must be small, clear, and explicit if the computer is to be able to check the proof. Computer-checked proofs also are electronic artifacts and can be searched and analyzed in ways different from those used to study an informal proof. Thus, with the help of a computer, it is possible to examine a computer-checked proof fairly exhaustively. The purpose of this paper is to analyze the notion of

(first-order) completeness by studying the new proof of Braselmann and Koepke. Our aim is to address a doubt about whether a machine-checked proofs of theorems could be illuminating; we wish to show that such proofs can indeed clarify our understanding of mathematical theorems.

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`Labelling in Modal Adaptive Logics. An Example`
Through their development, adaptive logics have often been devised as modal adaptive logics. That is, a modal logic L strengthened with the provisional application of a rule which is not in L itself. Logical systems using such an approach include inconsistency-adaptive logics based on Jaskowskis non-adjunctive approach, and logics for compatibility. While non-modal adaptive logics generally succeed in providing a natural reconstruction of reasoning, proof-formats for modal adaptive logics lack the same intuitiveness. Basically the drawbacks of the proof-formats stem from adaptive logics reliance on a purely syntactic use of modal logics, thus leaving some natural (semantic) insights in modal languages aside. Compared to other adaptive logics (essentially the original inconsistency-adaptive logic ACLuN1) part of the appealing naturalness of dynamic proofs is lost (partly because the rules are defined indirectly with respect to the existence of a Hilbert-style proof). The main purpose of this paper is to provide a labelled proof-format for modal adaptive logics which does not suffer from the mentioned drawbacks.

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`Magical Diagonalization`
In this paper we will discuss the active part played by certain diagonal arguments in the genesis of Computability Theory.

These enigmatical words by Kleene were our point of departure:

When Church proposed this thesis, I sat down to disprove it by diagonalizing out of the class of the -definable functions. But, quickly realizing that the diagonalization cannot be done effectively, I became overnight a

supporter of the thesis.

There are quite a few points made in this extract that may be surprising. Firstly, it talks about a proof by diagonalisation in order to test —in fact to try to falsify— a hypothesis that is not strictly formal. Second, it states that such a proof or diagonal construction fails. Third, it seems to use the failure as a support for the thesis. Finally, the episode we have just described took place at a time, autumn 1933, in which many of the results that characterize Computability Theory had not yet materialized.

The aim of this paper is to show that Church and Kleene discovered a way to block a very particular instance of a diagonal construction: one that is closely related to the content of Church's thesis. We will start by analysing the logical structure of a diagonal construction. Then we will introduce the historical context in order to analyse the reasons that might have led Kleene to think that the failure of this very specific diagonal proof could support the thesis.

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`The Metaphysics of Begriffsschrift Quantifiers`

Following a suggestive idea of van Heijenoorts (1967) that has more recently developed into an interpretive line (Ricketts (1985)), I take a detailed look at Freges understanding of quantification as he presents it in his earliest technical work on logic, the *Begriffsschrift* (1879). I situate this work in historical relation to Kant and some tensions in nineteenth century post-Kantian logic. By so doing, I argue that some important features of Freges conception of quantification emerge which have been overlooked by standard accounts.

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`On the expressive power of calculi with explicit substitution`

The object of this paper is to study and compare different calculi of explicit substitution for the lambda calculus, such as lambda sigma, lambda s, lambda upsilon and lambda x. We present preliminary results about specific substitution functions and structures which are present in the substitution calculus of some of these lambda calculi, starting from the

question if the identity function can be achieved with some substitution combination. We selected the lambda s and lambda upsilon de Bruijn calculi and exemplify with them due to their different styles. We show that the addition of the identity substitution to the calculus syntax, and appropriate rules, may preserve good properties. A long-term goal is to find a relation between the different substitution functions of a calculus and its good properties in some way. This could lead to an interesting comparison between calculi of explicit substitution.

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`A General Rule for Existential Quantifiers Elimination in Free Variable Semantic Tableaux`

During the past decade, tableaux systems have been subject of a renewed interest motivated by a theoretical and practical development that led to tableaux based automated or interactive theorem provers.

Existential quantifiers elimination in tableau proofs is dealt with by the delta-rule, introduced by Smullyan in the context of ground tableaux. Since then, the delta-rule has undergone several liberalizations, in the context of free variable tableaux. Such improvements fulfill the requirements of increasing system efficiency and of preserving the semantics of the existential quantifier.

Since the latter requirement could not be easily satisfied and new, more natural, and efficient delta-rule variants may show up, it is helpful to determine the basic conditions that any delta-rule should satisfy in order that soundness of the system is preserved.

We present a general delta-rule proviso, called meta delta-rule, giving a sufficient condition for a delta-rule variant to preserve soundness of a tableaux system.

The meta delta-rule provides a soundness proof schema, general information to choose right Skolem symbols, to construct the augmented signature and models and to compare different variants of the rule.

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`Intrinsic forcing and interpretation in Kripke models`
We examine some model theoretic themes such as Morleyisation and interpretation for a certain subclass of linear frame constant domain Kripke models.

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`Conceptoidal Logic as the Synthesis of Aristotelian Syllogistic and Predicate Calculus`
By the term 'conceptoid' I mean the function of a particular type represented to me an appropriate mathematical model of the logic-philosophical category 'concept'. At informative interpretation of any formal axiomatic theory we deal with a collection of main judgements expressing ratio of main concepts and serving, thus, as implicit definitions of these concepts. Purely process of building concepts on the basis of given ratio of them is committed in consciousness of the person and is very weakly inspected by modern means of formal logic. The conceptoidal logic allows reduce that ratio to the system of the function equations. For solution of this system the method of iterations is acceptable, and the convergence of a repetitive process to required set of nonblank conceptoids means consistency of the given axiomatic theory. The researches of feasibilities of conceptoidal logic for handle of knowledge bases in computer artificial intelligence's systems will now be carried out.

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`Lean Quaternary Temporal Logic: LQTL`
Boolean Logic does not implicitly provide a way of easily representing temporal logic. Lean Quaternary Temporal Logic(LQTL) offers a parsimonious representation of temporal logic with a nice explicit four valued ordering for aggregates of states. The outcomes of iterating LQTL are described and implications and applications are suggested.

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`Fuzzy logics among weakly implicative logics`
We present two interesting classes of propositional logics (understood as many-to-one consequence relation) related to mathematical fuzzy logic, and give some of their properties and characterizations. Weakly Implicative Logics are logics complete wrt preordered matrices (with upper sets of designated values). The class makes a good compromise between generality and easy tractability. Weakly Implicative Fuzzy Logics are those of them that are complete wrt linear matrices. We show several equivalent characterizations of the latter (eg, subdirect representation), and argue that they can be understood as the agenda of mathematical fuzzy logic. Furthermore, we show a uniform way of defining first-order logics over both classes of propositional logics. Our overall aim is to study the relationships between the area of fuzzy logics and other parts of logical landscape; and the development of universal methods for proving metamathematical theorems for broad classes of (fuzzy) logics at once.

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`A Uniform Interpolation and Propositional Quantifiers in Modal Logics`
We investigate uniform interpolants in propositional modal logics from the proof-theoretical point of view.

Our method is adopted from Andrew Pitts proof of uniform interpolation in intuitionistic propositional logic. The proof is based on a simulation of certain quantifiers ranging over propositional variables and uses a terminating sequent calculus for which structural rules are admissible.

We shall present this sort of proof of the uniform interpolation theorem for the minimal normal modal logic K as the basic step. It provides an explicite algorithm constructing the interpolants.

We discuss other modal logics extending K: the modal logic K4 for which the uniform interpolation fails and the Gdel-Lb provability logic GL.

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`Super-S5 logic S5-2 and semantics for logic programs`
We study logic programs under Gelfond's translation but using Modal Logic S5. We show that for arbitrary Logic Programs Ground NM modal logics between T and S5 are equivalent. Furthermore, that these logics are also equivalent to a NM logic that we call S52 logic constructed using the well known FOUR bilattice. However, we will call GNM-S5 this semantic to remind its origin based on S5. For normal programs, our approachis closely related to the Well-Founded-by-Cases Semantics. GNM-S5 satisfies Extended Cut and also satisfies classicality (as WFS+ does). Hence, we claim that GNM-S5 is a good candidate for a nonmonotonic semantics in the direction of classical logic.

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`Psychologism, Conventionalism, and the Epistemology of Logic`
How is basic logical knowledge possible? After describing three problems for a straightforward answer to the question, I reconstruct and discuss three approaches that attempt to locate a source of entitlement in the meaning of the logical constants. I show that each approach is either a form of psychologism or conventionalism. I end by raising a new question that points to a lacuna that must be filled if the dilemma of psychologism and conventionalism is to be gotten out of.

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`A Normalized Natural Deduction System for`
`a Modal Relevant Logic`
The paper sets up a Fitch-style natural deduction system for a modal relevant logic. The logic is an S4 modal logic based on the relevant logic DW, called DW-S4. I will firstly sketch the proof of normalization of DW and show how this proof extends to DW-S4.

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`Transcendental Logic's New Clothes`

In this paper I explain why philosophy in the sense of transcendental philosophy presupposes that there is a universal logic, and why this sets a limit to some understandings of logical pluralism. It seems that logical pluralism is either a version of relativistic semantic idealism a position no one should easily associate herself with, not the last, since it is wrong or it is only an appeal to the fruitfulness of a division of labour in logic research that is a helpful attitude to stop useless controversies, but it has little epistemological impact beyond what we already know about partial descriptions in other fields of inquiry.

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`Logic, Metaphysics and Meaning`
As defined by J.Y.Beziau, the objectives of Universal Logic (UL) are to accomplish a unification of the multiplicity of logics, generation of logics for specific purposes, determination of the domain of validity of metatheorems and clarification of basic logical concepts and axioms. Bziau suggests that UL allows precise definitions to be given of, in particular, truth-functionality and the laws of logic. While the first group of topics lies clearly within the standard domain of logic, the second, in my view, strongly implies metaphysical problems about the relation between logic and reality, that is, between logic, metaphysics and theories of meaning. It is not a trivial question to ask whether logic grounds metaphysics, as Kripke suggests, or metaphysics grounds logic. It can be shown that all classical and non-classical logics, for example, intuitionist logic, "import" physical or metaphysical assumptions based on a view of reality that presuppose a particular, essentially binary logic. Consequently, a major effort is necessary to avoid circularity. For UL to be truly universal, the concept of logic itself might further extension, or some other term, capturing the relevant ontology, might be preferable.

In the paper, I will look at the ideas of two major 20th Century thinkers, the metaphysics of Michael Dummett and the philosophical logic of the almost completely unknown Franco-Romanian Stphane Lupasco. Lupasco's novel framework grounds logical principles in basic physics. In the application of these principles to the above issues, the boundaries between logic, epistemology and phenomenology will not disappear, but

they will become more permeable. Classical topics, such as the square of oppositions, may be seen in a new light. This project may increase the value of UL as a major advance in the tools available to the logician and give an additional dimension to it, enabling its application in areas previously considered inaccessible.

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`Polynomial Ring Calculus for Logical Inference`
I discuss a new algebraic proof method for finitely-many-valued logics (and its particularization for PC) based on reducing polynomials over finite fields. The resulting mechanizable proof method is of interest for automatic proof theory, and is also appropriate for investigating questions on complexity.

Algebraic proof systems arise in the context of propositional calculus by identifying formulas as multivariable polynomials in the ring G[X] (where G is a Galois field) and by reducing propositional provability to checking whether or not such polynomials have values outside a prescribed range (in the classical case, if they have zeros). In this way, questions of satisfiability and provability can be treated by generalizations of the famous Hilbert's Nullstellensatz, a central result of algebraic geometry. I sketch here the ideas on the method, motivating the uses of this fundamental result to obtain new proof procedures for finite many-valued logics, and discussing its extensions to infinite-valued logics.

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`From Poetics to Logic: Exploring Some Neglected Aspects of Aristotle's Organon`
This inquiry started many years ago when, following a suggestion found in Avicenna (and partially in Thomas Aquinas), I tried to read Aristotles Poetics and Rhetoric as if they were an integral part of the Organon instead of separate works as they were sorted by Andronicus of Rhodes.

The results were quite surprising.

First, poetics and rhetoric, considered as sciences of speech, were much more intimately related to Aristotles analytical logic than it was generally

acknowledeged by prominent interpreters such as David Ross, Ingemar Dring, Éric Weil or even Chaim Perelman.

Dialectics (the Topics) operated as a bridge leading from these two sciences to analytical logic.

The types of speech encompassed by the four respective sciences did not only form a ladder, ascending from the more loose forms of persuasion to the more rigorous ones, but there was between them a whole net of cross-currents and implications that were too much obvious for Aristotle to remain unaware of them, notwithstanding the fact that he doesnt describe them anywhere.

There was, in short, an unified science of persuasive speech, whose principles were implicitly intertwined in the fabric of Aristotles Organon. These principles came to light as soon as one admitted the hypothesis that Poetics and Rhetoric were "a part of Aristotle's science of logic, as stressed by Avicenna. By means of a comparative study of the works consecrated by Aristotle to poetics, rhetoric, dialectics and analytics, these principles could be unearthed and accurately expressed. I called them the theory of the four discourses.

What is still more instigating, there was a deep consistency between them and Aristotles theory of abstractive knowledge. A very strict parallelism could be uncovered between the ladder of persuasive speech, which ascended from the imaginative argument to analytical proof, and the degrees of abstraction that climbed from sensuous perception to scientific reasoning.

The relationship that Aristotle envisaged between analytical logic and the looser forms of persuasive speech could not any more be seen as an opposition or a simple typological distinction, but as a whole system of transitions and conversions, intimately linked with the organic integrity of the human soul as capable of perception, memory, abstraction and reasoning.

Seen through the light of the theory of the four discourses, Aristotles philosophy shows to be more consistent than we could believe it to be after so many discussions about the philosophers evolution and changing opinions concerning vital points of his philosophy .

The theory of the four discourses has, moreover, some implications concerning Aristotles self-interpretation as a link in the historical chain

of Greek philosophy. This self-interpretation contains the seeds of a new understanding of cultural history as illuminated by the transition from myth to political rhetoric, to dialectical investigation and to the logical formalism of scientific knowledge.

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`Semantical Negation and Completeness`

The goal of this work is to discuss the semantical notions of classical negation, universal negation, existential negation and semantical completeness, in such way that they are independent of the particular semantical system in which they appear. The main challenge is to be as general possible, avoiding restrictions on the central elements of the theory that might be necessary if any particular discipline is adopted.

Semantical systems can be caracterized as symetrical and positive, by using semantical classical negation. An AbSem is said to be symmetrical if every sentence have a negation in the system.

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`About the origin of cylindric algebras`

The reference for cylindric algebras is the book of Henkin, Monk and Tarski in 1985 [1] where cylindric algebras are presented as an abstract generalisation of boolean algebras and where it is said (vol. 1, p. 23): "The theory of cylindric algebras was founded by Tarski, in collaboration with his former students Louise H. Chin, (Lim) and Frederick B. Thomson, during the period 1948-52". Henkin, Tarski and Monk also give (vol I, p.473) 2 references of a work of the mathematician Marc Krasner. The older one, from 1938, [2] is no more available but a more recent, short article of Krasner, in 1958 [3] explains that Krasner came to the idea of cylindric algebras from Galois's classical theory. The present work briefly exposes Galois' classical theory and the article of Krasner from 1958 [3].

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`Fuzzy logics in the logical landscape`

There is a formal delimitation of the class of fuzzy logics as class of logics complete w.r.t. linearly ordered matrices. We concentrate on elaborating this class and showing its connection with other known parts of the "logical landscape".

First, we reinterpret the core notions from the existing fuzzy logic research agenda (like standard completeness, extension by Baaz delta, etc.) in this formal setting. Then, we show that for each logic we can assign the weakest fuzzy logic extending it and use this fact as a methodological guideline for introducing new fuzzy logics.

Although there are more general theories of non-classical logics (like Abstract Algebraic Logic), they omit the characteristic properties of existing fuzzy logics. We demonstrate that the proposed formal theory of the class of fuzzy logics represents a reasonable compromise between generality and usefulness of its results for particular logics.

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`A New Real Axiomatization of D2`

In the late forties, StanisLaw JaSkowski published his papers on the discursive sentential calculus, D2. He provided a definition of it by an interpretation in the language of S5 of Lewis. The well-known axiomatization of D2 with the discursive connectives as primitives was introduced by da Costa and Dubikajtis in 1977.

However, it turns out that one of the axioms they used is not a thesis of the real JaSkowskis system (it is due to the fact that the authors used a different definition of the discursive conjunction).

The aim of my talk is to introduce a real axiomatization of D2, present a direct semantics for D2 suggested by Kripke-type semantics and prove that the axiomatization is sound and complete with respect to it.

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`A Galois framework with applications to equational characterizations of function classes`

In this presentation we focus on the definability of classes of functions of several variables on an arbitrary set A and valued on a possibly different set B.

We survey several approaches for characterizing function classes and provide simple conditions in terms of stability under certain function class compositions, which guarantee the existence of such characterizations. These methods are considered within a general Galois framework for functions of several variables.

In particular, we shall concentrate on definability by relational constraints and by functional equations, and establish a connection between these two definability notions.

Specializations by imposing certain invariance conditions on constraints and algebraic-syntactic restrictions on equations will also be considered.

The recent results discussed in this presentation were obtained jointly with Stephan Foldes.

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`Two Calculuses with Inequalities of Linear Combinations`

We propose a sequent calculus for extended formulas. The definition of an extended formula has an additional assertion;an inequality of any two linear combination of extended formulas is an extended formula.Only rational numbers are used for linear combination coefficients. It is rather suitable for the computer models. The extended formulas are convenient to describe the idea of perceptron. So the proposed sequent calculus may be used to represent an essential knowledge for artificial intelligence systems. We prove that the proposed calculus is conservative extension of traditional first order logic.

The proposed calculus may be used in informational systems when we use sums of properties.We will present the extension of propositional sequent calculus by inequalities of linear combination of the extended for-

mulas.The proposed extended formulas are more suitable for describing the perceptron idea in neural network.Proposed calculuses are steps to universal logic for knowledge representation in the information systems.

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`Are procedures logical objects?`

In this talk I will be concerned with the following question: can the sort of procedures customarily studied in computer science as algorithms coherently be regarded as mathematical objects in their own right? I will argue that, counter to both the traditional understanding of Church's Thesis and to recent proposals of Moschovakis and Gurevich, the proper context in which to approach this issue is not by attempting to identify individual algorithms with instances of particular models of computation. I will suggest that a significantly more promising approach is to locate an appropriate congruence on (formally presented) algorithms in the style of an abstraction principle of the sort which have been studied by (e.g.) Boolos, Heck, Hale and Wright in the attempt to rehabilitate Frege's logicist programme in the foundations of mathematics. I will discuss several of the exigencies involved with carry out such a plan including the need to formulate an adequately abstract models of computation, the potential applicability of techniques from modal logic and process algebra and underlying question of the consistency of the resulting second-order system.

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`Using Combinatory Logic for a synthesis and an analysis of meaning`

In the analysis of Natural Languages, there are two approaches of semantics : one, with the denotation and Model theory, the second with the representation of meaning. We are working in the second approach, using C.L with types for associating a predicate with its meaning. We take in amount two levels of description : (i) a predicative level with different lexical predicates and their arguments;

(ii) a representation of meanings by means of a scheme

(close to the notion of 'Scheme' given by Kant) . Every level is described as an applicative and typed formal calculus which relates predicative relations to instanced schemes.

At the level of predicative relation, from two basic types (term and proposition), are derived all types (predicates, quantifiers, connectors, negation, modal operators ...) At the level of meanings, we use basic types (individuals, locative places, massive, collective entities) and some typed relators as abstract operations, topological operators (Kuratowskiś algebra), movement, change, control, teleonomy...

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`Another paradox, 100 years later`

An arithmetical formal system PA without quantifiers is defined. We show a model for PA, and we exhibit a algorithm to decide, for all sentences of PA, whether it is true in the model. We arithmetize PA, and, using the diagonal function, we construct a sentence which says, in the model, that it is not demonstrable in PA; then we prove the inconsistency of PA. We compare our result with the Gödel's theorem and the Church's theorem, The three of them have an unexpressed condition: the algorithm thesis (that all algorithm is, or correspond with, a total and effectively calculable arithmetical function). Thus, it is necessary to conclude that algorithm thesis is not valid. We finish comparing our paradox to the liar's paradox.

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`Logic and Natural Language: Universal Logical Analysis of Natural Language`

One of the generally accepted features of logic is the fact that logic is above all an instrument. And this instrument has begun to be widely used for analyzing natural language during recent years. Topics such as description of language, determination of meaning of language expression as well as creating the formal semantics for natural languages have become new fields for applying logic. My contribution deals with the foundations of such an applications of logic. On a specific example of language par-

alogism described by Aristotle I will show great advantages of such an application as well as the reason why universal logical analysis of natural language has to always fail regardless which system of logic is used.

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`Natural Deduction Systems for da Costa's Hierarchy of Paraconsistent Logics`

In this work, we introduce the hierarchies of natural deduction propositional and quantificational systems DNC_n and DNC_n^*, $1 \leq n \leq w$, respectively.

We prove, by using the method of subordinated proofs introduced by Fitch (1952), that each one of the systems of these hierarchies is equivalent, respectively, to the corresponding system of da Costas hierarchies of propositional and quantificational paraconsistent calculi C_n and C_n^*, respectively.

Based on the definitions of the concepts of categorical proof, normal categorical proof, non-trivial categorical proof, direct reduction and reduction of a proof, we prove a Normalization Theorem (Fundamental Theorem, la Fitch (1952)), concerning categorical proofs.

THEOREM. In DNC_n and DNC_n^*, every categorical proof Π of length s or less is non-trivial, and has at least one reduction Σ which is non-trivial, normal, and no longer than the length of Π.

Following, we prove a subformula property and the non-triviality of the systems DNC_n and DNC_n^*.

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`Logical Form`

Logic is formal in the sense that all arguments of the same form as logically valid arguments are also logically valid and hence truth-preserving. (M. Gomez-Torrente)

In the paper we argue that to discover the entailment relation wherever it holds logical form can serve the purpose. The urgency of inferring logical consequences becomes obvious as soon as logic is applied to analyzing natural language expressions because the historically developed grammatical structure of a natural language hides the logical form that should underlie the given expressions. We present a method of analyzing natural language expressions that makes it possible to discover the most adequate analysis such that all the logical consequences of the analyzed statements can be inferred.

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`Categorical Abstract Algebraic Logic: The Isomorphism Theorem`
A well known result of Algebraic Logic states that two k-systems are equivalent iff there exists an isomorphism between their lattices of theories commuting with substitutions. This result can easily adapted to Gentzen systems, which extend k-systems. Recent works on Abstract Algebraic Logic have found in the Category Theory a powerful tool. Logics appears in this wide context as π-institutions, which generalize the concept of Gentzen systems among others. Voutsadakis proposed a notion of equivalence of π-institutions that extends the notion of equivalence between Gentzen systems. Moreover, he proved a criterion for this equivalence similar to the classical one but only for term π-institutions. In this paper I show with an example that this criterion is not valid for all π-institutions and I extend the notion of term π-institution to the notion of multi-term π-institution in order to cover Gentzen systems, which cannot be presented as term π-institutions.

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`Universal algebra and Boolean functions`
Clones and other equationally definable classes of Boolean functions are discussed with particular regard to lattice operations, the iterative operations of Malcev, and function class composition. Function class composition is seen to underlie DNF, CNF, Zhegalkin polynomial, and other normal form representations.

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`On the algebraization of valuation semantics`

In 1989, W. Blok and D. Pigozzi proposed a precise mathematical definition of the notion of algebraizable logic, which generalizes the traditional Lindenbaum-Tarski method. Nevertheless, many interesting logics fall out of the scope of this approach. It is the case of the so-called nontruth-functional logics, and in particular of the paraconsistent systems of da Costa. The major problem with these logics is the lack of congruence for some connective(s), the key ingredient in the algebraization process. Our goal is to generalize the Blok-Pigozzi approach by dropping the assumption that formulas should be homomorphically evaluated over algebras of truth-values of the same type.

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`Change, developpement and progress. Prof. R. Suszko's study in dynamics of theories`

The main purpose of my paper is a presentation of a project of prof. Roman Suszko called diachronic logic. The project is considered as a part of Ajdukiewicz's programm. Suszko introduced a distinction between the synchronic logic and diachronic logic. The synchronic logic consists of a language, axioms (logical and non-logical), a consequence operation and interpretations (models). The diachronic logic is a formal representation of evolutionary and revolutionary changes of scientific theories and of a human knowledge in general.

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`On the formulation of the principle of correspondance`

Tarski's conception of truth implies the principle of bivalence, if fundamental logical laws are presupposed. This poses a major problem of coherence for many authors who restrict bivalence to the past and present

and who nevertheless maintain the excluded third (like Aristotle and his commentators concerning the sea-battle argument). Many of these authors do, however, formulate the principle of correspondance by way of conclusions and not of conditionals. This way inconsistency is avoided. The paper discusses advantages and implications of adopting a correspondance theory of truth thus formulated in an Aristotelian manner.

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`Towards A Language for Beliefs and Knowledge Representation A Roadmap`

A roadmap of a formal logic programming language for beliefs and knowledge representation is presented by means of a society of intelligent agents, based on strong theoretical theories like epistemology and intuitionistic logic. We describe its general structure and explain why the need of those bases and how to measure beliefs so that they become knowledge by suggesting several methods to construct the latter with belief evolution. Some of them are consensus, belief negotiation, argumentation, and by meme evolution. Possible future applications and the need to build such a system, towards a conscious artificial conscious autonomous agent are also discussed.

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`Maps and Universal Constructions for Interoperability of Logical Theories`

Institutions are widely recognized as one of the most important formal notions of logic for specification pusposes. In this work we approach this subject by taking (logical) theories in arbitrary institutions as a way to express high-level architectural descriptions of fragments of a system and use theory morphisms induced by maps of institutions as a way to interoperate or connect these heterogeneous descriptions. Gluing of these arbitrary theories can be achieved by special colimit constructions induced by a given category of maps. It is shown that this colimit constructions

is universaly induced by a grothendieck construction.

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`Towards Universality in Logic: Philosophical Comments on Multimodal Systems`
One of the main aims of modal logic in the 21st century is to combine different isolated modal logics into more useful and flexible systems. In my paper I concentrate on presenting and evaluating one of the promising approaches in that area presented in The Is-Ought Problem. An Investigation in Philosophical Logic by Gerhard Schurz (Kluwer Academic Publishers, 1997; see also Kit Fine and Gerhard Schurz, Transfer Theorems for Multimodal Logics). Schurz generalizes his approach from alethic-deontic predicate logics to multimodal logics including any sentence operator. Particularly Schurz compares (1) value operators, (2) action operators, (3) knowledge-, belief-, speech- and volition-operators with each other. Schurz provides us with many interesting classifications, e.g. between descriptive and ethical operators and between neutralizing and nonneutralizing descriptive operators. In my paper I mainly deal with philosophical motivations and justifications connected with multimodal logics as presented by Gerhard Schurz.

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`A formal deductive system of fuzzy logic based on Schweizer-Sklar T-norm (`$p < 0$`)`
Based on Schweizer-Sklar T-norm (in this paper, we assume $p < 0$), a formal deductive system (is called) of fuzzy logic is introduced for the first time. We show that the system is a schematic extension of Lukasiewicz logic system, and Lukasiewicz logic system is a particular form of when two negation coincide (i.e. p=(1). The reliability theorem of is proved. The notion of partial ordering logic algebra is proposed based on formal

deductive system, and its basic properties and filter theory are discussed.

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`The Logic of Foundations and the Foundations of Logic`

In formal systems initialisation and closure are usually problematic. In mathematics itself reliance is placed on plausible assumptions as in the ZFC axioms of set theory with logic used to justify sufficiency and completeness.

When the subject is logic itself, the foundations are even more problematic because of the need to be self-referencing. These problems become critical in the use of logic for new (synthetic) applications where model foundations may be unreliable. Kant advanced the notion that propositions of a categorial imperative may be a priori but synthetic. It seems that his categorial imperative may be formally realised in the 'arrow of category theory'. This may help to resolve logically, and at the level of logic, the debate questioning the (analytic) status of category theory and its foundations. *References*

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`Pluralism in logic: intuitionistic logic and the case of smooth infinitesimal analysis`

In this paper, we support a Carnapian position of tolerance with regard to multiple systems of logic, suited to different purposes. But this in itself does not answer the question of whether apparent conflicts among systems are always resoluble. The case of intuitionistic logic is especially instructive. Its interpretation itself depends on the purpose and context. In its best known applications, in foundations of mathematics, we have argued

that it poses no genuine conflict with classical logic, as its logical symbols are given systematically different readings (proof-conditional, as contrasted with classical truth-conditional). Formal conflicts, e.g. Brouwer's continuity theorem vs. classical existence (in abundance) of discontinuous functions, are only apparent, not genuine. (Genuine conflicts can of course be found over extra-logical matters, e.g. the meaningfulness of classical mathematical practice.) Matters are less straightforward, however, in the case of smooth infinitesimal analysis, with its nilpotent infinitesimals, which must renounce the law of excluded middle in order to avoid outright inconsistency. Constructivist readings of logical connectives are not really appropriate in this case (as we argue), and the question is, what alternatives are there? Can a structuralist approach help, and how? These are the new questions we will explore, suggesting that a curious kind of vagueness-compatible with mathematical precision–may provide the key.

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`A logical model of rationality as conformity`

I provide three logico-mathematical solutions for the problem of characterizing "rational choice" in the case in which one agent is to choose from a finite set of options with the goal of conforming to the choice she expects another like-minded yet otherwise unaccessible agent to make.

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`Kripke's mathematical theory of truth`

Kripke's (1975) formal theory of truth is viewed as a criticism of Tarski's (1933) hierarchy of meta-languages, such that any object language cannot contain its own semantics. By contrast, Kripke defends the conception of a formal object language composed of an (infinite) hierarchy of partial interpretations. Truth is a partially interpreted predicate, and its interpretation is completed only through the mathematical property of (transfinite) induction thanks to which the truth predicate reaches a fixed point. In other words, Kripke's argument is derived from the Knaster-Tarski theorem (1955) asserting that the set of fixed points of a function

f in a lattice L forms a complete lattice. Yet, I purport to show that the mathematical foundation of Kripke's theory of truth is much broader than lattice theory, insofar as it rests on a principle first defined by Dedekind (1872) and pertaining to the Dedekind cuts of an arithmetic continuum.

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`A characterization of Quantified Hybrid Logic`
Quantified Hybrid Logic is an expansion of quantified modal logic. It contains the hybrid logic components: usual modal operators, names for states (nominals), variables over states, the operators for asserting that a formula holds at a named state and a binder that binds a state variable to the current state. It also contains the first order components: first order variables and constants and first order quantifiers.

Hybrid languages are modal logics where formulas can refer to states. In this work we deal with models of quantified hybrid logic with non constant domains and explore them. In the case of modal predicate logic that systems has been characterized by means of translations into a partial heterogeneous logic. We show in detail this "non orthodox" quantified hybrid logic and we provide a syntactic characterization in terms of heterogeneous partial formulas and models.

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`Consitency and Relevance`
I investigate how a notion of relevance can help to characterise a consequence operator with respect to an agent's set of beliefs. This is particuarly useful in the case of resource bounded agents, for which we cannot assume that a belief set will always remain consistent, but which we may want to draw certain consequences from. A notion of relevance is suggested, which partitions an agent's belief set into relevance classes. We can then define a consequence operator on the entire set of beliefs with respect to the consequences of some relevance class. Given a notion of the topic of a belief, we let a topic select an appropriate relevance class when performing a belief revision. We investigate the properties of such consequence operators and of belief bases structured by relevance, and

suggest their application to the field of resource bounded belief revision.

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`Minimal logical systems with R-operator: their metalogical properties and ways of extensions`
The main purpose of the paper is to describe two kinds of logical systems with R-operator.

The first one was introduced by Jerzy Los and developed by other logicians. These authors usually treated it as a temporal operator and their research concerned mainly syntactical aspects of R-operator. However, we can treat it more generally without deciding about its nature. It enables us to indicate a minimal group of axioms.

We shall also consider a completely different interpretation of R-operator. We can interpret it as intentional one, taking into account an relation of accessibility. It makes us change a minimal set of axioms. Moreover, we can look for new axioms that impose some additional constraints on semantic structures.

After a formal part of my paper I shall suggest some possible extensions of minimal extensional and intensional R-systems that make us add new axioms and produce new questions concerning metalogical properties of obtained systems.

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`Labeled Event Structure Semanti of Linear Logic Planning`
Labeled event structures is a model of concurrency, where causality between actions is expressed by a partial order and the nondeterminism is expressed by a conflict relation on actions. We further elaborate on the linear logic approach to planning, and provide a labeled event structure semantics for the planning problems. This way, we establish a bridge between concurrency and planning which provides a behavioral semantics of plans. As the underlying formalism, we employ the recently developed calculus of structures with the gain of additional proof theoretical properties, e.g., deep inference, which are not available in the sequent calculus presentation of linear logic. We provide an implementation of our ap-

proach and argue that our methods can be used to import methods of concurrency to planning.

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`Non Normality in Modal Logics, a Dialogical Survey`
We propose to try and give a unified account of non normality in modal logics, by expressing it withing the dialogical framework. We begin with the dialogical expression of reasoning in minimal models (Chellas 1980) and them build our way up to K.

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`Truth Function Theory in Predicate Logic`
There is a formulation of the truth function theory allowing to extend the last one onto the undecidable theoretical fields, in particular, onto predicate logic. This formulation is deductible from Frege's triangle. New semantic property of logical possibility (on Frege's triangle) is needed for this deduction. As a result truth function theory in new formulation allow us to find (in predicate logic) denumerable sets of classes of decidable formulas rather than search such isolated classes. Mentioned theory also have the pure mathematical consequences. At first, calculation of number of lines in truth table for any predicate formula can't be realized with the aid of 7 known arithmetic operations: it needs of introduction of the 8th operation of hyperpower into arithmetics. At second, the problem of truth estimation of the predicate formulas has a pure combinatorial interpretation as problem of calculation of combinatorial sums of special structure.

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`Uniforming the operational semantics of logic programming and sequent calculus`
The main issue which will be covered in our talk is the diversity of com-

putational methods and paradigms, which were developed by classical Gentzen-style proof theory (sequent calculus) and by logic programming (resolution method). The special attention will be paid to relations between syntax and semantics within logic programming. To formalise an interplay between sequent calculus and resolution method, we will provide an algorithm for transformation of proofs made in resolution calculus of first order logic programming to proofs made in Gentzen-style first-order sequent calculus. Finally, we will show that the provability of a first order formula in sequent calculus is equivalent to the computation of an answer for the corresponding logic program and the corresponding goal in resolution calculus. This will constitute the main result of the present work.

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`Clusters and modes of presentation`

Cluster semantics as used in the local reasoning approach (Fagin and Halpern) proves to be a promising tool for handling inconsistencies and indeterminacies in a variety of modal logics.

We attempt to generalize the cluster semantics method, and combine it with a "mode of presentation" function (a variant of which is introduced by Ye and Fitting) for presenting objects in various respects.

In the logic of belief the following weak sense of belief can also be introduced:

$$M, s \models_v B_i^{W2}\phi \text{ iff } \forall T \in \mathcal{C}_i(s)\ \exists t \in T,\ M, t \models_v \phi.$$

Resulting inconsistencies (plausible for *de re* beliefs) can be remedied using modes of representation to model consistent *de dicto* beliefs.

Clusters-and-modes semantics is also applicable in deontic logic, where it makes it possible to model *de re* inconsistent obligations. Cluster semantics has also an interesting application in temporal logic, increasing the indeterminacy of future moments of linear time.

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`Undecidability reconsidered`

The paper presents a formal reconstruction of Hilbert's and Bernay's

undecidability-proof of arithmetic, on which their undecidability-proof of first order logic relies on Grundlagen der Mathematik II (Supplement 2, C). Presuming the formal reconstruction of their proof the paper discusses several critics of undecidability-proofs. As the proof is a *reductio ad absurdum* relying on several assumptions the conclusion of the undecidability of first order logic is underdetermined. Two criticized assumptions are Church-thesis and the definition of a diagonal function. The paper ends by presenting an additional critic that does not negate the assumptions of the proof but the implied use of a meta language that allows one to formulate statements about the object-language. This critic presumes Wittgenstein's point of view that it is impossible to make true or false statements about the object language. Wittgenstein's critic of the use of meta language is grounded in a distinction of propositional functions and operations. He presupposes that formal properties such as derivability or logical validity should be defined by operations and that this excludes the possibility to use formal predicates such as is derivable ($\vdash$) or is logical valid ($\models$) as logical predicates in meta language. At last, it will be argued that the correctness of the undecidability-proof as well as its critics is undecidable unless a decision procedure will be presented.

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`Classical model existence theorem in propositional logics`

In classical propositional logic the classical model existence theorem, sometimes inappropriately called the extended completeness theorem, states the every consistent set of sentences has a classical model. From a proof-theoretic point of view, if one considers any weaker sub-logic L of classical logic CL, due to the weaker derivability one may think that L-consistency should be different from CL-consistency, i.e., for any proof-theoretically weaker system L there exist some L-consistent but not CL-consistent sets. (An impression like this may be from the completeness theorem, which states the equivalence of derivability and validity of classical logic.)

It is not so. We present a systematic way of axiomatizing propositional logics (dealing with $\neg\top$-consistency, *bot*-consistency, simple consistency, absolute consistency) so that the classical model existence theorem or the

extended completeness theorem (for any Σ, φ, $\Sigma \models \varphi$ implies $\Sigma \vdash \varphi$) hold.

Corollaries of this are:

Glivenko's theorem, and that classical model existence property does not characterize CL.

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A boolean prime ideal free proof of the embedding theorem of implication algebras into boolean implication algebras

J. C. Abbott has shown that an arbitrary implication algebra is embeddable into a boolean implication algebra (i.e.: associated to a suitable boolean algebra). But his proof depends on the prime ideal theorem for Boolean algebras. Without using this theorem, through an existential proof we prove a completeness theorem on positive implicative Propositional Calculus, which enables us to give a new proof of the above embedding theorem of Abbott.

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`Universality in temporal logic extended by predicate abstraction`

M.Fitting has proposed recently the idea of extension of propositional modal logics by predicate lambda-abstraction. He suggested to extend a modal propositional logic L by adding relation symbols, flexible constants and the operator of predicate abstraction, but no quantifiers. We apply this machinery to the case of propositional temporal logic. We show that the temporal logic extended with predicate abstraction and with just one flexible constant is capable to model faitfully finite state machines with one counter. It follows that the universal computational model, two counter automata may be fully specified in the logic with two flexible constants and therefore such a logic is not recursively axiomatizable.

Finally we show that in respect to expressive power the temporal logic with abstraction is placed strictly in between of propositional temporal logic and first-order temporal logic.

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`The Blok Incompleteness Theorem: how to generalize it and why`
This paper strengthens a famous theorem in modal logic known as The Blok Alternative. Namely, we show that the theorem holds if we replace "complete for Kripke frames" by "complete for lattice-complete algebras", "complete for atomic and completely additive algebras" or "complete for algebras which admit residuals" in the formulation of the theorem. It has quite surprising consequences for the theory of so-called minimal hybrid extensions or minimal tense extensions.

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`How should we study History of Logic?`
History of Logic is a discipline and an area of research that is not currently recognized by all logicians. I suggest to look at this area first historically and then analytically. By historical approach I mean
(a) presenting history of logic as a collection of logical theories ascribed to eminent logicians
(b) showing how logical theories are developing from one thinker to another.
Analytical approach is the one that moves the other way round. It starts from the conception, or model, of what one believes modern logic is. The key point of this kind of history of logic is that there will appear a multiplicity of histories each of which would stick to an old logical idea which seem to correspond to a newly born theory in the framework of modern logic.

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`Tableau Systems for Some Paraconsistent Modal Logics`
In this paper we present tableau-style proof theories for some modal extensions of two paraconsistent propositional logics: $RM3$, which allows for truth value gluts, and the weaker $BN4$, which also allows for truth value gaps. These proof theories are shown to be sound and complete with respect to their corresponding semantics. For comparison, we then

present some Hilbert-style axiomatizations of these systems proposed by Lou Goble, and bring out some of the comparative advantages and disadvantages of these vis-à-vis our tableau systems.

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`Evaluation games for fuzzy logics`
The paper deals with a game theoretical semantics for a broad class of fuzzy logics in the framework of evaluation games. We show that it is more general than the standard interpretation of fuzzy logics - it avoids the problem of safe structures. We introduce the notion of informational independence for fuzzy logics which leads - as in the classical case - to the formulas lacking a (partial) truth value.

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`Implicit Definability and Interpolation in Non-Classical Logics`
An exposition of known results and further directions on interpolation and definability in non-classical logics will be presented. We deal with various versions of interpolation and of Beth's properties: together with traditional variants of these properties we consider relatively new projective Beth properties and restricted interpolation. An algebraic approach gives us general methods of work with large families of logics: modal, intermediate, positive, paraconsistent, substructural, etc.

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`An abstract model to refine beliefs`
We attempt to model the process by which new or original beliefs are restricted to some condition, instead of being fully accepted or rejected. We call this process belief refinement. The use of the AGM model and commitment to classical logic to model refinement create some shortcomings, especially in normative cases where some versions of well-known deontic paradoxes show up. To overcome these limitations we generalize refinement operators to a setting of abstract logic where the consequence oper-

ator is not specified. In the picture of belief/normative change we come to, the agent does not correct (substitute) her beliefs/norms in front of conflicting experience; rather he/she searches for justifications for them through refinement of her propositions. We also discuss the possibility to use input/output logics to model refinement.

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`Prime Forms and Belief Revision`
The aim of this article is to revisit Dalal's operator for belief revision. Dalal has proposed a technique for revising belief bases based on the minimization of a distance between interpretations. The result is a concrete operator that can be considered either from a semantical point of view (distance between interpretations) or from a syntactical point of view (number of atoms that have their truth values changed). Dalal has shown that the so-called Alchourrn, Gardenfors and Makinson (AGM) postulates are satisfied by its operator. The AGM postulates constrain the revision process so that minimal changes occur in the belief set. In this article, our contribution is twofold: first, we improve Dalal's algorithm by avoiding multiple satisfiability checking, which are NP-complete tasks. Our algorithm requires only one NP-stage if beliefs are expressed in a specific syntax, namely the prime implicates and prime implicants. Second, we propose a new distance based on the number of prime implicates in contradiction with the incoming new information. We argue that in some cases changing a minimal set of propositional symbols do not necessarily entail minimal changes.

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`Normalizable Natural Deduction Rules for S4 Modal Operators`
Natural deduction systems for classical, intuitionistic and minimal S4/S5 modal logics with weak normalization were first presented by Prawitz in his PhD thesis. Therein, only $\Box$ was taken as primitive, although in classical S4/S5 systems, $\Diamond$ may be defined as $\neg\Box\neg$. There are some cut-free

Gentzen systems for S4/S5, and normalizable natural deduction systems for intuitionistic modal logics, but normalizable natural deduction systems for classical S4 and S5 with both $\Box$ and $\Diamond$ as primitive symbols were not yet introduced. For classical (without $\vee$ and $\exists$ and with restrictions to $\bot_C$), intuitionistic and minimal S4, Prawitz presented a normalizable version for the introduction of $\Box$, $\Box$I, by using a notion of essentially modal formula. However, Prawitz's rule for the introduction of $\Box$ in S4 is problematic. Medeiros, in the *Logic Colloquium 2003*, presented a counter-example where reductions involving $\bot_C$ did fail, and fix the problem for classical S4. In this presentation, we will introduce an S4 rule for the elimination of $\Diamond$, $\Diamond$E, which is also normalizable. Furthermore, by the fact that $\Diamond$ is a primitive symbol in our system, we will also show a new S4 rule for $\Box$I. Beyond these new rules for S4 modal operators, we will present the overall normalization procedure that takes into account all connectives, quantifiers and modal operators.

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`On defining constructive negation in logics of entailment`

We name a logic L a "logic of entailment" if L is a relevance logic with the Ackermann Property. The concept of negation we have in mind is (minimally) intuitionistic in character. The aim of this paper is to study within the context of the ternary relational semantics the possibilities of introducing constructive type of negations (in the sense here considered) in logics of entailment equivalent to or included in the positive logic of entailment E+.

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`Normal Logic Without Bivalence`

Classical two valued logic is perfectly satisfactory for mainstream propositions. But there are many propositions not in the mainstream. Classical logic for instance has problems dealing with issues concerning what is not, what could have been, what may or may not be, what is impossible and

what is necessary. For these, we need a more general, more inclusive logic.

A normal logic is a logic, whether bivalent or not, that satisfies certain conditions. Classical logic is usually thought of as normal; non-classical logics are generally considered deviant or non-standard logics, logics that deviate from the classical norm in order to achieve any of a variety of special purposes. But classical logic is not the norm of logic; it is just one realization of normal logic, a realization in which bivalence holds. There are also normal three valued logics, four valued logics, normal logics with any number of values. Normal structure is exemplified by Kleene's strong three valued tables for negation, conjunction, disjunction and negation. When there is a hierarchy of more more than two values, logical consequence preserves this hierarchy. The logic that results looks very similar to classical logic, the similarity due to the fact that both are normal logics. But there is a major difference. The logic developed in this paper does not assume bivalence.

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`Lewis Carroll's ‘‘Workable" Theory of Hypotheticals`
It's well known that Lewis Carroll, the author of the Alice books, was actually an Oxford University mathematician. There is at least one area in which Carroll's logical works influenced greatly his successors: Hypotheticals. Lewis Carroll wrote two papers on the subject, both published in the philosophical review *Mind*: *A logical Paradox* (1894) and "What the Tortoise said to Achilles (1895). Both have been widely cited and commented by the 19th and 20th centuries philosophers and logicians. A survey of the literature shows that no place is made for Carroll's own conception of Hypotheticals. The generally accepted idea is that Lewis Carroll himself was not conscious of the importance of his writings. However, a look at Carroll's private papers shows that he was developing a "workable theory of Hypotheticals, which, even if he died without revealing its content, can partially be reconstructed.

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`Model theory for Kripke Structures`

We study the relations of being substructure and elementary substructure between Kripke models of intuitionistic predicate logic with the same arbitrary frame. We prove analogues of Tarski's test and Löwenheim-Skolem's theorems as determined by our definitions. The relations between corresponding worlds of two Kripke models $\mathcal{K} \preceq \mathcal{K}'$ are studied.

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`The Logical ‘‘Tetradecahedron" Belongs to a (Fractal)Series of Geometrical Multidimensional ‘‘Logical n-Hyper-Tetradecahedra"`

This paper deals with n-opposition theory , an emerging field between modal logic and geometry. After recalling the basic tenets of the theory (Blanché, Béziau, Moretti, Pellissier), the paper will focus on a restricted but important family of alpha-3(m)-structures (the "logical hexagons"), and show that linear modal 3(m)-graphs generate, when m varies through N*, a very nice set of geometrical (almost fractal) regularities, organised in a series of n-dimensional solids, the logical n-hyper-tetradecahedra . These solids generalize Béziau and Moretti's "logical tetradecahedron", and are in fact a restricted but essential part of the beta-3(m)-structure predicted by n-opposition theory. It will be argued that, jointly with Pellissier's setting method for exhaustively expressing modal graphs, the series here obtained, when duly generalized, should help dealing with the difficult problem of determining the logical-geometrical shape of the general beta-n(m)-structure, namely by solving the problem concerning the general beta-3(m)-structure.

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`Transparent intensional modal logic and model theory`

Transparent Intensional Logic (TIL) is a highly expressive logical system. This system has been founded by Pavel Tichy and it was intended chiefly for logical analysis of natural language. Its expressive power has a great use in logical artificial intelligence. There is a need for a logic capable of recording any feature that could arise. We argue that TIL can serve this purpose but there is still much research to do, mainly foundations of TIL as classical logic and accommodation of other logics. In this paper

we are about to present a kind of model theory for TIL and show that it correlates with the intuitive view of models.

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`Pouring new wine into old skin: Hume and the Early Wittgenstein on Inductions and Causation`

This paper compares Humes claims about induction and Causation (in both the itshape Treatise and the *Enquiry* to the prima facie similar treatment of these issues by Wittgenstein in the Tractatus (esp. 6.3-6.3751 and 5.135-5.1363). The proposition that there are no grounds for believing that the sun will rise tomorrow appears in all three texts, and always does so within strongly anti-metaphysical frameworks. However there is much controversy regarding the exact nature of these frameworks and how they relate to the proposition in question. In the case of Hume, there is the question of whether or not he held a regularity view of causation. The early Wittgenstein, by contrast, explicitly states that There is no compulsion making one thing happen because another has happened. The only necessity that exists is logical necessity (T6.37). The trouble, however, is that the he took most (if not all) of the propositions of the Tractatus to be nonsense. Moreover, there is much debate as to whether or not he took these nonsensical propositions to nevertheless show profound ineffable truths which cannot be said. In this paper we examine the relation between these old and new readings of both Hume and Wittgenstein. We conclude that whether or not Hume was a proto-Wittgensteinian depends on whether the early Wittgenstein was a Humean, though of course whether or not Wittgenstein was truly Humean (i.e. true to Hume) in turn depends on whether Hume was a proto-Wittgensteinian.

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`Algebras for non structural logics`

This work deals with the question about algebraizability of non structural logics. Taking the subset of substitutions that preserve consequences

(structural substitutions), and taking a subset of the homomorphisms from the formula-algebra to each abstract logic model, we obtained a theory that reflects the lack of structurality in the logic and in its models. Defining equivalence between a logic and an extension of Birkhoff's (bidimentional) logic of congruences, in such a way that two they have the same structural substitutions and the same algebras in their models, we assert that the logic is PNS-algebraizable (PNS for Possibly Non Structural), and this process has several paralelisms with Abstract Algebraic Logic.

As results we have: Annotated Logics are PNS-algebraizable, equational definition of (least) filter in reduced models remain valid, and Padoa's method also remain valid. Moreover, if a logic is structural, our develop is not distinguishable of the standard Abstract Algebraic Logic.

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`The completeness theorem for temporal logic based on strictly ordered A-spaces`

The concept of A-space were introduced by Ershov with the purpose to develop the theory of computable functionals. Before axiomatizations of modal and temporal logics associated with strictly ordered f-spaces were obtained. Now the polymodal logic based on linear ordered A-spaces is considered. Polymodal calculus was introduced based on strictly ordered A-spaces with chosen basis subset. We prove that this calculus is complete with respect to the class of all strictly ordered A-frames. Also we prove that this calculus has the finite model property and therefore it is decidable.

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`Yet Another Proof of Cantor's Theorem`

We construct a novel proof of Cantor's theorem in set theory.

It has been an important endeavor in logic and mathematics to determine whether the proofs of basic theorems can be reformulated without invoking certain kinds of logical primitives. A striking instance of such a reformulation was provided by Yablo's paradox, which demonstrated

that it was possible to construct paradoxical sentences in logic, without the need to invoke either direct or indirect self-reference.

We carve another such path in this paper, by constructing a new proof of Cantor's theorem in set theory, without explicitly invoking the negation operation.

Every proof of Cantor's theorem - that for no set there is a function mapping its members onto all its subsets - constructs a subset which is *em left-over* by any onto mapping from any set to its powerset. The traditional diagonalization proof involves an explicit invocation of the negation operation in order to define the *em left-over* subset.

Our new proof of Cantor's theorem, though it uses diagonalization at a certain level, constructs the *em left-over* subset without explicitly invoking the negation operation.

Further, our proof can also be rewritten in a form which uses negation explicitly.

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`The Problems of Parallel Programs Representation in the Dynamic Logic`

Common sense does not impose so strict limitation between parallel and nonparallel programs as it makes for the parallel and nonparallel geometrical figures, or solids. As a consequence, the criterion of what kind of programs are assumed to be parallel may vary not just among the different fields of science, but even within one area. In the paper, the problem of delimiting parallel and non-parallel programs in the language of logic is analised.

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`Tableaux for minimal entailment`

Given a first order formal language L, the semantics is taken from L-structures whose universe has a finite number of elements. Then, for a natural number n, a restricted to n entailment relation, or minimal entailment relation, is defined between set of formulae and formulae. From the basic tableau system for classical logic, by modifying the rule for ex-

istential quantifier, a new tableau system is obtained. After proving the theorem according to which any finite set of sentences is n-satisfiable, n as natural number, if and only if its modified tableau has at least one finished open branch with depth less than (or equal to) n, some remarks about the applicability to finite model theory and others are made.

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`Some Transition Theorems for the Class of Extensions of Nelson's Paraconsistent Logic`
Description of pretabular logics and of logics with Craig interpolation property is transfered from the class of superintuitionistic logics to the class of extensions of Nelson's paraconsistent logic N4 with additional constant for absurdity, which generalizes the results of Sendlewski and Goranko for extensions of Nelson's explosive logic N3. It turns out that the class of N4-extensions, as well as the class of N3-extensions contains exactly three pretabular logics. These are maximal conservative extensions of pretabular superintuitionistic logics with the help of strong negation. At the same time, the class of intermediate logics contains 7 logics with Craig interpolation property, the class of N3-extensions contains 14 non-trivial logics with the same property, finally, the class of N4-extensions contains 28 non-trivial logics possessing Craig interpolation property.

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`A Proposal for a paraconsistent and paracomplete lecture of scotism: modal dilemmas and ontology of truth`
In this paper I want to propose some arguments for these assertions: 1) usually, the principle of explosion is attribuited to Pseudo-Scotus (*ex falso sequitur quodlibet* I believe that Pseudo-Scotus doesn't believe in the principle of explosion, at the contrary the same text supposed to be manifesting the principle of explosion is a critical argumentation against it - Scotist philosophy is stressing for a relevant conception of implication: 2) Scotism, by a strong ontological conception of norms as the issue of God's or human's will, refuses the universal validity of the principle of

bivalence so, it is possible to stress that there are genuine moral dilemmas, i.e. true contradictions there are metaphysicals and practical scotist reasons for a paraconsistent philosophy.

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`How the question ‘‘What is Logic?" leads to the idea of ‘‘Logic of Analogies`

The idea of "logic of analogies, or "dynamical logic is analyzed. This idea lies in the intersection of humanitarian sciences such as psychology and linguistics, and those parts of cognitive sciences which deal with the idea of "perception. From the point of view of modern logic most regions of pre-consciences processes are barely formalizable. We believe that it is true and it is so because of unavoidably static nature of theoretical language as such, independently on whether we talk about logic, mathematics or any other branch of natural science. However, human language, human thinking and human way of being in the world is principally dynamical. And, on the other hand, it is by far not just chaotic. Putting things together, we believe that only certain ways of computer modeling of logical processes (those that could not be grasped by any static logical theories) may pretend that they are the true models of (pre)conscience, or lingual, or even creative processes.

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`‘‘Setting" the Modal Graphs`

Our aim is to show that translating "modal graphs theory" into set theory by a suited device, through identifying logical modal formulas with appropriate sub-sets, one can, in a constructive and exhaustive way, by means of a simple recurring combinatory, exhibit all n-oppositional figures (that is, all alpha-n(m)-structures: hexagons, cubes, ., etc.) contained into the logic produced by the starting modal n(m)-graph (an exhaustiveness which was unreachable until now). In this paper we will handle explicitly the classical case of the modal 3(3)-graph, getting to a very elegant tetraicosahedronal geometrisation of this logic.

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`Logical rules and the a priori`
I discuss the question whether (and in which sense) we can see logic as an *a priori* matter. I argue for the conclusion that as logical rules are inseparably tied to language, knowledge of logic is inseparable from knowledge of (a certain) language; and hence that the only sense in which logic can be *a priori* is that we are born with predispositions to acquire languages of a certain sort, and that we cannot become what we call reasonable without acquiring such a language.

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`On some contradictions in (some) paraconsistent logics`
Paraconsistent logics are meant to deal with contradictions in the input without necessarily exploding. This aim is successfully achieved in such logics as da Costas (1974) and Batens (dynamic logics). Both of these make use of the *reductio ad absurdum* argument, tacitly accepting the principle of contradiction as their law.

Another type of paraconsistent logics presents a different type of contradictions. This is a contradiction within the logical commentary, that is, within the structure of the system. It accompanies the contradictions in the subject matter processed in the system. This happens e.g. within the proposals by Rescher and Brandom (1980) and Hunter (QC).

The final type of inconsistency to be met in paraconsistent logics is a contradiction between the logical commentary and the facts, to be found in Priest writings on relevant logics.

In each case its the Principle that remains untouched.

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`Syntactic Knowledge Fusion in a LDS Framework`
The aim of the paper is to present a formal model for the syntactic aggregation of equally reliable belief bases. The problem of merging different knowledge bases arises in several disciplines, from artificial intelligence to group decision-making.

A general problem with the syntactic majoritarian fusion operators is that they cannot take into account the source of each piece of information. This implies that from the union of the knowledge bases, different maximal consistent subsets are considered equivalent even if the information in one subset is supported by more bases than the information in another subset. This can be efficiently avoided using labeled formulas. This approach is inspired by the theory of Labelled Deductive Systems.

Furthermore, a syntactic fusion operator, which equally distributes the level of individual dissatisfaction, will be defined.

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`Constructing Kripke models of first-order theories`

We consider Kripke models for first order intuitionistic theories. A given model is called a n-elementary extension model if the natural ordering of its worlds, weak submodel relation, is strengthened to elementary submodel relation restricted to the class of Σ_n formulas.

Our main result gives a characterization of n-elementary extension models. The characterization in question allows us to find an axiomatization of the class of all 1-elementary-extension T-normal models for some suitable theories T.

We also provide examples of constructions of models of some subtheories of Heyting Arithmetic with applications to independence results. Moreover, we construct finite Kripke models of some weak arithmetic theories T such that some of their worlds validate only much weaker classical theory than the classical counterpart of T.

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`CondLean 2.0: an Efficient Theorem Prover for Standard Conditional Logics`

Conditional Logics have a long history, and recently they have found interesting applications in several areas of artificial intelligence. In spite of their significance, very few proof systems have been proposed for these logics.

We present CondLean 2.0, an efficient theorem prover for some standard conditional logics. It is a SICStus Prolog implementation of sequent calculi BSeqS recently introduced. The program comprises a set of clauses, each one of them represents a sequent rule or axiom.

The proof search is provided for free by the mere depth-first search mechanism of Prolog, without any additional ad hoc mechanism. CondLean 2.0 also comprises a graphical interface written in Java. We have tested CondLean 2.0 on over a significant set of sample sequents of increasing complexity and its performances are promising.

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`Irrevocability of the past and time-dependent modalities`

I consider an argument for taking necessity, as it occurs in a formal statement of the irrevocability of the past, to be a time-dependent modality. The argument has the form of an indirect proof, and shows that if we take the necessity operator to work semantically as a universal quantifier over possible worlds accessible from the current world of evaluation, without taking into account the role of time in determining the domain of such universal quantification, we run into undesirable consequences. The key idea which I exploit in the paper goes back to Thomason (1984), and consists in making the modal accessibility relation into a ternary one, where time is one of the three arguments of the relation. This change in the underlying accessibility relation is what makes it possible to represent time-functionality of modal operators.

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`Harmony and Modality`

Inferentialism about the logical connectives is the claim that their meanings are given by the rules for their use. Although the meaning of the connectives must be capable of being given by the inference rules for their use, not just any set of rules suffices to give them meaning, as Prior's example of 'tonk' revealed. The pioneers in the development of natural deduction systems for modal logic were Curry and Fitch. First puzzle: their logics have different Necessity- introduction-rules, but the

same Necessity- elimination-rules. Secondly, some of their logics share Necessity-introduction-rules, but lack a Necessity- elimination-rule. Both facts seem in tension with the demand for harmony in the rules. We proceed to formulate rules for the normal modal logics which are in harmony that is, in which the introduction-rule encapsulates the whole meaning of the modal operator and in which a clear distinction can be made whereby each rule has a form appropriate to each logic, by using the notion of a labelled deductive system, following Simpson and others.

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`From Universal Algebra to Universal Logic`
Whitehead's 'Treatise on Universal Algebra' intends to investigate all systems of symbolic reasoning related to ordinary algebra on the basis of Grassmann's and Hamilton's algebras, and on Boole's symbolic logic. We first review the developments of algebra and logic, from Boole and the early symbolic algebraists to the multiple algebras of Cayley, Peirce and Sylvester. These are the algebras that the later called 'universal'. Boole also initiated invariant theory, a major topic of research in 19th century algebra, that will lead us to Birckhoff's universal algebra through the developments of abstract algebra in the first decades of 20th century. Finally, relying on this notion of invariant in the context of Relevant Logics and their algebraic counterparts, we consider various structural properties of some of these logics that such a notion allows to enlight, in particular, those properties related to the Sylvester-Meyer's lemma.

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`Hirokawa on Right Weakening and Right Contraction`
In his paper, "Right Weakening and Right Contraction in *LK*", Hirokawa shows that for a certain sequent calculus formulation of first order classical logic, the structural rules of thinning on the right and contraction on the right cannot be separated; that is, any proof of a *singular* sequent using n occurrences of one will also use n occurrences of the other. Hirokawa notes that his result is sensitive to the formulation. In this paper we investigate this sensitivity, both with respect to the formulations of

the rules governing the connectives present and to the choice of the connectives themselves.

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`Identity and (De)Categorification`
In my paper I consider the issue of identity (i) in Frege's Grundlagen and (ii) in the category-theoretical framework, particularly in the recent program of "categorification" proposed by Baez and Dolan. While Frege supposes identity to be an unique universal logical concept, the program of categorification aims to deversification and systematic weakening of the notion of identity (providing an exact meaning of colloquial mathematical talk about identity "up to" certain equivalence). I also compare Frege's concept of abstraction with that of decategorification introduced by Baez and Dolan, and provide a simple example illustrating the phenomenon of stabilization in n-categories. Finally I touch upon some general philosophical questions concerning the category-theoretic account of identity.

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`Inference in Discrete Linear Temporal`
We study logical inference in terms of admissible consecutions (admissible inference rules) for the temporal linear logics. We start by a proof that even linear temporal logics do not enjoy finite model property. Main results of our research are:

Theorem 1. The temporal logic $DLTL$ of all integer numbers is decidable w.r.t. admissible inference rules.

Theorem 2. The temporal logic $L(cln)$ based on all natural numbers is decidable w.r.t. admissible inference rules.

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`The critique of formal deduction`
The issue of decidability is extremely important for the analysis of the axiomatic systems of The issue of decidability is paramount for the analysis of the axiomatic systems of science. In order to decide which formulae

function as laws inside an axiomatic system, certain criteria are necessary, based on which the formulae functioning as laws can be distinguished from the other formulae of the system. In modern logic, the criteria of decidability materialize into decision methods: the truth tables method, the normal forms method, the reduction method, etc. One of the most strongly contested aspects related to decision methods is their artificial nature and the fact that they cannot cover the diversity of argumentative practices. Decidability is also criticized because decision methods are far too diversified and also redundant, based on the same principles. Are decision methods really methods of decision? Some methods do not decide, but explain a rational course that cannot be understood at first sight. Strictly speaking, these are not methods of decision any longer.

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`Bimodal Logics with Irreflexive Modality`

As is well known, standard modal propositional logic cannot define all the natural assumptions related to ordered set: irreflexivity, antisymmetry and etc. In order to overcome this lack of expressive power, various additional tools have been proposed, e.g., difference operator D, nominals and satisfaction operator @i. In this talk, we propose a new extension of standard modal logic. Our extension consists in adding an operator ■ whose semantics is based on the intersection of inequality $\neq$ and accessibility relation R. Here, we will concentrate on answering the following two questions: (I) frame definability: what properties related to ordered set are definable in our new language? (II) transfer of logical properties: if unimodal logics enjoy Kripke completeness and finite frame property, then the corresponding bimodal logics in our new extension has the same logical properties, too?

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`On Causal Relevance in Belief Revision`

Ranking of beliefs is important in the belief revision process since they

suggest us a mechanism with which beliefs to give up when all the beliefs are comparable with each other. However, existing entrenchment orderings fall short of capturing the way conditional beliefs are entrenched in a knowledge base. We don' t have an approriate entrenchment ordering for ordering the conditional beliefs In this exposition, we propose a causal analogue of entrenchment ordering- namely *Causal Epistemic Entrenchment* ordering. Such an ordering is based on the intuitive notion of causal relevance. In the process we emphasize the need for causal epistemic states to enrich standard belief states with the source of causal information. Finally, we show AGM postulates needs to be modified in order to incorporate causal information.

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`The relative efficiency of propositional proofs systems for classical and non-classical logic`

It is well known that there is some hierarchy of the proof systems under the p-simulation relation, which determines the relative efficiency of proof systems for Classical Propositional Logic. In our paper the analogous hierarchy has been constructed for the well-known systems of Intuitionistic Propositonal Logic, as well as for some systems of Minimal Joganson's) Propositional Logic, described by us. We investigate also the relation between some of the corresponding proof systems of classical and non-classical logic. (joint work with An. Chubaryan, Arm. Chubaryan)

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`Why not universal logic ? Why no universal logic ! ?`

Can everything be qualified as logically true at times, or are there any natural laws ? Although universality is viewed nowadays as an old-fashioned myth, some persistent traits seem to hold for every particular system. Which ones ? From Aristotles certainty to Carnap's tolerance including Quine's charity, a large debate contrasts logical universalists and relativists. How to settle the matter ?

It will be attempted to show that any particular formal language requires a minimal justification for its rules and theorems, but that no one

can transcend some philosophic commitments. How then to admit of any natural logic ? A crucial distinction will be made between logic as a general type and as a single token : beyond its competing applications within formal systems, it appears as a law-like and inscrutable discipline which cannot be universal as one, for want of a common purpose between logicians themselves.

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`Generalized Rules, Direct Negation, and Definitional Reflection`

Generalized elimination rules for arbitrary logical connectives are modelled after the standard elimination rules for disjunction and existential quantification, expressing the idea that everything which can be derived from the premisses of each introduction rule for a formula, can be derived from the formula itself. In the framework of definitional reflection, this is extended to the case where, as in logic programming, arbitrary clauses for atomic formulae determine introduction inferences, by proposing a generalized elimination schema with respect to such clauses. This idea can be further extended to the case of explicit (direct) negation, where both assertion rules and rejection rules are present. Due to the rejection operator we can dualize clauses, generating positive from negative clauses and vice versa. The talk discusses different ways of defining this dualization, and addresses the question of how dualized (secondary) clauses interact with (primary) clauses given by definition.

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`Temporality in logics as a discovering activity:`
`a philosophical note on application`

I will argue that logic has its own temporality which stands at different level of time as manifold of temporality, based on an ontology which considers movement and information as primitive and state and object as secondary or higher order item regulating functions and roles of primitive items. A formal system of logic is represented syntactically. But there must be a reason that we call it logic. It is our feeling of some normativity for application of the system. In such case, logic is applied

to our activity to get or envisage with some information or situation, we call them discovering. In general, discovering gathers information at each stage. Roughly say, temporality of an activity at one stage is room for or relation with gatherable (but possibly uncertain) information provided other activities or processes. We consider discovering process which is an applicant of some logic. In this case, normativity comes from the relation between inference e rules. In actual application, we rely on gtruthh of sequent or theorem. A proposition is true means that, without any other information, what the proposition says is acceptable or forced in every application of the logical system where this proposition is represented. On this view, we will think about temporality of proof as doubled intention like Husserl's theory of time.

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`Is nonmonotonic logic a logic of induction?`

The study of non-deductive inferences has played a fundamental role in both artificial intelligence (AI) and philosophy of science. While in the former it has given rise to the development of nonmonotonic logics, as AI theorists have named them, in the later it has attracted philosophers in the pursuit of a so-called logic of induction. In this paper, we intent to analyze to which extent nonmonotonic logic can be said to be a logic of induction, in the philosophical sense of the expression. As a case study we will consider one of the most wide spread nonmonotonic formalisms Reiters default logic. From this brief analysis we will come up with what we believe to be interesting results concerning the foundations of nonmonotonic reasoning.

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`A Poor Concept Script`

Logic since Frege has universally accepted the overall grammar of his *B*egriffschrift, even though his symbols have been changed for more convenient ones. It is shown in this paper that there are at least three main faults with Frege's grammar, and that these have been what has generated some of the main philosophical problems and paradoxes in the tradition

which followed him. Clearly all future logics developed from this historical base must incorporate improved grammars which avoid these difficulties.

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`Classical versus quantum PDL`
I will present an axiomatization for a Logic of Quantum Actions LQA. This logic has been developed in joint work with A. Baltag, and basically is a quantum version of PDL (Propositional Dynamic Logic). I will pay special attention to the Kripke style semantics of LQA and focus on the representation theorem (and hence, completeness result) with respect to classical infinite Hilbert spaces and "phase-free" quantum actions. As a logic, LQA pushes the work on quantum modal logic one step forward into an action-labeled version (with labels for quantum "tests" and unitary evolutions).

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`Abductive reasoning through delta-resolution`
In order to explore the duality between deductive and abductive reasoning, we present a propositional calculus, named delta-resolution, dual to the resolution one. We say it is an abductive calculus, because every formula we obtain is not a logical consequence of the premises, but an hypothesis of them. Within this calculus, a process of abduction is defined so that for a given abductive problem: (1) every formula generated by this process is a minimal abductive hypothesis (soundness), and (2) every minimal abductive hypothesis is generated by delta-resolution (completeness). We have implemented this process in Prolog, concluding its better efficiency than other approaches (like the Aliseda's semantic tableau one). The extension to first order logic has been explored too. The delta-resolution calculus has also a philosophical interest, based on the parallelism between the processes it follows and many ideas coming from the Philosophy of Science.

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`An abstract consequence structure`
Tarski's pioneer work on abstract logic conceived the consequence structure as a pair (X,Cn) where X is a non-empty set (infinite and denumerable) and Cn a function on the power set of X, satisfying the some postulates. Based on these axioms, Tarski proved a series of important results. A detailed analysis of such proofs shows that several of these results do not depend on the relation of inclusion between sets but only on structural properties of this relation, which may be seen as an ordered structure. Even the notion of finitude, which is employed in the third postulate may be replaced by an ordered substructure satisfying some constraints. Therefore, Tarki's structure could be represented in a still more abstract setting where reference is made only to the ordering relation on the domain of the structure. In our work we construct this abstract consequence structure and show that it keeps some results of Tarki's original construction.

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`First order logic with empty individual constants`
In contrast to classical first order logic, MC1 is a system, which is capable of dealing with empty names (individual constants). It is interpreted on a domain, which contains a subset of - technical - elements. These are the values of the interpretation of empty constants. The latter take part in sentence forming the usual way. All atomic sentences containing empty terms become false, consequently their negations are true. This might be unwanted, so MC2 introduces true predicative statements containing empty constants based on meaning postulates. Relying on the discussion about referential vs. substitutional interpretation, different types of individual constants get different treatments. The main advantage of that approach is it's independence of extra-linguistic facts - in particular, there is no need to check whether non-existing entities have or have not a property.

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`Institutions: Methodological Implications`

Institutions have been introduced by Goguen and Burstall as an abstract concept of logical system. The main idea was to do computing as much possible independent from the underlying logical system. We claim that the theory of Institutions should be seen as an abstract meta-theory for semantics since they satisfy the Tarski-type criteria: Generality, Material adequateness, Interdisciplinarity, Formal correctness, distinction between object and meta-languages. From the methodological point of view institutions provide: Relativistic view, ?op-down approach, Dynamic level of abstraction, Translation of problems and solutions, and use of more than one languages.

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`Temporal Logic of Branching time and extensive games`

In this paper we would like to consider possibilities of description of games in the terms of temporal logic of branching time. Games are specific process. If we consider a notion of process, then we have to consider its temporal context. It seems that a natural way of interpretation of games is its interpretation in terms of temporal logic. Extensive games can be modeled in terms of temporal logic of branching time if a notion of agent we add to semantics and define a notion of prediction. Moreover, we would like to discuss on possibilities of description of infinite extensive games in terms of temporal logic of branching time based on intuitionistic logic.

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`Studying MV-algebras with the tool of natural duality`

In this lecture, we propose to summarize the recent applications of the tool of natural duality to the study of MV-algebras. For exemple, for a given finitely generated subvariety A of the variety of MV-algebras, we can use natural duality to study the free and projective members of A and the properties of subalgebra lattices of the algebras of A. We can also extend, as in the boolean case, the duality to some classes of MV-algebras with an additive modal operator.

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`Judicial knowledge revision with minimal negation`
A set of legal sentences, or a code, forms a colossal knowledge base; when we revise a law in it, the scope of its influence may often be enormous. The idealistic revision should certify the logical consistency, viz., the knowledge base Δ does not contain both of φ and $\neg\varphi$ for each propositional sentence. However, being considered the variety of interpretation and the abstractness of laws, this ideal is not practical. Because legal sentences includes multiple concepts of negation, such as contradiction, partial negation, dual negation, denial, prohibition, and so on, these should not be reduced to a unique symbol of $\neg$.

In this study, we adopt the concept of graded negation by Gabbay et.al and present a paraconsistent logic of judicial knowledge revision.

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`On minimal sufficiently rich sets of formulas`
The aim of the talk is to present a general algebraic setting for investigations into so-called *s*ufficiently rich sets of formulas over a given logic and especially into minimal (or smallest) sets of such formulas. The crucial role played by splitting formulas and splitting algebras is revealed. The findings are applied to the realm of intermediate logics, normal modal logics and substructural logics without contraction.

In the research I have made intense use of ideas presented in papers of M.Zakharyaschev, V.Jankov, S.Jakowski, A.Kuzniecovand V.Gerchiu.

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`Algebrizing Hybrid Logic`
In this paper we introduce and study an extension of hybrid logic in which the set of nominals may be endowed with an algebraic structure. Among other things we present an adaptation of the notion of a bisimulation to this language, and a sound and complete tableau calculus.We motivate our contribution with some examples: The connection of Hybrid Logic with Monadic Second Order Logic and Graph Rewriting are the most in-

tresting ones.

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`Many-Valued Multiple-Expert modal models`

In AI and other branches of Computer Science expert models are often studied and used. The experts we use here have the task of evaluating formulas of modal logic. An expert model consists of a set of experts and a domination relation, which dictates how each expert's opinion must be in accordance to opinions expressed by other experts. In this setting, experts may be dominant or dominated.

Such expert models were introduced and investigated by Fitting in the period of 1991-92. Fitting examined models where experts would assign truth-values to formulas in the classical two-valued (true/false) manner; these were called multiple-expert modal models. Moreover, he introduced Heyting-style semantics for modal logics – called many-valued modal models – and showed their equivalence to multiple-expert modal models.

In this paper, we examine multiple-expert modal models in which experts reason in a many-valued fashion: they assign truth-values choosing from a finite distributive lattice (ie. a finite Heyting algebra) of truth-values. These expert models, which generalize those of Fitting, are called many-valued multiple-expert modal models and are shown to be as well embeddable – and thus equivalent – to many-valued modal models. Hence, many-valuedness has no intrinsic consequences for multiple-expert modal models.

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On Logics for Generally and their Relational Interpretations

Some logics for generally (LG's, for short) were introduced for handling assertions with vague notions, such as some versions of 'generally' and 'rarely', by non-standard generalized quantifiers. Here, we show that such LG's can be faithfully embedded into first-order theories of certain

predicates, called coherent. This provides a framework where the semantic intuitions of families (for 'generally') can be combined with proof methods for classical first-order logic (CFOL, for short). This framework supports theorem proving about 'generally', as it enables using proof procedures and theorem provers for CFOL, and it also helps clarifying the role of such extensions of CFOL. We concentrate on some LG's, but the main lines can be adapted to similar LG's.

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`Infinite-Valued Propositional Type Theory for Semantics`

In natural language semantics along the lines of Montague the simple type theory by Church functions as a kind of universal logic where possible worlds are treated as indices. The logic is also the starting point for many automated reasoning systems and is one of the traditional foundations of mathematics. However, in natural language semantics consistency cannot be assumed and a paraconsistent logic seems needed. The combination of higher order logic and paraconsistent logic has not been much investigated. We propose a paraconsistent type theory that is in a sense even a simplification of the simple type theory. There is only one basic type, namely the type of propositions, with a countably infinite universe of truth values. The system can be seen as a many-valued variant of the elegant propositional type logic by Henkin and Andrews, and it has interesting relationships to transfinite type theory.

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`On the Problem of the Adequacy of Representation of Knowledge`

The process of the fragmentation of knowledge takes place in the human mind, according to the differentiation of the objects in the reality that is being recognized. This fragmentation is not, therefore, unrestricted, does not act like cookie cutter (in Putnam's sense), by use of which we can invest objects with any given shape. This is so because knowledge is obtained in two ways: theoretically and empirically. On theoretical grounds, from the asserted units of knowledge are derived other ones, whereas the empirical approach records the knowledge that comes as a

result of experience. Agreement between the theoretical and empirical kinds of knowledge is usually executed through a representation of this knowledge, that is its representation in a language of the domain of science. The task of providing an agreement of knowledge thus formulated is called the problem of the adequacy of representation of knowledge.

The aim of the present work is to formulate the bases of a formal theory of the adequacy of representation of knowledge. This theory is built over the classical set theory ZF.

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`Negation in Categorial Grammar`

Buszkowski investigated three ways of using negative information in Categorial Grammar: (i) admitting negative data in type assignments, (ii) using restrictions of language models, and (iiii) admitting negated types. Whereas Buszkowski investigated the addition of De Morgan negation to the associative Lambek Calculus of syntactic types, in this paper introducing negated types into the non-associative Lambek Calculus results in a kind of strong negation that turns the functor-type forming directional implications of Categorial Grammar into connexive implications. For example, $\sim (y/x)$ is provably equivalent with $(\sim y/x)$. Thus, an expression e is of type $\sim (y/x)$ iff for any expression e' of type x, the phrase structure ee' is not of type y. We define the product-free non-associative Lambek calculus NL with strong negation and prove cut-elimination, decidability, and completeness with respect to a relational semantics. We shall also discuss the introduction of negated product types.

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`Emerging Truth: A Metamathematical Model`

The paper includes a set theoretic construction upon which an emerging notion of truth can be built. The inspiration for the construction is physical science rather than arithmetic. The viability of the model as a useful image presupposes that complex model relations can be identified and assessed. If the construction has sufficient clarity and intuitive appeal, the next step is to generate actual knowledge structures (complexes of facts,

theories and inference rules) and see whether the architecture of the construction permits information otherwise unavailable to be found. The key to the construction is to see epistemic adequacy as a function of explanatory adequacy over time, rather than as conformity to pre-existing models (e.g. predicted outcomes). For the latter the relation between theory and data is a function mapping expectations onto outcomes. This construction relies on a function that maps from a deep explanatory base onto the theories upon which ex pectations are based.

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`Meaning and Interpretation`
The paper is an attempt at a logical explication of some crucial notions of general semantics and pragmatics. A general, axiomatic, formal logical theory of meaning and interpretation is outlined in this paper. In the theory, according to the token-type distinction of Peirce, language is formalized on two levels: first as a language of token-objects (material, physical objects) and then as a language of type-objects (ideal, abstract objects). The basic notions, i.e. the concepts of a well-formed expressions, its meaning, denotation and interpretation are defined on the type-level by means of some primitive notions introduced on the token-level.

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`Is logic axiomatizable?`
I defend the negative answer to the question in the title by considering sentences that involve plural constructions (or plurals), such as There are some critics who admire only one another. We can intuitively see that this sentence is logically implied by infinitely many sentences, but not by any finite number of sentences among them. So the logic of languages that are rich enough to include the sentence is not axiomatizable.

To put this argument in proper perspective, I shall discuss contemporary accounts of plurals and suggest that the accounts fail to do justice to the logic of plurals because they are based on the traditional view of plurals as devices for abbreviating their singular cousins. And I shall give a sketch of my account of the logic of plurals that are based on the view

of plurals as substantial devices that complement singular constructions.

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`Compositionality and the Truth Predicate`
A compositional semantics is a key component in the construction of modern formal languages. However, it will be demonstrated in this paper that this assumption of compositionality has a cost for a formal language. It will be shown that a consistent truth predicate, for any formal language with a compositional semantics, must be restricted in some sense. This result will be established by examining certain phenomena involving the Liar Statement and statements about the Liar Statement.

Given this result, the common restrictions placed on the definition of a truth predicate in a formal language seem to be the result of assuming a compositional semantics, not a necessary feature of a formal language. This opens the possibility that a formal language with a non-compositional semantics could support its own unrestricted truth predicate. The paper concludes by addressing the question of what can be learnt about the structure of such a formal language from the phenomena identified.

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`Moods and Negation`
The aim of this paper is to pose some general questions and sketch some tentative answers regarding the phenomenology of negation in the natural language. The theoretical framework that is being used combines dynamic semantics [Groenendijk, Stokhof, Veltman] with dynamic modal logic [Van Benthem, De Rijke]. For the purpose of providing a ground for the discussion, a simple system of dynamic semantics for imperative logic will be presented. The system combines: Lemmon's approach to syntax in imperative logic, treatment of commands as prescribed actions [Segerberg, Belnap et al.] and simple three points action semantics [Von Wright]. Several interrelated issues will be briefly discussed: the relation between speech acts with negative content and negated speech acts, the universality of negation across natural language moods, the typology of

natural language imperatives and their expressive power, the characteristics of logical rules for negative imperatives given the structural rules for prima facie consequence relation.

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`The Ways of Orient Logic`

This article discusses the logic in orient philosophy. Talk about the deep logical phenomena in the Book of Change, the ZhongGuang theory in Buddhism?. In the view of algebra logic is a kind of relation, a nice logic. I have studied the inner essence of logic in orient philosophy. I found that there are many formal phases-changing structures in these theories, I integrate the ways of calculate in orient philosophy with normal mathematics. With the help of Formal Semantics and Fractal analysis, through the thick fog of culture I will give orient logic a clear image. On the other hand, classical logics show us their own seats and characters in the full-aspects view of orient philosophy. I will talk about a principle that every existence have its own logic value or say function. From this sight we can gain a new image of the world and it will help us approach the essence of logic.

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`Quasi-logical quantifiers and semantic universals`

One of the empirical "universalistic" claims concerning natural language quantifiers is that all quantifiers are conservative ($CONS$). The purpose of this talk is: (1) to characterise algebraically a (new) class of quantifiers called $QLOG$, quasi-logical quantifiers, and (2) to justify the following language universal: all natural language determiners satisfying certain syntactic conditions denote quasi-logical quantifiers. Most of the established formal results are valid only in finite models.

$QLOG$ is defined as follows: $F \in QLOG$ iff for all properties X, Y_1, Y_2 if $|X \cap Y_1| = |X \cap Y_2|$ then $F(X)(Y_1) = F(X)(Y_2)$. The following results are established:
(1) $QLOG$ is an atomic Boolean algebra which is a proper sub-algebra of $CONS$

(2) Algebras $CARD$ and $CO-CARD$ are proper sub-algebras of $QLOG$
(3)The algebra $QLOG$ is atomic and its atoms are determined as follows: for all m and A the function $at_{A,m}$ such that $at_{A,m}(X)(Y) = 1$ if $X = A$ and $|X \cap Y| = m$ and $at_{A,m}(X)(Y) = 0$ otherwise is an atom of $QLOG$.
(4) Proportional quantifiers are $QLOG$

Since natural languages have n-ary determiners we generalise most of the above algebras to algebras of n-ary functions. This move allows us to reanalyse some unary determiners as binary making the proposed universal more plausible.

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