Final Report
Automating Coherent Logic
– ACL –

Marc Bezem*

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1 Summary

The ACL project addresses the technological challenge of developing a system for automated reasoning in first-order logic (FOL) by translating reasoning problems to a fragment of FOL called coherent logic (CL). Since CL is relatively new as a logic for automated reasoning, an important part of the project has been devoted to developing the supporting theory. The complete project description can be found on the project homepage `http://www.ii.uib.no/acl/`. In addition one can find there:

- A list with the main participants
- Complete progress reports 2007-2012

This report is based on a selection of the above information, but will present the results in a more unifying perspective, making use of the fact that the form of this part of the report is not bound to the strict limitations inherent to filling out webforms. In particular, we will not duplicate the long lists of publications and other quantitative information that can be found in the sections "Resultatindikatorer" and "Publiseringsinformasjon" of the yearly progress reports, including the current report on the web.

*Department of Computer Science, Bergen University, Postboks 7800, N-5020 Bergen, Norway, `bezem@ii.uib.no`

First of all, we have been very fortunate with the ACL project as ACL has made it possible to do research for which we otherwise wouldn't have had the resources. Secondly, ACL has strengthened our national and international collaborations. Finally, it has given a number of our students (M.Sc. and Ph.D.) a good start of their career as an academic, both at universities, at research institutions, in companies and in the public service.

2 Goals and Results

We recall the overall goals of the ACL project, each followed by a description of the relevant results:

G1. To build a system for automated reasoning based on CL to support *logical frameworks*

This goal has been achieved: there are several CL-provers being developed, many of them generate proof objects that can be verified in proof assistants such as Coq [2] and Isabelle [3]. The prover `coherent` *is fully integrated as a tactic in Isabelle. A non-exhaustive list of six CL-provers can be found on page 30 of Polonsky's PhD thesis [6]. Polonsky's thesis contains (among other results, see below) a complete description of a translation from FOL to CL, accompanied by a working implementation and experimental results [7]. One of the provers by Hovland is available at* `http://code.google.com/p/clp/`.

G2. To compare CL to other approaches to automated reasoning (resolution, tableaux, matrix methods)

This goal has been achieved to a large extent. The prover Geo has participated in the CADE ATP System Competition [1] with reasonable success in the category First-order Formula (FOF, best result: place 6 of 11 systems in 2006) and in the category Formula Not Theorem (FNT, best result: place 2 of 3 systems in 2007). This is close to the original goal to end among the 5 best. (Winning is very difficult with limited resources, one competes against systems in which at least 10 man-year have been invested.)

G3. To publish in good journals and conference proceedings

This goal has completely been achieved, see the web-report. Andrew Polonsky successfully defended his PhD thesis on 17 Januar 2011.

3 Other results

Even though ACL is a small project (with one PhD student and one postdoc funded), it has had quite some impact beyond the results directly related to the goals as described in the the previous section. In this section we highlight a selection of these other results.

- ACL has helped the following researchers starting their academic career.
  - Roger Antonsen, ACL postdoc 2008-2010. Holds currently a tenured position as lecturer at the Department of Informatics, University of Oslo.
  - Andrew Polonsky, ACL PhD student 2007-2010. Is currently a postdoc in the Intelligent Systems Group of the Institute for Computing and Information Sciences at the Radboud University, Nijmegen. Has also been a postdoc at the Free University, Amsterdam.
  - Dag Hovland, ACL postdoc 2011-2012. Has been PhD student in the NFR-funded project Secure and Heterogeneous Information Presentation (SHIP). Is currently a postdoc at the Department of Informatics, University of Oslo.
  - Eivind Jahren, ACL research assistant August–December 2012. Will continue as PhD student at the Department of Informatics, University of Bergen.
- The PhD thesis of Andrew Polonsky has been awarded the prestigious Ackermann Award 2012. The Ackermann Award is the EACSL Outstanding Dissertation Award for Logic in Computer Science. Citation: "Andrew Polonsky receives the 2012 Ackermann Award of the European Association of Computer Science Logic (EACSL) for his thesis *Proofs, Types and Lambda Calculus*. His thesis brings a number of valuable results in λ-calculus. In particular, it solves in a negative way the range property problem for the theory H, stated by Barendregt in 1976. [.....] The first part of the thesis contains an interesting analysis of the connection between coherent logic and general first-order logic. The thesis is of high level of original creativity. Not only are strong

results presented, but Polonsky also shows creativity stating open problems, which undoubtedly are fruitful for future research." The complete report of the Jury has been published in the proceedings of the 26th International Workshop/21st Annual Conference of the EACSL [8].

- We have organized two major international conferences, TYPES and CSL'11 in Bergen (8–15 September 2011). There were in total 133 participants from over 20 countries. The proceedings of CSL'11 are published in the series LIPIcs, Leibniz International Proceedings in Informatics `http://www.dagstuhl.de/dagpub/978-3-939897-32-3`. A selection of papers will be published as a special issue of the journal Logical Methods in Computer Science.

- Bezem was local organiser of the workshop "New Frontiers in Informatics (NEFI, 11.09.2012) preceding the annual meeting of the Academia Europaea, in Bergen. He gave one of the twelve presentations, entitled "Elements of Mathematics in the Digital Age". Bezem represents Norway in the EU COST Action IC0901 Rich Models Toolkit.

- A new collaboration has emerged: the Automated Reasoning Group (ARGO), Department of Computer Science, Faculty of Mathematics, University of Belgrade. There have already been two visits (in January 2010 and July/August 2012). The ARGO group is actively pursuing the construction of a really fast CL-prover. This is a very important collaboration for the future development of Coherent Logic.

References

[1] The CADE ATP System Competition, `www.cs.miami.edu/~tptp/CASC/`

[2] The Coq Development Team, *The Coq Proof Assistant Reference Manual, Version 8.0*. Available at: `coq.inria.fr/`

[3] L.C. Paulson. *The Isabelle Reference Manual*. University of Cambridge, Computer Laboratory, 1998. Available at: `www.cl.cam.ac.uk/Research/HVG/Isabelle/`

[4] Maude: `http://maude.cs.uiuc.edu/`

[5] Thousands of Problems for Theorem Provers, *The TPTP Problem Library for Automated Theorem Proving*, `www.cs.miami.edu/~tptp`.

[6] Andrew Polonsky, *Proofs, Types and Lambda Calculus*, PhD Thesis, University of Bergen, 2011.

[7] Andrew Polonsky, *Proofs, Types and Lambda Calculus*, Datasets and source code, PhD Thesis, Bergen Open Research Archive, 2012. `http://hdl.handle.net/1956/5657`

[8] Thierry Coquand and Anuj Dawar and Damian Niwinski, *The Ackermann Award 2012*. In: Patrick Cégielski and Arnaud Durand (eds.), *Computer Science Logic (CSL'12) - 26th International Workshop/21st Annual Conference of the EACSL*, pages 1–5, Leibniz International Proceedings in Informatics (LIPIcs), Vol. 16, ISBN 978-3-939897-42-2, ISSN 1868-8969, 2012