

Progress Report 04 (Final Report)  
ConsRel, Fapesp Project 2004/14107-2  
Logical Consequence and Combinations of Logics  
— Fundamentals and Efficient Applications

Period: May 1st, 2008 to March 31th, 2009

Main Researcher: Walter Carnielli (CLE/IFCH-UNICAMP)

**Resumo**

This is the fourth and final report of CONSREL Project covering activities developed during the period from May 1st, 2008 to March 31th, 2009. The first section contains a brief summary of this report in Portuguese. Most of the bibliographical production of the Project can be found at

<http://www.cle.unicamp.br/principal/grupogta/Thematic-Consrel-FAPESP/>

**Sumário**

O Projeto CONSREL trata da investigação acerca das relações de consequência, enfocando diversas vertentes:

1. estudo da questão da expressividade das relações de consequência dentro de padrões específicos, tais como aspectos qualitativos versus quantitativos;
2. investigação das formas gerais de semânticas formais (isto é, semânticas formuladas com precisão matemática e para as quais se possa dispor de métodos ou técnicas de caráter formal, em particular algébrico ou categorial);
3. investigação dos métodos e técnicas de combinação (síntese) de sistemas lógicos ou de relações de consequência;
4. investigação dos métodos e técnicas de decomposição (análise) de sistemas lógicos.

O Projeto, em resumo, se constitui dos seguintes módulos:

- Módulo 1: Fundamentos de Combinação de Sistemas Lógicos (*Task 1: Fundamentals of Combining Logics*);
- Módulo 2: Aspectos Computacionais das Combinação de Sistemas Lógicos e Demonstração Automática de Teoremas (*Task 3: Computational Aspects of Combinations of Logics and Theorem Proving*);
- Módulo 3: Lógicas Quânticas e Algoritmos (*Task 3: Quantum Logics and Algorithms*).

Todas as produções bibliográficas do Projeto encontram-se disponíveis na página:

<http://www.cle.unicamp.br/principal/grupoglt/Thematic-Consrel-FAPESP/>

Fazemos aqui uma breve descrição, quantitativa e qualitativa, a respeito dos principais resultados atingidos dentro de cada “Task” no período de 01/05/2008 até 31/03/2008. Para uma avaliação qualitativa deve-se consultar a Seção 2. Para uma descrição das atividades organizadas a partir dos membros componentes do Projeto deve-se consultar a Seção 3.

Dentro da **Task 1: Fundamentals of Combining Logics**, coordenada por Marcelo Coniglio, foram elaborados e publicados 12 artigos completos em revistas ou capítulos de livros e 13 artigos em conferências sobre tópicos relativos às diferentes linhas de pesquisa deste módulo. Uma nova e promissória linha de pesquisa foi inaugurada, concernente à representação e combinação de sistemas lógicos utilizando a linguagem de multigrafos.

Alguns dos trabalhos, como parte das tarefas específicas da Task, são devotados à investigação das questões básicas relativas aos processos de combinação de lógicas e à definição de tradução entre lógicas. Outros artigos tratam de outros aspectos mais específicos das combinação entre lógicas, tais como a combinação de lógicas algebrizáveis e o desenvolvimento de quantificadores modulados.

Com relação à **Task 2: Computational Aspects of Combinations of Logics and Theorem Proving**, coordenada por Marcelo Finger, foram publicados 4 artigos completos em revistas e 12 artigos em conferências, todos eles relevantes às linhas de pesquisa desta Task: aproximação de lógicas, provadores automáticos eficientes de teoremas e inferência sensível a recursos. Uma das características principais da pesquisa desenvolvida nesta Task foi, como em anos anteriores, a procura de aplicações, principalmente no contexto de robótica, através do desenvolvimento de jogos educativos baseados na noção prática de inferência. Vários trabalhos foram desenvolvidos nesta direção.

Finalmente, no que concerne à **Task 3: Quantum Logics and Algorithms**, coordenada por Walter Carnielli, um artigo foi publicado, outro está sendo preparado e um evento (workshop) foi organizado em Istanbul, Turquia. Diversos seminários e palestras foram ainda apresentados.

Além disso, continuamos a trabalhar no seguinte artigo, submetido a críticas por pareceristas de uma importante revista científica:

“*A Paraconsistent Approach to Quantum Computing*”, cuja nova versão está sendo submetida a publicação internacional. Versões preliminares foram postadas nos “CLE e-Prints” e no sítio “arxiv”:

[http://www.cle.unicamp.br/e-prints/vol\\_8,n\\_1,2008.html](http://www.cle.unicamp.br/e-prints/vol_8,n_1,2008.html)  
(<http://arxiv.org/abs/0802.0150>).

A difícil investigação sobre a questão da expressabilidade lógica dos estados quânticos emaranhados continua, tendo como base lógicas não-adjuntivas definidas através de operadores modais. Outro problema ainda não resolvido se refere à possibilidade de se estender o famoso Teorema de Cook para circuitos lógicos não-standard (definidos por meio de cálculos de polinômios com variáveis ocultas) e algum progresso tem sido feito nessa direção.

Na nossa avaliação o quarto ano do Projeto revela que o esforço de pesquisa unificado em torno do temas das “Relações de Consequência” foi altamente compensador, e o Projeto atingiu (ou melhor, está atingindo) seus mais altos objetivos. Uma continuação do Projeto por mais um ano está sendo proposta em conjunto com este relatório.

Continuando com a notação adotada nos relatórios anteriores,  $\boxed{\text{Ref}}$  denota que a referência [Ref] corresponde a uma publicação produzida pelos membros do Projeto durante o período.

## 1 Introduction

The fourth year of the CONSREL Project, as the previous ones, has been a very productive period. Many papers were published or submitted for publication in important scientific journals, and several MSc and PhD students have finished their theses in the context of the Project.

Following a policy of saving paper, and as done in the previous report, we do not include printed material in the Scientific Report. Most of the papers published within the context of the Project can be found at the following webpage:

<http://www.cle.unicamp.br/principal/grupoglt/Thematic-Consrel-FAPESP/>

The structure of this Report is as follows: The rest of this section recalls the Project’s setting, describing its domain, goals and the structure in which the Project tasks were divided. Section 2 reports the achievements in each of the Project tasks. Section 3 details the personal contribution of each member to the Project’s goals. Finally, Section 5 discusses work in progress, plotting the directions of the Project in its continuation. Using the same notation as in the previous report,  $\boxed{\text{Ref}}$  denotes that the reference [Ref] corresponds to a publication produced by Project members within the reported period .

## 1.1 The Project domain

The Project CONSREL deals with the topic of Logical Consequence and Combinations of Logics. This wide topic allows us to deal with many subjects, and we have chosen to concentrate on the following:

- The study of methods for combining logics. This encompasses the ways logics can be put together to generate more complex systems, as well as the ways a logic can be decomposed into simpler ones. The combination procedures can generate a single logic, as in the fibring or in the possible-translations approach, or the process can be asymptotic and generate a class of logics, as in the families of logics that approximate classical logic.
- The study of practical applications of combinations of logics, which covers the fields of theorem proving, AI, belief revision and the study of novel models of computation, such as quantum computation and quantum algorithms.

To cover this wide spectrum we face the problem of combining logics from the mathematical, computational, conceptual and philosophical points of view.

## 1.2 The Project goals

As we have stated in the Project proposal, the aims of this Project are directed towards the following aspects of combination of logics:

1. To study the fundamental issues of combining logics, covering the following points:
  - Specific methods for combining logics, such as *fusion*, *products* and *fibring*.
  - Algebraic and categorial aspects of logic combinations, such as *Blok-Pigozzi algebraization*.
  - Formal semantics for logic combination, such as *possible-translations semantics* and *society semantics*.
2. The study of computational aspects of logical combination, addressing the following topics:
  - Approximations of classical logic and the development of approximate theorem provers.
  - Belief Revision and its relation with the notions of relevance generated by approximation processes.
  - Logics *with* uncertainty, as opposed to logics that reason *about* uncertainty. These logics of practical interest can be modeled as a combination of classical logics with probability theory or with fuzzy logics.

3. The study of particular logics of interest resulting from combination of logics, namely:
  - Quantum Logics, which are connected to mathematical questions on Hilbert Spaces, Lie Algebras and Topology.
  - Quantum algorithms which, from the standpoint of combination mechanisms, can be seen as superpositions of classical models.

### 1.3 The Structure of the Project

To achieve the above mentioned goals, the Project is divided into three main tasks, each of which by its turn subdivided into several subtasks, as follows.

**Task 1: Fundamentals of Combining Logics**, coordinated by Marcelo Coniglio. Subtasks:

- Subtask 1.1: Combinations of Logics and their Applications
- Subtask 1.2: Splitting and Algebraizing Logics
- Subtask 1.3: Algebraic Semantics for Modal Logics
- Subtask 1.4: Algebraic and Categorical Aspects of Logical Consequence

**Task 2: Computational Aspects of Combinations of Logics and Theorem Proving**, coordinated by Marcelo Finger. Subtasks:

- Subtask 2.1: Approximations of Classical Propositional Logic
- Subtask 2.2: Logics for Ontologies<sup>1</sup>
- Subtask 2.3: Resource Sensitive Inference
- Subtask 2.4: Automatizing Paraconsistent Inference

**Task 3: Quantum Logics and Algorithms**, coordinated by Walter Carnielli. Subtasks:

- Subtask 3.1: Quantum Computation and Quantum Logics
- Subtask 3.2: Polynomial Ring Proof Procedures
- Subtask 3.3: Paraconsistent Turing Machines

### 1.4 Human Resources of the Project

Some adjustments in the human resources connected to the Project, due to different reasons, are the following:

- The Task Coordinator Marcelo Finger (DCC-IME-USP) will continue leading this Task but now not listed as a “main researcher”, since he will be acting as a “main researcher” of another FAPESP Thematic Project;

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<sup>1</sup>This Subtask replaces the Subtask “First-Order Approximate Inference”.

- Joselyto Riani (DCC-IME-USP), Angela Weiss (MAT-IME-USP) and Odilon Otávio Luciano (IME- USP) have left the project due to personal reasons;
- Carlos Hifume and Rodrigo de Alvarenga Freire (IFCH-UNICAMP) finished their PhD and left the project;
- Samir Gorsky, Newton Marques Peron, Rodrigo Podiacki and Teófilo de Sousa Reis (IFCH- UNICAMP) and Guilherme de Souza Rabello (IME - USP) finished their MSc and left the project;
- Márcio Moretto Ribeiro (DCC-IME-USP) and Anderson de Araújo have been promoted to PhD students last year;
- Leandro Suguitani and Rafael Rodrigues Testa (IFCH- UNICAMP) finished their MSc but continue into the project as Phd students.
- New Master students were incorporated into the Project:  
Dante Cardoso, from IFCH- UNICAMP, with a grant from CNPq; Tarcísio Genaro Rodrigues, from IFCH- UNICAMP, with a grant from FAPESP; Fernando Giroto, from IFCH- UNICAMP.
- New PhD students were incorporated into the Project:  
Marcos A. Alves and Evandro Gomes, from IFCH- UNICAMP.
- New external collaborators were incorporated into the Project: Catarina Dutilh-Novaes (from the Faculty of Humanities, Department of Philosophy University of Amsterdam), Leon van de Torre (from the Faculté des Sciences, de la Technologie et de la Communication, Université du Luxembourg, Luxembourg) and José Nicoladelli (from CEFET- Curitiba, Paraná).

The updated group of researchers consists from now on of the following people:

#### **Project Coordinator**

- Walter Carnielli (IFCH and CLE - UNICAMP) (**Main Researcher**)

#### **Task Coordinator**

- Marcelo Coniglio (IFCH and CLE - UNICAMP)(**Main Researcher**)

#### **Task Coordinator**

- Marcelo Finger (DCC-IME-USP)

#### **Researchers**

- Marcelo Finger (DCC-IME-USP)
- Flavio Soares Correa da Silva (DCC-IME-USP)

- Itala D’Ottaviano (IFCH and CLE - UNICAMP) (**Main Researcher**)
- Hércules de Araujo Feitosa (MAT-UNESP-Bauru)
- João Marcos (DIMAp/ CCET- UFRN)
- Hugo Mariano (MAT-IME-USP)
- Adolfo Gustavo Serra Seca Neto (DCC-UEDSC)
- Renata Wassermann(DCC-IME-USP)

#### **Post-Doc Members**

- Milton Augustinis de Castro (IFCH -UNICAMP)
- Alexandre Costa-Leite(IFCH -UNICAMP)

#### **PhD Students**

- Juan Carlos Agudelo Agudelo (IFCH-UNICAMP) (name in publications: Juan Carlos Agudelo)
- Marcos A. Alves (IFCH-UNICAMP)
- Juliana Bueno (IFCH-UNICAMP) (name in publications: Juliana Bueno-Soler)
- Evandro Gomes (IFCH- UNICAMP)
- Márcio Moretto Ribeiro (DCC-IME-USP)
- Luiz Henrique da Cruz Silvestrini (IFCH- UNICAMP)
- Leandro Suguítani (IFCH- UNICAMP)
- Rafael Rodrigues Testa (IFCH- UNICAMP)
- Anderson de Araújo IFCH- UNICAMP)

#### **MSc Students**

- Pietro Kreiton Carolino (IFCH- UNICAMP)
- Dante Cardoso (IFCH- UNICAMP)
- Mauricio S. C. Hernandez (IME-USP)
- Fernando Giroto (IFCH- UNICAMP)
- Tarcísio Genaro Rodrigues (IFCH-UNICAMP)

#### **External Participants**

- Jean-Yves Béziau (now at the Brazilian Science Foundation FUNCAP/CNPq, Fortaleza, CE, Brazil)
- Carlos Caleiro (IST, Lisbon)
- Eduardo Fermé (Department of Mathematics and Engineering, Universidade da Madeira, Portugal)
- Dov Gabbay (King’s College, London)

- Paulo Mateus (IST, Lisbon)
- José Nicoladelli ( CEFET- Curitiba, Paraná).
- Catarina Dutilh-Novaes (Faculty of Humanities, Department of Philosophy University of Amsterdam)
- João Rasga (IST, Lisbon)
- Amilcar Sernadas (IST, Lisbon)
- Cristina Sernadas (IST, Lisbon)
- Leon van de Torre (Université du Luxembourg, Luxembourg)
- Jorge Petrucio Viana (IM-UFF, Rio de Janeiro)

## 2 Report by Tasks

### Task 1: Fundamentals of Combining Logics

*Task coordinator: Marcelo Coniglio*

This task is mainly dedicated to the study and the development of a general theory of combination of logic systems, from a theoretical and conceptual point of view.

During the period under analysis a good amount of results were obtained in the scope of this Task.

Specifically, a very satisfactory number of papers and communications were produced by the team members, some of them in collaboration with external project members and other researchers. Some of these papers were published or accepted for publication, others have been submitted for publication, and some have been released as electronic preprints, with the purpose of being submitted in the near future. Altogether, 12 complete articles (journal papers or book chapters) and 13 articles in conferences concerning this task were published during the period being evaluated. Moreover, 3 articles were submitted to international journals for publication.

Additionally, 6 Master's dissertations elaborated by student members of the team (one of them endowed with a grant from FAPESP) were concluded. All dissertations concern topics of this project Task.

The research developed in the reported period covered the four corresponding subtasks. As happened in the previous years of the Project, the advancements can be classified into two main lines: the first line concerns to the study of general conceptual issues about combination and representation of logic systems. The second one is about the analysis of specific techniques for composing and decomposing logic systems.

#### Subtask 1.1: Combinations of Logics and their Applications

One of the most interesting achievements concerning this subtask, with promising perspectives, is the development, together with the colleagues of the

Security and Quantum Information Group (SQIG) of the IST (Lisbon) led by A. Sernadas of a new formalism capable to represent logic systems and their fibring by using concepts from graph theory. Briefly, the use of the novel notion of *m-graph*, that is, a graph where each edge can have a finite sequence of nodes as source, allows to represent logic systems and their different aspects. So, signatures, interpretation structures and deduction systems can be seen as m-graphs. After defining a category freely generated by a m-graph, formulas and expressions in general can be seen as morphisms. Moreover, derivations involving rule instantiation are also morphisms. Soundness and completeness theorems were obtained, which apply to very different logics encompassing, among others, substructural logics as well as logics with nondeterministic semantics. Concerning combinations, a graph-theoretic account of fibring was developed within this framework. Thus, fibring of two signatures is seen as an m-graph where the nodes and the m-edges include the sorts and the constructors of the signatures at hand. Fibring of two models is an m-graph where the nodes and the m-edges are the values and the operations in the models, respectively. Fibring of two deductive systems is an m-graph whose nodes are language expressions and the m-edges represent the inference rules of the two original systems. Moreover, it is proved that all these fibring constructions are universal. Soundness and completeness were proved to be preserved under very general conditions. The more striking result is that, in this setting, the collapsing problem appearing in several combinations of logic systems can be avoided. All the results of the first stage of this program research are described in the following papers:

[SSC09a] A. Sernadas, C. Sernadas, J. Rasga and M. Coniglio. A graph-theoretic account of logics. *Journal of Logic and Computation*, 2009, in print.

[SSC09b] A. Sernadas, C. Sernadas, J. Rasga and M. Coniglio. On graph-theoretic fibring of logics. *Journal of Logic and Computation*, 2009, in print.

Still in the line of research of fibring methods, new results on the preservation of metaproperties by fibring, more specifically on the preservation of interpolation by fibring, were obtained. The results were published in the following article:

[CRS08] W. Carnielli, J. Rasga, and C. Sernadas. Preservation of interpolation features by fibring. *Journal of Logic and Computation*, 18(1):123–151, 2008.

As in the previous years, the investigations on the subject of the general theory of consequence relations and translations between logics were continued during the period under evaluation. On the one hand, the survey article on translations between logics mentioned in the previous report was improved, and a new notion of translations (based on our previous research on meta-translations) called *contextual translations* was proposed. The results of this investigation were reported in the following article:

[CCD09] Walter Carnielli, Marcelo E. Coniglio and Itala M.L. D’Ottaviano. New dimensions on translations between logics. *Logica Universalis*, 2009, in print.

With respect to the consequence relations, a new line of research was inaugurated concerning the generation of a (non-necessarily) Tarskian consequence relation from a given set of basic inferences (or generators). This formalism, called *input/output logics*, was introduced in the literature by Leon van der Torre and David Makinson in 2000. The present investigation, developed together with van der Torre, generalizes the previous research in the literature towards abstract Tarskian consequence relations, showing that many of the original results hold in a very general setting. This gives rise to new forms of general input/output consequence relations in the sense that each Tarskian logic has associated to it different input/output inference engines, with promising capabilities for reasoning in intensional scenarios. Moreover, it is also possible to regard such input/output consequence relations as a method for combining logics, by allowing a logic for inputs and a different logic for outputs. An article was elaborated and submitted containing the first results of this research:

[CCvT09] W. Carnielli, M.E. Coniglio and L. van der Torre. Input/Output Consequence Relations: Reasoning with Intensional Contexts. Submitted, 2009.

On a more philosophical side of our research on logical consequence, a conceptual analysis of the notion of logical consequence was started, departing from a different perspective than previous researches on this subject developed by members of the team (see Progress Report 02). In the present research, three characteristics of the logical consequence, based on its intuitive notion, were analyzed: *necessity*, *formality* and *apriority*. An argument against the conceptual adequacy of the standard semantic conception of logical consequence was presented, trying to show that it does not satisfy the three characteristics mentioned above. We suggest, according to Etchemendy’s argument, that this conception does not satisfy these characteristics for being based on a specific universe, namely the universe of set theories of ZF type. The first results of this research were published in the article below.

[AD08] M.A. Alves and I.M.L. D’Ottaviano. Uma crítica à concepção semântica de consequência lógica (*A criticism to the semantic conception of logical consequence*, in Portuguese). *CLE e-Prints*, vol. 8(6), 2008.

This subtask also devotes some efforts to the study of non-classical logics. In the period under evaluation, and as in the previous years of the Project, some interesting results were obtained.

The Logics of Formal Inconsistency (LFI’s), introduced by members of the team and now widely studied in the literature, are paraconsistent logics which

permit the internalization of the concepts of consistency and inconsistency inside the object language. A conceptual analysis of the philosophical grounds of LFI's and of paraconsistency in general, was developed and presented in a Plenary Talk delivered by M. Coniglio at the *Fourth World Congress of Paraconsistency (WCP4)* held in Melbourne, on July, 2008. The full results of the research were reported in the articles below.

[CC08] W. Carnielli and M.E. Coniglio. Aristóteles, Paraconsistency e a Tradição Budista (Aristotle, Paraconsistentism and the Buddhist Tradition, in Portuguese). *O que nos faz pensar*, 23:163–175, June 2008.

[CC09] W. Carnielli and M.E. Coniglio. On discourses addressed by infidel logicians. Submitted, 2009.

The study of first-order LFI's was developed by a master student of the team, Rodrigo Podiacki, together with his supervisor, Walter Carnielli. The standard notion of first-order structures was modified in order to cope with paraconsistency, in particular with the consistency operator and the paraconsistent negation, which are non-truth-functional. The classical FOL calculus was appropriately modified, and soundness and completeness theorems were obtained. The main results were presented in

[PodCar08] Rodrigo Podiacki and W.A. Carnielli. Completeness Theorems for First-Order Logics of Formal Inconsistency. *CLE e-Prints*, vol. 8(6), 2008.

[Pod08] Rodrigo Podiacki. Lógicas da Inconsistência Formal de Primeira Ordem. Master's thesis, IFCH, State University of Campinas, 2008.

Still on the side of LFI's, the research line concerning the combination of certain LFI's with deontic operators (the so-called *Logics of Deontic Inconsistency*, LDI's) inaugurated in 2007 was continued, and very interesting results were obtained. A novel analysis of deontic paradoxes in the context of LDI's was realized by a master student of the team, Newton Peron, together with his supervisor, Marcelo Coniglio, and new systems of this kind were introduced. The results of this research were reported in

[PC08] N.M. Peron and M.E. Coniglio. Logics of Deontic Inconsistencies and Paradoxes. *CLE e-Prints*, vol. 8(6), 2008.

The student Peron finished his Master's dissertation during this period working along this line of research.

[Per09] Newton Marques Peron. Lógicas da Inconsistência Deontica. Master's thesis, IFCH, State University of Campinas, 2009.

The possible existence of traces of paraconsistency in the Aristotelian theory of syllogism was studied by members of the team. Two passages of the *Organon* (*Analytica Priora*, B15 and *Analytica Posteriora*, A11) are interesting to appreciate the Aristotelian treatment of contradiction in his deductive theory. A logical interpretation of the Aristotelian results as antilogism, proposed by Christine Ladd-Franklin, is proposed in terms of da Costa's calculi  $C_n$ , for  $1 \leq n \leq \omega$ . This approach seems to be new in the literature. The results of this research were related in the following articles:

[GD08] Evandro L. Gomes and Itala M.L. D'Ottaviano. Aristotle's theory of syllogism and paraconsistency. *CLE e-Prints*, vol. 8(6), 2008.

[GD09] Evandro L. Gomes and Itala M.L. D'Ottaviano. Aristotle's theory of deduction and paraconsistency. Submitted, 2009.

In previous research concerning this Task, a method for obtaining a 2-valued semantics for many-valued logics with enough expressive power was given (see Progress Report 01 and Progress Report 02). Continuing with this research, a concrete implementation of the method devised in the previous research was obtained. This allows to automatically obtain sound and complete classic-like tableaux systems for a very comprehensive class of finite-valued logics. The method was implemented in the functional programming language ML. The results of this research were published at

[MenMar08a] Dalmo Mendonça and João Marcos. Automatic extraction of axiomatizations in terms of two-signed tableaux for finite-valued logics. *CLE e-Prints*, vol. 8(6), 2008.

[MenMar08b] Dalmo Mendonça and João Marcos. Towards fully automated axiom extraction for finite-valued logics. In *Proceedings of the IJCAR'08 Workshop on Practical Aspects of Automated Reasoning (PAAR-2008)*, Sydney, Australia, August 2008. CEUR Workshop Proceedings v.373. Preprint available at:  
<http://sunsite.informatik.rwth-aachen.de/Publications/CEUR-WS/Vol-373/paper-03.pdf>.

[MarMen09] João Marcos and Dalmo Mendonça. Towards fully automated axiom extraction for finite-valued logics. In: [CCD09b], 2009, in print. Preprint available at:  
<http://wslc.math.ist.utl.pt/ftp/pub/MarcosJ/08-MM-towards.pdf>.

Finally, our research on argumentation theory applied to normative system was continued. Another master student of the team, Rafael Testa, finished his Master's dissertation last year working along this line of research.

[Tes08] Rafael Rodrigues Testa. Dilemas Deônticos: Uma Abordagem Baseada em Relações de Preferência. Master's thesis, IFCH, State University of Campinas, 2008.

Two articles derived of this research were published. The first one shows how to solve conflicting normative systems (formalized in Standard Deontic Logic) by defining a relation of preference between norms:

[TC08] Rafael R. Testa and Marcelo E. Coniglio. Solving normative conflicts using preference relations. *CLE e-Prints*, vol. 8(6), 2008.

The second one presents a more conceptual analysis of the method above, by means of some pragmatological considerations:

[TC09a] Rafael R. Testa and Marcelo E. Coniglio. Dilemas deonticos e escolha: considerações pragmáticas (*Deontic dilemmas and choice: pragmatological considerations*, in Portuguese). *Revista Brasileira de Filosofia*, vol. 232, 2009, in print.

In the previous Progress Report an article discussing the impossibility of constructing a complete formal theory to the human capacity of recognition of first-order arithmetical truths, based on Gödel's First Incompleteness Theorem, was presented. The authors continued this research, and new conclusions and arguments were presented in the article below.

[DT09] Itala M.L. D'Ottaviano and Ricardo Tassinari. "Cogito Ergo Sum Non Machina!- Sobre a impossibilidade de modelagem completa do reconhecimento humano de verdades da aritmética de primeira ordem. *Cognitio - Revista de Filosofia*, 2009, in print.

Still concerning Gödel's First Incompleteness Theorem, some connections among the proofs of this famous theorem presented by G. Boolos, G. Chaitin and S. Kripke were analyzed. This research was communicated in

[deA08] Anderson de Araujo. On a *Different Sort of Reason* for the Incompleteness of Algorithms. Book of Abstracts of "CLE 30/XV EBL / XIV SLALM", (May 2008), Paraty, RJ, Brazil, p. 102.

### Subtask 1.2: Splitting and Algebraizing Logics

Starting from the point of view of decomposition of logics by means of possible-translation semantics, a novel approach applied to modal logics containing negations weaker than classical (since, for instance paraconsistent negations) was developed by a PhD student of the team, Juliana Bueno:

[Bue08] Juliana Bueno-Soler. Possible-translations semantics for catholic modal logics. *CLE e-Prints*, vol. 8(6), 2008.

In particular, more results on the combination of modal logics and LFI's were obtained, but under a slightly different perspective than [PC08] and [Per09] mentioned above. Bueno's Phd Thesis concerning this topic and other topics related to this Subtask and to **Subtask 1.3** is expected to be concluded in the next months.

Still concerning theory and applications of the splitting method of possible-translation, the study of a generalization of possible-translations semantics by using multifunctions and category theory, as described in previous reports, was continued (see **Subtask 1.4** below).

### **Subtask 1.3: Algebraic Semantics for Modal Logics**

The goal of this subtask is the study of abstract consequence operators and generalized (or modulated) quantifiers (such as 'generally', 'rarely', 'most', etc.), and their relationship to other logics, in particular, to modal logics. One aspect of the Project is to study algebraic semantics for such logics, as well as to develop applications to epistemology and philosophy of science.

As in previous years, this subtask was very active, and several articles were produced. The most relevant productions within this line of research are listed below.

[CarG08] Walter Carnielli and Maria C.C. Grácio. Modulated logics and flexible reasoning. *Logic and Logical Philosophy*, 17:211–249, 2009.

[FNG09] Hércules A. Feitosa, Mauri C. do Nascimento and Maria C.C. Grácio. Algebraic elements for the notion of 'many'. *CLE e-Prints*, vol. 9(1), 2009.

[NGF08] Mauri C. do Nascimento, Maria C.C. Grácio and Hércules A. Feitosa. Modelando um quantificador não clássico (*Modelling a non-classical quantifier*, in Portuguese). In: **ERMAC: I Encontro Regional de Matemática Aplicada e Computacional**, ERMAC, Bauru, 2008.

[FGN08] Hércules A. Feitosa, Maria C.C. Grácio and Mauri C. do Nascimento. Sobre os quantificadores generalizados (*On generalized quantifier*, in Portuguese). In: **V Encontro da Associação de Filosofia e História da Ciência do Cone Sul - Florianópolis 2006**, pp. 197–206. AFHIC, Campinas, 2008.

[GFN08] Maria C.C. Grácio, Hércules A. Feitosa and Mauri C. do Nascimento. Linguagem e inferência indutiva em sistemas dedutivos (*Language and inductive inference in deductive systems*, in Portuguese). In: **Pensamento e Linguagem: subjetividade, comunicação e arte**, pp. 141–166. Eds.: J.G. Coelho and M.M. Vicente. Editora Unesp, São Paulo, 2008.

[SN08] Luiz H. da Cruz Silvestrini and Mauri C. do Nascimento. Localizando pontos no tableau TLP para a lógica do plausível (*Localizing points in the TLP tableau for the logic of plausibility*, in Portuguese). In: **V Encontro da Associação de Filosofia e História da Ciência do Cone Sul - Florianópolis 2006**, pp. 197–206. AFHIC, Campinas, 2008.

Continuing the studies related in the previous Research Report, the algebraic semantics for modal logics introduced by Lemmon and Scott in the “Lemmon Notes” was analyzed in the context of the modal logics G-infinite. From this research, a Master’s dissertation elaborated by a student member of the team, Samuel Gorski, was finished in the period under analysis:

[Gor08] Samir Bezerra Gorsky. A semântica algébrica para as lógicas modais e seu interesse filosófico. Master’s thesis, IFCH, State University of Campinas, 2008.

The investigations on da Costa’s theories of truth and quasi-truth (see Research report 01) in the context of this Subtask were continued. The following paper contains most of the results obtained last year :

[D09] Itala M.L. D’Ottaviano. On the concept of quasi-truth. In **Proceedings of the Colloque 2008 of l’Académie Internationale de Philosophie des Sciences (A.I.P.S.)**. A.I.P.S., in print.

Finally, the problem of finding an appropriate algebraic structure for quasi-set theory was addressed. Quasi-set theory was proposed as a mathematical context to investigate collections of indistinguishable objects. It was discovered that an algebraic structure having most of the standard properties of an orthocomplete orthomodular lattice, which is the lattice of the closed subspaces of a Hilbert space, is appropriate to model quasi-set. The obtained results were reported in the following article:

[KF09] Décio Krause and Hércules A. Feitosa. Algebraic aspects of quantum indiscernibility. In: [CCD09b], 2009, in print.

#### **Subtask 1.4: Algebraic and Categorical Aspects of Logical Consequence**

This subtask was originally designated to obtain applications for the subject of combining logics by using tools from category theory, with emphasis in fibring and possible-translations semantics.

The previous research on the generalization of Possible-Translation Semantics by using multifunctions, mentioned in the Research Report 03 (and in **Subtask 1.2** above) give origin to a Master’s dissertation elaborated by a student member of the team, Teófilo Reis:

[Rei08] Teófilo de Souza Reis. Conectivos feixíveis: uma abordagem categorial às semânticas de traduções possíveis e à noção de forma lógica. Master’s thesis, IFCH, State University of Campinas, 2008.

Additionally, an article was produced in this line of research:

[RC08] Teófilo de Souza Reis and Marcelo E. Coniglio. Covering logics via possible-translations. *CLE e-Prints*, vol. 8(6), 2008.

In the context of this Subtask, investigations concerning profinite L-structures, that is, the cofiltered limits of finite L-structures, were developed. In particular, it was proved that profinite L-structures are retracts of ultraproducts of finite L-structures (see Research Report 02). The same authors continued and expanded their research in this direction, as described in the paper below.

[MM09] Hugo L. Mariano and Francisco Miraglia. On Profinite Structures. In: [CCD09b], 2009, in print.

Finally, the studies about Tarski’s approach to first-order logic through algebras of relations developed by a master student of the team, Leandro Suguitani, give origin to a Master’s dissertation defended last year:

[Su08] Leandro Oliva Suguitani. Álgebra de Relações: uma axiomatização Tarskiana. Master’s thesis, IFCH, State University of Campinas, 2008.

Additionally, an article concerning this topic was produced:

[SD08] Leandro Suguitani and Itala M.L. D’Ottaviano. Tarski’s relation algebra and “Borner’s Operator”. *CLE e-Prints*, vol. 8(6), 2008.

## Task 2: Computational Aspects of Combinations of Logics and Theorem Proving

*Task coordinator: Marcelo Finger*

This task deals with the study of the computational and practical aspects of combination of logic systems.

In general, this task has been very successful. Several papers on approximation of classical propositional logic have been produced, turning the participants of this task as international references on the topic. In 2008, even PhD Thesis in Australia (at the University of New South Wales) were based on the works developed at this task. Several implementations were produced. The subtask of approximating first-order logic was not developed but, instead, we were able

to cover other logics, such as modal/temporal logics and description logics with applications over web-semantics.

For the future, we expect to go on developing the fields opened at this task. We plan to continue the studies on the proof theory of non-analytic cuts, and we plan to study revision and approximations of Description Logics. Also, we plan to implement a tool to aid the task of teaching logic and logical inference.

During the last year of the project, this task has continued its progress in several in its ongoing subtasks. This progress is detailed below.

### **Subtask 2.1: Approximations of Classical Propositional Logic**

In a previous report, the work on approximations has led us to the *Cut and Pay* method for approximating a logic. This is a methods, with several variations, in which approximations are processed by means of controlling the number of applications of cut rules. But this applications the computation of *non-analytic cuts* in proofs, an area of proof theory which has not been explored so far, mainly due to the predominance of cut-elimination procedures.

So, we propose a method to compute those non-analytic cuts base on an abduction process. This is in fact a natural extension of a previous work (see Progress Report 03).

The paper presenting *Cut-Based Abduction* is:

[DFG08] Marcello D’Agostino, Marcelo Finger, and Dov Gabbay. Cut-based abduction. *Logic Journal of the IGPL*, Accepted, 2008.

and a shorter, conference-size presentations was also produced:

[Fin08b] Marcelo Finger. Using abduction to compute efficient proofs. In *LSFA’08: Third Workshop on Logical and Semantic Frameworks, with Applications*, Salvador, 2008.

Further enquiries on the nature of analytic and non-analytic proofs in modal logics were obtained in the following result:

[Fin08c] Marcelo Finger. Analytic methods for the logic of proofs. *Journal of Logic and Computation*, Accepted, 2008.

### **Subtask 2.2: Logics for Ontologies**

This task studies a form of logic combination that support Ontologies and allows one to reason about ontology-based descriptions and their instantiations, with applications to the new field of web-semantics.

The study of revising ontology-based descriptions, based in previous work (see Progress Report 03), has produced new interesting results, published in national and international conferences:

[RW08a] Márcio Moretto Ribeiro and Renata Wassermann. *De-grees of Recovery and Inclusion in Belief Base Dynamics*. In: Twelfth

International Workshop on Non-Monotonic Reasoning, 2008, Sydney.

[RW08b] Marcio M. Ribeiro and Renata Wassermann. On the relation between remainder sets and kernels. In *Encontro Brasileiro de Lógica (EBL)*, Paraty, 2008.

[RW08c] Márcio Moretto Ribeiro and Renata Wassermann. *The Ontology Reviser Plug-In for Protégé*. In: WORKSHOP ON ONTOLOGIES AND THEIR APPLICATIONS (WONTO 2008), 2008, Salvador.

### Subtask 2.3: Resource Sensitive Inference

This was a very productive area, involving knowledge management, robotics and multi-agent systems.

With regards to knowledge management, the following journal paper was produced:

[tor08] Torres, G. E. S. and Colombo, E. and Correa da Silva, F. S. and Guerra, C. A. N. and Bandini, S. Design issues for knowledge artifacts. *Knowledge-based systems*, 21(8):856–867, 2008.

And the following book was published.

[fcsBook08] Correa da Silva, F. S. and Agusti-Cullell, J. , *Information Flow and Knowledge Sharing*, Elsevier Series on Capturing Intelligence, 2008.

Furthermore, several conference papers on knowledge-based agents were produced:

[viz08a] Vizzari, G. and Pizzi, G. and Correa da Silva, F. S., *A framework for execution and 3D visualization of situated cellular agent based crowd simulations*. In 23rd ACM Symposium on Applied Computing — Special Track on Advances on Computer Simulation, 2008.

[fcs08a] Correa da Silva, F. S., *Knowledge-based modality selection for information presentation in a mobile system for primary home-care*, Artificial Intelligence and Simulation of Behaviour 2008, 2008.

[fcs08b] Correa da Silva, F. S. and Vizzari, G. and Mosca, A. *Coupled MMAS: a formal model for non-deterministic multiagent simulations*. In Artificial Intelligence and Simulation of Behaviour 2008.

[gue08a] Guerra, C. A. N. and Correa da Silva, F. S. *Semantic web services for intelligence responsive environments*. In Artificial Intelligence and Simulation of Behaviour 2008.

[gue08b] Guerra, C. A. N. and Correa da Silva, F. S. *A middleware for smart environments*. In Artificial Intelligence and Simulation of Behaviour 2008.

[viz08b] Vizzari, G. and Bonomi, A. and Correa da Silva, F. S. *A framework for executing and visualizing situated cellular agent based crowd simulations*. In Proc. Of EMCSR 2008.

#### Subtask 2.4: Automatizing Paraconsistent Inference

After the successful defense of Adolfo Neto's PhD thesis, that thesis took part in a competition.

[NF08] Adolfo G. S. S. Neto and Marcelo Finger. *KEMS — A Multi-Strategy Tableau Prover*. In Proceedings of the VI Best MSc Dissertation/PhD Thesis Contest (CTDIA 2008), Salvador, 2008.

Finally, the research concerning the development of proof systems for da Costa's paraconsistent logics have been continued, with interesting new results. For the first time in the literature, a complete analytical tableaux system for da Costa's hierarchy of first-order calculi  $C_n^*$  was obtained. A peculiarity of the presentation is that the consistency operator is considered as a primitive connective, analogously to the situation with Logics of Formal Inconsistency (see **Subtask 1.1** above). The results were firstly published in the annals of a conference:

[CD08] Milton A. de Castro and Itala M.L. D'Ottaviano. Analytical tableaux for da Costa's paraconsistent logics. *CLE e-Prints*, vol. 8(6), 2008.

The complete version of the paper was submitted for publication in an international journal:

[CD09] Itala M.L. D'Ottaviano and Milton A. de Castro. Analytical tableaux for da Costa's paraconsistent logics. Submitted, 2009.

### Task 3: Quantum Logics and Algorithms

*Task coordinator: Walter Carnielli*

This task has become mature, and has acquired the wider perspective of investigating the influence of logic to theoretical computer science. In particular,

we are at the moment studying the relationship between Quantum Logics and Quantum Computation, the possibilities of new computation models and their application to the modeling of quantum computation in a wide range.

By substituting the underlying logic of axiomatic theories of Turing machines by a paraconsistent logic we arrive at the definition of new computation models. The first one is the *paraconsistent Turing machines*, which allows a partial simulation of superposed states of quantum computing, leading to the conception of algorithms which solve (under some restrictions) the well-known Deutsch's and Deutsch-Jozsa problems. This first model of computation, however, has some limited capabilities; it does not adequately represent for instance certain key features in quantum computing, as the notions of entangled states and relative phase. What is important is that even a more sharpened model of paraconsistent Turing machines can be defined, which better approaches the features of quantum computing.

– **Subtask 3.1: Quantum Computation and Quantum Logics**

This subtask is dedicated to investigate the relationship between logic systems and computation models, with emphasis on new quantum computation models. The basic assumption within this part of the project is that the underlying logic behind models of computation can play a major role. The analysis of sharp models of paraconsistent Turing machines and their role in expressing features of quantum computation is the topic for the Ph.D. thesis of the team student Juan Carlos Agudelo Agudelo (under a Ph.D. FAPESP grant), and part of his research interests are related to the subtasks of this Task. Preliminary results are being submitted to international journals in the area of logic and theoretical computer science.

– **Subtask 3.2: Polynomial Ring Proof Procedures**

The “polynomial ring proof procedures” is an original approach to theorem proving and semantics in classical and non-classical logics, related to algebraization of logics and to applications to quantum gates in quantum computation. From the perspective of theoretical quantum computation, this approach permits to define a new notion of *quantum circuits* whose interest for expressing quantum algorithms is being investigated.

– **Subtask 3.3: Paraconsistent Turing Machines**

This subtask is dedicated to investigate enhanced models of Paraconsistent Turing Machines and its connections with quantum computing. We are trying to show that by specifying a new paraconsistent logic with a non-separable conjunction (i.e., a paraconsistent non-separable logic) a new model of paraconsistent TMs can be defined, which we call *entangled paraconsistent* TMs (EParTMs). In such machines uniform entangled states can be successfully simulated. The comparison between different models of paraconsistent TMs, the dependence upon physical theories and their interest for quantum computation is being investigated.

## Research results and production

The following talks, conferences and publications have been obtained in connection with the above task and subtasks:

1. A study on certain criticisms about the dependence of computation on physical grounds only (and not logic, as it is our basic assumption);
2. Continuation of the investigation on the relationship between paraconsistent circuit models and quantum circuits.
3. Deeper study on the paraconsistent non-separable logics and their role on the entangled paraconsistent Turing Machines.

The items below represent the results of the work developed within the present Task within the reported period.

1. Juan Carlos Agudelo gave two talks related to some of the results about the relationship between paraconsistent logics and quantum computation:
  - Talk in the “CLE 30/ XV EBL / XIV SLALM”, Paraty, RJ, May 11-17, 2008:  
*Paraconsistency and Quantum Computation.*
  - Talk in the “XIII Encontro Nacional de Filosofia da ANPOF”, Canela, RS, October 6-10, 2008:  
*A tese de Church-Turing como principio físico.*
2. Walter Carnielli gave an invited talk at the:
  - First International Workshop on Foundations of Computer Science as Logic-Related, (August 2008), Istanbul, Turkey, *Computability: Logic versus Physics*

The event “First International Workshop on Foundations of Computer Science as Logic-Related” was an invited workshop, organized by W. Carnielli, as part of the “ICTAC 2008- 5th International Colloquium on Theoretical Aspects of Computing” held in Istanbul, Turkey, in August 2008.

Details are to be found at:

URL = <http://www.cle.unicamp.br/prof/carnielli/istanbul08/index08.html#0organization>

The workshop intended to discuss the philosophical, mathematical and technical aspects about the relevance of logic in the foundations of Computer Science, specially concerning new paradigms of computation.

A distinguished Program committee (besides W. Carnielli) accepted to give scientific backup to the event:

- Varol Akman (Bilkent University at Ankara, Turkey)
- Newton da Costa (UFSC at Florianópolis, Brazil)
- Giorgi Japaridze (Villanova University at Villanova, Pennsylvania, USA)
- Martin Davis (Professor Emeritus, New York University, NY, USA)

- Wilfrid Hodges (Queen Mary College, University of London)
- Amílcar Sernadas (IST at Lisbon, Portugal)
- Aldo Ursini (University of Siena at Siena, Italy)

The participation of names of such level attest, we believe, the relevance of this ongoing project.

The book chapter

[CarDor08] W. Carnielli and F. A. Dória, Are the foundations of computer science logic-dependent?, *in* “Dialogues, Logics and Other Strange Things—Essays in Honour of Shahid Rahman”, (editors Cedric Degremont, Laurent Keiff and Helge Ruckert), pages 87-107, College Publications, London, 2008.

was dedicated to analysis of the influence of logic in the foundations of computer science.

3. Still in the scope of this Task, a combinatorial problem by P. Erdős was treated and presented by a Master student of the team, Pietro Carolino:
  - [CaroC08] P.K. Carolino and W.A. Carnielli. Falsifying a Conjecture of Paul Erdős. Book of Abstracts of “CLE 30/ XV EBL / XIV SLALM”, (May 2008), Paraty, RJ, Brazil, p. 96.

### 3 Report by Members

We now expose, for each member of the Project, which were their main contributions to the Project.

#### Project Coordinator

- Walter Carnielli (IFCH and CLE – UNICAMP)

**Journal papers:** [CarCar08], [CRS08], [CC08], [CarG08].

**Book Chapters:** [CarDor08].

**Books:** [CP08], [EC08].

**Edited books:** [CCD09b].

**Student supervision – completed:** Rodrigo de Alvarenga Freire (PhD); Samir Gorsky and Rodrigo Podiack (MSc); Igor Carboni de Oliveira (Scientific Initiation).

**Student supervision – ongoing:** Juan Carlos Agudelo Agudelo (PhD), Anderson de Araujo (PhD), Pietro Carolino (Ms), Antonio Marmo (MSc).

#### Organization of events

- CLE 30/ XV EBL/ XIV SLALM, (May 2008), Paraty, RJ, Brazil  
URL = <http://www.cle.unicamp.br/cle30-eb1-slalm/index.php?pag=abertura.php>
- Logic School/ Escola de Lógica, CLE 30/ XV EBL / XIV SLALM. IMECC-UNICAMP, Campinas,SP, Brazil, May 8, 2008
- “First International Workshop on Foundations of Computer Science as Logic-Related”, Sabanci University, Istanbul, Turkey, August 2008.  
URL = <http://www.cle.unicamp.br/prof/carnielli/istanbul08/index08.html>

### Talks and conferences

- Carnielli, Walter (Conference). Arche-Philosophical Research Centre for Logic, Language, Metaphysics and Epistemology, (November 2008), Saint Andrews, Scotland, *Combining Logics by Means of Possible-Translation Semantics and Society Semantics*
- Carnielli, Walter (Conference). Arche-Philosophical Research Centre for Logic, Language, Metaphysics and Epistemology, (November 2008), Saint Andrews, Scotland, *Proving Paraconsistent, Many-Valued and Modal Logics by Handling Polynomials: a Happy Marriage between Logic and Algebra?*
- Carnielli, Walter (Conference). ILIAS Seminars- ICR- Université du Luxembourg, (October 2008), Luxembourg, *Possible-Translations Semantics and Logics of Formal Inconsistency*
- Carnielli, Walter (Conference). Logic Tea, (October 2008), Amsterdam, The Netherlands, *Sewing Logics Together: the possible-translations semantics and new meanings for old logics*
- Carnielli, Walter (Conference). First International Workshop on Foundations of Computer Science as Logic-Related, (August 2008), Istanbul, Turkey, *Computability: Logic versus Physics*
- Carnielli, Walter (Conference). University of Copenhagen, Denmark. (December 2008), *Proving Paraconsistent, Many-Valued and Modal Logics by Handling Polynomials: Some Perspectives on Polynomizing Logics.*
- Carnielli, Walter (Conference) University of Roskilde, Denmark. (December 2008), *Combining Logics*
- Carnielli, Walter (Conference), Universität Wien (Austria), (September 2008), *Polynomial as a proof method: a rendez vous between logic and algebra*
- Carnielli, Walter (Conference), Universität Münster, Germany, (February 2009), *Proving propositional and modal logics by handling formal polynomials: an elementary power series approach to logic, its roots and scope*
- Carnielli, Walter (Conference), Université Charles-de-Gaulle, Lille, France (February 2009), *Proving by handling polynomials: Revamping the heritage of George Boole*

- Carnielli, Walter (Tutorial), CLE- UNICAMP, CLE 30/ XV EBL/ XIV SLALM, (May 2008), Paraty, RJ, Brazil, *Possible-Translations Semantics/Semânticas de Traduções Possíveis*

### Communications

- Carnielli, Walter; Finger, M. (Communication). CLE 30/ XV EBL/ XIV SLALM, (May 2008), Paraty, RJ, Brazil, *Minimal axiomatizations and algebras rings: a conjectured relationship*
- Carnielli Walter; Carolino, P.K. (Communication) CLE 30 / XV EBL / XIV SLALM, (May 2008), Paraty, RJ, Brazil, *Falsifying a conjecture of Paul Erdős*
- Carnielli, Walter; Agudelo, J. C.(Communication) CLE 30 / XV EBL / XIV SLALM, (May 2008), Paraty, RJ, Brazil, *Paraconsistency aspects and quantum indiscernibility*

### Reviews

- Review of “Coherent systems”. Author: Karl Schlechta, Studies in Logic and Practical Reasoning, 2. Elsevier, Amsterdam, 2004. xx+447 pp, 09/2008, Review published in Mathematical Reviews, American Mathematical Society, USA, 2008.

### Post-Doc supervision:

- Alexandre Costa-Leite (FAPESP grantee) .

### Task Coordinators

- Marcelo Coniglio (IFCH and CLE – UNICAMP)

**Journal papers:** [CC08, CCD09, SSC09a, SSC09b, TC09a].

**Conference extended abstracts:** [PC08, RC08, TC08].

**Edited books:** [CCD09b].

**Submitted papers:** [CC09, CCvT09].

**Book drafts:** [TC09b].

**Tutorial:** [Con08].

**Student supervision – completed:** Teófilo de Sousa Reis, Rafael Rodrigues Testa and Newton Marques Peron (MSc).

**Student supervision – ongoing:** Luiz Henrique Silvestrini (PhD), Rafael Rodrigues Testa (PhD), Antonio Eduardo Consalvo (PhD), Tarcísio

Genaro Rodrigues (MSc), Roberto Guilherme Dumaresq Junior (MSc).

### Organization of events

- CLE 30/ XV EBL/ XIV SLALM, (May 2008), Paraty, RJ, Brazil  
URL = <http://www.cle.unicamp.br/cle30-eb1-slalm/index.php?pag=abertura.php>
- Logic School/ Escola de Lógica, CLE 30/ XV EBL / XIV SLALM.  
IMECC-UNICAMP, Campinas,SP, Brazil, May 8, 2008

### Talks, mini-courses and seminars:

- Tutorial in the “Logic School/ Escola de Lógica, CLE 30/ XV EBL / XIV SLALM”. IMECC-UNICAMP, Campinas, May 8, 2008:  
*Combining Logics.*
- Visit to the The Security and Quantum Information Group/IT, Instituto Superior Técnico, Lisbon, June 2008, developing research activities. Seminar in the “Logic and Computation Seminar”:  
*Logics of Deontic Inconsistency.*
- Plenary Talk in the “4th World Congress of Paraconsistency” (WCP4), Melbourne, Australia, July 14, 2008:  
*On discourses addressed by infidel logicians.*
- Talk in the “4th World Congress of Paraconsistency” (WCP4), Melbourne, Australia, July 17, 2008:  
*A paraconsistentist approach to deontic paradoxes.*
- Visit to the The Security and Quantum Information Group/IT, Instituto Superior Técnico, Lisbon, September 2008, developing research activities. Seminar in the “Logic and Computation Seminar”:  
*Metafibring and reconstruction of logics from its fragments.*
- Talk in the “XIII Encontro Nacional de Filosofia da ANPOF”, Canela, RS, October 6-10, 2008:  
*Metalógica de argumentações baseada na noção de peso argumentativo.*
- Talk in the “XI Colóquio Conesul de Filosofia das Ciências Formais”, Universidade Federal de Santa Maria, RS, Brazil, November 8-12, 2008:  
*Olhando as lógicas através dos grafos.*
- Talk at “Centro de Lógica Jurídica e Teorias da Argumentação”, Faculdade de São Bento, Mosteiro de São Bento, São Paulo, Brazil, December 16, 2008:  
*Sobre uma Teoria de Normas (Jurídicas).*

### Communications:

- Newton M. Peron and Marcelo E. Coniglio (Communication). CLE 30/ XV EBL / XIV SLALM, (May 2008), Paraty, RJ, Brazil, *Logics of Deontic Inconsistencies and Paradoxes*.
- Rafael R. Testa and Marcelo E. Coniglio (Communication). CLE 30/ XV EBL / XIV SLALM, (May 2008), Paraty, RJ, Brazil, *Solving normative conflicts using preference relations*.
- Teófilo S. Reis and Marcelo E. Coniglio (Communication). CLE 30/ XV EBL / XIV SLALM, (May 2008), Paraty, RJ, Brazil, *Covering logics via possible-translations*.

### Reviews:

- Review of the paper “An adaptive logic for relevant classical deduction” (Hans Lycke). Review published in *Mathematical Reviews*, American Mathematical Society, USA, 2008.
  - Review of the paper “Possible-translations semantics for some weak classically-based paraconsistent logics” (Joao Marcos). Review published in *Mathematical Reviews*, American Mathematical Society, USA, 2008.
  - Referee for the *Journal of Applied Non-Classical Logics*, 2008.
  - Referee for the *Logic Journal of the IGPL*, 2008.
  - Referee for *Logica Universalis*, 2008.
  - Referee report for *III Workshop on Logical and Semantic Frameworks, with Applications* (LSFA’08).
- Marcelo Finger (IME-USP)

**Accepted journal papers:** [DFG08, Fin08c].

**Conference abstracts:** [Fin08a].

**Conference extended abstracts:** [Fin08b, FBC08].

**Student supervision:** Fabio Natanael Kepler, Alexandre Arruda (PhD); Danilo Conde, Mauricio Simões Camilo Hernandez, Poliana Magalhães Reis (MSc); Thiago Coraini, Camila Matsubara, Lucas Cavalcante, Bruno Vercelino da Hora, Fábio Firmo, Rogério Papetti, Pedro Matiello, Helio Matayoshi (Scientific Initiation).

### Talks and conferences

- *Using Abduction to Compute Efficient Proofs* (invited talk), “LSFA’08: Third Workshop on Logical and Semantic Frameworks, with Applications”, Salvador 2008.
- *Minimality in Axiomatizations: an Algebraic Approach*, “(CLE 30–XV EBL–XIV SLALM) 30th Anniversary of the Centre for Logic,

- Epistemology and the History of Science, UNICAMP, 15th Brazilian Logic Conference, 14th Latin-American Symposium on Mathematical Logic". Paraty, 11–17 May 2008.
- *Revising Specifications with CTL Properties using Bounded Model Checking*, “Brazilian Symposium on Artificial Intelligence (SBIA)”, Salvador, 2008.
  - *Resource Use Pattern Analysis for Opportunistic Grids*, “6th International Workshop on Middleware for Grid Computing (MGC 2008)”, Leuven, Belgium, December 2008.

#### Events organization:

- Member of the Scientific Committee of “CLE 30–XV EBL–XIV SLALM” 30th Anniversary of the Centre for Logic, Epistemology and the History of Science, UNICAMP, 15th Brazilian Logic Conference, 14th Latin-American Symposium on Mathematical Logic”. Paraty, 11–17 May 2008.

#### Visits

- Visit to the University of Ferrara, Department of Philosophy. Italy, December 2008. Received by the head of the department, Marcello D’Agostino.

**Reviews:** Reviews to the following publications/institutions in 2008.

- CLE 30–XV EBL–XIV SLALM
- Fapesp
- Handbook of Philosophical Logic
- Information and Computation
- Journal of Logic and Computation
- Mathematical Reviews
- Propor 2008
- SBPC
- Synthese
- TIL 2008

#### Researchers

- Flavio Soares Correa da Silva (IME - USP):

**Journal paper:** [tor08].

**Conference papers:** [viz08a, viz08b, gue08a, gue08b, fcs08a, fcs08b].

**Book:** [fcsBook08].

**Student supervision – completed:** Gustavo Enrique Salazar Torres (MSc), Filipe Correa Lima da Silva (MSc).

**Student supervision – ongoing:** Ary Fagundes Bressane Neto (MSc), Erika Guetti (MSc), Fernando Bertolli Petroni (MSc), Juliana Yamashita (MSc), Omar Jardim Gaudio (MSc), Archias Alves de Almeida Filho (PhD), Claudia Josimar Abrao de Araujo (PhD), Crhistian Alberto Noriega Guerra (PhD), Rosimarci Pacheco Tonaco (PhD), Sirley Antonia Vitorio Oliveira (PhD).

- Hércules de Araujo Feitosa (MAT-UNESP-Bauru)

**Journal paper:** [FNG09].

**Conference papers:** [NGF08, FGN08].

**Book Chapters:** [GFN08, KF09].

**Student supervision – completed:** Maria Matulovic da Silva Fadel (MSc).

Ana Claudia de Jesus Golzio, Ângela Pereira Rodrigues, Ana Cláudia de Jesus Golzio (Scientific Initiation)

**Student supervision – ongoing:** Camila Augusta Vaine, Ângela Pereira Rodrigues (Scientific Initiation)

**Talks, mini-courses and seminars:**

- Talk in the Conference “CLE 30 Years, XV Brazilian Logic Conference, XIV Latin-American Symposium on Mathematical Logic”, Paraty, RJ, Brazil, May 2008  
*Algebraic aspects of quantum indiscernibility.*

- João Marcos (UFRN, Natal)

**Book Chapters:** [MarMen09].

**Conference extended abstracts:** [MenMar08a, MenMar08b].

**Student supervision – ongoing:** Dalmo Vinicius Gomes Mendonça (Scientific Initiation)

**Talks, mini-courses and seminars:**

- Escola Regional de Computação Bahia Alagoas Sergipe (ERBASE 2008), Salvador, BA, Brazil, 14-18 April 2008. Presentation of the

- invited speech: *A Fundamentação da Prova de Teoremas por Computador*.
- Talk in the Conference “CLE 30 Years, XV Brazilian Logic Conference, XIV Latin-American Symposium on Mathematical Logic”, Paraty, RJ, Brazil, May 2008.  
*Automatic extraction of axiomatizations in terms of two-signed tableaux for finite-valued logics.*
  - Talk in the “IV World Congress of Paraconsistency” (WCP4), Melbourne, Australia, 13-18 July 2008.  
*Logics of Formal Inconsistency.*
  - Talk in “IJCAR’08 Workshop on Practical Aspects of Automated Reasoning” (PAAR-2008), Sydney, Australia, 10-11 August 2008.  
*Towards fully automated axiom extraction for finite-valued logics.*
  - Talk in “Escola Potiguar de Computação e suas Aplicações” (EPOCA 2008), Natal, RN, Brazil, 22-24 October 2008.  
*A implementação colaborativa de uma suíte de ferramentas on-line de apoio ao ensino de Lógica.*
  - Talk in the “VIII Encontro Regional de Matemática Aplicada e Computacional” (VIII ERMAC), Natal, RN, 20-22 November 2008.  
*Logicamente: A implementação colaborativa de uma suíte de ferramentas on-line de apoio ao ensino de Lógica Implementação de um gerador e verificador de modelos finitos para a Lógica Clássica de Primeira Ordem.*

#### Reviews:

- Referee report for *Studia Logica*.
  - Referee report for *Logic Journal of the IGPL*.
  - Referee report for *III Workshop on Logical and Semantic Frameworks, with Applications* (LSFA’08).
- Hugo Luiz Mariano (IME – USP)

**Book Chapters:** [MM09].

#### Talks, mini-courses and seminars:

- Talk in the event event “CLE 30 YEARS/ XV EBL/ XIV SLALM”, Paraty-RJ, May 2008.  
*On Profinite Structures.*

#### Reviews

- Referee report for *Reports on Mathematical Logic*.
- Referee report for the proceedings of the event “CLE 30 YEARS/ XV EBL/ XIV SLALM” ([CCD09b]).

- Itala D’Ottaviano (IFCH and CLE – UNICAMP)

**Journal paper:** [CCD09, DT09].

**Conference papers:** [D09].

**Conference extended abstracts:** [AD08, CD08, GD08, SD08].

**Book Chapters:** [D09b].

**Edited Books:** [CCD09b].

**Submitted papers:** [CD09, GD09].

**Student supervision – completed:** Fábio Maia Bertato, Eberth Eleutério dos Santos (PhD); Leandro Suguitani (MSc); Dante Cardoso (Scientific Initiation).

**Student supervision – ongoing:** Juliana Bueno, Mauro Scheer, Marcos Alves, Evandro Gomes, Leandro Suguitani (PhD); Dante Cardoso (MsC)

**Post-doc supervision:** Milton Agustinis de Castro.

**Talks, mini-courses and seminars:**

- Plenary Talk in “XIV Semana de Matemática”, Universidade Estadual do Centro-Oeste - UNICENTRO, Guarapuava, PR, Brazil.  
*A Lógica Contemporânea: Filosofia ou Matemática?*
- Plenary Talk in “Coloquio Los Dias de la Complejidad”, Universidad del Rosario, Bogotá, Colômbia.  
*Non-Classical Logics and Applications.*
- Talk in “Réunion de l’Académie Internationale de Philosophie des Sciences (IIPS): Relations entre sciences naturelles et les sciences humaines”. Rovereto, Italy.  
*On da Costa’s Quasi-Truth*
- Talk in “AMS-SBM First Joint Meeting”, IMPA - Instituto Nacional de Matemática Pura e Aplicada, Rio de Janeiro, RJ, Brazil.  
*On the Development of Paraconsistent Logic.*
- Tutorial in the “Logic School/ Escola de Lógica, CLE 30/ XV EBL / XIV SLALM”. IMECC-UNICAMP, Campinas, May 8, 2008:  
*Translations between logics.*

- Adolfo Gustavo Serra Seca Neto (DAINF – UTFPR)

**Conference papers:** [NF08].

- Renata Wassermann (IME – USP)

**Conference papers:** [RW08a, RW08c].

**Conference abstracts:** [Was08, RW08b].

**Student supervision:** Marcio Moretto Ribeiro (PhD), Rodrigo Ferro (MSc), Paulo de Tarso Guerra (MSc), Carlos Atencio Torres (MSc), André Casado Castaño (MSc - concluded May/2008).

#### Talks and conferences

- *Inclusion versus Recovery in Belief Base Dynamics*, “(CLE 30–XV EBL–XIV SLALM) 30th Anniversary of the Centre for Logic, Epistemology and the History of Science, UNICAMP, 15th Brazilian Logic Conference, 14th Latin-American Symposium on Mathematical Logic”. Paraty, 11–17 May 2008.
- *Degrees of Recovery and Inclusion in Belief Base Dynamics*, “Twelfth International Workshop on Non-Monotonic Reasoning”, Sydney, September, 2008.

**Reviews:** Reviews to the following publications/institutions in 2008.

- \* Fapesp
- \* CNPq
- \* Journal of Logic and Computation
- \* IJCAI
- \* KR
- \* Australian AI
- \* SBIA
- \* Wonto

#### Post-Doc Students

- Milton Augustinis de Castro (IFCH – UNICAMP)

**Conference extended abstracts:** [CD08].

**Submitted papers:** [CD09].

#### Talks, mini-courses and seminars:

- *Analytical Tableaux for da Costa’s Paraconsistent Logics*, “(CLE 30–XV EBL–XIV SLALM) 30th Anniversary of the Centre for Logic, Epistemology and the History of Science, UNICAMP, 15th Brazilian Logic Conference, 14th Latin-American Symposium on Mathematical Logic”. Paraty, 11–17 May 2008.

## PhD Students

- Juan Carlos Agudelo Agudelo (IFCH-UNICAMP)

### Talks, mini-courses and seminars:

- Talk in the “CLE 30/ XV EBL / XIV SLALM”, Paraty, RJ, May 11-17, 2008:  
*Paraconsistency and Quantum Computation.*
- Talk in the “XIII Encontro Nacional de Filosofia da ANPOF”, Canela, RS, October 6-10, 2008:  
*A tese de Church-Turing como principio físico.*

- Juliana Bueno (IFCH-UNICAMP)

**Conference extended abstracts:** [Bue08].

### Translations:

- *Modalities and Multimodalities*, W. Carnielli and C. Pizzi. Springer, 2008 (Translated from Italian to English).

### Talks, mini-courses and seminars:

- Talk in the “CLE 30/ XV EBL / XIV SLALM”, Paraty, RJ, May 11-17, 2008:  
*Paraconsistency and Quantum Computation.*
- *Anodic and Cathodic Modalities: managing negation in modal logic.* ILLIAS Seminars- ICR - Université du Luxembourg, (October 2008), Luxembourg.

### Reviews

- Referee for the *Journal of Applied Non Classical Logic (JANCL)*.

- Rodrigo de Alvarenga Freire (CLE-UNICAMP)

### Talks and conferences

- Talk in the “I Encontro Internacional para Alunos de Graduação do Instituto de Matemática e Estatística da USP” (EIAGIME), São Paulo, August 30 to September 6, 2008:  
*Paradoxos Semânticos e a Teoria da Verdade de Tarski.*

**Thesis:** [Fre09].

## MSc Students

- Anderson de Araujo (IFCH- UNICAMP)

**Conference abstracts:** [deA08]

**Talks, mini-courses and seminars:**

- Talk in the “CLE 30/ XV EBL / XIV SLALM”, Paraty, RJ, May 11-17, 2008:

*On a Different Sort of Reason for the Incompleteness of Algorithms.*

- Márcio Moretto Ribeiro (IME – USP)

**Conference papers:** [RW08a, RW08b, RW08c].

- Leandro Suguitani (IFCH- UNICAMP)

**Conference extended abstracts:** [SD08]

**Dissertations:** [Su08]

**Talks, mini-courses and seminars:**

- Talk in the “CLE 30/ XV EBL / XIV SLALM”, Paraty, RJ, May 11-17, 2008:

*Tarski’s relation algebra and “Börner’s Operator”.*

- Newton Marques Peron (IFCH- UNICAMP)

**Conference extended abstracts:** [PC08]

**Dissertations:** [Per09]

**Talks, mini-courses and seminars:**

- Talk in the “CLE 30/ XV EBL / XIV SLALM”, Paraty, RJ, May 11-17, 2008:

*Logics of Deontic Inconsistencies and Paradoxes.*

- Pietro Kreiton Carolino (IFCH- UNICAMP)

**Conference abstracts:** [CaroC08]

**Talks, mini-courses and seminars:**

- Talk in the “CLE 30/ XV EBL / XIV SLALM”, Paraty, RJ, May 11-17, 2008:

*Falsifying a Conjecture of Paul Erdős.*

- Rafael Rodrigues Testa (IFCH-UNICAMP)

**Journal paper:** [TC09a]

**Conference extended abstracts:** [TC08]

**Dissertations:** [Tes08]

**Book drafts:** [TC09b]

**Talks, mini-courses and seminars:**

- Talk in the “CLE 30/ XV EBL / XIV SLALM”, Paraty, RJ, May 11-17, 2008:

*Solving normative conflicts using preference relations.*

- Teófilo de Sousa Reis (IFCH- UNICAMP)

**Conference extended abstracts:** [RC08]

**Dissertations:** [Rei08]

**Talks, mini-courses and seminars:**

- Talk in the “CLE 30/ XV EBL / XIV SLALM”, Paraty, RJ, May 11-17, 2008:

*Covering logics via possible-translations.*

## External Participants

- Dov Gabbay (King’s College, London)

**Journal papers:** [DFG08].

- João Rasga (IST, Lisbon)

**Journal papers:** [CRS08, SSC09a, SSC09b].

- Amílcar Sernadas (IST, Lisbon)

**Journal papers:** [SSC09a, SSC09b].

- Cristina Sernadas (IST, Lisbon)

**Journal papers:** [CRS08, SSC09a, SSC09b].

## 4 Academic events

During this period, an important international conference was accomplished.

### 4.1 Organization of CLE 30/ XV EBL / XIV SLALM

During the period under evaluation an important international join event, the “CLE 30/ XV EBL / XIV SLALM” was organized, with financial support from

FAPESP, CAPES, CNPq, FAEPEX-UNICAMP, National Science Foundation and Association for Symbolic Logic. The event constituted of three joint conferences:

- CLE 30 - 30th Anniversary of the Centre for Logic, Epistemology and the History of Science, UNICAMP;
- XV EBL - 15th Brazilian Logic Conference; and
- XIV SLALM - 14th Latin-American Symposium on Mathematical Logic.

The event was held in Paraty, RJ, from May 11th to May 17th, 2007, and housed the traditional meetings of the Brazilian Logic Society (SBL) and the Latin-American Conferences in logic plus the celebrations of the 30th anniversary of CLE. The conference was preceded by a “Logic School” held at UNICAMP, Campinas. A book was elaborated contained selected papers presented at the event. The articles were selected after a rigorous refereeing process, and the book, to be published in London by “College Publications”, is scheduled to appear in the next months:

[CCD09b] Walter A. Carnielli, Marcelo E. Coniglio and Itala M.L. D’Ottaviano (editors). **The Many Sides of Logics**. *Studies in Logic Series*, College Publications, 2009 (to appear).

All the activities connected to the event are reported in the present Scientific Report. The official event page is:

<http://www.cle.unicamp.br/cle30-eb1-slalm/index.php?pag=abertura.php>

## 5 Report of Work in Progress, Future Work and Appraisal

In order to offer subsidies for an assessment of the work accomplished in the Project and what is still being counted as future work, we provide here a short account of the work in progress:

- **Task 1: Fundamentals of Combining Logics**, coordinated by Marcelo Coniglio.

– Subtask 1.1: Combinations of Logics and their Applications.

Research on interactions between connectives when combined in different logics have revealed to be a source of interesting problems and is still in progress, and a paper on “possible-translations semantics” by using multifunctions is being prepared. On another topic, a conceptual paper emphasizing paraconsistency and modal paradoxes, by means of the Logics of Formal Inconsistency, is being written.

A related work on preservation of interpolation properties by fibring in collaboration is being developed with C. Sernadas and J. Rasga, external collaborators from the Instituto Superior Técnico, Lisbon.

- Subtask 1.2: Splitting and Algebraizing Logics.

A paper concerning the dual hierarchies of paraconsistent logics  $P^n$  and paracomplete logics  $I^n$ , and their relations in the context of Blok-Pigozzi’s notion of algebraizability is still in preparation.

- Subtask 1.3: Algebraic Semantics for Modal Logics.

We expect to continue our research on the quasi-truth theory. On the other hand, new concepts and applications of modulated quantifiers are expected to be developed. Specifically, as explained in previous Reports, the goal is to obtain applications to epistemology and philosophy of science of modulated quantifiers.

- Subtask 1.4: Algebraic and Categorical Aspects of Logical Consequence.

This subtask is mainly devoted to the use of tools from category theory for representation and combination of logics. An important achievement were two papers, still in preparation, concerning the presentation of logic systems based on the theory of m-graphs (i.s., graphs with finite sequences of vertexes as source of the edges). This work is being furthered in collaboration with A. Sernadas, C. Sernadas and J. Rasga, external collaborators from the Instituto Superior Técnico, Lisbon.

- **Task 2: Computational Aspects of Combinations of Logics and Theorem Proving**, coordinated by Marcelo Finger.

Several articles referring to this Task have been prepared by Marcelo Finger, Renata Wassermann, Flávio Soares Correa da Silva and external co-authors, Márcio Moretto Ribeiro, Adolfo G. S. S. Neto and Guilherme de Souza Rabello. The task had the participation, as co-author, of Dov M. Gabbay, external collaborator from King’s College, London. This task has been very productive and has many ongoing issues. Prof. Marcelo Finger will be leading the Task in the quality of project researcher but not as a “main researcher” any more.

- **Task 3: Quantum Logics and Algorithms**, coordinated by Walter Carnielli.

There are some problems connected to the well-known Cook’s theorem still being investigated. In particular, we are studying some first results similar to Cook’s theorem for paraconsistent Turing machines, which may confirm our running conjecture that paraconsistent circuits could efficiently solve Deutsch-Jozsa problem. Other questions involving the proposals of ‘non-standard’ complexity measure for handling classes of unconventional models of computation are waiting to be attacked, but have been postponed for the moment. A paper on the new polynomial ring calculus for **S5** is being written.

This project resulted, only counting the present report (between March 2008 and April 2009) in an impressive amount of work concentrated around the unifying topic of logical consequence:

- Books: 2
- Books edited: 1
- Books in preparation: 1
- Journal papers published, accepted or in print: 13
- Journal papers submitted: 2
- Conference papers or book chapters published, accepted or in print: 19

- Conference papers or book chapters submitted: 2
- Extended Abstracts: 13
- Master Dissertations: 6
- PhD Thesis : 3

Before these numbers, the previously delivered Reports count approximately 77 journal or conference papers, 5 books published or edited, 3 Master dissertations and 4 PhD thesis.

It is noteworthy to remark that two relevant books have been published:

- W.A. Carnielli, M.E. Coniglio, D. Gabbay, P. Gouveia, and C. Sernadas. *Analysis and Synthesis of Logics*. Applied Logic Series, vol. 35. Springer, 2008.
- W.A. Carnielli and C. Pizzi. *Modalities and Multimodalities*. Applied Logic Series. Springer, Amsterdam, 2008.

Besides such international publication, for the first time two books (both published in São Paulo in the scope of the Project) devoted to logic, computer science and foundations of mathematics have been awarded the “Prêmio Jabuti” (Jabuti Prize):

- *Lógica para Computação* (F. S. C. da Silva, M. Finger and A. C. V. de Melo.). Editora Thomson, Brazil, 2006.

and

- *Computabilidade, Funções Computáveis, Lógica e os Fundamentos da Matemática* (W.A. Carnielli and R.L. Epstein). Editora UNESP, São Paulo, Brazil, 2006.

Two new external international collaborators showed interest to be incorporated into the Project: Leon van de Torre (from the Faculté des Sciences, de la Technologie et de la Communication, Université du Luxembourg, Luxembourg) and Catarina Dutilh-Novaes (from the Faculty of Humanities, Department of Philosophy University of Amsterdam).

C. Dutilh-Novaes is also a visiting scholar at “*Arché*: Philosophical Research Centre for Logic, Language, Metaphysics and Epistemology ” of the University of St. Andrews, Scotland.

The University of St. Andrews is Scotland’s premier centre for philosophy and one of the top institutions for philosophy in the United Kingdom and Europe.

In June 2008, Arché was awarded a major funding for a research project on the “Foundations of Logical Consequence” from 2009 to 2012, commencing five years later we started our own project. Details to be found at:

<http://www.st-andrews.ac.uk/~arche/projects/logic/index.shtml>

Researchers of *Arché* manifested interest in exchanging ideas and people, and both sides consider that our projects to be complementary, though with several points in common. The *Arché* project will run through four big phases:

- Conceptions of Logical Consequence
- The Structure of Logical Consequence
- Revisionism in Logic
- The Epistemology of Logic

each one with intrinsic connections with our research. We plan, in the future, to introduce another conceptual dimension in our project, contemplating also this approach.

All this, not counting a number of talks, conferences and tutorials, justifies the need for an additional one-year extension of the project schedule just to close the work of pre-prints, books in preparation, and the editorial work on submitted or accepted journal papers.

We are thus applying for a one year extension, up to April 01, 2010, in order to finish the project and be able to offer a full account of the general project significance.

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