Mi-Pal

Standard Platform League

Intention to Participate

Australia & Spain

Team Information

Team Name:	Mi-Pal
Team Web Page:	www.mipal.net.au
Qualification video link	http://www.youtube.com/watch?v=4xuMadnoGl4&feature=youtu.be
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Team Description and Commitment

Mi-Pal has a long standing involvement and participation in RoboCup. Prof. Estivill-Castro supervised in 2001 the student team that was champion of the RoboCup Jr (Higher Education-Lego Mindstorms) category in Seattle, and was a team member of the NewBots (University of Newcastle) in 2001. As Mi-Pal, the team participated in the RoboCup SONY League in 4 consecutive years (2003-2006) and in RoboCup@Home twice (2006-2007). In those opportunities, the team scored many goals in regular matches and also performed competitively in the technical challenges. We were recognized for our debugging tools in the SONY Aibo platforms as well as for our software architecture and vision systems.

Figure 1: Mi-Pal participated in RoboCup SPL with 5 Nao robots in 2011 in Istanbul. In all matches the difference was less than one goal, and tied a game.

Our expertise has contributed to the development of high level models for embedded software systems, as well as flexible and generic software architecture. More recently our research has produced capabilities to model behaviors of robots at a high level description by combining reactive mechanisms (modeled by finite state machines) and non-monotonic reasoning (represented by logics like Plausible Logic). The team is supported by

1. the *Autonomous Systems Program* of the *Institute for Intelligent and Integrated Systems (IIIS)* at Griffith University, Queensland Australia, and

2. the *Grup de Recerca en Intelligència Artificial (Informàtica) (GRE)* of the *Departament de Tecnologies de la Informació i les Comunicacions (DTIC)* at Universitat Pompeu Fabra, Barcelona, Spain.

This is a statement of commitment to participate in the RoboCup 2012 SPL using the humanoid robot NAO manufactured by Aldebaran Robotics..

We have **four (4) Nao robots** and **one Nao Academic** in Brisbane, and **one Nao** in Barcelona. Prof. H. Geffner will coordinate students in Barcelona for RoboCup 2012. The team in Australia also consist of PhD, Masters, and honours students involved in specific research and development projects. Vitor Bottazzi, Andrey Kuplinov, and Carl Lusty, are students involved this year. At Griffith University academics can act as supervisors of the Industry Affiliates Program for 3rd year students who are accepted into the Mi-Pal facilities in Brisbane. Also, the IIIS regularly awards undergraduate summer scholarships to students involved in the development of Mi-Pal related tools and modules. The team is organized along the modules described in our reports for previous participation in RoboCup. Since 2010, we expanded our lab in Nathan Campus, Brisbane, as a result of additional support form the University and the Institute for Intelligent and Integrated Systems. We now accommodate a larger field.

We are proud that in the Aibo platform and now in the Nao platform (where the software is the core component of the competition), the software for 2011 was completely developed by the Mi-Pal team, and although we review the work of other teams, we did not re-used their code. For 2012 we may incorporate modules from other teams; for example, our qualification video shows switching to the walk from UNSW's rUNSWift.

Statement of research interests and planned activities

The Artificial Intelligence Group (`www.ai.upf.edu`) at the Department of Technology, in Universitat Pompeu Fabra, studies computational models of reasoning, action, and learning. The approach of the group is focused on efficient methods in automated planning. This work forms the base of a number of successful automated planners that have been developed by the group in collaboration with others internationally, and that has had a strong influence on the progress of the area. The research interest of the Interactive Technologies group at Universitt Pompeu Fabra are cooperative environments, intelligent interfaces, educational telematics, computational educational toys, and human modelling.

The research interests of the academic team at Griffith University are human-robot interaction, multi-agent systems, reasoning, and learning for intelligent mobile agents. We are interested in teams of agents immersed in dynamic, adversarial, non-deterministic and inaccessible environments. The development and research for a team participating in the Standard Platform League fits within the long term interest of the Institute for Intelligent and Integrated Systems at Griffith University [1]. Mi-Pal complements the following areas of research strength:

Intelligent systems, reasoning, pattern analysis. We research multi-agents systems that use non-monotonic reasoning. We currently use Plausible Logic, and directly involved in this line of research are Assoc. Prof. D. Billington, Prof. Estivill-Castro, Dr. R. Hexel and Dr. A. Rock. However, expertise in non-monotonic logics within the IIIS at Griffith involves A. Prof. K. Wang and Prof. Sattar who have previously focused on "Real-time high-level cognitive robotics controllers". At the IIIS, Prof. K. Paliwal is an international authority in voice recognition. Dr. Y. Gao and Dr. A. Liew are experts in image analysis. Other experts in pattern recognition and image processing include Dr. M. Blumenstein and Dr. P. Sheridan.

Robots for people. Prof. V. Estivill-Castro coordinates the research in collaboration with academics in Early Childhood Education and experts in Education for people with disabilities. Two internal grants have been awarded in this direction. Dr. J. Jo actively researches the areas of Robotics and Computer Games.

High level system modeling. Prof. G. Dromey became an authority in software engineering by his proposal to use Behavior Trees for requirements engineering (`www.behaviorengineering.org`). Griffith University is know internationally because of the reputation of the Software Quality Institute (`www.sqi.gu.edu.au`). Prof. V. Estivill-Castro and Dr. R Hexel have taken this approach

[1] `www.griffith.edu.au/engineering-information-technology/institute-integrated-intelligent-systems`

further by enabling knowledge-base descriptions using logics in models of behavior. This constitutes a model-driven engineering of software for robots and was successfully used to build all the behaviors of the participation at RoboCup 2011. More recently this research has enabled formal methods and model checking of software for embedded systems in collaboration with Dr. D. Rosenblueth at UNAM, in Mexico City (see publications).

The individual research interests and contributions of the academic members of the team directly involved in Mi-Pal are as follows (in alphabetical order):

Prof. Vladimir Estivill-Castro's research interests are *Data Mining, Machine Learning, Algorithmic Engineering, Complexity, Computational Geometry.* Dr. Estivill-Castro has been directly involved in programming, designing the software architecture, the image segmentation methods and team strategies. He developed algorithms for efficiently processing the vision and object recognition pipeline. He has supervised two master student projects (Bustamante, Anderson), two PhD projects (Lovell, Fenwick), two honours projects (MacKenzie, Seymon) and several (9) Industry Affiliate Projects associated with Mi-Pal.

Prof. Hector Geffner's research interests are *Models of reasoning and planning.* He authored the `TO Planner` that translates conformant problems into classical problems; this software was the winner of the 2006 IPC Conformant Track. Other software that has achieved meritorious and distinguished placements in bench-mark competitions include `TP*` (for Optimal Heuristic Regression Planner with Time and Resources), `CPT` (for Temporal POCL Planner based on Constraint Programming), `HSP2.0` (for Heuristic Search Planning), and `GPT` (a Planner than handles uncertainty and sensing).

Dr. René Hexel's research interests are *Distributed Systems and Networking; Mobile Computing, Real-Time Systems, Embedded Systems Operating Systems.* Dr. Hexel has experience in fusion of distributed sensors for intelligent systems. He implemented several simulators with a modular user graphical interface for several of the applications of Plausible Logic on board the Sony AIBO. He has worked on wireless signals for localization and he has supervised several projects in distributed teams of robots (like role synchronization) and Industry Affiliates Program projects at Mi-Pal.

Planned Activities

The following three lines of further research work are about to commence in 2012.

Planners on board of robots: Mi-Pal continues to have the ambition of reinvigorating its participation in RoboCup@Home. The research in Mi-Pal has always focused in legged robots as these are the ones that will accompany and assist people in human environments like the office and the home. This is the principal link of collaboration between the Barcelona and the Brisbane sections of the team. Universitat Pompeu Fabra will open in September 2012 a Masters of Artificial Intelligence for Interactive Smart Systems.

Humanoids interacting with elderly people: Mi-Pal has started the definition of project to use the Nao platform in projects involving care. We are starting collaboration with Prof. Wendy Moyle, Director of Research Centre for Clinical and Community Practice Innovation, (at Griffith University) who has started innovative ways of using robotics with patients suffering dementia.

Humanoids as assistive technologies in intelligent homes: We are also commencing a research project in collaboration with Prof. Jeffrey Soar (`www.usq.edu.au/research/usq/soar`) from University of Souther Queensland to explore the potential benefits of using humanoids as assistive technologies in intelligent homes. A demonstration prototype of an alarm system for elderly people in the home was prototyped by Mi-Pal at RoboCup@Home in 2007.

Summary of past relevant work and scientific publications

Mi-Pal relevant work includes tools for analyzing failures in the Aibo platform that became widely used by other teams. We also developed very fast methods for image segmentation [12]. The software engineering architecture and the software design patterns that support our model-driven engineering are based on a whiteboard architecture [19, 9]. This offers a cognitive architecture [26] or a *working memory* as well as a publisher-subscriber pattern for module communication, analogous to what others have called a repository architecture [27], or Data-Distribution Service [28]. Our whiteboard architecture is complementary to Aldebaran's inter-module communication and messaging architecture in the Red-Documentation; however, our approach enables extremely fast interprocess communication and more reliability than the Nao's current ALMemory (when using inter-process communication involves wrapping contents in SOAP). This architecture [9] enables execution of behaviors described with high models [10]. Our contributions are at the overlap of software engineering and robotics [6].

Mi-Pal has taken a model-driven engineering approach to the development of the complex software that constitutes the RoboCup challenge. Our first tool for a higher level of abstractions are logics, and in particular logics that emulate common reasoning. We argue for logics that describe a context by iterative refinement and are natural and analogous to how humans describe a context, starting from the most general case, then proving extensions or refinements. Similarly, our second tool are behaviours captured by a hierarchy of finite states machines. This also enables iterative refinement, describing the most general behaviour which is then refined by a sub-finite state machine.

Modelling by finite-state machines, where the labels for transitions can be statements in a logic that demand proof [13], has been contrasted with plain finite-state machines, Petri nets, and Behavior Trees (relevant behaviour modelling techniques in software engineering) [7]. Our approach produces smaller models, clarifies requirements and we can generate implementations for diverse platforms and programming languages. E.g., the same models can generate code in Java for a Lego Mindstorm[2] as well as C++ for a Nao[3].

We have illustrated [8] the power of non-monotonic logic to describe and complement the descriptions of Behavior Trees and of fine state machines for requirements engineering, illustrated further [6] in the context of embedded systems and robots.

Research outcomes

1 RoboCup Symposium [5, 14, 24, 25] and Robotic Soccer [4, 23]

2 Reasoning on board mobile robots [5, 3] and its use in software architectures and robotic behavior modelling [6, 7, 8, 9].

3 Human-robot interaction [14, 2, 1]

4 Object tracking and object recognition [22, 24, 16, 21, 25, 15, 12], and posture and gesture recognition [20].

5 Localization [5, 3, 11], path planning and visibility [18, 17].

Publications

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