

**TECHNISCHE FAKULTÄT DER  
CHRISTIAN-ALBRECHTS-UNIVERSITÄT  
ZU KIEL**



Christian-Albrechts-Universität zu Kiel

**almanach 08**

# Programming Languages and Compiler Construction

The research group „Programming Languages and Compiler Construction“ is interested in the design, implementation and application of programming languages intended to support the reliable implementation of complex systems. The research ranges from object-oriented design methods and the analysis of concurrent and distributed systems to the implementation and application of declarative programming languages, in particular, in the area of web-based systems. During the period reported below, the research has been supported by the DFG (German Research Foundation) and the DAAD (German Academic Exchange Service). The national and international collaborations with the University of Münster, the Technical University of Valencia (Spain), and the Portland State University (Oregon, USA) led to new research results.

## Results

During the reported period, the scientific work of the research group involved all areas related to declarative programming languages, e.g., design, semantics, implementation, development tools, and application of such languages. Declarative programming languages are based on clear mathematical foundations. They abstract from the underlying computer architecture and, thus, provide a higher programming level leading to more reliable programs. This also enables opportunities for improving the execution of programs. Instead of a stepwise execution oriented towards the sequential program text, a compiler may select a much more efficient demand-driven strategy oriented towards the data flow of the program. This separation of logic and control supports a more efficient program development. However, in case of programming errors, traditional debugging methods, like stepwise tracing of the program’s execution, are not appropriate. Therefore, we worked on new **debugging techniques**, like debugging by observing the evaluation of distinguished expressions or functions, or declarative debugging. The latter is implemented by a two-phase execution: the first phase executes the program and collects information about program execution. This information is used as an “oracle” for the second phase which present the program’s execution in a different order that is more comprehensible for the programmer.

**Testing** is an important method for quality assurance during software development. An important aspect of testing is the exploration of the test data. In a collaboration with the University of Münster, we investigated new methods to generate test data for functional logic programs. One can also generate test data for purely functional programs by executing them in a functional logic manner, i.e., by calling functions with unbound variables which will be instantiated with appropriate inputs that can be used as test data. Research aspects in this area are appropriate termination and code coverage criteria to control this process. In order to generate test data also for integer values, a new efficient representation of numbers based on algebraic data types has been developed.

In the area of the **design and semantics** of declarative languages, a new relational approach to define a denotational semantics has been developed in cooperation with the research group “Computer-Aided Program Development”. In a collaboration with the Portland State University (Oregon, USA), we worked on automatic error detection and new methods to encapsulate non-deterministic computations in functional logic programs.

We also investigated the **implementation** of functional logic programming languages. The implementation KiCS (Kiel Curry System) is based on a couple of new theoretical insights based on the research of our group in the previous years. In order to optimize programs or check for certain programming errors, we also developed new methods to approximate the patterns of run-time function calls at compile time. We also worked on the implementation of concurrent functional languages by the development of new implementations of software transactional memory, a recent concept for high-level concurrent programming.

Related to the **application** of declarative languages, we investigated high-level programming techniques to access and manipulate databases in a reliable manner. For this purpose, we developed a method to translate typed entity-relationship diagrams into declarative programs that support automatic consistency checks and transactions. Furthermore, we developed a new framework to specify graphical and web-based user interfaces in a uniform manner so that one can generate

graphical user interfaces for desktop applications as well as web-based user interfaces for web applications from the same interface specification. This approach decreases the implementation efforts for application systems.

Our research group was also engaged in **public relations** activities. For instance, we gave an introduction to elementary programming at the Girls' Day of the institute. The visiting students learnt basic programming techniques with the little ladybird Kara. This introduction has also been used for a one week course on programming where the participating students developed a distributed chat program in the concurrent functional language Erlang. This course was organized by Frank Huch (in collaboration with Thomas Wilke).

Concerning the staff of the research group, it should be mentioned that Frank Huch has left the research group in the middle of the last year in order to take a new position in the institute. There he is responsible to administrate the study programs of the institute. He is still listed in the report of this research group since his research is supported by and related to this group.

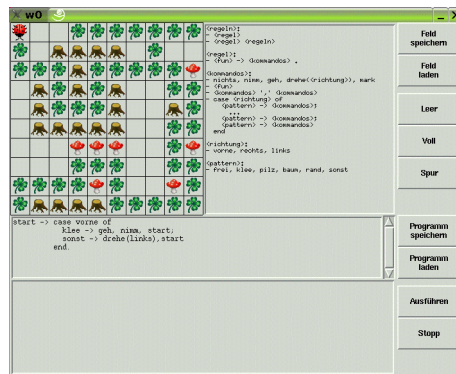


Fig. 1: Learning programming with the little ladybird Kara, Girls' Day/Schnupperstudium Informatik



Fig. 2: Participants of the "Schnupperstudium Informatik"

## Personnel

Head of the group: Prof. Dr. Michael Hanus; Secretary: Ulrike Pollakowski  
 Technical Staff: Dipl.-Ing. Thomas Heß (50%)

Scientific Staff:

Dr.phil. Bernd Braßel	01.01.-30.09.2008	DFG
Systematic Debugging in Declarative Programs		
Dipl.-Inf. Sebastian Fischer	01.01.-31.12.2008	CAU
Priv.-Doz. Dr. Frank Huch	01.01.-31.05.2008	CAU
Priv.-Doz. Dr. Frank Huch	01.06.-31.12.2008	CAU
Administration of study programs		
Dipl.-Inf. Fabian Reck	01.10.-31.12.2008	CAU
Dr. Friedemann Simon	01.01.-31.12.2008	CAU

## Lectures, Seminars, and Laboratory Course Offers

*Winter 2007/2008*

Diplomandenseminar, 2 hrs Seminar/Week,  
 Michael Hanus

G1.1 Informatik I - Programmierung, 4 (+ 2) hrs Lecture (+ Exercises)/Week,  
 Michael Hanus (+ Sebastian Fischer, Rudolf Berghammer, Sven Buchholz, Nils Siebel)

G1.3 - Programmierpraktikum P1, 3 hrs Lab/Week,  
 Frank Huch (+ Jan Christiansen)

MS0306 - Nebenläufige und verteilte Programmierung, 4 (+ 2) hrs Lecture (+ Exercises)/Week,  
 Frank Huch (+ Michael Hanus)

MS0308 - Programmier Techniken für die Künstliche Intelligenz, 2 (+ 4) hrs Lecture (+ Exercises)/Week,  
 Friedemann Simon

Arbeitsgemeinschaft Informatik, Logik und Mathematik, 2 hrs Seminar/Week,  
 Michael Hanus (+ Rudolf Berghammer)

*Summer 2008*

BA6.3: - Projektmodul Internetprogrammierung, 6 hrs Exercise/Week,  
 Michael Hanus (+ Sebastian Fischer)

Diplomandenseminar, 2 hrs Seminar/Week,  
 Michael Hanus

Fortgeschrittenenpraktikum: Internetprogrammierung, 4 hrs Exercise/Week,  
 Michael Hanus (+ Sebastian Fischer)

MS0302: - Übersetzerbau, 4 (+ 2) hrs Lecture (+ Exercises)/Week,  
 Michael Hanus

Systematisches Programmieren, 2 (+ 4) hrs Lecture (+ Exercises)/Week,  
Friedemann Simon

Arbeitsgemeinschaft Informatik, Logik und Mathematik, 2 hrs Seminar/Week,  
Michael Hanus (+ Rudolf Berghammer)

MS0304: - Funktionale Programmierung, 4 (+ 2) hrs Lecture (+ Exercises)/Week,  
Frank Huch (+ Jan Christiansen)

*Winter 2008/2009*

Diplomandenseminar, 2 hrs Seminar/Week,  
Michael Hanus

G1.1 Informatik I - Programmierung, 4 (+ 2) hrs Lecture (+ Exercises)/Week,  
Michael Hanus (+ Fabian Reck, Christina Otte)

BA6.5: Projektmodul - Werkzeuge zur Fehlersuche, 6 hrs Exercise/Week,  
Michael Hanus

Informatik für Nebenfächler, 4 (+ 2) hrs Lecture (+ Exercises)/Week,  
Frank Huch (+ Sebastian Fischer)

MS0301: Prinzipien von Programmiersprachen, 4 (+ 2) hrs Lecture (+ Exercises)/Week,  
Michael Hanus

Arbeitsgemeinschaft Informatik, Logik und Mathematik, 2 hrs Seminar/Week,  
Michael Hanus (+ Rudolf Berghammer)

MS0309: Softwaretechnik zum Zertifizieren von Systemen, 4 (+ 2) hrs Lecture (+ Exercises)/Week,  
Wolfgang Goerigk

MSP0302: Masterprojekt - Werkzeuge zur Fehlersuche, 4 hrs Exercise/Week,  
Michael Hanus

Objektorientierte Programmierung für Nebenfächler, 2 (+ 2) hrs Lecture (+ Exercises)/Week,  
Friedemann Simon

WI08: - Objektorientierte Programmierung, 2 (+ 2) hrs Lecture (+ Exercises)/Week,  
Friedemann Simon

### Third-Party Funds

DFG, *Systematische Fehlersuche in deklarativen Programmen*, 01.01.-31.12.2008 (59.109 EUR)

DAAD, *Implementation of Instrumented Semantics for Declarative Multi-Paradigm Languages*, 01.01.-31.12.2008  
(4.808 EUR)

### Further Cooperation, Consulting, and Technology Transfer

During the reported period, the research group collaborated with:

Portland State University (Sergio Antoy)

Technical University of Valencia (Josep Silva, German Vidal)

University of Münster (Herbert Kuchen)

## ◆ Diploma, Bachelor and Master Theses

- N. Klusczyk, *E-Learning - Bedeutung und Möglichkeiten in Schule und Wirtschaft*, 23.04.2008  
 C. Behse, *Corporate Performance Management - Konzepte und technische Umsetzung*, 29.04.2008  
 F. Reck, *Erweiterung des Concurrent Haskell Debuggers für transaktionsbasierte Kommunikation*, 30.04.2008  
 C. Kluß, *Deklarative Konstruktion Web-basierter Benutzerschnittstellen*, 07.10.2008  
 S. Koschnicke, *Entwicklung von Web-Applikationen aus deklarativen Beschreibungen*, 15.10.2008  
 H. Siegel, *Debugging Non-strict Programs by Strict Evaluation*, 29.10.2008  
 K.-H. Boll, *Datenschutz und Datensicherheit - Gestaltung und Konsequenzen für Schulen*, 26.01.2009

## ◆ Publications

Published in 2008

- Jan Christiansen, Sebastian Fischer, *EasyCheck – Test Data for Free*, FLOPS '08: Proceedings of the 9th International Symposium on Functional and Logic Programming, **Springer LNCS 4989**, 322 - 336 (2008)  
 Sebastian Fischer, Herbert Kuchen, *Data-Flow Testing of Declarative Programs*, ICFP'08: Proceedings of the 13th ACM SIGPLAN International Conference on Functional Programming, **ACM Press**, 201 - 212 (2008)  
 Bernd Braßel, Michael Hanus, Marion Müller, *High-Level Database Programming in Curry*, Proc. of the Tenth International Symposium on Practical Aspects of Declarative Languages, PADL 2008, **Springer LNCS 4902**, 316 - 332 (2008)  
 Michael Hanus, *Call Pattern Analysis for Functional Logic Programs*, Proc. of the 10th International ACM SIGPLAN Conference on Principles and Practice of Declarative Programming, PPDP 2008, **ACM Press**, 67 - 78 (2008)  
 Michael Hanus, Christof Kluß, *Declarative Programming of User Interfaces*, Proc.D 22nd Workshop on (Constraint) Logic Programming, **Technical Report 2008/08**, 37 - 49 (2008)  
 Michael Hanus, *Pre-Proceedings of the 18th International Symposium on Logic-based Program Synthesis and Transformation*, LOPSTR 2008, Universidad Politecnica de Valencia, **Technical Report DSIC-II/09/08**, (2008)  
 Sebastian Fischer, Michael Hanus, *Proc. 25. Workshop der GI-Fachgruppe Programmiersprachen und Rechenkonzepte*, Christian-Albrechts-Universität zu Kiel, **Technical Report 0811**, (2008)  
 Michael Hanus, *Call Pattern Analysis for Functional Logic Programs*, Christian-Albrechts-Universität zu Kiel, **Technical Report 0803**, (2008)  
 Michael Hanus, Dietmar Seipel, Armin Wolf, *Applications of Declarative Programming and Knowledge Management*, Springer Lecture Notes in Artificial Intelligence, **5437**, (2008)  
 Michael Hanus, *Logic-Based Program Synthesis and Transformation - Revised Selected Papers of the 18th International Symposium on Logic-based Program Synthesis and Transformation*, LOPSTR 2008, Springer Lecture Notes in Computer Science, **5438**, (2008)  
 Bernd Braßel, Jan Christiansen, *Denotation by Transformation: Towards Obtaining a Denotational Semantics by Transformation to Point-free Style*, Proceedings of the 17th International Symposium on Logic-Based Program Synthesis and Transformation (LOPSTR 2007), **Springer LNCS 4915**, 90 - 105 (2008)  
 Bernd Braßel, Sebastian Fischer, Frank Huch, *Declaring Numbers*, Electr. Notes Theor. Comput. Sci, **216**, 111 - 124 (2008)  
 Bernd Braßel, Holger Siegel, *Debugging Lazy Functional Programs by Asking the Oracle*, Proc. Implementation of Functional Languages (IFL 2007), **Springer LNCS 5083**, 183 - 200 (2008)  
 Bernd Braßel, Jan Christiansen, *A Relation Algebraic Semantics for a Lazy Functional Logic Language*, 10th International Conference on Relational Methods in Computer Science, and 5th International Conference on Applications of Kleene Algebra, RelMiCS/AKA 2008, **Springer LNCS 4988**, 37 - 53 (2008)  
 Bernd Braßel, *A Debugger for Functional Logic Languages*, 25. Workshop der GI-Fachgruppe Programmiersprachen und Rechenkonzepte, **Technical Report 0811**, 78 - 92 (2008)  
 Bernd Braßel, Frank Huch, *The Kiel Curry System KiCS*, Applications of Declarative Programming and Knowledge

Management, **Springer LNAI 5437**, 195 - 205 (2008)

Bernd Braßel, *A Technique to build Debugging Tools for Lazy Functional Logic Languages*, Proceedings of the 17th Workshop on Functional and (Constraint) Logic Programming (WFLP 2008), 63 - 76 (2008)

Bernd Braßel, Sebastian Fischer, *From Functional Logic Programs to Purely Functional Programs Preserving Laziness*, Proc. 20th Workshop on Implementation and Application of Functional Languages (IFL 2008), 214 - 215 (2008)

Sebastian Fischer, Herbert Kuchen, *Datenfluss in bedarfsgesteuerten Berechnungen*, 25. Workshop der GI-Fachgruppe Programmiersprachen und Rechenkonzepte, **Technical Report 0811**, 163 - 164 (2008)

Frank Huch, *Software Transactional Memory Without Validation*, Proceedings of the 20th International Symposium on Implementation and Application of Functional Languages, University of Hertfordshire, **Technical Report 474**, 257 - 260 (2008)

## Presentations

Sebastian Fischer, *EasyCheck - TestData for Free*, 9th International Symposium on Functional and Logic Programming, Ise, Japan, 16.04.2008

Sebastian Fischer, *Datenfluss in bedarfsgesteuerten Berechnungen*, 25. Workshop der GI-Fachgruppe Programmiersprachen und Rechenkonzepte, Bad Honnef, Germany, 07.05.2008

Sebastian Fischer, *Data-Flow Testing of Declarative Programs*, 13th ACM SIGPLAN International Conference on Functional Programming, Victoria, Canada, 23.09.2008

Michael Hanus, *Declarative Construction of Web User Interfaces*, Colloquium, Portland State University, Portland, Oregon, USA, 25.02.2008

Michael Hanus, *High-Level Database Programming in Curry*, 10th International Symposium on Practical Aspects of Declarative Languages (PADL 2008), San Francisco, California, USA, 08.01.2008

Michael Hanus, *Call Pattern Analysis for Functional Logic Programs*, 10th International ACM SIGPLAN Conference on Principles and Practice of Declarative Programming (PPDP 2008), Valencia, Spain, 15.07.2008

Michael Hanus, *Declarative Programming of User Interfaces*, 22nd Workshop on (Constraint) Logic Programming (WLP 2008), Dresden, Germany, 01.10.2008

Bernd Braßel, *Relation Algebraic Aspects of Semantics, Visualization and Implementation for Functional Logic Languages*, PhD Programme of the 10th International Conference on Relational Methods in Computer Science, and 5th International Conference on Applications of Kleene Algebra (RelMiCS/AKA 2008), Frauenwörth, Germany, 07.04.2008

Bernd Braßel, *A Relation Algebraic Semantics for a Lazy Functional Logic Language*, 10th International Conference on Relational Methods in Computer Science, and 5th International Conference on Applications of Kleene Algebra (RelMiCS/AKA 2008), Frauenwörth, Germany, 10.04.2008

Bernd Braßel, *A Debugger for Functional Logic Languages*, 25. Workshop der GI-Fachgruppe Programmiersprachen und Rechenkonzepte, Bad Honnef, Germany, 05.05.2008

Bernd Braßel, *A Technique to build Debugging Tools for Lazy Functional Logic Languages*, 17th Workshop on Functional and (Constraint) Logic Programming (WFLP 2008), Siena, Italy, 03.07.2008

Bernd Braßel, *From Functional Logic Programs to Purely Functional Programs Preserving Laziness*, 20th Workshop on Implementation and Application of Functional Languages (IFL 2008), Hatfield, UK, 11.09.2008

Frank Huch, *Software Transactional Memory Without Validation*, 20th International Symposium on Implementation and Application of Functional Languages, Hertfordshire, UK, 11.09.2008

## Further Activities and Events

S. Fischer: Research stay related to „Analyzing Coverage of Declarative Programs for Automatic Error Detection“ at Portland State University (Oregon, USA) with Prof. Sergio Antoy, August 4-15, 2008

- M. Hanus: Organization of the 25th Workshop of the GI-Fachgruppe Programmiersprachen und Rechenkonzepte, Bad Honnef (Germany), May 2008
- M. Hanus: Program committee member of TFP 2008 (Ninth Symposium on Trends in Functional Programming), Nijmegen (The Netherlands), May 2008
- M. Hanus: Program committee member of WFLP 2008 (17th Workshop on Functional and (Constraint) Logic Programming), Siena, Italy, July 2008
- M. Hanus: Program committee chair of LOPSTR 2008 (18th International Symposium on Logic-based Program Synthesis and Transformation), Valencia, July 2008
- M. Hanus: Program committee member of FDPE 2008 (International Workshop on Functional and Declarative Programming in Education), Victoria (Canada), September 2008
- M. Hanus: Program committee member of WLP 2008 (22nd Workshop on (Constraint) Logic Programming), Dresden, October 2008
- M. Hanus: Member of the Editorial Board of the Journal of Functional and Logic Programming
- M. Hanus: Chair of the executive committee of the Fachgruppe „Programmiersprachen und Rechenkonzepte“ of the Gesellschaft für Informatik e.V.
- M. Hanus: Member of the steering committee of the symposia on Logic-based Program Synthesis and Transformation
- M. Hanus: Member of the executive committee and vice-chair of the GLP (Gesellschaft für Logische Programmierung), German-speaking branch of the Association for Logic Programming (ALP)
- M. Hanus: Member of the advisory board of the GLP (Gesellschaft für Logische Programmierung), German-speaking branch of the Association for Logic Programming (ALP)
- M. Hanus: Member of the selection committee of the DAAD (German Academic Exchange Service) for the project-related support to scientific cooperation with Spain and Portugal
- M. Hanus: Member of the advisory board of the „Berufsakademie an der Wirtschaftsakademie Schleswig-Holstein“
- M. Hanus: Referee of the dissertation of Elke Tetzner (title: „Nutzerfreundliche Modellierung mit hybriden Systemen zur symbolischen Simulation in CLP“ ), University of Rostock, 2008
- M. Hanus: Research stay related to „Representing Functional Logic Computations“ at Portland State University (Oregon, USA) with Prof. Sergio Antoy, February 18-29, 2008
- M. Hanus: Lecture on „GUI Programming with Functional Logic Languages“ , Portland State University (Oregon, USA) February 28, 2008
- M. Hanus: Research stay related to „Encapsulating Functional Logic Computations“ at Portland State University (Oregon, USA) with Prof. Sergio Antoy, September 14-20, 2008
- M. Hanus: Lectures related to the advanced training of teachers (IQSH)
- M. Hanus: Chair of the managing directorate of the Institute of Computer Science, University of Kiel
- M. Hanus: Chair of the examinations board of computer science studies, University of Kiel
- M. Hanus: Member of the convent of the Faculty of Engineering, University of Kiel
- M. Hanus: Vice-member of the Senate Curriculum Committee, University of Kiel



M. Hanus: Vice-member of the Senate Equal Opportunities Committee, University of Kiel

F. Huch: Member of the Steering Committee of Symposia on Implementation and Application of Functional Languages (IFL)

F. Huch: Vice-Chair of the executive committee of the Fachgruppe „Programmiersprachen und Rechenkonzepte“ of the Gesellschaft für Informatik e.V.

F. Huch: Program committee co-chair of FDPE 2008 (International Workshop on Functional and Declarative Programming in Education), Victoria (Canada), September 2008

F. Huch: Member of the program committee of the 13th ACM SIGPLAN International Conference on Functional Programming, ICFP 2008, Victoria (Canada), September 2008

F. Huch: Member of the program committee of the 20th International Symposium on Implementation and Application of Functional Languages, IFL 2008, Hertfordshire, UK.

F. Huch: Programming course with the little ladybird Kara, Girls' Day, April 24th 2008

F. Huch: Organisation (together with Thomas Wilke) of the „Schnupperstudium Informatik für Schülerinnen und Schüler“, March 31st - April 4th, 2008, Kiel, 100 participants. Course on introduction to programming: navigation of a pirates ship by means of the programming language Erlang, final project: Development and implementation of a distributed chat.

F. Huch: Organisation (together with Thomas Wilke) of the „Schnupperstudium Informatik für Schülerinnen“, October 20th - 24th, 2008, Kiel, 22 participants. Course on introduction to programming: navigation of the little ladybird Kara by means of the programming language Erlang, final project: Development and implementation of a distributed chat.

F. Simon: Lectures related to the advanced training of teachers (IQSH)

F. Simon: Participation in seminars for students planning professional careers