**Start page**

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|---|---|
| Name of the Research Unit: | CENTRO DE INTELIGÊNCIA ARTIFICIAL - CENTRIA<br>**uID:**526 \| (L700526) |
| Coordinator: | Luis Manuel Sancho Moniz Pereira |
| Main Scientific Domain: | Electrical and Computer Engineering |
| Other subdomains: | Artificial Intelligence |
| The Research Unit resulted from a merge of: | n/a |

**Host institutions**

| | |
|---|---|
| Leading Host Institution | Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa |
| Other Institutions | n/a |

**Objectives and Achievements**

## Unit Description

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, Ryszard S. Michalski, 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.

## General Objectives

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.

## Main Achievements

The main achievements are listed in the 3 distinct subject areas of the Centre. Since there is only one Research Group, the presentation of the Centre’s achievements starts here, and continues in the Research Group section.

Sub-Area KRR&LP - 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, where CENTRIA heads the working group of “Evolution and Reactivity” of 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. The development of Prolog technology for the Semantic Web, including early proposals for RuleML, extensions of the Resource Description Framework, in order to be able to express negation information in the Semantic Web, and Fuzzy RuleML.

A4. 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.
A5. 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.
A6. Research on Cognitive Science related issues, namely the relationship between epistemology and logical AI, the modelling of cognitive decisions, as well as modelling societal behaviour.
A7. Formal logical representation of statistical reasoning, highlighting the fundamental differences between probabilistic logics and logics for probabilities.
A8. Various applications to model-based diagnosis, in digital circuits, and to protection systems of electrical power distribution networks (with a portuguese company).
A9. Development and benchmarking of distributed tabling procedures with termination detection, for definite logic programs.
A10. Connection of Java and Prolog, namely in Interprolog, a system making the connection to XSB-Prolog.
Sub-Area IIS - Intelligent Information Systems
B1. 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.
B2. 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.
(continues in the Research Group section, since there is a single Research Group)

**Activities**

## Integrative/multidisciplinary activities in the 2003-2006 period

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)

**Outreach activities in the 2003-2006 period**

ASPI (Socio-Professional Aspects of Computer Science lecture)

L. M. Pereira, “Artificial Intelligence”, May 2006.

SWERC

L. M. Pereira, “Prospective Programming with ACORDA”, SWERC’06, South Western Europe Regional ACM Programming Contest 2006. November, 17-19, 2006. Lisbon, Portugal. http://ctp.di.fct.unl.pt/SWERC2006/

Visit from secondary school to FCT/UNL

L. M. Pereira, Lógica, Inteligência Artificial, e Computador”, Visit from Escola Secundária de Rio Tinto to FCT/UNL, 19 March 2003.

Talks

L. M. Pereira, Manifesto, comunicação ao Encontro “Inovação, ciência e tecnologia: condições para o desenvolvimento científico e tecnológico do País - bloqueios, estratégias e soluções”, ISCTE, Lisboa 18 Dezembro 2004.

L. M. Pereira, IA e Sociedade do Conhecimento, Invited talk at “Dia Comemorativo dos 50 Anos da Inteligência Artificial", ISEP - Instituto Superior de Engenharia do Porto, Portugal, May 31, 2006.

L. M. Pereira, IA e Sociedade do Conhecimento, Invited talk at "Excelência - Centros de Inovação e Inteligência Artificial", Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, Portugal, May 18, 2006.

L. M. Pereira, Darwinismo Literário e Computação, Invited talk at "Velhos e Novos Media", Fórum Municipal Romeu Correia, Almada, Portugal, May 10, 2006.

L. M. Pereira, Nova Computação = Nova Ciência, Novo Conhecimento, Invited talk at “Novas Fronteiras da Ciência e do Conhecimento”, Alfândega do Porto, Porto, Portugal, April 1, 2006 . Transcrição.

Papers in Cultural Journals and Books

L. M. Pereira, Ciência e Paraciência, in Revista Intelectu, nº 10, November 2004.

Press and Media

L. M. Pereira, Doutorados nas Empresas, in: Diário Económico, October 12th, 2006.

L. M. Pereira, "Política de Ciências Tecnologia" - vídeo, interview in: Jornal Dois, RTP2, 22:00, June 19th, 2006.

L. M. Pereira, "Não há um movimento terrorista gerido por computadores", in:

supplement PÚBLICA of O PÚBLICO, March 6th, 2005.
L. M. Pereira, Três questões sobre Inteligência Artificial, Interview, NOVAS newsletter, pp. 7, nr. 22, October 2004.
L. M. Pereira, Opinião: Inteligência Artificial, in: e-Ciência - Magazine de Ciência Tecnologia e Inovação, pp. 26-26, nr. 27, 13/05/04, May 2004.
L. M. Pereira, Inteligência Artificial. Mito e Ciência, in: Ciberscópio - Cibersimulação, Coimbra: capital nacional da cultura 2003.
L. M. Pereira, Lógica, Inteligência Artificial e Computador, in: Ciberscópio - Cibersimulação, Coimbra: capital nacional da cultura 2003.

**Future vision of the Unit's activities for the period 2007-2010**

With GECAD/ISEP, CENTRIA has submitted an Associate Lab proposal, COGNOMA, with a broad scope in the global area of "Cognition in Humans and Machines", having as main mission to cooperate in a continuous, capable and efficient manner, in pursuing specific objectives of the national scientific and technological policy, namely in the areas of

- Ambient Intelligence and Embedded Systems
- Bio-Informatics
- Management of Critical Resources
- Computational Processing of Written Portuguese
- Knowledge Based, Cognitive and Learning Systems
- Intelligent Planning and Systems
- Semantic Web

intertwining the competence and know-how accumulated in the two COGNOMA centres, stimulating the integration of research, scientific education as well as the transfer of knowledge and technology to non academic sectors, and contributing to the associated small and medium companies.

COGNOMA will be the Artificial Intelligence (AI) Lab of reference in Portugal, ensuring its presence in the frontier of the most advanced software applications. It brings together the largest AI university centre and the best polytechnic research centre in the area, as well as selected researchers from other institutions. It applies its knowledge, skills and experiences recognised world wide as basic AI technologies, reflecting in its original DNA, to areas of critical application of intelligent software for the next decade, from biotechnology to energy, among many others.

The proposal is well in line with the strategic goals, both National and European, for Research and Development. The main objective of the 7th Framework Programme of the EU is the fulfilment of the Lisbon strategy, i.e. to transform the EU in the most competitive Knowledge Based Economy in the world. Such ambitious goal is not achievable without a clear involvement of the Knowledge Technologies that are at the core of the COGNOMA contributions towards the national and European development.

Moreover, the European Union assumes that the Information and Communication Technologies are a priority area, assigning to them, for the 2007 – 2013, the largest budget among the ten or so priority areas selected at a European level.

COGNOMA will centre its attention on the grand pillar of Knowledge, Cognitive and Learning Systems, including the Computational Processing of Written Portuguese. Additionally, COGNOMA will develop important activity within other related pillars, such as the thematic areas of Ambient Intelligence (and respective Embedded Systems), Bio-Informatics, Management of Critical Resources, Intelligent Planning Systems (and their control) and the Semantic Web. It should be stressed that these

thematic areas will not only contribute towards the priority area of Information and Communication Technologies, but also towards other areas rated as strategic by the EU, such as Energy, Transports and Security.

## Future Networking activities in the 2007-2010

The AI community in Portugal has reached its maturity, with more than 25 years of experience and with several consolidated research groups. The next natural step is a deeper collaboration between these groups, namely through the organization in aggregating ways. This is the research policy being pursued both in Portugal and in Europe.

AI aims at supporting, in symbiosis with the Human, in the creation of knowledge, to obtain and test it, to seek cognitive patterns and to perform diagnostic and prognostic tasks – in summary, all the repertoire of cognitive functionalities that are needed to perform research – together with the sensorial collection and robotics action that turns such activity in a larger undertaking.

This emphasis is captured with the concept of “cognoma”, taken by analogy with the notion of “genoma” (genome). Cognoma, thus intended as the cognition in both Humans and Machines, including the corresponding interface, has 3 major components: Human Cognition, Machine Cognition and Human-Machine Interaction.

If the automated processing of the genome leads us towards Bioinformatics and Biotechnology, we envisage, by analogy, that the cognoma will be the basis of the “cognotecnology” of the future, and the future of artificial intelligence lies in that it is an epistemological instrument, not only an autonomous agent of the humans, but mainly as a symbiotic agent: a leverage to support humans to do science and develop technology, and facilitate people in general to take advantage of it in their daily.

The proponents of the COGNOMA Associate Lab are CENTRIA/UNL (coordinator) and GECAD/ISEP. The two research centres, both evaluated with “VERY GOOD”, have a strong complementarily, a balanced dimension and participation, reaching 56 PhDs, and 65 other junior members, with a total of 121 researchers (in July 2006). These include 4 full professors, 9 associate and coordinating professors and a total of 7 holders of an “agregação” (similar to a “habilitation”).

The Lab also intends, through a National Network, to promote and use the varied and relevant national expertise, in concert with the Portuguese Association for Artificial Intelligence, and the Portuguese Chapter of the IEEE Computational Intelligence Society, and through the adoption by the proponents of individual researchers as their associated members. We can mention the association of researchers already formalised in the preparation of the proposal: Amílcar Cardoso (FCT/UC), Helder Coelho (FC/UL), João Pavão Martins (IST/UTL), José Carlos Quadrado (ISEL/IPL), Viriato Marques (ISEC/IPC), Carlos Bento (FCT/UC), Francisco Pereira (FCT/UC), Paulo Gomes (FCT/UC), and António Branco (FC/UL). Other relevant national researchers may follow suit.

Cognoma will multiply the effects of previous betting on the development of knowledge, science, organizations and people in Portugal.

CENTRIA has also networked with other centres, in 3 approved “Compromisso com a Ciência” proposals: #418, 442, 555.

**General Indicators**

| | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|
| Nº of Researchers (FTE)* | 21 | 21 | 22 | 24 |
| Masters Completed in the Period | 5 | 6 | 5 | 11 |

| PhDs Completed in the Period | 2 | 1 | 1 | 0 |
|---|---|---|---|---|

**Research Groups**

| | | Group Title | Principal Investigator |
|---|---|---|---|
| 1 | (2003-2010) | Artificial Intelligence | Luis Manuel Sancho Moniz Pereira |
| | | | |

**Group Description**

| | |
|---|---|
| Research Unit: | CENTRO DE INTELIGÊNCIA ARTIFICIAL - CENTRIA<br>**uID:**526 \| (L700526) |
| Group Name/Designation: | Artificial Intelligence |
| Principal Investigador: | Luis Manuel Sancho Moniz Pereira |
| Time Interval: | (2003-2010) |
| Location of Group (Host Institution): | Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa |
| Keywords: | Knowledge Representation and Reasoning; Intelligent Information Systems; Soft Computing and Constraints; Logic Programming |
| Funding, source, dates: | Pluriannual FCT total 2003-2006: 261.902 €<br>Programmatic FCT total 2003-2006: 166.667 €<br>Projects, total 2003-2006: 971.656 €<br>2003=232.653,00 €<br>DAAD 2.000<br>EU - IST 21.500<br>FCT 65.053<br>A.R. 15.000<br>CRUP 1.100<br>AdI 25.000<br>GRICES/Capes 3.000<br>INRIA/ICCTI 46.000<br>U Évora 48.000<br>2004=256.768 €<br>EU - IST 96.000,00<br>ERASMUS Mundus 12.500,00<br>ASIA Link 25.000,00<br>FCT 65.268,00<br>AdI 25.000,00<br>GRICES/Capes 33.000,00<br>2005=216.494 €<br>EU - IST 75.000,00<br>ERASMUS Mundus 15.000,00<br>ASIA Link 25.000,00<br>CRUP 1.150,00<br>FCT 47.344,00<br>AiD 20.000,00 |

| | |
|---|---|
| | GRICES/Capes 3.000,00<br>EU - eCONTENT 30.000,00<br>2006=245.744 €<br>EU - IST 75.000,00<br>ERASMUS Mundus 75.000,00<br>ASIA Link 25.000,00<br>CRUP 2.300,00<br>FCT 43.944,00<br>Leverhulme Trust 10.000,00<br>EU - eCONTENT 4.500,00 |

**PI and Researchers**

**Researchers in the Group (Ph.D. Only)**

| | |
|---|---|
| (CV) | Armando Manuel Garcia da Silva Fernandes |
| (CV) | Carlos Augusto Isaac Piló Viegas Damásio |
| (CV) | Francisco de Moura e Castro Ascensão de Azevedo |
| (CV) | Gregory Wheeler |
| (CV) | Helena Maria Duarte Freitas Mesquita Barbas |
| (CV) | Irene Pimenta Rodrigues |
| (CV) | João Alexandre Carvalho Pinheiro Leite |
| (CV) | João Carlos Gomes Moura Pires |
| (CV) | Jorge Carlos Ferreira Rodrigues da Cruz |
| (CV) | José Júlio Alves Alferes |
| (CV) | Lígia Maria Rodrigues da Silva Ferreira |
| (CV) | Ludwig Krippahl |
| (CV) | Luis Manuel Sancho Moniz Pereira |
| (CV) | Nuno Miguel Cavalheiro Marques |
| (CV) | Paulo Miguel Torres Duarte Quaresma |
| (CV) | Pedro Manuel Correa Calvente Barahona |
| (CV) | Reinhard Josef Klaus Kahle |
| (CV) | Salvador Luis de Bethencourt Pinto de Abreu |
| (CV) | Susana Maria Santos Nascimento Martins de Almeida |

**Other Researchers in the Group (Ph.D. Only)**

| | |
|---|---|
| (CV) | marco castellani |
| (CV) | Miguel Cruz Costa Calejo |
| (CV) | Paula Alexandra da Costa Amaral Jorge |
| (CV) | Pierangelo Dell'Acqua |
| (CV) | Terrance Lee Swift |

**Other Researchers in the Group (non Ph.D.)**

| | |
|---|---|
| (CV) | Agostinho Ernesto Lourenço Monteiro |
| (CV) | Alexandre Miguel dos Santos Martins Pinto |
| (CV) | Belinda Teixeira Vieira |

| | |
|---|---|
| (CV) | Cláudio Francisco Fernandes |
| (CV) | Federico Banti |
| (CV) | Freddy Priyatna |
| (CV) | Gonçalo Cardoso Lopes |
| (CV) | José Carlos Almeida dos Santos |
| (CV) | Luis Jorge Catela Quintano |
| (CV) | Manoela Ilic |
| (CV) | Marco Vargas Correia |
| (CV) | Mário António Rodrigues Grande Abrantes |
| (CV) | Martin Slota |
| (CV) | Miguel Ângelo Felgueiras Bento Alves |
| (CV) | Nuno Alexandre de Jesus Lopes |
| (CV) | Ricardo Miguel Silva Tavares Amador |
| (CV) | Ruben Frederico Duarte Viegas |
| (CV) | Rui Miguel Martinho Dias Jorge |
| (CV) | Tiago V. Maia |
| (CV) | Valéria Magalhães Pequeno |
| (CV) | Vasco Antunes Ferreira Leal Figueira |
| (CV) | Vitor Manuel Beires Pinto Nogueira |

**Objectives and Achievements**

## General Objectives

We have a single research group comprising everyone in the centre. Thus the Objectives are the same as those of the Unit itself.

## Main Achievements

(continuation of Main Achievements from the Unit, since we have a single Research Group)

B3. Implementation of a Question-Answering system using results from previous research on semantic web ontologies, and natural language dialogue systems for information retrieval.

B4. Several developments in data warehousing, namely a prototype for analyzing the pollutant emissions reported by the industry and a prototype for a Spatial OLAP.

B5. 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.

Sub-Area SCC - 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.

C5. Developments under way of new constraint solvers that will integrate much of the above research with that being carried in SAT solving, and deal with Temporally Annotated Contextual Constraint Logic Programming.

**Productivity**

## Publications in peer review Journals (3000 ca.)

**(Up to a max of 10. Always indicate at the end of the citation, impact factor of the journal (IF=) and number of citations (nº C=). Give title and full citation in original language. DO NOT translate)**

(GS = citations in Google Scholar)

R. Kahle A proof-theoretic view of necessity, SYNTHESE 148 (3): 659-673 FEB 2006.

IF = 0.364 ; nº C = 0; GS= 0

Gregory Wheeler, On the Structure of Rational Acceptance: Comments on Hawthorne and Bovens, Synthese, Vol. 144, No. 2, Pag. 287-304, 2005.

IF = 0.364 ; nº C = 0; GS= 2

Jorge Cruz and Pedro Barahona, Constraint Reasoning in Deep Biomedical Models, Journal of Artificial Intelligence in Medicine, Vol. 34, Pag. 77-88, Elsevier, May 2005.

IF = 1.882 ; nº C = 0; GS= 0

Paula Amaral and Pedro Barahona, A Framework for Optimal Correction of Inconsistent Linear Systems, Constraints, Vol. 10, No. 1, Pag. 67-86, Springer, January 2005.

IF = 0.759 ; nº C = 0; GS= 1

José Júlio Alferes, Luís Moniz Pereira and Terrance Swift, Abduction in Well-Founded Semantics and Generalized Stable Models via Tabled Dual Programs, Theory and Practice of Logic Programming, Vol. 4, No. 4, Pag. 383-428, 2004.

IF = 2.024 ; nº C = 3; GS=29

L. Granvilliers, Jorge Cruz and Pedro Barahona, Parameter Estimation Using Interval Computations, SIAM Journal on Scientific Computing (SISC), Vol. Special Issue on Uncertainty Quantification, 2004.

IF = 1.812 ; nº C = 1; GS=10

Aida Vitória, Carlos Viegas Damásio and Jan Maluszynski, From rough sets to rough knowledge bases, Fundamenta Informaticae, Vol. 57, No. 2-4, IOS Press, Oct 2003.

IF = 0.785 ; nº C = 2; GS = 7

Ludwig Krippahl, Moura JG and Palma PN, Modelling protein Complexes with BiGGER, Proteins-Structure Function and Genetics 52 (1): 19-23 Jul 2003

IF = 4.313 ; nº C = 11; GS= 10

Paulo Quaresma and Irene Rodrigues, PGR: Portuguese Attorney General's Office Decisions on the Web, in: Bartenstein, Geske, Hannebauer and Yoshie (eds), Web-Knowledge Management and Decision Support, LNAI, Springer, Vol. 2543, Pag. 51-61, 2003.

IF = 0.515 ; nº C = 3; GS=13

Susana Nascimento, B. Mirkin and Fernando Moura Pires, Modeling Proportional Membership in Fuzzy Clustering, IEEE Transactions on Fuzzy Systems- Fuzzy Systems in Knowledge Discovery and Data Mining, Vol. 2, No. 11, Pag. 173-186,

2003.

IF = 1.803 ; nº C = 1; GS= 4

## Other publications (3000 ca.)

**(Include only Books, chapters or full papers published in conference proceedings up to max of 10. Give title and full citation in original language)**

(GS = citations in Google Scholar)

Gregory Wheeler, Rational Acceptance and Conjunctive/Disjunctive Absorption, Journal of Logic, Language and Information, Vol. 15(1-2):49-63, 2006.

GS=2

João Alcântara, Carlos Viegas Damásio and Luís Moniz Pereira, An encompassing framework for Paraconsistent Logic Programs, J. Applied Logic, Vol. 3, No. 1, Pag. 67-95, (url), 2005.

GS=4

Paula Amaral and Pedro Barahona, Connections between the total least squares and the correction of an infeasible system of linear inequalities, Linear Algebra and its Applications, Vol. 395, Pag. 191-210, Elsevier, 2005.

GS=3

José Júlio Alferes, Ricardo Amador and Wolfgang May, A General Language for Evolution and Reactivity in the Semantic Web, in: Francois Fages and Sylvain Soliman (eds), Principles and Practice of Semantic Web Reasoning PPSWR'05, Lecture Notes in Computer Science, Springer, Vol. 3703, Pag. 101-115, 2005.

IF = 0.402 ; nº C = 2 GS=3

José Júlio Alferes, Federico Banti, Antonio Brogi and João Alexandre Leite, The Refined Extension Principle for Semantics of Dynamic Logic Programming, Studia Logica, Vol. 79, No. 1, Pag. 7-32, (url), 2005.

GS=17

João Alcântara, Carlos Viegas Damásio and Luís Moniz Pereira, An Encompassing Framework for Paraconsistent Logic Programs, Journal of Applied Logic, 2004.

GS=4

Jorge Cruz and Pedro Barahona, Constraint Reasoning over Differential Equations, Applied Numerical Analysis and Computational Mathematics, Vol. 1, No. 1, Pag. 140-154, Wiley, 2004.

GS=2

Anastasia Analyti, Grigoris Antoniou, Carlos Viegas Damásio and Gerd Wagner, Negation and Negative Information in the W3C Resource Description Framework, Annals of Mathematics, Computing & Teleinformatics, Vol. 2, No. 1, Pag. 25-34, TEI Larissa, 2004.

GS=6

Paulo Quaresma and Irene Rodrigues, A natural language interface for information retrieval on semantic web documents, in: E. Menasalvas, J. Segovia and P. Szczepaniak (eds), AWIC'2003 - Atlantic Web Intelligence Conference, Lecture Notes in Artificial Intelligence LNCS/LNAI 2663, Springer, Madrid, Spain, Pag. 142-154, May 2003.

IF = 0.515 ; nº C = 4 GS=5

Salvador Abreu and Daniel Diaz, Objective: in Minimum Context, in: Catuscia Palamidessi (eds), Logic Programming, 19th International Conference, ICLP 2003, Mumbai, India, December 9-13, 2003, Proceedings, Lecture Notes in Computer Science, Springer, Vol. 2916, ISBN 3-540-20642-6, Pag. 128-147, 2003.

IF = 0.515 ; nº C = 2; GS= 9

**Master and Ph.D. thesis completed (3000 ca.)**

Ph. Ds. (4)

L. Ferreira, Programação Por Restrições Distribuídas em Java, S. Abreu (s), UE, 2005.

J. Simão, Computational Modelling and Simulation of Human Social Behavior and Culture, L.M. Pereira (s), UNL, 2004.

L. Krippahl, Integrating Protein Structural Information, J. Moura and P. Barahona (s), UNL, 2003

J. Cruz, Constraint Reasoning for Differential Models, P. Barahona (s), FCT/UNL, 2003.

M.Sc. (27)

2006

A. Aires, Anaphora resolution in Portuguese Documents, P. Quaresma (s), UNL.

L. R. Soares, Revise Well-founded Semantics - a new semantics for logic programs, L. M. Pereira (s), UNL.

N. Hoàng Ngà, Fuzzy Description Logics with Modifiers, C. Damásio (co-s), UNL.

G. Loureiro, Formatação optimizada de Documentos usando Restrições no XSL:FO, F. Azevedo (s)., UNL

R. Matias, Integration of geographical information in OLAP systems, J. M. Pires (s)., UNL

V. Nigam, Dynamic Logic Programming for 3APL, J. Leite (s), UNL..

J. A. Santos, Mining Protein Data Banks for Structure Prediction, P. Barahona (s), UNL.

M. Knorr, A Comparative Study of Disjunctive Well-Founded Semantics, R. Kahle (co-s), UNL.

N. Datia, Decision Support Techniques Applied to Audiometry Data, J. Moura Pires (s), UNL.

N. Viana, Development of an ETL Software Architecture for Space-Oriented Activities with Real-time Constraints, J. M. Pires (s), UNL.

N. Hau, Constrant Programming with Social Golfer Problem, F. Azevedo (s), Hanoi U.

2005

R.D. Jorge, Diagnóstico de Sistemas de Protecção de Redes de Energia Eléctrica, C. Damásio (s), UNL.

A. Pinto, Explorations in Revised Stable Models: a new semantics for logic programs, L. Moniz Pereira (s), UNL.

R. S. Gomes, Representação do Conhecimento para Análise de Sistemas de Controle, I. Rodrigues (s), UE.

L.F. Silva, Topic & Law of Evidence (Computational View), L. M. Pereira and D. Gabbay (s), UNL.

P. Salgueiro, Um sistema Pergunta/Resposta para a Língua Portuguesa, Paulo Quaresma (s), UE.

2004

M. Bento Alves, Distributed tabled query evaluation of logic programs, C. Damásio (s), UNL.

M. Correia, Heuristic Search for Protein Structure Determination, P. Barahona (s), UNL.

D. Mendes, Integration of Prolog and Java, , S. Abreu (s), UE.

M. Homola, On relations of the various semantic approaches in … dynamic logic

programming, J. Leite (co-s), U. Bratislava.

J. Siska, Refined extension principle for multi-dimensional dynamic logic programming, J. Leite (co-s), U. Bratislava.

M.l Adamski, Personalization of Advertisements on the Internet, J. M.Pires (co-s), U. Bratislava.

2003

A. C. Dias, Sistemas de Informação e Decisão: O impacto da implementação de DataWarehouses..., J. Aparício (s), UNL.

J.Saias, Utilização de informação semâtica em sistemas de pesquisa de informação, UE, P. Quaresma (s), UE.

M. Engberg, An implementation of a rational, reactive agent, P. Dell'Acqua and L. M. Pereira (s), Linköping U.

A. Monteiro, Aplicação da Programação em Lógica Dinâmica ao Raciocínio Legal, L. M. Pereira (s), UNL.

J. Silva, Object Oriented Databases, J. Aparício (s), UNL.

**Patents/propotypes (2000 ca.)**

The internationalisation of CENTRIA is certified by:

• Editorial Board Membership

J. Automated Reasoning, Theory and Practice of Logic Programming, J. Universal Computer Science, J. Applied Logic, Electronic Transactions on AI, Computational Logic Newsletter, ACM Computing Surveys (Associate Editor for Artificial Intelligence), The Reasoner, AI Communications.

• Invited Talks

Among other talks in institutions and minor workshops, there were invited talks by members of CENTRIA at the PADL07, PPSWR03 and GeoCal06 conferences.

• International Recognition

L. Moniz Pereira was awarded (Dec 06) the Doctor Honoris Causa degree by the University of Dresden. 2 Members in review panels of EU-IST programme.

• Programme Committees

Members of CENTRIA participated in the PCs of over 100 International Conferences and workshops including: IJCAI05, AAAI07, AIME03,05,07, ECAI06, CP04,05,06, RuleML03,04,05,06, ECSQARU03, 05, 07, and EPIA03, 05, 07, JELIA04, 06, PADL04, 08, PPDP04,05, PPSWR03,06 and PROPOR06.

• International juris (Ph.Ds and Habilitation)

Habilitation – JF Grenoble (2006) – Danielle Ziébelin

Ph.D - UP Madrid (2003) – Susana Hernandez

• International projects

The international projects in which CENTRIA participated in 2003-06 have been funded with 696 k€ (EU–IST: 267 k€, EU–Erasmus Mundus: 165k€, EU–Asialink: 165k€, GRICES: 85 k€, other: 14k€).

• Joint Publications

From 245 publications of CENTRIA's members in 2003-06, 126 (51.4%) were made in collaboration with other researchers, 100 of which (40.8%) foreigners (18/28, 33/40, 27/34 and 22/24. Cf. annual reports).

• Graduate Training Networks

CENTRIA, via Dep. of CS of UNL, is one node (with Dresden, Bolzanno, Vienna and Madrid) of the European MSc. in Computational Logic, funded by the EU (ERASMUS

Mundus). A similar network, on the Semantic Web, is being finalised with Amsterdam, Bolzanno, Trento, Madrid and Innsbruck.

• Visitors

88 foreign researchers visited CENTRIA in 2003-2006 (22, 27, 15 and 24. Cf. annual reports).

**Organization of conferences (2000 ca.)**

• Available Proceedings

M. Dojat, E. Keravnou, and P. Barahona, Procs of AIME'03, 9th Int. Conf. on Artificial Intelligence in Medicine in Europe, Springer, LNAI 2780, Cyprus, Oct 2003.

F. M.-Pires and S. Abreu, Procs of EPIA'03, 11th Portuguese Conf. on Artificial Intelligence, Springer, LNAI 2902, Beja, Dec 2003.

J. Dix and J. Leite, Procs of CLIMA IV, 4th Int. Ws. on Computational Logic in Multi-Agent Systems, Springer, LNCS 3259, Fort Lauderdale, Jan 2004.

J. Leite, A. Omicini, P. Torroni and P. Yolum, Procs of DALT 2004, 2nd Int. Ws. on Agent Languages and Technologies, Springer, LNCS 3476, New York, Jul 2004.

J. Alferes and J. Leite, Procs of JELIA'04, 9th European Conference on Logics for Artificial Intelligence, Springer, LNCS 3229, Lisbon, Sep 2004.

J. and P. Torroni,, Procs of CLIMA V, 5th Int. Ws. on Computational Logic in Multi-Agent Systems, Springer, LNCS 3487, Lisbon, Sep 2004

A. Felty and P. Barahona, Procs of PPDP05, 7th ACM/SIGPLAN Int. Symp. on Principles and Practice of Declarative Programming, ACM, Lisbon, Jul 2005.

J. and P. Torroni,, Procs of CLIMA V, 5th Int. Ws. on Computational Logic in Multi-Agent Systems, Springer, LNCS 3487, Lisbon, Sep 2004

J. Alferes, J. Bailey, W. May and U. Schwertel, Procs of PPSWR 2006, 4th Int. W. on Principles and Practice of Semantic Web Reasoning, Springer, LNCS 4187, Montenegro, Jun, 2006.

P. Barahona, F. Bry, E. Franconi, N. Henze, and U. Sattler, eds. Reasoning Web, volume 4126 of Lecture Notes in Computer Science, Caparica, Portugal, Sep 2006.

• Non Commercially Available Proceedings

J. A. Leite, at al, Pre-Procs. of DALT'03, Melbourne, 2003.

F. Azevedo,et al, Procs of BeyondFD', Spain 2005.

L. M. Pereira and G. Wheeler, Procs. of CMSRA-IV), Lisbon 2005.

F. Azevedo, P. Barahona, F. Fages and F. Rossi, CSCLP'06, Caparica, 2006.

R. Kahle co-organised the 2003, 04, 05 & 06 editions of the Summer School and Ws. on Proof Theory, Computation and Complexity.

**Industry contract research (2000 ca.)**

The activity of CENTRIA has been mostly focussed on research that by its nature has not attracted much industrial collaboration in the form of formal contracts. Nevertheless, it is worth mentioning some collaborations in recent years, namely the development of Information Systems with Business Intelligence functionality, and the development of prototypes that have been incorporated in industrial products.

• An Information system was developed and is in actual use at the Assembleia da República (Portuguese Parliament) for managing various types of information regarding Parliament Sessions, members of Parliament data, as well as data from the Political parties represented, etc, that uses Web technology developed by a member of CENTRIA, recently deceased (J. Aparício).

• A Data warehousing systems was also developed and is being used in the Instituto do Ambiente (Environment Institute) that aggregates information from several sources for

better management of pollution, according to national and EU regulations, as well as to support the process of legislation in thia area.

• A commercial Prolog System (XSB-Prolog) , a leading open-source Prolog that extends Prolog with Tabling, Constraints, and Multi-threading. has been improved with several techniques (e.g. tabling and various types of negation), researched initially in CENTRIA. More information can be obtained from http://xsb.sourceforge.net/.

• CARDINAL, a library to deal with constraints over finite sets, which solver has special with inference capabilities on set functions such as cardinality, has been added to the open-source system ECLiPSe

http://eclipse.crosscoreop.com/eclipse/doc/bips/lib_public/cardinal/index.html

that has been open-sourced under the MPL (Cisco-style Mozilla Public Licence) in September 2006.

## Internationalization (2000 ca.)

**(Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the international level)**

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**Future Research**

## Objectives

Since there is a single Research Group the Future Objectives are those of the whole Unit, reported in Future Vision.

The gamut of the Objectives depends on the approval of the Associate Lab proposal titled "GOGNOMA - Cognition in Man and the Machine", of which CENTRIA is the coordinating node, submitted in July 2006, with our partner centre GECAD, and still under evaluation.

The proposal should be consulted for fuller understanding, as it does not fit here.

## Funding, source, dates

Since there is a single Research Group, see the Funding for the whole Unit.

## Previous publications in the area

Since there is a single Research Group, see the Publications of the whole Unit also:

(GS = citations in Google Scholar)

Anastasia Analyti, Grigoris Antoniou, Carlos Viegas Damásio and Gerd Wagner, Negation and Negative Information in the W3C Resource Description Framework, Annals of Mathematics, Computing & Teleinformatics, Vol. 2, No. 1, Pag. 25-34, TEI Larissa, 2004.

GS=6

Paulo Quaresma and Irene Rodrigues, PGR: Portuguese Attorney General's Office Decisions on the Web, in: Bartenstein, Geske, Hannebauer and Yoshie (eds), Web-Knowledge Management and Decision Support, LNAI, Springer, Vol. 2543, Pag. 51-61, 2003.

IF = 0.515 ; nº C = 3; GS=13

Susana Nascimento, B. Mirkin and Fernando Moura Pires, Modeling Proportional Membership in Fuzzy Clustering, IEEE Transactions on Fuzzy Systems- Fuzzy Systems in Knowledge Discovery and Data Mining, Vol. 2, No. 11, Pag. 173-186, 2003.

IF = 1.803 ; nº C = 1; GS= 4

José Júlio Alferes, Luís Moniz Pereira, H. Przymusinska and T. C. Przymusinski, LUPS - A language for updating logic programs, Artificial Intelligence, Vol. 138, No. 1-2, 2002.

IF = 2.271 ; nº C = 9 ; GS=79

Ludwig Krippahl and Pedro Barahona, PSICO: Solving Protein Structures with Constraint Programming and Optimisation, Constraints, Vol. 7, No. 3/4, Pag. 317-331, Kluwer Academic Press, 2002.

GS=10

## Special Requirements

To undertake the tasks of Associate Lab, COGNOMA requires the resources specified below, mostly in qualified researchers, namely with a Ph.D. degree and some pos-doc research experience. The adequate technical, administrative, laboratorial, scientism functioning of the Laboratory, including the dissemination of its activity and results, justify the other costs, according to the planning and scheduling presented.

Half of the budget below, in Euros, which is divided bewtween CENTRIA and GECAD:

RESOURCES Quant. Value Total
40 Post-docs scheduled over 5 years (12+6+8+10+4) at € 42K/year 132 42.000 5.544.000
4 Technicians (B.Sc/M.Sc) at € 28K/year, hired for 5 years. 20 28.000 560.000
400 Missions (2/person/year) for 40 people at € 2K each 400 2.000 800.000
Acquisition of Services for 5 years at € 150K /year 5 150.000 750.000
Marketing & Communication (installation in the 1st year at € 75K, € 15K in the following years and €30K in the last year) 150.000
Back office information system, equipment for 2 video-conference rooms and 2 voice servers (only 1st year) 100.000
Computing Equipment (Computers for Post-Docs, and 2 labs for test and demonstration of prototypes) 320.000
TOTAL 8.224.000