No 4 – August 2003

www2.cs.ucy.ac.cy/projects/colognet

Editorial

Antonis Kakas, Department of Computer Science, University of Cyprus, antonis@ucy.ac.cy

This is the fourth issue of the CoLogNET newsletter. Despite the challenging summer holidays, CoLogNET members and other researchers offered their contributions and as a result the collected material makes interesting reading. The August newsletter reports on the network activities that took place during the latest four months, on research developments in the areas of computational logic and other matters. It also introduces a new theme about reviews of interesting books in the areas of computational logic. You are welcome to send your own recommendations.

The current issue of the newsletter makes reference to the first review meeting organised in Lisbon where stimulating discussions took place about different topics, such as, the contract agreed with Elsevier for the Journal of Applied Logic, the efforts needed to promote education and training activities in Europe, and the endeavour for the development of the Who's Who in Computational Logic.

We would like to emphasize once more that the success of the newsletter depends on the continued interest of the CoLogNet members and other researchers outside the network to contribute with their own reports, articles, news items, reviews and any other appropriate information. In this issue, particularly, we greatly appreciate James Cheney's, Christian Urban's and Jordi Levy's acceptance of our invitation to contribute. We would also like to thank all the contributors for helping us put together this fourth issue of the newsletter. We expect more support and participation in the future, so as to enrich the quality of the newsletter.

Executive Council Report

Professor Jörg Siekman

Heike Scheuerpflug, Heike.Scheuerpflug@dfki.de

Review Meeting

With the collaboration and support of Luís Moniz Pereira the first review meeting was organised on 27 and 28 April 2003 in Lisbon. All council members (except Michael Fisher and Tony Kakas who were absent with valid excuse) attended the review and met with Dr. Fabrizio Sestini, CoLogNET's new project officer, and Dr. David Pearce who was invited as an external expert to assess the progress and quality of the CoLogNET project.

27 April, the first day of the meeting which served as a rehearsal day turned out to be very useful and basically mirrored the agenda for 28 April, the official review meeting. Besides going through each presentation and discussing focal points, the CoLogNET consortium was also invited to participate in a video lecture broadcast organised by the CoLogNET group for education & training on 27 April. Franz Baader from TU Dresden presented an excellent talk in a lecture room in Dresden which was simultaneously broadcasted in Lisbon.

After hard working and efficient sessions the Consortium was granted the delight to listen to Fado, in the restaurant "Club de Fado" located in the heart of Alfama, Lisbon. In many respects Lisbon proved to be the city of light – both on a professional and social level.

From "Club de Fado" restaurant

The review meeting scheduled for 28 April met the expectations of the Commission and the external expert. CoLogNET was acknowledged to be the most efficient and one of the best projects under the IST branch FET and its work was rated to have a profound historic impact on European and world research in computational logic:

"*The network has been active in all the areas planned, including infrastructure building, education and training, technology transfer and the various thematic areas defining the main structure of the network. In many respects the performance so far is on a par, and in several cases exceeds, what NoEs are expected to deliver.*"

From the Review Meeting in Lisbon

Research

All CoLogNET areas have seen significant progress to meet the project and area objectives and individual reports cover in more detail the specific area achievements.

A contract with Elesevier has been concluded for the Journal of Applied Logic. The journal is structured by logic sub areas

- *philosophical logic*
- *new logics arising from applications*
- *modal & temporal logic*
- *logic and constraint logic programming*
- *logic and software engineering*
- *logic and algebraic programming*
- *logic and language*
- *natural language processing*
- *formal methods specification and verification*
- *automated inference systems and modal checking*
- *logic in mechanical and electrical engineering*
- *logic for knowledge representation and the semantic web*
- *mathematical logic*
- *algebraic methods in logic*
- *applied non−classical logic*
- *logic applied to mathematics*
- *logic and neural nets*
- *non−monotonic logics and logics of change*
- *type theory for interactive systems*
- *logic and learning*
- *cognitive robotics: actions and causation*
- *computational models of scientific reasoning*
- *logic and uncertainty*
- *logic and law*
- *human reasoning*

with independent editorial boards and three managing editors who are responsible for the overall running of the journal. The editorial boards represent the leading researchers in their field of research and are considered world class researchers.

Besides the Journal of Applied Logic there is also the ambitious handbook series which is a compilation of the

- *Handbook of Philosophical Logic*
- *Handbook of Logic in Computer Science*
- *Handbook of Logic in Artificial Intelligence & Logic Programming*
- *Handbook of Defeasible Reasoning an Uncertainty Management*
- *Handbook of Tableaux*
- *Handbook of Logic of Argument and Interference*
- *Handbook of Time in AI*
- *Handbook of History and Philosophy of Logic*
- *Handbook of Logic and Philosophy of Science*

Furthermore, Elsevier started a new "red series" on applied logic on the initiative of the CoLogNET chairmen. This series is on par with the seminal "yellow series" on logic and is to complement what is viewed as a too narrow focus of the yellow series on mathematical logic.

Education

A Curriculum for an international masters programme in Computational Logic has been set up in Dresden and Lisbon. The double degree programme between Dresden and Lisbon has been accepted within the DAAD programme "Integrierte binationale Studiengänge mit Doppeldiplom". A complete description of courses within the distributed masters programme will be made available this year.

The Erasmus World Programme which provides the framework for further collaboration with other partner and host universities requires at least three universities as hosts. The Madrid university and other universities may be expected to join the programme. A respective proposal will be submitted this year. In addition funds from Alban (EU) programme for Latin America have been granted.

Furthermore, an electronic market place for the exchange of masters and PhD students and an electronic forum for open positions, jobs and study grants have been set up.

Of special note is also the support of PhD Students in the field of constraint logic programming to participate in CP'02 and CP'03. A PhD school on Logics of Specification Languages is being planned for 2004.

Of particular importance is also to support dynamic teaching materials and to enhance the ESSLLI archive for course material. The main idea is to draw from previous ESSLLI summer school lecturing and course material to optimise the accessibility and re–usability of the teaching material by integrating new media tools into the existing teaching practice.

Concise efforts to further promote education and training activities will help Europe to become the education and training centre for Computational Logic.

Technology Transfer

The main areas involved – formal methods and constraint logic programming have been highly active. Several industrial panels were organised in the field of CLP and CBD. A formal methods I–Day was organised at Floc'02. Both task forces, TF1 (Formal Methods) and TF2 (CLP, CBD & NLP) have already scheduled further industrial events:

- *TF2 Event at CP 2003 in Kinsale*
- *TF2 – ITCLS Satellite Workshop at FME 2003 in Pisa*
- *TF2 – ElsNET Satellite Workshop at 14th Amsterdam Colloquium*
- *TF1 – FM I–Day at FME 2003, Foundation of a "Formal Methods Industry Associaiton"*
- *TF1 – Organisation of a "Teaching Formal Methods" Symposium*
- *TF1 CoLogNET PhD Graduate School*
- *TF1 CoLogNET / CAI Journal Issue*

Besides ongoing activities and joint workshops to strengthen links with industry, a contact database has been set up which provides access to detailed information about industrial partners registered with CoLogNET (see www.colognet.org , section network structure).

Who is Who in Logic

One of the objectives of the network is to set up a large and international Who's Who in logic in the world. The realisation has made progress and a first draft for the Who's Who is online: http://www.aswad–project.org/colognet/index3.html . In a first step the partner have analysed the technical means for its realisation and a first meeting in Saarbrücken for further detailed discussion was held in May. A report was submitted to the consortium and online discussions on the discussed forms of implementation have been initiated. The Who's Who in Computational Logic is intended to serve as the main repository of information about research in the area of Computational Logic.

CoLogNET Portal

Access to the site of IFCoLog, CoLogNET and Compulog America is provided via an attractive and general entry point which provides a short introduction into the field of Computational Logic i.e. "What is Computational Logic". The CoLogNET website provides exhaustive information on the management structure of the consortium and the network areas as well as education and training activities, jobs and grants, task force activities, events and the "Who is Who". Section "Membership" and "Network Structure" are closely linked. The data stored in the CoLogNET database can either be viewed through the map or through data entries available under the alphabetic, academic, national and industrial listings in the "Network Structure". With this mechanism member nodes gain visibility in the field of Computational Logic.

As a result of the review meeting the membership procedure has been facilitated which means that members can now easily register by simply completing the online application form which will be submitted to the Executive Council for approval. Membership agreements only need to be signed in particular cases when long term funding is required.

The reviewer also called for some slight changes of the CoLogNET portal to better bring out the subject "Computational Logic" instead of the networks managerial aspects. It was also recommended to better link the area websites into the main portal. This means the next stage will focus more on getting computational logic content from the separate research area pages in the foreground of the main website.

Relations with other projects and networks

The collaboration between CoLogNET and Agentlink as well as between CoLogNET and Elsenet are already an integral part of the CoLogNET project.

Further relationships have been successfully established between CoLogNET and an IST thematic network in the CBD area, CBSEnet. A first joint workshop will be held from 25−26 in Cyprus.

In addition , Ktweb (Connecting Knowledge Technology Communities) and CoLogNET have set up a formal agreement of cooperation which will be reviewed at the next Executive Council meeting. Ktweb brings together the European projects and people working in information access and knowledge technologies – in research, academia and business – and offers information and resources in these domains at a global level. Computational Logic is fundamental in knowledge technologies and KTweb could serve as a channel for dissemination & promotion of the achievements in CoLogNET, by means of establishing a link between academia and industry. KTweb and CoLogNET will commit themselves to co−ordinate and exchange activities as follows:

KTweb and CoLogNET will put on their homepages a logo, linking to the other site;

KTweb will send out an e−mail alert every quarter to its registered users encouraging to visit and (if appropriate) to register with CoLogNET;

CoLogNET will go live with a one−page section – appropriately featured in the homepage – containing a 4000−characters description of KTweb. The narrative text will be provided by KTweb and will be subject to approval by CoLogNET, prior to publication;

Twice a year (and according to the indications by CoLogNET) an extensive article focusing upon CoLogNET's most recent key facts will be published on the KTweb Newsletter. The text will be provided by CoLogNET and will be subject to approval by KTweb, prior to publication;

CoLogNET members will be given the choice to become registered users and/or Community Directory members of KTweb;

CoLogNET will encourage its network members to make use of the KTweb Forum for their communication needs.

KTweb will make available the online facility free of any charge to CoLogNET members;

CoLogNET members will be given the possibility to publish articles, Technology Factsheets, Product Showcases, News, Events and Links on KTweb. For original (i.e. unpublished) articles, authors will receive from KTweb 500 euro. That without

prejudicing their right to re−publish the same piece afterwards on other information multipliers, provided that mention of KTweb is made (e.g. "Article first published on www.ktweb.org on dd/mm/yyyy").

New Area "Logic and Law"

A new Area *Logic and Law* was proposed to replace the original WP10.

This is an area of great importance with a very long (in fact more than many centuries) history. We have now found a potential chairman, Prof. Andrew Jones from Kings' College London, who is willing to build this up in collaboration with Prof. Dov Gabbay as a subnet and new area within CoLogNET. The project officer and the reviewer agreed in principle but proposed to restructure the new work package. The rewritten work package will be sent to the Executive Council and the Commission for final approval.

Summary and Outlook

In summary, the network has made an excellent start and has had already a significant effect on European and world research. The first 18 months have been extremely challenging for the project, with many tasks requiring considerably more coordinated action (e.g. coordination of partner , the new website portal, the Who's Who in Logic etc.) but we believe that the challenges can be dealt with and that the network is in a very good position.

To better support the networks dissemination activities, the networks mobile dissemination booth is being re−designed and equipped with new posters, leaflets and information brochures. The stand will have its first deployment at FME 2003 in Pisa. It can also be ordered from the coordinating site at DFKI for other dissemination activities.

As proposed at the review meeting a new scheme has been set up to provide funding for Eastern European research fellows to stay for a certain period at partner institutes. This activity targets mainly researchers from Eastern European countries to expand their contacts with member institutes of CoLogNET.

Luís Moniz Pereira, lmp@di.fct.unl.pt
Centro de Inteligência Artificial (CENTRIA), Universiddade Nova de Lisboa

EU programmes for non–European students

Transnational education is becoming increasingly common in Europe. Many institutions in the EU Member States have already developed bilateral relations with the universities and training centers in other countries in the area of higher education. The European Commission supports these links with third countries through a range of programmes in higher education aimed at reinforcing cooperation between higher education institutions in these countries and fostering mobility of students and scholars between Europe and the rest of the world.

The following EU education and research programmes are open to the third country nationals (some of them are also open to the nationals of the EU Member States, EFTA countries and countries candidates to the EU membership):

GLOBAL PROGRAMMES	**ERASMUS MUNDUS, MARIE CURIE ACTIONS, BUDGET HEADING A–3022**
LATIN AMERICA	**ALBAN, ALFA**
USA	**EC/USA PROGRAMME**
CANADA	**EC/CANADA PROGRAMME**
ASIA	**ASIA–LINK, AUNP, ASEF, EU–INDIA ECONOMIC CROSS CULTURAL PROGRAMME**
JAPAN	**EU/JAPAN PROJECTS**
AUSTRALIA	**EU/AUSTRALIA PROJECT**
EASTERN EUROPE and CENTRAL ASIA	**TEMPUS (TASIC)**
WESTERN BALKANS	**TEMPUS (CARDS)**
SOUTH AND EAST MEDITERRANEAN	**TEMPUS (MEDA)**
TURKEY	**JEAN MONNET SCHOLARSHIP PROGRAMME**

GLOBAL PROGRAMMES

ERASMUS MUNDUS – EU Global Scholarship Programme (to be launched in 2004)

Who is eligible?   Citizens of the countries other than the EU Member States, EFTA States and countries candidate for the accession to the EU, who may not have carried out his or her main activity (studies, work, etc.) for more

than a total of 12 months over the last five years in any of the Member States or the participating countries.

Type and duration – **scholarships for third country graduate students** selected to enrol for a full study period (up to 20 **of the scholarships** months) in European Union Master courses;

– **scholarships for third country visiting scholars** for teaching and scholarly assignments (average three months) connected with European Union Masters Courses

How to apply? *The information on the application procedure will be published as soon as it becomes available.*

Further *For more information on this programme, please, visit* http://www.study−in−europe.org/default.htm
information

MARIE CURIE ACTIONS (FP6) – GRANTS TO SUPPORT TRAINING AND MOBILITY OF RESEARCHERS

Who is eligible?	Citizens of the Third countries, the EU Member States and Associated States	
Type and duration of the scholarships	**Early stage researchers (postgraduates with less than 4 years research experience)**	**Experienced researchers (having a PhD or 4 years research experience)**

Host−driven actions

Marie Curie Host Fellowships for Early Stage Research Training (EST) support researchers in the acquisition of specific and technological research competencies as well as complementary skills in the early stage of their career, typically within the context of a PhD. Fellowships can range from three month up to three years.

Marie Curie Host Fellowships for the Transfer of Knowledge (ToK) support fellowships for experienced researchers of a duration between two months and two years. There are two schemes contemplated: *Marie Curie Development Scheme* in which researchers transfer knowledge to develop the research potential of institution and *Marie Curie Industry−Academia Strategic Partnership Scheme* supporting long−lasting collaborations between enterprises and universities via exchange of researchers.

– **Marie Curie Research Training Networks (RTN)** promote the training, mobility and professional development of researchers, through research and transfer of knowledge, within the frame of international collaborative research projects. Fellowships can range from three months up to three years.

– **Marie Curie Conferences and Training Courses (SCF, LCF)** provide support for researchers (with up to 10 years of research experience) to participate in specific training events (conferences, summer schools, laboratory courses etc.)

Individual−driven actions

Marie Curie Incoming International Fellowships (IIF) aim at attracting top−class researchers from the third countries to work in Europe with a view to developing mutually−beneficial research cooperation. Duration of stays can be one to two years (up to three years with return phase)

How to apply? *For host−driven actions* applications for funding are made by institutions (universities, research centres and enterprises). Successful hosts promote the vacancies and select the individual researchers themselves.

Individual researchers can consult the Pan−European Researcher's Mobility Portal (to be launched in May 2003), where the vacancies for research opportunities in Europe are published.

For individual−driven actions applications for funding are made to the European Commission jointly by the fellow and in liaison with the host organisation in response to *Call for Proposals*, which are published on the Marie Curie Actions website.

Further information http://europa.eu.int/comm/research/fp6/mariecurie−actions/home_en.html

BUDGET HEADING A−3022 − GRANTS TO SUPPORT YOUNG RESEARCHERS WORKING ON EUROPEAN INTEGRATION

Who is eligible? Citizens of the Third countries, the EU Member States, Associated States

Type and duration of the scholarships **Grants for young researchers** (aged up to 35) working on European integration and seeking to enhance their research by spending a period of maximum of 6 months in another country

How to apply? The programme is implemented through academic institutions (institutes, study and research centres, organisations or associations and university networks of teachers, researchers or students) and only academic institutions may apply for funding.

Individuals interested in mobility should contact the institution to which they belong.

Further information http://www.europa.eu.int/comm/education/ajm/call.html

LATIN AMERICA

ALBAN   Scholarship Programme for Latin Americans

Who is eligible? Citizens of Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay and Venezuela.

Type and duration of the scholarships – **Scholarships to do postgraduate studies** in the EU leading to a master or a doctorate degree;
– **Training scholarships for professionals**, working in the eligible Latin American countries, seeking high level specialisation training at a higher education or training EU centre. Scholarships may last from 6 month to 2 years (exceptionally 3 years) and are awarded in all subject areas with the exception of language learning.

How to apply? The applicants must submit their applications before the specified deadlines to the Alban Office: http://www.programalban.org

Further information http://www.europa.eu.int/comm/europeaid/projects/alban/index_en.htm

ALFA − Academic Cooperation Programme between the European Union and Latin America

Who is eligible? Citizens of Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay and Venezuela.

Type and duration of the scholarships – **Advanced training:** Doctorate (especially with co−tutoring), Master degrees or post−doctoral vocational specialisation courses (residences of 6 to 20 months by grant−holder).
– **Complementary training:** final year student mobility (residences of 6 to 10 months).
– **Short−term training:** as part of post−graduate studies (residences of up to 3 months).
– **Researchers training:** specialised scientific courses for researchers (residences of up to 6 months).

How to apply? The programme is implemented through networks of higher education institutions and only the networks may apply for funding. Individuals interested in mobility should contact the international relations department of the university to which they belong and inquire whether their institution is taking part in the programme.

Further information http://europa.eu.int/comm/europeaid/projects/alfa/index_en.htm

EC/USA Programme

Who is eligible? Citizens of the United States of America

Type and duration of the scholarships Grants are awarded to advanced undergraduate students (two or four−year colleges), and to graduate students in their second or third year for the following types of activities:
– **study periods abroad** in the partner university for a period of one semester or equivalent unit;
– **short intensive programmes** with a minimum duration of three weeks.

How to apply? The programme is implemented through networks of higher education institutions and only the networks may apply for funding. Individuals interested in mobility should contact the international relations department of the university to which they belong and inquire whether their institution is taking part in the programme.

Further information http://www.europa.eu.int/comm/education/ec−usa/usa.html

CANADA

EC/CANADA Programme

Who is eligible? Citizens of Canada

Type and duration of the scholarships Grants are awarded to advanced undergraduate students, and to graduate students in their second or third years for the following types of activities:
– **study periods abroad** in the partner university for a period of one semester or equivalent unit;
– **short intensive programmes** with a minimum duration of three weeks.

How to apply? The programme is implemented through networks of higher education institutions and only the networks may apply for funding. Individuals interested in mobility should contact the international relations department of the university to which they belong and inquire whether their institution is taking part in the programme.

Further information http://www.europa.eu.int/comm/education/canada/canada.html

ASIA

ASIA−LINK PROGRAMME

Who is eligible? Citizens of Afghanistan, Bangladesh, Bhutan, Cambodia, East Timor, India, Indonesia, Lao People's Democratic Republic, Malaysia, Maldives, Nepal, Pakistan, People's Republic of China (excluding Hong Kong and Macao), Philippines, Sri Lanka, Thailand, Vietnam.

Type and duration of the scholarships Grants are awarded to university teaching staff, in particular young faculty and future teachers (i.e. postgraduate students), and administrators covering such activities as:
– **short teaching/training missions** in Europe, especially those combining lectureship or training with activities such as seminars, research collaboration, thesis supervision, outreach conferences, or joint work with local staff;
– **short intensive overseas programmes** to permit attendance at relevant intensive courses (e.g. summer courses or joint modules) or seminars/workshops, the gathering of teaching/research material and the preparation/development of actions of other programme components leading to longer−term partnerships;
– **study/research abroad** for programmes at the Ph.D. and Master's level;
– **internships** when integrated within a structured co−operation between university and industries.

How to apply? The programme is implemented through networks of higher education institutions and only the networks may apply for funding. Individuals interested in mobility should contact the international relations department of the university to which they belong and inquire whether their institution is taking part in the programme.

Further information http://europa.eu.int/comm/europeaid/projects/asia−link/index_en.htm

ASEAN–EU University Network Programme (AUNP)

Who is eligible?	Citizens of Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Philippines, Singapore, Thailand, Vietnam.
Type and duration of the scholarships	Grants are awarded to university teaching staff, in particular young faculty and future teachers (i.e. postgraduate students), and administrators covering such activities as: – **short teaching/training missions** in Europe, especially those combining lectureship or training with activities such as seminars, research collaboration, thesis supervision, outreach conferences, or joint work with local staff; – **short intensive overseas programmes** to permit attendance at relevant intensive courses (e.g. summer courses or joint modules) or seminars/workshops, the gathering of teaching/research material and the preparation/development of actions of other programme components leading to longer–term partnerships; – **study/research abroad** for programmes at the Ph.D. and Master's level; – **internships** when integrated within a structured co–operation between university and industries.
How to apply?	The programme is implemented through networks of higher education institutions and <u>only the networks may apply for funding.</u> Individuals interested in mobility should contact the international relations department of the university to which they belong and inquire whether their institution is taking part in the programme.
Further information	http://www.europa.eu.int/comm/europeaid/projects/aunp/index_en.htm

ASIA–EUROPE FOUNDATION (ASEF) – Student Exchange Scholarships

Who is eligible?	Citizens of Brunei, China, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Thailand and Vietnam
Type and duration of the scholarships	Scholarships for undergraduate and postgraduate students to spend a study period (one or two semesters) in Europe in the partner university.
How to apply?	The programme is implemented through universities belonging to the ASEM Education Hubs–Education and Research Network (AEH–EARN). Individuals interested in mobility should contact AEH–EARN Co–ordinator at the university to which they belong (the list of participating higher education institutions is available on the programme website).
Further information	http://www.aeh.asef.org/mainframe.asp?select=about_SectionID3

EU–INDIA ECONOMIC CROSS CULTURAL PROGRAMME

Who is eligible?	Citizens of India
Type and duration of the scholarships	*For more information on this programme, please, visit http://www.study–in–europe.org/default.htm later.*
How to apply?	The programme is implemented through networks of higher education institutions and <u>only the networks may apply for funding.</u> Individuals interested in mobility should contact the international relations department of the university to which they belong and inquire whether their institution is taking part in the programme.
Further information	http://www.delind.cec.eu.int/en/csn/civil_society/eccp.htm

JAPAN

EU/JAPAN COOPERATION PROJECTS IN THE FIELD OF HIGHER EDUCATION

Who is eligible?	Citizens of Japan
Type and duration of the scholarships	Scholarships for postgraduate (Master) level students and undergraduate (3rd year or higher) students to spend a study period of minimum one academic semester and of maximum 1 academic year in the partner university in Europe.
How to apply?	The programme is implemented through networks of higher education institutions and only the networks may apply for funding. Individuals interested in mobility should contact the international relations department of the university to which they belong and inquire whether their institution is taking part in the programme.
Further information	http://www.europa.eu.int/comm/education/japan/japan.html

AUSTRALIA

EU/AUSTRALIA PILOT PROJECT

Who is eligible?	Citizens of Australia
Type and duration of the scholarships	Scholarships for Master level students to spend a study period of one academic semester in the partner university in Europe.
How to apply?	The programme is implemented through networks of higher education institutions and only the networks may apply for funding. The following universities take part in the project: the University of Western Sydney, The University of New England, The University of Western Australia and The University of Queensland. The European institutions are The Royal Veterinary and Agricultural University (Denmark), the University of Wales Aberystwyth (United Kingdom), Wageningen University and Research Centre (The Netherlands) and the University of Kassel (Germany).
Further information	http://europa.eu.int/rapid/start/cgi/guesten.ksh?p_action.gettxt=gt&doc=IP/02/1692|0|RAPID&lg=EN&display=

EASTERN EUROPE and CENTRAL ASIA, WESTERN BALKANS, SOUTH AND EAST MEDITERRANEAN

TEMPUS

Who is eligible?	**TACIS – EASTERN EUROPE and CENTRAL ASIA:** Citizens of Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Mongolia, Russian Federation, Tajikistan, Turkmenistan, Ukraine, Uzbekistan **CARDS – WESTERN BALKANS:** Citizens of Albania, Bosnia and Herzegovina, Croatia, Serbia and Montenegro, former Yugoslav Republic of Macedonia **MEDA** Citizens of Algeria, Egypt, Israel, Jordan, Lebanon, Morocco, the Palestinian Authority, Syria, Tunisia
Type and duration of the scholarships	Grants are awarded for a maximum period of 12 months to undergraduate students (who have completed at least two years of study), and to graduate, postgraduate and doctoral students for the following types of activities: – **study periods abroad** in the partner university with a minimum duration of 3 months; – **practical placements** with a minimum duration of one month in companies, industries or institutions in a EU Member State; – **participation in intensive course** with a minimum duration of two weeks for students at postgraduate level.
How to apply?	The programme is implemented through networks of higher education institutions and only the networks may apply for funding. Individuals interested in mobility should contact the international relations department of the university to which they belong and inquire whether their institution is taking part in the programme.
Further information	http://www.etf.eu.int/tempus.nsf

JEAN MONNET Scholarship Programme for Turkish Nationals

Who is eligible?	Citizens of the Republic of Turkey (max age 35)
Type and duration of the scholarships	**Scholarships for young graduates and professionals to do postgraduate studies on subjects related to the EU** at a university in one of the EU Member States
How to apply?	The candidates must be nominated by universities, ministries and other institutions to which they belong.
Further information	http://www.deltur.cec.eu.int/burs2003.html http://www.mfa.gov.tr/turkce/grupc/duyurular/01.htm

Two Postdoctoral Research Fellowships – Department of Computer Science, University of Liverpook, UK

Michael Fisher, M.Fisher@csc.liv.ac.uk
Department of Computer Science
University of Liverpool, Liverpool L69 7ZF, UK

Applications are invited for two EU−funded Marie−Curie post−doctoral fellowships, each of two years duration commencing in 2003. The fellowships are available within the Department of Computer Science at the University of Liverpool, and form part of the "Model Checking for Mobility" project.

The successful fellows will work on extending, refining and applying the model checking approach, investigating deductive, lightweight or multi−agent aspects of verification. Competence is sought in a range of areas and so candidates should possess some background in software engineering, ideally with expertise in multi−agent systems, programming languages, algorithmics, or logical techniques.

Applicants should possess a PhD in a related area or have at least four years full−time research experience at postgraduate level (other than doctoral studies). Due to the requirements of the funding body, candidates should be aged under 35, should be nationals of an EU (or EU−associated) state other than the UK, and should be able to commence this position during 2003.

Salary £18,265 − £23,296 pa (but fixed by EU regulations) (In addition a mobility allowance will be paid).

Informal enquiries to Professor M Fisher [M.Fisher@csc.liv.ac.uk]

For further details, visit the following web sites which contain specific information about:

- Marie−Curie development host fellowships subsistence allowance
  http://www.cordis.lu/improving/fellowships/mcf_devhost_contr.htm
- Marie−Curie development host fellowships eligibility
  http://www.cordis.lu/improving/fellowships/mcf_devhost.htm
- Model−Checking for Mobility project http://www.csc.liv.ac.uk/research/logics/MCM/

The closing date was 21 July 2003 and the selection process is in progress. Further particulars and details of the application procedure should be requested from:
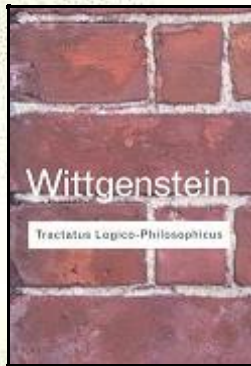
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Book reviews

Tractatus Logico Philosophicus (Routledge Classics)
by Ludwig Wittgenstein, David Francis Pears, Brian McGuinness, Bertr and Russell
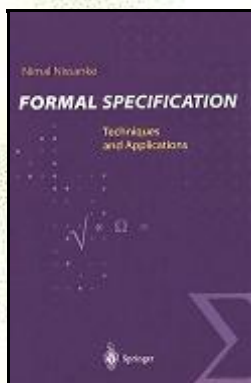
Editorial Reviews

Book Description
Perhaps the most important work of philosophy written in the twentieth century, Tractatus Logico–Philosophicus was the only philosophical work that Ludwig Wittgenstein published during his lifetime. Written in short, carefully numbered paragraphs of extreme brilliance, it captured the imagination of a generation of philosophers.

Synopsis
Perhaps the most important work of philosophy written in the 20th century, "Tractatus Logico–Philosophicus" was the only philosophical work that Ludwig Wittgenstein published during his lifetime. Written in short, carefully numbered paragraphs of extreme brilliance, it captured the imagination of a generation of philosophers. For Wittgenstein, logic was something we use to conquer a reality which is in itself both elusive and unobtainable. He famously summarized the book in the following words: "What can be said at all can be said clearly; and what we cannot talk about we must pass over in silence." The work is prefaced by Bertrand Russell's original introduction to the first English edition.

About the Author
Ludwig Wittgenstein (1889–1951). Regarded by many as the most outstanding philosopher of the twentieth century.

Formal Specification: Techniques and Applications
by Nimal Nissanke, Nismal Nissanke (Preface)

Editorial Reviews

Book Description
Formal Specification is a textbook for 2nd/3rd year undergraduate and postgraduate courses in Formal Methods which offers a practical and versatile approach to constructing specifications. It covers both model–based and algebraic approaches and emphasises the range of languages and approaches which are available. Mathematical principles are explained using examples from everyday life (like card games), in order to "demystify" them and make them more comprehensible. It includes: unrivalled coverage of the topic including all important, recent advances lots of exercises with model answers case studies to guide students through the main principles margin notes to identify key points. Readers of this book do not have to be fully competent in formal specification – it is written to be accessible to any student who wants to learn about the topic.

Book Info
Offers a practical and versatile approach to constructing formal specifications. Mathematical principles, abstraction and modularization are explained using examples from practical computing and every day life. Softcover.

Algebraic Foundations of Systems Specification (Ifip State−Of−The−Art Reports)
by E. Astesiano (Editor), H.−J Kreowski (Editor), B. Brieg−Bruckner (Editor), B. Krieg−Bruckner (Editor)

Editorial Reviews

Book Description
This IFIP state−of−the−art report presents a collection of fundamental high−quality contributions on the algebraic foundations of systems specification. The contributions cover and survey current topics and recent advances, and address such subjects as: the role of formal specification, algebraic preliminaries, partiality, institutions, specification semantics, structuring, refinement, specification languages, term rewriting, deduction and proof systems, object specification, concurrency, and the development process. The authors are well−known experts in the field. The book is an outcome of IFIP WG 1.3 (Foundations of Systems Specification) in cooperation with Esprit Basic Research WG COMPASS, and provides the foundations of the algebraic specification language CASL designed in the CoFI (Common Framework Initiative for Algebraic Specification and Development) project. It is aimed at system developers, researchers, and students.

Book Info
A state−of−the−art report presenting a collection of fundamental high quality contributions in the area of algebraic foundations of systems specification. Covers and surveys active topics and recent advances.

Your Recommendations

Constraint Solving over Multi−valued Logics
Application to Digital Circuits
Volume 91 Frontiers in Artificial Intelligence and Applications by *F. Azevedo*

Editorial Reviews

Book info
This book comes in the sequence of the success of the author's PhD thesis.

About the Author
Francisco Azevedo is an Assistant Professor at the Department of Computer Science of FCT/UNL in Portugal, since 2002, and a member of CENTRIA, its Artificial Intelligence Centre.

Book Description
Systems are subject to faults in their components, affecting their overall behaviour. In a 'black−box' system, such faults only become apparent in the output when appropriate inputs are given, which poses a number of satisfaction and optimisation problems regarding both testing and diagnosing. In this dissertation we address such problems, developing models with multi−valued logics that we formalise and generalise to multiple faults. Such logics extend Boolean logic by encoding dependencies on faults, thus allowing the modelling of an arbitrary

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number of diagnostic theories. The effectiveness of constraint solving over finite domains and sets is shown on several of the above problems.

Related links
PhD thesis: http://ssdi.di.fct.unl.pt/~fa/phd/ReadMe.html
Department of Computer Science: http://www.di.fct.unl.pt/
FCT: http://www.fct.unl.pt/
UNL: http://www.unl.pt/
CENTRIA: http://centria.di.fct.unl.pt/

Summer School and Workshop at TU Dresden

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University of Liverpool, Liverpool L69 7ZF, UK

From June 23 till July 4, 2003, the ``Summer School and Workshop on Proof Theory, Computation and Complexity'' (http://www.wv.inf.tu–dresden.de/~guglielm/WPT2/index.html) was organized at the TU Dresden by the members of the research group of Steffen Hölldobler –– Paola Bruscoli, Bertram Fronhöfer, Alessio Guglielmi, Charles Stewart, Sylvia Epp, Mariana Stantcheva, Aning Song –– and with external support by Birgit Elbl from the Universität der Bundeswehr München and Reinhard Kahle from the Universidade Nova de Lisboa.

At the summer school several highly qualified lecturers gave courses: Peter Aczel (Manchester, UK), Roy Dyckhoff (St Andrews, UK), Achim Jung (Birmingham, UK), Sara Negri and Jan von Plato (Helsinki, Finland), Stephen Simpson (Penn State, USA), Jim Lipton (Wesleyan, USA) and Reinhard Kahle (Universidade Nova de Lisboa). The last two days were devoted to a scientific workshop (http://www1.informatik.unibw–muenchen.de/Birgit/pcc03.html).

The summer school received funding from various sides: the International Quality Network `Rational mobile agents and systems of agents', the Graduiertenkolleg 334 `Specification of discrete processes and systems of processes by operational models and logics', the Consolato Generale d'Italia – Lipsia/Italienisches Generalkonsulat in Leipzig and also CoLogNet.

However, the most generous funding were 23,400 Euro for participation grants from the German Academic Exchange Service (DAAD) within a newly established funding program. This funding program, projected for many years, aims at developing under the rubric ``Deutsche Sommer–Akademie / German Summer–Academy'' a well–balanced set of German summer schools which are competitive on the international level. The funding from DAAD shall foster the participation of young foreign researchers at the summer school. At 1450 Euro, the participation grants from DAAD are relatively high and reserved for promising researchers.

After 2001 and 2002 this is the third event in a series of Summer Schools on Computational Logic at TU Dresden which shall be continued in 2004.

Implementing Rational Features for Agents in Logic Programming

Luís Moniz Pereira[2] lmp@di.fct.unl.pt

Universidade Nova de Lisboa

Outline

- Implementations of rational agent features[3].
- Overview of selected implemented features
  - ♦ Dynamic Logic Programming
  - ♦ Evolving Logic Programs
  - ♦ Reasoning Integration
  - ♦ Semantic Web application
- Implemented features left out: Belief Revision, Aduction
- W4 project: Well−founded semantics for the World Wide Web
- Conclusion

Introduction

We have implemented the following Rational Agent Features:

1. DLP – Dynamic Logic Programming
2. PDLP – DLP with preferences
3. MDLP – Multi−Dimensional DLP
4. LUPS – Language for Dynamic Updates
5. EVOLP – Evolving Logic Programs
6. Prolog based standard XML tools

Some of these are further detailed below. All can be followed up on via their respective hyperlink.

DLP is a semantics for updates of LPs by LP rules. It guarantees that most recent rules are set in force, and previous rules valid by inertia insofar as possible, i.e. are kept for as long as they do not conflict with more recent ones. Originally, in DLP default negation is treated as in the stable models semantics of generalized programs. Now it is also defined for the WFS.

EVOLP is a Logic Programming language for: specifying evolution of knowledge bases; allowing dynamic updates of specifications; capable of dealing with external events; dealing with sequences of sets of EVOLP rules.These rules are generalized LP rules (i.e. possibly with *not*s in heads) plus the special predicate *assert/1*, that can appear both in heads or bodies of rules. The argument of *assert/1* can be a full−blown EVOLP rule. The meaning of a sequence of update rules is given by sequences of models. Each sequence determines a possible evolution of the KB. Each model determines what is true after a number of evolution steps (i.e. a state) in the sequence:

- A first model in a sequence is built by "computing" the semantics of the first EVOLP program, where *assert/1* is as any other predicate.
- If *assert(Rule)* is true at some state, then the KB must be updated with *Rule.*
- This updating of the KB, and the "computation" of the next model in the sequence, is done as in DLP.

An example application concerns a personal assistant agent for email management able to: *Perform basic actions of sending, receiving, deleting messages; Storing and moving messages between folders; Filtering spam messages; Sending automatic replies and forwarding; Notifying the user of special situations.*

All of this dependent on user specified criteria, and where the specification may change dynamically[4].

We can integrate within the same logic programming framework incomplete, uncertain and paraconsistent reasoning forms. Furthermore, our semantics are able to detect the dependencies on contradiction[5]. Existing embeddings of other

formalisms into our framework are: Ordinary Horn clauses; Generalized Annotated Logic Programs; Fuzzy Logic Programs; Probabilistic Deductive Databases; Weighted Logic Programs and Statistical Defaults; Hybrid Probabilistic Logic Programs; Possibilistic Logic Programs; Quantitative Rules; Multi–adjoint Logic Programming; Rough Sets.

Our XML tools:

Non–validating XML parser with support for XML Namespaces, XML Base, complying with the recommendations of XML Info Sets. Reads US–ASCII, UTF–8, UTF–16, and ISO–8859–1 encodings.

- Converter of XML to Prolog terms.
- RuleML compiler for the Hornlog fragment, extended with default and explicit negation.
- Query evaluation procedures for Paraconsistent Well–founded Semantics with Explicit Negation.

These and the tools mentioned below, enable our group with possibilities regarding Semantic Web Applications of Logic Programming. This is being pursued in the wider context of the REWERSE NoE submitted to the FP6 (under evaluation but with good chances of approval, and having already passed the first hurdle). Our Logic Programming and the Semantic Web tools:

- RuleML standards.
- Implementation of Prolog based standard XML tools, namely a fully functional RuleML compiler for the Horn fragment with two types of negation (default and explicit).
- Evolution and updating of knowledge bases. The existing implementations are being integrated with RuleML.
- Semantics of logic programming. Supporting uncertain, incomplete, and paraconsistent reasoning (based on Well–founded Semantics and Answer Sets).
- Development of advanced Prolog compilers (GNU–Prolog and XSB).
- Development of distributed tabled query procedures for RuleML.
- Constraint Logic Programming.

The W4 project: Well–founded semantics for the WWW

The W4 project aims at developing Standard Prolog inter–operable tools for supporting distributed, secure, and integrated reasoning activities in the Semantic Web. The project goals are:

- Development of Prolog technology for XML, RDF, and RuleML.
- Development of a General Semantic framework for RuleML including default and explicit negation, supporting uncertain, incomplete, and paraconsistent reasoning.
- Development of distributed query evaluation procedures for RuleML, based on tabulation, according to the previous semantics.
- Development of Dynamic Semantics for evolution/update of Rule ML knowledge bases.
- Integration of different semantics in Rule ML (namely, Well–founded Semantics, Answer Sets, Fuzzy Logic Programming, Annotated Logic Programming, and Probabilistic Logic Programming).

Why have we chosen the Well–founded Semantics with tabling? Because:

- **THE** adopted semantics for definite, acyclic and (locally) stratified logic programs.
- Defined for every normal logic program, i.e. with default negation in the bodies.
- Polynomial data complexity.
- Efficient existing implementations, namely the SLG–WAM engine implemented in XSB. Good structural properties.
- It has an undefined truth–value...
- Many extensions exist over WFS, capturing paraconsistent, incomplete and uncertain reasoning.
- Update semantics via Dynamic Logic Programs.
- It can be readily "combined" with DBMSs, Prolog, and Stable Models engines.
- The existence of an *undefined* logical value is fundamental. While waiting for the answers to a remote goal invokation it can be assumed that its truth–value is undefined, and proceed the computation locally. Loops through default negation are dealt with in XSB, via goal suspension and resume operations.

- Tabling **IS** the right, successful, and available implementation technique to ensure better termination properties and polynomial complexity. Tabling is also a good way to address distributed query evaluation of definite and normal logic programs.

The major guidelines of the project are:

- Tractability of the underlying reasoning machinery.
- Build upon well−understood existing technology and theory, and widely accepted core semantics.
- General enough to accommodate and integrate several major reasoning forms.
- Should extend definite logic programming (Horn clauses). Desirable integration with (logic) functional languages.
- Most of the reasoning should be local (not very deep dependencies among goals at different locations).
- Fully distributed architecture, resorting to accepted standards, recommendations and protocols. Indeed, we have implemented and defined a general and "open" architecture for distributed tabled query−evaluation of definite logic programs. It has a low message complexity overhead. The architecture assumes two types of main components: table storage clients and prover clients. It addresses the issue of table completion by resorting to known termination detection distributed algorithms. It can immediately be extended to handle stratified negation.

The construction of prototypical systems depends on the definition of: Syntactic extensions (apparently, not very difficult); Goal invokation method (Namespaces, XLinks, SOAP, etc.) ; Selection of distributed query evaluation algorithms and corresponding protocols; Formatting of answers and substitutions (should be XML documents); Integration with ontologies. Further applications, testing, and evaluation is required for the construction of practical systems.

Conclusion

In our opinion, Well−founded semantics should be a major player in RuleML, properly integrated with Stable Models. A full−blown theory is available for important extensions of standard WFS/SMs, addressing many of the open issues of the Semantic Web. Most extensions resort to polynomial program transformations, namely those for evolution and update of knowledge bases. Can handle uncertainty, incompleteness, and paraconsistency. Efficient implementation technology exists, and important progress has been made in distributed query evaluation. An open, fully distributed, architecture is being proposed.

Footnotes

1. An updated summary of a presentation at "Logic−Based Agent Implementation", *An AgentLink/CologNet Symposium,* 3rd February, 2003, Barcelona, España. This work has been developed with contributions by (cf. publications): João Alcântara, José Júlio Alferes, António Brogi, Carlos Damásio, João Leite, Luís Moniz Pereira, Teodor Przymusinski, Halina Przymusinska, Paulo Quaresma.
2. E−mail: lmp@di.fct.unl.pt   URL: http://centria.di.fct.unl.pt/~ lmp
3. Available at http://centria.fct.unl.pt/~jja/updates/
4. Cf. J. J. Alferes, A. Brogi, J. A. Leite, L. M. Pereira, **Logic Programming for Evolving Agents**, Cooperative Information Agents (CIA0'3), Helsinki, Finland, August 2003. And, by the same authors, ***An Evolvable Rule−Based E−mail Agent (submitted).***
5. J. Alcântara, C. V. Damásio, L. M. Pereira, **An Encompassing Framework for Paraconsistent Logic Programs**, ***Journal of Applied Logic,*** to appear, 2003. C. V. Damásio, L. M. Pereira, **Hybrid Probabilistic Logic Programs as Residuated Logic Programs**, Special issue on Logics in Artificial Intelligence, ***Studia Logica***, 72(2):113−118, 2002.

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UNIF'03

17th International Workshop on Unification
Valencia, Spain, June 8–9, 2003
Jordi Levy, levy@iiia.csic.es
IIIA, CSIC, Spain

UNIF 2003 is the 17th in a series of annual international workshops on unification, the previous ones having been in Val D'Ajol, France (1987 and 1988), Lambrecht, Germany (1989), Leeds, England (1990), Barbizon, France (1991), Dagstuhl, Germany (1992), Boston, USA (1993), Val D'Ajol, France (1994), Sitges, Spain (1995), Herrsching, Germany (1996), Orléans, France (1997),Rome, Italy (1998), Frankfurt, Germany (1999), Pittsburgh, USA (2000), Siena, Italy (2001), and Copenhagen, Denmark (2002).

Unification is concerned with the problem of identifying given terms,either syntactically or modulo a given logical theory. The topic is understood in a rather broad sense at this workshop. The aim of UNIF 2003, as that of the previous meetings, is to to bring together people interested in unification, present recent (even unfinished) work, and discuss new ideas and trends in unification and related fields. In this edition of the workshop, the organizing committee decided to include a panel on ``Open Problems in Unification''.

A list of typical UNIF topics includes, but is not limited to:

- Unification
    - E–Unification
    - Unification Algorithm
    - Higher–Order Unification
    - String Unification
    - Context Unification
    - Combination problems
    - Disunification
    - Typed Unification
- Implementations

- Related Topics
    - Constraint Solving
    - Tree Descriptions
    - Matching
    - Narrowing
- Applications
    - Type Checking and Type Inference
    - Automated Deduction
    - Rewriting
    - Functional and Logic Programming
    - Grammars
    - Computational Linguistics

The 17th Int. Workshop on Unification (UNIF'03) was held June 8––9, in Valencia, Spain, as an affiliated workshop of the 14th Int. Conference on Rewriting Techniques and Applications (RTA'03), and as part of the Federated Conference on Rewriting, Deduction and Programming (RDP'03).

This technical report (the full text is available at http://www.dsic.upv.es/~rdp03/unif/proceedings.html) collects extended abstracts of the talks, and system demonstrations, and the abstracts of the two invited talks given by Dale Miller, on ``Definitions, Unification, and the Sequent Calculus'', and Wojciech Plandowski, on ``Test Sets for Large Families of Languages''. We are especially grateful to the invited speakers, Dale Miller and Wojciech Plandowski, for accepting our invitation. UNIF 2003 was made possible in part by the kind financial support of the Consejo Superior de Investigaciones Cientificas (CSIC), and the Network of Excellence in Computational Logic (CologNet). The organizing committee also wishes to thank the RTA steering committee, and the RDP'03 Organizing committee for their cooperation and support throughout the preparation of this meeting.

News from the Automated Reasoning Area of CologNet

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CADE−19 workshop on Grand Challenges

As part of CADE−19 in Miami, the AR area of CologNet supported a workshop on Challenges and Novel Applications for Automated Reasoning. Visit http://4c.ucc.ie/~tw/gc/ for more details.

The aim of the workshop was to identify the problems and novel applications that will stimulate researchers in the field for the next twenty or more years. The workshop was scheduled to take place on the afternoon of 28 July consisting of a mixture of invited talks, panels, brainstorming and discussion sessions.

We will have more news in the next issue, since the workshop was still in progress during the writing of the newsletter. Following is the workshop's programme:

- 14.00−14.45 Invited talk:
  Geoff Sutcliffe, "The Grand Challenge of Theorem Discovery"
- 14.50−15.30 Position statements:
  Peter Andrews, "A Universal Automated Information System for Science and Technology"
  Jacques Calmet, "Are there True Grand Challenges in Mechanized Mathematics?"
  Christoph Walther, "Concept formation"
- 15.30−16.00 Break
- 16.00−16.45 Panel discussion: (Toby Walsh moderator) j
  Simon Colton, Stephan Schulz, Volker Sorge, Cesare Tinelli
- 16.45−18.00 Novel applications:
  Raul Monroy, Computer Modelling the Human Immune System.
  Peter Baumgartner, Ulrich Furbach, Margret Gross−Hardt, Thomas Kleemann, Christoph Wernhard,
  KRHyper Inside: Model Based Deduction in Applications.
  Eleftheria Katsiri and Alan Mycroft,
  Knowledge Representation and Scalable Abstract Reasoning for Sentient Computing using First−Order Logic

6th International Conference on Theory and Applications of Satisfiability Testing − Portofino (Italy), May 5−8 2003

The AR area of CologNet supported an invited talk on "Challenges in SAT and QBF research".

The conference followed the Workshops on Satisfiability held in Siena (1996), Paderborn (1998), and Renesse (2000), the Workshop on Theory and Applications of Satisfiability Testing held in Boston (2001) and the Symposium on Theory and Applications of Satisfiability Testing held in Cincinnati (2002).

The purpose of this conference was to bring together researchers from different communities −− including theoretical computer science, artificial intelligence, verification, mathematical theorem−proving, electrical engineering, and operations research −− in order to share ideas and increase synergy between theoretical and empirical work. For more details see http://www.mrg.dist.unige.it/events/sat03/

17th International Workshop in Unifcation

The AR area of CologNet supported UNIF 2003. The aim of UNIF 2003, as that of the previous meetings, was to bring together people interested in unification, present recent (even unfinished) work, and discuss new ideas and trends in unification and related fields. In particular, it offered an opportunity for young researches and researchers working in related areas to get an overview of the current state of the art in unification theory and get in contact with the experts in the field. For more details see http://www.dsic.upv.es/~rdp03/unif/

The AR area of CologNet is supporting one of the main invited speakers at IJCAI–2003, Andrei Voronkov . He will be talking about "New Trends in Automated Reasoning". The conference will take place on August 9th to 15th, in Acapulco, Mexico. For more details see http://www.ijcai–03.org

Work in Progress: Logic Programming with Names and Binding

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Abstract

In this paper we describe work in progress on αProlog, a logic programming language with a built−in notion of names, binding and unification modulo α−equivalence. αProlog is based on a mild extension of first−order Horn formulae: instead of the usual first−order terms and first−order unification, it uses nominal terms and nominal unification introduced in [3].

Note: This paper is a revised version of [1].

1 Introduction

Logic programming is particularly suited for implementing inference rules defining relations over terms. Many interesting examples, however, involve terms with bound variables and α−equivalence. For example the typing relation for λ−terms is often formulated with the inference rules

$$M: T T' \quad N: T \quad \{x:T\} M: T'$$

with the implicit side−condition that in Γ (a set of type assignments for variables) no variable has more than one assignment. This side−condition is violated if the third rule is applied bottom−up and Γ in the conclusion already contains an assignment for x. In this case the bound variable x in λx.M needs to be renamed to a new x so that a type assignment for x can be safely added to Γ. It is understood that this renaming does not affect the `meaning' of the term, because terms are identified modulo α−equivalence.

However, this intuitive account of α−equivalence does not carry over to a correct declarative implementation in Prolog. For example, if we naïvely implement the typing rules with the clauses

```
member X X::L.
member X Y::L                        :- member X L.
type Gamma (var X) T                 :- member (pair X T) Gamma.
type Gamma (app M N) T'              :- type Gamma M (arrow T T'),
                                        type Gamma N T.
type Gamma (lam X M) (arrow T T')    :- type (pair X T)::Gamma M T'.
```

where X is a (logical) variable, then we get incorrect answers for λ−terms such as λx.λx. (x x). For this ill−formed term, the naïve implementation erroneously returns two possible types: $\tau \to (\tau \to \sigma) \to \sigma$ and $(\tau \to \sigma) \to \tau \to \sigma$. Although this problem can be fixed by judicious use of cut, first−order terms are unwieldy for implementing relations about syntax with binders correctly.

The traditional solution for this problem is to use a higher−order logic programming language, such as λProlog (see for example [2]), with higher−order terms. Such languages provide elegant mechanisms for dealing with binders, but they also introduce new problems: unification for higher−order terms is in general undecidable and if unifiers exist for a problem they may not be subsumed by a single most general unifier. Furthermore, inference rules such as the ones given above are specified using meta−variables (often also referred to as context−variables, which can be replaced with a term); using higher−order unification one needs to replace these meta−variables with function variables and moreover has to explicitly specify the parameters the function variables depend on. This leads to encodings that are quite different in form from their intuitive pen−and−paper counterparts since there dependences are left implicit as much as possible.

In this paper we shall present a logic programming language called αProlog in which one can implement the inference rules given above correctly as follows:

```
            type Gamma (var X) T                    :- member (pair X T) Gamma.
            type Gamma (app M N) T'                  :- type Gamma M (arrow T T'),
                                                        type Gamma N T.
            type Gamma (lam x.M) (arrow T T')  /  x#Gamma
                                                     :- type (pair x T)::Gamma M T'.
```

Posing the queries

      (a) `type nil (lam x.(lam x. (var x))) A`   and
      (b) `type nil (lam x.(lam x. (app (var x) (var x))) B`

to αProlog produces the unique answer [A:=arrow T (arrow T' T')] for (a), and no answer for (b).

Two novel features of αProlog are illustrated by the third clause of `type`. First, *abstractions* are a built–in notion of αProlog; thus we can write `(lam x.M)` in which x is taken from the syntactic category of names, M is a variable and `lam` a function symbol. This term is intended to unify with any λ–abstraction, for example `(lam x.var x)`, `(lam y.app (var x) (var y))` and so on, where in the first case the unifier is the capturing substitution [M:= var x]. Note that if we had used higher–order unification, then `(lam x.M)` does *not* unify with `(lam x.var x)`, because there is no capture–avoiding substitution that makes both terms equal. Also note that in αProlog binders have concrete names, which are not restricted to the scope of the abstraction. These names can be therefore used in the body of the clause, for example to add `(pair x T)` to the context Gamma. In contrast, in higher–order abstract syntax binders are anonymous and cannot escape their scope. So, in λProlog, a binder from the head cannot be used in the body of a clause.

Second, *freshness constraints*, here x#Gamma, can be attached to the heads of clauses; the freshness constraint x#Gamma ensures that the variable Gamma is not instantiated with a term containing x freely. Since the third clause is intended to implement the type inference rule for λ–abstractions, its operational behaviour is given by: choose fresh names for Gamma, x, M, T and T' (this is standard in Prolog–like languages), unify the head of the clause with the goal formula, apply the resulting unifier to the body of the clause and make sure that Gamma is not substituted with a term that contains free occurrences of the fresh name we have chosen for x.

2 Nominal terms and nominal unification

To calculate unifiers, αProlog employs the nominal unification algorithm of Urban et al. [3], which produces unifiers that make two terms equal modulo α–equivalence. Nominal unification retains the main advantages of first–order unification: all unification problems are decidable and solvable problems possess most general unifiers. It makes use of the notion of possibly capturing substitutions, i.e. substitutions that allow M to be substituted with `(var x)` in the term `(lam x.M)` without introducing a new name for the binder x, and the notion of name swapping. A name swapping is a pair of the form `(x y)`, and if applied for example to the term

      `lam x. app (lam x. var x)(app (var y) (var z))`

gives

      `lam y. app (lam y. var y)(app (var x) (var z)) .`

As can be seen the name swapping acts on all occurrences of x and y regardless whether they are bound, free or binding. The crucial point about name swapping is that it preserves α–equivalence. For instance, consider `lam y. var x` and `lam z. var x`, which are α–equivalent. Swapping x and y results in `lam x. var y` and `lam z.var y`, which are still α–equivalent, but naïvely substituting y for x results in variable capture in the first term.

Swappings are employed in the nominal unification algorithm when abstractions are unified. For example if one unifies the term `lam x.M` with `lam y.var y`, then M will be instantiated with the term `var x` which can be obtained by applying the swapping (x y) to `var y` (written as (x y)·var y). However care needs to be taken if x occurs freely in the term to which the swapping is applied. For example the unification problem

$$\texttt{lam x.M} \mathrel{\approx}? \texttt{ lam y. app (var y) (var x)}$$

does not have any solution (just replacing `M` by the `swapped' version of `app (var y) (var x)` does not yield two α–equivalent terms). This problem is solved in nominal unification by freshness constraints, which ensure that possible solutions respect α–equivalence. So for solving the unification problem given above one needs to solve

$$\texttt{M} \mathrel{\approx}? \texttt{(x y)·app (var y) (var x)} \quad \text{and} \quad \texttt{x} \mathrel{\mathrel{\#}}? \texttt{app (var y) (var x)}$$

where the first problem asks whether `M` and `app (var x) (var y)` unify, and the second problem asks whether `x` is fresh for `app (var y) (var x)`, i.e. `app (var y) (var x)` cannot contain any free occurrence of `x`. Since the latter does not hold, the unification problem fails–as expected.

While in the examples above the variable `M` is unified with ground terms only, nominal unification also solves more general unification problems involving open terms. For this the notion of freshness constraint needs some slight extension–for the details we refer the reader to [3] which also includes references about a formal verification of the correctness of the nominal unification algorithm using the proof assistant Isabelle.

3 αProlog examples

Considering the first experience we gained with αProlog there is good evidence that abstractions and freshness constraints from nominal unification provide useful programming constructs. Consider for example two of the transformations required for calculating a prenex–normal form of a formula

$$\forall x.P \heartsuit \forall x.Q \to \forall x.(P \heartsuit Q) \quad \text{and} \quad (\forall x.P) \heartsuit Q \to \forall x.(P \heartsuit Q)$$

where in the second transformation Q must not contain any free occurrence of x. These transformations can be implemented as the following clauses.

```
prenex (and (forall x.P) (forall x.Q)) (forall x.(and P Q)).
prenex (and (forall x.P) Q) (forall x.(and P Q)) / x#Q.
```

In the first clause, the use of nominal unification allows, roughly speaking, to synchronise the two binders. In effect this clause is applicable for any term of the form `(and (forall y....) (forall z....)`. What is pleasant about αProlog is that in this clause no explicit renaming of the binders is required: it will be done implicitly by the swapping operation of the unification algorithm. In the second clause, the freshness constraint `x#Q` makes sure that the side–condition placed upon the second transformation holds. In contrast, in a higher–order abstract syntax encoding, we cannot explicitly say that a variable must not occur in a term; instead we can only say that a variable may occur in a term. So, for example, we would have to make the potential dependences on x explicit everywhere in λProlog clauses defining prenex transformations:

```
prenex (and (forall x\P x) (forall x\Q x)) (forall x\(and (P x) (Q x))).
prenex (and (forall x\P x) Q) (forall x\(and (P x) Q)).
```

Another example is given below. It implements the capture–avoiding substitution of a variable in a λ–term[1].

```
id X X.
subst (var X) X T T.
subst (var Y) X T (var Y)        :- not(id X Y).
subst (app M N) X T (app M' N')  :- subst M X T M', subst N X T N'.
subst (lam y.M) X T (lam y.M')   /  y#T,X
                                 :- subst M X T M'.
```

Given this program, posing the query `subst (lam (x. var y)) y (var x) M` yields the result [M := lam x'.var x] where `x'` is chosen freshly during proof search.

Our final example is the definition of evaluation for λ–terms. We first define a relation which expresses β–reduction:

```
beta (app (lam (x.E)) E') R  :- subst E x E' R.
```

Now we define relations `step` that express one–step reduction of λ–terms, and `steps`, the reflexive, transitive closure of `step`:

```
step M M'                     :- beta M M'.
step (app M N) (app M' N)     :- step M M'.
step (app M N) (app M N')     :- step N N'.
step (lam (x.M)) (lam (x.M')) :- step M M'.


steps M M.
steps M M'                    :- step M M', steps M' M".
```

>From the experience we gained so far, all inference rules involving λ–terms can in αProlog be implemented nearly `one–to–one'. We wish to stress, however, that αProlog is not limited to defining relations on λ–terms. We have chosen the λ–calculus as an example because it well–known and the issues raised by binding and capture–avoiding substitution are widely appreciated. However, αProlog can also be used to write programs about languages with other forms of binding, provided these forms admit α–equivalence. Some examples include concurrency calculi such as the π–calculus and the Calculus of Mobile Ambients, in which names can be bound but are not subject to substitution by other (process) terms, only renaming. Another example is modeling imperative languages like C, in which variables serve a dual role as references to memory cells and their contents. Also, freshness constraints and fresh–name generation may be of interest in their own right, for example in modeling fresh–nonce generation in security protocols.

4 Conclusion

Currently, we have implemented a prototype interpreter for αProlog that permits user–defined datatypes and polymorphically typed Horn clauses. Work on verifying the correctness of αProlog's proof search algorithm relative to Nominal Logic and on optimizing the nominal unification algorithm is in progress. In the future, we plan to adapt more advanced logic program analyses for αProlog programs, such as mode, determinism, and termination analyses. Many interesting properties of languages can be framed in terms of such properties on relations; for example unicity and decidability of typechecking can be expressed in terms of determinism and termination of an appropriate moding of the typing relation. Eventually we wish to support general inductive theorem proving about αProlog programs. We believe that this will lead to better tools for computer–assisted reasoning about properties of languages.

References

[1] J. Cheney and C. Urban. System description: alpha–Prolog, a fresh approach to logic programming modulo alpha–equivalence. In J. Levy, M. Kohlhase, J. Niehren, and M. Villaret, editors, *Proceedings of the 17th International Workshop on Unification, UNIF'03*, pages 15–19, Valencia, Spain, June 2003. Departamento de Sistemas Informaticos y Computacion, Universidad Politecnica de Valencia. Technical Report DSIC–II/12/03.
[2] Gopalan Nadathur and Dale Miller. Higher–order logic programming. In D. Gabbay, C. Hogger, and A. Robinson, editors, *Handbook of Logic in AI and Logic Programming, Volume 5: Logic Programming*. Oxford, 1986.
[3] C. Urban, A. M. Pitts, and M. J. Gabbay. Nominal unification. In M. Baaz, editor, *Computer Science Logic and 8th Kurt Godel Colloquium (CSL'03 & KGC)*, Lecture Notes in Computer Science, Vienna, Austria, 2003. Springer–Verlag. To appear.

Footnotes:
[1] `not` is the usual negation–by–failure.

More Pictures from Lisbon

From the Review Meeting

From "Club de Fado" restaurant

Calendar of Events

July 2003

Start Date	End Date	Category	Subject	Place
28 July 2003	29 July 2003	WS	CADE–19 Call for Submission of Abstracts Deadline: has been closed	Miami Beach, United States
30 July 2003	2 August 2003	Conf	CADE–19 Call for Submission of Abstracts Deadline: has been closed	Miami Beach, United States

August 2003

Start Date	End Date	Category	Subject	Place
9 August 2003	15 August 2003	Conf	18th International Joint Conference on Artificial Intelligence Call for Submission of Abstracts Deadline: has been closed	Acapulco, Mexico
11 August 2003	11 August 2003	WS	Workshop on Agents and Automated Reasoning Call for Submission of Abstracts Deadline: has been closed	Acapulco, Mexico
25 August 2003	29 August 2003	Symp	MFCS 2003, 28th International Symposium on Mathematical Foundations of Computer Science Call for Submission of Abstracts Deadline: has been closed	Bratislava, Slovakia
27 August 2003	29 August 2003	WS	7th International Workshop CIA–2003 on Cooperative Information Agents Call for Submission of Abstracts Deadline: has been closed	Helsinki, Sonera Conference Center, Finland

September 2003

Start Date	End Date	Category	Subject	Place
8 September 2003	14 September 2003	Symp	FM 2003: the 12th International FME Symposium Call for Submission of Abstracts Deadline: has been closed	Pisa, Italy
1 September 2003	3 September 2003	Conf	HoloMAS 2003 Call for Submission of Abstracts Deadline: has been closed	Prague, Czech Republic
8 September 2003	14 September 2003	Symp	FM 2003 Call for Submission of Abstracts Deadline: has been closed	Pisa, Italy
15 September 2003	17 September 2003	Conf	3rd International Conference on Web Delivering of Music Call for Submission of Abstracts Deadline: has been closed	University of Leeds, LS2 9JT, United Kingdom
22 September 2003	26 September 2003	Conf	LPAR 2003 Call for Submission of Abstracts Deadline: has been closed	Almaty, Kazakhstan
25 September 2003	26 September 2003	WS	ICoS–4, 4th Workshop on Inference in Computational Semantics Call for Submission of Abstracts Deadline: has been closed	Nancy, France
29 September 2003	1 October 2003	Conf	EURESCOM Summit 2003 Call for Submission of Abstracts Deadline: has been closed	Heidelberg, Congress Hall, Germany

December 2003

Start Date	End Date	Category	Subject	Place
4 December 2003	7 December 2003	Conf	EPIA'03 – 11th Portuguese Conference on Artificial Intelligence Call for Submission of Abstracts Deadline: has been closed	Beja, Portugal
18 December 2003	18 December 2003	Symp	2nd CoLogNET–ElsNET Symposium Call for Submission of Abstracts Deadline: 1 September	Amsterdam, Netherlands
19 December 2003	21 December 2003	Col	14th Amsterdam Colloquium Call for Submission of Abstracts Deadline: 1 September	Amsterdam, Netherlands