CENTRIA
Centro de Inteligência Artificial – UNL

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2007 Report of Activities

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1 General assessment of activities in 2007

The present activity report was approved by the Scientific Committee of CENTRIA in June 2008. The plans approved in 2006 for 2007 were on the whole successfully carried out.

The Centre's web pages (visit `http://centria.di.fct.unl.pt/`) continued to be redesigned; a web page interface provides for easy updating and consulting, and latest information.

CENTRIA prepared in December for its evaluation by an international panel designated by FCT/MCTES in the first week of 2008, with evaluation results expected only mid 2008.

1.1 Unit Description. Form of organization and management

Hosted at the Department of Computer Science of FCT/UNL, the centre has also members with a PhD also from the U. Évora (4) and U. Coimbra (1), and FCSH/UNL (1). A number of researchers from other universities (U. Lisbon, T.U. Lisbon, U. Coimbra. U.Linkoping) are associate members. The Centre naturally includes a significant number of postdocs, post-graduate students and collaborators that have common research activity with its members.

At present the Centre has a Director, that represents the Centre externally, and a Management Board composed of 3 members that together with the Director which makes the main executive decisions. The Centre comprises a Scientific Council (those with a PhD degree), that not only elects the Director and the members of the Scientific Board but also must vote and approve the admission and exclusion of Members, and the general policies undertaken by the Centre, namely the yearly Reports of Activities, Future Plans, and Budgets.

The Centre has its own Advisory Board, composed of leading international researchers (Robert Kowalski, David S. Warren, Fernando Pereira, Ivan Bratko, and Joerg Siekmann), which is appraised of the Centre's activities and plans, and produces comments and suggestions towards their improvement. The activities of the Centre are organised in three main sub-areas: Knowledge Representation and Reasoning, and Logic Programming ; Intelligent Information Systems; and Soft Computing and Constraints. Each of these sub-areas has a coordinator in the Management Board, but the sub-areas they are not exclusive, in the sense that the members of the Centre are encouraged to collaborate in more than one sub-area, in order to exploit synergies and increase interdisciplinarity within the different sub-areas.

1.2 General Objectives of the unit as a whole

Knowledge Representation and Reasoning, and Logic Programming (KRRLP) The current aim of this area is to further develop the work on Logic Programming (LP) and its application to Knowledge Representation and Reasoning (KRR). This area has been focusing its activities on the following main topics: foundational research in the area of rational computational logic agents, logic programs and knowledge base updates; a general framework for integrating several reasoning forms (including fuzzy-logic, possibilistic logic, probabilistic systems, and non-monotonic logics); distributed tabling and revision systems; computational models and their implementation for a parallel and distributed logic programming language.

Intelligent Information Systems (IIS) In this area, research work covers the following topics: semantic web definition, tools for semantic web based integration of heterogeneous databases, intelligent agents for automatic classification of documents, definition of semantic web ontologies, and natural language dialogue systems for information retrieval from intelligent Information systems.

Recent work in IIS includes: Semantic Web definition, Tools for semantic web based integration of heterogeneous databases, intelligent agents for automatic classification of documents and definition of semantic web ontologies, natural language dialogue systems for information retrieval from intelligent Information systems and Data Warehouse Design and Query.

Soft Computing and Constraints (SCC) The planned research activity will not only extend ongoing work, but also explore new directions in both fundamental and applied research. In the

latter, and enlarging the scope of our long term interest in applications of AI in Medicine, we intend to address more applications in Bioinformatics, some of which are already under way. This is a scientific area of great importance at present, yielding rich sets of data that are a challenge to both CP and ML.

Recent work in SCC includes: integration of local search and constraint propagation, improvement of interaction of constraint propagation techniques with Computational Geometry methods, development of sets constraints solver, approaching different optimisation problems, work on global constraints, spatial constraints, and over-constrained problems, development of search techniques...

CENTRIA team covers a sufficiently large spectra of related research topics in the areas of constraint satisfaction and optimisation, as well as automated learning and data mining, so as to make it possible to share experiences and take advantage of the synergies and cross-fertilisation that is possible within this area, as well as with other areas in CENTRIA.

1.3 Main Achievements during the year of 2007

Sub-Area Knowledge Representation and Reasoning and Logic Programming

A1 Foundational work on logic programming updates, and its subsequent application in the context of the Semantic Web, in the IST project Rewerse, focussing on a general model, language and architecture for reactivity and evolution in the Semantic Web, relying on Event-Condition-Action (ECA) rules.

A2 A sorted multi-adjoint logic programming framework for reasoning with imprecise, incomplete, vague and paraconsistent information, as well as the exploration of Paraconsistent Answer Sets to represent Rough Knowledge Bases, and to implement a subset of statistical default logic.

A3 Multi-Agent Systems and Recommender Systems, allowing the modelling of dynamic agents (namely agents for the internet, with RuleML) by means of applications of updates, and other non-monotonic reasoning mechanisms such as preferences, to agents and agents' architectures.

A4 Semantics of logic programs with preferences, namely on preferential theory revision and its applications, updating for control, argumentation semantics for expressing some preferences in the context of distributed arguing agents and prospective logic programming.

A5 Formal logical representation of statistical reasoning, highlighting the fundamental differences between probabilistic logics and logics for probabilities.

Sub-Area Intelligent Information Systems

B1 Work in intelligent agents for automatic classification of documents, including best document representation, regarding feature reduction and selection and term weighting and the definition of semantic web ontologies.

B2 Implementation of a Question-Answering system using results from previous research on semantic web ontologies, and natural language dialogue systems for information retrieval.

B3 Several developments in data warehousing, namely a prototype for analyzing the pollutant emissions reported by the industry and a prototype for a Spatial OLAP.

Sub-Area Soft Computing and Constraints

C1 Development of original Constraint Programming (CP) techniques applicable in structural Bioinformatics problems (Protein Structure Determination and Protein docking). Application of machine learning techniques and data mining in Protein Data Bank (PDB) to improve search.

C2 Development of CP for Continuous Domains, including optimal correction of unfeasible linear constraints, a new constraint propagation method and inclusion of differential equations as first-order objects in CP. Applications of the framework (e.g. biomedical, parameter tuning).

C3 Implementation of an improved set constraint solver, Cardinal, now integrated in ECLiPSe Prolog, as a third-party library.

C4 Work on feature extraction from Oceanographic images, namely regarding image pre-processing for Eddy border recognition, including fuzzy clustering techniques for the problem of colour image segmentation, evolutionary programming for neural network training, and a random ellipse fitting algorithm.

1.4 Integrative/multidisciplinary activities in 2007

We successfully applied to the "Compromisso com a Ciência" senior postdoc scholarships, with 3 interdisciplinary proposals involving other research centres, within and outside our university: In the BIOINFO proposal applications are open for positions in a project involving Informatics, Structural Bio Chemistry, Molecular and Cell Biology, Materials Science and Physics. CENTRIA candidates must have earned a Ph.D. in the areas of machine learning and data mining, constraint programming and optimisation, simulation (including artificial life) or other Artificial Intelligence areas. The candidates should be familiar with application of these techniques to bioinformatics applications, namely for sequence matching and comparison, determination of protein structure and interaction, analysis of metabolic pathways, assessment of phylogenetic trees, and be able to interact with scientists from within and outside of the Institution, not only from the above mentioned research areas, but also from the areas of Structural Biochemistry and Molecular and Cell Biology.

In the GEOINFO proposal applications are open for positions for the development of techniques applicable to data collected with remote sensing methods, in order to retrieve and computationally analyze oceanic mesoscale phenomena. CENTRIA candidates must have be knowledgeable in Physics and Computer Science in general, particularly in fields like Physical Oceanography, Air-Sea Interaction, Remote Sensing, Machine Learning, and Intelligent Information Systems. Candidates will conduct satellite data processing and analysis applied to the ocean, and will develop fuzzy pattern recognition methods and neural networks using contextual models in order to identify and characterize oceanographic patterns, among other technique that may prove useful. They are expected to analyze and validate the oceanographic patterns (namely, associated with fronts and eddies) identified by means of automatic pattern recognition tools, using as reasoning criteria the results of realistic numerical simulations and the physical constraints of the oceanographic phenomena under study.

In the COGNOMA proposal applications open in the thematic areas of "Knowledge Based, Cognitive and Learning Systems" and "Semantic Web". Any candidate must be knowledgeable in one or more of these areas: Semantic Web; Knowledge and Reasoning Representation; Autonomous Agents and Multi-Agent Systems; Machine Learning; Logic Programming; Computation and Cognitive Sciences; Epistemological Foundations.

Work in CENTRIA also contributes to the Archival Science subarea of cataloguing and document retrieval, by using intelligent retrieval methods including natural language dialogues and automatic cataloguing approaches that use ontologies, the syntax and semantics of the document content. As a result there is a strong participation of CENTRIA researchers in several courses of "Ciencias Documentais" at Univ. Évora (1st and 2nd cycle)

1.5 Awards

Our member Ludwig Krippahl won in 2007 the prestigious IBM Portugal Scientific Research Prize 2006 awarded for original work on the integration of protein structural information, focusing on protein structure determination, modelling transient protein complexes and data integration.

Reinhard Kahle was awarded his Habilitation, with the work "The applicative realm", Habilitationthesis, Fakultät für Informations- und Kognitionswissenschaften, Universität Tübingen, July 2007.

The centre's director was nominated member of the Board of Trustees and of the Scientific Advisory Board of IMDEA-Software, Instituto Madrileno de Estudios Avanzados http://www.imdea.org/, a not-for-profit foundation in Madrid. The first meeting took place in November 2007

The centre's director became the Associate Editor for Artificial Intelligence of the ACM Computing Surveys.

The centre's director became Advisory Editor of the International Journal of Reasoning-based Intelligent Systems (IJRIS). Member Gregory Wheeler became member of the editorial board of The Reasoner.

1.6 Research and Education Networking and Projects

In July 2006, CENTRIA from UNL (coordinator) and GECAD from ISEP/IPP submitted a proposal, titled "COGNOMA", to acquire the status of Associate Laboratory, in accordance to Dec. Lei 125/99 from 20th April (see the 2006 report). It is still under evaluation, foreseen for 2008, after the centre's international panel evaluation, taking place at the beginning of 2008, is finished.

In September 2006, CENTRIA applied to FCT with 3 interdisciplinary projects, in collaboration with other research centres in the topics of Bioinformatics, Oceanography, and Man-Machine Cognition, in order to hire experienced postdocs for 5-year positions, according to the call `https://www.fct.mctes.pt/ciencia2007/indexEN.asp`. After evaluation, in mid 2007 the centre was awarded 5 postdocs contractual positions, put out the corresponding international calls, set up an international jury, and selected and approved 5 candidates. 3 of these start their contracts in the very beginning of 2008, the other 2 in the middle of 2008.

CENTRIA coordinates a new IBM-SUR (2007-10) Shared University Research award project "Parallel and Distributed Computational Models for Scientific Applications on Cell Processor Clusters".

In July 2006, several CENTRIA participated research projects were submitted to FCT/MCTES, for the call `https://www.fct.mctes.pt/projectos/concurso2006/`, and 5 were approved in late 2007, 2 coordinated by CENTRIA, 3 by partner research centres.

CENTRIA members, through the department of Computer Science, is continuing to participate in the research and education contracts between the Portuguese Government and Carnegie-Mellon University, and the University of Texas at Austin.

During academic year 2006/07, the "European MSc in Computational Logic (EMCL)", launched in 2004 and supported at UNL by CENTRIA members, continued its operation[1], with partial funding from the European Erasmus Mundus programme. We recall the objective of the program is to impart to the student a profound theoretical and practical knowledge required for professional practice in the field, to give him a survey of the individual disciplines of Computational Logic and to develop his ability to work according to scientific methods. In addition, the student is given the opportunity to plan his studies to fit a particular practical application. To acquire practice-oriented knowledge he may choose appropriate combinations of modules. By means of visits abroad and English as the language of instruction, the student is to be prepared for the increasing internationalism of science, commerce and industry.

In 2007, plans were made with the consortium to apply to Erasmus Mundus II (in 2008), in order to renew the 5-year contract and include a joint PhD program. The consortium successfully applied to Action 3 of the programme and established ties with a number of research and academic institutions in Australia, having NICTA as the coordinating Australian interface. The first exchange of students and scholars took place.

Also in 2007, UNL and other consortium members prepared to apply to the EMECW (Erasmus Mundus External Cooperation Window) with Russia. (The application took place in February 2008 and was successful.)

[1] See `http://ssdi.di.fct.unl.pt/masters/mcl/` for details.

The 3-year European funded Asia-Link project "Computational Logic as a Foundation for Computer Science and Intelligent Systems", began in September 04 finished in academic year 06/07. It was run in partnership with T.U. Dresden, Germany, U. Indonesia at Jakarta, and T.U. Hanoi, Vietnam. We recall the objective of the project is to promote the area of formal computational foundations of logic, computer science and intelligent systems, i. e., the area of Computational Logic, in South East Asia. It aims at upgrading the staff of the Asian partners within a joint team schema, joint supervision of MSc and PhD students within a sandwich schema, courses of European professors and lectures at the Asian universities, the organization of international summer schools, the development of curricula for single modules at the Asian universities.[2]
In particular, in 2007, we participated with 4 lecturers in the Hanoi summer school, and several students and professors from Vietnam and Indonesia were received at CENTRIA for extended stays. One student came back to register in the EMCL in 2007/08.

The reconfiguration of MEI, the department's MSc in Computer Science, begun in 2003/04, continued in 2006/2007, and afforded us with the opportunity to reinforce in it AI and Information Technology profiles, the latter including a semantic net component, also figuring prominently in the Computational Logic MSc.

CENTRIA joined the Graduate Training Network in Philosophy of Science in Europe (PSE), being member of the formal methods group (Team A) headed by Stephan Hartmann (Tilburg) and Franz Huber (Konstanz), and FCT Representative / Coordinator for Portugal's activities in the Philosophy of Science. (2007-2012).

CENTRIA members successfully taught, for the second time, the "Critical Thinking" course devised by them for the BSc in Computer Science at UNL. The experience was reported in paper at the international conference "Thinking'08".

Also of general significance, the 4-year European funded project, "REWERSE - Reasoning on the Web with Rules and Semantics", involving all areas of CENTRIA, which was initiated in March 04 (Cf. `http://www.rewerse.org/` for project details and our activities in 2007), continued on. REWERSE strives for advanced Web systems and applications sometimes referred to as Semantic Web. The term refers to one of the major current endeavours world wide in Information Technologies. Its goal may be briefly described as enriching the existing Web with meta-data and data processing (and meta-data processing) so as to provide Web-based systems with advanced (so-called intelligent) capabilities, in particular with context-awareness and decision support, strengthening a person centred, everyday use of the Web.

CENTRIA's participation involves a coordinating role in one of the major work-packages, "Evolution and Reactivity". CENTRIA is a major participant in REWERSE?s Education and Training work-package, besides its major participation in other important work-packages mentioned in the project, namely "Rule Markup", and "Bio-informatics", so that all of CENTRIA's areas are involved.

Pursuant to its new strategic ends, the centre renewed in 2007 3 postdocs scholarships of researchers, from Portugal, France and the USA.

1.7 Evolution

Our evolution can then best be gauged by comparing the plans with the present report: an overall positive evolution. The global indicators in the tables in Section 7 show and highlight, with respect to 2007 compared with 2006, that:

- Regarding publications: Compared to 2006, the total number of publications increased from 57 to 68, and the number of journal publications increased from 12 to 13. Nevertheless, the publications in collaboration with non-members remained high, but have decreased from 24 to 18. The international collaboration publications have decreased in proportion to the national collaboration publications, from 22/2 to 18/2. This phenomenon needs analysis and compensating measures. It may be due to a publication lull in new European projects, in

[2]See `http://europa.eu.int/comm/europeaid/projects/asia-link/index\_en.htm` for project details and activities in 2007.

the transition phase from the FP6 to FP7, though a couple of new European projects have started at the end of 2007.

- Regarding Projects: Number of ongoing projects has increased, from 11 in 2006 to 16 in 2007, mainly due to the approval at long last of national projects submitted in 2006. Three European projects, submitted in 2007 were not approved; 2 others were.

- Regarding Events Organization: This figure went from a high level of 4 in 2003, to an exceptional level of 7 in 2004, continued with 6 in 2005, 6 in 2006, and 5 in 2007. This has provided an added impact on the visibility of the centre.

  Reinhard Kahle was Programme Co-Chair of the International Workshop PCC - Proof, Computation, Complexity 2008, Swansea, Great Britain, April 2007.

  Salvador Abreu was program co-chair and organizer of the 7th Colloquium on Implementation of Constraint and LOgic Programming Systems – CICLOPS 2007, Porto, Portugal, September 2007.

  J. Leite Co-Chair of the 1st International Workshop on LAnguages, methodologies and Development tools for multi-agent systemS – LADS'007, Durham, UK, September 2007.

  Francisco Azevedo is co-organized and was programme co-chair of the EPIA 2007 Workshop on Search Techniques for Constraint Satisfaction (STCS'07), Guimarães, Portugal, December 2007.

  Gregory Wheeler, Co-Chair of the third workshop on combining probability and logic (Progic 2007), University of Kent, Canterbury, September 2007.

- International Teaching: José Alferes gave a 20 hours course on "Introduction Semantic Web" in the Hanoi University of Technologies, in March/April 2007. J. Leite gave the course "Programming languages for Multi-Agent Systems" at the 2007 International Conference on Autonomous Agents and Multiagent Systems – AAMAS'07, Honolulu, Hawai'i, May 2007 P. Barahona gave the course "Constraint Logic Programming and Bioinformatics Applications" at the 2007 Asia-Link Summer school in Hanoi, Vietnam, July/August 2007. J. Leite gave the course "Answer-Set Programming" at the 2007 Asialink Summer school in Hanoi, Vietnam, July/August 2007. J. Leite gave the course "Programming languages for Multi-Agent Systems" at the 9th European Agent Systems Summer School – EASSS'07, Durham, UK, August 2007.

- Postgraduate MSc and PhD students: The overall attraction of the centre for these postgraduate students continues. Their overall of number has increased from 23 in 2003 to 32 in 2004, to 37 in 2005, and 35 in 2006. See our comments forthwith.

  As expected, the launching of the international MSc course in Computational Logic, started 2004, produced a substantial increase in ongoing MSc thesis, from 20 to 25 in 2005, which decreased to 20 in 2006, and increased again to 24 in 2007. The number of completions went up significantly, again, from 11 in 2006 to 16 in 2007.

  The number of ongoing PhD students increased from 15 to 17. The output however was just 2 in 2007, where we had an expectation of 4 thesis to complete, but 2 moved to 2008 and were since then completed.

Other indicators, including a more detailed examination of types of publication, and publications by each subarea, are to be found in the annexes, and mentioned in each of the subarea reports.

The 2007 budget was executed according to plan, and the funding has been again received on time with the new government.

The distribution of the running funds among the members was made as usual on the basis of publication productivity, in number and type, according to a pre-defined set of rules we have been using over the past years. We made good in the 2007 budget the revision of points assigned to each publication type to further encourage publication in journals and highly recognized conferences.

The Advisory Committee was duly notified of last year's report and informally congratulated us on the activities reported. Prof. Robert Kowalski, member of our Advisory Board, visited CENTRIA for a month in March.

The detailed rendition of each of the subareas' activities is to be found below. A number of scientific bridges were pursued between the subareas, to reinforce the unity and cross-fertilization within the CENTRIA. The activities of 2008 and beyond will further promote the construction of these bridges.

See the new CENTRIA web pages for more information.

2 Sub-areas activities in 2007

2.1 Knowledge Representation and Reasoning, and Logic Programming

Work continued in the area of "Knowledge Representation and Reasoning, and Logic Programming" on the foundations of logic programming for knowledge representation and reasoning, applications and implementation of logic programming systems, with special focus on applications in the areas of the Semantic Web and Multi-Agent Systems, the former mostly due to the significant participation in an European project in the area. The scientific projects covering this activity were REWERSE, PROGICNET, and KRENI.

CENTRIA members co-organized the following scientific meetings in this area:

- João Leite was co-chair of the 1st International Workshop on LAnguages, methodologies and Development tools for multi-agent systemS – LADS'007, Durham, UK, September 2007, and co-found the Steering Committee for the Multi-Agent Logics, Languages, and Organisations Federation of Workshops (MALLOW).

- Salvador Abreu co-chaired the 7th International Colloquium on Implementation of Constraint and LOgic Programming Systems - CICLOPS 2007 [2], colocated with ICLP 2007 in Porto, Portugal.

- Reinhard Kahle was Programme Co-Chair of the International Workshop PCC - Proof, Computation, Complexity 2008, Swansea, Great Britain, April 2007.

- Gregory Wheeler, Co-Chair of the third workshop on combining probability and logic (Progic 2007), University of Kent, Canterbury, September 2007.

The education and training aspects have been covered by our MSc in Computer Science, and the European MSc. on Computational Logic (EMCL), as explained in the introduction, and with support from Erasmus Mundus and Asia Link European programmes. The EMCL consortium was successful in its application to Action 3 funding to liaise with Australian in academic institutions through NICTA.

On the international cooperation teaching side, José Alferes gave the course "Introduction to the Semantic Web", in Mar/Apr 07, at T.U. Hanoi, Vietname, and João Leite gave the course "Answer-Set Programming" at the 2007 Asialink Summer school in Hanoi, Vietnam, Jul/Aug 07, and a tutorial on Programming languages for Multi-Agent Systems at the 9th European Agent Systems Summer School – EASSS'07, Durham, UK, Aug 07.

Two foreign researchers from this scientific area were at CENTRIA in 2007 for longer periods. Prof. Robert Kowalski, member of our Advisory Board, visited us for a month in March to work on Knowledge Representation and Reasoning through Logic Programming, and on a European project proposal. Terrance Swift visited to teach Integrated Logic Systems in the EMCL and participate in ongoing research into Logic Programming extensions and their implementation. He became an associate member of CENTRIA in 2007.

We have continued our research on the theoretical development and practical application of the knowledge representation and reasoning paradigms such as Preferences, Answer-Set Programming

(ASP), Dynamic Logic Programming (DLP) and Evolving Logic Programming (EVOLP). Along this line of research, we developed a new semantical characterization of EVOLP [81] which served as the basis for an available implementation [80]. We continued the research on the application of Answer-Set Programming and Dynamic Logic Programming in Recommender Systems, reported in [50], having now a prototypical implementation. The application of DLP and EVOLP in the context of Multi-Agent Systems, as a means to represent agent beliefs, goals and behavior has also been pursued [51, 57, 56]. Regarding preferences, the work continued with the collaboration of the associate member Pierangelo Dell?Acqua, as report in several publications [63, 62, 64, 13].

An argumentation framework taking into account confidence degrees and able to map ontologies was proposed [77, 76]. The framework is based on Dung's argumentation framework with the extensions proposed by T. Bench-Capon (VAF – Value-based Argumentation Framework). The proposal extends Bench-Capon's VAF, associating confidence degrees with arguments and it shows quite promising results. The was also work on an argumentation-based proof procedure in a paraconsistent setting [26].

2007 was a pivotal year the center's research in uncertain reasoning. First, the William Harper and Gregory Wheeler collection Probability and Inference was published in College Publications, which is being followed by a special issue of Synthese to be edited by Horacio Arló-Costa and Gregory Wheeler due in 2009. Both volumes are devoted to the latest results on Evidential Probability (EP). Second, the preliminary results of PROGICNET were obtained in the last half of 2007 early 2008, which succeeded in providing a unified framework for probabilistic logic. The main output of this project, a 100 page paper presenting a unified framework for probabilistic logic, has been submitted for review at a prominent logic journal. Third, links between Carnegie Mellon University and CENTRIA were strengthened by Wheeler's visit to CMU in the fall of 2007. This visit set foundations for future work that includes (1) modeling causal and statistical reasoning, (2) the relationship between coherence, causation, and incremental confirmation, and (2) dynamic belief change and probabilistic reasoning.

These three events were pivotal in the following sense. In terms of Evidential Probability, the two volumes provide the definitive, up-to-date reference works for this theory of uncertain inference. Second, with the completion of Progicnet, the group is now shifting focus to building the research community and disseminating results. To this end Gregory Wheeler has joined the steering committees of the Probability Logic Workshops and also of the European Science Foundation (ESF) network project "Philosophy of Science from a European perspective", has become a pool referee for the ESF, and will host a Probability Logic Workshop in Lisbon in 2010 focused on dynamic updating. The third area concerns coherence measures, causal models, and dynamic belief change. Wheeler is collaborating with Richard Scheines, Professor and Head of the Philosophy Department, Professor of Machine Learning, and Professor of Human and Computer Interaction at Carnegie Mellon University, on two research initiatives. The first concerns the relationship between causal models and so-called coherence measures for statistical indicators and incremental confirmation of hypotheses, which is an active topic in Formal Epistemology and the foundations of the social sciences. The second project between Wheeler and Scheines is an educational initiative whereby courses could be run in conjunction with Carnegie Mellon and FCT/DI on the topics: Probability in AI; Causal and statistical reasoning; and Foundations of rational choice theory.

The long-term goal of the educational initiative is to offer an integrated set of courses covering techniques and the foundations for reasoning under conditions of uncertainty. The proposal is to develop courses tailored to extend the traditional strengths of KRRLP, such as an introduction to causal modeling, as well as provide courses strengthening the foundations for existing courses (e.g., game theoretic and modal logic foundations for Multi-Agent systems).

This year, work has started in the application of our expertise in semantics of logic programming for the definition of a semantics, procedures and implementation of hybrid knowledge bases, including (non-monotonic) rules and (monotonic) ontologies. Preliminary work towards this goal was made in 2007 [45, 46], and a PhD thesis as started on this subject, co-supervised by Pascal Hitzler from the University of Karlsruhe. This work is of particular relevance for application in the context of the Semantic Web.

Also in the context of Semantic Web development, the work continued in the context of EU

project Rewerse in close cooperation with the ISS. A main result in this year was the implementation of r3, a framework for active rules in the Semantic Web over heterogeneous component languages [23], and its integration with EVOLP. Further details about this work can be found in the section of ISS.

Still related to the Semantic Web, the work on the Extended Resource Description Framework has continued during this year by studying the complexity of reasoning (undecidable in general) as well as in the preparation of a journal paper (published during 2008). Meanwhile, the formalization of a principled framework for modular Web rule bases has been done and has been accepted for publication during 2008.

Regarding implementation of logic programming systems, a prototype of a distributed multi-threading implementation for GNU Prolog was developed and is documented in [55]. This article stemmed from the MSc thesis [100]. Also, this time in cooperation with SCC, a workflow modeling and execution system was built [43], using ISCO and GNU Prolog/CX in an AJAX web-based application setting. A contact-center business analysis tool was developed, also using ISCO and GNU Prolog/CX, and put into preliminary operation.

Still regarding implementations, we completed the implementation, in XSB-Prolog, of Neg-Abdual, a constructive negation abductive system in the well-founded semantics, within the KRENI project. There was also a Logic Programming implementation of a pioneering system for Modelling Morality with Prospective Logic, reported in [67]. Related to implementation, on procedures, the work on propositional tabulation proof procedures for fuzzy-like languages has been finally published during 2007 [12], which has been reported last year.

Work has also continued on more philosophical KRR and AI research on Artificial Epistemology, reported in the publications [61, 20, 8].

On the more mathematical side, continuation of a joint project with LORIA, Nancy, France, within the Programa Pessoa of GRICES-EGIDE, recursion-theoretic characterization of parallel classes of complexity are investigated. An (in the meanwhile successful) application for a project within the EUROCORES programme LogICCC, "Modelling intelligent interaction - Logic in the Humanities, Social and Computational sciences" was prepared, based on work on the mathematical, philosophical and computational foundation of dialogical reasoning.

2.2 Intelligent Information Sytems

In 2007, work has proceeded in the "Intelligent Information Sytems" (IIS) area, covering the topics of Data warehouses and integration of heterogeneous databases, tools for the semantic web, Ontologies, Intelligent agents for automatic classification of documents and natural language dialogue systems.

The most significant achievements in this area are:

- Development dialogue based system that enables the access in natural language to a web law information retrieval system, its semantic content being represented in OWL.
- Work in intelligent agents for automatic classification of documents, including best document representation, regarding feature reduction and selection and term weighting and the definition of semantic web ontologies.
- Implementation of a Question-Answering system using results from previous research on semantic web ontologies, and natural language dialogue systems for information retrieval.
- Several developments in data warehousing, namely a prototype for analyzing the pollutant emissions reported by the industry and a prototype for a Spatial OLAP.
- Improvement prototypes to the GNU Prolog language implementation allowing multi-threaded Prolog programs, integration of Contextual Logic Programming Constraint reasoning and other paradigms around Logic Programming, for the construction of real-world information systems.

Luís Moniz Pereira continued in 2007 as vice-president of EASE (European Association for Semantic Web Education).

In the context of the REWERSE network of excellence, jointly with the Knowledge Web network and the EASE association, a graduate curriculum for Semantic Web education was formulated, and Semantic Web topics organized into an ontology.

The work in the EU project REWERSE - Reasoning in The Web with Rules and Semantics continued during the whole of 2007. This almost coincided with the last year of REWERSE, which was scheduled to finish by the end of February 2008. Accordingly, much of the work in this last year was devoted to implementation of prototypes and of its usage in application areas. More concretely, in REWERSE CENTRIA contributed with:

- the implementation of r3, a framework for active rules in the Semantic Web over heterogeneous component languages, including the establishment of the rule ontology and markup, and the implementation of component languages;
- in the integration of logic programming updates languages in this system (and implementation), in very close co-operation with the KRRLP area;
- in the application with integration of bioinformatics services.

This latter application was done in close co-operation with the ISS area, integrated a MSc student, and consisted in the development of a pilot application for reasoning and reactivity on the Protein Data Bank. Using ECA rules and inference the system allows the user to set desired goals for data retrieval and the system can react to database updates retrieving the desired information, from protein structure to bibliographic references and other relevant information.

The work on the Extended Resource Description Framework has continued during this year by studying the complexity of reasoning (undecidable in general) as well as in the preparation of a journal paper (published during 2008). Meanwhile, the formalization of a principled framework for modular Web rule bases has been done and has been accepted for publication during 2008.

Question-answering systems continued to be the focus of research work. In the context of his PhD work, José Saias has improved his framework (see [74]), which was evaluated in an international forum – CLEF [75].

The construction of ontologies and the ontology mapping and merge task were analyzed in the context of an MSc work – Anderson Bertoldi – and of an ongoing PhD work – Cássia Santos [77, 76]. A methodology to create a juridical ontology [27] and an extension taking into account adjectives [31] were proposed.

The relevance of linguistic information in the text classification task was evaluated in the context of Teresa Gonçalves' PhD thesis (which was completed in November 2007 and successfully defended in January 2008).

Another research task was related to the evaluation of interactive information retrieval systems: a book chapter was published on this subject [21].

The work on POS-Tagging will be particularly relevant in project TOURS-PLAN (headed by GECAD and approved for funding by the FCT/MCTES in 2007) where we will focus on building a knowledge base relating texts in a corpus of distinct texts reporting on a selected set of places of tourist interest.

In 2007 Luis Quintano continued developing the Question-Answering system prototype, part of his Phd thesis, and started structuring the final document. As a result of this work, the conference article [72] was published.

Concerning the use of dialogues in the interaction with the user and in the processing of answer sets we, along with the partners in project DOMIR, have used the existing dialog system, adapting it to the historic documentation domain and integrating the dialog interface with other search modes. This has involved the exchange of data between the document database and the dialog database, the identification of semantic relations to be explored in the dialogues and the experimental inclusion of a natural language query mode in the search interface of the historic documentation application, one testbed of project DOMIR. Clarification dialogs are used to infer the user intentions and plans in order to supply the adequate answers to the user queries.

In project DOMIR we have also developed a natural language dialog system to query databases that incorporates clarification dialogs. The *dialog clarification tools* enable the system to disambiguate user questions as well as to present the information structure to users that are not aware of it. This dialogue tool has been applied to the information system at Universidade de Évora and to the "Terra de Santa Maria" documentation center.

Also in this project, CENTRIA researchers were envolved in the choice of controlled vocabularies for document annotation, the processing of natural language queries and the TRECVID evaluation process.

We have developed a natural language classifier that, given an English query and a set of concepts, is able to select the most relevant subset of concepts to classify the query. This classifier was developed using symbolic natural language processing, syntactic analysis and semantic interpretation using WordNet as the source of knowledge.

The results concerning evaluation of the retrieval system have exceeded our expectations. The MetaMedia multimedia retrieval system has been evaluated in the TRECVID international forum. Both project groups have been required to process the query topics, extract the relevant concepts, analyze the video dataset to extract descriptors and compute the answers. The results [34] are comparable to those obtained by international groups working in the area, validating the use of the proposed retrieval methods in video retrieval. As a resuly of the described work, Gustavo Laboreiro successfully completed his MSc. thesis [97].

Work on representing and querying ontologies using ISCO and Contextual Logic Programming was carried out resulting in the XPTO prototype, the articles [41, 52] and two MSc. theses, both having been submitted in 2007, one was discussed in December [98] and the other in 2008.

Work on automated data warehouse construction and declarative ETL (Extraction, Transfer and Loading) has proceeded, mostly as the work of one PhD. student (Valéria Pequeno) and makes extensive use of the tools built within CENTRIA, namely ISCO and GNU Prolog/CX.

A prototype for analyzing the pollutant emissions reported by the industry was developed for the Portuguese Environment Agency. Another development is a prototype for a Spatial OLAP [71]. CENTRIA researchers participated in two international projects for the European Space Agency, including work on an operational prototype for integration of space weather data (presently in use at ESOC). A tool for data extraction from semi-structured text files was developed [42, 73] and resulted in two MSc. theses [93, 102].

Work in CENTRIA also contributes to the Archival Science subarea of cataloguing and document retrieval, by using intelligent retrieval methods including natural language dialogues and automatic cataloguing approaches that use ontologies, the syntax and semantics of the document content. As a result there is a strong participation of CENTRIA researchers in several courses of the "Ciencias Documentais" at Universidade de Évora (1st and 2nd cycles.)

2.3 Soft Computing and Constraints

A number of different research directions were carried out in 2007 regarding constraint programming, both in its principles as well as in applications. Previous work on solving constraints over sets as well as to their application to model based diagnosis (on digital circuits) was consolidated by Francisco Azevedo, leading to two journal publications [11, 10]. Constraint solving over sets was also extended to constraint solving over graphs, where both nodes and edges are dealt with as sets, and a number of primitive constraints over graphs are mapped into constraints over sets. The implementation of GRASPER, a constraint solver over graphs, was carried out during the M.Sc. of Ruben Viegas, and was presented in different workshops [83, 84, 85]. Still in the area of constraints over sets, research carried out with Hau Van Nguyen on the detection and breaking of symmetries led to two publications[28, 29], one of which published in a volume co-edited by two CENTRIA members [4]. Ruben Viegas also implemented with L. M. Pereira an LP constraint system described in Architectural Design via Declarative Programming [69]. The development of CaSPER, the library of constraint solving modules implemented with a generic programming approach, which is the core of the Phd of Marco Correia was continued, and its generic approach has already proved its usefulness. On the one hand, it was easy to implement a version of Grasper

much faster than the initial implementation on ECLiPSe Prolog, as well as specialised solvers for bioinformatics (see below). On the other hand it made it possible to investigate the possibility of exploiting singleton consistencies. Although a relatively expensive look ahead propagation technique, it provides important heuristic information that more than compensates the computational overhead [37].

A new prototype for integrating probabilistic with constraint reasoning on continuous domains has been developed in the context of project PRECISE. The work was accomplished with Elsa Carvalho, during her first year Ph.D. research work, and benefited from her participation in the 2007 ACP summer school on constraint programming. A first paper, providing a general overview of the intended framework and some potential applications, was published and presented in [35]. Preliminary work was carried out on the theoretical foundations of probabilistic constraint reasoning and its interconnections with classical probabilities and traditional constraint reasoning, and the application to a promising area was accepted for publication.

Work on bioinformatics in 2007 covered improvements on PSICO, the algorithm for modelling protein structures from distance and angle constraint data, the integration of bioinformatics data in reactive reasoning engines on a semantic web framework and the modelling of transient protein complexes. Work on PSICO progressed both at the level of implementation and analysis. As part of his PhD programme, Marco Correia implemented several of PSICO's propagation and enumeration algorithms in CaSPER. This facilitated experimentation with different enumeration heuristics and an analysis of the enumeration search tree of PSICO, leading to some insights on the critical stages of the process and new possibilities for improvement [70]. This work also benefited from the concluding stages of the MSc programme of José Santos [104] on the application of machine learning to estimating the solvent exposure of amino acid residues in order to improve the enumeration heuristics [78].

The bioinformatics work also focused on developing methods for modelling transient protein complexes. The main effort in 2007 was to adapt Chemera and BiGGER, the molecular graphics and protein docking applications, to the automatic generation of protein complex models for combinations of multiple partners and to the statistical analysis of the large data sets thus generated (typically hundreds of thousands of structural models). This work was presented in the 2nd European Conference on Chemistry for Life Sciences [48] as well as in the Workshop on Constraint Based Methods for Bioinformatics [49].

The opportunities for exploiting constraint programming in structural bioinformatics applicactions, and in particular its application in the development of some of Chemera were presented in an invited talk at the PADL'07 conference [30] From his seminal work on this area, Ludwig Krippahl was the recipient of the 2006 IBM Scientific Award.

Work has continued on Temporally Annotated Contextual Constraint Logic Programming - see a new prototype implementation (TaCCxLP) is being developed [58, 59, 18, 60]. The collaboration with Drs. Werner Kriechbaum and Roland Sieffert at IBM's Böblingen research & development centre advanced, with the goal of developing a multicore-enabled (Cell-based) distributed constraint solving framework (this work is partially reported in [25]. Salvador Abreu gave a talk entitled "Constraint Programming and the Cell Processor" at the IBM labs for an audience of over 200. Two MSc theses were carried out, one ended in 2007 [87] and the other in 2008.

An IBM SUR grant was awarded to a proposal coordinated by Salvador Abreu, in a very competitive international framework, as a result of the previously mentioned collaborative work. Salvador Abreu also visited the University of Bordeaux-I INRIA FUTURS centre LaBRI, with the purpose of setting up a longer-term collaboration. As a result of this, the Egide/FCT project "CONTEMP – CONTranintes En Multi-Processeurs" was approved for funding, starting in 2008 and extending for two years.

In the Soft Computing sub-area, the work on eddy detection in satellite images by finding ellipses was continued. A new detector was created to find eddy centres by accumulating ellipse centres determined using geometric properties of ellipses, which finds several eddies in an image while the previous eddy detectors developed at CENTRIA could only find one eddy per image. This work on eddy detection allowed developing a general purpose state-of-the-art ellipse detector that determines all five ellipse parameters with an ellipse fitting algorithm instead of using accumulators

as other algorithms previously reported in scientific literature do. Tests with a newly created benchmark of images revealed that the developed detector is able to determine with great precision the position and boundaries of ellipses immerse in a considerable amount of noise, incomplete ellipses and ellipses with irregular boundaries. These techniques will be further developed in project LSTOP, jointly proposed with Instituto de Oceanografia / Univ. de Lisboa, which was approved for funding by the FCT/MCTES. Its main goal is the development of fuzzy clustering methods and their extensions to dynamic versions, for the automatic identification, analysis and tracking of oceanic meso-scale phenomena, like eddies and coastal upwelling, in the Iberian Coastal Ocean, from remote sensing images.

Another project, COPSRO, was proposed with the Birkbeck College, University of London, and GECAD and also approved for funding by the FCT/MCTES, whose main goal is the development of a methodology for profiling scientific research organizations using a domain ontology, such as profiling Computer Science research organizations by using the ACM classification tree. This will capitalise on previous joint work with Boris Mirkin from Birkbeck College, where additive clustering methods have been developed for representing a research organisation by a set of possibly overlapping or fuzzy subject clusters from relational data, coupled with a procedure for optimally mapping with parsimony the subject clusters to the subject area ontology [54].

In 2007 CENTRIA started collaboration on hybrid neuro-symbolic methods (NeSy) with Univ. Of Dresden (coordinated by Steffen Hölldobler), involving two MSc students on the study of techniques for distributing SOM maps, and on the improvement of error back propagation for feed-forward NeSy models [79, 53]. NeSy methods were researched for part-of-speech disambiguation, but other applications are sought, namely the processing natural language and oceanographic data. In the latter application area, project RENA was concluded and Gracindo Machado M. Sc. [99] was completed pointing out to the relevance of contexts up to 11 Km, as well as the dependency on external factors such as time of the year (season) for Eddy recognition and classification. Collaboration with former CENTRIA post-doctoral researchers has also continued in 2007 with Marco Castellani on Evolutionary Programming for Neural Networks [36] and Ning Chen on work on extending Categorical SOM maps for LVQ classification. Chen Ning (from the Chinese Academy in Beijing) came to teach in the EMCL a whole course of lectures in the Science of Computational Logic, including a substantial part in Machine learning, her speciality.

Under the "Compromisso para a Ciência" programme launched by the FCT/MCTES, three positions for post-doc researchers where granted in the area of SCC to CENTRIA, one in the topic of Bioinformatics (its conclusion was delayed until 2008) and the 2 others for working on Oceanography applications (Davide d'Alimonte and Armando Fernandes were selected, whose contracts started in the beginning of 2008).

3 List of ongoing projects in 2007

Name	TOURSPLAN - TOURS PLANning Support system
Status	Ongoing (start December 1st 2007, end November 30 2010)
Funding Institution	GECAD (ISEP) PTDC/EIA/74310/2006 (95000)
Principal researcher	Nuno C. Marques
Description	Nowadays personalization is becoming one of the main requisites of tourism sector. A step toward this personalization is achieved through this project. It focuses on personalised tour planning, based on route planning algorithms and recommendation techniques integration. The following goals are envisaged in the project: 1) Tourism domain knowledge base modelling through the use of ontologies or concept graphs, including sights, transportation and users profiles. 2) Recommendation strategies considering adaptive content selection based on context and user interest modelling can be an effective way to select information, giving to tourist a high level of personalisation. 3) Route planning algorithms can combine places of interest with transportation alternatives and schedules, resulting in detailed planned itineraries for the personalised tour plans previously generated. 4) The use of the adaptive hypermedia through adaptive presentation can improve content understanding turning the system more attractive, adapting better to its users.

Name	AutoDynAgents - Autonomic Agents with Self-Managing Capabilities for Dynamic Scheduling Support in a Cooperative Manufacturing System
Status	Ongoing (started February 16 2007)
Funding Institution	Fundação Ciência e Tecnologia (MCTES) PTDC/EME-GIN/66848/2006 (80000EUR)
Principal researcher	Luís Moniz Pereira
Description:	`http://www.gecad.isep.ipp.pt/Gecad/Projectos/ViewProj/?IdProj=56`

Name	IBM-SUR - Parallel and Distributed Computational Models for Scientific Applications on Cell Processor Clusters
Status	Ongoing (started 2007)
Funding Institution	IBM Corp. International
Principal researcher	Salvador Abreu
CENTRIA Participants	Luís Moniz Pereira, Armando Fernandes, Carlos Damásio, Francisco Azevedo, Irene Rodrigues, Lígia Ferreia, Pedro Barahona, Susana Nascimento
Description	The research groups of CENTRIA and CITI are involved in several projects which will benefit from the resources which will be allocated as a result of the present proposal. In the scope of this SUR application, we specifically target the following areas: Computer Science Concepts & Technologies - Constraint Programming and Parallel and Distributed Computing (including Cluster & Grid) - in particular, this includes Constraint Execution in multi-Cell clusters. Application areas: Bioinformatics and Life Sciences and Earth, Sea and Space research. For the current SUR proposal the main focus is the development of techniques and tools which may effectively draw on the potential of hierarchical parallel computing infrastructures, which goes from heterogeneous multicore processors such as the Cell to cluster systems. This goal is achieved by exploiting computational models well suited to the architecture.

Name	PROGICNET - Probability Logic and Probabilistic Networks
Status	Finished (started April 2006, ended April 2008)
Funding Institution	The Leverhulme Trust
Principal researcher	Gregory Wheeler
Description	The study of a unified framework for probability logics.
Results	Accepted proposal.

Name	KRENI - Knowledge Representation with Negative Information
Status	Finished (started January 2006, ended January 2008)
Funding Institution	Council of Rectors (CRUP)
Principal researcher	Luís Moniz Pereira
CENTRIA Participants	José Alferes
Description	The study of the negative information, its formalization and the way of representing and implementing this information in Logic Programming.
Results	Accepted proposal.

Name	PRECISE - in Science and Engineering
Status	Finished (started April 2005, ended March 2008)
Funding Institution	Fundação Ciência e Tecnologia (MCTES) POSI/EIA/59786/2004
Principal researcher	Pedro Barahona
CENTRIA Participants	Jorge Cruz
Description	This project aims at a) investigating possible ways of introducing probabilities (or mere likelyhoods) in the continuous constraint framework; b) developing extensions to our previous work in constraint propagation techniques in continuous constraints to address this extended framework; and c) Evaluate and validate this research, in a number of applications, namely biomedical and engineering.

Name	DOMIR - Dialogs and Ontologies for Multimedia Information Retrieval
Status	Finished (started March 2005, ended 2007)
Funding Institution	Fundação Ciência e Tecnologia (MCTES) FCT POSC/EIA/61109/2004 (90000 Euro)
Principal researcher	Irene Rodrigues
CENTRIA Participants	Paulo Miguel Quaresma, José Miguel, Gomes Saias, Luis Jorge Catela Quintano
Description	To go beyond text retrieval, the analysis of document components such as audio or image segments is required. The Metamedia prototype (FEUP) currently incorporates the extraction of audiovisual features and the automatic association of the corresponding descriptors to the document. Further work is required on audiovisual extraction, in order to create more expressive descriptors. Ontologies will be used at this point: both the inclusion of audiovisual descriptors in ontologies and their combination with domain ontologies will be explored. A second component is dialog management. The retrieval task can be significantly improved by gathering information from the user interaction and analyzing the dialog to extract user intentions and plans. Retrieval is an intrinsically imprecise task and therefore this line has to be complemented by appropriate evaluation procedures and tools. A third line of research is the refinement of the database model to encompass the association of metadata to objects at different levels, the compliance with audiovisual standards and the use of heterogeneous descriptors in the computation of similarity measures for retrieval. Audiovisual descriptors are commonly multi-dimensional and quantitative; the similarity measures required in retrieval open a large ground for new approaches.
Results	Working prototype.

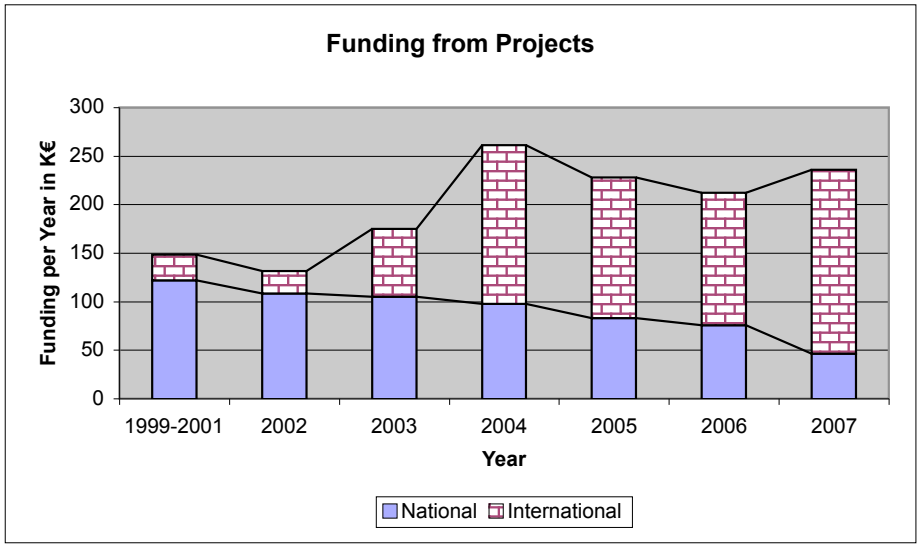
Name	PRACTIC - Processing and Reuse of Advanced Computational Techniques to Improve Constraint Solving
Status	Finished (started 2005, ended December 2007)
Funding Institution	Fundação Ciência e Tecnologia (MCTES)
Principal researcher	Pedro Barahona
CENTRIA Participants	Francisco Azevedo, Marco Correia, Ruben Viegas
Description	The project aims at developing advanced computing techniques, focussing in constraint programming, and to show how their integration with other techniques such as automated learning and meta-heuristics optimisation, can be used to solve a very important problem: the determination of protein structure from Nuclear Magnetic Resonance (NMR) spectroscopy.
Results	4 publications, 1 prototype (by CENTRIA members of the project).

Name	International M.Sc. Program in Computational Logic
Status	Ongoing (start September 2004, end September 2009)
Funding Institution	EU Erasmus Mundus
Principal researcher	Luís Moniz Pereira
CENTRIA Participants	José Alferes, João Leite
Description	One major activity was to setup and launch a joint distributed european MSc degree in Computational Logic with 4 other partners, initiated in the context of project CoLognet. This involved the creation of a new MSc in Computational Logic at UNL. Cf.
Results	Project continued in academic years 04/05 and 05/06. Several coordinating meetings. Yearly report.

Name	Computational Logic as a Foundation for Computer Science and Intelligent Systems
Status	Finished (started September 2004, ended September 2007)
Funding Institution	EU-IST - Asia-Link/VN/001
Principal researcher	Luís Moniz Pereira
CENTRIA Participants	José Alferes
Description	The objective of the project is to promote the area of formal computational foundations of logic, computer science and intelligent systems, i. e., the area of Computational Logic, in South East Asia. The European partners are already engaged in an effort to turn Europe into the leading place for education and training in this area. The three-year pro ject aims at upgrading the staff of the Asian partners within a joint team schema, joint supervision of MSc and PhD students within a sandwich schema, courses of European professors and lectures at the Asian universities, the organisation of international summer schools, the development of curricula for single modules at the Asian universities, and the incorporation of video-teaching methods in cooperation and teaching. Cf.
Results	Received several students from Vietnam and Indonesia for 6 month stays. Hosted a professor from T.U. Hanoi for 1 month. Taught a course at T.U. Hanoi in Jan/Feb05. Participated with one lecturer in the Summer School at T.U.Hanoi, August 05. Project coordination meetings. Yearly report.

Name	RENA - Remote Detection of Mediterranean Water Eddies in the Northeast Atlantic
Status	Finished (started September 2004, ended August 2007)
Funding Institution	Fundação Ciência e Tecnologia (MCTES) PDCTE/CTA/49945/2003-RENA
Principal researcher	Nuno C. Marques
CENTRIA Participants	Susana Nascimento, Marco Castellani, Armando Fernandes, 1 scholarship student
Description	Establishment of a methodology for the remote identification of Mediterranean Water (MW) eddies with a synergistic use of satellite remote sensing data from the ERS and ENVISAT missions, ocean circulation numerical models and artificial neural networks. A census of MW eddies in the Northeast Atlantic and the estimation of their generation frequency will be attempted based on the results. The pro ject also aims at determining the physical mechanisms controlling the interaction between the MW undercurrent/eddies and the coastal upwelling current system off the Iberian Peninsula.
Results	5 publications, 2 prototypes.

Name	REWERSE - Reasoning on the Web with Rules and Semantics
Status	Finished (started March 1st 2004, ended March 1st 2008)
Funding Institution	EU-IST
Principal researcher	Luís Moniz Pereira
CENTRIA Participants	José Alferes, Carlos Damásio, Pedro Barahona, Ludwig Kripphal, Ricardo Amador
Description	REWERSE strives for advanced Web systems and applications sometimes referred to as Semantic Web, a term coined in 2001 by Tim Berners-Lee et. al. in the article âThe Semantic Webâ in Scientific American. This term refers to one of the major current endeavours world wide in Information Technologies. Its goal may be briefly described as enriching the existing Web with meta-data and data processing (and meta-data processing) so as to provide Web-based systems with advanced (so-called intelligent) capabilities, in particular with context-awareness and decision support, strengthening a person centred, everyday use of the Web.
Results	Meetings, deliverables, and publications, in the area of our responsibility for Working Group Evolution and Reactivity. And according to participation in WGs Education and Training, Rule Markup Languages, Towards a Bioinformatics Semantic Web, and Personalised Information Systems.


Funding from Projects
Funding per Year in K€
300
250
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1999-2001
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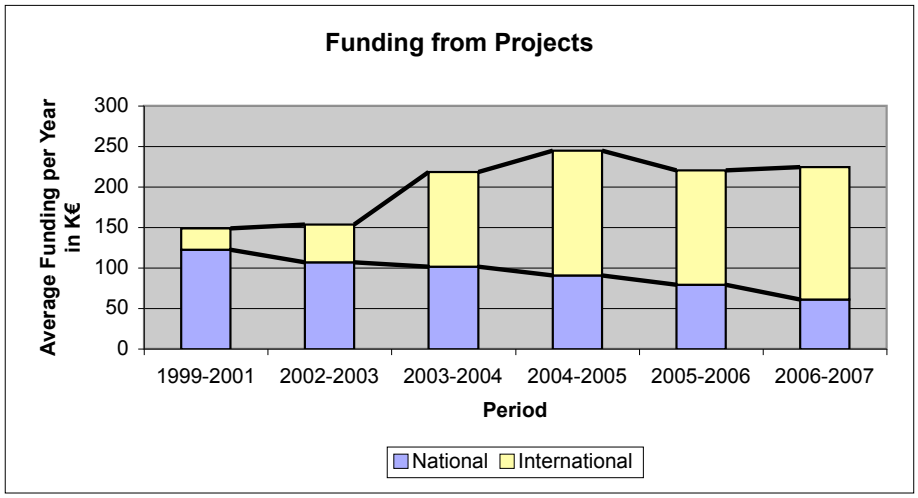
Funding from Projects
Average Funding per Year in K€
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250
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1999-2001
2002-2003
2003-2004
2004-2005
2005-2006
2006-2007
Period
National
International

4 List of Ph.D. students and topics in 2007

Completed MSc. thesis are now presented in section 5, under publications.

Name	João Fernando Lima Alcântara
Degree	Ph.D.
Supervisor	Carlos Viegas Damásio and Luís Moniz Pereira
Topic	Paraconsistent Disjunctive Extended Logic Programs
Start date	September 2001
Finish date	Mid 2008 (expected)

Name	Alexandre Miguel Pinto
Degree	Ph.D.
Supervisor	Luís Moniz Pereira
Topic	Ontologia para linguagens de especificação de acçîntencionais para regras reactivas
Start date	September 2005
Finish date	August 2009 (expected)

Name	Federico Banti
Degree	Ph.D.
Supervisor	José Alferes
Topic	A language for executing and reasoning about evolution of logic based agents
Start date	October 2003
Finish date	Delivered in December 2007, discussion for February 2008

Name	Teresa Gonçalves
Degree	Ph.D.
Supervisor	Paulo Quaresma
Topic	Automatic Classification of Portuguese Documents
Start date	October 2003
Finish date	2008 (expected)

Name	José Saias
Degree	Ph.D.
Supervisor	Paulo Quaresma
Topic	Automatic construction of ontologies and their application in the semantic web context
Start date	October 2004
Finish date	2008 (expected)

Name	Ana Luisa Leal
Degree	Ph.D.
Supervisor	Paulo Quaresma
Topic	Rhetorical Structures and Question Answering Systems
Start date	October 2004
Finish date	September 2008 (expected)

Name	Cássia Santos
Degree	Ph.D.
Supervisor	Paulo Quaresma
Topic	A Multi-Agent Architecture for Question-Anwering
Start date	October 2005
Finish date	September 2008 (expected)

Name	Vítor Nogueira
Degree	Ph.D.
Supervisor	Salvador Abreu and Gabriel David (Faculty of Engineering, University of Porto)
Topic	Constraint and Logic Languages for Hetherogeneous Database Systems
Start date	October 2001
Finish date	2008 (expected)

Name	Valeria Magalhães Pequeno
Degree	Ph.D.
Supervisor	João Moura Pires
Topic	Specification, maintenance and implementation of materialized object views in an object-relational data warehouse
Start date	July 2005
Finish date	September 2009 (expected)

Name	Luis Quintano
Degree	Ph.D.
Supervisor	Irene Pimenta Rodrigues
Topic	Natural Language Dialogues for IR from BD
Start date	October 2003
Finish date	2008 (expected)

Name	Marco Vargas Correia
Degree	Ph.D.
Supervisor	Pedro Barahona
Topic	Advanced Techniques for Improving Constraint Solving in Finite Domains
Start date	October 2004
Finish date	December 2008 (expected)

Name	Mário Abrantes
Degree	Ph.D.
Supervisor	Luís Moniz Pereira
Topic	Computational Logic semantics of contradiction removal
Start date	September 2005
Finish date	December 2010 (expected)

Name	Matthias Knorr
Degree	Ph.D.
Supervisor	José Alferes
Topic	Combining open and closed world knowledge representation for reasoning on the semantic web
Start date	September 2006
Finish date	March 2010 (expected)

Name	Ricardo Amador
Degree	Ph.D.
Supervisor	José Alferes
Topic	Web Integrated Development tools for Evolution and Re- activity.
Start date	September 2006
Finish date	2009 (expected)

Name	Carlos Filipe Freitas
Degree	Ph.D.
Supervisor	José Alferes
Topic	Geração de ideias em ambientes inteligentes de decisão.
Start date	September 2007
Finish date	2010 (expected)

Name	Martin Slota
Degree	Ph.D.
Supervisor	João Leite
Topic	Updates of ontologies with Rules.
Start date	September 2007
Finish date	2011 (expected)

Name	Orlando Sousa
Degree	Ph.D.
Supervisor	João Leite
Topic	Extração de Conhecimento Simbólico de Redes Neuronais Artificiais Aplicadas a Estratégias e Táticas de Negociação em Mercados Financeiros.
Start date	September 2007
Finish date	2011 (expected)

Name	Elsa Cristina Batista Bento Carvalho
Degree	Ph.D.
Supervisor	Pedro Barahona & Jorge Cruz
Topic	Integration of Guaranteed and Preferred intervals in Constraint Programming over Continuous Domains
Start date	October 2006
Finish date	October 2009 (expected)

5 Publications

5.1 Books

[1] Reinhard Kahle. *The applicative realm*, volume 40 of *Textos de Matemática*. Departamento de Matemática, Universidade de Coimbra, November 2007.

5.2 Edited books and journal special issues

[2] Salvador Abreu and Vitor Santos Costa, editors. *Proceedings of the 7th International Colloquium on Implementation of Constraint and LOgic Programming Systems - CICLOPS 2007*. Univ. Porto, September 2007.

[3] José Júlio Alferes and João Alexandre Leite. Special issue arising from the 9th european conference on logics in artificial intelligence, jelia'2004. *J. Applied Logic*, 5(3):389–391, January 2007.

[4] Francisco Azevedo, Pedro Barahona, Francois Fages, and Francesca Rossi, editors. *Recent Advances in Constraints*, volume 4651 of *LNAI*. Springer, May 2007.

[5] Arnold Beckmann, Ulrich Berger, Birgit Elbl, Reinhard Kahle, Karl-Heinz Niggl, Oliver Kullmann, Monika Seisenberger, , and Anton Setzer, editors. *PCC 2007, Proof, Computation, Complexity, International Workshop, Swansea, 13-14 April, 2007*. Computer Science Report Series, CSR 3-2007. University of Wales Swansea, April 2007.

[6] Mehdi Dastani, Amal El Fallah-Seghrouchni, João Alexandre Leite, and Paolo Torroni, editors. *Pre-Proceedings of the 1st Workshop on Languages, Methodologies and Development Tools for Multi-Agent Systems, LADS'007*, September 2007.

[7] William Harper and Gregory Wheeler, editors. *Probability and Inference: Essays In Honor of Henry E. Kyburg, Jr.* King's College Publications, London, 2007.

[8] Luís Moniz Pereira and Gregory Wheeler, editors. *Special issue from the Fourth Intl. Workshop on Computational Models of Scientific Reasoning and Applications*. Journal of Applied Logic. Elsevier, Nederlands, October 2007.

5.3 In International Journals

[9] Isa Alves, Rove Chishman, and Paulo Quaresma. Verbos do domínio jurídico: uma proposta de organização ontológica com vistas ao pln. *Veredas - Revista de Estudos Linguísticos da Universidade Federal de Juiz de Fora, Brasil*, 9(1/2):123–137, 2007.

[10] Francisco Azevedo. Cardinal: A finite sets constraint solver. *Constraints*, 12(1):93–129, March 2007.

[11] Francisco Azevedo. Maxx: Test pattern optimisation with local search over an extended logic. *Constraints*, 12(4):507–538, December 2007.

[12] Carlos Viegas Damásio, Jesús Medina, and Manuel Ojeda-Aciego. Termination of logic programs with imperfect information: applications and query procedure. *Journal of Applied Logic*, 5(3):435–458, 2007. Best papers of JELIA'2004.

[13] P. Dell'Acqua and Luís Moniz Pereira. Preferential theory revision. *Journal of Applied Logic*, 5(4):586–601, December 2007.

[14] Henry E. Kyburg Jr, Choh Man Teng, and Gregory Wheeler. Conditionals and consequences. *Journal of Applied Logic*, 5(4):638–650, 2007.

[15] Reinhard Kahle. Die gödelschen unvollständigkeitssätze. *Mathematische Semesterberichte*, 54(1):1–12, March 2007.

[16] Reinhard Kahle. Edwin D. Mares, Relevant Logic: A Philosophical Interpretation. *Studia Logica*, 85:419–424, April 2007. Book review.

[17] Reinhard Kahle. Freek Wiedijk (Ed.), The Seventeen Provers of the World. *Studia Logica*, November 2007. Book review.

[18] Vitor Nogueira and Salvador Abreu. Temporal contextual logic programming. *Electronic Notes in Theoretical Computer Science*, 177:219–233, June 2007.

[19] Luís Moniz Pereira. La incidencia filosófica de la programación lógica. *ÁGORA - Papeles de Filosofía*, 26(1):153–185, 2007.

[20] Luís Moniz Pereira. Towards an evolutionary epistemology. *CIM Bulletin*, 22, June 2007.

5.4 Book chapters

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5.5 In Proceedings of International Conferences

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[86] Gregory Wheeler. Two puzzles concerning measures of uncertainty and the positive boolean connectives. In José Neves, Manuel Santos, and José Machado, editors, *Progress in Artificial Intelligence (EPIA 2007)*, LNAI, pages 170–180, Berlin, 2007. Springer.

5.6 Theses

[87] Luis Almas. Dsm-pm2 adequacy for distributed constraint programming. Master's thesis, Universidade de Évora, December 2007. Salvador Abreu (superv.);.

[88] M. Babini. Dynamic logic programming for user modeling in recommender systems. Master's thesis, University of Bologna, Italy, January 2007. João Alexandre Leite (superv.);.

[89] Anderson Bertoldi. A semântica dos adjectivos: como e por que incluí-la em uma ontologia do domínio jurídico. Master's thesis, UNISINOS, S. Leopoldo, RS, Brasil, February 2007. Rove Chishman and Paulo Quaresma (superv.);.

[90] Peter Drabnik. On disjunction in modal logics. Master's thesis, Faculty of Mathematics, Physics, and Informatics, Comenius University, Bratislava, June 2007. Gregory Wheeler (superv.);.

[91] Ângela Camolas e Sousa. Categorização ou classificação automática de documentos de arquivo corrente: estudo de caso sobre a câmara municipal de palmela. Master's thesis, University of Évora, December 2007. Paulo Quaresma (superv.);.

[92] Jimmy Esbjörnsson. Emo - a computational emotional state module. emotions and their influence on the behaviour of autonomous agents. Master's thesis, Linköping University, May 2007. P. Dell'Acqua (superv.);.

[93] Ricardo Ferreira. Extensible metadata repository for information systems. Master's thesis, FCT / UNL, July 2007. João Moura Pires (superv.);.

[94] Daniel Franzen. A modular api for intelligent virtual agents. Master's thesis, Linköping University, January 2007. P. Dell'Acqua (superv.);.

[95] Anja Johansson. Modelling expectations and trust in virtual agents. Master's thesis, Linköping University, May 2007. P. Dell'Acqua (superv.);.

[96] P. Klimo. Planning support for evolp agent architecture. Master's thesis, Comenius University, Bratislava, Slovakia, May 2007. João Alexandre Leite (superv.);.

[97] Gustavo Laboreiro. Classificador para língua natural. Master's thesis, Universidade de Évora, November 2007. Irene Rodrigues (superv.);.

[98] Nuno Lopes. Representing and querying ontologies with contextual logic programming. Master's thesis, Universidade de Évora, December 2007. Salvador Abreu and (superv.);.

[99] Gracindo José Miguel Machado. Visualização e análise de vórtices de água em mapas térmicos da superfície oceânica. Master's thesis, Departamento de Informática, Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa, February 2007. Nuno Marques (superv.); (in Portuguese).

[100] Nuno Morgadinho. Distributed multi-threading in gnu prolog. Master's thesis, Universidade de Évora, October 2007. Salvador Abreu (superv.);.

[101] José Palmeiro. Arquitectura de agentes: Desenho e fundações de um modelo de negócio. Master's thesis, University of Évora, February 2007. Paulo Quaresma (superv.);.

[102] Ricardo Raminhos. Extraction and transformation of data from semi-structured text. Master's thesis, Universidade Nova de Lisboa, June 2007. João Moura Pires (superv.);.

[103] Carl-Johan Rosen. An ai engine for behavioural animation in a real time interactive installation. Master's thesis, Linköping University, May 2007. P. Dell'Acqua (superv.);.

[104] José Carlos Almeida Santos. Mining protein structure data. Master's thesis, Universidade Nova de Lisboa, January 2007. (superv.); Pedro Barahona and Ludwig Krippahl (superv.);.

[105] Paula Cristina Sousa Saraiva. Implementação de serviços de referência para assistentes digitais pessoais (pda's) nas bibliotecas de saúde em portugal. Master's thesis, University of Évora, July 2007. Paulo Quaresma (superv.);.

[106] M. Slota. Transformational semantics and implementation of evolving logic programs. Master's thesis, Comenius University, Bratislava, Slovakia, May 2007. João Alexandre Leite (superv.);.

[107] Gaston Tagni. An approach to complex event detection in the web. Master's thesis, FCT/UNL, March 2007. José Júlio Alferes (superv.);.

5.7 Other publications

[108] Salvador Abreu and Vitor Santos Costa. Workshop report: Colloquium on implementation of constraint logic programming systems. *The Association for Logic Programming Newsletter*, 20, n. 3/4, December 2007.

[109] João Alexandre Leite. The knowledge evolution group at centria. *The Association for Logic Programming Newsletter*, 20(2), May 2007.

[110] Luís Moniz Pereira. Wiki or bust. *The Association for Logic Programming Newsletter*, 20, n. 2, June 2007.

6 Missions and Visitors

6.1 Missions

Salvador Abreu

- Lisboa, Portugal, January 2007.
  Participation in the XATA2007 conference.
- Bordeaux, France, May 2007.
  Visit to LaBRI, a Université de Bordeaux-I research unit, with the purpose of establishing a european project, which was in the meantime approved (CONTEMP).
- Böblingen, Germany, June 2007.
  Visit to the IBM Corporation R&D labs in Böblingen, to give a presentation on Constraint Programming and the Cell Processor as well as to negociate an application for an IBM Shared University Research (SUR) grant.
- Porto, Portugal, September 2007.
  Participation in the ICLP 2007 conference and associated workshops, namely CICLOPS 2007.
- Würzburg, Germany, October 2007.
  Participation in the INAP 2007 conference.

José Alferes

- Guimarães, Portugal, December 2007
  Purpose: Participation in EPIA 2008, 13th Portuguese Conference on Artificial Intelligence.
- Madrid, Spain, November 2007
  Purpose: Participation in the bilateral meeting of CRUP project KRENI.
- Chiemsee, Germany, March 2006
  Purpose: Participation in the final meeting of project Rewerse, and the meeting of the I5 working group on Evolution and Reactivity.

- Munich, Germany, May 2007
  Purpose: Participation in the review meeting of project.
- Hanoi, Vietname, March/April 2007
  Purpose: Course at the Hanoi University of Technology.

Pedro Barahona

- Nice, France, January 2007.
  Invited talk in the PADL'07 conference.
- Munich, Germany, March 2007.
  Participation in Rewerse meeting.
- Madrid, Spain, June 2007.
  Invited talk in GIAA workshop.
- Providence, RH, USA, October 2007.
  IParticipation in the CP'08 conference.
- Guimarães, Portugal, December 2007.
  Participation in the EPIA 2007 conference.

Carlos Viegas Damásio

- Monastery Frauenwörth, Fraueninsel (Chiemsee), Germany, November 27-29, 2007
  Purpose: Participation in Final REWERSE Annual Meeting

Pierangelo Dell'Acqua

- Vienna, Austria, September 23-27, 2007
  Purpose: Participation in the Multidisciplinary Workshop on Advances in Preference Handling (M-Pref'07) at 33rd Intl. Conf. on Very Large Data Bases (VLDB'07).

Claúdio Fernandes

- Porto, Portugal, September 2007.
  Participation in the ICLP 2007 conference and associated workshops, namely CICLOPS 2007.
- Innsbruck, Austria, June 2007.
  Participation in OWLED 2007 (OWL: Experiences and Directions), Third International Workshop.

Reinhard Kahle

- Amsterdam, August 2007
  Purpose: Preparation of a project application within the ESF project LogICCC, together with Amsterdam and Tübingen (approved in 2008).
- Tübingen, July 2007
  Purpose: Habilitation at the Faculty of Information and Cognition Sciences, University of Tübingen.
- Nancy, February 2007
  Purpose: Collaboration with colleagues from LORIA, UNiversity of Nancy.
- Göttingen, January 2007
  Purpose: Department of Mathematics, University of Göttingen. Visit within the Coimbra-Group visiting staff programme/Erasmus collaboration.
- Tübingen, January 2007
  Purpose: Wilhelm-Schickard-Institute for Computer Science, University of Tübingen, Talk at the Kolloquium Logik und Sprachtheorie.

Matthias Knorr

- Bressanone, Italy, June 2007
  Purpose: Participation in 20th International Workshop on Description Logics (DL-2007)
- Osnabrück, Germany, September 2007
  Purpose: 30th Annual German Conference on Artificial Intelligence (KI-2007)
- Guimarães, Portugal, December 2007
  Purpose: 13th Portuguese Conference on Artificial Intelligence (EPIA 2007)

Ludwig Krippahl

- Wroclaw, September 2007
  Purpose: Participation in 2nd European Conference on Chemistry for Life Sciences.

João Leite

- Honolulu, Hawai'i, May 2007
  Purpose: Present a tutorial at AAMAS'07
- Durham, UK, August/September 2007
  Purpose: Co-chair LADS'007 and present a course at EASSS'07
- Hanoi, Vietnam, July/August 2007
  Purpose: Present a course at 2007 Asialink Summer school
- Guimarães, Portugal, December 2007
  Purpose: 13th Portuguese Conference on Artificial Intelligence (EPIA 2007)
- Porto, Portugal, September 2007
  Purpose: Attend CLIMA VIII.

Nuno Lopes

- Porto, Portugal, September 2007.
  Participation in the ICLP 2007 conference and associated workshops, namely CICLOPS 2007.

Nuno C. Marques

- Dresden, February 2007 Purpose: Collaboration with colleagues from ICCL, TU-Dresden.
- Prague, Czech Republic, July 2007 Purpose: Participation in EURO XXII, 22nd European Conference on Operational Research.
- Dresden, July 2007 Purpose: Collaboration with colleagues from ICCL, TU-Dresden.
- Guimarães, Portugal, December 2007 Purpose: Participation in EPIA 2008, 13th Portuguese Conference on Artificial Intelligence.

Vitor Nogueira

- Alicante, Spain, June 2007.
  Participation in the TIME 2007 conference.
- Porto, Portugal, September 2007.
  Participation in the ICLP 2007 conference and associated workshops, namely CICLOPS 2007.
- Guimarães, Portugal, December 2007.
  Participation in the EPIA 2007 conference.

Luís Moniz Pereira

- Guimarães, Portugal, December 2007
  Purpose: Participation in EPIA 2008, 13th Portuguese Conference on Artificial Intelligence.
- London, UK, January 2007
  Purpose: Promoting cooperation between CENTRIA network and Imperial College.
- London, UK, February 2007
  Purpose: Again, promoting cooperation between CENTRIA network and Imperial College.
- Coimbra, Portugal, March 2007
  Purpose: Yet again, promoting cooperation between CENTRIA network and Imperial College.
- Norrköping, Sweden, June 2007
  Purpose: Participation in the 13th Intl. Conf. on Thinking.
- Vienna, Austria, July 2007
  Purpose: Meeting of the Joint Committee of the European Master in Computational Logic.
- Madrid, Spain, November 2007
  Purpose: Participation in the bilateral meeting of CRUP project KRENI.
- Madrid, Spain, November 2007
  Purpose: Participation in the Advisory Board and the Board of Trustees meetings of IMDEA, the Instituto Madrileno De Estudios Avanzados - Software.

Alexandre Pinto

- Tempe, Arizona, USA, May 2007
  Purpose: Participation in ArgNMR-LPNMR 2007.
- Yerevan, Armenia, October 2007
  Purpose: Participation in the LPAR 2007.

Paulo Quaresma

- Stanford, USA, June, 2007
  Purpose: Participation in ICAIL 2007, 11th International Conference on Artificial Intelligence and Law.

Ruben Frederico Duarte Viegas

- Providence, Rhode Island, USA 2007
  Purpose: Participation in the Sixth International Workshop in Constraint Modelling and Reformulation (ModRef'07)
- Funchal, Madeira, PORTUGAL 2007
  Purpose: Participation in the International Conference on Enterprise Information Systems (ICEIS'07)
- Guimarães, PORTUGAL 2007
  Purpose: Participation in the Simpósio Doutoral em Inteligência Artificial (SDIA'07)
- Guimarães, PORTUGAL 2007
  Purpose: Participation in the Workshop on Search Techniques for Constraint Satisfaction (STCS'07)

Gregory Wheeler

- Bern-Leukerbad, Janurary 2007.
  Purpose: participation PROGICNET Project Meeting.

- Lisbon, February 2007.
  Purpose: Invited Talk, Center for the Philosophy of Science, University of Lisbon.
- Amsterdam, May 2007.
  Purpose: Invited Talk, *Foundations of the Formal Sciences VI: Reasoning about probabilities and probabilistic reasoning*, the Institute for Logic, Language, and Computation (ILLC), University of Amsterdam.
- Kent, September 2007.
  Purpose: Participation in *The 3rd Probability and Logic Workshop*;
  Purpose: participation PROGICNET Project Meeting.
- Pittsburgh, November 2007.
  Purpose: Invited Talk, Philosophy Department Colloquium, Carnegie Mellon University.
- Guimarães, December 2007.
  Purpose: Participation in *The 13th Portuguese Conference on Artificial Intelligence*.

6.2 Visitors

Chitta Baral Arizona State University, USA

Guillaume Bonfante LORIA, Nancy, France

David Pearce Universidad Rey Juan Carlos, Spain

Terrance Swift Medicine Rules, Maryland, USA

Kazumi Nakamatsu U. Hyogo, Japan

Robert Kowalski Imperial College, London, UK

Chen Ning Beijing Academy of Sciences, China

Steffen Holldobler T.U. Dresden, Germany

Yohanes Stefanus U. Indonesia, Depok, Indonesia

Ari Saptawijaya U. Indonesia, Depok, Indonesia

Carroline Puspa U. Indonesia, Depok, Indonesia

Manuel Hermenegildo U.P. Madrid, Spain

Pierangelo Dell'Acqua U. Linköping, Sweden

Lotfi Boudjenah U. Oran, Algeria

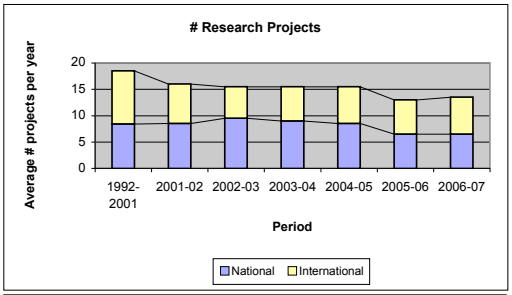
Jean-Yves Béziau Swiss Natl. Science Foundation, Neuchâtel, Switzerland

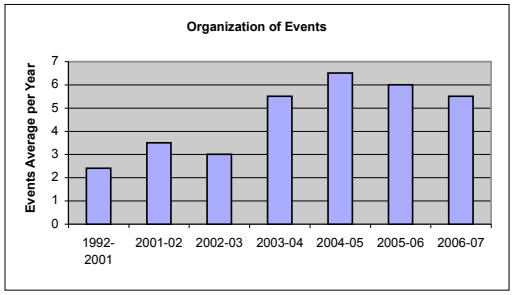
António Brogi U. Pisa, Pisa, Italy

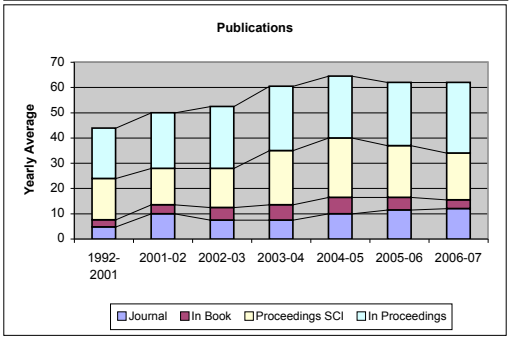
Umberto Straccia CNR Pisa, Italy

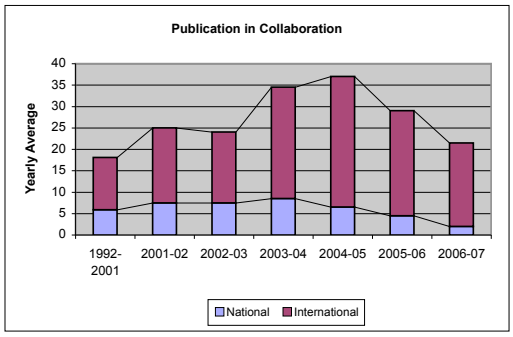
Matthias Baaz T. U. Wien, Vienna, Austria.

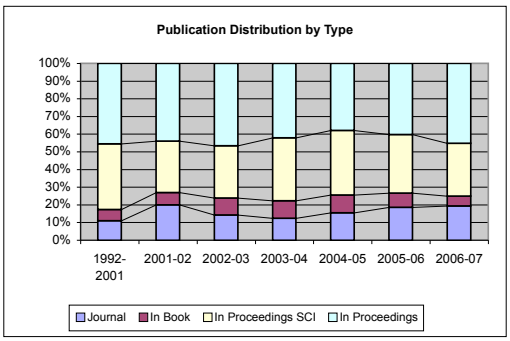
7 CENTRIA evolution graphics in 2007

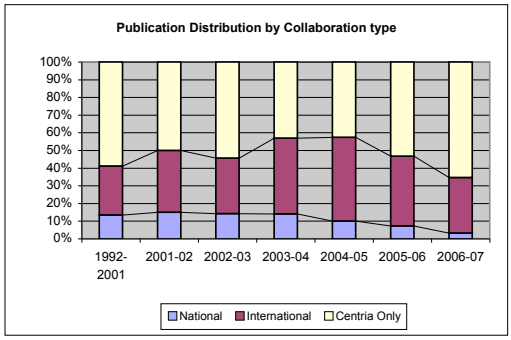


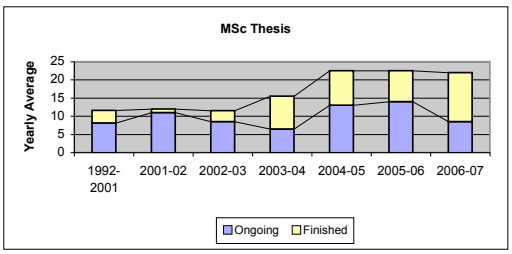


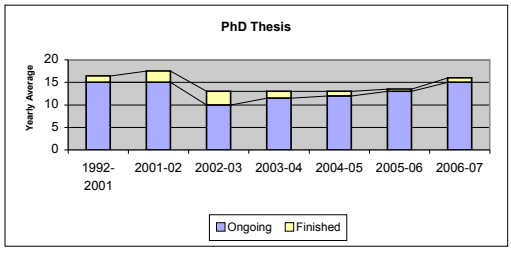


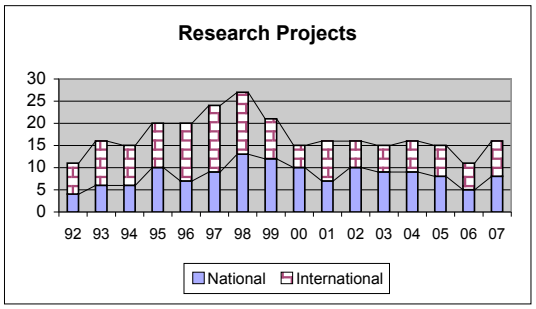








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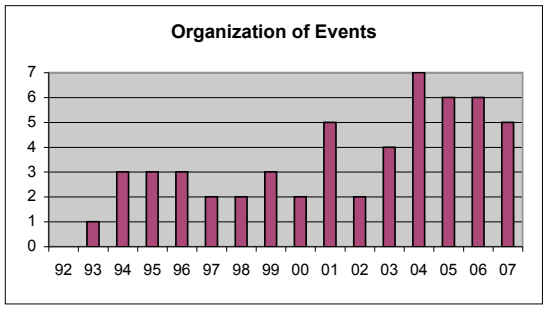
National
International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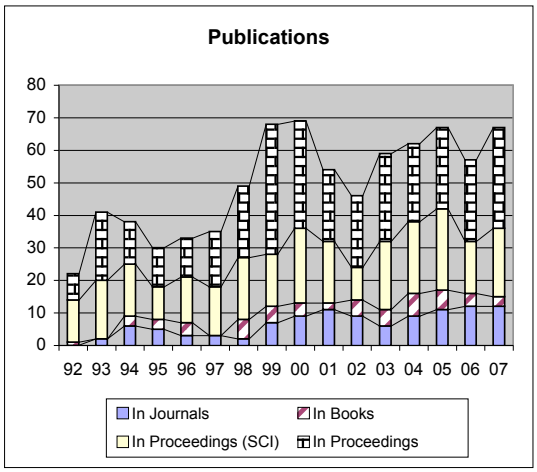
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20
10
0
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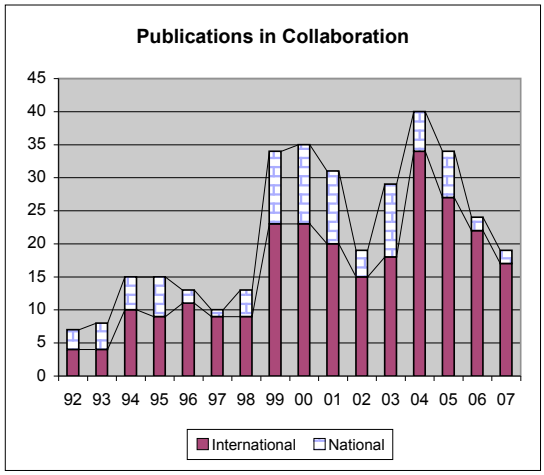
In Journals
In Books
In Proceedings (SCI)
In Proceedings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International
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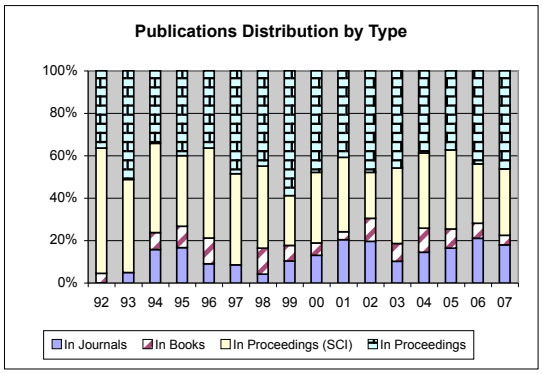
Publications Distribution by Type
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60%
40%
20%
0%
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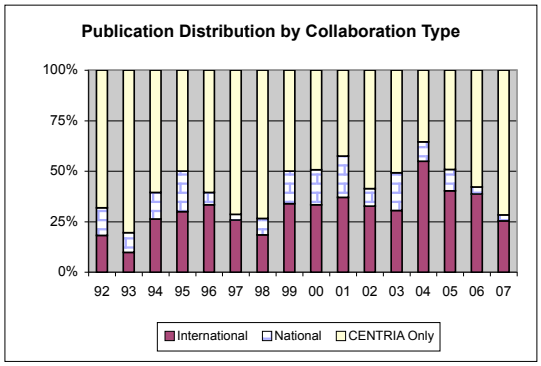
In Journals
In Books
In Proceedings (SCI)
In Proceedings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International
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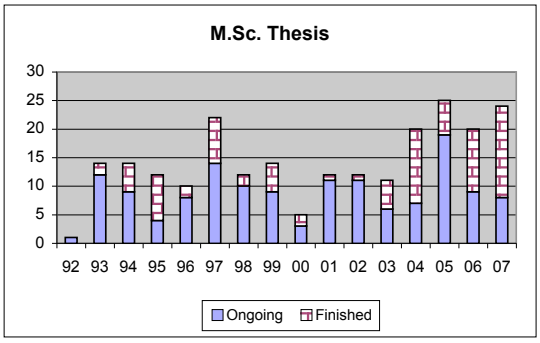
CENTRIA Only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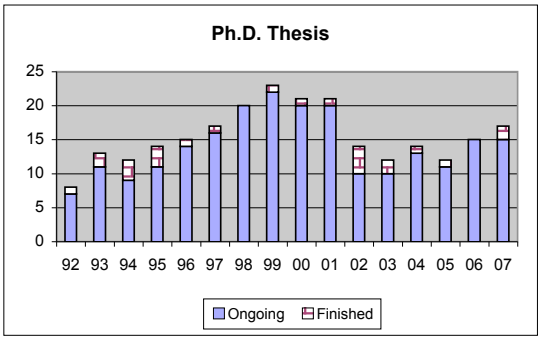
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Ongoing
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