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Report 2006 and Plan 2007

March 2007

Contents

Introductory Note

This report describes the results of the research done at NIAD&R (Distributed Artificial Intelligence & Robotics Lab) at the Engineering Faculty of the University of Porto during 2006 and the planned research for the next year. NIAD&R is one of the three goups inside LIACC - Laboratory of Artificial Intelligence and Computer Science (LIACC) of the University of Porto. This report follows the strutucture of the previous ones according to FCT metrics. Here we present NIAD&R report extracted from the more broad LIACC report. More information on LIACC activities can be retrieved from the LIACC Home Page (`http://www.liacc.up.pt`) or on demand.

1 Short Description of LIACC

The Laboratory of Artificial Intelligence and Computer Science (LIACC) of the University of Porto is a research centre that has already attained a good degree of visibility at both the national and the international levels. Its main aim is to pursue research, both at the theoretical and practical levels, in order to increase the quality of software in what concerns, for instance, declarativity, distributiveness, adaptativeness and flexibility. The main areas of research are (in alphabetic order):

- Coordination of Teams of Agents: agent-based robot control, hybrid architectures, simulated robosoccer;
- Declarative Programming and Parallelism: design and implementation (sequential or parallel) of declarative programming languages;
- Distributed Artificial Intelligence: multi-agent systems techniques and applications, agents negotiation and adaptation, Electronic Commerce;
- Information and Communication Networks: theoretical foundations, system architectures, and security mechanisms for mobile, ad-hoc and sensor networks, scalable solutions for reliable Quality of Service, service-oriented integration of heterogenous network infrastructures;
- Innovative Applications: development of practical applications based on recent languages and tools;
- Logic, Language and Computation: algorithmic complexity, formal systems, cryptography and language theory;
- Machine Learning: design and implementation of automatic inductive learning methods useful in classification and regression;
- Modelling of Cognitive and Behavioural Systems: agent-based models of social processes; biologically inspired control of autonomous agents and cognitive modeling; intelligent distributed system; knowledge representation; software agents;
- Optimization, Constraints and Heuristics: constraint programming, heuristics and metaheuristics for optimization and problem-solving;
- Parallel and Distributed Systems: design and implementation of programming environments with support for mobility and distribution of computations.

Results of this research have been extensively used by other institutions, both in the academic milieu and in the industry, and both in Portugal and abroad. Three examples of this are: the YAP Prolog compiler, the Data Mining Advisor (DMA), and the ARCA Expert System.

LIACC provides a research environment for the activities of several PhD students, and gives support to MSc courses organized by the Faculties of Science, Economics and Engineering.

LIACC participates in the activities of several international research networks, and has projects in colaboration with several institutions abroad and in Portugal.

Since its creation, back in 1988, LIACC has been able to maintain a good level of scientific production, as confirmed by previous independent evaluations, while giving an important contribution to the formation of a new generation of young researchers (as demonstrated by the conclusion of almost 30 doctoral degrees in the period 1999/2006). This in turn enhances the potential of LIACC to achieve not only higher production both in terms of quality and quantity, but also extend the research to new potentialy useful areas.

1(p) Descrição Sumária do LIACC

O Laboratório de Inteligência Artificial e Ciência de Computadores (LIACC) da Universidade do Porto é um centro de investigação que atingiu já um bom nível de visibilidade a nível quer nacional, quer internacional. O seu objectivo principal é a realização de investigação, tanto teórica como aplicada, que permita melhorar a qualidade do software no que se refere, por exemplo, a declaritividade, utilização distribuída, adaptabilidade e flexibilidade. As áreas de investigação mais importantes são (por ordem alfabética):

- Aplicações Inovadoras: desenvolvimento de aplicações práticas baseadas em novas linguagens e ferramentas;
- Aprendizagem: desenho e implementação de métodos automáticos de aprendizagem indutiva úteis para classificação e regressão;
- Coordenação de Equipas de Agentes: controle de robots baseado em agentes, arquitecturas híbridas, robôs simulados para competição em "futebol robótico";
- Descoberta de Conhecimentos e Prospecção de Dados: desenho e implementação de métodos para extracção, a partir de dados, de informação não trivial, potencialmente útil e fácil de interpretar;
- Inteligência Artificial Distribuída: técnicas e aplicações de sistemas multi-agente, negociação e adaptabilidade, Comércio Electrónico;
- Lógica, Linguagem e Computação: complexidade de algoritmos, sistemas formais, criptografia e teoria de linguagens;
- Modelos de Sistemas Cognitivos e Comportamentais: modelos de processos sociais baseados em agentes; controle de agentes autónomos com inspiração biológica e modelação cognitiva; sistemas distribuidos inteligentes; representação de conhecimento; agentes de software;
- Optimização, Restrições e Heurísticas: programação por restrições, heurísticas e meta-heurísticas para optimização e resolução de problemas;
- Programação Declarativa e Paralelismo: definição e implementação (sequencial ou paralela) de linguagens de programação declarativas;
- Redes de Comunicação e Informação: fundamentos teóricos, arquitecturas de sistema e mecanismos de segurança para redes de telecomunicações móveis, redes ad-hoc e redes distribuídas de sensores; soluções escaláveis com qualidade de serviço garantido, integração orientada para serviços em redes heterógeneas;
- Sistemas Paralelos e Distribuídos: desenho e implementação de ambientes de programação que suportem a mobilidade e a distribuição de computações.

Alguns resultados desta investigação têm sido aplicados intensivamente por outras instituições, tanto no meio académico como na indústria, e em Portugal e no estrangeiro. Três exemplos são: o compilador de Prolog YAP, o sistema "Data Mining Advisor (DMA)", e o Sistema Pericial ARCA.

O LIACC tem acolhido as actividades de investigação de um número significativo de estudantes de doutoramento, e dá apoio a Mestrados organizados pelas Faculdades de Ciências, de Economia e de Engenharia. Participa também nas actividades de redes de investigação internacionais, e tem projectos de colaboração com várias instituições estrangeiras e portuguesas.

Desde a sua criação em 1988, o LIACC tem conseguido manter um bom nível de produção científica, como confirmado pelos resultados de avaliações independentes já realizadas, ao mesmo tempo que tem dado um contributo importante na formação de uma nova geração de jovens investigadores (como o demonstra a conclusão de quase 30 doutoramentos no período 1999/2006). O que por outro lado reforça o potencial do LIACC para obter não só um elevado nível de produção científica em termos de qualidade e quantidade, mas também extender a investigação a novas áreas potencialmente úteis.

2 LIACC Organization

LIACC is organized as a set of three groups all of them under coordination of professors of the University of Porto:

- NCC — Computer Science Group coordinated by Prof. Miguel Filgueiras and Prof. Luís Damas;
- NIA&AD — Artificial Intelligence and Data Analysis Group coordinated by Prof. Pavel Brazdil;
- NIAD&R — Distributed Artificial Intelligence & Robotics Group coordinated by Prof. Eugénio Oliveira.

A separate presentation of each group is given in the overall report. Here we are reporting NIAD&R Group's activities.

LIACC has a Coordinating Board, whose present members are the 4 coordinators of the 3 groups, with a composition aproximately reflecting the proportionality of the number of members in each group. Each year one of the members of the Coordinating Board is appointed, in turn, as the coordinator of LIACC.

LIACC being a research centre dependent of the Rectorate of the University of Porto, the accounting services are provided by the Rectorate.

LIACC activities are periodically reviewed by an Advisory Committee. LIACC invites as members to this committee 3 researchers internationally recognized as outstanding experts. The current members of this committee are Prof. Claude Kirchner (LORIA, Nancy), Prof. Maarten Someren (University of Amsterdam) and Prof. Carles Sierra (Artificial Intelligence International Institut in Catalunia). The committee usually visits LIACC once a year and prepares a written commentary on the activities report and plan.

LIACC has a Scientific Council composed by all its researchers holding a PhD. The annual activities reports and plans are submitted to it for approval.

3 Reports and Plans

3.1 NIAD&R: the Distributed AI & Robotics Group

Team

Name	**Position**
Eugénio Oliveira	Senior Researcher
Ana Paula Rocha	Senior Researcher
Rui Camacho Ferreira da Silva	Senior Researcher
Luís Paulo Gonçalves dos Reis	PhD Researcher
Rosaldo Rossetti	PhD Researcher
Henrique Daniel Lopes Cardoso	Researcher
Andreia Malucelli	Researcher
Luís Miguel Martins Nunes	Researcher
António Manuel Correia Pereira	Researcher
Célia Talma Pinho Valente	Researcher
Luís António Diniz Morais Sarmento	Researcher
Alexessander da Silva Couto Alves	Researcher
Francisco António Fernandes Reinaldo	Researcher
Luis Henrique Ramilo Mota	Researcher
Rodrigo António M. Braga	Researcher
Pedro Miguel Faria	Researcher
Daniel Cardoso Moura	Research Assistant
Hugo Gravato Marques	Research Assistant
Nuno Miguel Tavares de Sousa	Research Assistant
Sónia Alexandra Sousa Rocha	Research Assistant
Daniel Palzer	Research Assistant
António Castro	Research Assistant
Rui Neves	Research Assistant
Vasco Vinhas	Research Assistant
Pedro Abreu	Research Assistant
External Collaborators	
Fernando Mouta	PhD Researcher
José Luís Pinto	Research Assistant
Bernd Schneiders	Erasmus Student
João Pedro Bugalho Certo	Student
Nuno Miguel Ferreira Cordeiro	Student

3.1.1 Results of research

Publications

Theses

1. Malucelli, Andreia, "'Ontology-based Services for Agents Interoperability"', PhD Thesis in Computer Engineering, Faculty of Engineering at the University of Porto, October 2006.
2. Nunes, Luis, "'Learning from Multiple Sources in Heterogeneous Groups of Agents"', PhD Thesis in Computer Science and Engineering, Faculty of Engineering at the University of Porto, April 2006.
3. Fonseca, Nuno A. "'Exploiting Parallelism in Inductive Logic"'. PHD Thesis in Computer Sciences, Faculty of Sciences at the University of Porto, October 2006.

Chapter in book

4. Cardoso, Henrique Lopes; Rocha, Ana Paula; Oliveira, Eugénio. "Virtual Organization Support through Electronic Institutions and Normative Multi-Agent Systems", in Jean-Philippe Rennard (ed.), Handbook of Research on Nature-Inspired Computing for Economics and Management, Idea Group Inc., ISBN 1-59140-984-5, pp. 786-804.
5. Malucelli, Andreia; Cardoso, Henrique Lopes; Oliveira, Eugénio, "Enriching a MAS Environment with Institutional Services", in book "'Environments for Multi-Agent Systems II", D. Weyns, H. Van Dyke Parunak F. Michel (eds.), Lecture Notes in Artificial Intelligence 3830, Springer, ISBN: 3-540-32614-6, pp. 105-120.
6. Konstantopoulos, Stasinos; Camacho, Rui; Costa, Vitor; Fonseca, Nuno. "Induction as search", in book "Artificial Intelligence for Advanced Problem Solving Techniques", Dr. Dimitris Vrakas and Prof. Ioannis Vlahavas (eds.), Aristotle, University of Thessaloniki, Greece (to appear)

Papers in international journal with referees (edited abroad or in Portugal)

7. Malucelli, Andreia; Palzer, Daniel; Oliveira, Eugénio. "Ontology-based Services to help solving the heterogeneity problem in e-commerce negotiations". in Journal of Electronic Commerce Research and Applications - Special Issue Electronic data engineering: the next frontier in e-commerce. Vol. 5(3), pp. 29-43, Elsevier.
8. Reinaldo, Francisco; Siqueira, Marcus; Camacho, Rui; Reis, Luís Paulo. "Multi-Strategy Learning Made Easy", in N. Bardis et al. (Eds.) WSEAS Transactions on Systems, Issue 10, Vol. 5, pp. 2378-2384, WSEAS Press, 2006, ISSN 1109-2777.
9. Srinivasan, Ashwin; Page, David; Camacho, Rui; King, Ross."Quantitative Pharmacophore Models with Inductive Logic Programming", Machine Learning Journal, Vol. 64, N. 1/2/3, pp 65-90, 2006, ISSN 0885-6125.
10. Pereira, António; Duarte, Pedro; Norro, Alain. "Different modelling tools of aquatic ecosystems: A proposal for a unified approach", in Ecological Informatics, Vol. 1 (2006) 407-421.
11. Reinaldo, Francisco; Siqueira, Marcus; Camacho, Rui; Reis, Luís Paulo. "A tool for Multi-Strategy Learning", in Gelbukh, A. and Reyes-Garcia, C. eds, Special Issue: Advances in Artificial Intelligence, Research in Computing Science, Vol. 26, pp.51-60, November 2006, ISSN: 1870-4069.

12. Certo, João; Cordeiro,Nuno; Reinaldo, Francisco; Reis, Luís Paulo; Lau, Nuno. "FCPx: A Tool for Evaluating Teams' Performance in RoboCup Rescue Simulation League", in Gelbukh, A. and Reyes-Garcia, C. eds, Special Issue: Advances in Artificial Intelligence, Research in Computing Science, Vol. 26, pp.137-148, November 2006, ISSN: 1870-4069.

Publications in series reviewed by the Science Citation Index or published by major international houses.

13. Sarmento, Luís. "SIEMÊS - a Named-Entity Recognizer for Portuguese Relying on Similarity Rules", in R. Vieira, P. Quaresma, M. das Graças Volpe Nunes, N. J. Mamede, C. Oliveira e M. C. Dias, (editors) Proceedings of the 7th International Workshop on Computational Processing of the Portuguese Language, PROPOR 2006, Vol. 3960 de Lecture Notes in Computer Science, Springer, Itatiaia, Brasil, págs. 90-99, 2006

14. Sarmento,Luís; Pinto, Ana Sofia; Cabral, Luís. "REPENTINO - A collaborative wide-scope gazetteer for Entity Recognition in Portuguese", in R. Vieira, P. Quaresma, M. das Graças Volpe Nunes, N. J. Mamede, C. Oliveira e M. C. Dias, (editors) Proceedings of the 7th International Workshop on Computational Processing of the Portuguese Language, PROPOR 2006, Vol. 3960 de Lecture Notes in Computer Science, Springer, Itatiaia, Brasil, págs. 31-40, 2006.

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17. Santos, Diana; Cardoso, Nuno. "A Golden Resource for Named Entity Recognition in Portuguese", em R. Vieira, P. Quaresma, M. das Graças Volpe Nunes, N. J. Mamede, C. Oliveira e M. C. Dias, (ed.), 'Proceedings of the 7th International Workshop on Computational Processing of the Portuguese Language, PROPOR 2006', Lecture Notes in Computer Science,Vol. 3960, Springer, pp. 69-79, 2006.

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19. Malucelli, Andreia; Castro, António; Oliveira, Eugénio. "Crew and Aircraft Recovery through a Multi-Agent Airline Electronic Market", in Proceedings of e-Commerce, IADIS International Conference, Sandeep K., Isaías, P. (eds.), pp. 51-58, Barcelona, December 2006.

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22. Cardoso, Henrique Lopes; Leitão, Paulo; Oliveira, Eugénio. "An Approach to Inter-Organizational Workflow Management in an Electronic Institution", in 12th IFAC Symposium on Information Control Problems in Manufacturing (INCOM'2006), Vol. I - Information Systems, Control and Interoperability, Track "Holonic and Multi-agent Technologies for Industrial Systems", IFAC, pp. 429-434, Saint-Etienne, France, May 17th-19th 2006.

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25. Torres, José; Hutchison, David; Reis, Luís Paulo. "Semantic Image Retrieval Using Region-Based Relevance Feedback", in Stéphane Marchand-Maillet et al. (eds.) CD Proceedings of the 4th Int. Workshop on Adaptive Image Retrieval, Geneva, Switzerland, July 27-28, 2006.

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36. Santos, Diana; Seco, Nuno; Cardoso, Nuno; Vilela, Rui. "HAREM: An Advanced NER Evaluation Contest for Portuguese", in Proceedings of the 5th International Conference on Language Resources and Evaluation,LREC'2006, Génova, Italia, May 2006.

37. Daniel, Moura; Oliveira, Eugénio. "Fighting Fire with Agents", in Proceedings of EUMAS'06-Forth European Workshop on Multi-Agent Systems, A. Omicini, B. Dunin-Keplicz, J. Padjet (eds.), pp.225-234, Lisboa, December 2006.

38. Restivo, André; Reis,Luís Paulo. "Clustering Agent Optimization Results in Dynamic Scenarios", in Proceedings of EUMAS 2006, Fourth European Workshop on Multi-Agent Systems, A. Omicini, B. Dunin-Keplicz, J. Padjet (eds.), Lisbon, Portugal, 14-15 December, 2006.

39. Soares, M.G.; Malheiro, B.; Restivo, F.J. "Internet based VRS Code Positioning", Proceedings of the Second International European Conference on the Use of Modern Information and Communication Technologies (ECUMICT'2006), Ed. Luc de Backer, Nevelland v.z.w., Gent, Bélgium, March 2006.

40. Barteneva, Daria; Lau, Nuno; Reis, Luís Paulo. "Implementation of Emotional Behaviors in Multi-Agent System using Fuzzy Logic and Temperamental Decision Mechanism", in Proceedings of EUMAS 2006, Fourth European Workshop on Multi-Agent Systems, A. Omicini, B. Dunin-Keplicz, J. Padjet (eds.), Lisbon, Portugal, 14-15 December, 2006.

41. Correia, N.; Malucelli, A.; Fidalgo, N.; Custódio, L.; Malheiro,B. "Modelação de um Mercado da Pequena Geração Dispersa através de Agentes e Serviços Web", Actas da 4**?** Conferência Nacional sobre XML: Aplicações e Tecnologias Associadas (XATA'2006), J. Carlos Ramalho, J. Correia Lopes, A. Simões,(Eds.), Portalegre, Portugal, February 2006.

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42. Castro, António; Oliveira, Eugénio. "The Rationale behind the Development of an Airline Operations Control Centre using GAIA based methodology", Submitted to International Journal of Agent-Oriented Software Engineering, Inderscience Publishers.

43. Nunes, Luís; Oliveira, Eugénio."Communication During Learning in Heterogeneous Teams", submitted to Journal of Autonomous Agents and Multi-Agent Systems, Springer.

44. Cardoso, Henrique; Oliveira, Eugénio; "Institutional Reality and Norms: Specifying and Monitoring Agent Organizations", submitted to International Journal of Cooperative Information Systems (IJCIS), Special Issue on "Emergent Agent Societies".

45. Cardoso, Henrique Lopes and Oliveira, Eugénio; "Electronic Institutions for B2B: Dynamic Normative Environments", submitted to Artificial Intelligence and Law, Special issue on Agents, Institutions and Legal Theory.

46. Duarte, Pedro; Azevedo, B., Guerreiro, M., Ribeiro,C., Bandeira, R., Pereira, A., Falcão,M., Serpa, D., Reia, J. "Biogeochemical modeling of Ria Formosa (South Portugal)", Hydrobiology.

Other publications

47. Schneiders, Bernd. "Implementation of an ontology mapping algorithm", LIACC Technical Report, 2006.
48. Duarte, Pedro; Pereira, António; Falcão, M.; Serpa, D.; Ribeiro, C.; Bandeira, R.; Azevedo,B. "Biogeochemical Modelling of Ria Formosa (South Coast of Portugal) with EcoDynamo", Technical Report of University Fernando Pessoa - Centre for Modelling and Analysis of Environmental Systems, 2006.
49. Duarte, Pedro; Azevedo, B.; Ribeiro, C.; Pereira, António; Falcão, M.; Serpa, D.; Bandeira,R.; Reia,J. "Scenario Analysis in Ria Formosa with EcoDynamo" Technical Report under the EESD project EVK3-CT-2002-00084), University Fernando Pessoa - Centre for Modelling and Analysis of Environmental Systems, June 2006.
50. Pereira, António; Duarte, Pedro. "DSS Application (Ria Formosa Lagoon)", Technical report of University Fernando Pessoa - Centre for Modelling and Analysis of Environmental Systems, 2006.
51. Neves, Rui Jorge Canelhas Bastos. "Electronic Institutions providing Automatic Contracting for Virtual Organizations", LIACC Technical Report, August 2006.

Prototypes

In all cases LIACC is the entity responsible for the certification.

- ForEV V.2.0: Virtual Enterprise Formation Platform. ForEV is an Agent-based tool and platform enabling multi-attribute, adaptive negotiation between enterprises aiming at forming a temporary consortium. Now implemented in JADE and Java. A.P. Rocha, H.L.Cardoso, E.Oliveira,R.Neves, (new version), 2006.
- PyroSim V.1.3. A simple Graphical Simulator for "Emotion-like" based Agents evolving in Fire Combat scenario. L. Sarmento, D. Moura, (new version), 2006.
- Serviço de Ontologias baseado em Agentes, Andreia Malucelli, (new), 2006.
- "Dynamic Scenario Simulation Optimization", André Restivo, L.P.Reis(new), 2006.
- , AFRANCI Tool - enables easy development of architectures based on behaviors, F.Reinaldo, M. Siqueira, R. Camacho and Luís Paulo Reis (new), 2006.
- FC Portugal 2D - Simulation 2D League Team - RoboCup - Version 2005. L. P. Reis and N. Lau, IEETA/UA (new version), 2006.
- FC Portugal 3D - Simulation 3D League Team - RoboCup, Luís Paulo Reis, Nuno Lau, José Silva and André Guimarães, (new version), 2006.
- EcoDynamo - Agent Based Coastal Ecosystems Simulator, Pedro Duartea, (CEMAS/UFP) and António Pereia, Luís Paulo Reis,(new version), 2006.
- FC Portugal Rescue Team, João Certo, Nuno Cordeiro, Luís Paulo Reis, Nuno Lau,(new version), 2006.

Theses supervised

Doctoral theses completed

1. Malucelli, Andreia, "Ontology-based Services for Agents Interoperability", PHD in Computer Engineering, Faculty of Engineering, University of Porto, October 2006, (Supervisor Eugénio Oliveira).

2. Fonseca, Nuno A. "Exploiting Parallelism in Inductive Logic". PHD Thesis in Computer Sciences, Faculty of Sciences, University of Porto, October 2006, (Co-supervisor Rui Camacho).

3. Nunes, Luis, "Learning from Multiple Sources in Heterogeneous Groups of Agents", PhD Thesis in Computer Science and Engineering, Faculty of Engineering at the University of Porto, April 2006, (Supervisor Eugénio Oliveira).

Doctoral theses in preparation

1. Cardoso, Henrique Lopes. "Agent-based Electronic Institutions enabling Automatic Electronic Contracts for Virtual Organisations", PHD Program in Informatics Engineering, FEUP, (Supervisor Eugénio Oliveira).

2. Sarmento, Luis Morais. "Analisador Semântico Robusto e de Cobertura Larga para o Português", PHD Program in Informatics Engineering, FEUP, (Supervisor Eugénio Oliveira).

3. Castro, António, "Multi-Agent Systems for Airline crews management", PHD Program in Informatics Engineering, FEUP, (Supervisor Eugénio Oliveira).

4. Pereira, António Manuel. "Agent-Based Intelligent Simulation of Coastal Ecossystems ", (Supervisor Luís Paulo Reis).

5. Vinhas, Vasco. (Title still under discussion), PHD Program in Informatics Engineering, FEUP, (Co-Supervision Eugénio Oliveira, L.P.Reis).

6. Reinaldo, Francisco Antonio Fernandes. "Learning Methodologies for Autonomous Agents: Apllications in RoboCup Rescue / Métodos de Aprendizagem para Agentes Autónomos: Aplicações no RoboCup Rescue", (Co-Supervision Rui Camacho and Luís Paulo Reis).

7. Valente, Célia Talma. "Methodologies for Business Processes and Distributed Workflows in Inter-Organisational Environments", PHD Program in Informatics Engineering, FEUP, (Co-supervision Eugénio Oliveira and A. Lucas Soares).

8. Moreira, Pedro Miguel do Vale. "Intelligent 3D Visualization of Urban Scenarios / Visualização 3D Inteligente de Cenários Urbanos", (Co-supervision Augusto Sousa and Luis Paulo Reis).

9. Leão, Carlos Alberto de Sousa. "Distributed System for Object Tracking and Performance Analysis: Applications in Industry and Sports / Sistema Distribuído de Detecção, Seguimento e Análise de Desempenho no Trabalho: Aplicações na Indústria e Desporto",(Co-Supervision Luis Paulo Reis).

10. Mota, Luis Henrique Ramilo. "Common Framework for Cooperative Robotics: Applications in RoboCup / Arquitectura Genérica para Robótica Cooperativa: Aplicações no RoboCup", (Co-Supervisor Luis Paulo Reis).

11. Faria, Pedro Miguel. "Multimedia Interface with an Intelligent Wheelchair / Interface Multimédia com uma Cadeira de Rodas Inteligente", (Supervisor Luis Paulo Reis).

12. Braga, Rodrigo "Planeamento e Controlo de Acções de uam Cadeira de Rodas Inteligente / Action Planning and Control in na Intelligent Wheelchair", PHD Program in Informatics Engineering, FEUP, (Co-supervisor, L.P.Reis).

13. Coelho, Luís Filipe M. P. "Natural Landmark Localization for Service Robots", Doutoramento em Eng. Electrotécnica e de Computadores, FEUP, (Co-supervisor L.P. Reis).

14. António Filipe D. M. R. Marques, Sistema Inteligente de Análise e Simulação de Jogos de Futebol / Soccer Intelligent Game Analysys and Simulation System, Doutoramento em Eng. Electrotécnica e de Computadores, FEUP,(Co-supervisor L.P. Reis).

Master theses completed

1. Moura, Daniel Cardoso. "Learning Capabilities of Emotion-based Agents". (Supervisor Eugénio Oliveira).
2. Raimundo, Marta. "Sistema de Aprendizagem Baseado na Educação Real S.A.B.E.R", Master in Artificial Intelligence and Intelligent Systems, FEUP, 2006, (Supervisor Eugénio Oliveira).
3. Cardoso, Paulo César Basto. "Personal Assistant for Selecting VoIP Services", Master in Redes e Serviços de Comunicação (FEUP), July 2006, (Co-supervisor L.P.Reis).
4. Restivo, André Monteiro Oliveira. "Dynamic Scenario Simulation Optimization", Master in Artificial Intelligence and Intelligent Systems (FEUP, FCUP, FEP), October 2006, (Supervisor L.P.Reis).
5. Cardoso, Nuno Francisco Pereira Freire. "Avaliação de Sistemas de Reconhecimento de Entidades Mencionadas", Master in Artificial Intelligence and Intelligent Systems, Faculdade de Engenharia da Universidade do Porto, Dezembro de 2006, (Supervisor Eugénio Oliveira).
6. Pereira, Guilherme. "Agent-mediated Travel Agency". Master in Artificial Intelligence and Intelligent Systems, 2006,(Supervisor Eugénio Oliveira).

Master theses in preparation

1. Fernandes, Orlando. "Virtual Enterprise Formation and Monitoring through automatic platforms". Master Thesis on AI and Intelligent Systems. (Co-Supervisors E. Oliveira and A.P.Rocha).
2. Castro, António. "A Multi-Agent System for Intelligent Monitoring of Airline Operations". (Supervisor Eugénio Oliveira).
3. Pinto, João Luís "An Electronic Market for trading Electrical Energy". (Supervisor Eugénio Oliveira).
4. Rocha, Sónia Alexandra. "Agent-based Web Information Retrieval". (Supervisor Eugénio Oliveira).
5. Lomba, Cristina Alice, "Negotiation Methodologies in Virtual Enterprises Formation" (Supervisor Ana Paula Rocha).
6. Almeida, Rui. "Opponent Behavior Prediction in Simulated Robotic Soccer / Previsão de Comportamentos de Adversários no Domínio do Futebol Robótico Simulado", (Co-supervisor Luis Paulo Reis) .
7. Miranda, José Carlos. "Real Time Robotic Vision" Supervisor Luis Paulo Reis).
8. Sousa, Nuno. "Emotion-based Facilitator Agents". (Supervisor Eugénio Oliveira)
9. Pereira, David. "Logic Formalization Emotion-based Agent Architectures / Formalização Lógica de emoções em arquitecturas de Agentes" (Co- supervision Eugénio Oliveira and Nelma Moreira).
10. Barteneva, Darya Alexandrovna. "Visual Programming of Small Robots", (Co-supervisor Luis Paulo Reis).
11. Valente, Pedro. "'Gestão de Conhecimento em Instituições de Ensino Superior/Knowledge Management in Universities, Master in Informatics Engineering (Co-supervisor L. P. Reis).

12. Espain, Rute Daniela Martins. "Desenvolvimento de um Sistema de Seguimento de Plataformas Móveis". (B. Malheiro).

13. Correia, Nuno Alexandre Sarmento. "Desenvolvimento de um Mercado de Comércio Electrónico constituído por Agentes Móveis" (B.Malheiro).

Organization of scientific meetings

- The IEEE/WIC /ACM International Conference on Intelligent Agent Technology, Hong Kong, Dec2006 (VICE Co-Chair Eugénio Oliveira).
- The 17th European Conference on Machine Learning and the 10th European Conference on Principles and Practice of Knowledge Discovery in Databases, Berlin, September 2006. (Rui Camacho, Steering Committee).
- Co-Chair of the "Special Track" in "Holonic and Multi-Agent Technologies for Industrial Systems", 12nd IFAC Simposium on "Information Control Problems in Manufacturing", Saint Etiénne, May, 2006.
- Concurso Encontro Nacional de Programação em Lógica e Funcional/ Meeting of Logic and Functional Programming. Faculty of Engineering of Porto, May 5-7 2006 (Luís Paulo Reis).
- 1st Conference on Scientific Research Methodologies (CoMIC'06), Doctoral Programme in Informatics Engineering, 9th January 2006, FEUP, Portugal. (Henrique Cardoso, Luis Sarmento, Célia T. Martins).

Participation in Organization Committees:

- 1st Conference on Scientific Research Methodologies (CoMIC'06), Doctoral Programme in Informatics Engineering, 9th January 2006, FEUP, Portugal. (Henrique Cardoso, Luis Sarmento, Célia T. Martins).

Participation in Programme Committees:

- AAMAS'06- Fifth International Joint Conference on Autonomous Agents and MultiAgent Systems, Future University, Hakodate, Japan, May 8-12, 2006. (E. Oliveira, L.P. Reis).
- WI'2006: The 2006 IEEE/WIC/ACM International Conference on Web Intelligence, Hong Kong, December 2006. (A.P. Rocha).
- Workshop "Practical Data Mining: Applications, Experiences and Challenges" in ECML/PKDD 2006. (R. Camacho).
- (IADM-06) - IEEE/WIC/ACM Workshop on Interaction between Agents and Data Mining 2006, Hong Kong. (E. Oliveira).
- DaWaK 2006, 8th International Conference on Data Warehousing and Knowledge Discovery. (R. Camacho).
- IBERAMIA'2006 - Ibero-American Conference on Artificial Intelligence, Ribeirão Preto, Brasil, October, 23-27, 2006.(L.P.Reis).
- EUMAS - Forth European Workshop on Multi-Agent Systems, Lisboa, Portugal (ADVISORY BOARD member, E. Oliveira).
- 16th International Conference on Inductive Logic Programming,Santiago de Compostela, Spain, 2006, (R. Camacho).
- BESAI 2006 - 5th ECAI Workshop on Binding Environmental Sciences and Artificial Intelligence, August 29, 2006, Riva del Garda, Italy. (E. Oliveira).
- ADMA 2006, The First International Conference on Advanced Data Mining and Applications 2006. (R. Camacho).

- The 10th International Conference on CSCW in Design, May 3-5, 2006, Southeast University, Nanjing, China. (E. Oliveira).
- ECML 2006, 17th European Conference on Machine Learning, 2006. (R. Camacho).
- 7th IFIP International Conference on Information Technology for BALANCED AUTOMATION SYSTEMS in Manufacturing and Services, Niagara Falls, Ontario, Canada, September 2006. (E. Oliveira).
- II WAAMD, Workshop em Algoritmos e Aplicações de Mineração de Dados no Simpósio Brasileiro de Banco de Dados, SBBD, 2006. (R. Camacho).
- SBIA´2006, The Brazilian AI Symposium, Ribeirão Preto, Brazil, 2006. (E. Oliveira).
- "Agents in Traffic and Transportation (ATT)" Workshop at the AAMAS 2006, in Hakodate, Japan. (R. Rossetti, E. Oliveira).
- 19. PRO-VE'06 7th Working Conference on Virtual Enterprises, Helsinki, Finland, 2006.(E. Oliveira).
- The AAMAS06 Workshop on Coordination, Organization, Institutions and Norms in agent systems (COIN), Hakodate, Japan, 8-12 May, 2006. (E. Oliveira).
- CENPLF'2006, Concurso Encontro Nacional de Programação em Lógica e Funcional/ Meeting of Logic and Functional Programming. Faculty of Engineering of Porto, May 5-7 2006
- CISTI'2006, 1? Conferência Ibérica de Sistemas e Tecnologias de Informação, Esposende, Portugal, 21-23 Junho 2006 (L.P. Reis).
- Encontro Científico do Robótica 2006 (Scientific Meeting of the Portuguese Robotics Open), Guimarães, April, 28, 2006. (L.P. Reis).
- RoboCup 2006 International Symposium, Bremen, Germany, June, 19-20, 2006. (L.P.Reis)
- TLeIA 2006: First National Reward for Student Projects in Artificial Intelligence, Portugal, 2006. (A.P.Rocha, L.P. Reis).
- 1st Conference on Scientific Research Methodologies (CoMIC'06), Doctoral Programme in Informatics Engineering, 9th January 2006, FEUP, Portugal.(Henrique Cardoso, Célia Talma, Luis Sarmento, L.P.Reis, E. Oliveira).
- XATA2007 - XML: Aplicações e Tecnologias Associadas, 15 e 16 de Fevereiro de 2007, Lisboa, Portugal. (B. Malheiro).
- ECUMICT'2006 - Second International European Conference on the Use of Modern Information and Communication Technologies, 30 e 31 de Março de 2006, Gent, Belgium (B. Malheiro).

Editorial Boards

- Member of the Editorial Board of the International Journal "Autonomous Agents and Multiagent Systems" Kluwer Academic Publishers (E. Oliveira).
- Member of the European Board for the IOS and Ohmsha Ltd. "Frontiers in AI and its Applications" sub-series for promoting world wide outstanding dissertations in Artificial Intelligence (E. Oliveira).
- Member of the Editorial Board of the International Journal on Agent Oriented Software Engineering, Inderscience.
- International Journal of Computational Intelligence, Enformatika, ISSN 1304-2386, (Luís Paulo Reis).
- Tékhne - Revista de Estudos Politécnicos / Polytechnical Studies Review, (Luís Paulo Reis).

Advanced and post-graduate courses

- Doctoral (PhD) Program on Informatcs Engineering, Faculty of Engineering, University of Porto, (Director:E.Oliveira; L.P.Reis, A. P. Rocha).
- Artificial Intelligence and Intelligent Systems Master's Course, Faculty of Engineering and Faculty of Economics, University of Porto 2004-5. (E. Oliveira, R. Camacho, Ana P. Rocha, Luís P.Reis).
- Informatics Engineering Master Course, Faculty of Engineering, University of Porto, 2003-4. (E. Oliveira, R. Camacho,L.P. Reis, A.P.Rocha).
- Participation on "'Join the RoboLution BEST Course"', September 2006. (L.P.Reis, E. Oliveira).
- "A Instituição Electrónica como suporte da actividade de Empresas Virtuais", Seminários da Faculdade de Economia da Universidade do Porto, Março de 2006. (A.P.Rocha).
- Erasmus student supervision: Bernd Schneiders, Germany (E. Oliveira).
- Erasmus student supervision: António Calo, Spain (E. Oliveira).

Awards

- Best paper award in Holonic and Multi-agent Technologies for Industrial Systems. Holonic and MAS track at INCOM'06, "An Approach to Inter-Organizational Workflow Management in an Electronic Institution". (Henrique Lopes Cardoso, Paulo Leitão, Eugénio Oliveira).
- First place at the European Championship RoboCup 2006, Eindhoven (3D Simulation League) - RoboCup Federation, April 2006, FC Portugal Team (L.P.Reis and IEETA/U.Aveiro).
- Second place at the European Championship RoboCup 2006, Eindhoven (2D Simulation League) - RoboCup Federation, April 2006, FC Portugal Team (L.P.Reis and IEETA/U.Aveiro).
- First place at the European Championship RoboCup Rescue 2006, Eindhoven (Robot Rerscue League) - RoboCup Federation, April 2006, FC Portugal Team (L.P.Reis and IEETA/U.Aveiro).
- First place at RoboCup 2006, Bremen (3D Simulation League) - RoboCup Federation, April 2006, FC Portugal Team (L.P.Reis and IEETA/U.Aveiro).

3.1.2 Plan for 2007

Scientific Goals

NIAD&R (Distributed Artificial Intelligence & Robotics Group) is LIACC's group belonging to the Faculty of Engineering at the University of Porto. Our team includes 6 PhD (three Senior), 19 Researchers including PhD students(11 working in part-time), 3 other MSc's students and 4 external collaborators. NIAD&R is the smallest LIACC's group and is mostly devoted to the research in Distributed Artificial Intelligence and Agent-based Systems. More precisely, both the theoretical and practical aspects of Autonomous Agents as well as Multi-Agent Systems have been the broad areas of interest for our research. Our main motivation relies on improving models for agent-based systems interoperability coordination and applications. We can further identify specific topics inside these areas as shown below: (i) Electronic Institution for agent-based B2B operations, (ii) Agents' Adaptation, Learning and Emotions; (iii) Multi-Agent teams' coordination and simulation; (iv) Multi-agent Systems applications and Intelligent Text Mining. In the following sub-sections a more detailed description of the work we intend to pursue is presented

3.1.2.1 Electronic Institution for agent-based B2B inter-Operability

Eugénio Oliveira, Ana Paula Rocha, Henrique L. Cardoso, Andreia Malucelli, Célia Valente, P.Leitão (Collab.)
Coordinator: Eugénio Oliveira
Research direction: Research in the context of this issue aims at developing an Electronic Institution for safe and trustable agent-based business operations. This objective includes the development of appropriate models for B2B Negotiation and Monitoring processes as well as to provide platforms, tools and frameworks enabling Agents' interoperability in the context of Virtual Enterprises Life Cycle.
Research goals: Our main concern is to define a computational representation of electronic contracts suitable to automatic monitoring procedures executed by an Electronic Institution. An electronic contract includes a set of norms that contractual agents agree upon. Electronic contracts should make it possible to represent Virtual Organization/Enterprise settings, defined in terms of consortiums aggregating the efforts of different organizations.
Recent work (2006):The Virtual Organization contract definition seeks to take advantage of a normative environment. Contracts have as a ground basis a set of predefined norms at an institutional level, which may be applicable to different contract types. A generic contract model was defined that simultaneously: (1) takes advantage of an established normative system, enabling an easy creation of new contracts with little information needed; (2) is expansible, allowing the inclusion of non-predefined information and contractual norms, while keeping its computability. This approach will allow us to apply and validate the system in different business domains. Contracts are represented using an XML schema. Contracts are then translated, together with applicable norms, into a rule engine (Jess) whose responsibility is to monitor them. In Jess, contracts correspond to contexts within which certain norms apply. Each contract indicates the super-context from which it may inherit norms applicable to contracts of its type.

Current and future work:

- Refining the contract creation process, taking into account the negotiation phase that precedes it.
- Further expand contract monitoring to the shop-floor level, integrating with an inter-organizational workflow monitoring service.
- Instantiating the generic contract model considering appropriate case-studies.

Electronic Institution Platform *Research goals:To deliver a web-based Electronic Institution comprising services assisting agents interaction in the Virtual Enterprise life-cycle. More specifically, the Electronic Institution should provide services such as negotiation mediation, ontology mapping, contract drafting, contract monitoring and enforcement, and reputation indexes.* Recent work (2006):

- The implementation and integration of institutional services is in an advanced stage. These developments are based on a careful architectural design of the Electronic Institution platform (based on JADE).
- The Electronic Institution's normative environment, as well as the norm monitoring service, has been detailed and formalized. It is based on the concepts of "institutional reality" (Searle) and "institutional power" (Sergot). The contract monitoring service exploits the hierarchical norm organization, based on "contexts".
- Bibliographic research has been conducted concerning the study of trust, reputation and norm learning within institutions.
- Ontology-based services have been integrated with the Electronic Institution platform.
- An architecture and interface of an inter-organizational workflow management service has been specified.

Current and future work:

- Specification and description of case-studies appropriate for demonstration is on the way.
- Future work includes the study and development of partners' trust and reputation models to be included in the Electronic Institution platform.
- The study of learning processes for norm evolution is also under consideration.

3.1.2.2 Agents' Adaptation, Learning and Emotions

Luís Nunes, Luís Sarmento, Daniel Moura, Eugénio Oliveira, Rui Camacho, Alexessander Alves
Coordinator:Eugénio Oliveira
Research direction: Agents' intelligent processes mostly rely on learning capabilities and sophisticated architectures. Through this research line we aim at studying both agent and multi-agent learning on one hand, and emotion-like features driven architectures, on the other hand
(i) Agents and Multi-agent learning. The main goal of this research issue is to find an answer to the following question: "(How) can several different, heterogeneous, Learning Agents improve their performance by exchanging information during their own learning process?". We are also researching on computational learning methods for bioinformatics.

(ii) Emotion-based agents' architecture. Through this research issue we would like to answer another important question: "Will it be possible to escape from usual utility-based decision functions, by using emotion-like features, in what decision-making for autonomous agents as well as for teams of Agents is concerned?"

Agents and Multi-Agent Learning *Research goals:* 1- (How) can several different Learning Agents improve their performance by exchanging information during their own learning process?"; 2- Concerning Inductive Logic Programming algorithms applied to Bio-Informatics, how to apply Inductive Logic Programming (ILP) to the Protein Folding problem (collaboration with REQUIMTE); 3- How to apply ILP to analysis of genomic sequences (collaboration with IBMC).

Recent work (2006):

- Our studies on the effects of communication during learning in teams of agents that use different learning algorithms have been concluded. These studies were based in experiments in different scenarios: the Predator-Prey domain, a Traffic Control simulation based on real data and a Load-Balance simulation.
- During the above mentioned studies we have identified several weaknesses of the process, proposed and tested new solutions. The weaknesses are mainly related to the synchronization of information exchange in a team and to the integration of advice from peers using different learning algorithms. A PhD thesis on this subject was successfully concluded during 2006.
- We are using ILP in the prediction of secondary protein structure based on the primary structure and properties of the amino-acids. We also use ILP to find rules that predict the location of helices and beta-sheets based on the linear sequence of residues of each protein. Concerning the problem of genomic sequence analysis we are addressing, we want to "explain" the behaviour of disjoint exons based on their sequence of both bases surrounding introns.
- We have developed a program to access periodically the Dunbrac/Pixies Web page to obtain the most recent list of proteins with very low homology. With that list the program fetches the protein sequences at the PDB repository. item We have also developed the basic background knowledge useful to tacle the Protein Folding problem with ILP.
- We developed pre-processing analysis to the sequences data that allow us to substantially reduce the number of hypotheses during the ILP execution stage. These preprocessing analysis is based on the computation of individual and pair propensities.
- We developed the background knowledge for the genomic sequence analysis.

FUTURE WORK:

- We intend to apply ILP to 3 sub-problems associated with the prediction of the secondary structure of proteins: i) identify when an alpha-helix starts; ii) predict when an alpha-helix ends and; iii) predict the size of an alpha-helix.
- We will also apply ILP to the genomic sequence analysis problem.

Emotion-like based Agents *Research goals:1- Modelling and specifying an emotion-based agent architecture; 2- tactical models for coordinating a small team of emotion-based agents*

RECENT WORK:

- While our past work in this area mainly concerned the refinement of basic concepts of the emotion-based agent architecture, the work in 2006 was focused on providing a more appropriate formalization of the new agent architecture. We have thus proposed an extension to the BDI architecture capable of supporting Artificial Emotions, named Emotional-BDI Architecture. This architecture is original in the sense that is designed to extend the BDI architecture with explicit representation of two important concepts that are related to emotional processing: Capabilities and Resources. This is achieved while trying to keeping the same logic formalisms already in place for the BDI architecture.
- Through the "Emotional-BDI model", in which we added new components for managing resources and capabilities, as well as for managing the activation of emotions; second, we extended Rao and Georgeff's logic, by adding new modal operators which describe the new components present in the Emotional-BDI model. Using this new "E_BDI" logic, we model the activation conditions of three emotions and the effects that their presence has in the agent behaviour.

- We have introduced the "E_BDI logic", by defining its syntax, semantics and describing the properties of the modal operators. We also presented some results about the interaction between time and actions. The formal specification of the activation and effects of the following set of emotions: *fear*, *anxiety* and *self-confidence* have been developed.
- In 2006 we were able to implement a tactical model to coordinate small teams of emotion-based agents (here, agents are firefighters that try to control a forest fire). In the present model, there are two coordination levels: global coordination and local coordination. Global coordination uses predefined tactics (based on real firefighting tactics) that specify the team overall approach to fire at a high-level. New tactics can be added and it is also possible to extend previously defined tactics. A leader agent evaluates the scenario (using its own perception and information communicated by other agents) and based on the current tactic it assigns high-level tasks to the other agents. Local coordination is necessary to carry out these high-level tasks effectively. Agents that share the same tasks use perception and predefined rules in order to cooperate without using communication. We tested an implementation of this model by experimenting several firefighting tactics in two scenarios. We have demonstrated that, like in reality, different fire scenarios require different firefighting tactics in order to minimize fire damage. Additionally, the tactics that performed best in the tested scenarios are the ones that we were expecting according to firefighting theory.
- A Master thesis on the Tactics for Emotion-based Agent teams was successfully submitted.

Current and future work:

- To finalize and submit a Master thesis on the E_BDI agent architecture model.
- Future work concerning emotion-based agent teams will include performing more experiments in other types of scenarios. We need to enhancing and validating the simulatorin order to give more credibility to our experiments. After this, we are planning to use machine-learning algorithms over the the experimental results for trying to discover rules for tactic selection. At this stage, we are also ready to take advantageous of the the agents emotional mechanism for making higher-level decisions, such as tactical decisions, and to study the effect of emotions in the overall team performance.

3.3.2.3 Multi-Agent Coordination, Simulation and Cooperative Robotics

L.Reis, A.Pereira, F.Reinaldo, L.Mota, P.Faria, R.Braga, D.Barteneva, A.Restivo, P.Valente, scholarship holders.
Coordinator:Luís Paulo Reis

Research direction: Coordinating teams of autonomous (or semi-autonomous) agents that perform in rich, dynamic, both cooperative and adversarial environments is a major aim of this work line. For this objective, we are exploring several research directions that can be seen as complementary: new coordination protocols; methodologies for analyzing team behavior; implementation of agent-based common framework suitable for controlling teams of cooperative robots for robosoccer; design of realistic multi-agent simulators (Coastal Ecosystems Simulator); generalizating these methods to other domains.

Agent-based Simulation *Research goal: We have being pursuing the development of realistic agent-based simulators. In this context several simulators were developed or extended*

Recent work (2006):

- A complete multi-agent simulation system for ecological environments - EcoDynamo - was developed. This system includes an ecological simulator, a 3D graphical visualizer, and an automatic calibration agent based on machine learning techniques capable of

calibrating complex ecological models. It also includes different agents with learning, optimization and negotiation capabilities, representing the often-neglected intelligent entities present in this type of environment. These agents interact with the simulation software in an intelligent manner simulating the behaviour of humans and increase the simulation realism.

- Agents interact with the system using ECOLANG, a language developed to describe ecological systems. The simulation system is now being applied to coastal ecological models, including Ria Formosa in Algarve and used for aquaculture optimization and environmental resource management, studying how correct management of environmental resources can make progress in the direction of sustainability.
- New features for known simulators like SoccerServer 2D robotic soccer simulator and RoboCup Search and Rescue simulator were implemented. In this context we have adapted the SoccerServer simulation system to enable more realistic soccer simulation using models of real soccer players and strategies defined by real soccer coaches.

Current and future work:

- Future work will be concerned with improving EcoDynamo calibration agent and developing new agents to interact with the simulators. These agents will enable the system to be used for aquaculture optimization and for predicting the long-term effect of human interaction with the ecosystem.

Multi-Agent Coordination *Research goals: This research line aims at developing coordination protocols for teams of autonomous (or semi-autonomous) agents that perform in rich, dynamic, both competitive and adversarial environments. It also aims at developing methodologies for organizing and making available knowledge, languages and protocols that enable teamwork*

Recent work:

- We have developed several new coordination methods for teams of autonomous agents that can be applyed to realistic simulations like robotic soccer, search and rescue, cibermouse, traffic and ecological simulations. Based on our previous work on strategic modeling, we have developed a multi-purpose, adaptable, strategic coordination layer that allows management of heterogeneous teams, for both centralized and decentralized environments, with reduced use of communication. The model uses a multi-level hierarchical approach. In the first, lower level, the concept of roles is used to reflect the agent's usual activities. The second level introduces a sub-tactic that aggregates agents with various roles to solve partial objectives. On top of the sub-tactics, formations are used to distribute available agents throughout the sub-tactics. A higher tactical level, then, uses a hybrid method to switch formations. This method is based on a combination of events, situations and precedence. On top of the previous levels, a strategic level is defined that allows commuting between tactics according to scenario conditions.
- We have also developed a framework for high-level setplay definition and execution, applicable to any RoboCup cooperative league and similar domains. The framework is based in a standard, league-independent and flexible language that defines setplays which may be interpreted and executed at run-time. These methodologies were applied for both RoboCup Rescue and RoboCup Soccer and tested in real competitions and controlled experiments. It enabled us to win three leagues in RoboCup European championship and to be champions of RoboCup 2006 in the Simulation 3D league, showing the usefulness of the approach.

Current and future work:

- Future work is concerned with the development of a graphical tool for designing team strategies with an associated source code generator. These developments will enable

a more generalized use of our strategic layer in the context of RoboCup and in other cooperative domains.

- We plan to use the strategical layer, through different instantiations, built by means of our graphical tool, in all our teams (simulation 2D, simulation 3D, small-size, middle-size, legged, simulation rescue and physical visualization) participating in European and world RoboCup competitions in 2007.

Intelligent Robotics *Research goals: Real/simulated robot teams for competitions*

Recent work:

- Together with IEETA/Univ.Aveiro and ISR-P we have developed seven real/simulated robotic teams (simulation 2D, simulation 3D, Coach, small-size, middle-size, 4legged and rescue) and we have participated in five different leagues in RoboCup 2006 European championship (held in Eindhoven, Holland) and in the World Robotic Soccer Championship, (held in Bremen, Germany). In the European championship we won three leagues: Simulation 3D, Simulation Rescue and Small-Size and achieved second place in the Simulation 2D league. Our 3D team was also World Champion of RoboCup, scoring 77 goals with conceding a single goal on this competition.
- In this research line we are also developing an intelligent wheelchair for individuals with cerebral palsy and quadriplegia. The interaction with the chair is based on facial expressions recognition methodologies, appropriated for the detection of expressions on individuals with Quadriplegia and Cerebral Palsy Handicapped and its integration as the main interaction mechanism to control and configure the wheelchair. The wheelchair control module is based on a multi-agent system with learning capabilities and a user interface that allows interaction, using an appropriated high-level command language. The first results obtained using a simulator showed that our approach has potential to enable a wheelchair to be fully controlled through facial expressions.

Current and future work:

- Future work includes the participation in RoboCup 2007 (Atlanta) and European RoboCup (Hanover) with our simulated and robotic teams in soccer and rescue competitions. Regarding our wheelchair, future work includes the improvement of the vision system, aiming to allow the system to better perform in outdoor environments or rough lighting conditions. We also intend to construct, from scratch, a real wheelchair prototype and test the methodologies previously developed using simulators in this wheelchair. Future work includes also the development of high-level planning methodologies to enable the user to control the wheelchair for performing complex tasks in the environment, using simple facial expressions.

Individual and Team Performance Analysis *Research goals: This research line aims at creating methodologies for analyzing individual and team performance during the accomplishment of complex tasks (like playing soccer, performing a search and rescue operation or an industrial collective labor), and using them for coaching teams of autonomous agents. We have developed prototypes referred below*

Recent work:

- A distributed surveillance system, based on autonomous surveillance agents capable of following a surveillance policy communicated by a central agent in a specific language.
- A soccer intelligent analysis system based on surveillance agents (with 3D player and ball detection capabilities) and a central agent capable of creating match reports including player individual performance (passes, shoots, runs, dribbles, etc.) and team performance information (ball possession and circulation, playing style, space of effective play, etc.).

- FCPx tool for high-level evaluation of RoboCup Rescue simulated team's strategies.

Current and future work:

- Future work will be concerned with developing methodologies for automatic game analysis and player model automatic creation and the improvement of our player detection and tracking system.

3.1.2.4 Text Mining and Agent-based Systems applications

Luis Sarmento, J.L.Pinto, N. Sousa, S.Rocha, G.Pereira, A. Castro, H. Marques,R. Rossetti, E. Oliveira,

Coordinator:Eugénio Oliveira

Research direction:Two years ago we have started a new line of research related to Natural Language processing and Text Mining. This work includes a partnership with the Linguateca Project. Moreover we also aim at applying agent and multi-agent architectures, negotiation protocols and learning algorithms to specific application domains.

Natural Language Processing and Text Mining *Research goal:We intend to build up algorithms to mine very large Data Bases of portuguese text. This implies the following more precise research goals: 1- development of semantic analysis tools for information extraction purposes; 2- development of lightly supervised machine learning methods foradaptive semantic analysis tools from raw text and a small set of examples (bootstrapping techniques); 3- development of automatic question-answering systems.*

Recent work (2006):

- In 2006, most of the work was dedicated to the development of a named-entity recognition (NER) system, SIEMÊS. The system relies on a very large gazetteer for Portuguese (REPENTINO), a small specific-domain lexicon and a set of manually encoded rules. SIEMÊS is already able to identify and classify more than 100 different types of entities. We have participated, with this system, in the HAREM evaluation contest organized by Linguateca (http://poloxldb.linguateca.pt/harem.php).
- The SIEMÊS NER system was also used as the underlying semantic analysis tool of RAPOSA, an automatic question-answering system for Portuguese that was also developed during last year. RAPOSA participated in the QA@CLEF evaluation track promoted by the Cross-Language Evaluation Forum (http://www.clef-campaign.org/).

Current and future work:

- In 2007 we are focusing on developing machine learning methods to be used in the construction of the key components of a wide-scope semantic analysis systems namely, sets of rules, specialized lexicons and gazetteers. We are specially focusing on bootstrapping methods that try to expand and generalize a set of seed examples given by the user by searching vast amounts of text. For this purpose, we are using the Wikipedia collection which allows us to test our machine learning methods in several natural languages. We hope that these machine learning methods will enable us to quickly build up the resources required for instantiating semantic analysis systems specialized for different applications and languages.

A Multi-Agent System for Intelligent Monitoring of Airline Operations *Research goals: We intend to specify and implement a multi-agent system for monitoring of airline operations, including intelligent crew, aircraft and passenger problems recovery.*

Recent work (2006):

- The Multi-Agent System deals with different operational bases and all bases cooperate to find the solutions to the local problems. Robustness is a key feature and we achieve that through redundancy in finding the possible solutions to the problems, using specialized agents that compete in finding the best solution to be applied.
- To be an "Intelligent System" some kind of learning must be available. We are using learning to define the crew member's profile, to learn the use of stand by crew members and include this learning in future crew scheduling and in suggesting new solutions based on previous decisions.
- To foster the cooperation between different airline companies we explore the possibility of having a "kind of electronic market" of crew members and aircrafts, to be used in crew and aircraft recovery. This would work as a "market" of solutions to specific local problems and these solutions would compete with the recommended local solutions.

Current and future work (2007):

- A master thesis is being produced.
- To specify and implement a prototype that will evaluate the hypothesis made over relevant scenarios.

Control Startegies Characterization for Heterogeneous MAS *Research goals: to extract good control strategies emerging from heterogeneous multi-agent interaction. The application domain is Traffic Control for metropolitan regions*

Recent work (2005 - 2006):

- Development and implementation of prototype software for microscopic simulation models to assess the project requirements as for the introduction of agent architectures for intelligent traffic control at different levels;
- Evaluation of current microscopic traffic simulators supporting different traffic control models and offering facilities to integrate the concept of agents. Examples include SUMO, ITSUMO, MITSIM, DRACULA, Paramics and AIMSUN2;
- Assessment of agent-based methodologies for multi-agent systems specification and development, in which case a combination of GAIA and AUML was adopted;
- Adoption of a GIS package to support the implementation of the parametric data structures underlying the MASTTER Lab framework, offering adequate tools to handle and analyze spatial and geographically referenced information;
- First meetings between the Portuguese and the Brazilian partners for mutual understanding of the project objectives and strategic planning of activities. An add-in component was implemented and introduced in the ITSUMO simulator to support further developments of the project, allowing integration of different agent controllers in the simulation loop. Dr. Rosaldo Rossetti visited Prof. Ana Bazzan' group in November 2005, in Porto Alegre, Brazil;
- Following meetings between the Portuguese and the Brazilian partners for revaluating the project objectives and asses its progress. Different simulation scenarios were proposed to test different approaches to traffic control in two basic levels, one local and another global. For the former, Q-Learning agents were implemented to control traffic lights at intersections accounting for variable recurrent flows, whereas some discussion started on possible alternatives for the global perspective of control in the second level. Profs. Ana Bazzan and Roberto Silva visited our LIACC group in February 2006.

Current and future work:

- Developing agents at the second level of control, to be integrated in the simulation framework and to cooperate with agents at the first level;

- Building up different algorithms for traffic control agents and making them interoperate in a dynamic environment, where different interactions, relying either on explicit communication or not, can be observed. Interactions can happen in different ways, ranging from cooperation to competition, with mechanisms for dynamic coalitions or team formation;
- Making available a suitable agent-based traffic control simulator to test and assess different control strategies. It is also expected to support decisions of experts and practitioners in devising and selecting control policies to be applied in the real world;
- Modeling different driver behaviors in simulated scenarios and their interactions (either implicit of explicit) with intelligent control devices and other intelligent transportation solutions. A future work in this way is being proposed with the objective of studying how different groups of cooperating and competing multi-agent systems can learn in partially observed and highly dynamic and uncertain domains;
- Inducing dynamic control hierarchies of control, with dynamic placement of agents at each level of the hierarchy. Specifying learning agents to deal with control results at a lower level;
- Modeling informational agents to overcome problems of inaccessibility so as to tailor information to foster agents' learning in the transportation domain.

4-legged robotic surveillance- "Smart Guardian" *Research goals: The main goal of the Smart Guardian project is to create an Agent that makes use of Learning techniques when patrolling and detecting intruders in a dynamic environment.*

Past work (2005-2006):

- To define the basic architecture that enables the robot to be sufficiently curious to investigate parts of the unknown world and to move to locations pointed out by the user. We are using Tekkotsu framework (developed at CMU) a C++ layer on top of OPEN-R that provides a greater abstraction over the low level details of the robot. The Robot Interface has been abstracted to a common model, allowing adapting to other robots with minimal changes.
- A BDI Agent Architecture that is adapted for Real-Time to control the Robot, has been designed and implemented.
- A realistic Simulator has been implemented that can be used to test agents before deploying the system into real robot.
- The World Model Updating Algorithm first steps have been implemented allowing the robot to map the environment within range of its sensors, although the robot still doesn't move using this model.
- Analysis of the algorithms for the Path Planning has been completed and ready to be implemented.

Current and future work (2007):

- To document the Platform developed to use the AIBO has a Robot, thus enabling it to be used in the classroom.
- Specify the Algorithm and Techniques that need to be implemented to make the system a Multi-Agent System.

Agent-based Electrical Energy e-Market *Research goals:To design a secure platform to enable trusted encounters between agents representing energy costumers and suppliers in an Electronic Market. Current European efforts for the establishment of both deregulated Electrical Energy Markets and Electronic Commerce platforms can be brought together through appropriate multi-agent platforms enabling autonomous agents interaction for automatic trading.* Recent work:

- In the specification of the multi-agent system encompassing the needed functionalities for the Electrical Energy e-market, we have until now emphasising security procedures, accountability of the communications, good performance and software portability. Also, integration with legacy systems has been privileged. In our Electricity E-Market, agents authenticate through digital certificates, while messages between the market operator and the market agents are digitally signed. We have selected the TLS/SSl protocol and, as for the message digital signatures is concerned, the open standards are being used. They rely on classical MAC and cryptography algorithms used in SSL. Market operator is seen as a trusted third partner, responsible for registration, auctions and matching bids and offers.

Current and future work:

- To apply and integrate all those developed algorithms in a single platform for an Energy market auction-based simulation

Multi-Agent System for Web searching *Research and Development goals: We are designing a multi-agent system which tries to capitalize from different agents parallel Web searching tasks to enhance the overall system performance on finding relevant web pages for specific users.* Recent work (2006):

- The final Agent-based Information Retrieval System has been implemented and evaluated. Final results have shown significant improvments on searching for relevant information when compared to traditional web searchers.
- A Master's thesis has been successfully submitted.

3.1.3 Ongoing projects

A. Electronic Institution including Electronic Contracting for Virtual Organizations (Instituição Electrónica incluindo Contratação Automática para Organizações Virtuais)

Project Title: POSI/EIA/57672/2004
Duration: 24 months (May 2005 - April 2007)
Funding Entity: FCT/POSI
Funding: 40 000 EUR
Coordinator at LIACC: Eugénio Oliveira
LIACC Research Team: Ana Paula Rocha, Henrique Lopes Cardoso, Rui Neves, Paulo Leitão, Eugénio Oliveira
Partners:LIACC - University of Porto; Escola Superior de Tecnologia e de Gestão de Bragança; CentralCasa, Desenvolvimento de projectos de Domótica, Lda

This project aims at developing a software framework - an Electronic Institution - where agents representing different enterprises can interact in a regulated fashion. The concept of an Electronic Institution is related to real-world institutions that define the norms and rules of the society, regulating the activity of its individuals. We intend to specify and implement a normative framework that imposes such governance to computational agents, including general norms and rules, as well as those directly related to contractual activities. Within this normative layer, a representation formalism for contracts will be devised, allowing contracts to be validated and their execution to be verified. Together with these regulations, institutional services assisting contractual activities are of primary importance, specifically devoted to the creation and operation of Virtual Organizations. These services include negotiation mediation, contract templates, ontologies, and contract validation, monitoring and enforcement. The execution of contracts that formalize cooperative business operations imposes some concerns in which the integration of different workflows is concerned. Therefore, in this project we also intend, as a complementary task, to address the interdependencies between inter-organizational workflow enactment and contract specification and execution monitoring.

Recent work (2006):

- Definition of a general-purpose contract model
- Implementation of previously specified contracting services
- Development of a normative environment for contract execution monitoring
- Study of the state-of-the-art on reputation, trust, and norm learning and evolution
- Integration of ontology services
- Architecture specification for an inter-organizational workflow management service

Current and future work

- Refinement of the contract creation process
- Exploiting trust and reputation within the electronic institution platform
- Case-study description
- Further integration and evaluation of the platform

B. ABSES - Agent Based Simulation of Ecological Systems

Project Title: FCT/POSC/EIA/57671/2004
Duration: 30 months (Apr 2005 - Oct 2007)
Funding Entity: FCT/POSC
Funding: 75000 EUR
Coordinator at LIACC: Luís Paulo Reis
LIACC Research Team: Luís Paulo Reis, António Pereira, Francisco Reinaldo, Tiago Fonseca
Partners: CEMAS - University Fernando Pessoa

ABSES project aims at developing a complete multi-agent system for performing ecological realistic simulation, including: an ecological simulator, a graphical visualizer, a Calibration Agent based on learning techniques capable of calibrating complex ecological models and autonomous agents representing the intelligent entities present in the simulation. The system will be applied to ecological models of coastal ecosystems and used for aquaculture optimization. Specific objectives include:

- Creation of calibrated models for different coastal ecosystems enabling it s realistic simulation;
- Implementation of a user-friendly agent-based coastal ecosystems simulation software;
- Construction of an automatic model calibration agent based on machine learning techniques;
- Implementation of an on- line visualizer for ecological simulations;
- Construction of agents with learning and negotiation capabilities for representing humans present in the ecological simulations;

Recent work (2005):

- EcoDynamo - Realistic ecological simulation software;
- Calibrated model of Ria Formosa - Algarve, Portugal;
- ECOLANG - A language to describe ecological systems (Pereira et al., 2005);
- First version of our Calibration Agent for ecological simulations.

Current and future work

- Refinement of EcoDynamo simulation software;
- Development of a graphical visualizer for ecological simulations;
- Introduction of machine learning techniques in the Calibration Agent;
- Development of Aquaculture Agents capable of cultivating bivalves in the coastal ecosystem with intelligent seeding, inspecting and harvesting capabilities

C. Control Strategies Characterization for Heterogeneous MAS

Project Title: GRICES/CAPES PROJECT
Duration: 2 years (March 2005- March 2007)
Funding Entity: Bi-lateral (Brasil/Portugal) GRICES (Portugal) / CAPES (Brasil)
Funding: Missions.
Coordinator at LIACC: Eugénio Oliveira
LIACC Research Team: Rosaldo Rossetti, Joaquim Canhoto, Luis Nunes, Eugénio Oliveira
Partners: UFRGS, Porto Alegre, Brasil (Prof. Ana Bazzan)
The aim of the project is to extract control strategies emerging from heterogeneous multi-agent interaction. The application domain is Traffic Control for metropolitan regions implying the joint study of multi-agent systems interoperability and Intelligent Transportation Control Systems. Software Agents controlling traffic in a simulator are evaluated through other higher level specialist agents. These specialists try to induce successful both local and global control strategies to be applied further on in traffic control. Physical components, such as travellers, traffic control systems, and intelligent transportation solutions are replicated to the virtual domain where their delegates (or agents) are instantiated. Agents for inducing control strategies observe such synthetic population, can directly intervene and experiment on it, and apply coordination policies to tune the behaviour of some elements in order to improve overall performance. Integration of all the results yielded in this project within such a dynamic iterative loop to affect the real world is a longer term goal to pursue.

The project specific objectives are:

- Definition of an agent-based model for the MASTTER Lab framework (Laboratory for MAS-based Traffic and Transportation Engineering Research);
- Modeling and implementation of a traffic simulator for agent-base traffic control specification of different types of agents for traffic control;
- Definition of when, what and how agents should communicate at the simulation level;
- Definition of Learning Agents capable of inferring control strategies from data available at the lower level;
- Enforcing new strategies on the scenario and evaluating them.

Recent work (2005 - 2006):

- Development and implementation of prototype software for microscopic simulation models;
- Evaluation of current microscopic traffic simulators;
- Assessment of agent-based methodologies for multi-agent systems specification and development;
- Adoption of a GIS package to support the implementation of the parametric data structures underlying the MASTTER Lab framework;
- Meetings between the Portuguese and the Brazilian partners. Dr. Rosaldo Rossetti visited Prof. Ana Bazzan' group in November 2005, in Porto Alegre, Brazil;
- Following meetings between the Portuguese and the Brazilian partners for revaluating the project objectives and asses its progress. Ana Bazzan and Roberto Silva visited our group in February 2006.

Current and future work:

- Developing agents at the second level of control, to be integrated in the simulation framework and to cooperate with agents at the first level;
- Building up different algorithms for traffic control agents;
- Making available a suitable agent-based traffic control simulator;
- Modeling different driver behaviors.
- Modeling other informational agents.

D. RESCUE: Coordination of Heterogeneous Teams in Search and Rescue Scenarios

Project Title: FCT/POSC/EIA/63240/2004
Duration: 24 months (May 2005 - Apr 2007)
Funding Entity: FCT/POSC
Funding: 32800 EUR
Coordinator at LIACC: Luís Paulo Reis
LIACC Research Team: Luís Paulo Reis, Francisco Reinaldo, João Certo, Nuno Cordeiro
Partners: IEETA - University of Aveiro

This project is exactly intended to develop methodologies enabling to build a Simulation RoboCup Rescue Team. For this, several different problems must be addressed, including: agent architecture, basic skills, decision mechanisms, path planning capabilities, communication protocols, cooperation protocols, global strategy, etc. The Project also aims at developing a RoboCup Rescue team with innovative coordination methodologies and that is able to integrate learning techniques in its reasoning procedures. The coordination methodologies will be adaptations and extensions of previously researched coordination framework coming from our experience in FC Portugal team of RoboCup Soccer Simulation League (world champion in RoboCup 2000). The project specific objectives are:

- Definition of a team strategy for search and rescue tasks including sub strategies for fire brigades, ambulance teams and police forces;
- Definition of a hierarchical agent architecture for rescue agents including learning, communication and advanced coordination capabilities;
- Implementation of communication, coordination and supervision methodologies in agent teams accomplishing complex tasks in dynamic environment s;
- Development of a tool for automatic team strategy evaluation enabling to gather high-level information from Rescue simulations;
- Integration of learning methodologies to improve agents performance;
- Participation in RoboCup Rescue Osaka2005 and Bremen2006 international competitions.

Recent work (2005):

- Development of an agent architecture and low-level skills for rescue agents;
- Development of a team strategy model for search and rescue operation;
- Development of FC Portugal Rescue 2005 team (¡http://www.fe.up.pt/ rescue¿);
- Development of FCPx tool for high-level evaluation of rescue teams strategies (¡http://www.fe.up.pt/ rescue/FCPx¿);
- Participation in RoboCup Rescue

Current and future work

- Integration of learning methodologies in rescue agents by using our FCPx tool to gather simulation data enabling performance evaluation of different team strategies;
- Adaptation of coordination methodologies from our FC Portugal soccer team to the search and rescue domain;
- Creation of a general communication language for search and rescue operations enabling agents built by different universities to participate in the same rescue operation.
- Participation in RoboCup 2006 (Bremen, Germany, June 2006).

3.1.4 Cooperation

1. Universidade Federal do Rio Grande do Sul, Porto Alegre, Brasil. Research Project, Seminar, visit under the GRICES-CAPES Program (Pof. Ana Bazzan).
2. University of York, Computer Science Department. Collaboration in PhD. (Daniel Kudenko).

Links with foreign institutions

- University of York, United Kingdom, Dr. Daniel Kudenko.
- Université de Technologie de Compiègne, France, Prof. Jean Paul Barthès.
- DFKI – German Artificial Intelligence Research Center, Saarbrücken, Dr. Klaus Fischer.
- Humboldt Universitat Berlin, Institut fur Informatik,Prof. Hans Dieter-Burkhard.
- University of Utrecht, Dr. Frank Dignum and Dr. Virginia Dignum.
- École National des Mines de Saint-Étienne, France, Dr. Olivier Boissier.
- University of Trier, Germany, Dr. Norbert Kuhn.
- Information Processing Laboratory of the Oulu University, Finland.
- Sobolev Institute of Mathematics of the Russian Academy of Sciences, Novosibirsk.
- Universidade Federal do Rio Grande do Sul, Prof. Ana Bazzan.
- Universidad Autónoma de Yucatán, Merida, México, Prof. Luis A. M. Ubando.
- The Centre for Biomedical Engineering, University College of London, Dr. Stephen Taylor.
- City College, University of London, Dr. Eduardo Alonso.
- OFAI, Austrian AI Research Cente, Vienna - Paolo Petta.
- Czech Tecnical University, Prague, Professor Vladimir Marik
- International Institute for Artificial Intelligence, Spain, Dr. Carles Sierra.
- Pontifícia Universidade Católica de Curitiba, Brasil, Dr. Marcus Shmeil and Dr. Andreia Malucelli.
- Pontíficia Universidade Católica do Rio Grande do Sul
- Centro Universitário do Leste de Minas Gerais - UnilesteMG, Coronel Fabriciano, Minas Gerias, Brasil, Prof. Antonio Machado Filho.

There have been training and post-graduation relations with:

- Universidade Católica de Curitiba, Brasil, Professor Marcos Shmeil. (Andreia Malucelli)
- Humboldt Universitat Berlin, Institut fur Informatik,Prof. Hans Dieter-Burkhard. (Luis Mota).
- The Centre for Biomedical Engineering, University College of London, Dr. Stephen Taylor.
- University of Trier, Germany, Dr. Norbert Kuhn. (Bernd Schneiders, Daniel Palzer).
- Universidade Federal do Rio Grande do Sul, Prof. Ana Bazzan.
- Pontifícia Universidade Católica do Rio Grande do Sul (Rodrigo Braga).

Links with national institutions

- FCT- Fundação para a Ciência e a Tecnologia.
- IEETA- Universidade de Aveiro. Prof. Nuno Lau.
- UNL/FCT- Universidade Nova de Lisboa. Prof. Steiger Garção.
- IST- Universidade Técnica de Lisboa. Prof. Ana Paiva and Prof. J. Pavão Martins.

- FCUL- Faculdade de Ciências da Universidade de Lisboa. Prof. Helder Coelho.
- ISCTE- Instituto Superior de Ciências do Trabalho e da Empresa, Lisboa. Dr. Luis Nunes.
- CEMAS - Universidade Fernando Pessoa, Prof. Pedro Duarte.
- IPB- Escola Superior de Tecnologia e Gestão, Instituto Politécnico de Bragança. (Dr. Paulo Leitão).
- INESC Porto - Prof. Augusto de Sousa.
- CEREM - Universidade Fernando Pessoa, Prof. Nuno Ribeiro.
- TAP- Transportes Aéreos Portuguêses, Lisboa.

There has been collaboration in post-graduation actions with:

- ISCTE- Instituto Superior de Ciências do Trabalho e da Empresa, Lisboa. Dr. Luis Nunes.
- IEETA- Universidade de Aveiro. Prof. Nuno Lau.(Pedro Faria - PhD, Carlos Leão - PhD, Darya Barteneva - MSc).
- CEMAS - Universidade Fernando Pessoa, Prof. Pedro Duarte (António Pereira - PhD).
- INESC Porto - Prof. Augusto de Sousa, Prof. Manuel Matos (Pedro Moreira - PhD, JLPinto - MSc).
- CEREM - Universidade Fernando Pessoa, Prof. Nuno Ribeiro (Paulo Cardoso -MSc).
- TAP- Transportes Aéreos Portuguêses, Lisboa. (António Castro- MSc)
- Instituto Politécnico de Viana do Castelo.(Daniel Moura- MSc).