Curriculum Vitae

Paola Bruscoli
http://www.cs.bath.ac.uk/pb/

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Education

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

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

Employment

1/02/13–12/05/2016
Research Fellow, EPSRC Project "Efficient and Natural Proof Systems", University of Bath (GBR)

1/04/11–30/09/12
Substitute Associate Professor in Computational Logic (Vertretungsprofessor - W2), Technische Universität Dresden, Fakultät Informatik, International Centre for Computational Logic (DEU)

1/10/08–30/09/10
Researcher, ANR-Project *Démosthène*, INRIA Nancy-Grand Est and Teaching Fellow at Université Nancy 2 and École Nationale Superieure des Mines, Nancy (FRA)

1/09/08– Educational Consultant for the International Baccalaureate Organisation, at Cardiff centre: currently, Chief Examiner for Computer Science (GBR)

1/2/07–30/06/08
Research Fellow (EPSRC) at University of Bath, Computer Science Department (GBR)

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

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

9–12/95 Scientific Collaborator at GMD-FIRST GmbH, Berlin Adlershof (DEU)

1–12/93 Researcher and Teaching Assistant at Università di Bologna, Computer Science Department (ITA)

7–12/92 Research Fellow at Università di Pisa, Computer Science Department (ITA)

Awards

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

1993–1996 PhD-studentiship competitive stipend, awarded by the Italian Ministry of University, Scientific Research and Technology (MURST), at Università di Ancona, Faculty of Engineering.

Qualifications

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

Research Interests

Proof theory, proof complexity and theoretical computer science, applications of logic in AI.

Teaching

In parentheses, the number of semesters each of the mentioned topics has been taught:

Undergraduate level – 10 one-semester courses on the following topics: formal languages and compilers (2), theoretical computer science (1), complexity (1), databases (1), programming in Java (1), mathematical and computational logic (2), informatics and internet (2).
Postgraduate level – 23 one-semester courses on the following topics: Mathematical and computational logic (8), AI and bioinformatics (1), proof theory (3), deep inference (3), automated deduction (3), foundations of logic programming languages (2) foundations of constraint programming languages (1), programming in Prolog/ECLiPSe (2).
In addition to these, I offered further intensive crash courses in deep inference at summer schools or specific venues.

Invitations, Committees, Editorial Activity

- International Baccalaureate Organisation – Chief Examiners Conference, La Hague, March 2016.
- EPSRC ICT Prioritisation Meeting, Panel Member, February 2016.
- International Baccalaureate Organisation – External Review Committee for DP Curriculum, advisor, La Hague, January 2016.
- PC Member and organiser of *WENPS, Workshop on Efficient and Natural Proof Systems*, December 2015, Bath.
- European Summer School on Logic, Language and Information, ESSLLI August 2015 - Barcelona; invited lecturer for "Introduction to Deep Inference", Invited Lecturer for an Advanced Course
- Member of the Athena Swan Departmental Self Assessment Committee - Dept of Computer Science, University of Bath.
- PC Member for *"SD'14", Third International Workshop on Structures and Deduction*, satellite event of the *Federated Logic Conference, FLoC'14*, Wien.
- Invitee at a networking event "Counting on Girls – Women In Engineering and Science (WISE) initiative", Ralph Allen School, Bath 2014
- PC Member for *"CSL'13", 22nd EACSL Annual Conference on Computer Science Logic*, Torino.
- EPSRC ICT Panel Member, February 2013.
- Audit for the Internationalisation Process, TU Dresden, May 2011, interviewee.
- PC Member for *"CL&C'08" Second International Workshop on Classical Logic and Computation*, co-located with ICALP 2008, Reykjavik.
- PC Member and co-editor for *"Structures and Deduction 2005 - The Quest for the Essence of Proofs," International Workshop*, co-located with ICALP 2005, Lisbon.
- Invited tutorial at the International Conference on Logic Programming, Mumbai, 2003.

Enterprise, Outreach Activities, Public Engagement

- *Chief Examiner for Computer Science for Int'l Baccalaureate Organisation (previously, Deputy Chief Examiner).*
  Activities include: curriculum review and design for Computer Science and ICT-oriented school curricula at Diploma Level, at an international dimension, with attention to suitability for university entry (specifically UCAS). This includes also collaborative work in exam paper production and components of the assessment process and quality assurance.
  This year I will take part to a broader curriculum development exercise, as it not only addresses subjects in computing but also a probable re-design of the IB Diploma and profiling of all STEM subjects.
  Some of the IB schools are already feeders of Universities abroad that appear as partners of University of Bath in relation to plans in Internationalisation.
  It is in th emission and ethos of IB to support education in developing countries and in general to reduce the digital divide; this year for the first time it has been accepted to introduce a further element of addressing female education in relation to STEM. In this context a pilot educational project involving Arduino Technologies is currently running in some areas of Venezuela and Ecuador.
- *The Bath based hub of the Computing At School Network.*
  The Network offers support and training to teachers in computer science following the recent British National Curriculum guidelines and aims. I am occasionally asked to contribute talks or meetings at the Ralph Allen School in Bath for this.
- *Athena-Swan related initiatives.*
  I am occasionally asked to promote STEM subjects targeting in particular female school pupils, as researcher from University of Bath: this includes career orientation days prior selection of subjects

for A-levels. I took part to comparable outreach initiatives to promote computer science in schools in France and in Germany when I was based at INRIA and at TU Dresden, with the associations *EPI - Enseignants pour l'Informatique* and *Informatik in der Schule e.V.*, respectively.
As a member of the Departmental Self Assessment Team, coordinated by Nicolai Vorobjov, I took part to the workd to bid for the Departmental Bronze award: The Department obtained it in October 2015. One of the first scientific events that will address the proposed action plan is the WENPS workshop, of which I am one of the organisers.

- *Underwater protocol for diving archeologists*
  Back in the '90s, as a scuba-diver with an interest in archeology, I took part as a volunteer to a an initiative funded by the "Soprintendenza delle Belle Arti di Firenze" for an mapping of a roman submersed harbour out of Leghorn. Since the group of volunteers included computer scientists and engineers we produced a protocol of communication underwater, for archeological-focussed divers, as alternative to the one adopted by the Forces that were otherwise employed for mapping. The new protocol was better fit for purpose as it was ore respectful for the archeological nature of the exploration site, and it became the standard for these kind of operations in Italy. I am aware that it has then been refined and is now in use also in France and Spain. Relocation to continental Europe (inland), and two maternities have interrupted my diving.

Management, Coordination, Events

- The "International MSc Program in Computational Logic – TU Dresden".

In the academic year 1997-98 I started working for this specific study program that was entirely managed and taught in English. It was one of the first initiatives in International Education at HE funded by the European Union. Until 2005 all my roles at TU Dresden, in research, teaching, management, were essentially bounded to projects in the area of international education and mobility.

In addition to teaching and research (in deep inference) I was in charge of several administrative and management activities for the coordination of the international program. This included organisation and planning of summer schools and scientific meetings in the broad area of computational logic, some elements for the accreditation process and quality assurance of the MSc Programme, internal support with the university administration for the certification of degrees.

All these initiatives rapidly contributed raising the profile of the MSc Program, becoming the only one available in Europe on this specific area of research, and the second largest one in Germany. The presence of high quality and innovative research was an integral component of the success of the MSc curriculum that had an annual cap of 40 offers each year against 1400 requests. AFter a few years it was consoidated by an international programme in Computational Engineering oriented more towards a skilled professional profile, rather than a research one.

The whole period I spent in Dresden has been particularly enriching to me, for the complexity and the variety of roles that I had the possibility to cover. It gave me the opportunity to better appreciate and understand the impact that of big changes and challenges may have, locally, in cultural, sociological and political terms.

The program quickly evolved into a Dual Degree with Uni Nova de Lisboa, and then into a joint consortium of Universities that includes Uni Nova de Lisboa, Università di Bolzano, Technische Universität Wien, Technische Universität Dresden, and joint partners in Australia, Indonesia, Chile and Canada.

The synergies in research, teaching, dissemination to which I contributed as group membrr, led to the constitution of the "International Centre for Computational Logic" in Dresden.

- The "European PhD Program in Computational Logic – TU Dresden".

Between 2011 and 2012, I have been asked by my former colleagues in Dresden to temporarily cover (18 months) the Chair in Computational Logic at TU Dresden: I was offered a Associate Professor position, fixed term.

The need for a cover arose when the International Centre in Computational Logic had received approval to start an European PhD Programme in Computational Logic and, simultaneously, TU Dresden was bidding as Centre of Excellence (Exzellenzinitiative). While my role was mostly related to the smooth running of the educational offer, I was asked to take part to the University audit for Internationalisation, given my previous contribution.

- Meetings and summer schools.

The following events are all related to my research area and project and I had an active role in their organisation and coordination:

WENPS: Workshop on Efficient and Natural Proof Systems, Bath 15-16 December 2015:
http://www.cs.bath.ac.uk/ag/ENPS/wenps2015.html

Sharing and Sequentiality in Proof Systems with Locality - Workshop, Bath 2014:
http://www.cs.bath.ac.uk/ag/SSPSL/w.html

REDO: Redesigning Logical Syntax – Meeting, Bath 2010:
http://www.lix.polytechnique.fr/~lutz/orgs/redo-meeting-sep10.html

Geometric and Logic Approaches to Computation, Nancy 2010
http://demosthene.loria.fr/GLAC.html

REDO: Redesigning Logical Syntax – Meeting, Nancy 2009:
http://www.lix.polytechnique.fr/~lutz/orgs/redo-meeting-nov09.html

Deep Inference Christmas Meeting, Dresden 2007:
http://www.lix.polytechnique.fr/~lutz/orgs/DIworkshop-DD-Dec2007.html

Proof Theory Meeting, Bath 2006:
http://www.cs.bath.ac.uk/ag/w/pt06.html

Workshop on Deep Inference and Proof Theory, Dresden 2005:
http://www.wv.inf.tu-dresden.de/~ozan/workshop.html

Structures and Deduction - ICALP Workshop, Lisbon 2005:
http://www.cs.bath.ac.uk/ag/w/sd05/

ICCL Workshop Proof Theory, Dresden 2005:
http://www.iccl.tu-dresden.de/~guglielm/WPT05/

ICCL Workshop Proof Theory, Dresden 2004:
http://www.computational-logic.org/iccl/events/WPT-2004/

ICCL Summer School 2004 – Proof Theory and Automated Theorem Proving, Dresden 2004:
http://www.computational-logic.org/iccl/events/SA-2004/

Workshop on Structural Proof Theory, Dresden 2003:
http://www.iccl.tu-dresden.de/~guglielm/WSPT/index.html

Summer School and Workshop on Proof Theory, Computation and Complexity, Dresden 2003:
http://www.iccl.tu-dresden.de/~guglielm/WPT2/index.html

Workshop on Proof Theory and Computation, Dresden 2002:
http://www.iccl.tu-dresden.de/~guglielm/WPT/index.html

Workshop on Proof Theory, Dresden 2000:
http://www.iccl.tu-dresden.de/~guglielm/WPT00/workshop.html

- Research Group in Deep Inference and Structural Proof Theory.

Research in Deep Inference started in 1998 at TU-Dresden (and was primarily located there until 2005) when Alessio Guglielmi and I started a research group on structural proof theory. There was no research activity in proof theory at our Faculty, and the initial group was involving at that time 4 local MSc students. The focus of research was on a new methodology in structural proof theory, now widely known as Deep Inference. The notion was proposed by Alessio and the work of our doctoral theses is to be considered precursors that contributed to formulate the concept.

At the end of 2005 we moved to the University of Bath; then in 2008 at INRIA Nancy when a major project was receiving generous funding from the French Agence Nationale de la Recherche. We returned to Bath in 2010. During these years the activities in the area of deep inference consolidated and expanded and generated a positive ripple effect with intense international collaborations.

Deep inference research is present in France, Italy, Germany, Switzerland, Austria, and very close

groups are in Australia and Singapore.

At present, the research group in Mathematical and Logical Foundations at the University of Bath includes Proof Theory of the deep inference kind, Semantics and Category Theory.

I have been involved, as group member, in several joint international research projects with other partner institutions. Further details, referring only to the activities in my current area of research, can be found at `http://alessio.guglielmi.name/res/cos/index.html#Grants`

Selected Papers

- Paola Bruscoli, Alessio Guglielmi, Tom Gundersen and Michel Parigot. A Proposal for Formalism B. (In preparation).
- Paola Bruscoli, Alessio Guglielmi, Tom Gundersen and Michel Parigot. A Quasi-polynomial Cut-Elimination Procedure in Deep Inference via Atomic Flows and Threshold Formulae. In E. Clarke and A. Voronkov Eds. *Proceedings of LPAR-16, Dakar (Senegal)*, 2010. Available at `http://cs.bath.ac.uk/ag/p/QPNDI.pdf`.
  Journal full version accepted for publication in *Logical Methods for Computer Science*, 2015).
- Paola Bruscoli and Alessio Guglielmi. On the Proof Complexity of Deep Inference. *ACM Transaction on Computational Logic*, Vol. 10, Nr 2, Pages 1–34. Available at `http://cs.bath.ac.uk/ag/p/PrComplDI.pdf`, 2009.
- 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.
- 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.
- 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.
- 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.
- 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.
- 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.
- 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.
- 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.
- 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.
- 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.

Teaching Statement

I have extensive experience in teaching, course development and management activities, gained while working in several institutions, with a variety of audiences, in international environments, and at different stages of university degrees.

This includes both course at undergraduate as well as postgraduate level, delivered in English, German, Italian and French. My current position as Research Fellow doesn't require me any teaching duty, however, I do enjoy teaching and I am still active in offering intensive courses as invited lecturer at specific venues.

I am a very effective teacher because I care. In Dresden I introduced the quality survey assessing courses and lecturers, as a way of improving the study material and its delivery. My students have always assessed my courses very positively, appreciating in particular the motivation I could transmit, the balance and mix of theory and practice. Whenever I had tutors (PG students close to their graduation) or technicians I trained them to deliver some exercise classes or laboratory sessions, and mentored them.

My experience at Undergraduate level includes courses in Programming, Databases, Computability, Formal Methods and Compilers to UG students in Computer Science, and general courses in ICT to non-specialist UG students in Humanities and Law, and Programming courses to Engineers.

For some advanced and specialist courses closer to my area of research, which I offered at MSc and PhD level, the attendees were often characterised by a large diversity of educational and international background (PGT in Engineering, Maths, Statistics, Business, Computer Science). The variety of situations and contexts allowed me to improve my abilities in lecturing while refining further soft skills. Eventually, it allowed me to obtain the French Qualification as Maître de Conférences.

As a lecturer I always tend to adapt the course and my style to the specific needs of the audience, and looking for their feedback. This contributes the sense of cooperation and also sense of responsibility among the students. Teaching to non-experts is for me a good training opportunity to refine my presentation skills in research dissemination as well as for public engagement and enterprise initiatives, for example with the International Baccalaureate.

I spent many years (especially at TU Dresden) offering courses at all levels, including very specialistic level, in several areas of Theoretical Computer Science, Computational Logic, Logic and its Applications, Knowledge Representation and Reasoning, Multi-agents Systems, Automated Deduction, Proof Theory and Proof Complexity, Declarative Programming, Formal Languages and Compilers.

I could also effectively contribute courses in more traditional, core areas of computer science, such as algorithms, networking, machine learning, programming, operation research, graph theory, database and information systems, just to mention a few.

My interest in internationalisation and international programmes and exchanges emerges from my CV, especially in relation to my work in Dresden as well as the collaboration with the International Baccalaureate. The range and nature of all these activities includes familiarity and working knowledge of technical aspects of accreditation, curriculum design/review, transition with UCAS.

Research Statement

My research is in structural proof theory, with the deep inference methodology. Proof theory studies mathematical proofs, properties and ways to combine them and, for computer science, it provides solid foundations in language design. Strong mathematical properties (or certificates) are relevant to many aspects of software development, including modularity, composition mechanisms, sharing and re-usability, verification. Deep inference is now a well established methodology in proof theory that distinguishes itself from traditional approaches by abandoning the notion of 'main connective' and adopting a contextual form of rewriting logical implications. The resulting proof theory is more rich, it addresses aspects of locality, and opens new scenarios in proofs complexity and proof normalisation.

Complexity is essentially related to the size of a proof and to the level of compression that can be achieved in our proof systems. By developing proof transformation methods while keeping the complexity of the proof under control, we address the semantical problem of identity of proofs by using syntactical means. All these aspects may be understood as the complexity of a certificate, and consequently of the time needed to verify it. In perspective, one may think of applications in compiler optimisation, in quality assurance (of software) and software development, libraries of mathematical proofs.

Our current EPSRC project aims in designing a deep inference-based formalism (dubbed Formalism B) that further abstracts those formalisms we have designed so far, by embedding, at the level of the formalism, further compression capability. The Calculus of Structures and Open Deduction are two well developed formalisms in deep inference, essentially equivalent, that focus on the logical ways of composing proofs. These formalisms are as powerful as those considered as the strongest one in proof complexity, and exhibit speed up results, both in normalisation and proof manipulations with traditional proof theoretical approach that are meaningful for language design. We aim in incorporating substitution into them, which is known to contribute proof compression in axiomatic formalisms. There are some technical challenges, and since accurate design is vital for a formalism (not just a proof system), interactions with different groups are essential to provide valuable insight from different perspectives.

In the future I plan to continue expanding the following aspects of my research, which is still primarily theoretical at this stage, and simultaneously I would like to explore some applications bridging with other groups.

- Deep inference was proved to be necessary to treat, proof theoretically, a fragment of CCS where a sequential and a parallel operator coexist: this was an open problem that I contributed to solve. Recursion and fixed

points are further elements that we need to bring into the formalism as these are key to any language. Some ideas are emerging from a collaboration with Luca Roversi at the University of Turin, with whom I am exploring the options to extend the range of concurrent operators to be captured, algebraically, in a deep inference proof system.

- The finer granularity of inference rules applications supports a variety of proof transformations, including cut-elimination, of reduced computational cost (from exponential to quasi-polynomial). A question is whether these techniques can be further improved or have substantial effects in the implementation of weaker systems. From the point of view of complexity, resolution based calculi are widely used for practical purposes especially in relation to SAT: while we know that deep inference can easily simulate resolution, we never started real implementations addressing specifically SAT, nor we studied, from a proof complexity point of view, how deep inference systems for resolution compare with the many methods based on resolutions for quantified boolean formulae. This problem is interesting from both a theoretical and an applicative perspective.

- Deep inference approaches have been successfully applied also in the context of modal logics, showing that cut-elimination theorems exist in cases where sequent calculi were failing. It is open whether some specific logics of the temporal or spatial kind, of interest to some groups in bio-computing/membrane computing, can still be addressed.

- Deep inference support graphical elements to visualise the logical proof construction. A plan of proposing educational game based on deep inference could be a way to promote the teaching of propositional classical logic in schools, requiring expertise in game development and interaction.