# CENTRIA Centro de Inteligência Artificial — UNL

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# 2009 Report of Activities

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### 1 Introduction

The present activity report was approved by the Scientific Committee of CENTRIA in May 2010. The plans approved in 2008 for 2009 were on the whole successfully carried out. However, in January of 2010, CENTRIA received the final decision from FCT/MCTES concerning the center's evaluation for the period 2003-2006. This topic is discussed in detail in §1.7, and our efforts toward restructuring the center in light of the constructive comments from the FCT/MCTES evaluation exercise are discussed in §1.8. Readers may wish to consult the details of our restructuring plan

The center's web pages (visit http://centria.di.fct.unl.pt/) provides the latest information.

### 1.1 Unit Description: Form of Organization and Management

before looking at the summary of our productivity in §1.9.

Hosted at the Department of Computer Science of the Faculty of Science and Technology of The New University of Lisbon (FCT/UNL), the center also has members (all with a PhDs) from the University of Évora (4). A number of researchers from other universities (University of Lisbon, IST Lisbon, University of Coimbra, University of Linkoping, Sweden, and University of Cardiff, Wales), UNL Faculty of Social Sciences and Humanities (FCSH/UNL) are associate members. The center naturally includes a significant number of postdocs, post-graduate students and collaborators that have common research activity with its members.

At present the center has a Director, who represents the center externally, and an Executive Board composed of 3 members which, together with the Director, makes the main executive decisions. The center comprises a Scientific Council (those with a PhD degree), that elects the Director and the members of the Scientific Board and also votes to approve the admission and exclusion of Members and the general policies undertaken by the center, namely the yearly Reports of Activities, Future Plans, and Budgets.

The center 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 center's activities and plans, and produces comments and suggestions towards their improvement.

The activities of the center are organized 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 Executive Board, but the sub-areas are not exclusive, in the sense that the members of the center are encouraged to collaborate in more than one sub-area, in order to exploit synergies and increase interdisciplinarity within the different sub-areas. A detailed report from each subarea is found in §2.

#### 1.2 General Objectives of the Unit

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 focuses its activities on the following main topics: foundational research in the areas of rational computational logic agents, logic programs and knowledge base updates, and formal epistemology; a general framework for integrating several reasoning forms for uncertainty (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 definitions, 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 and clinical medical informatics.

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 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 of 2009

- 1. Three PhD students successfully completed their degrees in 2009, Cássia Trojahn dos Santos (Évora), Ana Luísa Leal (Évora), and Vitor Nogueira (Évora). Congratulations!
- 2. Damásio, et. al.'s study of fixed-point theory for the case of multivalued mappings [85] was published in the prestigious SIAM Journal on Computing.
- 3. In addition, several papers were presented at the top conference venues in 2009, including AAAI, AAMAS, ICLP, IJCAI, ICSOC, LPNMR, ICWS, and research articles appeared in top journals several top ranked journals in associated areas, including The British Journal for the Philosophy of Science, IEEE Geoscience Remote Sensing Letters, Journal of Atmospheric Oceanic Technology, Remote Sensing of Environment, and Studia Logica.
- 4. There is growing interest in applications of the research at CENTRIA by several Portuguese companies: A 2-year QREN supported project, XEO-ECC, of the company iTds Internet, Tecnologias e Desenvolvimento de Software, started in 2009; preliminary studies applying Constraint Programming to improve the control of a robotic arm were supported by VIS-TEON; a protocol was started with Albatroz Engineering to develop globally optimized solutions for Power Line Maintenance Inspection; Wide Scope co-sponsored CP'09 and began collaborating on student projects.
- 5. Pedro Barahona was conference chair of the 15th International Conference on Principles and Practice of Constraint Programming (CP 2009); Jorge Cruz was Sponsorship Chair, and Francisco Azevedo Publicity Chair. Elsa Carvalho and Ludwig Krippahl were co-chairs of the Organizing Committee.
- 6. New guidelines were introduced to restructure the center; see §1.8 for details.
- 7. Two new CIENCIA senior researchers joined CENTRIA, Francisco Santos and Choh Man Teng. Welcome Francisco and Choh Man!

### 1.4 Integrative/Multidisciplinary Activities in 2008

Project LSTOP, in collaboration with the Institute of Oceanography, Universidade de Lisboa, has yielded several results in fuzzy clustering of sea surface temperature (SST) images, inxlusinf a software tool called FuzzyUpwell that integrates automatic recognition of upwelling regions from the SST fuzzy segmentation. New functions have also been added to a software system for remote sensing oceanography satellite pictures, called SeaEddy, which aims to improve classification on the basis of statistical pattern recognition models and AI rules. Davide D'Alimonte was invited to present the algorithm for detecting eddy structures in the 2010 Ocean Sciences conference, which is a top conference in oceanography.

To build bridges with other formal areas within Lisbon, we created the 'Formal Epistemology @ UNL' group (http://centria.di.fct.unl.pt/fe/index.html), which is an informal collection of members from CENTRIA working in this area, and the Institute for the Philosophy of Language (IFL) at FCT/FCSH who apply formal methods to the study of knowledge and its role in reasoning, decision making, and action. Two reading groups were formed, *Readings in Contemporary Philosophy* (with Erich Rast at the IFL) and *The Logic Reading Group* (LRG), and a joint project proposal was submitted to FCT/MCTES.

### 1.5 Staff Changes

Choh Man Teng and Francisco Santos joined CENTRIA as senior research scientists, under the CIÊNCIA 2009 program, and Jesse Alama joined as a post-doc researcher, supervised by Reinhard Kahle, and supported by an award from FCT/MCTES.

In accordance with the stricter rules for maintaining membership as an effective member §1.8, three members where moved from effective member status to associate members.

### 1.6 Projects and Education Networking

New Projects Project DiFoS, "Dialogical Foundations of Semantics", started in spring of 2009. Reinhard Kahle is co-PI.

Continuing Projects: CENTRIA members, through the department of Computer Science, continue 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 2008/09, the "European MSc in Computational Logic (EMCL)", launched in 2004 and supported at UNL by CENTRIA members, continued its operation<sup>1</sup>, 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.

Finally, Pedro Barahona became the EMCL coordinator at UNL. He replaced José Alferes, who became President of the DI in September 2009.

### 1.7 Results of FCT/MCTES Review for 2003-2006

In January of 2008 the center was evaluated by an international panel for the 2002-2006 period and the results of this report were delivered in December 2008. The center's ranking was downgraded from 4 (Very Good) to 3 (Good), on a five-point scale. We immediately appealed, and presented evidence for a negative bias in the evaluation of the group of Computer Science and Electrical Engineering (CS/EE) in general, and a negative bias against CENTRIA in particular. The Advisory

<sup>&</sup>lt;sup>1</sup>See http://ssdi.di.fct.unl.pt/masters/mcl/ for details.

Committee was duly notified of this situation and has submitted a letter of support of our position to the ministry.

In January 2010 the board learned that our appeal for a re-evaluation was denied. While we continue to maintain that the original evaluation and the appeals process were flawed, resulting in inconsistent classifications of centers that are easy to document, we nevertheless believe that our interests are best served by making adjustments to the center to meet the two substantive criticisms from the evaluators. The first concerned the low number of PhD theses finished during the evaluation period, whereas the second concerned the venues we selected to publish our results.

The report stated:

Concerning training, the Ph.D. output in the period under examination, though of high quality, is critically low.

Response to low PhD production: We maintained that the low number was mostly to do with our respective DI departments switching to the Bologna cycle, and indeed we've seen our PhD production return to an acceptable range: 3 in 2008, 3 in 2009, and we expect no fewer than 3 PhD theses to be completed in 2010.

The report stated:

The Artificial Intelligence Group is performing good research. The productivity is good, both in terms of papers and prototypical systems, nevertheless the quality of the international journals and conferences chosen for publication could be improved, as only occasionally they reach the top level in their reference field. A more significant presence in international top-level journals should be encouraged.

Response to choice of venue: Our appeals panel raised a similar concern in its follow-up report about research impact. This group based their argument—to CENTRIA, and to some other centers we are aware of—on a variety of bibliometric arguments. One of the difficulties with the appeals process, which we alluded to above, is that the arguments offered by the evaluators are not robust: the final classification of centers do not agree with a consistent application of the standards that we've seen applied to justify individual decisions.

That said, and our frustrations noted, we recognize a need to not only boost our publications in reference journals and top conferences, but to change the culture of the center from one that rewards quantity to one that rewards quality. We describe our new policies designed to achieve these changes in  $\S1.8$ .

### 1.8 Restructuring of CENTRIA

The goal of restructuring CENTRIA is to improve the ranking of the center, and our aim is to do so by improving both the quality and impact of our research. There are three pieces to our strategy. The first addresses the need to improve the quality of publication venues, the second addresses revised criteria for membership status within the center, and the third addresses better resource management through the creation of teams.

### 1.8.1 New Rules for Rating Publication Venues

**Basic motivation:** The new system for measuring productivity of members weighs the impact of publication venues using four categories, A\*, A, B, and C. The intent is to create an incentive for members to publish in better venues, even if this results in fewer over all publications.

The idea works this way: You get twice as many utiles for an A\* publication than you do for an A, and three times more for an A than for a B, and three times more for a B than a C. Within the same category you get more utiles for a journal publication than a conference publication. Finally, you cannot run up your account of utiles with a lot of low grade papers: there are fixed limits on how many papers in categories B and C that you can exchange for utiles.

To categorize venues, we have built a database using the Australian CORE list of computer science journals and computer science conferences, the most recent ESF journal ranking for theoretical philosophy and logic with corresponding H- and G- impact rankings, and the ISI database for environmental sciences and oceanography. Publication venues that do not appear in the database are automatically assigned a 'C' ranking by default, and appeals for grade changes are decided by the CENTRIA executive board. Although no ranking scheme is either perfect or complete, the aim of our model is to reflect the consensus views of quality publication venues in the fields CENTRIA researchers are active in, and to encourage our members to publish in the very best venues possible. Decisions to alter the model will be guided foremost by this aim.

The following table summarizes the payoff table and limits for all recognized categories. To illustrate, each A\* major or minor journal paper gives you 54 points and there are no limits to the number of points that a member may accrue from published A\* papers in any given year. Each B full conference paper gives you 3 points, but you are limited to collecting 9 points per year from publishing B full conference papers. Details about the classification categories follow the table.

<b>Publication Type</b>	Grade	Weight	Limit
Monograph	Α	54	
	В	27	
	С	9	3
Edited Books	A*	27	
	Α	9	
	В	3	3
	С	1	3
Book Chapters	Α	27	
	В	9	3
	С	3	3
Journals (Major)	A*	54	
	Α	27	
	В	9	3
	С	3	3
Journals (Minor)	A*	9	
	Α	9	
	В	3	3
	С	1	3
	A*	18	
Conferences (Full)	Α	9	
	В	3	3
	С	1	3
	A*	9	
Conferences (Short)	Α	3	
	В	1	3
	С	1	3
PhD Theses		27	
MSc Theses		2	3

### **Publication Point Assignment Rules**

### 1. Monographs:

- A Book contract with a major publisher for original research<sup>2</sup>
- B Textbook with a major publisher (w/contract) or original research with minor publisher.
- C All other books.

### 2. Edited Books:

- i.) Editing a conference proceedings counts as one (1) paper published in that conference venue.
- ii.) Guest editing an A\* journal counts as one A journal paper; guest editing an A journal counts as one B journal paper; guest editing a B journal counts as one C journal paper; guest editing a C journal counts as one C journal paper.

 $<sup>^{2}</sup>$ A major publisher is understood to be a recognized academic publisher; the author(s) must have a book contract specifying payment to the author: 'pay-to-play' book contracts excluded.

- iii.) Other edited volumes are classified by the CENTIA board.
- 3. Book Chapters:<sup>3</sup>
  - A Major Book
  - B Minor Book
  - C Local Publisher
- 4. **Journal articles major**: Original research.
- 5. **Journal -minor** Short discussion notes, reviews, and abstracts.
- 6. Conferences full Full research articles published in indexed proceedings.
- 7. Conferences short Short papers
- 8. PhD Thesis: Successful PhD theses supervised by members
- 9. MSc Thesis: Successful MSc theses supervised by members

**Limits:** Every A\* and A paper will accrue points; every PhD thesis will accrue points; and every B or higher monograph will accrue points. Otherwise, payoffs to each member for category B and C publications and MSc theses are limited to 3 per year, per category of publication.

**Accounting:** Every member, full or associate, accrues publication points. The only difference in point distribution involves co-authored articles, which is addressed by these rules:

- a) papers with 1 CENTRIA author (full or associate) will assign all points to that CENTRIA author, independent of external co-authors;
- b) papers with 2 or more CENTRIA co-authors:
  - Full members: papers with 2 or more full members will be awarded (1.5 \* points assigned to the paper), and those points will be divided evenly between the 2 or more CENTRIA authors who are full members;
  - **Associate members:** papers with 1 or more associate will assign points to associate members by dividing (1.5\* points assigned to the paper) by all n CENTRIA authors, and assigning this fraction of points to each associate co-author.

**Defaults:** Since the databases are recognized to be incomplete, the default classification for publications not in the database is the lowest category by type; authors may appeal to the CENTRIA board for reclassification with an argument.

**Database:** See the appendix for our classification of publication venues.

**Affiliation:** No publication will receive any points unless 'CENTRIA' appears on the title page, indicating institutional affiliation.

 $<sup>^3{\</sup>rm Classification}$  determined by the CENTRIA board on a case-by-case basis.

#### 1.8.2 New Rules for Membership

Basic Motivation: The Center for Artificial Intelligence is committed to the pursuit of excellence in research. Although there are several indicators used to assess research, the center's reputation rests primarily on the quality of its publication record. Hence, CENTRIA's rules for admission for full, effective membership (hereafter: 'full membership') shall rely primarily on the quality of an individual's research record.

To this end, each publication is graded within a scale that takes into account the impact of publication venue, which is determined by rankings of scientific journals and conferences published by reputable scientific organizations, and/or corroborated by verifiable bibliometric data. The policy intends to encourage members to strive to publish in the best venues possible, thereby rewarding publication quality over publication quantity. For details on this ranking system and the rules for assignment publication points, see section §1.8.1.

To obtain/maintain full membership in CENTRIA for any given year, it is generally required that an individual's publication points average over the preceding two years be no less than 15. Strong contributions in other areas (e.g., PhD student or post-doc supervision, funded projects, international scientific outreach) may be considered as grounds for an exception to the rule for individuals whose research record falls below threshold for a given period. Finally, the 15 point threshold is a necessary but not sufficient condition for full membership; for example, the FCT/MCTES effectively requires full members to be residents of Portugal.

These basic principles are implemented in the rules and procedures given below.

### Membership Rules

- 1. To become a full or associate member of CENTRIA, a research must apply to the CENTRIA Board by presenting a CV and a letter of intent.
- 2. Based on the fit between the candidates declared research profile and the established research areas within CENTRIA, and an evaluation of the candidate's strength as evidenced by CV, the Board decides whether to accept the candidate.
- 3. An accepted candidate is eligible to become a full member only if s/he:
  - (a) is the author of publications in the previous two years that, according to the CENTRIA Publication Rankings, yields a publication points average no less than 15 points; or
  - (b) presents evidence of strong contributions in other areas critical to the mission of the center, whose merit is considered by the board in the context of compensating for not satisfying condition 3a; (critical areas include project funding, PhD and Post-doc supervision, and scientific outreach, such as membership of editorial boards, program committee or organization committee chairs).
- 4. Eligible candidates become full members, provided the candidate satisfies all other binding conditions for this position specified by any statutes binding on the center as determined by the executive board.
- 5. All other accepted candidates become associate members of CENTRIA.
- 6. With the exception of new members, whose membership must be decided within 3 months of candidacy, all full members and associate members of CENTRIA are evaluated in the first 3 months of every year.
- 7. Any full or associate member, whose evaluation meets the conditions for full membership in item 3 above during the evaluation period of any given year remains a full member for that year, if already a full member, or is eligible to become a full member. (See #4).
- 8. Any full or associate member whose evaluation does not meet the conditions for full membership in item 3 above during the evaluation period of any given year becomes an associate member for that year, even if previously a full member.

- 9. The changes in membership status described in items 6 and 7 take effect starting in the last day of the previous year and continue for one year.
- 10. An associate member who shows no evidence of active research for 3 consecutive years will lose membership in the center.

### 1.8.3 CENTRIA Organization of Research Activities

Basic Motivation: As of April 2010, CENTRIA has been organized in three broad research areas: "Knowledge Representation and Reasoning & Logic Programming" (KRR&LP)", "Soft Computing and Constraints" (SCC), and "Intelligent Information Systems" (IIS). This organization scheme was introduce six years ago, and much has changed in CENTRIA since then. The number of full members has grown, including a substantial and successful recruitment of researchers from abroad. This development, combined with evolving interests in the center, has resulted in a significantly different research profile. Thus, we need to update the description of activities of the center.

A related issue concerns how CENTRIA allocates the annual operating funds. As of April 2010, each year a portion of the annual budget was distributed to full members, based on their productivity, and each full member held an individual running account. This system was reasonable to maintain when there were few members and plentiful funds per member, but our current situation is reversed: we have slightly more full members than in the recent past but a substantially smaller annual budget. The upshot is that it is untenable to scatter our scarce resources according to the previous arrangement. Instead, it makes more sense to focus our funds on a few key areas of research with an aim toward increasing our publication profile, which should improve our odds for returning to previous levels of annual funding, and with an aim to drawing external funding through projects. This change requires a method for identifying and managing those areas, which we address below.

These two considerations drive a new proposal for organizing research and distributing research funds, while maintaining two tenants that have guided CENTRIA since its founding, namely:

- The center is not divided into groups of members, but is arranged around various sub-topics of AI that all members are free to participate in;
- The distribution of annual funds is based on the productivity of the members.

With this in mind, we turn to the new organization rules of CENTRIA.

### **Organization Rules:**

- 1. CENTRIA has just one area of research, "Artificial Intelligence", which is the single area declared to Portuguese Science Foundation, FCT/MCTES. All members of the center should conduct research within this broad area.
- 2. Research activities of the center are organized by research topics. Each research topic should be sufficiently broad, such that it is capable of encompassing the activities (of the equivalent of) at least 4 full members of CENTRIA.
- 3. Research topics are proposed by groups of members, approved by the scientific council of CENTRIA, and re-evaluated at least every 3 years.
- 4. Guidelines for proposals: Each proposal must include (i) a clear description of the topic, (ii) evidence that the topic is related to a current, international research effort, (iii) the team, comprised of full and associate members of CENTRIA and a designated leader, (iv) the plans, resources and goals for the proposed team to be achieved within 3 years.
- 5. Each member of CENTRIA must participate in at least one research topic.
- 6. Any member can participate in more than one topic. In such cases, the member must declare which percentage s/he contributes to each of the topics she participates in.

7. No member can lead more than one research topic.

#### **Allocation of Annual Funds**

- 1. In the first 3 months of every calendar year, the leader of each research team, in coordination with team members, is responsible for preparing an annual report of activities for the preceding year. This report must include a list of publications for that year, completed PhD theses in that area, projects, and other achievements.
- 2. Funds are allocated to a team using the CENTRIA publication points system discussed in the CENTRIA Publications Rankings document. The total allocated to a team is determined by the weighted total publication points recorded in the annual report, where the weight corresponds to the percentage time of an author to a team.
- 3. The funds of the topic are then managed by the leader, which should coordinate this with other members participating in the team.

Implementation of the Proposal Within the calendar year of a call for research proposals, the following schedule should apply

- 1. Members should organize and propose research topics until June 15th.
- 2. Topics are pre-approved by the CENTRIA board by July 15th. Pre-approved topics are sent to the advisory board for feedback.
- 3. Pre-approved topics will be presented at a CENTRIA workshop in October, after which the topics will be approved or rejected by the scientific council of CENTRIA. The advisory board will be invited to attend the workshop.
- 4. The leaders of the approved topics, together with the board, will prepare a general description of the activities and goals of the center in November.
- 5. Teams will formally begin January 1st of the following year.

#### 1.8.4 Assessing the New Strategy

In section §1.9 we present our productivity indicators for 2009 in Table 1, where one can already see some signs that our new policies are having the intended effect. Specifically, and most directly relevant in response to our evaluation, we published 22 journal articles in 2009 — a record high—but, more importantly, fully a third of those appeared in top venues ( $A^*$  or A), and nearly half in  $A^*$ -, A- or B-class journals. For other key comparisons, see Table 1.

#### 1.9 Evolution

The global indicators in Table 1 show and highlight our productivity indicators for 2009, compared with our recent history for the last three years (2007-09). Here we present highlights.

- 1. Publications: CENTRIA members published
  - (a) 22 articles in international journals during 2008-09, our highest output in this category to date;
    - 8 of these journal articles (36%) appear in outstanding or excellent journals (A or A\*);
    - 45% appear in A\*-, A-, or B-class journals.
  - (b) A modest increase in conference papers, from 46 in 2008 to 56 in 2009:

- Most of this increase from 2008 is due to EPIA, which publishes a 'B' Springer proceedings. However, when comparing 2007 to 2009 we see a marked increase (A or A\*) publications in total—10 in 2007, versus 18 in 2009—due to our focus on publishing in outstanding or excellent journals.
- (c) Table 2 highlights the overall positive trends in publishing in higher profile venues.
- (d) 86 published papers overall, excluding MSc and PhD theses.

Now compare our recent publication history—over the 2007 to 2009 period—by the new classification scheme outlined in the previous section.

Table 1: Publication Indicators

Year	Category	Count	$\mathbf{A}^*$	A	В	$\mathbf{C}$	Total
Monograph			-				0
	Edited Books		-		1	2	3
	Book Chapters		-	1	2	2	5
	Journals	major   minor total	1   0 1	5   2 7	$\begin{array}{c c} 2 & 0 \\ 2 & \end{array}$	$\begin{array}{c} 12 \mid 0 \\ 12 \end{array}$	20   2 22
	Conferences	$egin{array}{c} { m full} \mid { m short} \ { m total} \end{array}$	$\begin{array}{c} 2\mid 0 \\ 2 \end{array}$	7   0 7	$\begin{array}{c} 12 \mid 0 \\ 12 \end{array}$	$\begin{array}{c} 35 \mid 0 \\ 35 \end{array}$	56   0 56
2009			3	15	17	<b>51</b>	86
	Monographs		-				0
	Edited Books		-	1	2	2	5
	Book Chapters		-		2	2	4
	Journals	major   minor		4   0 4	$\begin{array}{c c} 2 & 0 \\ 2 & \end{array}$	$9 \mid 0$	$\begin{array}{c} 15 \mid 0 \\ 15 \end{array}$
	Conferences	full   short total	4   1 5	3   2 5	6   0 6	$\begin{array}{c} 30 \mid 0 \\ 30 \end{array}$	$\begin{array}{c} 43 \mid 3 \\ 46 \end{array}$
2008			5	10	12	43	70
	Monographs		-			1	1
	Edited Books		-		3	2	5
	Book Chapters		-		1	1	2
	Journals	major   minor		$\begin{array}{c c} 2 & 2 \\ 4 \end{array}$	$3 \mid 1$ $4$	8   0 8	13   3 16
	Conferences	full   short total	-	5   1 6	18   0 18	$\begin{array}{c} 38 \mid 0 \\ 38 \end{array}$	$\begin{array}{c} 61 \mid 1 \\ 62 \end{array}$
2007			0	10	<b>2</b> 6	<b>50</b>	86

- 2. Projects: There were a combination of 17 projects that either started or continued in 2009.
- 3. Events Organization: CENTRIA members organized, co-organized, or chaired 12 scientific events in 2009.

Table 2: Changes in Publication Venues

	A* or A	A* or A or B
journal	$8/22 \approx 36\%$	$10/22 \approx 45\%$
conferences	$10/56 \approx 18\%$	$21/56 \approx 38\%$
total:	18	31
journal	$4/15 \approx 27\%$	6/15 = 40%
conferences	$10/46 \approx 22\%$	$16/46 \approx 35\%$
total:	14	22
journal	4/16 = 25%	8/16 = 50%
conferences	$6/62 \approx 9\%$	$24/62 \approx 39\%$
total:	10	32
	conferences total:  journal conferences total:  journal conferences	$\begin{array}{lll} & 36.72 \\ & \text{journal} \\ & \text{conferences} \\ & \textbf{total:} \\ & \textbf{10}/56 \approx 18\% \\ & \textbf{18} \\ \\ & \text{journal} \\ & 4/15 \approx 27\% \\ & \text{conferences} \\ & \textbf{total:} \\ & \textbf{14} \\ \\ & \text{journal} \\ & 4/16 = 25\% \\ & \text{conferences} \\ & 6/62 \approx 9\% \\ \end{array}$

### 1.10 Graduate Teaching

1. Postgraduate MSc and PhD students: 3 PhD theses were completed in 2008, and 12 MSc theses.

See the CENTRIA web pages for more information.

### 2 Sub-area Reports

### 2.1 Knowledge Representation and Reasoning, and Logic Programming

CENTRIA continues its work in the broad area of Knowledge Representation and Reasoning, particularly associated to Logical based approaches to Knowledge Representation, and in many aspect with strong connection to logic programming, and to logic programming implementation. This work ranges from foundation of Knowledge Representation and Reasoning, to the implementation of system for Knowledge Representation, and touching several application areas. A strong emphasis has been put in the recent years in applications to the Semantic Web and to Multi-Agent Systems.

In the beginning of 2009 a new member, Marco Alberti, has entered CENTRIA, with a 5-year Research Fellow contract of CIÊNCIA 2007. This was also the year when a new European project – DiFoS - Dialogical Foundations of Semantics – started, and Jesse Alama has been given a pos doc grant associated to this project. The group of CENTRIA researcher working in this area also enlarged by PhD students who started their work in 2009 in this Knowledge Representation related issues, namely: João Moura, Miguel Alves, Sofia Gomes, Han The Anh.

In 2009 CENTRIA members co-organized the following scientific meetings in this area:

- Gregory Wheeler was Programme Committee Co-Chair of *The Workshops on Combining Probability and Logic* (PROGIC 2009).
- João Leite was Co-Chair of the 2nd Workshop on Languages, Methodologies and Development Tools for Multi-Agent Systems (LADS'009) which took place in September 2009, Turin, Italy. Proceedings to be published by Springer-Verlag.
- Carlos Damásio organised, together with Fernando Silva (Universidade do Porto), the COLA thematic track of the Portuguese Conference on Artificial Intelligence EPIA 2009 which covers the broad area of Computational Logic and its applications, with special interest on topics related with new formalisms, environments, and applications.

- Reinhard Kahle co-organised the 19th International Symposium on Logic-Based Program Synthesis and Transformation LOPSTR 2009, which took place in September, Coimbra.
- Reinhard Kahle was Programme Committee Co-Chair of 18th EACSL Annual Conference on Computer Science Logic .
- Reinhard Kahle organised the Workshop Gentzen Centenary The Quest of Consistency, a workshop associated to Computer Science Logic 2009, which took place in September, Coimbra.
- Reinhard Kahle co-organised the 8th Proof, Computation and Complexity PCC 2008, which took place in July, Nancy, France.

Our editorial activities continued, with a new editorial position, as Gregory Wheeler was named area editor for Probabilistic Frameworks for *PhilPapers*, and also part of the founding contributors to *Choice and Inference*, a formal epistemology blog. Related to this, it is worth noting that the *Certain Doubts* blog, of which Gregory Wheeler is also founding contributor, was named a Top-10 academic philosophy blog by Blogs.com in 2009. Luís Moniz Pereira also edited, together with J. Neves, J. Machado, M. Santos, a special issue – Progress in Artificial Intelligence I, select extended papers from 13th Portuguese Intl. Conf. on Artificial Intelligence - Part I – of the International Journal of Reasoning-based Intelligent Systems (IJRIS),1(3/4), 2009.

During 2009, member working in this area also had a number of activities in reviewing projects and projects proposals. In fact, Alfredo Gabaldon and José Alferes participated in the review of NSF proposal, José Alferes and João Leite participated in the review of projects and proposal for the European Commission (FP6 projects and FP7 and FET proposals), Gregory Wheeler and Reinhard Kahle participated in the review of proposal for the European Science Foundation ESF, and João Leite participated in the review of projects and proposal for "Agência de Inovação – AdI".

To build bridges with more formal areas, and with other groups in Lisbon, we created the 'Formal Epistemology @ UNL' group

(http://centria.di.fct.unl.pt/fe/index.html), which is an informal collection of members from CENTRIA working in this area, and the Institute for the Philosophy of Language (IFL) at FCT/FCSH who apply formal methods to the study of knowledge and its role in reasoning, decision making, and action. Two reading groups were formed, *Readings in Contemporary Philosophy* (with Erich Rast at the IFL) and *The Logic Reading Group* (LRG), and a joint project proposal was submitted to FCT/MCES.

Our education activities continued integrated in the PhD Programme and MSc programme in Computer Science at UNL and UÉvora, and also in the European MSc in Computational Logic. Unfortunately, the proposal for ERASMUS MUNDUS of the PhD Programme in Computational Logic (EPCL) that was submitted in the beginning of 2009 together with T.U. Dresden, T.U. Wien, F.U. Bozen-Bolzano, and also 3 third-country partnes, NICTA in Australia, Simon Fraser University in Canada, and Universidad de Chile in Chile, was put on the reserve short list, but ended not being funded in 2009. The call was very competitive and we were encouraged to resubmit the proposal in 2010, which we will do until end of April 2010.

There was also activity in this area in Summer School and tutorial. Namely, João Leite was invited to give a course on Agent Programming Languages at the 11th European Agent Systems Summer School, EASSS'09, which took place in Turin, Italy, August/September 2009. The course was given in collaboration with Koen Hindriks (University of Delft). Together with with M. Dastani (University of Utrecht) and Koen Hindriks (University of Delft), João Leite presented a tutorial on Programming Languages and Development Tools for Multi-Agent Systems as part of the program of the 8th International Conference on Autonomous Agents and Multi-Agent Systems, AAMAS'09, in Budapest, Hungary, May 2009.

João Leite was Invited Speaker at the 7th International Workshop on Declarative Agent Languages and Technologies (DALT 2009), which took place together with the 9th International Joint

Conference on Autonomous Agents and Multiagent Systems (AAMAS 2009) in Budapest, Hungary, May 2009, where he presented a talk entitled "Playing with Rules". We also organised an informal workshop at CENTRIA on the Semantic Web, with the purpose of establishing ties between the people working on the Semantic Web, and visitors from the University of Leipzig and the University of Technology Sydney.

Regarding the scientific work during 2009 in this area, a major achievement was the study of fixed-point theory for the case of multivalued mappings [85]. Unlike monotone single-valued functions, multivalued mappings may have zero, one, or (possibly infinitely) many minimal fixed-points. We have overviewed and investigated the existence and computation of minimal fixed-points of multivalued mappings, whose domain is a complete lattice and whose range is its power set. We have also shown how these results are applied to a general form of logic programs, where the truth space is a complete lattice. In particular, a multivalued operator is defined whose fixed-points are in one-to-one correspondence with the models of the logic program, including the disjunctive case. We expect to generalise the framework to the case of anti-monotonic multivalued mappings in order to obtain a fully integrated.

We continued theoretical and practical work on evolution of Knowledge Bases and Action Languages, now reinforced by the new members of CENTRIA. We extended the language of Evolving Logic Programs to allow for the representation and reasoning about Non-Markovian Evolution [8]. We also developed a formalization of Activity Recognition based on Gelfond-Lifschitz "Action Languages" approach to reasoning about dynamic domains, and published an approach to specifying Advanced DatabaseTransaction Models in the Situation Calculus. Related to this, and also as developments of Evolving Logic Programs, there was work on modelling evolution prospecting agents in the Logic Programming framework of Prospective Logic Programming [68, 63], with applications to storytelling and decision making [64]. Still regarding evolution, we have worked on philosophical perspectives in Epistemology of AI, Cognitive Science, and Knowledge Representation, arguing for a symbiotic man/machine epistemologic evolution, and the role of Logic and automated reasoning in it [60].

Theoretical work on innovative semantics of Logic Programming semantics, and corresponding implementation, also seen important developments in this year [72, 76, 75, 86, 73].

Regarding application to the Semantic Web, the development of the Extended Resource Framework continued, namely modularity aspects. The success of the Semantic Web is impossible without any form of modularity, encapsulation, and access control. Previously, we have extended Resource Description Framework graphs with weak and strong negation, as well as derivation rules, for which a stable model semantics with decidable reasoning task has been identified (ERDF n-stable model semantics). In [11] we propose a framework for modular ERDF ontologies, called modular ERDF framework, which enables collaborative reasoning over a set of ERDF ontologies, while support for hidden knowledge is also provided. The modular ERDF stable model semantics of modular ERDF ontologies is defined, extending the ERDF n-stable model semantics. Our proposed framework supports local semantics and different points of view, local closed-world and open-world assumptions, and scoped negation-as-failure. Several complexity results are provided. A prototypical implementation has been started during 2009 and is made available at http://centria.di.fct.unl.pt/ cd/mweb.

We have also explored the combination of open and closed world assumption in the Semantic Web, by continuing our work on MKNF Hybrid Knowledge Bases combining Description Logic and Logic Programming rules. A query-driven proof procedure was defined [9], and implemented in the context of a MSc Thesis. We also contributed to the development of a general architecture for Situation Awareness based on theorem provers, ontologies, Description Logic reasoners, and Natural Language Processors.

Also close to the Semantic Web, there was work on ontology matching in 2009, also integrated in the ISS area, resulting in a PhD thesis by Cássia Santos and two papers in international conferences [88, 89]. The proposed approach uses cooperative multi-agents with an argumentation framework in order to map the ontology concepts.

Related to application of multi-agent systems, we continued work in the application of Answer-Set Programming and Dynamic Logic Programming in Recommender Systems [36], and used

Answer-Set Programming to obtain uniform encodings of 66 different resource allocation problems, and their solutions [43].

Also close to the area of multi-agent systems, we have worked in applications of Abductive Logic Programming, instantiated on the SCIFF framework. In particular, a novel extension has been provided by an integration with constrained optimization. On the application side, the SCIFF proof procedure has been employed as a reasoner in automated contracting in service-oriented architectures (with an integration with semantic technology for representation of ontological knowledge), proof of properties of business processes, and semantics of multi-agent interaction [87, 6, 5].

There was also work on applications to agent intention recognition [65, 62, 66], and to computational modelling of morality itemoral-ijris09,cmm09,lmp-jcc-09,mmpl-book. Cooperation by resolving contradictions in learning, by genetic learning, and by cooperative argumentation semantics [70], abductive reasoning and side-effects examination, plus preferences, both semantics and implementation [71, 67], were also studied and defined this year.

In the context of the DiFoS project, that started in March, we intensified our research in the Epistemology of Mathematics. With the arrival of the aforementioned project Post-Doc, Jesse Alama special emphasis is put on the aspect of computer aided theorem proving [39, 38].

Coherence reasoning appeals to cases where disparate pieces of evidence supporting an hypothesis lend more support when taken together than when considered in isolation; for example, in isolation, a divorcing accountant, unbalanced books, and a one-way ticket to Rio may be signal (at best) middle life boredom, but together they point to fraud. An long open question, since C.I. Lewis's work in the 1940s, is whether there are invariant probabilistic properties of cogent coherence reasoning, but recent (2003, 2005) negative results have been thought to show this problem impossible to solve. However, we [92] present positive results that compare the association of evidence simpliciter to the association of evidence "caused" by some hypothesis which yield a robust indicator of positive confirmation, and we conjecture that the recent impossibility results are artifacts of independence conditions previously assumed to be benign assumptions to simplify the mathematics. [95] then shows how the negative results are indeed entirely a consequence of the causal structure regulating the relationship between evidence variables and hypothesis variables, which are non-parametric properties of the probability models imposed by those simplifying independence conditions. We are continuing to develop this account, in collaboration with researchers at Carnegie Mellon, and our results have recently been extended to handle variable evidence sets with collaborators at the Niels Bohr institute.

We also continued work finishing up PROGICNET, editing a special issue of the Journal of Applied Logic on combining probability and logic (also with Fabio Cozman) [22], and publishing a sample application of the PROGICNET framework to a psychometric example for the FotFS proceedings [83]. Finally, the publication of the PROGICNET magnum opus, "Probabilistic Logics and Probabilistic Networks", was delayed until early 2010 (as of this writing).

In parallel, we have also provided a new implementation of the P-log system in the XSB Prolog system [14] by resorting to the interface of XSB with the Answer Set Solver Smodels. By using the tabling mechanism of XSB, our system is most of the times faster than the original P-log implementation. In addition, our implementation has query features not supported by P-log, as well as new set operations for domain definition. Regarding implementations, there were also some developments around Contextual Logic Programming, building up to Vitor Nogueira's PhD thesis. Notably, one CENTRIA member, Salvador Abreu, was invited to the 1st Prolog System Implementor's workshop, held at K.U. Leuven (Belgium).

### 2.2 Intelligent Information Systems

During 2009, research in the area of Inteligent Information Systems progressed on the following topics: Data warehouses and integration of heterogeneous databases; tools for the semantic web; Ontologies and their applications to specific problem domains; Intelligent agents for automatic classification of documents; natural language dialogue systems.

• The 18th International Conference on Applications of Declarative Programming and Knowledge Management (INAP 2009) took place in Evora in November. Sal-

vador Abreu was program co-chair with Dietmar Seipel (U.Würzburg) while the conference organization was led by Vitor Nogueira.

- Development of a logical framework to construct and maintain Temporal Organization Information Systems. This framework builds upon a logical language called Temporal Contextual Logic Programming that deeply integrates modularity with temporal reasoning making the usage of a module time dependent. Vitor Nogueira completed his PhD thesis on the subject in May 2009.
- Ontology matching was the focus of research in 2009, resulting in a PhD thesis by Cássia Santos and two papers in international conferences [88, 89]. The proposed approach uses cooperative multi-agents with an argumentation framework in order to map the ontology concepts.
- **Document Classification:** research about the use of semantic information to classify text documents was continued and extended and a new proposal was published [34]. In this proposal, semantic information is represented in DRS graph-structures and graph-kernels are used to calculate distances and to classify documents.
  - Machine learning techniques were also applied in applied research with a portuguese software house ViaTecla. The results were published in two conferences [46, 47].
  - Discourse analysis was also a focus of research and a PhD thesis by Ana Luísa Leal about this topic was finished in 2009.
- The MEDON project "MEDON Using Ontologies to model data and medical procedures," an FCT funded project, started in January 2009 and aims to create a medical ontology able to represent medical knowledge and procedures. A collaboration protocol was made with the "Hospital de Évora" and specific medical exams are being analysed and represented.
- MWeb: in this period we have developed a prototypical implementation of the Modular Web Framework (MWeb) allowing the use and combination of several rulebases in a principled way, supporting safe uses of non-monotonic negation in scoped closed and open world assumptions in logic rules for Semantic Web applications. The existing prototypical implementation can be found at http://centria.di.fct.unl.pt/~cd/mweb. Currently it supports experimentally RDF Schema ontologies and is integrated with the state-of-the-art inference engines XSB and Smodels.
- A particular application of Semantic Web technology to Web 2.0 is reported in [50]. In user centric network paradigms like IMS 2.0 (Internet Protocol Multimedia Services) and Web 2.0, the user must be able to describe in an unambiguous way both himself together with the contents he produces, since the SOA (Service Oriented Architecture) promotes the emergence of more and more services. We describe a Matcher network functionality that aims to provide guidance to the user in such an ecosystem service jungle. The Matcher is a framework not only to allow the user and service providers to produce semantically enabled (user, service and content) profiles and match these profiles, but also to obtain useful results using simple tags and semantically enabled tags.
- Declarative ETL: during 2009, research on declarative approaches to ETL progressed in the context of a Ph.D. thesis (Valéria Pequeno) with an outcome of 3 publications on international conferences, [PSP09], [PP09d] and [PP09b]. A prototype was developed using Logic Programming with Contexts and ISCO [Abreu06] used to represent the schemas, the mappings and an inference mechanisms that infers new mappings. Meanwhile the Ph.D. thesis is on writing phase with its conclusion expected by the end of May 2010.
- The previous work on Spatial OLAP was further developed in the context of a (concluded) MSc. thesis [Jorge09] and a fully functional prototype was built. A new student started MSc thesis work on the same area in September 2010. Also in the area of Metadata for Information systems two MSc theses were finished [RA09], [Rio09]. In October we start, with a portuguese

company named ITDS, a QREN project called - Enterprise Communication Center, which main objectives are: (i) to provide main set of Ontologies and methodologies to extend them to specific domains; (ii) automatic classification of communications (emails and other communication channels) based on those ontologies; (iii) Ontology based search and browse on a communications repository. The project will provide the framework for 3 MSc which started in September 2009. The project will be finished on January 2011.

### 2.3 Soft Computing and Constraints

### Major achievements

- 1. A number of good results in applications to Oceanography, led to a contract with ESA, aiming at validation of MERIS marine products at a number of European basins, as well as an invitation to Davide D'Alimonte for an invited talk at the Ocean Sciences conference (Portland, February 2010).
- 2. Interest on applications of Constraint Programming by a number of Portuguese companies. Some preliminary studies were made to improve the control of a robotorised arm in VISTEON, a protocol was started with Albatroz Engineering aiming at developing global optimisation solutions regarding Power Line Maintenance Inspection, and support by Wide Scope to CP'09 and preliminary collaboration in students' projects.
- 3. Bridging the gap between the SCC area and other areas explored in CENTRIA, namely Logic Based Reasoning Agents, leading to a number of publications and project proposals.
- Recognition of the research in CENTRIA by the Constraint Programming Association, that commissioned to CENTRIA members the organisation of CP'2009 in Lisbon (September 2009).

General Objectives: The area of Soft Computing and Constraints can be regarded, in a very abstract view, as addressing optimisation problems usually dealing with several constraints, although with a great variety of approaches. More specifically, several traditional areas of Artificial Intelligence are handled here. Machine learning, either supervised or unsupervised, regarded as optimisation in that it aims at finding the best model to fit the observations, is an important topic in AI and is covered, if only partially in SCC. Our research has led to interesting results in fuzzy clustering, as well as in less conventional techniques, developed in CENTRIA to learn models to explain observed oceanographic data. The other major sub-area in SCC is constraint programming, where a number of techniques are studied to significantly prune the complexity of combinatorial problems. We are concerned with the implementation of a number of constraint solvers, dealing with various types of domains, both finite and continuous, either simple or structured (e.g. sets and graphs). Notwithstanding all the basic research that is carried on general purpose techniques and formalisms, the topics under study quite naturally lead to various types of applications, among which Bioinformatics and Oceanography are the most prominent at resent.

Future Research In the area of SCC, we intend to consolidate in the near future the research that has been more successful. Here we can include the development of new models in Oceanography both in the localisation of eddies but also in the derivation of optically-active seawater compounds in coastal and open ocean waters, the main topic of the project constructed with ESA which has just started. The collaboration with Bribeck College will also be continued, given the quality of the results achieved so far. Choh Man Teng, that has recently joined CENTRIA will also be expected to broaden the area of machine learning (we hope that an European project recently submitted where she is a member will help on this direction and attract students to this area). The topic of Constraint Programming will be pursued in many directions. A number of new challenges will be met, namely the improvement of the current Casper constraint solver, not only in Finite Domains (exploitation of local search and improved heuristics) but also the integration of solvers of continuous domains (where our ideas have been hard to develop in specialised prototypes). The

improvements on the solving capabilities will be also pushed by our expected collaboration with industry (the tentative collaboration with VISTEON already led to improvements on Casper, and the collaboration with Albatroz is expected to have a similar effect). Finally, we will explore some uses of Constraint Programming in other areas of CENTRIA. The abduction scheme implemented in SCIFF already incorporates some constraint programming, but we find it possible to improve this integration. The study of probabilistic models has also opened the way to collaboration (and a project proposal). Finally, two projects proposed with IST (one of them also with Carnegie Mellon) will explore the potential of the integration of SAT and Finite Domain solvers for software verification (model Checking).

Report of SCC The research work on Soft Computing in CENTRIA has followed many different directions. In the domain of oceanographic applications, a number of results results were obtained in project LSTOP (contract PDCT/EIA/68183/2006). An Anomalous Pattern Fuzzy Clustering (AP-FCM) algorithm has been developed as an unsupervised version of fuzzy clustering, which automatically determines the number of clusters. The AP-FCM has been successfully applied in the segmentation of Sea Surface Temperature (SST) images for the identification of upwelling regions. A set of features are constructed from the AP-FCM segmentation taking into account domain knowledge of the phenomena, and a threshold procedure defined that allows to retrieve the upwelling regions from the SST fuzzy segmentations.

A total of 61 SST images covering large diversity of upwelling situations, have been analysed. The results show that by tuning the AP-FCM stop conditions it fits a good number of clusters providing an effective segmentation of the SST images whose spatial visualization of fuzzy membership closely reproduces the original images [52], [51]. Oceanographers' evaluation of the former results under a qualitative scale leads to mean/standard deviations of 4.6 (out of 5)/0.33 and 3.8 (out of 5)/0.57, in the evaluation of the AP-FCM segmentations and automatic annotation of the upwelling regions, respectively.

We have proceed on the analysis of measures of classification uncertainty of the defuzzified clusters, which allow to characterize the 'transition cluster' (separating the various upwelling regions from offshore waters) with fuzzy boundaries, whose spatial variability is tuned with alpha-cuts. A software tool, FuzzyUpwell, integrates ongoing work on automatic recognition and analysis of upwelling. This interactive tool supports Oceanographers' analysis with good visualization facilities and parameterisation of thresholds, and is already being used by the colleagues of Institute of Oceanography, Universidade de Lisboa. The master thesis [30] by Pedro Franco has been successful defended in the framework of this work.

New functionalities have also been added to the SeaEddy software, for remote sensing of oceanography satellite pictures, initially developed in 2008 for identifying Eddy-Related Structure from Iso-SST patterns. The scope of these software extensions is to allow for the creation of a database of labelled features through a direct collaboration with a research scientist of the Institute of Oceanography of the University of Lisbon. This task is considered the core of the research project to improve the classification scheme on the basis of statistical pattern recognition models and artificial intelligence rules. Davide D'Alimonte was invited to present the algorithm for detecting eddy-related structures in the "Ocean Sciences" conference (22th to 26th of February 2010—Portland, Oregon, US), one of the most recognized meetings in the oceanography research domain.

As the result of collaboration with Tamito Kajiyama of CITI, a Monte Carlo Code for Ocean Colour simulations has been developed to model in-water radiometric fields in a two-dimensional domain with a high spatial resolution. Investigations have been performed to study the effects of deployment speed and sampling frequency on in-water radiometric measurements from free-fall optical radiometer systems in view of identifying the profiling conditions that minimize uncertainties in the derived in situ data products. Results have been presented at the Parallel Processing and Applied Mathematics conference [40], as well as submitted for publication to the Applied Optics journal.

In October 2009 started the project "Technical Assistance for the Validation of Meris Marine Products at Several European Coastal Basins" founded by ESA. The scope of the research work is

to address the validation of MERIS marine products at the following European basins: the Adriatic Sea, the Baltic Sea and the Black Sea. The rational for a basin-specific analysis is the difficulty to achieve the same accuracy when deriving optically-active seawater compounds in coastal and open ocean waters. The reference database of field measurements needed for the implementation of the ocean colour algorithms has been recently compiled during a meeting at the Joint Research Centre of Ispra, Italy (17th to 30th of January, 2010).

In view of extending the ocean colour investigations, two proposals were submitted to the FCT/MCTES. One proposal, in partnership with the Centro de Informtica e Tecnologias da Informao (CITI/FCT/UNL) with the scope of extending the functionalities of the Monte Carlo code for simulating the radiative transfer in the seawater medium (PTDC/CCI-CIN/103107/2008). The other proposal, a joint effort between Institute de Oceanografia (CO/FC/UL), CENTRIA, CITI and the Institute for Environment and Sustainability of the Joint Research Centre, European Commission (JRC-IES), is about the bio-optical characterization and validation of ocean colour satellite observations in the coastal waters of Portugal (PTDC/MAR/101615/2008). Finally, support has been given as member of the organizing committee of the Optical Physical and Ecosystem Regional Assessment (OPERA) Workshop (NATO Undersea Research Centre. La Spezia, Italy—14th to 16th of January, 2010).

In the framework of the project COPSRO (contract PTDC/EIA/69988/2006), three surveys have been conducted under the Electronic Survey tool (ESSA- available at https://copsro.di.fct.unl.pt/), in three Universities: CENTRIA, of Universidade Nova de Lisboa, CS department, Birkbeck Colledge, University of London, and CS department, Instituto Superior de Engenharia do Porto (DEI-ISEP), to collect data about ongoing research activities according to the ACM-CCS taxonomy. The work has been advanced in collaboration with Boris Mirkin, from Birkbeck College, Univerty of London. A new spectral method for additive fuzzy clustering was developed, ADDItive Fuzzy Spectral clustering (ADDI-FS), which operates on an extension of the spectral decomposition of a similarity matrix and extracts clusters one by one. ADDI-FS has a number of links to some published methods (relational fuzzy clustering) but differs in that it includes model-based stopping criteria, and utilizes meaningful data normalization options. The method has shown to perform well on several relational data types differently normalized: community network structure data, affinity between multidimensional vectors, and more conventional relational data. Particular attention has been given to the application of ADDI-FS to real-world data of similarity between research topics resulting from the ESSA surveys conducted in 2009. The obtained thematic fuzzy clusters are meaningful, being consistent with the informal assessment of the research activities conducted in each of the research organizations [49]. A master thesis by Rui Felizardo will also be completed soon on this framework.

In order to interpret the fuzzy thematic clusters in terms of the ACM-CCS taxonomy, the work has proceed to a new method, 'Parsimonious Cluster Lifting', which allows a conceptual generalization of the thematic clusters mapped over the ACM-CCS in terms of "head subjects", their "gaps" and "offshoots". Preliminary work is in [49] and on a paper to be published in 2010.

Luís Moniz Pereira was also very active in other topics in the area of Soft Computing. In joint work with Han The Han, Bayes Networks were combined with Planning for "Intention Recognition", within an integrated Logic Programming approach, with application in particular to "Elder Care" [65], [62], with a further publication in 2010. He also investigated decision making by modelling probabilistic causation, its evolution in possible future scenarios as well as an analysis of the side-effects obtained in the process of decision making, leading to three more publications [64], [77], [74]. Moreover, he analysed cooperation between agents, through their Cooperation by resolving contradictions in learning, by genetic learning, and by cooperative argumentation semantics [70].

Neural network research on using neuro-symbolic encodings as a way to guide learning algorithms has continued. The relevance of proper encoding of True/False values, as described by Nuno Marques [44] should be useful for applying the described method to practical problems. He also continued collaboration in linguistics in CL/FCSH/UNL (preliminary data and systems already taking into account advantages of NeSy encodings) and with GECAD, both in the framework of project TOURS-PLAN as well as with Ning Chen, regarding applications of Self-Organizing Maps to categorical data. Nuno Marques also organised the EPIA'2010 thematic track on Knowledge

Discovery and Business Intelligence.

It should also be mentioned, in the interface of Soft Computing and Constraint Solving constraint solving, of Marco Alberti's main research on extensions and applications of Abductive Logic Programming, instantiated on the SCIFF framework. In particular, a novel extension has been provided by an integration of abduction with constrained optimization: given an abductive logic program, the abductive answer to a query is provided, that minimizes an objective function, under constraints provided in the program and in the query.

Many other developments in Constraint programming and applications were carried out in 2009. The Casper constraint solver, developed by Marco Correia, during his PhD supervised by Pedro Barahona was tested in the control of a robotised arm to place electronic components on printed circuit boards and proved to be competitive with the current software used in Visteon. Future developments of this cooperation with external industry were postponed to the end of MarcoOs PhD (mid-2010). Meanwhile the views, central to CasperOs solving capabilities on decomposable constraints were formalised and presented in a publication [20].

The capabilities of Casper were found interesting to include a CENTRIA team in a joint project with Instituto Superior Técnico (IST/UTL - João Marques Silva) and Carnegie Mellon (Edmund Clarke), aiming at model checking and software verification (CMU-PT/ELE/0009/2009). Another joint project with IST/UTL for the development of Logic-based Optimization procedures, combining SAT, SMT and CP approaches to various optimisation problems was also proposed to the FCT/MCTES (PTDC/EIA-CCO/113965/2009).

Still in the topic of solvers implementation, The development of the parallel local search framework was started, in collaboration with researchers from Univ. of Paris I and the initial results were published [1]. Work started on the generic parallel constraint solver, involving Vasco Pedro and Salvador Abreu. The supervision of Rui Machado's PhD thesis (on parallel execution for different declarative programming models) forms the starting point for a longer-term collaboration with the Fraunhofer Institute's ITWM laboratory in Kaikserslautern, Germany.

In the area of continuous constraints, a probabilistic continuous constraint framework has been developed by Elsa Carvalho, jointly supervised by Jorge Cruz and Pedro Barahona, which combines continuous constraint reasoning with probabilistic reasoning. Uncertainty, usually represented by intervals of possible values, can be further characterized in this framework by probability distributions distinguishing between different possible scenarios based on their likelihoods. In the area of decision problems where both decision and uncontrollable ("state of the world") variables are present, reliability problems were identified as an interesting type of problems that could benefit from the proposed framework. The aim is to characterize the possible solutions (the decisions) with respect to their reliability, i.e. taking into account the assumed likelihood of the possible scenarios (values for the uncontrollable variables). Normally, in this kind of problems there are one or more optimization criteria and so the framework was extended to deal with this kind of multi-criteria optimization problems. Two papers were submitted and accepted for publication in 2010. The first, explaining the application of the framework to reliability problems and how it can be extended to deal with reliability-based optimization problems was accepted for publication in the 25th Symposium On Applied Computing, Lausanne, Switzerland, in March 2010. The other, addressing the capabilities of the framework to deal with decision problems in the presence of uncertainty and non-linearity, namely inverse and reliability problems, will be presented at the International Symposium on Integrated Uncertainty Management and Applications, in Kanazawa (Japan), in April.

A potential application of continuous constraints was identified in interaction with Gregory Wheeler and Choh Man Teng, regarding the satisfiability of probabilistic models that can be mapped into sets of constraints, and pose interesting challenges on the approximations and quantifications adopted. This preliminary work has led to a proposal of a project (EPIC - PTDC/EIA-CCO/115615/2009) made to the FCT/MCTES, and supported by Clark Glymour (Carnegie Mellon).

In the area of constraints over structured domains, the work on graph constraints, namely the implementation of Grasper, a constraint solver for graphs based on an optimised mapping to sets constraints and the lazy handling of path constraints in the underlying graphs, was finalised [90],

[91] (another publication is due in 2010). Unfortunately, Francisco AzevedoÔs student, Ruben Viegas, that carried out much of this work left CENTRIA for personal reasons and gave up finishing a promising PhD. Still related to sets constraints, research was made on solving nonograms, leading to the M.Sc. of Luís Mingote, supervised by Francisco Azevedo, and a subsequent publication [45]. Francisco Azevedo has also started a cooperation protocol between UNL and Albatroz Engineering (www.albatroz-eng.com), aiming at developing global optimisation solutions regarding Power Line Maintenance Inspection (PLMI).

The application of constraint programming in Bioinformatics has progressed this year, focussed in the problem of secondary structure of RNA. The approach followed, structured alignment, aims at trying to obtain the secondary structure of RNA molecules by aligning similar molecules taking into account not only their bases (A,C,G,U) but also its potential structure. The method, that hybridises dynamic programming applied to structure prediction (SankoffÔs recursions), with constraint programming ideas that adopt domains on which bases can bind, was used by Olivier Perriquet in the development of a tool, Arnica (URL: XXX), first outlined in the NETTAB workshop in Catania, and subsequently presented in EPIA'09. An extended version is being prepared for a journal, and we hope that OlivierÔs leave from CENTRIA will not jeopardise this goal. Still in Bioinformatics, a comprehensive survey on the applications of Constraint Programming and Hybrid solvers on this area was commissioned to CENTRIA and was accepted for publication in December, with expected publication in 2010. Some analogies between bioinformatics and linguistics applications (e.g. grammars in sequences of characters have lead to a successful proposition of a joint project with University of Tarragona (CHRBio - FUP E-72/09).

To conclude it is worth mentioning that research on Constraint Programming in CENTRIA was acknowledged by the Association of Constraint Programming, that accepted our bid to organise, in September 2009, the 15th International Conference on Constraint Programming, CP2009 (in the UNL Rectorate), chaired by Pedro Barahona, and organised with the support of Francisco Azevedo (Publicity Chair) and Jorge Cruz (Financial Chair).

# 3 List of ongoing projects in 2009

Name	PNL - Pedro Nunes Lectures
Status	Ongoing (start July 1st 2009, end July 31 2010)
Funding Institution	Fundação Gulbenkian (7500)
Principal researcher	Reinhard Kahle
Description	Pedro Nunes Lectures is an initiative of Centro Internacional de Matemática (CIM) in cooperation with Sociedade Portuguesa de Matemática (SPM), with
	the support of the Fundação Calouste Gulbenkian, to promote visits of notable mathematicians to Portugal. Each visitor is invited to give two or three lectures
	in Portuguese Universities on the recent developments in mathematics, their
	applications and cultural impact. Pedro Nunes Lectures are aimed to a vast
	audience, with wide mathematical interests, especially PhD students and youth
	researchers.
Name	CHRBio - Constraint- and Hypothetical-based Reasoning for Bioinformatics
Status	Ongoing (start April 1st 2009, end March 1st 2011)
Funding Institution	Council of Rectors (CRUP) (10000)
Principal researcher	Pedro Barahona
CENTRIA Partici-	Ludwig Kripphal
pants	
Description	The goal of this project is to enrich the quality of the research in both groups
	through collaborating. Therefore, each group will provide its specialisation in
	the subject. On the one hand the UNL group has a long experience working
	with constraint programming in bioinformatics, namely on structural bioinfor-
	matics where constraint technology has been applied both for determining the
	structure of proteins as well as for efficient protein docking. The URV team
	has done extensive research on logic based language processing incorporating constraint technology via CHR in their systems, and applied it successfully to
	bioinformatics, namely in genomics (RNA and DNA processing). In this con-
	text, the groups should be able to exploit the synergy between their computing
	techniques, as well as the bioinformatics areas they have covered so far, and pro-
	vide both new applications for the techniques, motivating their development,
	and new insights into how to solve a wide range of bioinformatics problems.

Name	DiFoS - Dialogical Foundations of Semantics
Status	Ongoing (start March 1st 2009, end February 29 2012)
Funding Institution	Fundação Ciência e Tecnologia (MCTES) LogICCC/0001/2007 (43.200,00)
Principal researcher	Reinhard Kahle
CENTRIA Partici-	Francisco Azevedo, Gregory Wheeler, João Leite, Luís Moniz Pereira, Jesse
pants	Alama
Description	Collaborative Research Project within the EUROCORES programme "Log-
	iCCC" of the European Science Foundation (ESF) Principal Investigators of
	the DiFoS project:
	Peter Schroeder-Heister (Tübingen) Reinhard Kahle (Lisbon) Benedikt Löwe
	(Amsterdam)
	The project work will start in autumn 2008. Project titles of other projects
	within LogiCCC:
	* Logic for Interaction (LINT) * The Logic of Causal and Probabilistic Rea-
	soning in Uncertain Environments (LcpR) * Logical Models of Reasoning with
	Vague Information (LoMoReVi) * Games for Analysis and Synthesis of Inter-
	active Computational Systems (GASICS) * Vagueness, Approximation, and
	Granularity (VAAG) * Computational Foundations of Social Choice (CFSC)
	* SOCIAL SOFTWARE for elections, the allocation of tenders and coali-
	tion/alliance formation (SSEAC)
	(links will be inserted as soon as all project pages have been set up) Preliminary
	description of the DiFoS project:
	Incorporating interaction into the traditionally static picture of logic is one
	of the most vital and fascinating topics in current logical research. The broad
	research area of "Logic and Games" deals with reasoning about games, but also
	with the use of games in reasoning, Looking at the current preoccupation of
	researchers with interaction in logic, it is easy to forget that the use of dialogues
	in logic goes back at least to Lorenzen's 1958 paper "Logik und Agon", and
	has its roots in much older traditions, going back to the pre-Socratics.
	Our project aims to (1) describe the foundational value of Lorenzen's dialogical
	logic, and (2) embed it into a modern scientific context taking into account its
	historical roots.
	(1) The foundational investigations consist in (i) discussing and clarifying tech-
	nical points of dialogue semantics, and (ii) evaluating its philosophical back-
	ground claims as well as its potential to lay the foundations for logical reasoning
	in mathematics, computer science and linguistics. These foundational investi-
	gations are the heart of the project and will be carried out in the form of two
	Master Projects, which are not assigned to a particular site, but are central
	projects which all three principal investigators are jointly committed to.
	(2) The embedding into a modern context and the historical roots are subjects
	of several collaborative projects between two sites each, as well as of individual
	local projects. They investigate the role of negation and of definitional rea-
	soning as paradigms for reasoning in general, the use of dialogues in informal
	and semi-formal mathematical proofs, the use of zero-knowledge proofs and
	extended logic programs in computer science, and of dialogical versions of the
	propositions-as-types approach within linguistics. Concerning the historical
	roots we concentrate, besides studying the modern history of dialogical logic,
	on medieval theories of obligationes.
	on medical incorres of obligationes.

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Name	MEDON - Using Ontologies to model data and medical procedures
Status Funding Institution Principal researcher Description	Ongoing (start January 1st 2009, end December 31 2011) Fundação Ciência e Tecnologia (MCTES) PTDC/EIA/80772/2006 (50000) Paulo Miguel Quaresma This project aims to create a medical ontology allowing the representation of a) medical procedures and algorithms; b) clinical data; c) time events. The ontology will be defined in OWL (ontology web language) and computational applications able to manage the ontology and its instances will be created: a) manually via a web application; b) automatically via a XML input format; c) automatically via documents written in natural language. Medical procedures represented in the ontology can be implemented via a general application able to model algorithms and to register medical data. The medical knowledge base can be queried via questions posed by users in natural language.

Name	LSTOP - Learning Spatio-Temporal Oceanographic Patterns
Status	Ongoing (start February 2008, end January 2011)
Funding Institution	Fundação Ciência e Tecnologia (MCTES) PTDC/EIA/68183/2006
Principal researcher	Susana Nascimento
CENTRIA Participants	Armando Fernandes (2008-2009), Nuno C. Marques, Davide D'Alimonte
Description	The main objective of this project is the development of Machine Learning methods for the automatic identification, analysis and prediction of oceanographic mesoscale phenomena in the Iberian Coastal Ocean (eddies, upwelling and coastal counter-current), including their spatio-temporal evolution, from remote sensing images. Dynamic versions of fuzzy clutstering will be investigated in the identification and tracking of these phenomena, and knowledge-aware neural networks will be studied for their classification and prediction incorporating domain knowledge.
Name	COPSRO - Computational Approach to Ontology Profiling of Scientific Research Organisations
Status	Ongoing (start January 2008, end December 2010)
Funding Institution	Fundação Ciência e Tecnologia (MCTES) PTDC/EIA/69988/2006 (146.837,00 â¬)
Principal researcher	Susana Nascimento
CENTRIA Partici-	Luís Moniz Pereira
pants	
Description	The main objective of this research work is to develop a methodology for ontology profiling scientific research organisations, including:  1. A reliable and valid research subject extraction method developing text mining techniques. 2. An effective method for establishing within-organisation similarities between the ontology items. 3. Adequate clustering methods for representing a research organisation by a set of possibly overlapping or fuzzy subject clusters. 4. Optimally mapping the subject clusters to the subject area ontology to reveal organisation and evaluation of individual organisation profiles. 6. Combining individual organisation profiles into an aggregate profile. 7. Characterization of aggregate profiles by rule extraction. 8. Experimental verification of the method.  The proposed methodology will be applied to scientific research organisations of computer science, specifically, Computer Science (CS) departments of Universities in Portugal and UK, having as ontology of reference the ACM Classification System (http://www.acm.org/class/1998/ccs98.html).
Name	CONTEMP - CONTraintes Exécutées en MultiProcesseurs
Status	Ongoing (start January 2008, end December 2010)
Funding Institution	GRICES-FCT/MCTES and EGIDE (EUR 19,000)
Principal researcher	Salvador Abreu
CENTRIA Participants	Lígia Ferreia, Pedro Barahona, Ludwig Kripphal
Description	This project involves the RUNTIME team at Univ. of Bordeaux-I/INRIA and will promote cooperation in parallel execution of constraints on hierarchical multiprocessors.

Name	Design and implementation of an architecture for interactive, cognitive virtual
	characters
Status	Ongoing (start January 2008, end December 2009)
Funding Institution	KK stiftelse KK-stiftelse (300000 SEK)
Principal researcher	Pierangelo DellâAcqua
Description	We consider virtual, autonomous characters situated in dynamic, unpredictable, virtual worlds. To render these characters self-animated (i.e., alive) in real time performances, we need to make them able to perceive, reason and act in the world where they are situated. This goal can be achieved by ascribing characters cognitive capabilities together with reactive functionalities. The focus of this proposal is to deploy state-of-the-art artificial intelligence ethods into character simulation and extract and address new research issues in computer graphics and artificial intelligence in the context of the developed applications. The specific aims of the project are to develop: - a model for perception and action, that is a model to couple the virtual world and the mental state of the characters a model of an architecture (for characters) combining high-level cognitive capabilities with lowlevel reactive functionalities an implementation of the characterÂś architecture.
Name	JEDI - A Joint Environment for Deduction and Induction
Status	Ongoing (start January 2008, end March 2011)
Funding Institution	Fundação Ciência e Tecnologia (MCTES): EUR 199,725
Principal researcher	Salvador Abreu
Description	The main objective of this project is to obtain a novel logic programming environment that combines deduction with induction, offering a novel and state-of-the-art solution for spatial data handling in all of its aspects, namely: spatial data modeling, spatial query languages and spatial data-mining. The project will also develop and implement real-world applications, such as the study of biodiversity and wildfires, supported by JEDI.
Name	STAMPA - Sophisticated TAbling Mechanisms for Prolog and their Applications
Status	Ongoing (start January 2008, end December 2010)
Funding Institution	Fundação Ciência e Tecnologia (MCTES): EUR 150,000
Principal researcher	Salvador Abreu
Description	Develop novel techniques and models to improve the execution of tabling logic programming in order to solve complex real-world problems, mainly, in four well-known and established Logic Programming paradigms: Inductive Logic Programming, Deductive Databases, Answer Set Programming and the Extended Andorra Model.

Name	PSE - The Philosophy of Science in a European perspective - ESF networking
	Programme
Status	Ongoing (start 2008, end 2013)
Funding Institution	European Science Foundation
Principal researcher	Gregory Wheeler
Description	In the beginning of the last century an important European tradition of investi-
	gations into the nature of scientific knowledge took definitive shape. This devel-
	opment comprised a wide range of different disciplines and a number of different
	European countries. It included renowned scientists, such as Ernst Mach, Lud-
	wig Boltzmann, Carl Menger, Ludwig and Richard von Mises, Otto Neurath,
	Albert Einstein, Max Planck, Pierre Duhem, Henri Poincaré, Karl Pearson,
	to mention but a few, and involved not only empirical disciplines, but for-
	mal ones too (David Hilbert, Kurt Gödel, Federigo Enriques, Jan Aukasiewicz,
	Alfred Tarski, Bertrand Russell). This scientific and philosophical movement,
	involving but not confined to Central Logical Empiricism in Vienna, Berlin and
	Prague, was strongly interdisciplinary and cross-disciplinary. It produced an
	extensive and stimulating literature and prepared the ground for a wide array
	of reflections on the structure of science, its aims and limits.
	It is our aim to rekindle and reinforce this European tradition in the philosophy
	of science.

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 envis-
	aged 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

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;

It suggested by (Buhalis, 2001) that eTourism revolutionizes all business processes, the entire value chain as well as the strategic relationships of tourism organizations with all their stakeholders. So, it increasingly determines the competitiveness of the organization, and therefore, it is critical for the competitiveness of the tourism industry in the longer term. One of the most frequent problems faced by tourists when visiting a country, a particular region or a city is deciding what to do, where to go and how to reach there, in a limited amount of time available. The most widespread information is offered by means of guidebooks which contain general purpose references, with little relevance to the interest of a particular individual, often the tourist find himself lost among that information. Tailoring information to the interests of the visitor along with journey plans suggestions seems to be the best alternative in order to improve touristâs activities. This project focuses on personalised tour planning including sights, transportation modes and users profiles, based on route planning algorithms and adaptive recommendation techniques integration. Adaptive 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. 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. The system gathers knowledge about the touristâs profiles, creating groups and stereotypes with specific interests and features, allowing characteristics inheritance. The âtour basketâ stores touristâs travel history, where all the places he visited are stored, which leads to accumulated knowledge about personal profiles. This knowledge, together with tourist stereotypes offer a mean of learning about general and specific interests of tourists, so that this information can serve as a basis for studying new forms of tourist products. which can be useful for the tourism sector, namely public entities (e.g. city council) as well as for travel agencies. It will, also, be possible, for the tourist, to return information on accomplished tours. So, the system gathers knowledge about touristâs opinions and preferences. Based on this knowledge and on profile groups categorised information can be delivered according to tourist specific interests, namely events, factual information, useful tips, promotional offers, recommended places to visit and more. TOURS PLAN system can be used by city councils in order to explore better their tourism resources and give tourists a personalized service, which can be very attractive and improves tourism service offer.

Name	AutoDynAgents - Autonomic Agents with Self-Managing Capabilities for Dy-
- Charles	namic 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 (80000?)
Principal researcher	Luís Moniz Pereira
Description	O projecto AutoDynAgents visa a utilização do paradigma dos Sistemas Multi-Agente (SMA) no suporte ao escalonamento dinâmico e distribuído em sistemas de fabrico. O sistema será dotado com capacidades de auto-gestão, de modo a reduzir a complexidade do processo de gestão deste tipo de sistemas e a intervenção humana. O objectivo do projecto é definir uma plataforma baseada em SMA e em técnicas Inspiradas em Sistemas Biológicos com capacidades de aprendizagem e auto-gestão para a resolução de problemas de escalonamento complexos, com recurso a negociação cooperativa. O sistema de escalonamento deverá ser dotado com capacidade de diagnóstico e resolução de problemas, incorporando o conceito da Computação Autónoma(CA). O produto final pretendido é um Sistema de Escalonamento Autónomo no qual uma comunidade de agentes modela um sistema real de fabrico sujeito a perturbações. Os Agentes devem ser capazes de aprendizagem e gestão do seu comportamento interno
	e das suas relações com outros agentes, através de negociação cooperativa de
	acordo com a política de negócio definida pelos gestores.
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 Partici-	Luís Moniz Pereira, Armando Fernandes, Carlos Damásio, Francisco Azevedo,
pants Description	Irene Rodrigues, Lígia Ferreia, Pedro Barahona, Susana Nascimento 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 proces- sors such as the Cell to cluster systems. This goal is achieved by exploiting computational models well suited to the architecture.  International M.Sc. Program in Computational Logic
Status Funding Institution	Ongoing (start September 2004, end September 2009) EU Erasmus Mundus
Principal researcher	Luís Moniz Pereira
CENTRIA Partici-	José Alferes, João Leite
pants 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.

# 4 List of Ph.D. students and topics in 2009

### 4.1 Ph. D. students

Name	Han The Anh
Degree	Ph. D.
Supervisor	Luís Manuel Sancho Moniz Pereira
Topic	Evolution of Cognitive Agent Systems
Start date	October 2009
Finish date	September 2013

Name	Nuno Miguel Soares Datia
Degree	Ph. D.
Supervisor	João Carlos Gomes Moura Pires
Topic	Toward an intelligent personal digital photo's retrieval by automating
	annotations using semantics and propagation
Start date	September 2009
Finish date	
Name	Sofia Gomes
Degree	Ph. D.
Supervisor	José Alferes
Topic	
Start date	September 2009
Finish date	
Name	Pedro Salgueiro
Degree	Ph. D.
0	
Supervisor	Salvador Abreu
_	Salvador Abreu Constraint-based DSL for Intrusion Detection
Supervisor	
Supervisor Topic	Constraint-based DSL for Intrusion Detection
Supervisor Topic Start date	Constraint-based DSL for Intrusion Detection January 2008
Supervisor Topic Start date Finish date	Constraint-based DSL for Intrusion Detection January 2008 2011 (expected)
Supervisor Topic Start date Finish date	Constraint-based DSL for Intrusion Detection January 2008 2011 (expected)  Pedro Patinho
Supervisor Topic Start date Finish date Name Degree	Constraint-based DSL for Intrusion Detection January 2008 2011 (expected) Pedro Patinho Ph. D.
Supervisor Topic Start date Finish date  Name Degree Supervisor	Constraint-based DSL for Intrusion Detection January 2008 2011 (expected)  Pedro Patinho Ph. D. Salvador Abreu
Supervisor Topic Start date Finish date  Name Degree Supervisor	Constraint-based DSL for Intrusion Detection January 2008 2011 (expected)  Pedro Patinho Ph. D. Salvador Abreu Parallel and Distributed Execution Models for Declarative Programming

### 4.2 M. Sc. students

Name	Tiago Miguel Correia dos Santos
Degree	M. Sc.
Supervisor	Vitor Manuel Beires Pinto Nogueira
Topic	Declarative agents aware of the spatial-temporal context
Start date	November 2009
Finish date	November 2010

Name	Ricardo Fernando Muacho Fernandes Lima Neves
Degree	M. Sc.
Supervisor	José Júlio Alves Alferes and João Carlos Gomes Moura Pires
Topic	Classificação automática de textos baseados em ontologias
Start date	September 2009
Finish date	

Name	Bernardo Matos Carrasqueira Figueiredo de Oliveira
Degree	M. Sc.
Supervisor	José Júlio Alves Alferes and João Carlos Gomes Moura Pires
Topic	Pesquisa e navegação num arquivo de comunicações baseado em ontolo-
	gias
Start date	September 2009
Finish date	
Name	Ygor Couto Cardoso
Degree	M. Sc.
Supervisor	José Júlio Alves Alferes and João Carlos Gomes Moura Pires
Topic	Métodos de Criação, Avaliação e Extensão de Ontologias para descrição
	de comunicações em contexto
Start date	September 2009
Finish date	
Name	Ricardo Filipe da Cruz dos Santos de Almeida e Silva
Degree	M. Sc.
Supervisor	João Carlos Gomes Moura Pires
Topic	Solap +
Start date	September 2009
Finish date	
Name	Paulo Pires
Degree	M. Sc.
Supervisor	Salvador Abreu
Topic	Business Intelligence em sistemas de apoio à gestão de frotas
Start date	September 2008
Finish date	March 2010 (submitted)
Name	Paulo André
Degree	M. Sc.
Supervisor	Salvador Abreu
Topic	Compiling WAM code to the EAM
Start date	April 2009
Finish date	March 2010 (submitted)

### 5 Visitors

### • Gregory Wheeler

Marco Castellani, Cardiff, United Kingdom. 2009-04-14 - 2009-04-25.

Guest lectuers for multiagent systems course; CENTRIA seminar; collaboration with G. Wheeler on optimization algorithms for credal sets.

Allen Tien, Johns Hopkins / mdlogix, USA. 2009-04-29 - 2009-05-06.

To plan the submission of several medical informatics project proposals to the National Institutes of Health (NIH), USA.

Clark Glymour, Carnegie Mellon University, USA. 2009-11-22 - 2009-11-28.

Ongoing collaboration with Choh Man Teng & Gregory Wheeler

#### • Luís Moniz Pereira

Pierangelo Dell'Acqua, Linköping, Sweden. 2009-07-01 - 2009-07-22.

Research collaboration.

Terrance Swift, MDLOGIX, USA. 2009-04-16 - 2009-05-20.

Research collaboration.

Allen Tien, MDLOGIX, USA. 2009-04-29 - 2009-05-08.

Research collaboration and prepare 2 projects for submission.

Terrance Swift, MDLOGIX, USA. 2009-11-05 - 2009-11-13.

Participate in INAP'09, develop joint research, and write co-authored papers.

Teodor Przymusinski, University of California at Riverside, USA. 2009-08-12 - 2009-08-17.

Collaborate in research.

Halina Przymusinska, California State Polytechnic University at Ponoma, USA. 2009-08-12 - 2009-08-17.

Collaborate in research.

Lotfi Boudjenah, Oran, Algeria. 2009-12-01 - 2009-12-11.

Collaborate on research in robotics.

Yohanes Stefanus, Indonesia, Indonesia. 2009-05-01 - 2009-06-20.

Teach Advanced Logics in the EMCL.

#### • Reinhard Kahle

Eunice Neves, Ourém, Portugal. 2009-05-15 - 2009-05-15.

Talk in the Seminar "História e Filosofia da Matemática": A História da Matemática no Ensino Não Superior

Jaime Carvalho e Silva, Coimbra, Portugal. 2009-05-22 - 2009-05-22.

Talk in the Seminar "História e Filosofia da Matemática": O uso da História da Matemática na sala de aula no Ensino Secundário

Luís Saraiva, Lisboa, Portugal. 2009-05-29 - 2009-05-29.

Talk in the Seminar "História e Filosofia da Matemática": Manoel Ferreira de Araújo Guimarães (1777-1838) e a Academia Real Militar do Rio de Janeiro

Helmuth Malonek, Aveiro, Portugal. 2009-06-05 - 2009-06-05.

Talk in the Seminar "História e Filosofia da Matemática": Portugal e a Matemática antes e depois da Primeira Guerra Mundial

Jesse Alama, Stanford, USA. 2009-04-15 - 2009-04-24.

Application as Post-Doc grant for the DiFoS project.

Yasser Omar, Lisboa (Técnica), Portugal. 2009-11-27 - 2009-11-27.

Talk in the Seminar "Logic and Computation": Quantum Bits and their Applications

João Rasga, Lisboa (Técnica), Portugal. 2009-12-11 - 2009-12-11.

Talk in the Seminar "Logic and Computation": Decidability of first-order theories: a model-theoretic perspective

Félix Costa, Lisboa (Técnica), Portugal. 2009-12-18 - 2009-12-18.

Talk in the Seminar "Logic and Computation": Computable scientists, uncomputable world

#### • João Leite

Sanjay Modgil, Imperial College London, U.K.. 2009-06-20 - 2009-06-26. Joint research.

Sebastian Hellmann, University of Leipzig, Germany. 2009-11-09 - 2009-11-09. Talk at Semantic Web Workshop

Claus Stadler, University of Leipzig, Germany. 2009-11-09 - 2009-11-09.

Talk at Semantic Web Workshop

Shan Chen, University of Technology Sydney, Australia. 2009-11-09 - 2009-11-09.

Visiting CENTRIA and participation in Semantic Web Workshop

### • José Júlio Alferes

Susana Hernades, Universidade Politecnica de Madrid, Spain. 2009-10-21 - 2009-10-22. Participating in Thesis Committee

#### • Pedro Barahona

Barry O'Sullivan, Cork (4C), Ireland. 2009-09-20 - 2009-09-25.

Attendance of CP'09, discusions regarding future common activities

Veronica Dahl, Simon Fraser, Vancouver, Canada. 2009-09-15 - 2009-09-19.

Meetings in the scope of project CHRBio

Mark Wallace, Monash, Melbourne, Australia. 2009-09-20 - 2009-09-24.

Participation in CP'09. Discussions on future collaborations, namely on the EMCL

Steffen Holldobler, Dresden, Germany. 2009-11-18 - 2009-11-20.

EMCL Meeting

Enrico Franconi, Bolzano, Italy. 2009-11-18 - 2009-11-20.

EMCL meeting

#### • Paulo Quaresma

Marcos González, University of Santiago de Compostela, Spain. 2009-09-21 - 2009-10-02

Collaboration in research projects under the context of a bilateral project University of Évora – University of Santiago de Compostela, financed by CRUP.

#### • Susana Nascimento

Boris Mirkin, Birkbeck, University of London, U.K.. 2009-08-11 - 2009-08-21. Work in the framework of the COPSRO project

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## 6 Appendix

### 6.1 CENTRIA publication spreadsheet