

Relatório de Execução Material

1º ano

FLUX – Flexible Logical Updates, POSI/SRI/40958/2001

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Introduction

The scientific goals of the project for its first year were achieved in the various tasks (cf. description below), without any major deviation from what has been proposed.

The output of the project in terms of publications, theses, organizations of events and prototypical implementation globally exceeded what was expected in the proposal of FLUX for the first year. In fact, the following output has been obtained:

- One PhD thesis has been defended with success (João Leite), in the area of the project, and supervised by a project member (Luís Moniz Pereira) – one PhD thesis was expected.
- One MSc thesis with work integrated in FLUX (task 1) has been defended with success (Agostinho Monteiro), supervised by a project member (Luís Moniz Pereira) – one MSc thesis was expected.
- Two journal articles have been published (one was expected in the proposal), and 9 papers were published as book chapter and in proceedings of international conferences and workshops (8 were expected in the proposal).
- Four prototypical implementations were developed (2 were expected): a legal server based on LUPS (cf. task 1); an interpreter for multi-dimensional updates (task 3); an interpreter for the defined language EVOLP (task 3); a compiler combining updates and preferences (task 3).
- Three international scientific events (2 were expected in the proposal) were co-organized by project members, in areas related to FLUX. Though only one of them took place during year one of the project, most of the organization work had been developed in that period:
 - *CLIMA '02, 3rd International Workshop on Computational Logic in Multi-Agent Systems*, affiliated with the International Conference on Logic Programming (ICLP'02), Copenhagen, August 2002. Co-organized by João Leite, Jürgen Dix and Ken Satoh. Selected papers of this workshop are to be published in a special issue of the Annals of Mathematics and Artificial Intelligence.
 - *DALT-2003, Workshop on Declarative Agent Languages and Technologies*, affiliated with the International Conference on Autonomous Agents and Multi-Agent Systems (AAMAS'03), Melbourne, July 2003. Co-organized by João Leite, Andrea Omicini, Leon Sterling and Paolo Torroni. Proceedings will be published in Springer LNAI.
 - *MAAII'03, Multi-Agents and Artificial Intelligence for the Internet*, affiliated with the Portuguese Conference on Artificial Intelligence (EPIA'03), Beja, December 2003. Co-organized by Carlos Damásio and José Maia Neves. Paper in this workshop will be published in the conference proceeding, to appear in Springer LNAI.

International contacts have been established, and two visits of foreign researchers took place:

- One visit of Paolo Torroni, from the Università di Bologna, for discussing the application of the results of FLUX to agent technology, and in particular to that developed within the European project SOCS, of which Paolo is a member. Co-authored publications are expected in the near future, as a result of this visit.
- Another visit by David Pearce, from the Universidad Rey Juan Carlos, for discussing logical foundation of the work on updates developed within FLUX. For strengthening this collaboration a joint project has been submitted to “Acções Integradas Luso-Espanholas”.

Also important for the establishing of international links, was the participation of FLUX members in the proposal of a European Network of Excellence – *REWERSE, Reasoning on the Web with Rules and Semantic* – where FLUX principal researcher appears as coordinator of the working group on “Evolution and Reactivity”. This international proposal may provide important international links and application domains for testing the results of FLUX. The proposal has passed the scientific evaluation, and is now in the process of negotiation towards the elaboration of the contract.

In summary, during year one the work on FLUX has been developed according to what was foreseen in the proposal and its goals had been achieved. It should be noted, however, that these results were obtained with less resources than what has been planned. In fact, one of the project members, João Leite, which was supposed to work full time in the project, by the end of year 1 could only dedicated to it 25% of his time. This happened due to a quite late reply to an application for a post-doc grant from FCT to João Leite to work full time in FLUX. Though positive, when the answer came João Leite already had to find another source of support, making it impossible to him to accept then the post-doc grant. Before João Leite found this other source of support, he was partially supported by FLUX with “acquisition of services” funds, to work full time on the project. Also important for this lack of human resources was the fact that calls for PhD grants in FCT did not occur for a long time. This made it much more difficult to find, and support, the PhD students foreseen in the project proposal. In fact, we could only support one new PhD student, from other funds, to work on FLUX. This situation cannot continue for year 2, since no more of these funds are available. The possible non attribution of PhD grants from FCT for students to work in FLUX (which had been proposed) would cause a serious impact in the human resources available for the project development, and could have a quite negative impact on the expected results.

Summary of the task's activities

Below we describe the specific scientific and experimental results obtained in each of the project's task during the first year of the project FLUX.

All the publications mentioned are available from the principal researcher on request, and will appear at the project's home page soon.

Task 1 – Application domains

In this task we are expected to show how the dynamic LP framework can be applied to legal reasoning and to software specifications. It had been foreseen that this task would be active in the first year by applying results previously obtained by the FLUX team, in the domains of legal reasoning and of software specification, and by providing feedback to the language definition task. This foreseen work has been carried out successfully.

In fact, during the first year, work was done trying to show how the dynamic LP framework can be applied to the legal domain. In order to achieve this goal, it was necessary to interact with juridical experts from the Portuguese Attorney General's Office and to identify some relevant examples.

In the legal domain, knowledge may be produced by different national and/or international entities and they may have different levels of priority. For instance, a Portuguese Supreme Court decision supersedes a Relation Court decision but it may be defeated by a European High Court one. Moreover, the rules (laws/regulations) change over time in a way that can introduce contradictions with the previous instances. As a consequence, after each law change it may be necessary to calculate the new updated rules and to reason with and about them. It can be important to be able to "go-back" in time and to know what was valid in specific previous time points. A student from the final year of the Informatics Engineering degree at the University of Évora, Nuno Graça, was the person responsible (with funds from FLUX) for the implementation of a legal server, which uses LUPS (defined over XSB-Prolog) to model the legal knowledge.

A paper, "Using dynamic logic programming to model legal reasoning", describing the proposed methodology was accepted for presentation at the AGP'03 – APPIA-GULP-PRODE 2003 Joint Conference on Declarative Programming, in Reggio Calabria, Italy (September 2003).

This work will continue in the next two years of the project and we expect that Nuno Graça will continue the research in the context of an MSc degree.

Another approach to the application of dynamic logic programming to the representation of legal knowledge was done by Agostinho Monteiro in the context of his MSc thesis, "Programação em Lógica, com actualizações dinâmicas, no raciocínio legal (Protecção Fitossanitária de Vegetais)" - "Logic Programming, with dynamic updates, applied to the legal reasoning (health vegetable protection)". It has passed in January, 2003, at the Universidade Nova de Lisboa, and supervised by Luís Moniz Pereira. In his work, Agostinho Oliveira showed that dynamic logic programming can be applied successfully to a large problem from the legal domain with hundreds of rules. He modeled the European legislation about the protection of vegetables (what is and what is not allowed to be imported/exported by European countries). In this domain, knowledge has evolved dramatically in the last years: new legislation updating the previous one; new countries entering the European union. Dynamic logic programming showed to be an adequate framework to model these evolving environments. This type of application will be

continued in the context of a possible PhD thesis by Agostinho Monteiro, depending on resources.

The second area of application, software specification, followed two distinct approaches:

1. Application of dynamic logic programming to the specification of a specific software system;
2. Evaluation of dynamic logic programming as a tool for the specification of general software systems.

Regarding the first approach, a personal assistant agent for e-mail management was specified. This work was described in two papers accepted to be presented in international conferences:

[J. J. Alferes, A. Brogi, J. A. Leite, L. M. Pereira, **An Evolving Agent with EVOLP**](#), in N. Leone, P. Rullo (eds.), Procs. of [APPIA-GULP-PRODE'02 Joint Conf. on Declarative Programming \(AGP'03\)](#), September 2003.

[J. J. Alferes, A. Brogi, J. A. Leite, L. M. Pereira, **Logic Programming for Evolving Agents**](#), in M. Klusch, A. Omicini, S. Ossowski (eds.), Procs. of [Cooperative Information Agents \(CIA0'3\)](#), August 2003.

In the second approach, the goal is to evaluate the use of dynamic logic programming as a tool for the specification of general software systems. As domain for this evaluation we have chosen legal software systems. In fact, it is well known that the specification of legal systems has many problems and difficulties. For instance, in the context of the IST EU projects E-POWER and E-COURT, UML (User Modeling Language) is being used to model the specification of such systems. However, UML has shown to have problems modeling evolving specifications and more complex relations between data. Work will be done aiming to identify and to characterize the existent main problems.

During the second year of this project we expect to obtain concrete results and, specifically, to be able to compare the dynamic logic programming approach with the UML approach.

Task 2 – Application to database-driven web interfaces

The goal of this task is to demonstrate the feasibility of using dynamic LP reasoning tools in lowering development and maintenance costs of web database-driven applications, by prototyping an extended version of the Declarativa WAM (*Web Application Maker*) tool. For year 1, our goal was to make the necessary adaptations and integration in these tools, in order to make it possible to test the dynamic LP mechanism, and start with some preliminary experiments. These goals were achieved.

The WAM tool provides a web user interface to a database by generating it as needed, based on its specification contained in the "WAMmodel" for an application. WAM includes a generic (Transact-SQL) script, 'WMScript', to automatically build a WAMmodel, given any database. Application development proceeds by human editing of the WAMmodel. The main objective of this FLUX task is to replace WMScript by a "better" script, WMFlux, in the sense that the human developer effort needed to make the final application interface is smaller.

As planned, a Prolog representation was designed for the WAMmodel and its application database schema, including some other (server procedural code) abstract facets. An utility was developed to export and import this representation, so that a logic programmer can experiment manipulating WAMmodels and see the resulting web interface. All this was integrated into the standard WAMAdmin tool in the main WAM distribution, and can be tried online at <http://showroom.declarativa.com>.

Afterwards a preliminary experiment was done, WMFlux1, re-implementing in Prolog the heuristic rules currently embedded in WMScript. This was augmented with additional rules suggested by WAM developers. It became already clear that there are contradictory (WAMmodel creation) rules, and so in year 2 WMFlux1 will be rebuilt on a MDLP framework with the Lisbon group. A learning approach (from multiple <database schema, WAMmodel> pairs) will be tried afterwards, possibly on year 3.

The above work and perspectives are described in a Declarativa technical report, "Transforming web database interface specifications with logic programming", Miguel Calejo and Mário Araújo, 2003.

In addition to several trips to Lisbon (namely on January 22 2003, where he presented "Web Application Maker - a declarative web database tool" as a CENTRIA seminar), on December 2002 Miguel Calejo visited the SUNY campus at Stony Brook; there he met leading members of the XSB Prolog group, namely David S. Warren and Terrance Swift, presenting the WAM tool and discussing possible integration of WAMmodels with other interface declarative models already in use there.

Task 3 – Language definition

The goal of this task is the definition of a dynamic LP language, its declarative and operational semantics, and its implementation. In year 1, this task, as foreseen in the proposal concentrated on the extensions and generalizations (language and declarative semantics) of the results of LP updates and combination of programs, obtained in the past by the FLUX team, that were already identified as important for the application domains studied within the project and for the long term research goals. The extensions and generalizations envisaged in the proposal, were all developed, also counting with feedback from other task (viz. tasks 1 in the domain of software specification, which already uses the extended language, and task 5 in what regards computing environment aware agent behaviors, which served as a major testbed preceding the definition of the extensions.

The main publication in this task is exactly the one which defined the envisaged generalization of the language (dubbed EVOLP) for allowing the integration, in a single unified LP framework, of (static) knowledge about the domain, and of knowledge about the changes in the domain, and the extension of the language to allow for self-evolving knowledge, i.e. knowledge in the specification about the evolution of the specification itself:

J. J. Alferes, [A. Brogi](#), [J. A. Leite](#) and [L. M. Pereira](#), [Evolving Logic Programs](#), In S. Flesca, S. Greco, N. Leone, G. Ianni (eds.), Proceedings of the 8th European Conference on Logics in Artificial Intelligence (JELIA'02), pages 50-61, Springer-Verlag, LNCS 2424, 2002.

The combination of the results about updates of single logic programs, and the results about combination of various programs, into a single framework, also foreseen for year 1 of FLUX, is described in:

[J. A. Leite](#), **J. J. Alferes**, [L. M. Pereira](#), H. Przymusinska, and [T. C. Przymusinski](#), [A Language for Multi-dimensional Updates](#). In J. Dix, J. A. Leite and K. Satoh (eds.), Proceedings of the 3rd International Workshop on Computational Logic in Multi-Agent Systems, (CLIMA'02), pages 19-34, no. 93 of Datalogiske Skrifter (Writings on Computer Science), Roskilde University, Denmark, 2002.

an extended version of which was later published in a journal:

[J. A. Leite](#), **J. J. Alferes**, [L. M. Pereira](#), H. Przymusinska, and [T. C. Przymusinski](#), [A Language for Multi-dimensional Updates](#). In [Electronic Notes in Theoretical Computer Science 70\(5\)](#), 2002

Though not foreseen for the first year, work has also been done in the integration of the language for updates with preferences, and corresponding implementation. This work is described in:

J. J. Alferes, **P. Dell'Acqua**, and **L. M. Pereira**, **A Compilation of Updates plus Preferences**, In S. Flesca, S. Greco, N. Leone, G. Ianni (eds.), Proceedings of the 8th European Conference on Logics in Artificial Intelligence (JELIA'02), pages 62-73, Spriger-Verlag, LNCS 2424, 2002.

Finally, the previous work on dynamic LP languages has been consolidated, and an article has been published in the Artificial Intelligence journal (see below in Publications).

All the theoretical work above, developed in this task, has been implemented. These prototypical implementations can be found in the project's home page.

Task 4 – Abduction in dynamic languages

The work in this task was only supposed to start in the beginning of the second year of the project. Accordingly, there is nothing to report here.

The progress achieved in the other tasks, make it possible to start the work in this task now, and no deviations from the proposed work are foreseen.

Task 5 – Epistemic agents

This task is devoted to more general issues, related to the longer term goal of the research team of building LP rational epistemic agents. The adequacy of the results in other task of FLUX to this more ambitious goal is to be pursued, and richer application domains investigated. This link with the long term research of the team, made in this task, is expected to provide additional feedback for the language definition. More precisely, in this task we envisaged to study theory methods and tools for epistemic agents: hypothetical introspective reasoning for choosing between preferred self-updates; meta-updating and self-development, i.e. hierarchies of update rules for updating update rules; monitoring and controlling self-development via internal (constrained) rules of evolution, and via environment control. Work has been developed in all these topics during year 1. The results of this work are described below, mainly by pointing to the publications. The results are indexed by the above mentioned topics.

There was some good progress attested by the number and kind of publications, beginning to address each of the task's concerns. Ongoing work is not reported, and is left for the next yearly report.

Theory, methods, and tools for epistemic agents:

The general problems and approaches of this task have been published:

[L. M. Pereira](#), *[Philosophical Incidence of Logical Programming](#)*, in: Handbook of the Logic of Argument and Inference, D. Gabbay et al. (eds.), pp. 425-448, [Studies in Logic and Practical Reasoning series, volume 1](#), Elsevier Science 2002.

A general architecture for epistemic agents has been designed, and its description published:

[J. A. Leite](#), [J. J. Alferes](#) and [L. M. Pereira](#), *[MINERVA - A Dynamic Logic Programming Agent Architecture](#)*, In J. J. Meyer and M. Tambe (eds.), Intelligent Agents VIII, pages 141-157, Springer-Verlag, LNAI 2333, 2002.

Hypothetical introspective reasoning for choosing between preferred self-updates.

The following extended abstract paper was accepted at the Third International Workshop COMPUTATIONAL MODELS OF SCIENTIFIC REASONING AND APPLICATIONS (III CMSRA)

Argentine National Library, Buenos Aires, September 14-15, 2003

<http://www.lip.uns.edu.ar/cmsra/>

“Common-sense reasoning as proto-scientific agent activity”

Pierangelo Dell'Acqua and Luís Moniz Pereira

The summary is:

To illustrate the title, we construe an example illustrative of a doctor/patient cooperative diagnostic situation development. This involves an initial patient situation requiring causal explanation; plus his interactive recourse to a doctor, whose initial therapeutic theory, diagnoses, and diagnostic preferences, are conducive to his advising the patient; and furthermore, initiative is required by the patient about courses of action to obtain prescribed medicine, and experimentation and observation of its effect; but meanwhile, unforeseen circumstances provide unexpected new information and action from a third agent, become pertinent for the problem at hand; as a result, the doctor's original theory is revised, in what regards his diagnostic preferences, in the light of the patient's experimentation, and the unexpected triggering of an unforeseen action by the third party.

To model this proto-scientific narrative, we employ the integrative formal computational machinery we have been developing and implementing for rational cooperative epistemic agents. In our logic-based framework, agents can update their own and each other's theories, which are comprised of knowledge, active rules, integrity constraints, goals, abducibles, and preferences; they can engage in abductive reasoning involving updatable preferences; set each other goals; react to circumstances; plan and carry out actions; and revise their theories and preferences by means of concurrent updates on self and others.

The full paper will further explore these dimensions and connections, and be self-contained by inclusion of the formal apparatus spread out in other publications. It is due August 15, 2003.

This problem addressed in the extended abstract paper has been solved, implemented, and tested.

Meta-updating and self-development

Work in this topic is described in the following two publications, both presented in January 2003:

[P. Dell'Acqua, L. M. Pereira, Preferring and Updating in Logic-based Agents](#), in Bartenstein, Geske, Hannebauer, Yoshie (eds.), *Web-Knowledge Management and Decision Support, Selected papers from the 14th Int. Conf. on Applications of Prolog*, pp. 69-71, Springer-Verlag, LNAI 2543, 2003.

[P. Dell'Acqua, L. M. Pereira, A Logical Framework for Modelling eMAS](#), in [V. Dahl, P. Wadler](#) (eds.), *Practical Aspects of Declarative Languages (PADL'03)*, New Orleans, USA, Springer-Verlag, LNAI, 2003.

Monitoring and controlling self-development via internal (constrained) rules of evolution, and via environment control.

In the publication below we study how to combining self-updates with environmental updates, and using different computation modes accordingly:

[J. J. Alferes, A. Brogi, J. A. Leite, L. M. Pereira, **Computing Environment-Aware Agent Behaviours with Logic Program Updates**](#), in A. Pettorossi (ed), Logic Based Program Synthesis and Transformation, 11th Int. Workshop LOPSTR, Selected Papers, pp. 216-232, Springer-Verlag, LNCS 2372, 2002.

This other paper concerns the combination of user updates and preferences with the program ones:

[P. Dell'Acqua, L. M. Pereira, A. Vitória, **User preference information in query answering**](#), in A. Motro, T. Andreasen (eds.), Fifth Int. Conf. on Flexible Query Answering Systems (FQAS'02), pp. 163-173, October 27 - 29, 2002, Copenhagen, Denmark, Springer, LNAI 2522 2002.

Publications

Though this report also mentions, in the description of the work in the various tasks, several papers that were made and even accepted but not published in the first year of the project, here we only list the papers that were in fact published during the period. The ones accepted but not published yet will be listed, with the complete references, in the progress report of year 2.

All of these papers are available from the principal researcher on request, and in the projects home page.

Paper in scientific journals:

- J. J. Alferes, L. M. Pereira, H. Przymusinska and T. C. Przymusinski, LUPS - a language for updating logic programs. In *Artificial Intelligence* 138(1&2), June 2002.
- J. A. Leite, J. J. Alferes, L. M. Pereira, H. Przymusinska, and T. C. Przymusinski, A Language for Multi-dimensional Updates. In *Electronic Notes in Theoretical Computer Science* 70(5), 2002.

Book chapters:

- L. M. Pereira, Philosophical Incidence of Logical Programming, in: *Handbook of the Logic of Argument and Inference*, D. Gabbay et al. (eds.), pp. 425-448, *Studies in Logic and Practical Reasoning* series, volume 1, Elsevier Science 2002.

Paper in proceedings of scientific meetings with refereeing:

- J. J. Alferes, A. Brogi, J. A. Leite and L. M. Pereira, Evolving Logic Programs, In S. Flesca, S. Greco, N. Leone, G. Ianni (eds.), *Proceedings of the 8th European Conference on Logics in Artificial Intelligence (JELIA'02)*, pages 50-61, Springer-Verlag, LNCS 2424, 2002.
- J. J. Alferes, A. Brogi, J. A. Leite and L. M. Pereira, Computing Environment-Aware Agent Behaviours with Logic Program Updates, In A. Pettorossi (ed), *Logic Based Program Synthesis and Transformation, 11th International Workshop, (LOPSTR'01), Selected Papers*, pages 216-232, Springer-Verlag, LNCS 2372, 2002.
- J. J. Alferes, P. Dell'Acqua, and L. M. Pereira, A Compilation of Updates plus Preferences, In S. Flesca, S. Greco, N. Leone, G. Ianni (eds.), *Proceedings of the 8th European Conference on Logics in Artificial Intelligence (JELIA'02)*, pages 62-73, Springer-Verlag, LNCS 2424, 2002.

- P. Dell'Acqua, L. M. Pereira, Preferring and Updating in Logic-based Agents, in Bartenstein, Geske, Hannebauer, Yoshie (eds.), Web-Knowledge Management and Decision Support, Selected papers from the 14th Int. Conf. on Applications of Prolog, pp. 69-71, Springer-Verlag, LNAI 2543, 2003.
- P. Dell'Acqua, L. M. Pereira, A Logical Framework for Modelling eMAS, in V. Dahl, P. Wadler (eds.), Practical Aspects of Declarative Languages (PADL'03), New Orleans, USA, Springer-Verlag, LNAI, 2003.
- P. Dell'Acqua, L. M. Pereira, A. Vitória, User preference information in query answering, in A. Motro, T. Andreasen (eds.), Fifth Int. Conf. on Flexible Query Answering Systems (FQAS'02), pp. 163-173, October 27 - 29, 2002, Copenhagen, Denmark, Springer, LNAI 2522 2002.
- J. A. Leite, J. J. Alferes and L. M. Pereira, MINERVA - A Dynamic Logic Programming Agent Architecture, In J. J. Meyer and M. Tambe (eds.), Intelligent Agents VIII, pages 141-157, Springer-Verlag, LNAI 2333, 2002.
- J. A. Leite, J. J. Alferes, L. M. Pereira, H. Przymusinska, and T. C. Przymusinski, A Language for Multi-dimensional Updates. In J. Dix, J. A. Leite and K. Satoh (eds.), Proceedings of the 3rd International Workshop on Computational Logic in Multi-Agent Systems, (CLIMA'02), pages 19-34, no. 93 of Datalogiske Skrifter (Writings on Computer Science), Roskilde University, Denmark, 2002.