Curriculum Vitae

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April 5, 2010

1 Contact Information

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2 General Information

Education

8/9/1997 PhD in Computer Science, University of Ancona, Italy.

10/4/1992 Italian *"Laurea"* in Computer Science, University of Pisa, Italy.

Qualifications

2004, 2008 French Qualifications for the role of *"Maître de Conférences"* for Computer Science.

Current Position

Researcher (Ingenieur expert, fixed term), within the ANR Project *Démosthène* at INRIA Nancy-Grand Est.

Employment

03/10– Teaching Assistant (Enseignant vacataire), École Nationale Superieure des Mines, Nancy.

10/09– Teaching Assistant (Enseignant vacataire), Université Nancy 2.

1/10/08–(30/09/10)
Researcher (Ingenieur expert), ANR Project *Démosthène*, INRIA Nancy-Grand Est.

1/09/08– Consultant, International Baccalaureate Organisation, Cardiff.

1/2/07–30/06/08
Research Fellow at University of Bath, Computer Science Department.

2/10/06–2/2/07
Teaching Fellow at University of Bath, Computer Science Department.

1/10/97–31/12/05
: Assistant professor at the Technische Universität Dresden, Fakultät Informatik (at the International Centre in Computational Logic).

9/95–12/95 Scientific Collaborator at GMD-FIRST GmbH, Berlin Adlershof.

1/93–12/93 Researcher and Teaching Assistant at University of Bologna, Computer Science Department.

7/92–12/92 Research Fellow at University of Pisa, Computer Science Department.

Individual Grants

2001—2003 Grant from the Sächsische Ministerium für Wissenschaft und Kunst, (Programme HWP), for financing my position as employed researcher (Wiss. Mitarb. BAT-O 2A).

1997 Grant from the European Educational Forum - University of Eindhoven for participating to the two-weeks s"Summer School on Computational and Syntactic Methods", in Mierlo.

1/1/96–30/6/96
: EU-HCM PhD fellowship at Technische Universität Berlin, Fakultät Informatik, Institut für Angewandte Informatik.

1993—1996 PhD-student grant, from the Italian Ministry of University, Scientific Research and Technology (MURST), at University of Ancona, Faculty of Engineering.

Invitations for Scientific Visits and Courses

14-21/12/2007
: Technische Universität Dresden, International Center for Computational Logic:
Guest lecturer for the MSc/PhD Programme, teaching the course "Introduction to Deep Inference and Proof Nets" with Lutz Straßburger.

13/12/2003 ICLP '03 (International Conference on Logic Programming, Mumbai):
The Programme Committee of ICLP'03 invites me to present a tutorial on the proof theoretical foundations of logic programming. The supporting paper (refereed), co-authored with Alessio Guglielmi, is [ICLP03].

10/1997 Technische Universität Dresden, Fakultät Informatik –Künstliche Intelligenz:
Guest lecturer for the International Masters Programme in Computational Logic.

9—12/1995 GMD FIRST Berlin (Gesellschaft für Mathematik und Datenverarbeitung, GmbH):
Invited scientific stage, within the group co-ordinated by Ulrich Geske, supported by Deutsche Forschungsgesellschaft (DFG) for a co-operation in the project "VERMEIL". Objective of this project was the development and integration of formal methods and of knowledge based methods for the design and configuration of process control systems. I worked with the teams of Ulrich Geske and Stefan Jähnichen on the theme "Planning and concurrency in linear logic".

Invited Talks

2/7/08 Computer Science Department, University of Southampton (Wessex Theory Seminar, inaugural meeting): *Threshold formulae for normalisation in deep inference.*

18/6/08 Workshop "Deep Inference, its Algebra, Geometry and Syntax" INRIA Nancy-Grand Est: *Threshold formulae in deep inference.*

9-12/01/08 Faculdade de Ciência, Universidade do Porto, Portugal: *Exploiting Deep Inference in Complexity and Identity of Proofs.*

13-14/3/07 PCC'07 (Proofs, Computation and Complexity), Swansea: *On the proof complexity of deep inference.*

1-2/12/06 SWODI'06 (Small Workshop on Deep Inference), Paris: *Tseitin's Extension, Substitution and Deep Inference.*

23/2/06 INRIA-Lorraine, Nancy, Équipe Calligramme: *Exploiting Deep Inference in Complexity.*

24/11/03 INRIA-Lorraine, Nancy, Équipe Calligramme: *Linear Logic Proofs via Macro Rules.*

13/12/02 WLP, 17. Workshop Logische Programmierung (11–14/12/02), Dresden: *A Purely Logical Account of Sequentiality in Proof Search.*

27-28/5/99 "Logik in der Informatik", 3. Workshop 7. Fachgruppentreffen der GI Fachgruppe 0.1.6, Dresden: *Proof Search and Non-Determinism in First Order Linear Logic.*

18/7/97 Technische Universität Dresden: *Partial Order Planning as Proof Search in Linear Logic.*

17/10/95 Technische Universität Berlin: *Expressiveness of the Abstract Linear Logic Programming Language FORUM in Planning and Concurrency.*

15/5/95 GMD FIRST Berlin: *Planning (and Concurrency) in Linear Abstract Logic Programming.*

Research Interests

Proof theory, proof complexity and theoretical computer science.

3 Teaching

Experience

Mathematical logic, computational logic, formal languages and compilers, theoretical computer science, complexity, proof theory, automated deduction, databases, artificial intelligence, bioinformatics, at BSc and MSc level, as well as courses for non-specialists.

Interests for Teaching

I will be glad to contribute my teaching for any traditional course in computer science, such as (and not limited to):
Databases, information systems, networks, algorithms, complexity, graph theory, operation research, security and cryptography, system engineering, web programming, system architectures, operating systems, programming languages, object oriented programming.

Summary of Past/Current Courses

Institution	Course	level	hrs	language
U. Bologna	Metodi per il Trattamento dell'Informazione	Laurea 4	45 hrs	Italian
U. Bologna	Linguaggi Formali e Compilatori	Laurea 4	60 hrs	Italian
ICCL Dresden	Introduction to Computational Logic	MSc 1	120 hrs	English
ICCL Dresden	Deduction Systems	MSc 1	20 hrs	English
ICCL Dresden	Special Topics in Computational Logic	MSc 2	30 hrs	English
ICCL Dresden	Inductive Logic Programming and Bioinformatics	MSc 2	30 hrs	English
ICCL Dresden	Substructural Logics and Proof Theory	MSc 2	30 hrs	English
ICCL Dresden	Selected Topics in Proof Theory	MSc 2	90 hrs	English
ICCL Dresden	Intr. to Sequent Calculus and Abstract Logic Progr.	MSc 2	60 hrs	English
ICCL Dresden	Introduction to Deep Inference and Proof Nets	MSc 2/PhD	10 hrs	English
TU Dresden	Logik 2	Vordiplom	40 hrs	German
U. Bath	Formal Systems, Logic and Semantics	BSc 2/3	54 hrs	English
U. Nancy 2	Certificat d'Informatique et Internet - 1	L1	36 hrs	French
U. Nancy 2	Certificat d'Informatique et Internet - 2	L1	36 hrs	French
ENS des Mines, Nancy	Programmation Java	L1	30 hrs	French

In relation to this table:

- frontal hours are indicated;
- I had full responsibility for the (part of the) courses I tought in Italy, Germany, UK;
- for all courses I had responsibility of the intermediate tests and final exams, assessment, corrections, evaluation.

4 Events Organisation

8/12/2000 *Workshop on Proof Theory, Dresden.*
One day of seminars, with six international speakers and around ten participants.
`http://www.computational-logic.org/~guglielm/WPT00/workshop.html`

3–14/6/02 *Workshop on Proof Theory and Computation, Dresden.*
Two weeks of courses and presentations for PhD students, with seven international lecturers and around thirty international participants.
`http://iccl.tu-Dresden.de/~guglielm/WPT/`

23/6–4/7/03 *Summer School and Workshop on Proof Theory, Computation and Complexity, Dresden.*
Two weeks of courses and presentations for PhD students, with nine international lecturers and around sixty international participants. We received a total financing of 30500 EUR, from different sources.
`http://iccl.tu-Dresden.de/~guglielm/WPT2/`

19–21/11/03 *Workshop on Structural Proof Theory, Dresden.*
Three days of meetings and presentations with eight international speakers.
`http://iccl.tu-Dresden.de/~guglielm/WSPT/`

14–25/6/04 *ICCL Summer School on Proof Theory and Automated Theorem Proving, Dresden.*
Two week series of courses and talks for PhD students, with eight international lecturers and around sixty international participants. We received a total financing of 36000 EUR, from different sources.
`http://iccl.tu-Dresden.de/iccl/events/ICCL-SS-2004`

27–28/9/04 *ICCL Workshop on Proof Theory 2004, Dresden.*
Two days of meetings and presentations with 16 international speakers.
`http://www.computational-logic.org/iccl/events/WPT-2004/`

21–23/2/05 *ICCL Workshop on Proof Theory 2005, Dresden.*
Three days of meetings and presentations with 10 international speakers.
`http://iccl.tu-Dresden.de/~guglielm/WPT05/`

16–17/7/05 *Structures and Deductions – The quest for the essence of proofs. ICALP Satellite Workshop, Lisbon.*
Organised with François Lamarche (INRIA-Lorraine), and Charles Stewart (Technische Universität Dresden).
`http://www.prooftheory.org/sd05`

6–8/7/06 *Proof Theory Meeting, Bath*
Three days of meetings and presentations with 10 international speakers.
`http://www.cs.bath.ac.uk/ag/w/pt06.html`

16–18/11/09 *REDO: Redesigning Logical Syntax, Nancy*
Three days of meetings and presentations with 16 international participants, around the REDO - Project (ARC 2009 Project).
`http://www.lix.polytechnique.fr/~lutz/orgs/redo-meeting-nov09.html`

23-24/02/10 *Geometric and logic approaches to computations, Nancy*
Two days of conferences and meetings with international speakers.
`http://demosthene.loria.fr/GLAC.html`

5 Collective and Administrative Responsibilities

Formation of a research group working on Proof Theory, at Technische Universität Dresden
Starting from 1998, Alessio Guglielmi initiated a very active working group on proof theory in Dresden, which I belonged to, and that I contributed shaping. I should stress that before the hiring of the two of us there was no research on proof theory going on at the Computer Science Department in Dresden. We could invite several scientists, internationally renowned, for teaching courses related to proof theory for the International Masters Programme in Computational Logic. This allowed disseminating the discipline within our Department. The intense relations with these researchers from all over the world witness the visibility of our research group at international level. A complete list of activities is available at
`http://www.iccl.tu-dresden.de/~guglielm/group/events.html`

International Summer Schools – Constitution of a Permanent School in Dresden
Alessio Guglielmi and myself took the initiative of organising three summer schools on proof theory, which were very successful. These eventually led to the constitution of a permanent summer school in Dresden, on themes related to Computational Logic, entirely financed by the German Federal Government through the DAAD agency. On its turn, the permanent summer school allowed to consolidate the visibility of the Centre of Excellence ICCL (International Centre in Computational Logic), which was going to be created in Dresden, almost simultaneously.
`http://www.computational-logic.org/content/events/summerschools.php?id=24`

Design of the Web Portal, International Centre in Computational Logic, Dresden
From January 1999 to December 2001 I was responsible of the design and maintainance of the web site of the International Masters Programme in Computational Logic. Later in 2003, I participated to the design of the portal of the International Centre for Computational Logic, which was finally produced by an external company.

People Supervision
In Bath, I have supervised the work of 4 research students employed as tutors for the course CM20019 I was teaching, in 2006.
In Dresden, I have supervised the work of four student assistants, temporarily hired for managing the official portal of the International Masters Programme in Computational Logic and for other ancillary tasks. Later, I supervised a technician who finally became responsible of the web site maintainance. I have also assisted administrative personnel in the preparation of three editions of the brochure marketing this study programme.
In Cesena, I assisted and contributed to the instruction of administrative and technical personnel for software installation and the preparation of computer laboratories for students.

Administration and Management for the International Masters Programme in Computational Logic, Dresden
From January 1998 to December 2001 I have been in charge of several activities related to this specific study programme (and at a minor extent also after 2001) reporting to the Head of the Study Programme.
These include: participation in students admission and recruitment; organisation of courses and seminars offered by guest lecturers for the taught Masters in coordination with the Graduiertenkolleg (postgraduate school); participation to the MSc curriculum development as double-degree with Universidade Nova de Lisboa (in 2003); courses' profiling according to the ECTS (European Credit Transfer System); support for student exchanges (in relation to Erasmus); coordination of some procedures relative to immigration issues, involving the University Students' Office, German Consulates and the Immigration Office in Dresden; ensuring and enhancing equal opportunities within the Masters, and coordination on these programmes, with the general administration of Technische Universität Dresden; teaching quality monitoring.

Member of the Board for the Selection of Administrative Personnel
In 2000 and 2002, for the post of secretary at the Institute of Artificial Intelligence, in Dresden.

Budget, Resource and Project Management
I directly administered the resources for all the workshops in proof theory organised in Dresden, and participated in managing the budget for the summer schools in years 2002, 2003 and 2004. For all these events I contributed in an essential way in searching and contacting sponsors (University, DFG, DAAD, consulates, private corporations, cultural foundations). The budget for the summer school in year 2004 was of 36000 EUR.

In the years 2003 and 2004 our group on Proof Theory in Dresden obtained research funding from DAAD for two years, under the bilateral French-German agreement PROCOPE, for common researches on deep inference with the group Calligramme at INRIA Lorraine, in Nancy. I managed the resources for our group (7400 EUR) and took care of the administrative procedures, in addition to participating to the researches.

I obtained financial support for the Workshop Structures and Deduction '05 – Satellite Workshop at ICALP in Lisbon, co-organised with our Partners in Calligramme, and for which I managed the budget. I could also provide travel grants for three students and an academic from Dresden, provided respectively by DAAD and DFG.

Editorial Activity
Coordinator of the editorial board for 'Structures and Deductions '05 - ICALP Workshop', Lisbon.

Consultant for the International Baccalaureate Organisation, Cardiff
IBO counts thousands of schools, all over the world, offering international degrees at all levels, up to bachelor degree (equivalent to A-AS-O-level). For the bachelor program I am deputy chief examiner for computer science, covering the schools located in the Europe-Middle East region. I am member of

- Examination Board,
- Curriculum Review Programme Committee,
- Internal Assessment Board.

6 Research

My research activity has always been in the realm of design of proof systems, and in general in the paradigm of proof search as computation. I work in structural proof theory, especially using the deep inference methodology and I have a special interest for logics of the substructural kind. These latter ones can in fact be applied in the design of logical languages for concurrency, with a strong proof theoretical foundation.

I interrupted working actively on research from 1998 to 2000 included, when I became mother of two children: in that period, I devoted more time to teaching and management.

Current Research Programme

My current researches address proof search and proof complexity issues in proof systems of the deep inference kind, with the objective of developing proof systems that can be applied for giving a logical foundation to languages for concurrency. These researches are part of the Project *Démosthène* (funded by an ANR-Chaire d'Excellence) at INRIA Nancy.
I study proofs, according to the vision of proof-as-computation. A proof is a formal justification of a theorem in some mathematical theory, but it can also be seen as the computation of a program by an interpreter. The theorem is the program, the interpreter closely corresponds to a deductive system, and the (search for a) proof is the computation. Understanding computation through logical proofs finds an obvious applications in the (possibly, semi-automated) verification of software and the design of computer languages. Moreover, in principle, it allows to link the operational activity of programming

and computing to more and more sophisticated mathematical models of logical theories: these latter ones, on their turn, can then be used to better understand computation to the aim of developing more secure and reliable software.

Deep inference is an established paradigm in proof theory and it has been especially developed during the past 10 years according to the proof-as-computation perspective. Several deep-inference based formalisms have been proposed, and among them the calculus of structures is the most developed, both for the variety of logics that have been expressed therein, and for the richness of the proof theoretical properties of these proof systems.

To explain deep inference, and in particular its objectives, it is sufficient to think in general terms of deductive systems. Deductive systems are sets of inference rules; these rules, in the so-called analytic systems, allow to envisage some natural way for designing algorithms that can control the proof search process. This process is at the base of automated deduction and the design of logic programming languages.

Deep inference proposes a radical rethinking of the traditional methodologies in proof theory, by strengthening the point of view of parallelism: in fact, differently from the traditional methods in proof theory, which find their origins in mathematics, the motivations for deep inference stem from modern computer science, with a sensibility towards issues related to distribution, locality, concurrency.

Inference rules in deep inference systems have the finest granularity possible; as a consequence, the algorithms for proof search are not influenced by the specific shape that the representation of the formalism itself would impose in the execution of the computation. As a result, the whole proof search process acquires a more parallel organisation. In comparison to the traditional means in proof theory, where the proof search process and the proof itself, are computational activities that can be parallelised to a certain, limited extent, the same activities in deep inference systems allow for a view closer to the world of parallel and distributed computations, as a consequence of the chosen representation of the formalism itself.

The results in deep inference, so far, have been spectacular. In addition to generalising traditional proof theory in every aspect, we obtain the following results, previously unachieved using traditional proof theoretical methods and in many cases now provably non-achievable with the traditional methods:

1. most modal logics can be described uniformly with analytic systems;

2. several classes of known hard tautologies have analytic deep-inference proofs that are exponentially shorter than their proofs in all other analytic, traditional proof systems;

3. the operators of basic process algebras can be faithfully logically captured in deep-inference based proof systems, thanks to a fully algebraic correspondence between the logical operators of the proof system and those of the process algebra;

4. deep-inference proofs have been further analysed and studied to address the problem of identity of proofs; to this purpose, further, more abstract, deep-inference formalisms have been proposed, allowing to hide unnecessary (bureaucratic) details in proofs while preserving their complexity; these formalisms, dubbed bureaucracy-free, have an independent proof theoretical appeal;

5. some of the newly proposed "bureaucracy-free" deep-inference formalisms adopt a graphical representation of (abstract versions of) proofs, to visualise information of structural nature that we want to observe; the chosen representation facilitates a form of reasoning which is inherently more "geometric", based on locality and symmetry; we expect to find novel forms of normalisation, useful not only to address the problem of identity of proofs but also having an impact on the mechanisms for proof search;

6. on the complexity side, we observed that proof normalisation in deep inference in propositional classical logic (cut elimination) has a quasipolynomial cost instead of an exponential one, as it happens in traditional proof theoretic methodologies; for this result we have made use of the new bureacracy-free deep inference formalisms.

All the points mentioned above are directly relevant and of strategic importance for computer science. They are in fact related to applications to evaluate the quality of a computer system, in terms of its security and reliability through the verification of its components and their interactions, and these are obvious, necessary features for designing and mastering network infrastructures and communication services platforms. Given this frame, my current research lines focus on the following aspects:

- Extending the range of process algebra operators captured by deep inference, in particular by the calculus of structures;
- Studying and defining a more operational notion of provability in deep inference, in the spirit of Miller's uniform provability for the sequent calculus;
- Treatment of non-determinism in the proof-search process in the calculus of structures;
- Applications of the mentioned investigations to verification and security;
- Exploiting the exponential speed-up of deep inference proofs for classical logic, for getting more efficient computations;
- Further exploiting the results on quasi-polynomial normalisation for classical logic, as well as studying other possible forms of normalisation, also for incremental extensions of classical logics.

Chronology of Research Activities

In the sequel I illustrate the main themes I have been working on, where citations refer to my list of publications, indicating also the projects and institutions where my research (or position) has been supported.

1992-1993 **Semantics of Constructive Negation in Constraint Logic Programs**. Observable semantics capture several aspects of computations in logic programs, and they are useful for program analysis, transformation and verification. In [CAAP94] we defined constructive negation and in [GULP93,CLog93a,TRIN] intensional negation for CLP programs; we proposed several non-ground formal semantics modelling computed answers, and we established some equivalences wrt the non-ground 3-valued program completion.
• *Organisation:* University of Pisa.
• *Supported by:* ESPRIT-BRA Parforce 6707, CNR Semantica di linguaggi logici.

1993 **Extensions of Logical Languages with Set Theory**. A constructive version of negation is also at the basis of some syntactical constructs of a CLP language dealing explicitly with sets based upon a process of set-unification [ICLP93W,CLog93b,IntSet].
• *Organisations:* University of Bologna, Campus in Cesena and University of Pisa.
• *Supported by:* ESPRIT-BRA Parforce 6707.

1994–1997, 2003– **Abstract Logic Programming in Linear Logic for Planning and Coordination**. Linear logic treats some aspects of synchronization and rewriting, common both to planning and concurrency, in a better way than what is possible by means of classical logic. The combination of linear logic with the methods of Abstract Logic Programming (ALP) yields expressive languages and strong mathematical methods for planning and coordination languages. In [GULP94,SBIA94] we showed that a known framework for plan generation admits a presentation as an ALP language, amenable of extensions. In [GULP95] we deal with the problem of logically treating sequentiality: we apply further these results to logically specify the coordination language Gamma in [Gamma,CLog95]. In our opinion this language is adequate to treat some forms of temporal and spatial reasoning as well [Th97]. The works [SPS,LPAR03] present a harmonic system for linear logic: computations in this system become much closer to behavioural semantics of process algebras. These papers are precursor of further

researches based on the calculus of structures, and are part of my PhD thesis [Th97]. An introductive paper on abstract logic programming, presented as invited tutorial for the International Conference on Logic Programming 2003, is [ICLP03].

• *Organisations:* Researches done over the years at University of Pisa, University of Bologna, University of Ancona, GMD-First Berlin, Technische Universität Berlin, Technische Universität Dresden.

• *Supported by:* ESPRIT-BRA Parforce, ESPRIT-BRA Coordination, Italian Research Ministry for University, Research and Techology (MURST), German Research Ministry for Research and Education (BMBF), German Research Council (DFG) – project Vermeil, German Academic Exchange Service (DAAD), and by the EU-HCM Programme – Project Deduktion.

2001– **Linear Logics and Process Algebras, Deep Inference and The Calculus of Structures**. The objective is to reach a proof theoretical foundation for the design of languages for concurrency. Computations in process algebra are related to proof search in a given formal logical system, and this must happen with a strict algebraic correspondence between the operators of the process algebra and the logical relations of the formal system. The calculus of structures has been a significant step forward. In [BVL,WLP] a fragment of CCS is studied, and I give the first direct account of sequentiality in a process algebra by means of a logical relation.

• *Organisations:* Technische Universität Dresden, University of Bath.

• *Supported by:* CoLogNet, German Research Council (DFG), French-German Partnership DAAD-PROCOPE, Saxonian Ministry for Education and Arts (SMWK - HWP Programme).

2005– **Issues in Complexity and Proof-Search in Presence of Deep Inference**. Proofs and derivations in logical systems in the calculus of structures show new symmetries and dualities and enjoy new properties of decompositions, which would be impossible in more traditional formalisations, like for example, those in the sequent calculus. It is then interesting to understand the contribution of deep inference to studies in proof complexity, especially for propositional classical logic and, orthogonally, to try and exploit these regularities for reaching a more procedural notion of provability in deep inference systems.

Relatively to complexity, we know that the calculus of structures, a formalism of the deep inference kind, can polynomially simulate Frege systems, which are considered the most powerful, for complexity considerations, among the traditional proof systems. It is also possible to simulate, modulo a polynomial, several other proof systems that are very different in spirit: both deductive and procedural ones, either operating in a direct way or by refutation. This feature allows to think of the calculus of structure as a common ground where different known proof methodologies, of different strength, can be handled, and allowing to perform them all as tactics. If analyticity of the formalism matters, then deep inference exhibits an example where we observe an exponential speed-up over the sequent calculus. This example is provided by Statman's tautologies: proofs of these formulae have of exponential size in cut-free sequent calculi systems for classical logics, such as Gentzen's proof system LK, and polynomial ones if the cut rule is admitted. Yet, proof systems for classical logic in the calculus of structure, and hence employing deep inference, allows building polynomial proofs also in absence of the cut.

Furthermore, extensions to Frege systems with Tseitin's rule and substitutions can be elegantly accomodated in deep inference. A paper on these results is [PC], related to presentation at meetings [AIR07,PCC07b], and constitute a first base for future research on proof complexity.

As expected, the advantages we have in terms of proof complexity are at the expenses of the proof-search process. The more freedom in rule application in deep inference systems, makes the proof-search process more non-deterministic than, for example, in the sequent calculus. However, the richer proof theory of the calculus of structures, and

in particular, some specific theorems abut normal forms in deep inference, that we call decomposition and splitting theorems, could help in this sense to producing a notion of provability with the same value uniform provability has for the sequent calculus. The calculus of structures generalises the sequent calculus, so in principle it seems to be possible to borrow ideas on uniform provability and apply them in the new formalism. We are currently trying to exploit splitting theorems in the proof search process and define a more general notion of provability based on that. This direction of research is complementary to other techniques formulated by Kahramanogullari, applied in existing implementation, for controlling some sources of non-determinism.

• *Organisations:* Technische Universität Dresden and University of Bath.

• *Supported by:* partially funded by French-British Partnership BC-Alliance and German-British Partnership BC-ARC and by EPSRC.

2008- **On Normalisation and Complexity in Deep Inference**. In the sequent calculus, normalisation is intended as cut-elimination, and this procedure is known to have exponential complexity. The same techniques may be ported to deep inference. We can however greatly improve the complexity up to a quasi polynomial order using the so-called "threshold" formulae that implement some specific boolean functions. These are usually studied in the realm of computational complexity, in relation to circuits. Deep inference allows a peculiar use of threshold formulae, in contrast to what happens in the sequent calculus: the representation of proofs induced by the formalism does not allow to use threshold formulae at the best of their potential. We can apply them to a system for classical logic, whereas in the literature in the sequent calculus we see their use limited to monotone classical logic. At a technical level, we make use of "atomic flows", as well as of the notation of "Formalism A": these are two deep-inference formalisms, more abstract than the calculus of structures, which have been developed for addressing the problem of proof identity. The former one allows to work on a more abstract version of proofs, where some unnecessary details (for our purposes) of the computation have been hidden: in particular we want to hide simple cases of permutability among rules, and keep track instead of the structural information of propositional variables in proofs, i.e. their creation, duplication and annihilation. Of the latter formalism, which constitutes another major milestone in researches addressing the problem of proof identity, we make here a limited use: it provides a visual method of composition of proofs which is more convenient for observing the interplay of and effects of threshold functions. Both formalisms shall be regarded as intermediate developments for answering the problem of identity of proofs, which is one of the axes of the Démosthène project. These results have been presented at workshops in Nancy, Oslo, Southampton; the paper [QPNc] has been recently accepted for conference publication, the longer journal version [QPN] has been submitted.

• *Organisations:* University of Bath, INRIA Nancy-Grand Est.

• *Projects:* EPSRC (Engineering and Physical Science Research Council); Senior Chaire d'Excellence ANR Projet Démostène.

Recent Research Group Grants

In addition to the individual research grants previously illustrated, I participate in the following research grants, awarded to other academics, as group member:

2009–2010 **"REDO: Redesigning Logical Syntax", INRIA - Action de Recherche Collaborative**. Deep inference is one of the three main themes of this project, funded for around 20.000 EUR i 2009 and 40.000 EUR in 2010 for a post-doc and for (expected) 41.000 EUR in 2010 from INRIA. The project involves members of Calligramme, Démosthène and Parsifal at INRIA, as well as the Computer Science Department in Bath. Proincipal investigators are Alessio Guglielmi (Bath and Démosthène), François Lamarche (Calligramme) and Lutz Straßburger (Parsifal, coordinator).

2008–2010 **"Identity and Geometric Essence of Proofs (Démosthène)" ANR- Senior Chaire d'Excellence 2008**. Awarded to Alessio Guglielmi, the roject, of a duration of 2 years takes place at INRIA Nancy Grand Est. The project amounts in 355.000 EUR from ANR, out of a total cost of ca 750.000 EUR, the rest being covered by INRIA. My employment as Ingenieur de Recherche Expert is linked to this project and envisages collaboration with members of the teams Calligramme and Pareo.

2007-2008 **"Complexity and Nondeterminism in Deep Inference", Engineering and Physical Research Council (EPSRC)**. 17-month project, at University of Bath, funded for 188,072 GBP, where I am co-investigator together with Alessio Guglielmi (principal investigaor).

2006–2008 **British-German bilateral agreement (BC ARC)**. The proof theory group at U. Bath, I collaborate with, obtains a two-year grant for common researches with the group of proof theory at Technische Universität Dresden, starting in 2006. We receive support of 2650 GBP by the British Council.

2005–2007 **French-British bilateral agreement (BC Alliance)**. The proof theory group at U. Bath, I collaborate with, obtains for the year 2006 a research grant with the group PPS at U. Paris 7. We receive support of 2300 GBP by the British Council.

2003-04 **French-German bilateral agreement (DAAD Procope)**. Our proof theory group at Technische Universität Dresden obtains a 2-year research grant for common investigations on deep inference with the Équipe Calligramme, INRIA Lorraine, Nancy. We receive 7600 EUR by DAAD, and our French partner, presumably, comparable resources.

Committees and Editorial Activity

- PC Member of *"CL&C'08" Second International Workshop on Classical Logic and Computation*, co-located with ICALP 2008, Reykjavik.
- PC Member of *"Structures and Deduction 2005 - The Quest for the Essence of Proofs," International Workshop*, co-located with ICALP 2005, Lisbon.
- Co-Editor of *"Structures and Deduction 2005 - The Quest for the Essence of Proofs*.

7 Publications

Abstracts available from `http://www.cs.bath.ac.uk/pb/`

In preparation

[ADI] Paola Bruscoli and Alessio Guglielmi. *On analyticity in deep inference.* Available at `http://cs.bath.ac.uk/ag/p/ADI.pdf`

[QPN] Paola Bruscoli, Alessio Guglielmi, Tom Gundersen and Michel Parigot. *Quasipolynomial Normalisation in Deep Inference via Atomic Flows and Threshold Formulae.* Journal version, ready to be submitted. Year 2009. Available at `http://cs.bath.ac.uk/ag/p/QuasiPolNormDI.pdf`

International Journals

[PC] Paola Bruscoli and Alessio Guglielmi. *On the Proof Complexity of Deep Inference*. ACM Transaction on Computational Logic, Volume 10, Number 2, Pages 1–34, Year 2009. `http://cs.bath.ac.uk/ag/p/PrComplDI.pdf`.

[SPS] Paola Bruscoli and Alessio Guglielmi. *On structuring proof search for first order linear logic.* Theoretical Computer Science, Volume 360, Issues 1-3, 21 August 2006. Pages 42—76. `http://www.sciencedirect.com/science/issue/5674-2006-996399998-629448` Also as Technical Report WV-03-10, Technische Universität Dresden, 2003. `http://cs.bath.ac.uk/pb/sps/spsj.pdf`

Chapters in books with international reviewing committee

[Gamma] Paola Bruscoli and Alessio Guglielmi. *A linear logic view of Gamma style computations as proof searches*. In Jean-Marc Andreoli, Chris Hankin, and Daniel Le Mètayer, editors, *Coordination Programming: Mechanisms, Models and Semantics*, pages 249–273. Imperial College Press, 1996.

International conferences with selection panel

[QPCE] Paola Bruscoli, Alessio Guglielmi, Tom Gundersen and Michel Parigot. *A Quasipolynomial Cut-Elimination Procedure in Deep Inference via Atomic Flows and Threshold Formulae*. Accepted at LPAR 16th Conference, Dakar (Senegal) 2010. Available at `http://cs.bath.ac.uk/ag/p/QPNDI.pdf`

[BVL] Paola Bruscoli. A Purely Logical Account of Sequentiality in Proof Search. In Peter J. Stuckey, editor, *Logic Programming, 18th International Conference*, volume 2401 of *Lecture Notes in Artificial Intelligence*, pages 302–316. Springer-Verlag, 2002.
`http://www.cs.bath.ac.uk/pb/bvl/bvl.pdf`

[ICLP03] Paola Bruscoli and Alessio Guglielmi. *A tutorial on proof theoretic foundations of logic programming*. In Catuscia Palamidessi, editor, *Logic Programming, 19th International Conference*, volume 2916 of *Lecture Notes in Computer Science*, pages 109–127. Springer-Verlag, 2003. Invited tutorial.
`http://www.ki.inf.tu-dresden.de/~guglielm/res/pap/PrThFoundLP.pdf`

[LPAR03] Paola Bruscoli and Alessio Guglielmi. On structuring proof search for first order linear logic. In Moshe Y. Vardi and Andrei Voronkov, editors, *LPAR 2003*, volume 2850 of *Lecture Notes in Artificial Intelligence*, pages 389–406. Springer-Verlag, 2003.
`http://www.cs.bath.ac.uk/pb/sps/sps.pdf`

[IntSet] Paola Bruscoli, Agostino Dovier, Enrico Pontelli, Gianfranco Rossi. Compiling Intensional Sets in CLP. In P. Van Entenryck, editor, *Proceedings of 11th Int'l Conference on Logic Programming, ICLP '94, S. Margherita Ligure (Italy)*, pages 647–661. The MIT Press, 1994.

[CAAP94] Paola Bruscoli, Francesca Levi, Giorgio Levi, Maria Chiara Meo. Compilative Constructive Negation in Constraint Logic Programs. In Sophie Tyson, editor, *Proceedings of Colloquium on Trees in Algebra and Programming, CAAP '94, Edinburgh (Scotland)*, volume 787 of *Lecture Notes in Computer Science*, pages 52— 67. Springer-Verlag, 1994.

[GULP95] Paola Bruscoli and Alessio Guglielmi. A linear logic programming language with parallel and sequential conjunction. In *GULP-PRODE '95, Joint Conference on Declarative Programming, Marina di Vietri, Italy*, pages 409–420. University of Salerno, 1995.

[GULP94] Paola Bruscoli and Alessio Guglielmi. Expressiveness of the abstract logic programming language Forum in planning and concurrency. In *GULP-PRODE '94, Joint Conference on Declarative Programming, Peniscola, Spain*, volume 2, pages 221–237. Universidad Politecnica De Valencia, 46071 Valencia, Spain, 1994.

[ICLP93W] Paola Bruscoli, Agostino Dovier, Enrico Pontelli, and Gianfranco Rossi. Extensional and Intensional Sets in CLP with Intensional Negation. *In ICLP '93 Post-Conference Workshop on Logic Programming with Sets, Budapest, Hungary, 1993*. Distributed among participants.

National conferences with selection panel

[WLP] Paola Bruscoli. A purely logical account of sequentiality in proof search – Extended Abstract. In Bertram Fronhöfer and Steffen Hölldobler editors, *17. WLP: Workshop Logische Programmierung, TU Dresden, December 11–13, 2002*. Technische Berichte der Fakultät Informatik, TU Dresden, 01062 Dresden TUD–FI03–03, April 2003. ISSN 1430–211X.

[SBIA94] Paola Bruscoli, Alessio Guglielmi, and Giorgio Levi. Planning and abstract logic programming: A linear logic approach. In *XI Brazilian Symposium on Artificial Intelligence, Fortaleza*, pages 285–299, 1994.

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Editorial project, with international program committee

[SD05] Paola Bruscoli, Francois Lamarche, Charles Stewart Eds. *Structures and Deduction – The Quest for the Essence of Proofs* (satellite workshop of ICALP '05). Technische Berichte der Fakultät Informatik, TU Dresden, 01062 Dresden; TUD–FI05–08, Juli 2005. ISSN 1430–211X.
`http://www.ki.inf.tu-dresden.de/~paola/SD05/SD05-Proc.pdf`

Unrefereed papers and notes

[PCC08] Paola Bruscoli, Alessio Guglielmi, Tom Gundersen. *Quasipolynomial Normalisation in Deep Inference via Atomic Flows and Threshold Formulae*. Workshop Proof Computation and Complexity 2008, Oslo. (Distributed among participants)

[AIR07] Paola Bruscoli and Alessio Guglielmi. On Analytic Inference Rules in the Calculus of Structures. Available at `http://cs.bath.ac.uk/ag/p/Onan.pdf`, 2007.

[PCC07b] Paola Bruscoli and Alessio Guglielmi. On the complexity of deep inference. In *Informal Proceedings of Proof, Computation and Complexity*, Swansea 2007.

[CLog95] Paola Bruscoli and Alessio Guglielmi. On Gamma style computations in abstract linear logic programming. In *Informal Proceedings of the Fourth Compulog-Network Subgroup Meeting on Programming Languages, Marina di Vietri, Italy*, 1995.

[CLog93a] Paola Bruscoli, Francesca Levi, Giorgio Levi, and Maria Chiara Meo. Intensional Negation in Constraint Logic Programs. In *Informal Proceedings of the Second Compulog Area Network Meeting joint with Workshop on Logic Languages, Pisa*, 1993.

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[TRIN] Paola Bruscoli, Francesca Levi, Giorgio Levi, and Maria Chiara Meo. Intensional Negation in CLP. Technical Report 11/93, Dipartimento di Informatica, Università di Pisa, 1993.

[SeDen] Paola Bruscoli and Gianfranco Rossi. Note sulla Semantica Denotazionale di un Semplice Linguaggio Imperativo. Corso di laurea in Scienze dell'Informazione, Cesena, 1993.

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