SFB 378 - Fortsetzungsantrag (4. F rderperiode: 2005, 06, 07) zu
Teilprojekt MI 4 OMEGA: Ressourcenadaptive Beweisplanung

MI 4 OMEGA: Agent-oriented Proof Planning

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Previous and current work

In the current funding period we have concentrated on the following research topics; where AP (Arbeitspaket) indicates the workpackage and square brackets refer to the respective publications.

AP1, AP2 & AP3: Proof Planning (PP), Agent-based Reasoning (AR) and their Integration

These workpackages are concerned with proof planning (top-down; AP2), agent-based reasoning (bottom-up; AP3) and their integration (AP1).

- A Framework for agent-based reasoning (PhD-Sorge-01)
- Agent-based reasoning as a means to combine and distribute complex reasoning procedures and external reasoners [Calculemus-01, KI-01]
- Agent-based assertion retrieval [Festschrift-Siekmann-03, MKM-01]
- Theory formation and proof planning [Calculemus-02]
- Multi-strategy proof planning [PhD-Meier-03]
- Randomization and restarts [ECP-01]
- Proof planning and logic layer [IJCAR-WS-01]
- Generality of proof planning [35-Years-of-Automath-03]
- Mathematical representations vs. logical representations [Australien-AI-Conference-02,FLOC-02-WS]
- Semantic guidance in proof planning [Tech-Rep-Bham-01]

AP4 Case Studies

This workpackage promised large case studies for an empirical evaluation of the OMEGA system, its proof of concept or a listing of shortcomings respectively, which will be the subject of the final funding period.

- Exploration of residue classes [JSC-02,EUROCAST-01]
- Proof planning for permutation group problems [CADE-03]
- Agent-based theorem proving in naive set theory [KI-01]
- Proof construction, interactive island planning [35-Years-of-Automath-03]
- Certifying solutions to permutation group problems [CADE-03]

AP5: Learning

This workpackage was deemphasized by the reviewers: they considered the workload to broad and too much. Nevertheless we worked on this topic in collaboration with the University of Birmingham, achieving the following results:

- System Learnomatic [CADE-02]
- Learning of proof methods [ECAI-02,CADE-WS-01]

AP6 Infrastructure

The OMEGA system integrates currently more than twenty external theorem proving and computer algebra systems. Our main contributions in this respect are:

§ New logic layer CORE for OMEGA [PhD-Autexier-03, UITP-03, MSc-Huebner-03]
§ Proof presentation [PhD-Fiedler-01,ICCS-01,NLDB-01,ICNLP-02,COLING-02]
§ OMEGA system environment [IJCAI-01,IJCAR-01]
§ MBASE: mathematical knowledge base [JSC-01]
§ MATHWEB-sb: mathematical software bus [CADE-02,Calculemus-02,Calculemus-01]

Wrapping up the project

After more than ten years of development the OMEGA system is now one of the largest projects on an international scale w.r.t. integration of reasoning tools for a mathematical assistent system and it is among the top leading systems worldwide. In this final period of the SFB we will now concentrate on the following topics**:**

- Knowledge based proof-planning can be considered as sufficiently developed; only minor aspects will be further investigated
- However, the logic layer where proof planning is currently based upon has been identified as insufficient. CORE is an answer to this problem and our challenge in the next phase is to optimally adapt proof planning to CORE.
- An integration of agent-oriented techniques is useful to overcome limitations caused by the current sequential proof planning approach; the challenge will be to optimally balance deliberative and reactive reasoning aspects.
- We expect that a final prototype can be realized till the end of the SFB.

Plans for the next period

The immediate task is the replacement of the ND based logic layer of OMEGA: CORE and the new task structures on top of CORE will support full assertion level reasoning. The idea is to handle logic level reasoning aspects within CORE below the task structures layer and to place proof planning and user interaction on top of the task structures. This means in particular that logic level details (such as formula decompositions) will be hidden from the user. The operations on the task level will be modeled as pro-active agents (adaptation of O-ANTS) and Multi-strategy proof planning will be adapted to this scenario; the pro-active agents will be combined with deliberative heuristic guidance mechanisms and the interplay between both will be based on communication of resource information. New topics are:

§ Interplay with external mathematical knowledge bases; agent-based assertion/knowledge retrieval; integration of management of change; tool support for theory exploration
§ Publication-oriented user interface based on TeXmacs
§ Integration of external reasoners and computer algebra systems via brokering mechanisms
§ The evaluation of the interaction and reasoning layer will be carried out with the help of data of the tutorial NL dialog from the DIALOG project and we plan additional case studies in Analysis, Set Theory and Topology in cooperation with the Theorema Project (Buchberger,Linz) and the CALCULEMUS network.

Cooperation within the SFB: **DIALOG** (Siekmann/Pinkal/Benzm ller)

External cooperation

- The University of Birmingham (Manfred Kerber/Volker Sorge)
- International University of Bremen (Michael Kohlhase)
- DFKI LeActiveMath Project (Erica Melis)
- DFKI VSE Project (Dieter Hutter/Werner Stephan)
- Universit t Linz, RISC Hagenberg, Theorema Projekt (Bruno Buchberger)
- Carnegie Mellon University : Philosophy Department (Wilfried Sieg), Mathematics Department (Peter Andrews), Computer Science Department (Frank Pfenning
- Universit Paris-Sud, Texmacs Project (Joris van der Hoeven)

The EU Calculemus Research Training Network is our main source of cooperation within Europe, where OMEGA and MATHWEB now play a major r le.

Requested Funding

2 BAT IIa positions
2 Hiwis + 1 or 2 Hiwi GA (due to the high amount of implementation tasks)