



IST-510255

EmBounded

Automatic Prediction of Resource Bounds for Embedded Systems

Specific Targeted Research Project (STReP)
FET Open

D37 (WP10): Sixth Project Workshop

Due date of deliverable: 31 August 2008
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Start date of project: 1st March 2005

Duration: 48 months

Lead contractor: St Andrews University

Revision: 1.2

Purpose: The main goal of this sixth project workshop was to disseminate our research results on static resource analyses for Hume to other researchers in this field, via an open workshop co-located with a well established symposium in the programming languages community.

Results: The presentation of our resource analyses for Hume met strong interest from the groups present at the workshop. One concrete outcome of the workshop was a coordinated effort to combine the research directions through an appropriate EU programme. Furthermore, it was decided to aim for a regular, annual workshop on the topic of resource analysis to maintain the research momentum gained by this meeting.

Conclusion: The one day workshop on resource analysis (ResAn08) was a very lively platform for exchanging research results between the various groups. Other groups expressed interest in our analyses for Hume and in the quality of the bounds that can be generated. For the EmBounded project partners new developments in the area of amortised-cost-based analyses were of immediate relevance.

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Dissemination Level		
PU	Public	*
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential only for members of the consortium (including the Commission Services)	

Sixth Project Workshop

Hans-Wolfgang Loidl <hwloidl@tcs.ifi.lmu.de>
Institut für Informatik, Theoretische Informatik
Ludwig-Maximilians Universität Oettingenstr 67, D 80538 München

Kevin Hammond <kh@cs.st-andrews.ac.uk>
School of Computing Science, Univ of St Andrews,
St Andrews KY16 9SX, Scotland

1 Summary

The sixth project workshop “ResAn08 — Workshop on Resource Analysis”, was held in Hatfield, England on September 9th, 2008. This was the second open workshop within the EmBounded project. The workshop was co-located with the “10th International Symposium on Implementation and Application of Functional Languages (IFL’08)”, hosted by the University of Hertfordshire. This co-location attracted a strong audience from the programming language community, and in particular from developers of related analyses.

This workshop served as a platform for dissemination of our research results in the area of resource analyses, and provided an opportunity to give us input on the latest results of groups working in similar areas. Most notably, the workshop was attended by researchers from a wide range of research groups, focusing on resource analyses for widely varying language such as C, C++, Java bytecode, logic programming and functional programming. Several project-relevant tools and techniques were presented: the COSTA system for cost analysis of Java bytecode (by Puebla); several extensions of amortised-cost based resource analysis to stack-like (non-monotonic) resources (by Campbell), to super-linear constraints (by Tamalet), and for integration with separation logic (by Atkey). Concrete loop bound analyses, to aide general resource analyses, were presented for C (by Bonenfant) and for C++ (by Prantl). Theoretical foundations were covered through presentations on implicit computational complexity (by Roversi), on the generation of a cost analysis from a quantitative operational semantics (by Cachera) and on a resource-aware semantics for a .functional language with explicit de-allocation (by Montenegro).

The workshop concluded with a general discussion session, exploring opportunities of co-operation and of sharing our research results and tool. Via a Skype conference call we discussed possibilities of a larger EU wide cooperation in the form of a Coordinated Action in the area of resource analysis. Based on the good attendance and the very productive atmosphere of the meeting it was agreed, that we should aim for a regular, annual workshop in this area, to retain the momentum gained by this workshop. A follow-on workshop with the title “FOPARA: Foundational and Practical Aspects of Resource Analysis” will be held in Eindhoven on November 3rd, 2009, co-located with the “International Symposium on Formal Methods” and organised by the group at the University of Nijmegen.

2 Participants

The workshop was attended by

- Robert Atkey, University of Edinburgh
- Armelle Bonenfant, Université Paul Sabatier, Toulouse
- David Cachera, IRISA, Rennes
- Brian Campbell, University of Edinburgh
- Christian Ferdinand, AbsInt GmbH, Saarbrücken
- Kevin Hammond, University of St Andrews
- Christoph Herrmann, University of St Andrews
- Steffen Jost, University of St Andrews
- Tamás Kozsik, Eötvös Loránd University
- Hans-Wolfgang Loidl, Ludwig-Maximilians University, Munich
- Manuel Montenegro, Universidad Complutense de Madrid
- Adrian Prantl, Vienna University of Technology
- German Puebla, Technical University of Madrid
- Luca Roversi, Università di Torino
- Norman Scaife, LASMEA, Université Clermont-Ferrand
- Alejandro Tamalet, University of Nijmegen

3 Programme

- 9:00–9:05 *Welcome*
- 9:05–9:30 *Long-Run Cost Analysis by Approximation of Linear Operators over Dioids*
David Cachera
- 9:30–9:55 *A Resource-Aware Semantics and Abstract Machine for a Functional Language with Explicit Deallocation*
Manuel Montenegro
- 9:55–10:20 *Upper Bounds of Resource Usage for Java Bytecode using COSTA and its Web Interface*
German Puebla
- 10:20–10:45 *A Declarative Approach to finding Timing Constraints in High-level Program Representations*
Adrian Prantl
- 10:45–11:15 BREAK
- 11:15–11:40 *Hume and the EmBounded Project*
Kevin Hammond
- 11:40–12:05 *Modern processor architectures make WCET analysis for Hume challenging*
Christian Ferdinand
- 12:05–12:30 *oRange: A Tool For Static Loop Bound Analysis*
Armelle Bonenfant
- 12:30–14:00 LUNCH
- 14:00–14:25 *Introduction to Amortised Program Analysis*
Steffen Jost
- 14:25–14:50 *Practical Resource Analysis for Hume*
Hans-Wolfgang Loidl
- 14:50–15:15 *Hume Case Study: Embedded Control of an Inverted Pendulum*
Norman Scaife
- 15:15–15:40 *Combining high-level and low-level WCET analysis for Hume programs*
Christoph Herrmann
- 15:40–16:00 BREAK
- 16:00–16:25 *Amortised memory analysis using the depth of data structures*
Brian Campbell
- 16:25–16:50 *Amortised Resource Analysis with Separation Logic*
Robert Atkey
- 16:50–17:15 *A perspective on the AHA project*
Alejandro Tamalet
- 17:15–17:40 *Implicit Computational Complexity*
Luca Roversi
- 17:40–
All

The programme of the workshop, with copies of the abstracts and presentations, is online at <http://www.embounded.org/pubs/workshops/080909-Hertfordshire/>.

4 Assessment

The main goal of this sixth project workshop was *dissemination of project results* and input for the project in terms of latest research results and tools in areas related to resource analysis. 6 of the 15 presentations covered results from the EmBounded project. In particular the presentations of mature prototypes of heap space, stack space and worst-case execution time were received with strong interest by the attendants. This triggered fruitful discussions in particular with several other groups, who had picked up our approach to static analysis based on amortised costs and were developing this approach further. Based on these discussions we could identify concrete possibilities of integrating sub-analyses or tools by these partners into our own analysis. We are currently pursuing these possibilities, which open up promising new research directions for successor projects to EmBounded. The presentations on concrete techniques and tools were balanced by the more theoretical presentations on implicit computational complexity and the generation of a cost analysis from a quantitative operational semantics. These gave us a broader view of the area, with potential for long term exploitation.

The main *result* was the presentation of a mature prototype for heap space, stack space and worst-case execution time analysis for Hume [Jos07a, Jos07b]. The quality of the software has much improved since the first presentation at the open workshop in Budapest, the fourth project workshop (see D19 [Ham07]). As a result, we could present analysis results for realistic application programs, which were reported on in a separate talk. Apart from the high-quality results of the analysis, its high-performance was noted, too. Here we profit from the early design decision to use a high-performance, linear programming solver to obtain solutions, although this also limits the range of bounds we can produce in our system. An interesting tool in this aspect, and a possibility for cooperation, is the stand-alone recurrence-solver developed in the frame of the COSTA project, which generates bounds for a wider class of constrains.

In summary, we assess the workshop as a big success in terms of impact within our core community. We had interesting technical contributions following lively discussions, due to the very focused nature of the workshop. Possibilities of cooperation were identified, and an informal decision was taken to aim for a regular, annual workshop on the topic of resource analysis. A first follow-on workshop with the title “FOPARA: Foundational and Practical Aspects of Resource Analysis” will be held in Eindhoven on November 3rd, 2009, co-located with the “International Symposium on Formal Methods” and organised by the group at the University of Nijmegen. The main complaint of the attendants was that time within the one day workshop was too short to cover all the interesting research questions raised in the discussions.

References

- [Ham07] K.. Hammond. Fourth Project Workshop. EmBounded Project Deliverable, April 2007. Deliverable D19.
- [Jos07a] S. Jost. Prototype Implementation of Space Analyses. EmBounded Project Deliverable, February 2007. Deliverable D13.
- [Jos07b] S. Jost. Prototype Implementation of Time Analysis. EmBounded Project Deliverable, February 2007. Deliverable D15.