Annual Report 2012

Computer Science Department
of the
Faculty for Mathematics, Computer Science,
and Natural Sciences
at
RWTH Aachen University

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Preface

It is a great pleasure to welcome you as a reader of the annual report of the Computer Science Department at RWTH Aachen University. This report provides a summary of the research and teaching activities of our department in the period from November 2011 to October 2012. 2012 has been an extremely active year. Several important scientific achievements, various changes in our team of professors, and the celebration of 40 years Computer Science at our university. The major highlights are mentioned below, but the report provides much more information about our scientific successes, details about our teaching activities, and important recent developments in the department.

We had the pleasure to welcome many new students this year, both for the Bachelor program, as well as the Master program. Also in our international Master study programs such as Systems Software Engineering and Media Informatics several students from all around the world joined. During the summer semester, several diploma students took the last opportunity to do exams, and started working on their diploma theses. In the course of 2013, the last diploma students will finish their studies.

What did all happen this year at our department? To much to all be mentioned here, but let me focus on a couple of highlights. In May, we celebrated 40 years of Computer Science with a well-attended symposium. An overview over this period by our emiriti Walter Oberschelp and Manfred Nagl can be found in this report. A must to read for those of you that are interested in the history of the department. During the symposium, John Mylopoulos (Univ. of Trento, Italy, and Univ. of Toronto, Canada) received a honorary doctorate, the third one in CS@Aachen. Less than a month later, we celebrated the 60th birthday of Matthias Jarke, an occasion at which he received the Fraunhofer medal. In the summer semester, a series of talks were organized to celebrate the Alan Turing year.

In October, we welcomed Martin Grohe in our department as professor in Logic and Theory of Discrete Systems. From the upcoming summer semester on, he will lead the Chair of Informatik 7. He will present his research area at this year's Computer Science Day. Three colleagues left the department. Martin Hoefer accepted a W2-Professur at the MPI in Saarbrücken, James Gross started as associate professor at the KTH Stockholm, Sweden, and apl.-Prof. Martin Bücker took up his duties as W3-Professor at the University of Jena. We thank these colleagues for their contributions and engagement during their years in Aachen, and wish them a lot of success at their new positions.

After a long preparation phase, the construction of the new E3 Building started in September, and is planned to be completed before WS 13/14. In the mean while, the construction of new rooms for the B-IT research school in Aachen were completed. We also welcomed the new aixCAVE, with a surface of 25 square meters the largest CAVE in the world.

Various department members were invited as keynote speakers at highly ranked conferences, and several papers and theses were awarded. Too many to be mentioned here. Important distinctions and awards have been received. I'd like to mention a few highlights. Matthias Jarke has become a fellow of the GI, became a member of Acatech (the German Academy of Technical Sciences), and was re-elected as chairman of the Fraunhofer Verbund IuK Technologien. Berthold Vöcking became a member of the DFG review board for CS, whereas Bernhard Rumpe joined the board of the GI and Nagl joined the board of Informatics Europe. Last, but not least, Stefan Kowalewski was elected as Dean of the Faculty of Mathematics, Computer Science and Natural Sciences.

Finally, many national and international projects have been successfully acquired. Two highlights I want to mention. Bastian Leibe received an ERC Starting Grant for his project on "Computer Vision for Scene Understanding from a First-Person Perspective", and later this year received the Intel Young Faculty Research Award. Gerhard Lakemeyer was successful in acquiring a DFG Research Group on "Hybrid Reasoning for Intelligent Systems".

Many more achievements can be found in this report, and I invite all of you to start reading. We are looking forward to 2013 in which we expect to open our new E3 building, and in which several international conferences will be organized by the CS department, such as Software Engineering 2013, Euro Par, and the Kaspersky-Konferenz on Cybersecurity.

I'd like to thank Kai Jakobs for compiling this annual report.

Aachen, November 2012

Joost-Pieter Katoen
Head of Department

Berthold Vöcking
Former Head of Department

Faculty Life

40 Jahre Informatik an der RWTH Aachen: Die ersten 20 Jahre

Walter Oberschelp

Vortrag, gehalten am 11.5.2012 bei einer akademischen Feier aus Anlass der Ehrenpromotion von J.Mylopoulos

40 Jahre – eine solche Zahl scheint selbst für eingefleischte Zahlenmystiker kein besonderer Anlass zum Jubilieren. Aber ein kurzer Rückblick sei mir heute gestattet.

Im Juni 1972 beschloss die damalige Mathematisch-Naturwissenschaftliche Fakultät der RWTH, zum Wintersemester 1972/73 einen neuen Diplom-Studiengang Informatik einzurichten.

Wir müssen uns dabei eines Mannes erinnern, dessen Initiative wir die Informatik hier verdanken: Prof. Dr. Fritz Reutter, der damalige Leiter des Instituts für Geometrie, Numerik und Praktische Mathematik und Leiter eines Rechenzentrums, das weit und breit, d.h. im nieder- und mittelrheinischen Bereich, eine der wenigen Möglichkeiten bot, ein „Elektronengehirn" zu benutzen. Reutter hatte durch umsichtige Planung und durch zähes Verhandeln gegen viele Widerstände den Weg für die Informatik frei gemacht. Die Vorgeschichte hat er in der „Alma Mater Aquensis" 1971 dargelegt.

Prognosen können irren! Vor genau 40 Jahren, im Mai 1972, prophezeite der Club of Rome im schweizerischen St. Gallen sein Zukunfts-Szenario „Grenzen des Wachstums". Obwohl man schon damals mit World3 ein auf Großrechnern lauffähiges Weltmodell verwendete, kam die Informatik als Wachstumsfaktor noch nicht explizit vor. Heute sind wir klüger! Man ahnte zwar, dass die Informatik eine große Zukunft haben würde, aber die Entwicklung war kein Selbstläufer. Schon gar nicht in Aachen! Seinerzeit gab es in der Bundesrepublik nur sehr wenige Studiengänge für Informatik – wichtig waren vor allem Karlsruhe und die TU München. Die Initiative, Informatik an weiteren Hochschulen einzurichten, ging – etwas vereinfacht gesagt – vom Bund aus. Er hatte seine Hilfe für 1971, allerspätestens für 1972 zugesagt. Aber in Aachen war man keineswegs bedingungslos bereit, diesen Schritt zu tun. Die Elektrotechnik war sicher, die sich abzeichnenden Neuerungen in ihrer eigenen Fakultät als „Technische Informatik" verkraften zu können und hatte im Mai 1972 beschlossen, ein eigens Diplom-Fach Informatik in ihrer Fakultät nicht zu eröffnen. Die Mathematisch-Naturwissenschaftliche Fakultät (Fakultät 1) hatte – nolens volens – 1971 zwei Lehrstühle für „Angewandte Mathematik, insbesondere Informatik" ausgeschrieben und damit schon als klare Struktur-Vorgabe „Unterordnung unter die Mathematik" formuliert.

Auf den ersten dieser Lehrstühle wurde ich 1971 von der TU Hannover aus berufen, zunächst mit der Aufgabe, ab WS 1971/72 für den Diplom-Studiengang Mathematik das Nebenfach Informatik zu etablieren, was auch tatsächlich geschah.

Der Erfolg meiner Bewerbung beruhte offensichtlich auch auf meiner Herkunft aus der Mathematischen Logik in Münster mit H. Hermes, H. Scholz, W. Ackermann und G. Hasenjaeger, in der die Turing-Maschine bereits Standard-Lehrstoff gewesen war. Und mit der Turing-Maschine (wir sind heuer im Turing-Jahr!) und mit dem Begriff der Berechenbarkeit begann deshalb auch die Einführung in die Informatik. Programmieren war noch ein wunder Punkt! Fortran-Kurse gab es im Rechenzentrum. Für Algol hatten wir keinen

Compiler. Niklaus Wirth hatte zwar schon 1972 an der ETH in Zürich seine Programmiersprache Pascal in die Lehre eingeführt, aber das hatte sich noch nicht bis zu uns herumgesprochen. Die theoretische Programmiersprache MIX aus dem Standardwerk von Donald Knuth war schön und gut, aber sehr kompliziert. Ich habe dieserhalb immer noch ein schlechtes Gewissen, wenn ich an die damalige Zeit zurück denke.

Der Ruf auf den zweiten Lehrstuhl erging 1972 an Jürgen Merkwitz (†) vom Kernforschungszentrum Karlsruhe. Reutter schaffte es, die erforderlichen vier Lehrstühle mit einschlägigem Informatik-Know-How zusammen zu kratzen: Sein eigener Lehrstuhl, derjenige von W.Ameling in der Elektrotechnik und ein neuer Lehrstuhl für Betriebssysteme in der Elektrotechnik (D.Haupt) konnten vorgewiesen werden; sie standen aber kaum für die „Kern-Informatik", wie man sie damals verstand, zur Verfügung. Hier kamen nur die beiden neuen Lehrstühle in der Fakultät 1 in Betracht, die aber jeweils nur zur Hälfte der Informatik zugerechnet wurden.

Und dann kamen im November 1972 tatsächlich die ersten 80 Studierenden der Informatik, dazu noch viele weitere Mathematik-Studenten mit Nebenfach Informatik. Es gab einen Studienplan für das erste Semester mit meiner Einführungs-Vorlesung in die Informatik. Dazu viel Mathematik und eine vorläufige Diplomprüfungsordnung. Ich war anfangs der einzige Dozent in der Informatik. Unverantwortlich aus heutiger Sicht, damit einen Studiengang zu eröffnen!

Jürgen Merkwitz konnte erst zum SS 73 zusagen nach hartnäckigen Verhandlungen mit dem Land, die oft auf des Messers Schneide standen: Es ging um seine Ausstattung mit gemieteten Räumen am Büchel und um die Umbenennung und Umwidmung seines Lehrstuhls als „Informatik I". Mein eigener Lehrstuhl konnte Räume beziehen in der sog. „Baubaracke" – heute steht dort das Super C. Der Lehrstuhl teilte sich mit dem ebenfalls dort untergebrachten Lehrstuhl Mathematik, insbesondere Operations Research (Rolf Kaerkes) den für 200 000 DM angeschafften Rechner SPC 16, der 4KB „Kernspeicher" besaß und mit einer Lochstreifen-Peripherie ausgestattet war.

Die personelle Entwicklung der Informatik in den ersten 10 Jahren war leicht überschaubar: 1975 besetzte Klaus Indermark – aus Bonn kommend – den Lehrstuhl Informatik II, 1978 kam H.Noltemeier (auf Informatik III), der sich aber sehr bald (1981) nach Würzburg absetzte. Hinzu kam 1976 ein Lehrgebiet für Theoretische Informatik I mit Klaus Weihrauch. Dieser ging dann aber an die Fern-Uni Hagen, es folgte Britta Schinzel (1981-91 in Aachen, dann in Freiburg). Schließlich wurde 1982 ein weiteres Lehrgebiet Theoretische Informatik II eingerichtet, in dem Wolfgang Thomas (1989 Ruf nach Kiel) schon einmal Maß nahm für sein späteres Wirken an der RWTH (mein Nachfolger ab 1998).

Das war's zunächst! Ein Studien- und Forschungsfach mit sehr starken mathematischen Anteilen! Wir wenigen Informatiker versammelten uns in regelmäßigen Besprechungen im HKI, dem „Harten Kern Informatik", um den Schreibtisch eines Kollegen herum, um immer wieder an Studienplan und DPO (Diplom-Prüfungsordnung) herumzubasteln und anstehende Entscheidungen vorzubereiten. Eine vom Ministerium immer wieder eingeforderte Studienordnung haben wir in dieser Zeit nie zustande gebracht – es ging auch ohne!

Materielle Unterstützung erhielt die Informatik vor allem vom Bund mit dessen „Überregionalen Forschungsprogramm Informatik" ÜRF, das offiziell allein der Forschungs-Unterstützung dienen musste, aber notgedrungen und stillschweigend geduldet vorwiegend in der Lehre verbraten wurde. Aber es gab Forschung und viel qualifizierten wissenschaftlichen Nachwuchs. Ich nenne nur die Habilitationen der ersten 20 Jahre: Biskup, Damm, Klaeren, Loogen, Martini, Sonnenschein, Vogler und Vossen. Alle diese Kolleginnen und Kollegen sind heute Hochschul-Professoren!

Ein Kuriosum aus der damaligen Zeit: Die erste Habilitation (Joachim Biskup) stieß auf heftige Bedenken der vorwiegend aus Mathematikern bestehenden Kommission, weil der Kandidat in seinem Probe-Vortrag Overhead-Folien verwendete, wo doch der Habilitand gefälligst mit Kreide an der Tafel zu agieren hätte! Power Point gab es noch nicht, geschweige denn das Internet!

In den ersten 10 Jahren war unsere Informatik klar theorie-lastig. Man konnte sich damals einfach keinen Informatik-Professor vorstellen, der nicht auch alle Qualifikations-Stufen für einen Mathe-Prof. durchlaufen hatte. Ich selbst hatte ja als geprüfter Gymnasial-Lehrer dann meine mathematischen Weihen in Hannover durch Habilitation bei dem Behnke-Schüler Horst Tietz empfangen – meine Zusammenarbeit mit Wolfgang Händler und Bodo Schlender dort, die beide schon damals wirkliche Allround-Informatiker waren, zählte da nicht viel.

Eine stärker praxisorientierte Ausrichtung erhielt die Informatik erst 1984, als (durch Umwidmung eines OR-Lehrstuhls) Otto Spaniol auf I4 berufen werden konnte. Ein rasanter Aufschwung begann. Zwei Jahre später übernahm dann Manfred Nagl den seit 5 Jahren verwaisten Lehrstuhl Informatik III (ehemals Noltemeier), der auf Grund vieler administrativer Hemmnisse bis dato nicht hatte besetzt werden können. Nun endlich hatte die Informatik das erforderliche Angebots-Spektrum annähernd erreicht und die öffentliche Akzeptanz der Informatik war so gestiegen, dass sie sich 1992 – nach 20 Jahren, für volljährig erklären konnte.

Es gab natürlich Höhen und Tiefen: Der Jahresbericht 1990 beklagt, dass 5 von 11 Professuren vakant seien. Das schwerfällige Berufungsverfahren, Uneinigkeit über die künftigen Schwerpunkte der Informatik, der leergefegte Markt geeigneter Professoren trugen dazu bei. Die Konturen des Faches formten sich nur langsam: 1986 erschien der erste Jahresbericht der Fachgruppe; aus ihnen konnte man die weitere Entwicklung nunmehr besser verfolgen. Seit 1987 wird die Tradition des Tages der Informatik am ersten Freitag im Dezember kontinuierlich gepflegt. Das sind immerhin auch schon 25 Jahre! Die Dynamik der Weiter-Entwicklung verstärkte sich, besonders dank den neu berufenen Professoren. 1986 bis 1988 konnte etappenweise der Umzug in die ehemalige Pädagogische Hochschule an der Ahornstraße erfolgen – die Arbeitsräume am Büchel und im Fakultätsgebäude am Templergraben konnten aufgegeben werden. Der Ausbau einer facheigenen Bibliothek machte große Fortschritte: 1991 konnte mit Renate Eschenbach erstmals eine etatmäßige Leiterin eingestellt werden. Die Umstellung vom Zentralrechner zum PC und zum lokalen Rechnernetz fällt in diese Zeit; ebenso für Aachen neue Einrichtungen und Institutionen wie ein Graduiertenkolleg, der Industrieverbund REGINA und die Forschergruppe SUKITS.

Und mit neuen Kollegen begann die dritte Dezennie unserer Informatik: 1991 ergab sich mit der Berufung von Matthias Jarke auf den Lehrstuhl Informatik V eine ganz wichtige weitere Ausbaustufe. Im Bereich der nicht als Lehrstühle dotierten Lehrgebiete ergab sich eine gewaltige Fluktuation, denn die dorthin berufenen Kollegen wurden schnell wieder in höhere Positionen nach auswärts fortberufen und konnten nicht bei uns gehalten werden – sie gingen weg wie warme Semmeln! Bernd Walter (ab 86), Bernhard Steffen (ab 90), Alfons Kemper (ab 91) und Wolfgang Nejdl (ab 92), sie alle blieben nur kurze Zeit in Aachen.

Eine Statistik aus dem Jahresbericht zum WS 92/93 gibt einen rohen Überblick über den Studien-Erfolg der ersten 20 Jahre: Insgesamt 2800 Studierende wurden bei uns eingeschleust. 1200 studierten zu dieser Zeit. 800 hatten uns mit dem Abschluss-Diplom verlassen. In dem Verlust von 800 Studierenden verbergen sich Karteileichen wie auch viele oft tragische Einzelschicksale des Scheiterns.

Über diesen ersten 20 Jahren wollen wir nicht den Dunst der Selbst-Beweihräucherung aufsteigen lassen. Stattdessen müssen wir den Dank nach vielen Richtungen hin aussprechen, und ich möchte dies als der älteste „Überlebende“ stellvertretend tun:

Ohne die engagierte Hilfe der Fachkollegen aus der Mathematik wäre die Informatik hier nicht zustande gekommen. In gemeinsamer Arbeit mit dem DPA Mathematik (Vorsitz B.Rauhut) wurden immer wieder fächerübergreifend Prüfungsresultate verglichen und Vorurteile, nach denen die Informatiker die „Fußkranken der Mathematik“ seien, abgebaut. Da viele Studierende in beiden Fächern (und oft auch in der Physik) Prüfungen ablegten, konnte eine Gleichwertigkeit des Anforderungs-Niveaus dieser Fächer nachgewiesen werden. Und auch das Vorurteil, dass die (wenigen) Frauen die schlechteren Informatiker seien, wurde klar widerlegt. Einige Kollegen mit besonderer Nähe zur Informatik müssen namentlich genannt werden: Rolf Kaerkes(†), Rolf Möhring, F.Josef Radermacher und H.Jürgen Zimmermann, aus meiner persönlichen räumlichen Nähe Michael Richter (1975-86) und Erich Grädel (ab 1992). Aber auch dem Bereich Elektrotechnik ist die Informatik zu Dank verpflichtet. Es gab eine konstruktive Konkurrenz! Zu nennen sind vor allem Walter Ameling (†). Dieter Haupt, Friedel Hoßfeld und Otto Lange. Viele gemeinsame Diplomarbeiten und auch Dissertationen sind mit der Medizin, besonders im Bereich der Bild-Diagnostik entstanden (Rudolf Repges). Und in den großen Ingenieurwissenschaftlichen Instituten WZL, IKV, IBF usw., gab es von Anfang an viele gemeinsame Arbeiten, die der Informatik viel Praxisnähe bescherten.

Die Informatik in Aachen verdankt ihren Aufstieg aber nicht nur Professoren! Zahllose wissenschaftliche Mitarbeiter und Hilfskräfte haben am Aufbau mitgearbeitet. Sie sind in Übungen und Seminaren und beim Aufbau der Rechner-Strukturen oftmals über Gebühr beansprucht worden. Dies gilt auch in hohem Maße für unsere Sekretärinnen und für das gesamte technische Fachpersonal. Niemand konnte sich auf die bequeme Infrastruktur eines etablierten Faches zurückziehen – es musste improvisiert und oft mutig und kreativ gearbeitet werden. Die Jahres-Schluss-Endspurts in einer rigiden Haushalts-Bürokratie sind uns allen noch in guter Erinnerung.

Und angesichts der vielen Skandale in heutiger Zeit ist nun doch erwähnenswert: Es hat in dieser ganzen Zeit nicht einen einzigen Fall von unerlaubter Vorteilsnahme, Prüfungs-Begünstigung oder ähnlichem Missbrauch gegeben. Nicht einmal „Übergriffe“ wie in der Mathematik, wo ein erboster Professor eine Studentin, die während seiner Vorlesung strickte, mit Kreide beworfen haben soll. Auch Guttenplag dürfte bei uns nicht fündig werden. Die Qualität unserer vielen Promotionen steht außer Frage – dies muss besonders einmal gesagt werden aus Anlass einer Ehrenpromotion wie heute.

Ich erinnere mich an einen einzigen (ausländischen) Studierenden, der unsere Gebräuche noch nicht kannte und mir nach seiner Abreise einige Flaschen Cognac hinterließ mit dem Versprechen, mir künftig einen guten Job in seiner neu aufzubauenden Firma zu geben. Irgendwann ist diesen Flaschen bei einem Institutsfest der Garaus gemacht worden – eine offizielle Meldung an meinen Dienst-Vorgesetzten habe ich aber aus Zeitgründen nicht abgeben können.

Und noch ein Schlaglicht: Zur üblichen Wanderung der Erstsemester in den Aachener Stadtwald stellte ich bei der Verwaltung den Antrag auf Rückerstattung der von mir verauslagten 20 DM Miete für die Grillhütte. Als ich die Frage, ob dort Bier geflossen sei, bejahen musste, wurde ich abschlägig beschieden, da die Kriterien einer Dienst-Veranstaltung nicht gegeben seien. Und dabei blieb es. Und doch kann ich auch ein Loblied auf unsere Verwaltung, die selber oft unter ihren Vorschriften litt, anstimmen: Ich danke für viel Verständnis, besonders beim hektischen Jahresabschluss. Da hat dann ein Angestellter schon

einmal ein Auge zugedrückt, wenn ihm treuherzig versichert wurde, dass viele große Geräte fristgemäß in den allerletzten Dezembertagen wirklich geliefert worden seien oder dass manche Hilfskräfte in den letzten Jahreswochen mehrmals zwischen Lehrstühlen hin und her rotiert seien…

Zuletzt noch das entscheidende Wort zu unseren Studierenden. Sie waren engagiert und haben großes Verständnis für unsere Situation aufgebracht. Es gab (außer den zeitüblichen allgemeinen Protestaktionen) meiner Erinnerung nach keine größeren gezielten Proteste gegen unsere Arbeit. Immer wieder werde ich von unseren Alumni auf die Qualität der Ausbildung in dieser Gründerzeit angesprochen. Die ersten seinerzeit veröffentlichten Rankings haben dies bestätigt. Es war eine spannende Zeit! Und es blieb spannend, wie der Folgebericht von Manfred Nagl über die folgenden 20 Jahre zeigen wird.

40 Jahre Informatik an der RWTH: Die zweite Hälfte 1992 – 2012

Manfred Nagl

Eine halbe Stunde für vierzig Jahre, das entspricht einer Darstellung von sieben Kilometern auf einem Zentimeter. Von diesem Zentimeter hat mein Vorredner, Herr Oberschelp, die ihm zustehende Hälfte bereits verbraucht. Für die zweiten *zwanzig Jahre* verbleibt also ein *halber Zentimeter*. Erwarten Sie, verehrte Damen und Herren, deshalb keine Vollständigkeit, insbesondere nicht bei der Nennung von Namen und Verdiensten. Meine Ansprache ist somit eher eine Aufzählung von Merkpunkten als eine ausformulierte Rede.

In *vier kurzen Abschnitten* will ich (1) zunächst einige Fakten und Zahlen präsentieren, um den Rahmen unseres Außenauftritts abzustecken, (2) auf die inhaltlich wichtigsten Ereignisse und Entwicklungen in den zwanzig Jahren eingehen, (3) durch einige Vergleiche die Veränderungen über diese Zeit herausarbeiten und schließlich (4) zusammenfassen, den Blick nach vorne richten, aber auch einige kritische Dinge anmerken.

1. Rückblick mit Stolz

Wissenschaftliche *Leistung* präzise zu erfassen, ist nicht einfach. Diese hat ja eine stark inhaltliche Komponente. Man behilft sich daher meist mit *Parametern*, die diese Leistung charakterisieren und der Angabe der entsprechenden *Parameterwerte*.

Unsere großen Felder sind Forschung und Lehre, vgl. Abb. 1. Für diese großen Felder gibt es *Parameter*. Leistung heißt dabei immer, Erfolge in Relation zu den eingesetzten Ressourcen zu setzen. Schließlich müssen Erfolge auch kommuniziert werden, um Außenwirkung und Beachtung zu erzielen. Für diese vier Felder *Forschung*, *Lehre*, *Ressourcen* und *Außenwirkung / Beachtung* sind in Abb. 1 einige Parameter angegeben.

Zu den mit einem Pfeil gekennzeichneten Parametern werde ich in meinen Ausführungen später kurz eingehen. Die mit einem Haken versehenen Parameter sollen gleich jetzt aufgegriffen werden, um eine *erste Charakterisierung* des derzeitigen *Stands* der *Fachgruppe* Informatik zu liefern. Sie sehen also, dass ich nicht auf alle Parameter von Abb. 1 eingehe. Und die dort aufgeführten Parameter sind bei weitem nicht alle, die betrachtet werden können.

Beginnen wir also mit der *Charakterisierung* der *Parameter*, die mit einem Haken in Abb. 1 gekennzeichnet sind. Die *Forschung* der Fachgruppe überdeckt die meisten der großen Forschungsgebieter der derzeitigen Informatik. Gleichwohl werden bestimmte Schwerpunkte gebildet. Die Forschung ist anwendungsbezogen, mit starken Verbindungen zu verschiedenen Anwendungsfeldern, hauptsächlich zu den ingenieurwissenschaftlichen. Die Forschung hat dennoch eine starke theoretische Breite und Fundierung. In der *Lehre* hatten wir im letzten Jahr folgende Kennzahlen: Auf Diplom- und Masterniveau wurden 2011 bei uns 220 Absolventen ausgebildet, zusätzlich zu den 107 Bachelors. Bezüglich der Anzahl der Bachelorabsolventen sind wir nach dem Wechsel zum Bachelor-/Master-System immer noch nicht in einem eingeschwungenen Zustand angekommen, der bei 200 Bachelors pro Jahr liegen dürfte. Auf die *Ressourcen* gehen wir später genauer ein. Einige seien vorab erwähnt, auch weil sie bei Erfolgskennzahlen üblicherweise selten genannt werden, nämlich unsere eigenständigen Organisationen Informatik-Bibliothek, -Rechnerbetrieb sowie auch das Rechen- und Kommunikationszentrum der RWTH, das allgemeine Dienste auch für die Fachgruppe leistet.

Zwei Details zur *Außenwirkung*: Die Professorenbilanz (Einwerbung von außen; Ausbildung junger Wissenschaftler, die nach außen berufen werden; Abwehr von Angeboten von außen) war in den letzten 20 Jahren überaus positiv. Auch in den außeruniversitären und bundesweit sichtbaren Ämtern war die Fachgruppe außerordentlich präsent: In den letzten 10 Jahren kam ein Mitglied des Wissenschaftsrats, der Informatik-Hauptgutachter der DFG, der Präsident der GI und der Fakultätentagsvorsitzende aus Aachen.

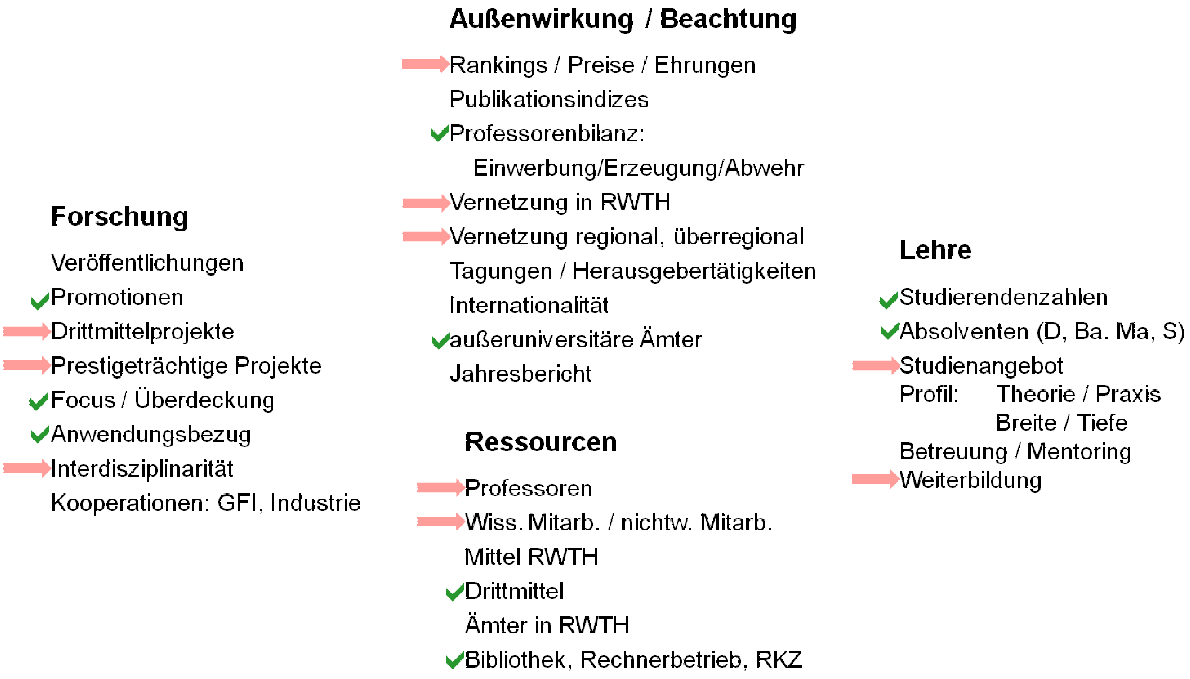


***Abbildung 1**: Parameter wissenschaftlicher Leistung*

Nun noch einige *Zahlen und Details zu einigen Parametern* der vier Felder: Im Mittel hatten wir in den letzten Jahren 27 *Promotionen* pro Jahr. Z.Zt. gibt es 2290 *Studierende* mit der Hauptrichtung Informatik und *2650*, die Informatik als ein Studienfach gewählt haben. Die Studierenden befinden sich in folgenden *Studiengängen*: im Bachelor-Studiengang Informatik, in den Master-Studiengängen Informatik, Software Systems Engineering, Media Informatics, im Diplom-Studiengang (keine Aufnahme mehr seit dem WS 2006/2007) , im Lehramts-Studiengang Sekundarstufe II, in den Studiengängen Technik-Kommunikation und Computational Engineering Science, an denen die Informatik beteiligt ist, sowie auch in einigen Nebenfachangeboten der Informatik. Derzeit hat die Fachgruppe 31 *Professorinnen* und *Professoren* (incl. der Juniorprofessoren und Nachwuchsgruppenleiter), 189 *wissenschaftliche Mitarbeiter* und ein *Drittmittelaufkommen* von 14,7 Mio. € pro Jahr. In den *Rankings* der Wirtschaftswoche, von CHE oder im DFG-Mittelranking belegt die Fachgruppe immer vorderste Plätze.

2. Zeitlich wichtige Ereignisse

In diesem Abschnitt beschreiben wir die *Meilensteine* der Entwicklung der Fachgruppe, festgehalten in zwei Abbildungen. Abb. 2 führt die *Professorenbilanz* auf, auf einem Zeitstrahl von 1992 bis 2012. Der horizontale Balken enthält die Namen der Sprecher der Fachgruppe in der jeweiligen Zeitperiode.

Oberhalb des Zeitstrahls finden sich die *Namen* der neuen *Professorinnen und Professoren* an ihrem jeweiligen Zugangsjahr. Wir erkennen, dass die *Zugänge in Wellen* erfolgten. Die Na-

men bis 1993 entsprechen dem Ausbau durch Hochschulsonderprogramm-Mittel, von 1995 bis 2005 dem Ausbau durch Mitteln der RWTH, der Fakultät, der Fachgruppe und des Bonn-Aachen International Center for Information Technology, in der Zeit ab 2006 ergeben sich die Zuwächse hauptsächlich durch Gelder im Rahmen der Exzellenzinitiative. In allen drei aufgeführten Phasen sind auch Namen aufgeführt, die ausscheidende Professoren ersetzt haben.

Oberhalb des Zeitstrahls finden sich auch die Namen der Professoren – durch einen Kreis gekennzeichnet – deren Wegberufungen an andere Orte erfolgreich abgewendet werden konnten. Die *Bleibebilanz* der Fachgruppe Informatik ist also überaus erfolgreich.

Unterhalb des Zeitstrahls finden sich – durch auf den Kopf gestellte Dreiecke kenntlich gemacht – die Habilitationen, d.h. die *Vorbereitung jüngerer Wissenschaftler für eine erfolgreiche Karriere andernorts*. Natürlich gab es auch Wegberufungen ohne vorausgehende Habilitationen.

Unterhalb des Zeitstrahls sind auch die *Abgänge* angegeben. Im Jahre 1995 verstarb Kollege Merkwitz. Vier Emeritierungen – gekennzeichnet durch Dreiecke – fanden danach statt. Alle Emeriti sind nach wie vor aktiv für die Fachgruppe tätig.

Unterhalb des horizontalen Balkens finden sind die Namen der Professoren aufgeführt, die an andere Universitäten wegberufen wurden. Bis auf zwei Ausnahmen handelt es sich um erste Rufe auf Professorenstellen für junge Wissenschaftler oder um Rufe auf höherwertige Professorenstellen. Somit zeigen diese *Wegberufungen* unsere *erfolgreiche Nachwuchsarbeit* bzw. die *fruchtbare Arbeit* von Kollegen, die sie *für Stellen* mit besserer Ausstattung an anderen Universitäten qualifiziert haben.

Nicht verhehlen will ich *zwei kritische Phasen*, die die Fachgruppe durchlaufen hat und die in Abb. 2 durch zwei dicke Ausrufezeichen gekennzeichnet sind. In der Zeit 1994/95 gab es eine große Zahl offener Professorenstellen, sodass ein großes Ungleichgewicht zwischen Studierenden und Professoren entstand. In der Zeit um 2001/02 gab es nach den Hypes DotCom, den Umstellungen aufgrund des Jahres 2000 und der Einführung des Euro einen so großen Sog von Seiten der Industrie, dass zu wenige Diplomierte/ Master für die Promotion an der Universität zurückblieben. Dies führte dazu, dass viel zu wenige Mitarbeiter für die Betreuung der Vielzahl der Studierenden vorhanden waren. Die Situation löste sich für uns glücklicherweise durch das Platzen der Blasen. Beide Phasen waren kritisch in dem Sinne, dass der langfristige Erfolg der Fachgruppe ernsthaft gefährdet war.

Abb. 3 gibt *wichtige Projekte* und Ereignisse der hier *betrachteten 20 Jahre* wieder. Wir konzentrieren uns dabei auf die Projekte mit *Finanzierung* durch die *Deutsche Forschungsgemeinschaft*, da diese mit einer größeren Reputation und Außenwahrnehmung verbunden sind.

Hier ist die *Forschergruppe* SUKITS von 90 bis 87, der *Sonderforschungsbereich* IMPROVE von 1997 bis 2006 und der *Transferbereich* 61 am Ende des SFB bis 2009 zu nennen. Ende 2011 kam die neue Forschergruppe Hybris hinzu. Weitere Beteiligungen an Sonderforschungsbereichen betreffen die SFBs 401, 427, 540 und 686. Auch bezüglich der Einwerbung von *Graduiertenkollegs* war die Fachgruppe überaus erfolgreich. Das begann mit dem GK „Informatik und Technik“ von 1991 bis 2000, dem nachfolgende GK „Software für Kommunikationssysteme“ von 2000 bis 2010. Im Jahre 2005 kam noch das neue Graduiertenkolleg AlgoSyn hinzu.

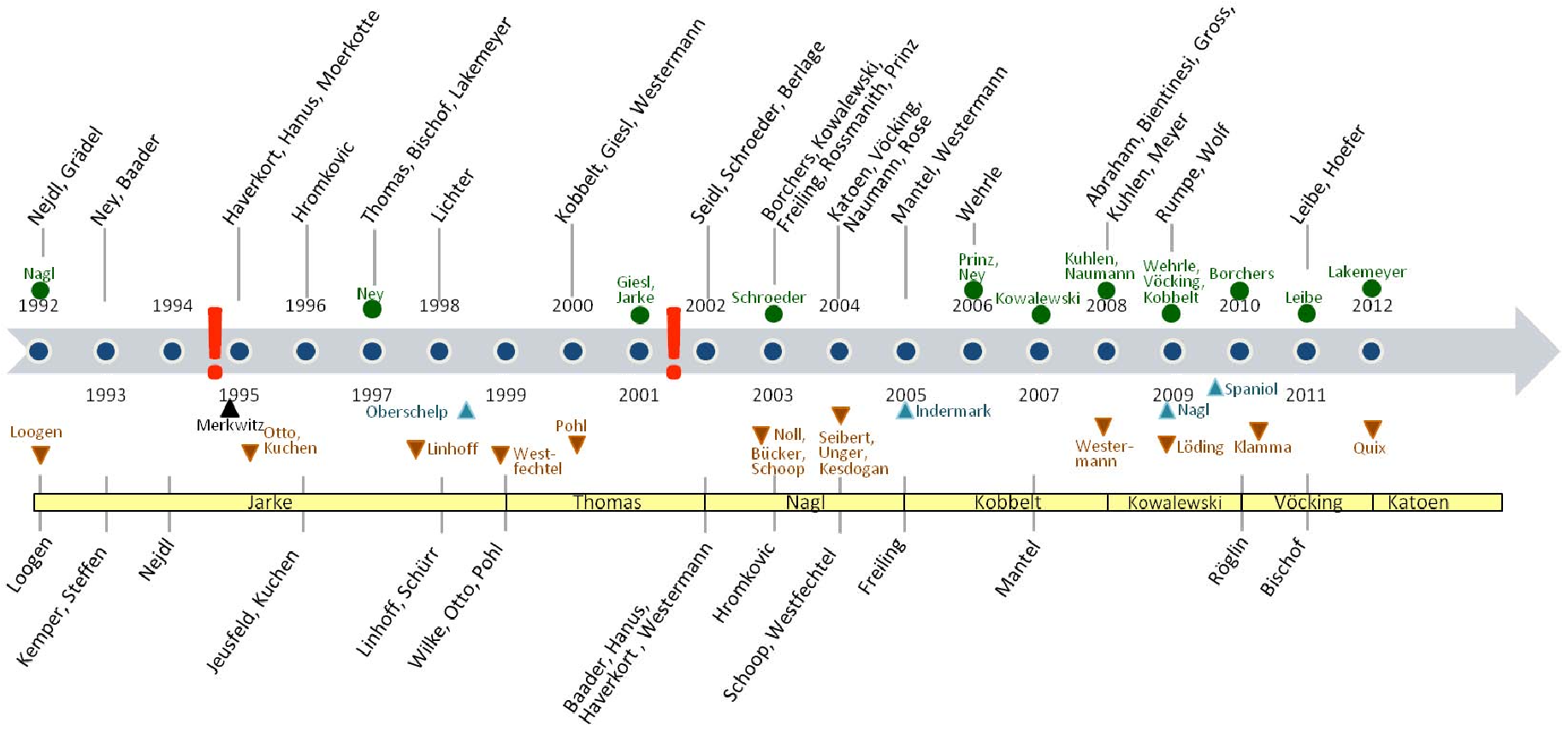


Abbildung 2: *Meilensteine der Entwicklung: Professorenbilanz*

Schließlich gaben die erfolgreichen Beteiligungen an diversen Maßnahmen der *Exzellenzinitiative* der Fachgruppe großen Auftrieb und auch einen erheblichen finanziellen Zuwachs. Hier ist in erster Linie das *Exzellenzcluster* UMIC – Fachgruppe Informatik zusammen mit der Fakultät für Elektrotechnik und Informationstechnik – zu nennen. Auch an dem Exzellenzcluster der Produktionstechnik ist die Fachgruppe beteiligt. Eine merkliche Beteiligung der Fachgruppe gibt es ferner bei der *Graduiertenschule* AICES.

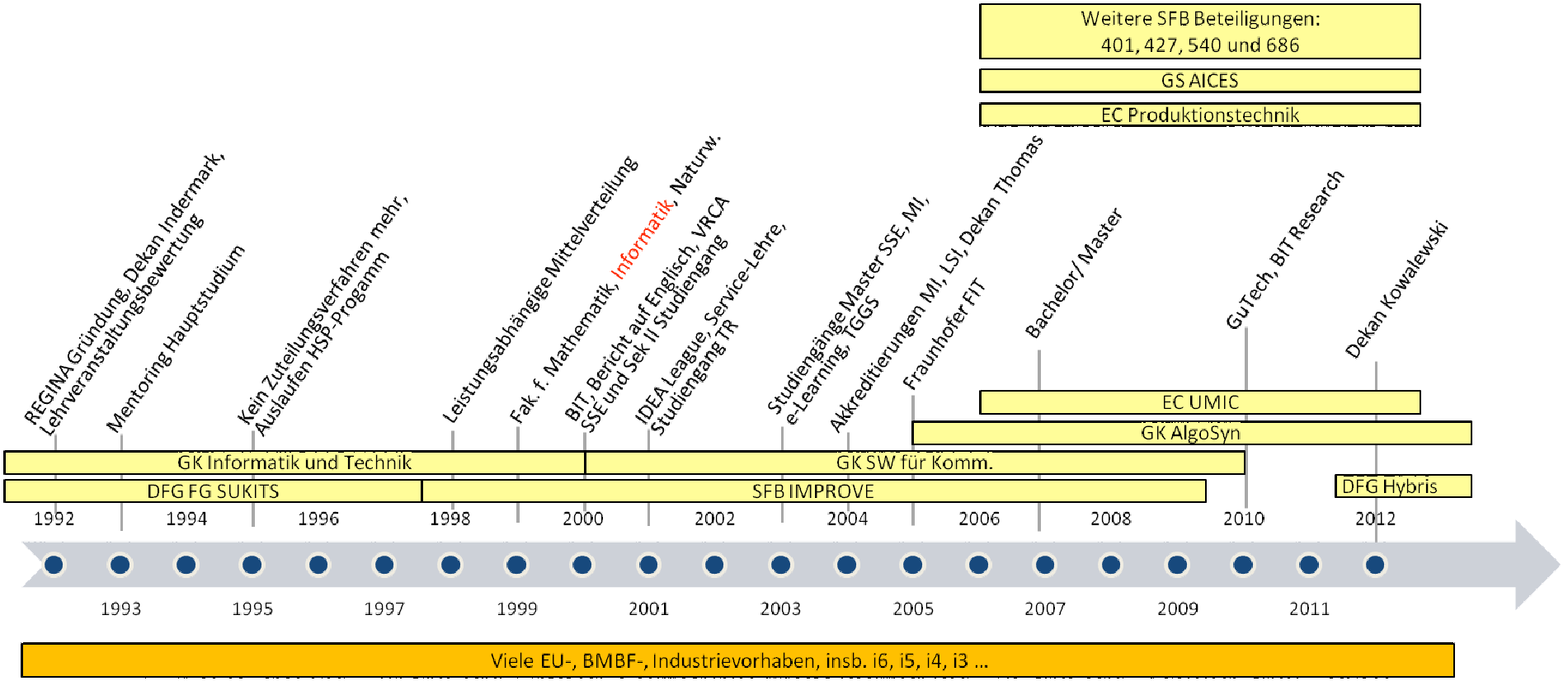
Wenn nicht ausgeführt, so doch erwähnt werden sollen die *zahlreichen weiteren Projekteinwerbungen* bei *EU-, BMBF-, Industrie-, NRW-Landesprojekten* und diversen *Stiftungen* mit einem erheblichen Finanzvolumen, an dem in erster Linie und in absteigender Reihenfolge die Lehrstühle Informatik 6, 5, 4 und auch 3 beteiligt waren.

Oberhalb der horizontalen Balken, die die erwähnten Projekte charakterisieren, finden sich noch *wichtige Ereignisse der letzten zwanzig Jahre*. Erlauben Sie, dass ich mich auf wenige beschränke. Im Jahre 1992 fand die Gründung des Regionalen Industrieclubs Aachen (*REGINA*) statt, der mit der Fachgruppe seitdem eng verflochten ist. Im Jahre 1999 wurde die *Fakultät* in Fakultät für Mathematik, Informatik und Naturwissenschaften *umbenannt*. 2000 wurde das bereits erwähnte *BIT* gegründet, 2010 BIT Research. Im Jahre 2000 und 2003 wurde die *neuen Studiengänge* Software Systems Engineering und Media Informatics eingerichtet, im Jahre 2003 und 2010 die auswärtigen „Ableger" der RWTH Thai-German Graduate School (*TGGS*) in Bangkok und German University of Technology in Oman (*GUTech*) in Muscat. Diese Studiengänge und Ausgründungen haben wesentlich zur *Internationalisierung* der Fachgruppe beigetragen.

Aus Platzgründen nicht erwähnt werden können die zahllosen *Preise*, *Ehrungen*, *Ämter*, gewonnenen *Wettbewerbe*, *Tagungen*, geschriebenen und herausgegebenen *Bücher* und *Artikel mit Auszeichnungen sowie* die Vielzahl durchgeführter *Feste*, die allesamt aufgrund der engagierten Arbeit der Aachener Wissenschaftler errungen, erzielt und gefeiert wurden. Dies alles hat das Ansehen außerhalb Aachens verstärkt.

Lassen Sie mich diesen Abschnitt mit einer *zusammenfassenden Charakterisierung* abschließen: Die Fachgruppe Informatik ist eine Mannschaft überaus engagierter Wissenschaftler. Sie ist forschungsstark und hat ein anwendungsbezogenes Profil, das auf Theorie baut. Sie ist offen für verschiedene Formen der Zusammenarbeit mit anderen Disziplinen in und außerhalb der RWTH, mit der Industrie und mit großen Forschungseinrichtungen. Sie ist international sichtbar durch Veröffentlichungen, internationale Studiengänge und Studierende aus dem Ausland sowie durch Ableger der RWTH in Thailand und Oman und auch viele internationale Kontakte und Zusammenarbeiten. Die Fachgruppe ist verbunden mit der regionalen Industrie über REGINA sowie auch mit der überregionalen Industrie in Deutschland, der EU und darüber hinaus.

Natürlich ist das *nicht nur eine Leistung der Wissenschaftler*, also der Professoren und der wissenschaftlichen Mitarbeiter. Bereits erwähnt wurden die Bibliothek, der Rechnerbetrieb Informatik sowie das RKZ der RWTH. Allgemein aufzuführen sind hier die Leistung der nichtwissenschaftlichen Mitarbeiter und insbesondere auch die der Studierenden, die über ihre Examensarbeiten zur wissenschaftlichen Arbeit merklich beitragen. Zu benennen ist hier auch die Fachschaft, also die Vertretung der Studierenden, die zu der Fachgruppe Informatik ein überaus konstruktives Verhältnis entwickelt hat.



... viele Preise, Ehrungen, Ämter, gewonne Wettbewerbe, Tagungen, Bücher und Feste

Abbildung 3: *Meilensteine der Entwicklung: Ereignisse, Projekte*

3. Vergleiche zwischen ehemals und jetzt

Im letzten Hauptabschnitt möchte ich anhand einiger Beispiele den Ausbaustand zu Beginn und zu Ende des Berichtszeitraums[1] einander gegenüberstellen. Dies gibt einen plastischen Eindruck von der *rasanten Entwicklung der Fachgruppe Informatik* in den letzten 20 Jahren.

Beginnen wir mit den *Professoren*. Abb. 4 zeigt links die Gruppe der Professoren vor dem Informatik-Gebäude im Jahre 1992 mit 7,5 Professoren, der Lehrstühle 1 bis 5, den beiden Lehrgebieten 2 und 3 und dem Lehrstuhl Angewandte Mathematik insbesondere Informatik, der halb zur Informatik und halb zur Mathematik zählte. Das auf der rechten Seite aufgenommene Bild von 2011, aufgenommen auf Rolduc bei einem Strategietreffen, ist, trotz der beiden einkopierten Damen Abraham und Meyer, mit 27 Personen (von 31) nicht vollständig. Der Vergleich der Bilder zeigt somit das rasante Anwachsen der Fachgruppe.

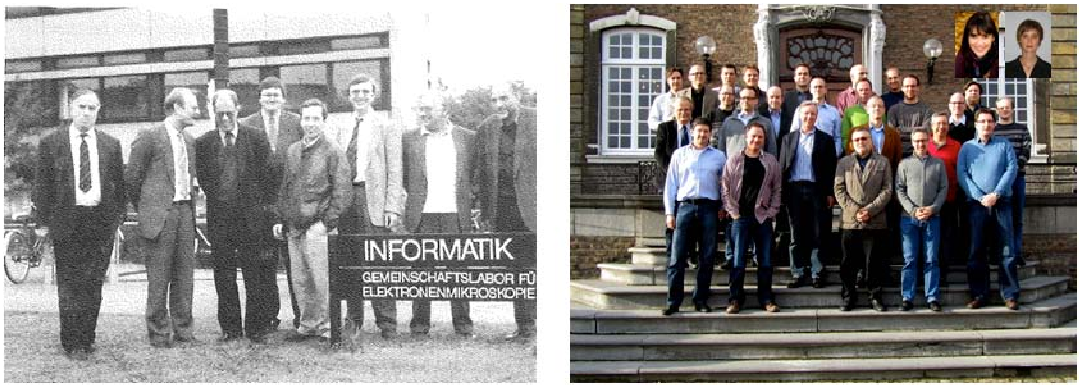


Abbildung 4: *Professoren 1992 (links) und 2011 (rechts)*

Die nächste Abb. 5 zeigt einen Lageplan des Informatik-Zentrums Hörn. Von den dort erkennbaren *Gebäuden* war 1992 - siehe linken Teil der Abbildung - nur das Gebäude E1 (schraffiert) und ein einziges halbes Stockwerk des Gebäudes E2 der Fachgruppe zugeteilt. Auf der rechten Seite sehen wir den jetzigen Ausbaustand. Das gesamte Informatik-Zentrum Hörn incl. Altbau ist von der Fachgruppe belegt, mit Ausnahme eines Flures im Gebäude E2 (GFE). Inzwischen wurde zusätzlich noch je die Hälfte der Gebäude E1 und E2 aufgestockt, um Räume für die Fachgruppe zu schaffen. Für das Exzellenzcluster UMIC wurde ein weiteres, neues Gebäude errichtet, das teilweise von der Fachgruppe belegt ist. Schließlich befinden sich einige Gruppen auch im inzwischen erweiterten RKZ[2]. Der Rest des Informatik-Zentrums Hörn sind Hörsäle und Seminarraume, die hauptsächlich von der Informatik genutzt werden. Das neue Gebäude E3, das 2013 fertiggestellt sein soll, befindet sich in Planung.

Das nächste Bild (Abb. 6) zeigt links die *Anzahl der wissenschaftlichen Mitarbeiter* wieder in den beiden Vergleichsjahren. Im Jahre 1992 gab es in der Fachgruppe 63,5 wissenschaftliche Mitarbeiter, 35 vom Land NRW bezahlt und 28,5 über eingeworbene Drittmittel, also ein Verhältnis von 1: 0,81. Dem gegenüber finden wir 2012 eine Zahl von 189 wissenschaftlichen Mitarbeitern, davon 44 vom Land und 145 aus Drittmitteln. Die entspricht jetzt einem Verhältnis eines vom Land bezahlten Mitarbeiters zu 3,3 Drittmittel-Mitarbeitern. Der Ausbau des Personals wurde somit fast ausnahmslos durch selbst und von außen eingeworbene Drittmittel erzielt. Das Verhältnis 1: 3,3 spricht zwar für die Qualität und das Engagement der Fachgruppe. Meines Erachtens wurde hier aber bereits eine sinnvolle Schwelle überschritten.

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[1] Gegenüberstellung meist mit 2011; das Jahr 2012 war zum Zeitpunkt des Vortrags nicht einmal zur Hälfte abgelaufen.
[2] Die Gebäude von UMIC und RKZ sind in der Abbildung nur als Verweise zu erkennen.

In der Abb. 7 finden wir die *Drittmittelzahlen* der Fachgruppe, die natürlich hauptsächlich aus der Bezahlung von Drittmittel-Mitarbeitern herrühren. Wir sehen, dass das Volumen von 2,68 im Jahre 1992 auf 14,7 Mio. € im Jahre 2011 angewachsen ist. Das ist ein Vergrößerungsfaktor von 5,5! Selbst wenn man den Betrag von 2,68 aus dem Jahre 1992 mit einer jährlichen Inflationsrate von 3% korrigiert, ergibt sich immer noch ein Zuwachs mit dem Faktor 3. Dabei sind die Drittmittel der Fraunhofer-Gruppe bei den Zuwächsen nicht eingerechnet.

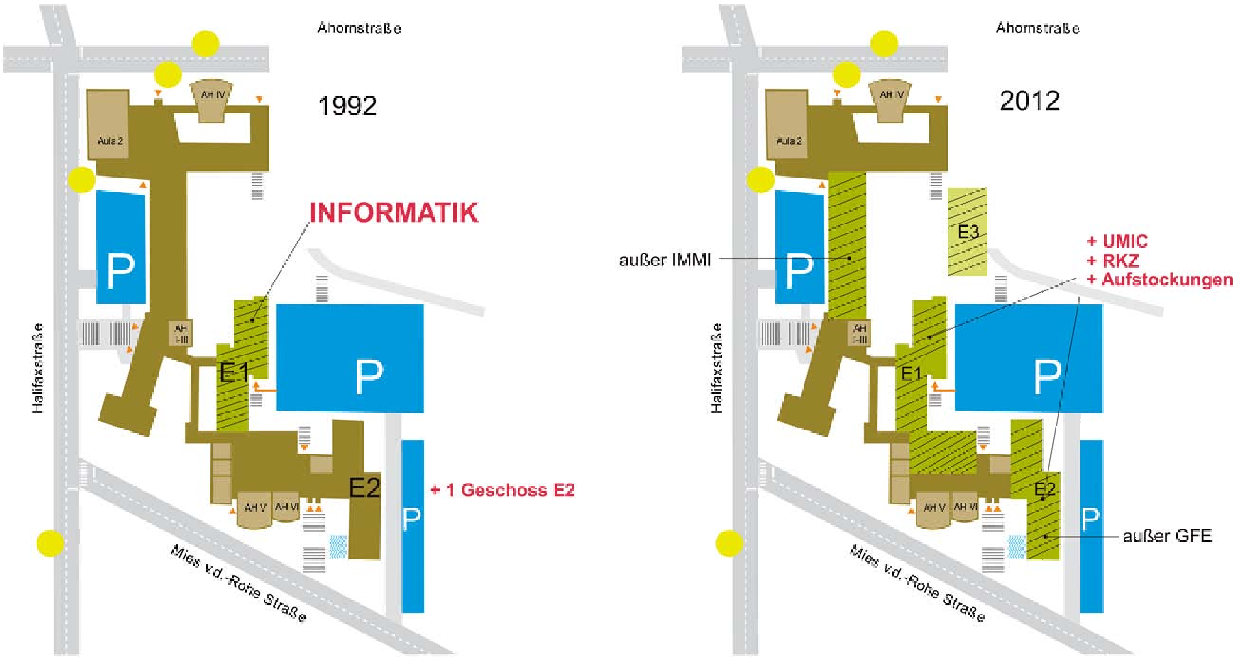


Abbildung 5: *Nutzfläche für die Informatik: 1992 (links) und jetzt (rechts)*

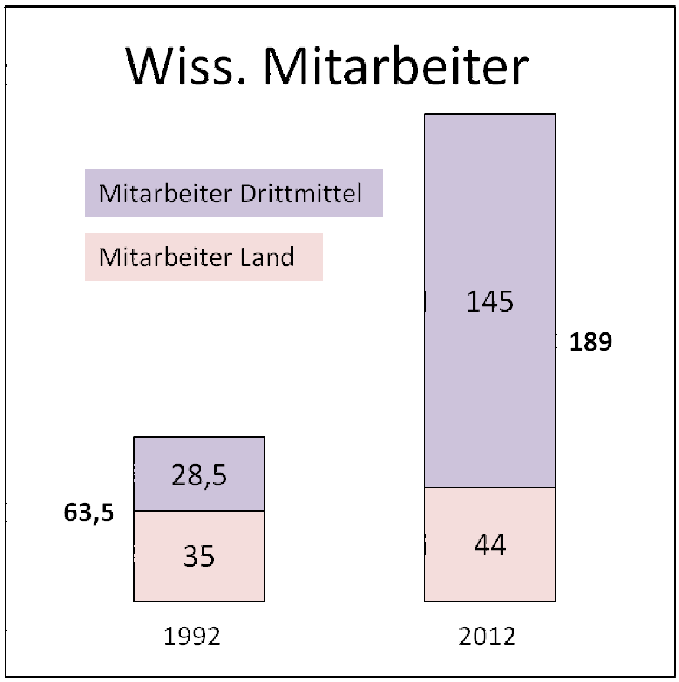


Abbildung 6: *Wissenschaftliche Mitarbeiter in der Informatik: 1992 (links) und jetzt (rechts)*

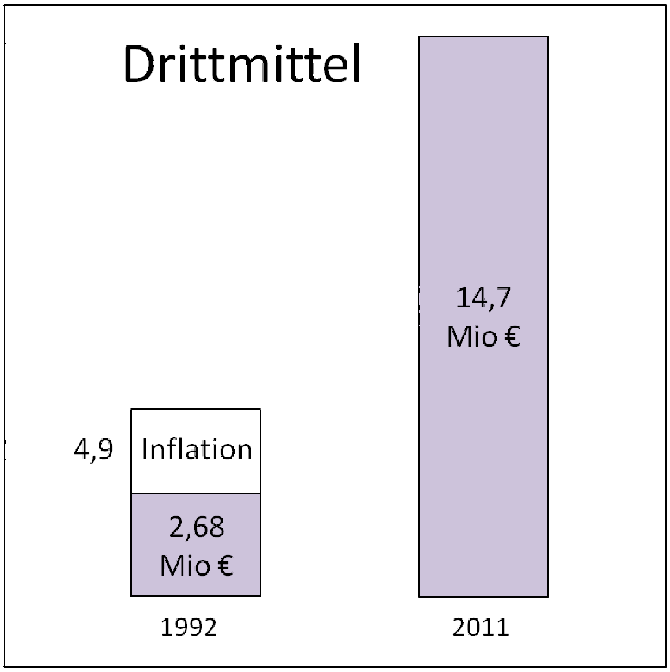


Abbildung 7: *Drittmittel in der Informatik: 1992 (links) und 2011 (rechts)*

In der Abb. 8 stellen wir einige *Kennzahlen* über *Abschlüsse* und *Arbeiten* für die beiden Vergleichsjahre einander gegenüber. Die *Studierendenzahlen* (alle Studierenden, die mit Informatik zu tun haben) haben sich verdoppelt. Das Gleiche trifft für die Master- bzw. Diplom-*Abschlüsse* zu. In Zukunft kommt aber noch etwa die gleiche Zahl von Bachelor-Arbeiten und -Abschlüssen hinzu. Wir hoffen, dass die überwiegende Zahl der Bachelors für den Master bleibt und noch von außen weitere dazukommen. Die Zahl der *Doktorprüfungen* hat sich versechsfacht. Interessant ist auch, wie viele *Abschlussarbeiten* (Diplom-/Masterarbeiten bzw. Doktorarbeiten) *in englischer Sprache* abgefasst werden. Bei Diplom-/ Masterarbeiten stieg der Anteil von 0 auf 40%, bei Doktorarbeiten hat er sich von 40% auf 80% verdoppelt.

Einige Vergleiche		
Stud.	1325	2650
Abschlüsse	89 D	186 D, Ma + 107 Ba
Dr. + Hab.	5 + 1	36 + 1
Arbeiten in Englisch	0% D 40% Dr.	40% D, Ma 80% Dr.
	1992	2011

Abbildung 8: *Vergleichszahlen für die Informatik 1992 und 2011*

Wir sehen also fast überall einen allgemeinen *Zuwachsfaktor* von 3 oder mehr. Dies spiegelt sich in auch in der Dicke der Jahresberichte wider. Ich habe Ihnen den von 1992 mit 178 Seiten und den von 2011 mit 504 Seiten mitgebracht; der Bericht für 2012 wird erst gegen Ende des Jahres fertiggestellt sein.

4. Zukunft und Reflexion

Die Fachgruppe Informatik steht – wie die Informatik in Deutschland und auch weltweit – vor *großen Herausforderungen*. *Informatiklösungen* sind *zukünftig* in einem vierfachen Sinne eingebettet: Wir hatten bereits in den letzten 10 Jahren (1) einen dramatischen Zuwachs an Lösungen und benötigten Arbeitskräften für eingebettete Systeme (z.B. Robotersteuerung), also Softwaresystemen, die in technische Systeme eingebettet sind. Diese eingebetteten Systeme sind (2) meist in weitere technische oder organisatorische Systeme eingebettet. Beispiele hierfür sind Produktions- und Lieferketten und allgemein Geschäftsprozesse in Unternehmen. Es ergibt sich also die Notwendigkeit zu einer weiteren Integration. Eine zusätzliche Einbettung erfolgt (3) auch in den örtlichen Kontext, der auch beweglich sein kann, und wiederum aus vielen Einbettungen bestehen kann (z.B. Internet der Dinge). Schließlich ist alles (4) in das globale Netz Web einzubetten, mit zukünftig eher semantischen Ausprägungen (Web 2.0 oder 3.0).

Somit sind zukünftige Lösungen *verteilt*. Sie sind auch oft *mobil*. Sie sind in verschiedenem Sinne eng *integriert*. Sie müssen auch *flexibel* sein, da nicht für jede Änderung ein neuer Entwicklungsprozess begonnen werden kann. Schließlich müssen sie den jeweiligen *Kontext berücksichtigen* und sie müssen auch *personalisierba*r sein, um den Charakteristika der Nutzer zu genügen. Der Bau entsprechender Systeme muss *besser verstanden* sein, um mit vertretbarem Aufwand zu neuen Lösungen zu kommen bzw. Lösungen auf den neuen Stand zu bringen. Will man hier saubere, effiziente Systeme mit umfassender Funktionalität bauen und später warten, so stellen sich viele *neue Forschungsfragen*, von den Gebieten der Theorie bis hin zu allen Gebieten der Praktischen und Angewandten Informatik.

Diese Fragen entsprechen dem Profil der Fachgruppe. Deren *Forschungsprofil*, praxisbezogen mit theoretischer Fundierung, Verbindung zu den Anwendungen, insbesondere aus den Ingenieurwissenschaften, wird auch andernorts angestrebt. Die Fachgruppe ist aufgefordert, ihr Profil und ihre Sichtbarkeit nach außen durch weitere *Anstrengungen* zu erhalten. Andere Fakultäten sind uns auf den Fersen! Insbesondere wollen wir auch das *Profil und die Qualität der Ausbildung* – auch hier die Verbindung von Theorie, Praxis und Anwendungen – bewahren, damit unsere Absolventen den ihnen gestellten Aufgaben genügen und sich weiterhin in der Industrie behaupten.

Natürlich haben wir auch *Schwachpunkte*. So ist der *Frauenanteil* auf der Ebene der Studierenden, Absolventen, Promovenden und insbesondere auch der Professoren zu niedrig. Das Gleiche gilt auch für die *Internationalisierung*, insbesondere für Mitarbeiter und Professoren. Schließlich ist – angesichts der demografischen Entwicklung – ein deutliches Engagement auf dem Gebiet der *Weiterbildung* für Mitarbeiter aus der Industrie nötig, eine Aufgabe, deren Bedeutung und Notwendigkeit bisher weder von den Universitäten noch von der Industrie ernsthaft wahrgenommen wurde.

Für Leistung ist auch Muße nötig. Ich habe oben bereits auf das bereits bedenkliche Maß hingewiesen, in welchem wir uns heute die Mittel selbst beschaffen müssen. Der Leistungsdruck wurde durch die Exzellenzinitiative noch einmal bedenklich verschärft. Die hochschulpolitischen Veränderungen sind nicht unbedingt kreativitätsfördernd: Umstellung auf das Bachelor- / Master-System; allenthalben Messung jeglicher Leistung, auch wenn man gar nicht weiß, was Leistung überhaupt ist; die Verminderung der Zeit für eigentliche Wissenschaft, weil

mehr Aktivitäten auf den Ebenen Management oder Marketing erforderlich sind; der erhebliche Aufwand, der derzeit in politische Arbeit gesteckt werden muss, damit in Zukunft das Arbeitsumfeld für wissenschaftliches Arbeiten überhaupt noch gegeben ist. Die Liste ließe sich beliebig fortsetzen. Unser Arbeitsumfeld Universität hat einen Weg beschritten, bei dem die Gefahr droht, dass in Zukunft Qualität durch Aktionismus ersetzt wird.

Die Fachgruppe Informatik ist eine gute Mannschaft, mit vielen sichtbaren Erfolgen, die in der RWTH und außerhalb der RWTH, auch international, wahrgenommen werden. Die Herausforderungen sind groß, wenn der Status quo gehalten werden soll oder noch einmal gesteigert werden soll. Es sind also weitere und *vielfältige Anstrengungen* nötig. Hoffentlich verbleibt dabei genügend *Zeit für die eigentliche Arbeit in Forschung und Lehre*. Konzentrieren wir uns also auf das Wesentliche und hoffen wir, dass uns für dieses Wesentliche auch die entsprechende Zeit eingeräumt und der nötige Rahmen mit entsprechenden Ressourcen geboten wird!

Honorary Doctorate for Professor John Mylopoulos

On May 11, 2012, John Mylopoulos Ph.D., Professor Chiara Fama at the University of Trento/ Italy, and Professor emeritus at the University of Toronto / Canada, was awarded the degree of Doctor honoris causa by the Faculty of Mathematics, Informatics, and Natural Sciences, RWTH Aachen University. The citation, handed over by Rector Prof. Dr. Ernst Schmachtenberg, focused on his role as the father of formally based conceptual modeling.

Professors Matthias Jarke (Information Systems, RWTH Aachen, and Chairman, Fraunhofer ICT Group) and Wolfgang Marquardt (Process Engineering, RWTH Aachen, and Chairman, German National Science Council) shared the laudatory speech. In his part, Jarke used a Social Network Analysis to highlight the central role of John Mylopoulos in interlinking the fields of software engineering, artificial intelligence, and databases through conceptual modeling; indeed, John Mylopoulos is the only individual ever who has been program chair of the top conferences in all three fields. His continued research impact has recently been documented by his award of an ERC Advanced Grant. Wolfgang Marquardt gave impressive examples how the conceptual modeling approaches fostered by John Mylopoulos have also transcended other engineering fields, especially the process modeling in chemical engineering.

John Mylopoulos is the third honorary doctoral graduate of the Informatics department whose 40th anniversary had been celebrated by a colloquium earlier in the day. His two predecessors Jan van Leeuwen and Reinhard Wilhelm also participated in the awards ceremony, as did many friends and colleagues from Germany, Europe, and North America, in addition to a large turn-out from within the Informatics department and the rest of RWTH Aachen. The award ceremony was followed by a festive dinner in Aachen's historic City Hall which lasted well into the night.

Rector Ernst Schmachtenberg and Senate President Wolfgang Thomas officially handed over the honorary degree certificate.

The two first honorary doctorate holders Professors Jan van Leeuwen (second from right) and Reinhard Wilhelm (third from left) were among the first to congratulate John Mylopoulos

Matthias Jarke turns 60

This year, Prof. Dr. Matthias Jarke, who holds the Chair Informatik 5 (Information Systems) turned 60. Traditionally, such an occasion is commemorated by a celebratory colloquium. It took place on 1 June and was formally opened by Prof. Joost-Pieter Katoen, the Head of the Computer Science Department. His introductory remarks highlighted Prof. Jarke's many achievements during his 20+ years at RWTH.

Two of Prof. Jarke's long-standing international collaborators, Tung X. Bui (University of Hawaii) and Yannis Vassiliou (National Technical University of Athens) saw to the international flavour of the event. They talked about 'Decision Support Systems and Digital Economies' and 'Information Systems Engineering', respectively.

Tradition has it that some of the honouree's 'academic children' also contribute to the programme of such events. In this case, Manfred Jeusfeld (PhD 1992), now with Tilburg University, gave a talk entitled 'ConceptBase = Meta-Object Facility plus Resource Description Framework'. Subsequently, Klaus Pohl (PhD 1995; University Duisburg-Essen) and Peter Peters (PhD 1996; McKinsey & Company) talked about 'Requirements and Software Engineering'.

Matthias Jarke's other hat is that of the Director of the Fraunhofer Institute for Applied Information Technology (FIT). Accordingly, Wolfgang Prinz, Head of the 'Cooperation Systems' department at FIT also gave a talk entitled 'Human-centered Computing in a Process Context'.

After the coffee break, this was followed by a presentation given by Ulrich Trottenberg (University of Cologne), Matthias' predecessor as Director of FIT. He presented the research centre 'Schloß Birlinghoven', where FIT is based.

The colloquium came to an end with some concluding remarks from Joost-Pieter Katoen.

It should be mentioned that on the occasion of his 60th birthday Matthias was also presented with the Fraunhofer Medal in recognition of his outstanding services to Fraunhofer-Gesellschaft (see below).

24. Open Day - Tag der Informatik

The 'Tag der Informatik' at the RWTH Aachen is the traditional colloquium where the research groups of the computer science department present their research and teaching activities. This event gives everybody the opportunity to gather information about the computer science department and to establish interdisciplinary contacts. This is accomplished by poster, software and hardware exhibitions of a multitude of computer science chairs as well as industrial and research partners. Traditionally, the event take place on the first Friday in December. In 2011, the vent was organised by the Chair of Computer Science 6 (Human Language Technology and Pattern Recognition).

Traditionally the event starts after lunch with an informal get together. This time, welcome addresses were given by RWTH's Vice-Rector Prof. Dr. Aloys Krieg, the Dean of the Faculty Faculty of Mathematics, Computer Science and Natural Sciences, Prof. Dr. Gerhard Hiß, and by the Head of the Department of Computer Science, Prof. Dr. Berthold Vöcking. This was followed by the introduction of the new Faculty members, Prof. Dr. Martin Hoefer, (Algorithmic Game Theory) and Prof. Dr. Bastian Leibe (Mobile Multimedia Processing) who briefly presented their respective fields of research.

The keynote speech was given by Dr. Jean-Luc Gauvain of the Computer Sciences Laboratory for Mechanics and Engineering Sciences (LIMSI) in Paris. The talk was entitled 'The Quaero project and spoken language processing for multimedia search in unstructured data'.

After the coffee break the ever popular 'One Minute Madness' (OMM) offered a number of junior researchers an opportunity to present their work to a not necessarily expert audience. OMM requires to do this presentation within 100 second ('One Hundred Second Madness' doesn't sound nearly as good as the original title) and with one non-animated slide. It's mostly entertaining and good fun.

The subsequent graduation ceremony was introduced by witty talks held by Prof. Dr. Klaus Indermark, Emeritus and the representative of the Alumni Club Dietrich Hunold. As part of the ceremony, several awards and prizes were given to outstanding graduates by different sponsors.

For many, the traditional evening banquet and After TdI party are the day's highlights. Here, the graduates, their families, many current students and alumni, the CS department staff and many visitors from industry and academia gather in a convivial with amply food and drink.

InfoCup 2011 BY Soptim

The InfoCup is the CoSc department's traditional football tournament. In 2011, it was once again sponsored by Soptim AG. The event took place on 1 July. Twelve teams had registered. Accordingly, the group phase comprised three groups with 6 teams each.

The teams and the groups:

Group A	Group B	Group C
UMIC	FS	i8/MMP
i6	i1	i7/mgi
i10	i4	i11
i2	i12	i5/LuFGi9

All team in Group A played on a similar level. At the end of the day, teams UMIC and i10 made the Quarter Finals, as die team i6 as 'lucky loser'. Team i4 clearly dominated Group B; teams i12 and i1 (the second lucky loser) also survived the preliminaries. Not unlike Group A, Group C was a very homogeneous group. While teams i8/MMP and i11 went through to the Quarter Finals, team i7/mgi very narrowly failed. Last year's winner, i5, didn't stand a chance this time. Bet the overall 'red lantern' was won by the Student Council's team.

The Quarter Finals brought some surprises. i4 lost to i6, i11 and i12 were also eliminated despite their respective strong performance in the preliminaries. As a result, all three teams from Group A were in the Semis, together with i8/MMP. Here, UMIC won on penalties against i8/MMP, and i10 repeated their victory in the preliminaries against i6, who also lost the match for third place to i8/MMP.

Similarly, the Finals saw a rematch between UMIC and i10. Yet, this time i10 came of better with a last minute goal; the end result was 2-1. Congratulations.

The final ranking:

1. i10
2. UMIC
3. i8/MMP
4. i6

5. i11
6. i12
7. i4
8. i1
9. i2
10. i5/LuFGi9
11. i7/mgi
12. Students Council

Players and spectators let the day gently fade away with the traditional After-Soccer-Party, enjoying the barbecue and the cold beer.

Computer Science Summer Party – Sommerfest der Informatik

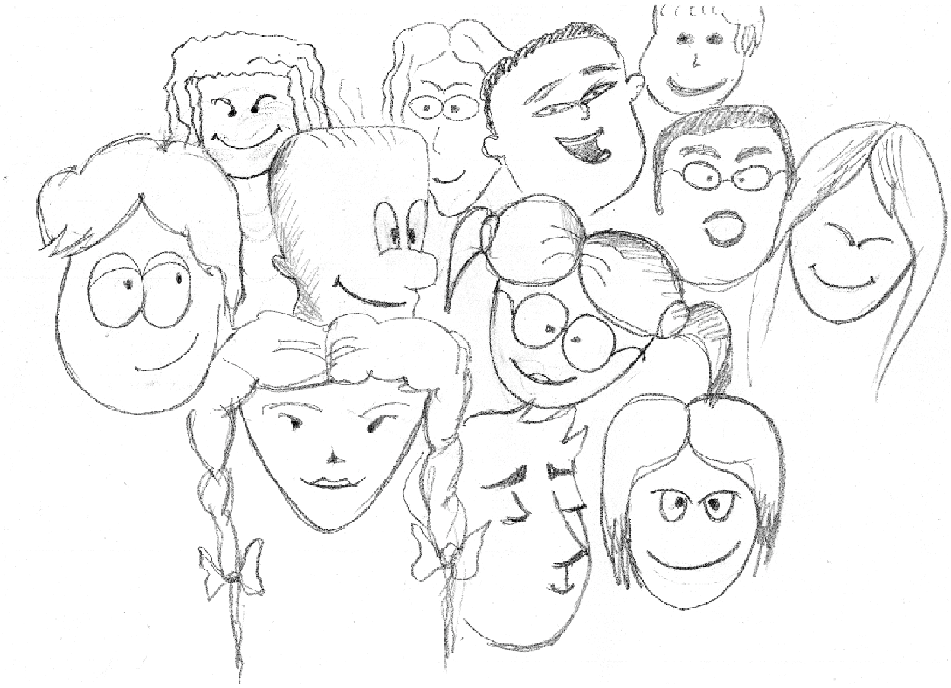
Each year, towards the end of the summer term, the Computer Science Department organises a summer party for the ceremonial presentation of diploma certificates to the graduates of the past six months. Once again, the events took place at Computer Science Centre (and its adjoining parking lot). Each event started with an introductory talk that was followed by a more humorous ceremonial talk. The official part ended with the presentation of the diploma certificates; over 150 students received their certificates at this year's summer party.

Said official ceremony was followed by the – less formal – party proper. A small(ish) buffet and plenty of drinks were on offer. The typical crowd of about 600 people attended the events, including the graduates and their families, current students, most of the staff of the computer science department, and several guests from other departments.

Bright Brains in Computer Science – Helle Köpfe in der Informatik

Starting seven years ago, the Department of Computer Science joined the support program *Aachener Model* for highly talented pupils from elementary schools in city and county of Aachen, which was continued since then. An external steering committee selected 16 children who attend the new program called *Helle Köpfe in der Informatik – Bright Brains in Computer Science*. During eight course meetings, faculty members of the Department of CS introduced the talented pupils to basic topics of computer science.

They particularly lay tress on the deeper insight that computer science exceeds simply working with computers by far.



The seminar set in 2010 had the following topics:

- Computer, Campus, Cleverness: erstes RWTH-Rendezvous (Helen Bolke-Hermanns)
- Warum kann man eine CD zerkratzen? (Peter Rossmanith)
- Suchen und Sortieren (Thomas Seidl)
- Die Nadel im Heuhaufen (Thomas Noll)
- Kara, der programmierbare Marienkäfer (Horst Lichter)
- Bunt ist meine Lieblingsfarbe (Jan Borchers)
- Rechnen mit Nullen und Einsen (Erika Abraham)
- Wie funktioniert das Internet? (Klaus Wehrle)

More Information and photos of all events can be found in the web:

/www.helle-koepfe.informatik.rwth-aachen.de/

The experiences made were very positive, and the program will be continued in the next years.

Teaching

Contents and Curricula of the Various Computer Science Programmes

BSc/MSc

Short Description:

Computer science is the research field dealing with the analysis, the conceptual planning, the implementation, and the application of information processing systems. This requires the study of the basic ideas and fundamental terms like algorithm, process, language, knowledge, complexity, simulation, and communication. Theoretical computer science clarifies these terms, investigates the limits between the possible and the impossible and studies the complexity of algorithms.

Applied computer science is a problem-oriented engineering science – just like other engineering disciplines. The only difference is that a computer engineer's tools are *algorithms* and the material is *information* instead of metal or silicon. Applied computer science offers and developes a variety of methods and techniques for programming languages, software development, information systems, communication systems, language- and image processing, computer graphics, and high performance computing. Many applications involve complex systems which consist of *agents*, communicating with each other and with the environment. Those "agents" can be software modules, but also machines. Other applications focus on finding efficient, scalable, and robust algorithmic solutions for a given problem with well-defined input and output data. As a consequence, computer science techniques enter almost all natural and engineering sciences as well as many areas of everyday life. So, computer science is a highly interdisciplinary science cooperating with various fields of application.

Degree: Bachelor/Master of Science RWTH Aachen University (B.Sc. RWTH/M.Sc. R*Standard period of study:* 6/4 semester

Required Qualifications

Multifaceted methods concerning the structuring, modelling, analysis and solution of problems are utilized within computer science. In fact, these go far beyond mere programming. Therefore, good mathematical knowledge is recommended (major high school course favored) while no deeper knowledge of a specific programming language or industrial experiences are required. During the study, good English knowledge is essential.

Overall Structure

Bachelor of Science RWTH Aachen University (B.Sc. RWTH)

The Bachelor study program in Computer Science aims at a broad education in the scientific fundamentals of Computer Science. In the Bachelor program, methodological competence and occupational field-specific qualifications shall be imparted, which build the basis for the subsequent Master program or an occupational activity. The Bachelor program comprises 180 ECTS Credits, which are a measure of the extent of the courses, and of the study time needed. The Bachelor exam comprises courses from the areas of Applied Computer Science (Programming; Data Structures and Algorithms; Databases and Information Systems; Introduction to Software Engineering), Technical Computer Science (Introduction to

Technical Computer Science; Electrical Engineering Fundamentals of Computer Science; Operating Systems and System Software; Hardware Programming; Dependable Distributed Systems), Theoretical Computer Science (Discrete Structures; Formal Systems, Automata, Processes; Computability and Complexity; Mathematical Logic), Mathematics (Analysis; Linear Algebra; Stochastics; Numerical Calculus), Compulsory Selectable Courses, Subsidiary Courses from a related non-Computer-Science area, as well as seminars, lab courses, and thesis. In general, all courses include weekly (oral or written) problems, of which 50% are required for examination entry. Examinations mainly are done study-attendant in form of a written or oral test.

Master of Science RWTH Aachen University (M.Sc. RWTH)

The Master study program provides advanced knowledge, skills, and methods in the area of Computer Science and shall lead to a high degree of scientific qualification and independence. The Master program comprises 120 ECTS Credits. The Master program comprises the areas of Theoretical Computer Science, Applied Computer Science, Software and Communication, Data- and Information Management, as well as Subsidiary Courses from a related non-Computer-Science area. Within each of the areas, courses can be chosen from a broad range of Compulsory Selectable Courses. The Master examination consist of study attendant exams for lectures, two seminars, a lab course, and the modules of the Subsidiary Area. Finally a specialized exam covering 12-18 ECTS Credits, as well as the Master thesis have to be performed.

Subsidiary Courses

In both the Bachelor and Master study programs, a subsidiary study course has to be chosen from: business administration, biology, electrical engineering, mathematics, physics. Other study courses, if offered at RWTH Aachen University, may be chosen upon approval by the examination committee.

Post-Graduate Studies

These correspond to the main research directions in the computer science department. Possible topics are amongst others: parallel algorithms, programming languages, software techniques, data communication and distributed systems, databases and information systems, knowledge-representations and cognitive robotics, sample- and language detection, as well as computer graphics and high performance computing.

Subject-Related Specialty

One specialty of studying computer science at the RWTH Aachen is the multifaceted cooperation between the computer science especially with the engineering science and the regional computer science industry, which makes professional experiences possible to the students early within their studies.

Professional Areas

Computer Scientists may find employment in many different professional areas which all bear upon information technology. For example chip producers, telecommunication companies, software companies, consulting firms, and users of administration systems (banks, insurances, public service etc.) or automation technology (producing industry, automotive and airplane industry). Because of the increasing use of computer systems in all areas, presently the career opportunities of computer science graduates are excellent!

Principles of Computer Science
as second major of the
'Technik-Kommunikation' Programme

Short description

Technik-Kommunikation is an interdisciplinary study major consisting of two main subjects. The compulsory first main subject is *Communication Science*. The second main subject is an eligible technical subject. Technical subjects currently offered are *Principles of Computer Science*, *Principles of Electrical Engineering and Information Technology*, *Technical Principles of Mechanical Engineering*, as well as *Technical Principles of Mining, Metallurgy, and Earth Sciences*. *Technik-Kommunikation* is coordinated by the education and research area *Textlinguistik* headed by Prof. Eva-Maria Jakobs located in the Philosophical Faculty of RWTH Aachen.

The first main subject *Communication Science* combines educational offers of several disciplines of the humanities at the Philosophical Faculty at the RWTH Aachen. The main focus standards, document testing, creativity, rhetoric, technical terminology, media/multimedia, sociology, psychology, foreign languages, and further training.

The second main subject *Principles of Computer Science* offered by the Computer Science Department of the RWTH Aachen aims at qualifying students to follow the development of computer science and its applications in breadth. Furthermore, an eligible specialization direction is intended to provide a training example for getting acquainted with a specific field of computer science. For example, this will be vital for cooperation in concrete projects of computer science (e.g. for system or user documentation, or the moderation of design processes), or during concentrated journalistic investigation in new areas of computer science. As indicated by the statistics below, more than half the students matriculated for *Technik-Kommunikation* have chosen *Principles of Computer Science* as their second main subject.

Required Qualifications

Besides a general technical interest, and the requirements for the first main subject *Communication Science* which comprise communicative skills in speech and writing, the second main subject *Principles of Computer Science* requires good mathematical knowledge, whereas knowledge of a specific programming language or industrial experiences are not required. During the study, good English knowledge is essential.

Overall Structure

The curriculum of the second main subject *Principles of Computer Science* is split into two parts. Stage I covers semesters 1 up to 4 while stage II covers semesters 5 to 9.

Stage I

The technical and methodical principles of computer science are taught over approx. 41 semester hours in total. The intermediate examination (*Zwischenpr¨ufung*), which extends over four individual exams, is passed study-attendant and comprises the topics Computer Science I (Programming, Application Software and Internet, Algorithms and Data Structures, Software Development), Computer Science II (Computability and Complexity, Computer Organization), and Mathematics (Linear Algebra, Differential and Integral Calculus). Practical courses or practical training certificates are prerequisite to an examination allowance. Examinations usually are performed in the form of a written test. In addition to the

courses already mentioned, a course electronics in computer science and a software practical have to be undertaken.

Stage II

Advanced and exemplary specialization knowledge of computer science is acquired over approx. 40 semester hours. This stage is threefold into the Compulsory Eligible Subject, Central Computer Science (a set of eligible courses making up 14 semester hours), and the Computer Science Specialization (Stage II includes System Programming, Automata Theory and Formal Languages, a mathematical course depending on the choice of specialization direction, and a choice of courses offered by the Department of Computer Science). For the second main subject *Principles of Computer Science*, Central Computer Science and the Computer Science Specialization will make up the two majors of the oral examination to obtain the *Magister/Magistra Artium* degree. In addition, one practical training and one seminar certificate have to be performed successfully.

Professional Areas

Graduates of *Technik-Kommunikation* with second main subject *Principles of Computer Science* will be able to find employment in a diversity of professional areas. The main focus will always be on knowledge transfer - possible areas are: documentation, presentation, public relations, corporate communication, technical writing, media management, information management, interface design, usability testing, concept development, as well as further training.

Secondary School Teachers' Curriculum in Computer Science

The subject of computer science at school

The aim of this curriculum is to give future teachers (in secondary school education) a firm basis for the school subject of computer science. This curriculum has been established a response to the growing importance of computer science in all branches of science and society. A central issue in the school education of computer science is its broad understanding of computer science as a discipline which provides concepts and tools for the analysis and construction of information processing systems - a scope which clearly transcends "programming" and the ability to run software systems.

Pupils should acquire fundamental concepts and some essential methods of computer science at school, thus looking beyond the superficial use of computer games and internet functions as every young person experiences them today.

The computer science curriculum for teachers is offered since the fall of 2000. The subject can (and must) be combined with another subject of study, like mathematics, physics, chemistry, biology, or any other subject, e.g., German or a foreign language. A smaller part (about one fifth) of the total curriculum has to be devoted to pedagogical studies.

An overview of the curriculum

Within the computer science curriculum, the first two years are concerned with basic foundations. The following courses have to be passed (each of them accompanied by practical exercises): Introduction to Programming, Computer Structures, Data Structures and Algorithms, System Programming, and Automata and Formal Languages. In addition, a software practicum and a pro-seminar are obligatory.

In the second phase, the third and fourth year of studies, a collection of more special subjects are to be chosen which have to cover a prescribed range of areas: Theoretical science, practical computer science, mathematical methods of computer science, and didactics of computer science. Five tracks of courses (and/or seminars) have to be selected such that all mentioned four major areas are represented. Final exams are to be passed in all chosen tracks. Also a thesis has to be prepared (in one of the subjects of study, though not necessarily in computer science).

The essential prequisites for a successful study of computer science are similar as for the diploma curriculum: a certain acquaintance with abstract methods and constructions as they are learned and trained in mathematics. Moreover, the ability to communicate with others (and of course, in particular with children) is a necessary condition for future success as a teacher.

The International Master Programme Software Systems Engineering

In 2000, the Computer Science Department launched the two-year Master programme *Software Systems Engineering*. It is primarily intended for international students holding a Bachelor degree in Computer Science, Computer Engineering, or a closely related field from an internationally recognized university-level institution. The programme aims to attract very good, if not the best students from all over the world in pursuit of a Master degree in Computer Science. In order to make the programme as attractive as possible to non- German speaking students, courses are offered entirely in English. To successfully complete the programme, students are required to earn 120 ECTS credits, including 30 credits for the Master thesis and 10 for German language classes. At present, about 80 students from 20 countries are enrolled in the programme.

Building on the strengths of our department, the programme focuses on the design and implementation of complex software systems, including their embedding in technical and socio-technical systems. The degree programme consists of a core curriculum and an area of specialization.

The core curriculum spans both Theoretical Computer Science (for example, Complexity Theory, Logic, Theory of Parallel Processes, Compiler Construction) and Practical Computer Science (for example, Programming Languages, Communication and Distributed Systems, Information Systems, Artificial Intelligence, Speech and Image Processing, Computer Graphics and Multi Media, Embedded Systems). The student is required to cover both subfields in sufficient breadth, which typically means taking three courses in each of the two subfields. In addition, a course on the management of large software system engineering projects is mandatory.

The area of specialization, which consists of courses combined with a seminar and a Master Thesis, can be any of the research areas of the Computer Science faculty members. The Master Thesis typically occupies the final six months of the programme and can be undertaken in cooperation with industry.

Since September 2004, Software Systems Engineering is also part of the *Erasmus Mundus* programme *European Master in Informatics*, which is offered together with the University of Edinburgh and the University of Trento. Participating students receive a two-year scholarship and spend the middle two semesters at one of the partner universities. At the end of the programme, they receive a double degree.

Media Informatics Master Programme

Goals of the Programme

Whilst a Bachelor degree in Computer Science typically qualifies a person to participate in large software projects, the Master degree provides the skills needed for leadership. Graduates of the programme Media Informatics can be expected to be technically innovative, to work as system architects, and to manage large projects. Students who excel during their Master's programme will also have the necessary qualifications to pursue a doctoral degree.

Formal Entrance Requirements

A candidate should have a recognised first degree (Bachelor of Science or Engineering) in Computer Science, Computer Engineering, Informatics, or other closely related discipline, awarded by an internationally recognised university-level institution. Candidates should have also performed above average in their undergraduate studies. The Graduate Record Examination (GRE) is also strongly recommended. For English-taught programmes candidates must be able to speak and write fluently in English (TOEFL 550 paper-based /213 computer-based or IELTS 6.0). English-speaking students attend a basic German language course that will start in August, two months prior to the beginning of the master programme. See English Language Requirements for RWTH Master Programmes and How to apply to RWTH Master Programmes for further information.

Special Entrance Requirements

The candidate should have a substantial background in computer science and mathematics. Typically this would include previously taken courses in the following areas: Calculus, Linear Algebra, Discrete Mathematics and Logic, Numerics, Probability Theory, Fundamentals of Computer Programming, Computer Architecture, Data Structures, Analysis of Algorithms, Programming Languages, Automata Theory, Computability and Complexity Theory. In addition, an applicant should have at least two advanced undergraduate courses on specialised topics such as Distributed Systems, Information Systems, Operating Systems or Multimedia Techniques.

General Description of the Programme

The international Master Programme in Media Informatics was introduced in 2002 at the Bonn-Aachen International Center for Information Technology (B-IT). Media Informatics is offered by RWTH Aachen University and the University of Bonn in co-operation with the Fraunhofer Institutes at Sankt Augustin near Bonn. This interdisciplinary programme will educate the participant to successfully master the novel technical and economic challenges at the crossroads of computer science, software engineering, next-generation communication systems, and media. The programme is distinguished by its international orientation, its focus on IT competence, and its high level of integration of research and teaching. The master's programme in Media Informatics consists of three main blocks: computer science and mathematical foundations, basic principles in media science and business, media informatics.

The programme is characterised by a significant proportion of research lab courses embedded in both basic and applied research of the participating Fraunhofer Institutes of Applied Information Technology (FIT), and Media Communication (IMK). Major topics include: digital interactive media, internet infrastructures, management of information, communication and security, knowledge management, visualisation, and virtual engineering on the basis of augmented reality. Special courses on modelling of spatial and mobile aspects, and on usage,

annotation, and retrieval of spatial data provide for a special focus in the important application domain of Geographical Information Systems. The programme of study also includes methodological aspects of designing media informatics systems from the perspectives of software engineering, usability, media design, and business requirements.

The final six months of the programme are dedicated to the master thesis which can be done in co-operation with industry. The course contents is structured according to the ECTS (European Credit Transfer System).

Career Opportunities

Computer scientists with an applied focus have been in great demand in the past, and this trend is expected to continue for the foreseeable future. With an M.Sc. degree in Media Informatics you will be well-prepared for the typical challenges faced when working in computer systems engineering and for creative work with audio-visual media. The ABCD region (Aachen, Bonn, Cologne; Düsseldorf) is home to many prospective employers, including global players such as Philips, Deutsche Telekom, Vodafone, Bertelsmann Group, as well as many television stations such as WDR, VIVA, etc.

Language of Instruction

The Programme will be taught completely in English

Duration of the Programme

Two years

Beginning of the Programme

October

Deadline for application:

March 1st the same year the programme starts

Further information

For further general information please check the RWTH webpages. If you have specific questions on course content please contact:

RWTH Aachen University
Chair Informatik 4
Media Informatics Team
52056 Aachen, Germany
E-Mail: msc-mi@b-it-center.de
Webpage: http://mi.b-it-center.de/

Courses Taught in 2012

Summer Term 2012

Diploma

Datenstrukturen und Algorithmen	Katoen, Heinen, von Styp - Rekowski, Dehnert	V (4)
Datenstrukturen und Algorithmen (Übung)	Katoen, Heinen, von Styp - Rekowski, Dehnert	Tut (2)
Datenstrukturen und Algorithmen (Globalübung)	Katoen, Heinen, von Styp - Rekowski, Dehnert, Raumverwaltung (Krüger)	Ü (2)
Klausur Datenstrukturen und Algorithmen	Katoen, Heinen, von Styp - Rekowski, Dehnert,	Kl
Systemprogrammierung	Kowalewski, Dernehl, Schommer, Betreuer	P (3)
Formale Systeme, Automaten, Prozesse	Thomas,	VT (3)
Formale Systeme, Automaten, Prozesse (Hörsaalübung)	Thomas, Olschewski, Otto	Ü (2)
Formale Systeme, Automaten, Prozesse (Gruppenübungen)	Thomas	Tut (2)
Klausur Formale Systeme, Automaten, Prozesse	Thomas,	Kl
Klausureinsicht Formale Systeme, Automaten und Prozesse	Thomas,	F
Lineare Algebra I für Informatiker	Hanke, Hiß,	V (3)
Lineare Algebra I für Informatiker	Hanke, Hiß,	Ü (2)
Klausur Lineare Algebra I für Informatiker	Hiß, Hanke,	KlT
Einführung in die angewandte Stochastik	Kamps	V (3)
Einführung in die angewandte Stochastik (Diskussion)	Kamps, Wang, Schmiedt	F (2)
Einführung in die angewandte Stochastik	Kamps, Wang, Schmiedt	Ü (1)
Prüfungsklausur Einführung in die angewandte Stochastik	Kamps, Cramer, Steland,	Kl
Prüfungsklausur Einführung in die angewandte Stochastik (Wdhl.)	Kamps, Cramer, Steland,	Kl
Klausureinsicht Einführung in die angewandte Stochastik	Kamps,	
Mathematische Logik	Löding, Grädel,	V (3)
Mathematische Logik	Löding, Grädel,	Tut (2)
Mathematische Logik (Diskussion)	Löding, Grädel,	F (1)
Klausur Mathematische Logik	Löding, Grädel,	Kl
Proseminar "Methoden und Werkzeuge"	Seidl, Hassani, Kranen	PS (2)
Datenstrukturen und Algorithmen (Übung)	Katoen, Heinen, von Styp - Rekowski, Dehnert	Tut (2)
Datenstrukturen und Algorithmen (Übung)	Katoen, Heinen, von Styp - Rekowski, Dehnert	Tut (2)
Softwarepraktikum: Implementierung	Katoen, Nguyen, Dehnert	PT (3)

heuristischer Algorithmen für Brettspiele		
Software-Projektpraktikum	Lichter, Hoffmann, Vianden	PT (3)
Software-Projektpraktikum Maschinelle Übersetzung	Ney, Huck, Freitag	VÜPT (4 (V1+Ü3))
Multimodal Media Madness	Borchers, Herkenrath, Völker, Krämer, Bohne,	VP (V1+P3)
Proseminar: Ausgewählte Kapitel der Computergraphik	Kobbelt, Sattler, Menzel	PST (2)
Künstliche Intelligenz	Lakemeyer, Schiffer, Niemüller, Beck, Schwering	PS (2)
Proseminar: Fortgeschrittene Programmierkonzepte in Java, Haskell und Prolog	Giesl, Otto, Emmes, Brockschmidt, Ströder	PS (3)

BSc

Algorithmen auf Graphen	Unger	PS (2)
Algorithmen auf Graphen I	Unger	S (2)
Algorithmen auf Graphen II	Seibert	S (2)
Applied Automata Theory	Thomas,	VT (3)
Applied Automata Theory	Thomas, Lang, Chaturvedi, N.N.,	Ü (2)
Applied Automata Theory (Exam)	Thomas,	Kl
Betriebssysteme und Systemsoftware	Leibe, Bitsch Link, Weyand	Ü (2)
Betriebssysteme und Systemsoftware	Leibe, Bitsch Link, Weyand	V (3)
Betriebssysteme und	Leibe, Bitsch Link, Weyand	Ü (2)
Compilerbau	Noll, Naumann,	V (3)
Compilerbau	Noll, Jansen, Gretz	Ü (2)
Current Research Topics in Computer Graphics, Geometry Processing, and Computer Vision	Kobbelt, Leibe, Ebke, Kremer	S (2)
Current Topics in Computer Vision and Machine Learning	Leibe, Horbert	S
Datenbanken und Informationssysteme	Jarke, Klamma, Geisler, Hannemann, Terwelp,	VT (3)
Datenbanken und Informationssysteme	Jarke, Klamma, Geisler, Hannemann, Terwelp	Ü (2)
Datenkommunikation und Sicherheit (vormals: Sichere verteilte Systeme)	Wehrle, Thißen, Viol,	V (3)
Datenkommunikation und Sicherheit (vormals: Sichere verteilte Systeme) - Diskussionsstunde	Wehrle, Thißen, Viol	Ü (2)
Datenkommunikation und Sicherheit (vormals: Sichere verteilte Systeme) - Klausur	Wehrle, Thißen, Viol,	Kl
Datenstrukturen und Algorithmen	Katoen, Heinen, von Styp - Rekowski, Dehnert	V (4)
Datenstrukturen und Algorithmen (Globalübung)	Katoen, Heinen, von Styp - Rekowski, Dehnert, Raumverwaltung (Krüger)	Ü (2)

Datenstrukturen und Algorithmen (Übung)	Katoen, Heinen, von Styp - Rekowski, Dehnert	Tut (2)
Die Softwaretechnik-Programmiersprache Ada 95	Nagl, Horst	VT (3)
Effiziente Algorithmen	Unger,	V (3)
Effiziente Algorithmen	Unger, Ochel, Geulen, Ries	Ü (2)
Einführung Anwendungsfächer im Bachelor Informatik	Schlüter,	
Einführung in die angewandte Stochastik	Kamps	V (3)
Einführung in die angewandte Stochastik	Kamps, Wang, Schmiedt	Ü (1)
Einführung in die angewandte Stochastik (Diskussion)	Kamps, Wang, Schmiedt	F (2)
Einführung in die angewandte Stochastik (Fragestunden)	Kamps, Wang, Schmiedt	F
Einführung in eingebettete Systeme	Kowalewski, Kamin	VÜ (3+1)
Einführung in High-Performance Computing	Bücker	VT (3)
Einführung in High-Performance Computing	Bücker	Ü (1)
Entwicklung NXT-gesteuerter LEGO-Fahrzeuge mit Java	Kowalewski, Hänsch, Kalkov	VPT (4)
Formale Systeme, Automaten, Prozesse	Thomas,	VT (3)
Formale Systeme, Automaten, Prozesse (Gruppenübungen)	Thomas	Tut (2)
Formale Systeme, Automaten, Prozesse (Hörsaalübung)	Thomas, Olschewski, Otto	Ü (2)
Foundations of Multi-Core Memory Models	Noll, Katoen, Yue, Wu, Gretz	S (2)
Funktionale Programmierung	Giesl	V (3)
Funktionale Programmierung	Giesl, Brockschmidt, Emmes	Ü (2)
Geschäftsmodelle und IT-Anwendungen in der Elektromobilität	Jarke, Bastian, Krempels, Terwelp	P (5)
Introduction to Knowledge Representation	Lakemeyer, Beck,	VÜT (3)
Klausur Betriebssysteme und Systemsoftware	Leibe, Bitsch Link, Weyand	Kl
Klausur Compilerbau	Noll,	Kl
Klausur Datenbanken und Informationssysteme	Jarke, Klamma,	Kl
Klausur Datenstrukturen und Algorithmen	Katoen, Heinen, von Styp - Rekowski, Dehnert,	Kl
Klausur Effiziente Algorithmen	Unger,	Kl
Klausur Formale Systeme, Automaten, Prozesse	Thomas,	Kl
Klausur Funktionale Programmierung	Giesl,	Kl
Klausur Introduction to Knowledge Representation	Lakemeyer,	KlT
Klausur Lineare Algebra I für Informatiker	Hiß, Hanke,	KlT
Klausur Mathematische Logik	Löding, Grädel,	Kl

Klausur Software-Qualitätssicherung	Lichter,	KIT
Klausureinsicht Einführung in die angewandte Stochastik	Kamps,	
Klausureinsicht Formale Systeme, Automaten und Prozesse	Thomas,	F
Kompressionsalgorithmen	Rossmanith, Langer, Reidl	S (2)
Künstliche Intelligenz	Lakemeyer, Schiffer, Niemüller, Beck, Schwering	PS (2)
Lineare Algebra I für Informatiker	Hanke, Hiß,	V (3)
Lineare Algebra I für Informatiker	Hanke, Hiß	F
Lineare Algebra I für Informatiker	Hanke, Hiß,	Ü (2)
Mathematische Logik	Löding, Grädel,	V (3)
Mathematische Logik	Löding, Grädel,	Tut (2)
Mathematische Logik (Diskussion)	Löding, Grädel,	F (1)
Mentoring Informatik	Fachgruppe Informatik, Akbari, Leonhardt	ÜT
Mentoring Informatik NTW	Nagl, Fachgruppe Informatik, Akbari, Leonhardt	Tut
Mobile & Locations Based Augmented Reality (AR) App/Game Entwicklung	Rumpe, Akbari, Leonhardt	P (4)
Mobile Internet Technology	Wehrle, Thißen	VÜ (3+1)
Modellierung und Analyse hybrider Systeme	Abraham, Chen,	VÜT (3+1)
Modellierung und Analyse hybrider Systeme Prüfung	Abraham,	
Multimodal Media Madness	Borchers, Herkenrath, Völker, Krämer, Bohne,	VP (V1+P3)
Nachholklausur Betriebssysteme und Systemsoftware	Leibe, Bitsch Link, Weyand	Kl
Netzwerke und Internet	Wehrle, Thißen,	PS (2)
Numerische Bibliotheken	Naumann	PS (2)
Probabilistic Method	Vöcking, Radke	S (2)
Proseminar: Ausgewählte Kapitel der Computergraphik	Kobbelt, Sattler, Menzel	PST (2)
Proseminar: Fortgeschrittene Programmierkonzepte in Java, Haskell und Prolog	Giesl, Otto, Emmes, Brockschmidt, Ströder	PS (3)
Prüfung Einführung in eingebettete Systeme	Kowalewski, Kamin,	Kl
Prüfung Einführung in High-Performance Computing	Bücker,	Kl
Prüfung Mobile Internet Technology	Wehrle, Thißen,	Kl
Prüfungsklausur Einführung in die angewandte Stochastik	Kamps, Cramer, Steland,	Kl
Prüfungsklausur Einführung in die angewandte Stochastik (Wdhl.)	Kamps, Cramer, Steland,	Kl

Robuste Software für heterogene Netzwerke	Kowalewski, Schommer	S (2)
Satisfiability Checking	Giesl, Abraham, Otto, Emmes, Loup, Jansen, Brockschmidt, Ströder, Nellen, Corzilius	S (2)
Selected Topics in Human Language Technology and Pattern Recognition	Ney	ST (2)
Selected Topics in IT-Security and Cryptography	Meyer, Weingarten	ST
Seminar "Advanced Data Analysis"	Seidl, Ivanescu	ST (2)
Seminar Dynamische Systeme	Kowalewski, Hänsch	ST (2)
Seminar Robust Reliable Robotics	Lakemeyer, Niemüller, Schiffer, Belle, Beck	S (2)
Seminar über Automatentheorie	Thomas, Löding	S (2)
Seminar: Advanced Internet Technology	Wehrle, Thißen,	S (2)
Seminar: Aktuelle Themen der Virtuellen Realität	Kuhlen,	S (2)
Seminar: Mobile Internet Technology	Wehrle, Thißen,	S (2)
Seminar: Mobile Networks	Gross	S (2)
Software Engineering Seminar: Modellbasierte Softwareentwicklung	Rumpe, Mir Seyed Nazari	ST (2)
Software-Architekturen	Nagl, Horst	V (3)
Software-Architekturen	Nagl, Horst	ÜT (2)
Software-Architekturen	Nagl, Horst	MP
Software-Projektpraktikum	Lichter, Hoffmann, Vianden	PT (3)
Software-Projektpraktikum Maschinelle Übersetzung	Ney, Huck, Freitag	VÜPT (4)
Software-Qualitätssicherung	Lichter	VT (3)
Software-Qualitätssicherung	Lichter, Ganser, Dragomir	ÜT (2)
Softwarepraktikum "Developing a Pinball Game"	Kobbelt, Krecklau, Li,	P (4)
Softwarepraktikum: Implementierung heuristischer Algorithmen für Brettspiele	Katoen, Nguyen, Dehnert	PT (3)
Systemprogrammierung	Kowalewski, Dernehl, Schommer, Betreuer	P (3)
Theoretical Aspects of Distributed Computing in Sensor Networks	Vöcking, Keßelheim,	S (2)
Vorkurs Mathematik für Informatiker	Cramer, Kamps, Katzur	V
Web Science Seminar	Jarke, Klamma, Renzel	ST (2)
Zweite Klausur Effiziente Algorithmen	Unger,	Kl

MSc

Accenture Campus Challenge 2011: Enterprise 2.0-Plattformen - Ideen- und Produktentwicklung auf Basis von nutzergenerierten Inhalten	Quix, Jarke	P (4)

Advanced Data Models	Jarke, Quix, Li, Kastrati	VÜT (V3/Ü1)
Advanced Learning Technologies	Schroeder, Chatti, Thüs,	VÜ (3+2)
Advanced Learning Technologies - Masterexam	Schroeder, Chatti	MPT
Advanced Model Checking	Katoen,	V (3)
Advanced Model Checking	Katoen, Sher Vira, Chakraborty, Yue	Ü (2)
Algorithmen auf Graphen I	Unger	S (2)
Algorithmen auf Graphen II	Seibert	S (2)
Algorithmen und Komplexität	Vöcking	S (2)
Algorithmische Spieltheorie	Hoefer	V (3)
Algorithmische Spieltheorie	Hoefer	Ü (2)
Analyse von Algorithmen	Rossmanith	V (4)
Analyse von Algorithmen (Klausur)	Rossmanith,	Kl
Analyse von Algorithmen (Übungen)	Rossmanith, Langer, Reidl, Sikdar	Ü (2)
Applied Automata Theory	Thomas,	VT (3)
Applied Automata Theory	Thomas, Lang, Chaturvedi, N.N.,	Ü (2)
Applied Automata Theory (Exam)	Thomas,	Kl
Arbeitsgemeinschaft Informationslogistik	Jarke, Krempels, Terwelp	AG (2)
Arbeitsgemeinschaft Metadata in Community Information Systems	Jarke, Klamma	AGT (2)
Arbeitsgemeinschaft Model Management	Jarke, Quix	AG (2)
Arbeitsgemeinschaft Programmverifikation	Giesl, Brockschmidt, Emmes, Otto, Plücker, Ströder,	Ü (2)
Arbeitsgemeinschaft: Communication Systems Engineering	Wehrle, Thißen	AG (3)
Arbeitsgemeinschaft: Mobile Communications	Wehrle, Thißen	AG (3)
Arbeitsgemeinschaft: Sensornetze	Wehrle, Thißen	AG (3)
Automatic Generation and Analysis of Algorithms	Bientinesi	VP V3/ÜE1
Automatic Generation and Analysis of Algorithms - Final Exam	Bientinesi	MP V3/ÜE1
Compilerbau	Noll, Naumann,	V (3)
Compilerbau	Noll, Jansen, Gretz	Ü (2)
CSCW und Groupware: Konzepte und Systeme zur computergestützten Zusammenarbeit	Prinz	VÜT (V2/Ü1)
Designing Interactive Systems II	Borchers, Wittenhagen, Heller, Lichtschlag,	VÜ (V3/Ü2)
Designing Interactive Systems II (Klausur)	Borchers, Wittenhagen, Heller, Lichtschlag	Kl (V3/Ü2)

Die Softwaretechnik-Programmiersprache Ada 95	Nagl, Horst	VT (3)
Einführung in eingebettete Systeme	Kowalewski, Kamin	VÜ (3+1)
Einführung in High-Performance Computing	Bücker	VT (3)
Einführung in High-Performance Computing	Bücker	Ü (1)
Exploring High-dimensional Data: Advanced Mining Techniques	Seidl, Günnemann,	VÜ (3+2)
Fortgeschrittene Methoden in der Automatischen Spracherkennung	Schlüter, Ney,	VÜ (3/1)
Foundations of Multi-Core Memory Models	Noll, Katoen, Yue, Wu, Gretz	S (2)
Funktionale Programmierung	Giesl	V (3)
Funktionale Programmierung	Giesl, Brockschmidt, Emmes	Ü (2)
Generative Softwareentwicklung	Rumpe, Schindler, Mir Seyed Nazari	VÜT (3+2)
Generative Softwareentwicklung - Prüfung	Rumpe,	Kl
Geometrieverarbeitung	Kobbelt,	V (3)
Geometrieverarbeitung	Kobbelt, Dekkers, Schaefer	Ü (2)
Geometrieverarbeitung (Klausur)	Kobbelt,	Kl
Globale Beleuchtung und Image-based Rendering	Kobbelt, Bachelor Informatik	V (3)
Globale Beleuchtung und Image-based Rendering	Kobbelt, Möbius, Frohn	Ü (2)
Globale Beleuchtung und Image-based Rendering (Klausur)	Kobbelt,	Kl
Infinite Games	Löding	VT (3)
Infinite Games	Löding, Spelten	Ü (2)
Infinite Games (Exam)	Löding,	MP
Innovationen im Software Engineering	Rumpe, Hermerschmidt,	VT (2)
Innovationen im Software Engineering - Prüfung	Rumpe, Hermerschmidt	BPT (2)
Introduction to Knowledge Representation	Lakemeyer, Beck,	VÜT (3)
Klausur Advanced Data Models	Jarke, Quix,	Kl
Klausur Compilerbau	Noll,	Kl
Klausur Exploring High-dimensional Data	Seidl	Kl
Klausur Funktionale Programmierung	Giesl,	Kl
Klausur Introduction to Knowledge Representation	Lakemeyer,	KlT
Klausur Parallele Programmierung II	Wolf,	Kl
Klausur Software-Projektmanagement	Lichter,	Kl
Klausur Software-Qualitätssicherung	Lichter,	KlT
Klausur zu CSCW und Groupware: Konzepte und Systeme zur computergestützten	Prinz	Kl

Zusammenarbeit		
Kombinatorische Probleme im Wissenschaftlichen Rechnen	Naumann	VÜ (2+2)
Kombinatorische Probleme im Wissenschaftlichen Rechnen	Naumann	Kl
Kompressionsalgorithmen	Rossmanith, Langer, Reidl	S (2)
Lehrstuhlkolloquium	Kowalewski	EK
Lehrstuhlseminar	Katoen, Giesl, Abraham	S (2)
Machine Learning	Leibe, Floros	VÜT (3+1)
Master-Mentorenprogramm: Angewandte Informatik		
Master-Mentorenprogramm: Daten- & Informationsmanagement		
Master-Mentorenprogramm: Software & Kommunikation		
Master-Mentorenprogramm: Theoretische Informatik		
Masterprüfung Fortgeschrittene Methoden in der Automatischen Spracherkennung	Ney, Schlüter,	MP
Mobile & Locations Based Augmented Reality (AR) App/Game Entwicklung	Rumpe, Akbari, Leonhardt	P (4)
Mobile Internet Technology	Wehrle, Thißen	VÜ (3+1)
Modellierung eines Solarturmkraftwerks	Abraham, Richter	P (4)
Modellierung und Analyse hybrider Systeme	Abraham, Chen,	VÜT (3+1)
Modellierung und Analyse hybrider Systeme Prüfung	Abraham,	
Network Simulation	Gross	V (3+1)
Parallele Programmierung II	Wolf,	VT (V3)
Parallele Programmierung II	Wolf,	Ü (Ü2)
Praktikum "Data Mining Algorithmen"	Seidl, Boden, Fries	P (4)
Praktikum Sensor-Netzwerke	Wehrle, Thißen	P (4)
Praktikum Virtuelle Realität	Kuhlen, Beer, Pick	PT (4)
Probabilistic Method	Vöcking, Radke	S (2)
Prozess Management	Rose	VÜ (V2/Ü1)
Prozesse und Methoden beim Testen von Software	Kriebel, Mir Seyed Nazari,	VT (V2)
Prozesse und Methoden beim Testen von Software - Klausur	Rumpe, Kriebel,	KlT
Prozessmanagement (Klausur)	Rose	KlT
Pruefung Sicherheit in der	Meyer	Kl

Mobilkommunikation		
Prüfung Advanced Methods of Cryptography	Mathar,	Kl
Prüfung Advanced Model Checking	Katoen	Kl
Prüfung Algorithmische Spieltheorie	Hoefer,	MP
Prüfung Cryptography I	Mathar,	KlT
Prüfung Einführung in eingebettete Systeme	Kowalewski, Kamin,	Kl
Prüfung Einführung in High-Performance Computing	Bücker,	Kl
Prüfung Machine Learning	Leibe	MP
Prüfung Mobile Internet Technology	Wehrle, Thißen,	Kl
Prüfung Network Simulation	Gross,	MP
Prüfung Sicherheit und Zuverlässigkeit softwaregesteuerter Systeme	Kowalewski,	Kl
Prüfung Theorie Verteilter Systeme	Vöcking,	Kl
Prüfung: Research Focus Class on Communication Systems	Wehrle,	MP
Research Focus Class on Communication Systems	Wehrle, Thißen	VÜ (V3+Ü2)
Robuste Software für heterogene Netzwerke	Kowalewski, Schommer	S (2)
Satisfiability Checking	Giesl, Abraham, Otto, Emmes, Loup, Jansen, Brockschmidt, Ströder, Nellen, Corzilius	S (2)
SCRUM-Basierte Software Entwicklung im Bereich Internet der Dinge	Jarke, Zimmermann	P (5)
Security Lab	Meyer, Neugebauer, Schloesser	P (4)
Selected Topics in Human Language Technology and Pattern Recognition	Ney	ST (2)
Selected Topics in IT-Security and Cryptography	Meyer, Weingarten	ST
Seminar "Advanced Data Analysis"	Seidl, Ivanescu	ST (2)
Seminar Dynamische Systeme	Kowalewski, Hänsch	ST (2)
Seminar Robust Reliable Robotics	Lakemeyer, Niemüller, Schiffer, Belle, Beck	S (2)
Seminar über Automatentheorie	Thomas, Löding	S (2)
Seminar: Advanced Internet Technology	Wehrle, Thißen,	S (2)
Seminar: Aktuelle Themen der Virtuellen Realität	Kuhlen,	S (2)
Seminar: Mobile Internet Technology	Wehrle, Thißen,	S (2)
Seminar: Mobile Networks	Gross	S (2)
Seminar: Mobile Networks	Gross	S (2)
Sicherheit in der Mobilkommunikation	Meyer, Gilger	VÜT (3+1)
Sicherheit und Zuverlässigkeit softwaregesteuerter Systeme	Kowalewski, Förster	VÜ (V3/Ü1)

Simplex in SMT	Abraham, Loup, Corzilius	P (4)
Software Engineering Praktikum: Smart Feedback Apps	Rumpe, Kurpick, Pinkernell, Look, Lindt	PT (4)
Software Engineering Seminar: Modellbasierte Softwareentwicklung	Rumpe, Mir Seyed Nazari	ST (2)
Software-Architekturen	Nagl, Horst	V (3)
Software-Architekturen	Nagl, Horst	ÜT (2)
Software-Architekturen	Nagl, Horst	MP
Software-Projektmanagement	Pricope, Lichter, Harun	VT (2)
Software-Projektmanagement	Lichter, Pricope, Harun	Ü (1)
Software-Qualitätssicherung	Lichter	VT (3)
Software-Qualitätssicherung	Lichter, Ganser, Dragomir	ÜT (2)
The Geometry Processing Pipeline	Kobbelt, Sibbing, Zimmer, Campen	PT (4)
The Media Computing Project (Praktikum Hauptstudium)	Borchers, Möllers, Wacharamanotham,	P (2)
Theoretical Aspects of Distributed Computing in Sensor Networks	Vöcking, Keßelheim,	S (2)
Theorie verteilter Systeme	Vöcking	V (3)
Theorie verteilter Systeme	Vöcking, Reiffenhäuser, Winkler	Ü (2)
Vorkurs Informatik	Lichter, Ganser, Katoen	VÜ
Web Science Seminar	Jarke, Klamma, Renzel	ST (2)

Winter 2012/13

Diploma

Klausureinsicht Einführung in die angewandte Stochastik (Wdh.)	Kamps	
Mensch-Maschine-Interaktion	Borchers, Wittenhagen, Krämer,	PS (2)
Proseminar "Elementary Data Mining Techniques"	Seidl, Hassani, Boden	PS (2)
Proseminar: Algorithmen und Werkzeuge für die Verifikation	Abraham, Jansen, Loup, Chen, Nellen, Corzilius	PS (2)
Unternehmensgründung und neue Medien	Jarke, Klamma, Renzel, Nicolaescu	PT

BSc

Advanced Internet Technology	Wehrle, Thißen,	V (3)
Analysis für Informatiker	Sander,	V (4)
Analysis für Informatiker	Sander,	Ü (2)
Analysis für Informatiker (Diskussion in Gruppen)	Sander,	Ü (2)

Automatic Speech Recognition	Schlüter, Ney,	V (4)
Automatic Speech Recognition	Schlüter, Ney, Nußbaum	ÜT (2)
Bachelorprüfung Einführung in statistische Klassifikation	Ney,	MP
Basic Techniques in Computer Graphics	Kobbelt,	V (3)
Basic Techniques in Computer Graphics	Kobbelt, Sattler, Menzel, Campen, Kremer	Ü (2)
Basic Techniques in Computer Graphics (Klausur)	Kobbelt,	Kl
Berechenbarkeit und Kompexität (Globalübung)	Rossmanith, Langer, Reidl, Sikdar,	Ü (2)
Berechenbarkeit und Komplexität	Rossmanith	V (3)
Berechenbarkeit und Komplexität	Rossmanith	Tut
Current Research Topics in Computer Graphics and Geometry Processing	Kobbelt, Zimmer, Frohn	ST (2)
Data Mining Algorithmen	Seidl	VÜT (3+2)
Data Mining Algorithmen Prüfung	Seidl,	KlT,
Designing Interactive Systems I	Borchers, Völker, Corsten, Wacharamanotham,	VÜT (V3/Ü2)
Designing Interactive Systems I - Klausur	Borchers, Völker, Corsten, Wacharamanotham,	Kl (V3/Ü2)
Die Softwaretechnik-Programmiersprache Ada	Nagl, Kurpick,	VT (3)
Die Softwaretechnik-Programmiersprache Ada	Nagl, Kurpick	ÜT (3)
Die Softwaretechnik-Programmiersprache Ada	Nagl, Kurpick	Kl (3)
Diskrete Strukturen	Hanke, Hiß,	VÜ (3+1)
Einführung in die Technische Informatik	Kowalewski, Kalkov, Dernehl	V (4)
Einführung in die Technische Informatik	Kowalewski, Kalkov, Dernehl	Ü (2)
Einführung in statistische Klassifikation	Ney, Schlüter,	V (4)
Einführung in statistische Klassifikation	Ney, Wiesler, Lehnen	ÜT (2)
Entwurfs- und Programmierkonzepte mobiler Applikationen	Kowalewski, Franke	PS (4)
Erfüllbarkeitsüberprüfung (Satisfiability Checking)	Abraham, Corzilius, Jansen, Loup	VÜT (V3 Ü1)
Erfüllbarkeitsüberprüfung Prüfung	Abraham,	MP
Explorative Suche mit Lego Mindstorms Robotern	Abraham, Nellen,	P (3)
Formale Grundlagen der UML	Katoen	Kl
Game Programming	Kobbelt	VPS (3)
Game Programming	Kobbelt, Sibbing, Möbius, Ebke	MP
Implementierung eines Brettspiels inklusive KI	Rossmanith, Langer, Reidl, Sikdar	VP (4)

Infinite Computations	Thomas,	VT (3)
Infinite Computations	Thomas, Chaturvedi,	Ü (2)
Infinite Computations (Exam)	Thomas,	Kl
Introduction to Artificial Intelligence	Lakemeyer, Niemüller, Schwering,	VÜT (V3Ü2)
Introduction to Scientific Computing Languages	Bientinesi	VPT (V3/ÜE1)
Introduction to Scientific Computing Languages - Final Exam	Bientinesi,	MPT (V3/ÜE1)
iPhone Anwendungsprogrammierung	Borchers, Lichtschlag, Heller	VÜ (V3Ü2)
iPhone Anwendungsprogrammierung - Klausur (3 Credits)	Borchers, Lichtschlag, Heller,	Kl (V3Ü2)
iPhone Anwendungsprogrammierung - Klausur (6 Credits)	Borchers, Lichtschlag, Heller,	Kl (V3Ü2)
Klausur Analysis für Informatiker	Stens	KlT
Klausur Berechenbarkeit u. Komplexität	Rossmanith,	KlT
Klausur Berechenbarkeit und Komplexität (Wdhl.)	Rossmanith,	Kl
Klausur Diskrete Strukturen	Hanke, Hiß,	Kl
Klausur Diskrete Strukturen (Wdhl.)	Hanke, Hiß,	Kl
Klausur Einführung in die Technische Informatik	Kowalewski,	Kl
Klausur Implementierung von Datenbanken	Jarke, Quix, Kastrati, Li, Geisler	Kl
Klausur Introduction to Artificial Intelligence	Lakemeyer, Niemüller, Schwering	KlT
Klausur Numerisches Rechnen	Grepl,	KlT
Klausur Numerisches Rechnen (Nachholtermin)	Grepl,	T
Klausur Programmierung	Giesl,	Kl
Klausur: Advanced Internet Technology	Wehrle, Thißen,	Kl (3+1)
Mathematische Logik II	Grädel,	V (3)
Mathematische Logik II	Grädel,	Ü (2)
Mensch-Maschine-Interaktion	Borchers, Wittenhagen, Krämer,	PS (2)
Mentoring Informatik	Fachgruppe Informatik, Akbari, Leonhardt	ÜT
Modellbasierte Softwareentwicklung	Rumpe, Hölldobler, Schindler,	VÜT (2+3)
Modellbasierte Softwareentwicklung	Rumpe, Schindler, Hölldobler	KlT
Numerisches Rechnen	Grepl,	V (3)
Numerisches Rechnen (Beratungstermin)	Grepl, Esser, Zhang, Berger	F (2)
Numerisches Rechnen (Großübung)	Grepl, Esser, Zhang, Berger	Ü (2)
Programmierung	Giesl, Brockschmidt, Emmes, Otto, Ströder,	V (4)
Programmierung (Globalübung)	Giesl, Brockschmidt, Emmes, Otto, Ströder,	Ü (2)
Programmierung (Übung - Tutorium)	Giesl, Brockschmidt, Emmes, Otto, Ströder,	Ü (2)

Proseminar Automatentheorie	Thomas, Löding,	PST (2)
Proseminar Datenkompression	Ney, Schlüter	PST (2)
Proseminar Informationstheorie	Grohe	PS (2)
Proseminar: Algorithmen und Werkzeuge für die Verifikation	Abraham, Jansen, Loup, Chen, Nellen, Corzilius	PS (2)
Prüfung Mathematische Logik II (mündlich)	Grädel,	MP
Rechnergestütztes Differenzieren	Naumann	VÜ (4)
Rechnergestütztes Differenzieren	Naumann	Kl
Selected Topics in Human Language Technology and Pattern Recognition	Ney	S (2)
Seminar "Aktuelle Entwicklungen des Multimedia Retrieval"	Seidl,	ST (2)
Seminar Information Management in the Web	Quix, Jarke, Geisler, Kastrati	S (2)
Seminar Learning Analytics & Educational Data Mining	Schroeder, Chatti, Thüs	HS (2)
Seminar Logik und Komplexität	Grohe	S (2)
Seminar Parallele Programmierung	Wolf, Simulation Sciences Dozenten	S (1)
Seminar über Automatentheorie (Bachelor)	Thomas, Felscher,	ST (2)
Seminar über Automatentheorie (Master)	Löding, Lang,	S (2)
Seminar: Advanced Internet Technology	Wehrle, Thißen, Schmidt,	S (2)
Seminar: Logik, Komplexität, Spiele	Grädel,	ST (2)
Seminar: Mobile Internet Technology	Wehrle, Thißen, Schmidt,	S (2)
Software Engineering Praktikum (B.Sc.): Mobile & Locations Based Augmented Reality (AR) App/Game Entwicklung	Akbari, Leonhardt, Rumpe	P (4)
Software Engineering Praktikum (B.Sc.): Model-Based Robotics Software Development	Rumpe, Ringert, Wortmann	P (4)
Software-Architekturen	Rumpe, Nagl	VT (3)
Softwarepraktikum "Developing a Mini Racing Game"	Kobbelt, Krecklau, Li	PT (4)
Softwaretechnik	Rumpe, Horst,	VT (3)
Softwaretechnik	Rumpe, Horst,	Ü (2)
Softwaretechnik	Rumpe, Horst	Kl
Systemprogrammierung	Kowalewski, Schommer, Gerlitz, Betreuer	P (3)
Turing-Award-Gewinner	Katoen, Noll,	PS (2)
Übung: Advanced Internet Technology	Wehrle, Thißen,	Ü (1)
Unternehmensgründung und neue Medien	Jarke, Klamma, Renzel, Nicolaescu	PT
Verifikationsverfahren	Giesl, Brockschmidt, Emmes, Fuhs, Otto, Ströder,	S (2)
Web Technologien (Web Tech 1) Bachelorprüfung	Schroeder, Chatti, Thüs,	
Web Technologien (WebTech 1)	Schroeder, Chatti, Thüs,	VÜ (3+2)

Master

Advanced Internet Technology	Wehrle, Thißen,	V (3)
Advanced Machine Learning	Leibe	VT (3+1)
Advanced Methods of Cryptography	Mathar,	V (2)
Advanced Methods of Cryptography	Mathar, Reyer, Maier	Ü (1)
Algorithmische Kryptographie	Unger	V (3)
Algorithmische Kryptographie	Geulen	Ü (2)
Angewandte Softwaretechnik im Lebenszyklus der Automobilelektronik	Rumpe, Schleicher, Müller	VT (V1Ü1)
Angewandte Softwaretechnik im Lebenszyklus der Automobilelektronik	Rumpe, Schleicher, Müller	Kl (V1Ü1)
Arbeitsgemeinschaft Model Management	Jarke, Quix	AGT (2)
Arbeitsgemeinschaft: Advanced Community Information Systems	Jarke, Klamma	AGT (2)
Arbeitsgemeinschaft: Communication Systems Engineering	Wehrle, Thißen	AG (3)
Arbeitsgemeinschaft: Mobile Communications	Wehrle, Thißen	AG (3)
Arbeitsgemeinschaft: Probabilistic Model Checking	Katoen, Noll, Nguyen	S (2)
Arbeitsgemeinschaft: Programmverifikation	Giesl, Brockschmidt, Emmes, Fuhs, Otto, Plücker, Ströder	Ü (2)
Arbeitsgemeinschaft: Sensornetze	Wehrle, Thißen	AG (3)
Automatic Speech Recognition	Schlüter, Ney,	V (4)
Automatic Speech Recognition	Schlüter, Ney, Nußbaum	ÜT (2)
Basic Techniques in Computer Graphics	Kobbelt,	V (3)
Basic Techniques in Computer Graphics	Kobbelt, Sattler, Menzel, Campen, Kremer	Ü (2)
Basic Techniques in Computer Graphics (Klausur)	Kobbelt,	Kl
Carolo Cup 2012	Kowalewski, Dernehl	P (4)
Computer Vision	Leibe	VÜT (3+1)
Current Research Topics in Computer Graphics and Geometry Processing	Kobbelt, Zimmer, Frohn	ST (2)
Das Graphisomorphieproblem	Grohe	VÜT (V3+Ü2)
Das Graphisomorphieproblem (Exam)	Grohe,	MP
Designing Interactive Systems I	Borchers, Völker, Corsten, Wacharamanotham,	VÜT (V3/Ü2)
Designing Interactive Systems I - Klausur	Borchers, Völker, Corsten, Wacharamanotham,	Kl (V3/Ü2)
Die Softwaretechnik-Programmiersprache Ada	Nagl, Kurpick,	VT (3)

Die Softwaretechnik-Programmiersprache Ada	Nagl, Kurpick	ÜT (3)
Die Softwaretechnik-Programmiersprache Ada	Nagl, Kurpick	Kl (3)
Dynamische Systeme für Informatiker	Kowalewski, Hänsch,	VÜ (3+1)
Einführung in die Bioinformatik	Berlage,	VT (2)
Einführung in statistische Klassifikation	Ney, Schlüter,	V (4)
Einführung in statistische Klassifikation	Ney, Wiesler, Lehnen	ÜT (2)
Entwicklung eines 3D Replikators	Kowalewski, Stollenwerk	P (2)
Erfolgreiche Anwendungen Formaler Methoden	Noll, Katoen,	S (2)
Erfüllbarkeitsüberprüfung (Satisfiability Checking)	Abraham, Corzilius, Jansen, Loup	VÜT (V3 Ü1)
Erfüllbarkeitsüberprüfung Prüfung	Abraham,	MP
Exploring Multimedia Data: Content-based Search and Retrieval	Seidl, Beecks, Ivanescu	VÜ (3+2)
Formale Grundlagen der UML	Katoen	Kl
Formale Grundlagen von UML	Katoen,	V (3)
Formale Grundlagen von UML	Katoen	Ü (2)
Game Development	Kobbelt, Sibbing, Möbius, Ebke	P (4)
Game Programming	Kobbelt	VPS (3)
Game Programming	Kobbelt, Sibbing, Möbius, Ebke	MP
Generative Aspekte der Software Entwicklung in der Automotive Domäne	Rumpe, Berger	VT (V2)
Generative Aspekte der Software Entwicklung in der Automotive Domäne	Rumpe, Berger	Kl
Hightech Entrepreneurship and new Media	Jarke, Klamma, Kravcik, Derntl, Hannemann	VPT (V1/ÜT4)
Implementation of Databases	Jarke, Quix, Kastrati, Li, Geisler	VÜT (V3/Ü1)
Infinite Computations	Thomas,	VT (3)
Infinite Computations	Thomas, Chaturvedi,	Ü (2)
Infinite Computations (Exam)	Thomas,	Kl
Innovationen im Software Engineering	Rumpe, Hermerschmidt,	VT (2)
Innovationen im Software Engineering - Prüfung	Rumpe, Hermerschmidt	BP (2)
Introduction to Artificial Intelligence	Lakemeyer, Niemüller, Schwering,	VÜT (V3Ü2)
Introduction to Scientific Computing Languages	Bientinesi	VPT (V3/ÜE1)
Introduction to Scientific Computing Languages - Final Exam	Bientinesi,	MPT (V3/ÜE1)
iPhone Anwendungsprogrammierung	Borchers, Lichtschlag, Heller	(V3Ü2)

iPhone Anwendungsprogrammierung - Klausur (3 Credits)	Borchers, Lichtschlag, Heller,	Kl (V3Ü2)
iPhone Anwendungsprogrammierung - Klausur (6 Credits)	Borchers, Lichtschlag, Heller,	Kl (V3Ü2)
Klausur Advanced Methods of Cryptography	Mathar,	Kl
Klausur Dynamische Systeme für Informatiker	Kowalewski,	Kl
Klausur Einführung in die Bioinformatik	Berlage,	Kl
Klausur Exploring Multimedia Data	Seidl	Kl
Klausur Implementierung von Datenbanken	Jarke, Quix, Kastrati, Li, Geisler	Kl
Klausur Introduction to Artificial Intelligence	Lakemeyer, Niemüller, Schwering	KlT
Klausur Objektorientierte Software-Konstruktion	Lichter	KlT
Klausur Parallele Programmierung I	Wolf,	Kl
Klausur Web Science	Jarke, Klamma, Derntl, Petrushyna, Kovachev,	Kl
Klausur: Advanced Internet Technology	Wehrle, Thißen,	Kl (3+1)
Klausur: Multimedia Internet Technology	Wehrle, Thißen,	Kl
Lab Course "Robot Communication and Coordination"	Lakemeyer, Schiffer, Niemüller, Schwering	P (4)
Languages for Scientific Computing	Bientinesi	ST (V2)
Lehrstuhlkolloquium	Kowalewski	EK
Lehrstuhlseminar	Katoen, Giesl, Abraham, Noll	S (2)
Master-Mentorenprogramm: Angewandte Informatik		T
Master-Mentorenprogramm: Daten- & Informationsmanagement		T
Master-Mentorenprogramm: Software & Kommunikation		
Master-Mentorenprogramm: Theoretische Informatik		T
Masterprüfung Automatic Speech Recognition	Ney,	MP
Masterprüfung Einführung in statistische Klassifikation	Ney,	MP
Mathematische Logik II	Grädel,	V (4)
Mathematische Logik II	Grädel,	Ü (2)
Medical Image Processing: Seminar	Deserno, Kobbelt, Ney, Rossmanith, Seidl, Spitzer	ST (2)
Medical Image Processing: Seminar	Deserno, Kobbelt, Ney, Rossmanith, Seidl, Spitzer	ST (2)
Modellbasierte Softwareentwicklung	Rumpe, Hölldobler, Schindler,	VÜT (2+3)
Modellbasierte Softwareentwicklung	Rumpe, Schindler, Hölldobler	KlT
Multimedia Internet Technology	Wehrle, Thißen,	VÜT

		(V3/Ü1)
Objektorientierte Software-Konstruktion	Lichter	VT (3)
Objektorientierte Software-Konstruktion	Lichter, Vianden, Pricope, Harun	ÜT (2)
Parallele Programmierung I	Wolf,	VT (V3)
Parallele Programmierung I	Wolf,	Ü (Ü2)
Praktikum "Communication Systems"	Wehrle, Thißen	P (4)
Praktikum automatische Spracherkennung	Ney, Schlüter, Sundermeyer	P (4)
Prüfung Advanced Machine Learning	Leibe,	MP
Prüfung Algorithmische Kryptographie	Unger,	MP
Prüfung Computer Vision	Leibe,	MP
Prüfung Mathematische Logik II (mündlich)	Grädel,	MP
Prüfung Rekursionstheorie	Thomas,	MP
Prüfung Statische Programmanalyse	Noll,	MP
Prüfung: Research Focus Class on Communication Systems	Wehrle	MP
Rekursionstheorie	Thomas	VT (2)
Rekursionstheorie	Thomas, Lang	Ü (1)
Research Focus Class on Communication Systems	Wehrle, Thißen	VÜ (V3+Ü2)
SCRUM-basierte Software-Entwicklung	Jarke, Zimmermann	P (5)
Selected Topics in Human Language Technology and Pattern Recognition	Ney	S (2)
Seminar "Aktuelle Entwicklungen des Multimedia Retrieval"	Seidl,	ST (2)
Seminar Information Management in the Web	Quix, Jarke, Geisler, Kastrati	S (2)
Seminar Learning Analytics & Educational Data Mining	Schroeder, Chatti, Thüs	HS (2)
Seminar Logik und Komplexität	Grohe	S (2)
Seminar Parallele Programmierung	Wolf, Simulation Sciences Dozenten	S (1)
Seminar über Automatentheorie (Bachelor)	Thomas, Felscher,	ST (2)
Seminar über Automatentheorie (Master)	Löding, Lang,	S (2)
Seminar: Advanced Internet Technology	Wehrle, Thißen, Schmidt,	S (2)
Seminar: Logik, Komplexität, Spiele	Grädel,	ST (2)
Seminar: Mobile Internet Technology	Wehrle, Thißen, Schmidt,	S (2)
Software Architektur Darstellung und Evaluierung	Lichter, Dragomir, Harun	S
Software Engineering Praktikum (M.Sc.): Global Software Engineering	Rumpe, Kurpick	P (4)
Software Engineering Praktikum (M.Sc.): Mobile & Locations Based Augmented Reality (AR) App/Game Entwicklung	Akbari, Leonhardt, Rumpe	P (4)
Software Engineering Praktikum (M.Sc.):	Rumpe, Ringert, Wortmann	P (4)

Model-Based Robotics Software Development		
Software Engineering Seminar (M.Sc.): Mobile & Locations Based Augmented Reality (AR) App/Game Entwicklung	Rumpe, Akbari, Leonhardt	S (2)
Software-Architekturen	Rumpe, Nagl	VT (3)
Statische Programmanalyse	Noll,	V (3)
Statische Programmanalyse	Noll, Jansen, Dehnert	Ü (2)
The Media Computing Project (Praktikum Hauptstudium)	Borchers, Wacharamanotham, Bohne,	PT (2)
Tree Automata	Löding	VT (2)
Tree Automata	Löding	Ü
Tree Automata (Exam)	Löding	MP
Übung: Advanced Internet Technology	Wehrle, Thißen,	Ü (1)
Verifikationsverfahren	Giesl, Brockschmidt, Emmes, Fuhs, Otto, Ströder,	S (2)
Virtuelle Realität	Kuhlen,	VÜT (3+1 oder 2+1)
Virtuelle Realität	Kuhlen,	MPT
Web Science	Jarke, Klamma, Derntl, Petrushyna, Kovachev	VT (V3/Ü1)
Web Technologien (Web Tech 1) Masterprüfung	Schroeder, Chatti, Thüs,	KlT
Web Technologien (WebTech 1)	Schroeder, Chatti, Thüs,	VÜ (3+2)

Diploma, Bachelor and Master Theses

Master Theses

Title German	Title English	First Name	Last name
Erreichbarkeit mit Ressourcenschranken für Pushdownsysteme	Ressource-bounded Reachability on Pushdown Systems	Martin	Lang
	Efficient Features for Histogram Intersection Kernel based Object Detection	Johannes	Frohn
	A Tool based Approach for the Extraction of Regerence Models Concepts	Ana-Maria-Cristina	Dragomir
	Prototyping Realtime Colaborative Applications	Jibran	Javed
	Prototyping Power Loading for CSMA-based Wireless Networks	Humberto	Escudero Argumanez
	Perceptually Tuned Color Reduction for Document Images	Adrian	Rodrigues Valadez
	Brainstorming using Multi-Touch Tabletop	Radu	Poenaru
Zuverlässigkeitsanalyse dynamischer Fehlerbäume	Reliability Analysis of Dynamic Fault Trees	Silvio	De Carolis
	Novel Techniques for Gesture Based Interaction with Magnetosensitive Devices in Digital Entertainment	Hengwei	Chang
Entwicklung eines Frameworks zur Generierung persistenter Datenmodelle	Development of a Framework for Generating Persistent Data Models	Jan	Marten
Erstellung eines Rahmenwerks zur Evaluierung von Community Erfolg am Beispiel von RESTful Web Services	Enabling a Framework for the Evaluation of Community Success by the Example of RESTful Web Services	Patrick	Schlebusch
Entwicklung von Softwarearchitektur-Produktlinien mittels Delta-Modellierung	Product Line Engineering of Software Architectures using Delta-Modeling	Thomas	Kutz
Kontrollflusssprache für Modelltransformationen in MontiCore	Control Flow Language for Model Transformations in MontiCore	Christian	Schreder
Verbesserung der User Experience von Mobile Video Media mit Cloud Services	Improving User Experience of Mobile Video Media Using Cloud Services	Michael	Lottko
	XMPP-based Mobile Multimedia Collaboration	Ismail Gökhan	Aksakalli
	Mobile Learning Game Engine	Marvin	Hoffmann

Title German	Title English	First Name	Last name
Entwicklung eines autonomen Flugkontrollsystems für MAVs	Development of an Autonomous Flight Control System for Micro Aerial Vehicles	Christian	Dernehl
	Ideaball: A Physical Artifact for Moderating and Analyzing Brainstorming Sessions	Clio	Kakoulli
	Passing by Interaction in Public	Tongyan	Ning
	Interactive, Cooperative Story Telling - The Storybroad System	Fabio	Mauri
	Implementing a Man-in-the-middle Attack on Bluetooth 2.1 Passkey Entry	Jian	Wang
	Design and Implementation of Collaborative Personal Learning Environment for Mobile Device	Ijaz	Ahmed
	Sketching Ideas: A Collaborative Interactive Space for Supporting Creativity	Neyla	Rojas Pena
Konzeptentwurf für Echtzeit in Android und Integration in die Plattform	Design and Integration of Real-Time into the Android Platform	Igor	Kalkov
	Resource Management in the Dynamic Accelerator-Cluster Architecture	Suraj	Prabhakaran
Design und Usability-Studie eines Learning Analytics Werkzeugs	Design and Usability Study of a Learning Analytics Tool	Mareike	Bültmann
	Real-time Map Matching in Car-to-X Applications	Gerti	Mitre
	Areceiver Base Rate Adaptation Mechanism for IEEE 802.II	Anwar	Hithnawi
Co-Optjects: Sofort zugängliche Benutzeroberflächen durch Alltagsgegenstände	Co-Optjects: Instant User Interfaces through Everyday Objects	Christian	Corsten
	Robust Expert Ranking in Community-based Fake Multimedia Detection Systems	Cristina	Balasoiu
	Comparison and Evaluation of Procedoral and Stereo Modeling Techniques for Rapid Prototyping of Real Cities	Hanjie	Zhao
	Natural Interaction using Touchless Gestures - Usage in Book Navigation	Sanchayita	Sarkar
	Detecting and Visualizing Overlapping Facebook Communities with Node XL	Arber	Ceni
	Amicis - A Multisource Social Interaction and Communication	Petru	Nicolaescu

Title German	Title English	First Name	Last name
	Analysis Tool		
	Using Social Networking Information to Enhance Collaboration in the SSE Lab	Zied	Mansouri
Intraoperative Resektionsunterstützung in der Leberchirurgie	Intraoperative Resection Guidance in Liver Surgery	Ursula	Marciniak
Leichtgewichtige systemweite Leistungsüberwachung auf Hochleistungsrechnern	Light-weight System-wide Performance Monitoring on High-Performance Computing Systems	Christopher	Schleiden
	Implementation of User Defined Execution Environments using Virtualization in UNICORE	Kiran	Javaid
	Collective Activity Recognition based on Spatio-Temporal Distribution of Objects	Emmanouil	Tzouridis
	Open Street SLAM: Combining Visual SLAM with Cadastral Maps	Benito	van der Zander
	Semi-Supervised Online Learning for Low-Level Tracking	Theodora	Kontogianni
	Exploring Personalized Instructions with Mobile Augmented Reality to Assist Operating Physical Interfaces	Can	Liu
	Conjunctive Triple Queries Over Unstructured Data	Danilo	Djordjevic
	Tracking Hand Tremor on Touchscreens	Alexandru	Popa
Untersuchung der Dekodierung von parallelen Eingabeströmen in der Gebärdensprache	Investigations on Decoding of Parallel Input Streams in Sign Language	Christian	Oberdörfer
Informationssystem zur Navigation mit Landmarken in komplexen Gebäuden	Informationsystem for Landmark-based Navigation in Complex Buildings	Paul	Heiniz
	Limitation Analysis and Implementation of Paradigmatic Solutions for Unified Communication Software on Mobile Platforms	Zaheer	Ahmad
	Model-Based Resource Monitoring and Optimization	Canan	Kasaci
	Building an Effective Rewarding System Based on Reputation	Henri	Agaraj
	Optimizations for Packet Filters	Mircea	Gherzan
	Object Selection and Adaptive Trajectories in DRACON	Alisa	Novosad
	Agent-based Simulation of Effectual and Cousol Behaviors of	Klesti	Hoxha

Title German	Title English	First Name	Last name
	Entrepreneurs		
	Occupancy and Behavior Profiling for Energy Efficiency in Buildings	Bateer	Siqin
Evaluierung von interaktiven Tablets für die Verbesserung des Kundenservices in Restaurants	Evaluation of Interactive Tablets for Improving Customer Service in Restaurants	Julian	Meichsner
	Towards Realistic Multi-Person Tracking by Integration of Social Forces	Philipp	Fischer
	Conception and Development of a Personalized Social Magazine for Tablets to Support Information Management	Irfan	Mirza
	A Classification of Interaction Styles that Span Multiple Systems	Ying	Zhang
	Sentence Boundary Detection for Broadcast news Recordings	Georgi	Dzhambazov
	Tag-Based Collaborative Filtering Recommendation in Plem (Personal Learning Environment Manager)	Simona	Dakova
	LumiNet 2 - A Wearable Sensor and Illumination Network for Fashion	Mariana	Bocoi
	Signal-based Estimation of the Number of Simultaneous Speakers	Umer	Rafi
Konzeptionelle Erweiterung von Projektdashboards für unerfahrene Anwender	Conceptual Extension of Project Dashboards for Inexperienced Users	Frederic	Evers
	Model-Based Critcality Analysis by Impact Isolation	Bernhard	Ern
	Development of an EJB-Based Business Goal Management Environment	Bogdan	Kyryliuk
	Generierung Javaee-basierter Cloud-Architekturen	Minh Quan	Tran
	A Global Oneway Control Channel for Opportunistic Networking	Alaa	Alhamoud
How's My Driving? Verbesserung des Fahrverhalten durch Feedback	How's My Driving? Providing Driver Feedback to Improve Driving	Christoph	Vobis
	The Impact of Body Posture on Couchtable Accuracy	Norbert	Dumont
	Lange-scale Image-based Locallization using Learnt Projection for Local Features	Guoyu	Lu
Projected Spectral Clustering auf Graphen mit Feature Vektoren	Projected Spectral Clustering on Graphs with Feature Vectors	Sebastian	Raubach

Title German	Title English	First Name	Last name
	Residual Prediction in High Efficiency Video Coding	Tarek	Sheha
Prozedurale Modellierung von Lebewesen	Procedural Modeling of Creatures	Andreas	Neu
Absicherung von privater Aushandlung von geordneten Mengen gegen aktive Angreifer	Towards Securing Private Ordered Set Reconciliation against Active Attackers	Lucas	Brutschy
Quantitative Analyse von Markov-Automaten	Quantitative Analysis of Markov Automata	Dennis	Guck
	Service Negotiation and Selective Disclosure of End-Point Information for On-Path Middleboxes	Anupam	Ashish
	Design and Inplementation of a Flat SGSN Functionality for 36PP Release 11 Evolved Packet System	Dwianto Dana	Satriya
	Algorithmic Mechanism Design for Multi-Unit Auctions	Andreas	Tönnis
Mechanism-Design für Schedulingprobleme	Mechanism Design for Scheduling Problems	Martin	Blume
	Underdetermined bidirectional prediction	Philip	Driessen
	Fabiji: A tablet kiosk to facilitate creating and sharing documentation at fab labs	Zhao	He
	Efficient retrieval of mobility patterns on mobile devices	Simona-Claudia	Florescu
	Perceptual evaluation of BTF compression techniques	Sohail	Akhtar
	Coping with Jamming Attacks with the Help of Cross-Layer Design	Dominik	Dennisen
	Certificateless Encryption Using Biometric Identity	Kumar	Sharad
	Object-Oriented Data Model of the Semiconductor Industry aligned to SCOR on the example of Infineon with focus on product	Can	Sun
Optimierung eines Verfahrens zur Verifizierung von Diagnosedaten für Steuergeräte aus dem Nutzfahrzeugbereich	Optimization of a method for verification of diagnostic data for ECUs in the area of commercial vehicles	Thomas	Gatterdam
	Interlinking cross-application desktop hierarchies to overcome their semantic lacuna	Ramesh	Turshani
Approximationsalgorithmen für das VCPN-Problem	Approximation Algorithms for the VCPk-problem	Bernhard	Schamberg
	Gesture Interface for Micro-	Ivan	Golod

Title German	Title English	First Name	Last name
	Interactions in Domestic Spaces		
Evaluation und Implementierung von Sicherheitsstrategien für Massendaten in Cloud-Umgebungen	Evaluation and Implementation of Security and Privacy Strategies for Mass Data in the Cloud	Thomas	Freese
	Hybrid Server-Client Image-Based Localization and Tracking for Mobile Devices	Sven	Middelberg
Qualitätsgestufte Modelevolution in Ecore-Bibliotheken	Quality Staged Model Evolution in Ecore Libraries	Alexander	Roth
Aktives Lernen in der Informatik durch E-Learning-Plattformen am Beispiel eines Schülerwettbewerbs	Active Learning in Comuter Science by Using E-Learning Platforms Considering the Example of a Pupil´s Contest	Jennifer	Lierenfeld
Empfehlungssystemarchitektur für Ecore Bibliotheken	Recommender System Architecture for Ecore Libraries	Andrej	Dyck

Bacholer Theses

Title German	Title English	First Name	Last Name
Optimierung von Log-Linearen Modellen und stochastische Verfahren	Optimization of Log-Linear Models and Online Learning	Alexander	Richard
	Online Interval Scheduling	Sven	Schneider
Konzeption und Entwicklung einer Webapplikation zur Verwaltung und Visualisierung von Energiedaten	Conception and Development of an Energy Reporting Web Application	Benjamin	Meyer
Ein kollaboratives Lernwerkzeug für Sortieralgorithmen auf Multitouch Tischen	A Collaborative Learning Tool for Sorting Algorithms on Multitouch Tables	Torsten	Sehy
	A Mobile Payment Architecture for Samll Scales	Jan	Rüth
Automatenmodelle und Logiken für Wortrelationen	Automata and Logics for Relations over Words	Annette	Huhn
Syntaktische und semantische Analyse von Hyperkantenersetzungsgrammatiken zur Heapabstraktion	Syntactic and Semantic Analysis of Hyperedge Replacement Grammars for Heap Abstraction	Gereon	Kremer
Entwicklung eines Systems zur Spezifikation und Auswertung von Kennlinien für den Energiennavigator	Development of a characteristics specification and evaluation system for the energy navigator	Tuan Dung	Nguyen
Evaluation von Heuristiken zur Erkennung von Kryptoroutinen in Software	Evaluating Heuristics for Detection of Cryptography in Software	Felix	Matenaar

Title German	Title English	First Name	Last Name
Quellcodenavigation anhand von Callstack-Kontexten	Navigating Source Code via Call Stack Contexts	Joachim	Kurz
Entwicklung einer DSL für Modelle von virtuellen Systemen	Development of an DSL for models of virtual systems	Christian	Theis
Adaptives Filter-Framework für die MediaBase	Adaptive Filter-Framework for the MediaBase	Michael	Hackstein
Ein Codeanalysetool für RubySicherheitsaudits	A Code Analysis Toolkit for Ruby Security Audits	Cornelius	Aschermann
Entwicklung eines Tarifauswahlverfahrens für einen WLAN Roaming Client unter Android	Development of a Tariff Selection App for a WLAN Roaming Client for Android	David	Sosnitza
Erkennung von Ereignissen in Videos anhand von Objektpfaden	Event Detection in Videos Based on Object Trajectories	Anne	Kathrein
Projekterfassung für das Audiovisuelle Medienzentrum (AUMZ)	Project Management Tool for the audio-visual Media Center	Alexandra	Linden
Fortschritte in lateinischer Handschrift-Erkennung	Advances in latin script recognition	Hendrik	Pesch
Zustandspartitionierung für das Model-Checking von Binärcode	State Partitioning for Model Checking Binary Code	Florian	Caron
	Action Detection in Video with Local Self-Similarities	Sebastian	Mühr
Eine visuelle Erweiterung von digitalen Vinyl-Systemen zur Navigation in Musikstücken	An augmented In-Track Navigation Display for Digital Vinyl Systems	Justus	Lauten
	Enabling Runtime Migration of Application Context between iOS Devices	Christopher	Blum
Strombasierte Spezifikation in Isabelle/HOLCF	Stream-Based Specification in Isabelle/HOLCF - towards ALICE 2.0	Andreas	Krüger
Datenbankgestützte Analyse von Prozessartefakten in der modellbasierten Software-Produktlinien-Entwicklung	Database-Supported Analysis of Process Artefacts in Model-Based Software Product Line Development	Jeannette	Kraemer
TinyOS zur Frühwarnung vor Endrutschen	TinyOS for early landslide detection	Lucas	Braun
Touch-Studie: Ein Software Rahmen für die Gestaltung von Multi-Touch Nutzer Studien	Touch-Study: A Software Framework for Designing Multi-Touch User Studies	Thomas	Mauzer
Zustandsmodellierung technischer Anlagen am Anwendungsbeispiel des Energie-Navigators	State-based modelling of technical facilities using the example of the Energie-Navigator	Sebastian	Roidl
Eine Analyse sicherheitsrelevanter und hochverfügbarer Kommunikationsprotokolle im Kontext signaltechnisch sicherer	An Analysis of safe and highly available Communication Protocols in the context of Railway Signaling Systems and a Prototype	Sebastian	Löwenhag

Title German	Title English	First Name	Last Name
Bahnanwendungen und eine Prototypimplementierung in eingebetteten Sysemen	Implementation in embedded Systems		
Ähnlichkeitssuche in Datenbanken von Bildfolgen	Similarity Search in Image Series Databases	Manfred	Smieschek
Eine Erweiterung der GiNaCRA Bibliothek für die zylindrische algebraische Zerlegung	An Extension of the GiNaCRA Library for the Cylindrical Algebraic Decomposition	Joachim	Redies
Verbesserung der Benutzbarkeit von Klassendiagrammvergleichen	Improving the Usability of Class Diagram Differencing	Jonathan	Reece
Die Überwachung und Koordination von verteilten S²E Instanzen	Monitoring and Coordination of Distributed S²E Instances	Russ	Jukic
Parallele symbolische verteilte Ausführung für skalierbares Testen in der Cloud	Parallalizing Symbolic Distributed Execution for Scalable Testing in the Cloud	Xinyu	Ge
Erweiterung von S²E für das Testen von verteilten Systemen		Philipp	Kaiser
Erstellung und Evaluation einer Hardwareplattform zur präzisen Ladezustandserfassung von Blei-Gel-Akkumulatoren	Design of Hardware Platform to evaluate precise Charging States of Lead-Acid-Batteries	Dominik	Poppe
Clusterbasierte Suchstrategien für hohe Codeabdeckung in symbolischer verteilter Ausführung	Cluster Based Search Strategies for High Code Coverage in Symbolic Distributed Execution	Johannes	van der Giet
YUI-Prototyp zur Orchestrierung von cloud-basierten Services, Apps und Geräten	YUI-Prototype for Orchestrating Cloud-Based Services, Apps and Devices	André	Küpper
VisiCut: Ein Anwendungsgenre für Lasercutter in der persönlichen Fabrikation	Visicut: An Application Genre for Lasercutting in Personal Fabrication	Thomas	Oster
FabScan: Kostengünstiges 3D-Laserscannen physikalischer Objekte	FabScan: Affordable 3D Laser Scanning of Physical Objects	Francis	Engelmann
Analyse von Verhaltensspezifikationen von interaktiven verteilten Systemen mit Mona	Analysis of Behavioral Specifications for Distributed Interactive Systems with Mona	Dennis	Kirch
Visualisierung abstrahierter Zustände der Java Virtual Machine	Visualization of Abstracted States of the Java Virtual Machine	Jonas	Dederichs
Konzeptuelles Design und Implementierung einer mobilen Applikation für personalisierte Webdienste an Hochschulen auf Basis von Windows Phone 7 und Sharepoint 2010	Conceptual Design and Implementation of a Mobile Application for personalized Webservices in Higher Education based on Windows Phone 7 and Sharepoint 2010	Wjatscheslaw	Belopolski
Implementierung personalisierter karten- und ortsbasierender Dienste für Universitätsstudierende auf Basis von Windows Phone 7	Implementation of personalized Map and location based Services for students in higher education based on Windows Phone 7	Konstantin	Ostrovsky

Title German	Title English	First Name	Last Name
Entwicklung Web-basierter Editor und Simulationsumgebung für vernetzte Produktstrukturen	Development of a web-based editor and simulation environment for interconnected product structures	Paul	Chomicz
Entwicklung eines erweiterbaren Generator-Frameworks für Modelldokumentationen	Development of an extendable Modeldocumentation Generator Framework	Christoph	Hommelsheim
Community-Basierte Prozedurale Modellierung Moderner Architektur	Community-Based Procedural Modeling of Modern Architecture	Sebastian	Landwehr
Entwicklung einer Managementsoftware zum Hardwareeinsatz in der medienunterstützten Lehre	Development of a Software Application for Managing Hardware Equipment in Medical Education	Roland	Doepke
Konstruktion und Effizienz eines hierarchischen, topologischen Overlays für WMNs	Construction and Performance of a Hierarchical, Topological Overlay for WMNs	Martin	Serror
Aufbau und Nutzung von dienstleistungsorientierten Drahtlosnetzwerken	On-demand content-centric Wi-Fi provisioning	David	Martin
Entwicklung einer wiederverwendbaren Komponentenbibliothek zur Überwachung von Online-Systemen	Development of a reusable component library to monitor online systems	Tim	Ix
Smartphone-basierte Gebäudekartenerstellung	Smartphone-based Indoor Mapping	André	Pomp
Erweiterung des Gargoyle Codegenerators um semantische Beziehungen	Extending the Gargoyle Codegen with semantic relationships	Tristan	Langer
Fehlertoleranz für das Real-Time Transport Protocol (RTP)	Error Tolerance for the Real-Time Transport Protocol (RTP)	David	Orlea
Ein web-basiertes Dashboard für große Mengen von Web 2.0 Artefakten	A Web-Based Reporting Dashboard for Large-Scale Collections of Web 2.0 Artifacts	Stephan	Erdtmann
Konzeption einer Internetplattform zur Dokumentation von Metriken	Cenception of an Internet Platform for the Documentation of Metrics	Michael	Schlimnat
Generierung von SSF-basierten grafischen Benutzeroberflächen für Web-basierte Informationssysteme	Generation of SSF-based Graphical User Interfaces for Web-based Information Systems	Claude	Mangen
Generierung von Systemtests für Web-basierte Informationssysteme	System Test Generation for Web-Based Information Systems	Michael	Krein
	Emulating BitTorrent swarms using a discrete-event based simulator	Alexander	Hocks
Verwendung von diskontinuierlichen Phrasen in der statistischen maschinellen Übersetzung	Discontinuous Phrases for Statistical Machine Translation	Erik	Scharwächter
	Advanced Trace-Based Analysis of Hybrid Programs	Felix	Voigtlaender
Unterstützung der	Autocompletion supoort for DSL	Alexander	Kogaj

Title German	Title English	First Name	Last Name
Autovervollständigung für IDEs von domainspezifischen Sprachen	IDEs		
Strombasierte Modellierung von Robotern unter Verwendung von I/O^(omega) Automaten und MontiArc	Action-Stream-Based Modeling of Robots using I/O^(omega)-automata and MontiArc	Philip	Martzok
Automatische Komplexitätsanalyse für Integer-Termersetzungssysteme	Automated Complexity Analysis for Integer Term Rewrite Systems	Marcel	Klinzing
Bewertung von Diskriminierungsnetzwerken für regelbasierte Systeme	Rating of Discrimination Networks for Rule-Based Systems	Fabian	Ohler
Integration von Hardwareabstraktion und Hardwareansteuerung im eingebetteten Echtzeitbetriebssystem ChibiOS	Integration of hardware abstraction and hardware control in the embedded real-time operating system ChibiOS	Florian	Sehl
Sichere Überquerung einer Kreuzung mit einer Fahrzeugkolonne	Safe crossing of an intersection with a platoon of wehicles	Ali	Tarzan
Effiziente Überquerung einer ampelgesteuerten Kreuzung mit einer Fahrzeugkolonne	Efficient Crossing of a Signalized Intersection with a Platoon of Vehicles	Lars	Tholen
Erstellung einer modellbasierten Engineering Software für ACPLT/csHMI	Building a model-based engineering software for process control environments with ACPLT/csHMI	Yannick	Rocks
Erhebungsinstrument auf Basis von Tablet-Geräten	Tablet-based survey instrument	Simon	Bruns
Eine Studie zur Produktivität und Performanz von modernen Vektorprozessoren	A Study on Productivity and Performance of Modern Vecotr Procesors	Paul	Springer
Echtzeitfähige bildbasierte Reflektionen	Real-time Image-Based Reflections	Christian	Hamm
	Folio: Augmenting books on interactive tabletops	Christian	Cherek
Entwicklung eines Dokumenten-Transformations-Services für die Online Software Transformation Plattform	Development of a document transformation service for the Online Software Transformation Platform	Daniel	Meckenstock
	Automated Termination Analysis for Java programs on cyclic data	Richard	Musiol
Optimierung einer oktagonbasierten Wertebereichsanalyse durch Lokalisierung abstrakter Speicherstellen	Optimization of an octagon based value range analysis using localization of abstract memories	Sebastian	Schmitz
Interaktive Visualisierung von Telekommunikations-Protkoll-Spezifikationen	Interactive Visualization of Telecommunication Protocol Specs	Mirko	Hartmann

Title German	Title English	First Name	Last Name
	Development and Integration of a Statistical Evaluation Framework for a Collaborative Web Platform	Michael	Hennings
Analyse des Privatsphäreverlustes bei der Nutzung des World Wide Web	Analysing the Privacy Leakage of Web Usage	Andreas	Kirmse
Unterstützung der Entwicklung von sensorbasierten Smartphone Anwendungen	Assisting the Develpment of Sensor-based Smartphone Applications	Vadim	Kraus
Auswertung von MSO-Formeln über Hypergraphsprachen	Deciding MSO over Languages of Hypergraphs	Max	Görtz
Support Vector Maschine Klassifikation basierend auf Kreuzkorrelation Prototypen in der Knochenalterbestimmung	Support Vector Machine Classification based on Correlation Prototypes applied to Bone Age Assessment	Markus	Harmsen
	Gossipmule: Scanning and Disseminating Information between Stations in Cooperative WLANs	Alexander	Paulus
	Low Memory Program Reversal	Bo	Wang
Verbesserung der Reisesicherheit im ÖPNV durch mobile Anwendungen		Stefan	Wüller
Zielbasierte Priorisierung von Verbesserungsmaßnahmen - nicht abgegeben	Goal based Ranking of Improvement Practices	Hong Minh	Dinh
	Recent and Future Botnet Techniques	Felix	Glaser
	A P2P Shared Storage System based on XMPP	Nicolas	Inden
	SMT-based termination analysis for integer rewrite systems	Matthias	Hoelzel
Datenbankgestützte Analyse von Signalflüssen in Simulink-Modellen	Database-Supported Analysis of Signal Flow in Simulink Models	Robert	Gleis
Visualisierung von Clusteringergebnissen in Graphen mit Knotenattributen	Visualization of Clustering Results in Graphs with Node Attributes	Roman	Haag
Gröbner Basen in SMT-konformen Entscheidungsverfahren	On Gröbner Bases in SMT-Compliant Decision Procedures	Jan	Junges
Gewichtete Aggregation von Markov Ketten	Weighted Lumpability on Markov Chains	Christoph	Worreschk
Reverse Engineering des Windows Phone Process Execution Models	Reverse Engineering of the Windows Phone Process Execution Model	Norman	Hansen
Kontextsensitive Autovervollständigung in der UML/P	context-sensitive autocompletion in the UML/P	Bao Loc	Nguyen Ngo
Regelbasierte Initialisierung von	Rule based Initialization of Project	Elena	Emelyanova

Title German	Title English	First Name	Last Name
Projektdashboards	Dashboards		
	Designing an Energy Consumption Visualization for an End User Home Automation Display	Konstantinos	Tsoleridis
Ein mobiles Dashboard für L2P	A mobile dashboard for L2P	Walter	Sanchez Ibrahim
Modellbasierte Komponententests mit Sequenzdiagrammen	Model-based testing of components using sequence diagrams	Roland	Moers
Verhaltensmodellierung von Robotern mit Iow Automaten	Behavioral Modeling of Robots with Iow Automata	Lidia	Lang
	Algorithms for Large Networks in the NoSQL Database ArangoDB	Lucas	Dohmen
Prozedurale Fassaden mit Kameraabhängigem Geometrischem Detail	View-Dependent Geometric Detail for Procedural Facades	Janis	Born
Zwei-Wege-Transducer über Wörtern	Two-Way Transducers over Words	Christoph	Matheja
Virtuelle Bildflächenvergrößerung mittels Blickverfolgungs-Technologie	Virtual Screen Enlargement using Gaze Tracking Technology	Max	Lyon
FPGA-Implementierung eines Algorithmus zur Ratenanpassung für IEEE 802.11	Implementing On-Demand Rate Adaption for IEEE 802.11	Erwin	Fang
Lastverteilungsverfahren für parallele ereignisorientierte Simulation auf Mehrprozessorsystemen	Load balancing mechanisms for parallel discrete event simulation on multiprocessor systems	Marc	Peiter
Einsatz von Metrik-Dashboards im industriellen Umfeld		Nils	Hans
Laufzeitumgebung für cloud-basierte Fahrzeuganwendungen	Runtime environment for cloud-based automotive applications	Peter	Damm
	Using Satisfiability Checking for Automated Return Oriented Programming	Felix	Wilhelm
Modulare und Boolesche Abstraktion von SPS-Programmen	Modular and Boolean Abstraction of PLC-Programs	Dimitri	Bohlender
Abstraktionsverfeinerung mittels Gegenbeispielen für die Verifikation hybrider SFCs	Counterexample-Guided Abstraction Refinement for Hybrid SFC Verification	Kai	Driessen
Bimaschinen und ihre Minimierung	Bimachines and their Minimization	Jera	Hensel
Typtheorie, Zertifizierte Programmierung und Compilerverifikation	Type Theory, Certified Programming and Compiler Verification	Jens	Katelaan
	City-Reconstructions by crowdsourcing	Ole	Untzelmann
Mesh-Entfaltungsstrategie für leichten Papiermodellbau	Mesh Unfolding Strategy for Easy Papercrafting	Frederic	Schiltz

Title German	Title English	First Name	Last Name
RF Jamming Interferenzen in WLAN basierten 802.11p Fahrzeugnetzwerken	RF Jamming in 802.11p-Based Vehicular Networks	Oliver	Kotulski
Entwicklung eines Abrechnungssystems für Cloud-basierte Anwendungen	Development of an Accountingsystem for cloud-based Applications	Martin	Lang
Visuelle Parameter-Exploration für Prozedurale Texturen	Visual Parameter Space Exploration for Procedural Textures	Markus	Over
Verifikation und Synthese für Parametrische Markow-Ketten	Verification and Synthesis for Parametric Markov Chains	Matthias	Volk
	Traffic Characterization in Wireless Cooperative Networks	Robert	Echelmeyer
Generative Entwicklung von User-Interfaces für Smart-Cars	Generative Engineering of User Interfaces for Smart-Cars	Alex	Tritthart
Lokale Suche in Globaler Optimierung mittels McCormick-Relaxationen	Local Search in Global Optimization by McCormick Relaxations	Angelika	Schwarz
Effiziente Approximative geodätische Berechnungen auf Dreiecksnetzen	Efficient Approximate Geodesics on Triangle Meshes	Martin	Heistermann
Implementierung des HIP DEX und Optimierungen für Sensornetzwerke	Implementation of the HIP Diet Exchange and Optimizations for Smart Object Networks	Jens	Hiller
Markierungsloses Tracking mit synthetisch trainierten Modellen	Markerless Tracking with synthetically trained Models	Florian	George
Inferenz von Grammatiken zur Heapabstraktion	Inferring Heap Abstraction Grammars	Alexander	Weinert
	Hacklt!-Framework	Florian	Kerber
Entwicklung einer Rollenspezifischen Benutzerschnittstelle zur Konfiguration von Metrik-Dashboards	Development of a Role-specific User Interface for the Configuration of Metric Dashboards	Stefan	Guha
	Simulation and Visualization of compressible fluids interacting with rigid bodies	Philip	Trettner
Entwicklung eines adaptiven Frameworks zum automatischen Import von Sensordaten in Cyberphysical Systems am Beispiel des Energie Navigators	Development of an adaptable framework for automatic sensor data import in cyber-physical systems exemplified by the Energy Navigator	Rui	Ruhrländer
Entwicklung von Web-Demonstratoren für OSTP-Services	Development of Web-Demontrators for OSTP-Services	Paul	Wiedeking
	Wireless Network Virtualization on Android Devices	Julian	Becker
Preprocessing für das Lösen nicht-linearer algebraischer Formeln	Preprocessing for Solving Non-Linear Algebraic Formulas	Dennis	Scully

Diploma, Bachelor and Master Theses

Master Theses

Title German	Title English	First Name	Last name
Erreichbarkeit mit Ressourcenschranken für Pushdownsysteme	Ressource-bounded Reachability on Pushdown Systems	Martin	Lang
	Efficient Features for Histogram Intersection Kernel based Object Detection	Johannes	Frohn
	A Tool based Approach for the Extraction of Regerence Models Concepts	Ana-Maria-Cristina	Dragomir
	Prototyping Realtime Colaborative Applications	Jibran	Javed
	Prototyping Power Loading for CSMA-based Wireless Networks	Humberto	Escudero Argumanez
	Perceptually Tuned Color Reduction for Document Images	Adrian	Rodrigues Valadez
	Brainstorming using Multi-Touch Tabletop	Radu	Poenaru
Zuverlässigkeitsanalyse dynamischer Fehlerbäume	Reliability Analysis of Dynamic Fault Trees	Silvio	De Carolis
	Novel Techniques for Gesture Based Interaction with Magnetosensitive Devices in Digital Entertainment	Hengwei	Chang
Entwicklung eines Frameworks zur Generierung persistenter Datenmodelle	Development of a Framework for Generating Persistent Data Models	Jan	Marten
Erstellung eines Rahmenwerks zur Evaluierung von Community Erfolg am Beispiel von RESTful Web Services	Enabling a Framework for the Evaluation of Community Success by the Example of RESTful Web Services	Patrick	Schlebusch
Entwicklung von Softwarearchitektur-Produktlinien mittels Delta-Modellierung	Product Line Engineering of Software Architectures using Delta-Modeling	Thomas	Kutz
Kontrollflusssprache für Modelltransformationen in MontiCore	Control Flow Language for Model Transformations in MontiCore	Christian	Schreder
Verbesserung der User Experience von Mobile Video Media mit Cloud Services	Improving User Experience of Mobile Video Media Using Cloud Services	Michael	Lottko
	XMPP-based Mobile Multimedia Collaboration	Ismail Gökhan	Aksakalli
	Mobile Learning Game Engine	Marvin	Hoffmann

Title German	Title English	First Name	Last name
Entwicklung eines autonomen Flugkontrollsystems für MAVs	Development of an Autonomous Flight Control System for Micro Aerial Vehicles	Christian	Dernehl
	Ideaball: A Physical Artifact for Moderating and Analyzing Brainstorming Sessions	Clio	Kakoulli
	Passing by Interaction in Public	Tongyan	Ning
	Interactive, Cooperative Story Telling - The Storybroad System	Fabio	Mauri
	Implementing a Man-in-the-middle Attack on Bluetooth 2.1 Passkey Entry	Jian	Wang
	Design and Implementation of Collaborative Personal Learning Environment for Mobile Device	Ijaz	Ahmed
	Sketching Ideas: A Collaborative Interactive Space for Supporting Creativity	Neyla	Rojas Pena
Konzeptentwurf für Echtzeit in Android und Integration in die Plattform	Design and Integration of Real-Time into the Android Platform	Igor	Kalkov
	Resource Management in the Dynamic Accelerator-Cluster Architecture	Suraj	Prabhakaran
Design und Usability-Studie eines Learning Analytics Werkzeugs	Design and Usability Study of a Learning Analytics Tool	Mareike	Bültmann
	Real-time Map Matching in Car-to-X Applications	Gerti	Mitre
	Areceiver Base Rate Adaptation Mechanism for IEEE 802.II	Anwar	Hithnawi
Co-Optjects: Sofort zugängliche Benutzeroberflächen durch Alltagsgegenstände	Co-Optjects: Instant User Interfaces through Everyday Objects	Christian	Corsten
	Robust Expert Ranking in Community-based Fake Multimedia Detection Systems	Cristina	Balasoiu
	Comparison and Evaluation of Procedoral and Stereo Modeling Techniques for Rapid Prototyping of Real Cities	Hanjie	Zhao
	Natural Interaction using Touchless Gestures - Usage in Book Navigation	Sanchayita	Sarkar
	Detecting and Visualizing Overlapping Facebook Communities with Node XL	Arber	Ceni
	Amicis - A Multisource Social Interaction and Communication	Petru	Nicolaescu

Title German	Title English	First Name	Last name
	Analysis Tool		
	Using Social Networking Information to Enhance Collaboration in the SSE Lab	Zied	Mansouri
Intraoperative Resektionsunterstützung in der Leberchirurgie	Intraoperative Resection Guidance in Liver Surgery	Ursula	Marciniak
Leichtgewichtige systemweite Leistungsüberwachung auf Hochleistungsrechnern	Light-weight System-wide Performance Monitoring on High-Performance Computing Systems	Christopher	Schleiden
	Implementation of User Defined Execution Environments using Virtualization in UNICORE	Kiran	Javaid
	Collective Activity Recognition based on Spatio-Temporal Distribution of Objects	Emmanouil	Tzouridis
	Open Street SLAM: Combining Visual SLAM with Cadastral Maps	Benito	van der Zander
	Semi-Supervised Online Learning for Low-Level Tracking	Theodora	Kontogianni
	Exploring Personalized Instructions with Mobile Augmented Reality to Assist Operating Physical Interfaces	Can	Liu
	Conjunctive Triple Queries Over Unstructured Data	Danilo	Djordjevic
	Tracking Hand Tremor on Touchscreens	Alexandru	Popa
Untersuchung der Dekodierung von parallelen Eingabeströmen in der Gebärdensprache	Investigations on Decoding of Parallel Input Streams in Sign Language	Christian	Oberdörfer
Informationssystem zur Navigation mit Landmarken in komplexen Gebäuden	Informationsystem for Landmark-based Navigation in Complex Buildings	Paul	Heiniz
	Limitation Analysis and Implementation of Paradigmatic Solutions for Unified Communication Software on Mobile Platforms	Zaheer	Ahmad
	Model-Based Resource Monitoring and Optimization	Canan	Kasaci
	Building an Effective Rewarding System Based on Reputation	Henri	Agaraj
	Optimizations for Packet Filters	Mircea	Gherzan
	Object Selection and Adaptive Trajectories in DRACON	Alisa	Novosad
	Agent-based Simulation of Effectual and Cousol Behaviors of	Klesti	Hoxha

Title German	Title English	First Name	Last name
	Entrepreneurs		
	Occupancy and Behavior Profiling for Energy Efficiency in Buildings	Bateer	Siqin
Evaluierung von interaktiven Tablets für die Verbesserung des Kundenservices in Restaurants	Evaluation of Interactive Tablets for Improving Customer Service in Restaurants	Julian	Meichsner
	Towards Realistic Multi-Person Tracking by Integration of Social Forces	Philipp	Fischer
	Conception and Development of a Personalized Social Magazine for Tablets to Support Information Management	Irfan	Mirza
	A Classification of Interaction Styles that Span Multiple Systems	Ying	Zhang
	Sentence Boundary Detection for Broadcast news Recordings	Georgi	Dzhambazov
	Tag-Based Collaborative Filtering Recommendation in Plem (Personal Learning Environment Manager)	Simona	Dakova
	LumiNet 2 - A Wearable Sensor and Illumination Network for Fashion	Mariana	Bocoi
	Signal-based Estimation of the Number of Simultaneous Speakers	Umer	Rafi
Konzeptionelle Erweiterung von Projektdashboards für unerfahrene Anwender	Conceptual Extension of Project Dashboards for Inexperienced Users	Frederic	Evers
	Model-Based Critcality Analysis by Impact Isolation	Bernhard	Ern
	Development of an EJB-Based Business Goal Management Environment	Bogdan	Kyryliuk
	Generierung Javaee-basierter Cloud-Architekturen	Minh Quan	Tran
	A Global Oneway Control Channel for Opportunistic Networking	Alaa	Alhamoud
How's My Driving? Verbesserung des Fahrverhalten durch Feedback	How's My Driving? Providing Driver Feedback to Improve Driving	Christoph	Vobis
	The Impact of Body Posture on Couchtable Accuracy	Norbert	Dumont
	Lange-scale Image-based Locallization using Learnt Projection for Local Features	Guoyu	Lu
Projected Spectral Clustering auf Graphen mit Feature Vektoren	Projected Spectral Clustering on Graphs with Feature Vectors	Sebastian	Raubach

Title German	Title English	First Name	Last name
	Residual Prediction in High Efficiency Video Coding	Tarek	Sheha
Prozedurale Modellierung von Lebewesen	Procedural Modeling of Creatures	Andreas	Neu
Absicherung von privater Aushandlung von geordneten Mengen gegen aktive Angreifer	Towards Securing Private Ordered Set Reconciliation against Active Attackers	Lucas	Brutschy
Quantitative Analyse von Markov-Automaten	Quantitative Analysis of Markov Automata	Dennis	Guck
	Service Negotiation and Selective Disclosure of End-Point Information for On-Path Middleboxes	Anupam	Ashish
	Design and Inplementation of a Flat SGSN Functionality for 36PP Release 11 Evolved Packet System	Dwianto Dana	Satriya
	Algorithmic Mechanism Design for Multi-Unit Auctions	Andreas	Tönnis
Mechanism-Design für Schedulingprobleme	Mechanism Design for Scheduling Problems	Martin	Blume
	Underdetermined bidirectional prediction	Philip	Driessen
	Fabiji: A tablet kiosk to facilitate creating and sharing documentation at fab labs	Zhao	He
	Efficient retrieval of mobility patterns on mobile devices	Simona-Claudia	Florescu
	Perceptual evaluation of BTF compression techniques	Sohail	Akhtar
	Coping with Jamming Attacks with the Help of Cross-Layer Design	Dominik	Dennisen
	Certificateless Encryption Using Biometric Identity	Kumar	Sharad
	Object-Oriented Data Model of the Semiconductor Industry aligned to SCOR on the example of Infineon with focus on product	Can	Sun
Optimierung eines Verfahrens zur Verifizierung von Diagnosedaten für Steuergeräte aus dem Nutzfahrzeugbereich	Optimization of a method for verification of diagnostic data for ECUs in the area of commercial vehicles	Thomas	Gatterdam
	Interlinking cross-application desktop hierarchies to overcome their semantic lacuna	Ramesh	Turshani
Approximationsalgorithmen für das VCPN-Problem	Approximation Algorithms for the VCPk-problem	Bernhard	Schamberg
	Gesture Interface for Micro-	Ivan	Golod

Title German	Title English	First Name	Last name
	Interactions in Domestic Spaces		
Evaluation und Implementierung von Sicherheitsstrategien für Massendaten in Cloud-Umgebungen	Evaluation and Implementation of Security and Privacy Strategies for Mass Data in the Cloud	Thomas	Freese
	Hybrid Server-Client Image-Based Localization and Tracking for Mobile Devices	Sven	Middelberg
Qualitätsgestufte Modelevolution in Ecore-Bibliotheken	Quality Staged Model Evolution in Ecore Libraries	Alexander	Roth
Aktives Lernen in der Informatik durch E-Learning-Plattformen am Beispiel eines Schülerwettbewerbs	Active Learning in Comuter Science by Using E-Learning Platforms Considering the Example of a Pupil´s Contest	Jennifer	Lierenfeld
Empfehlungssystemarchitektur für Ecore Bibliotheken	Recommender System Architecture for Ecore Libraries	Andrej	Dyck

Bacholer Theses

Title German	Title English	First Name	Last Name
Optimierung von Log-Linearen Modellen und stochastische Verfahren	Optimization of Log-Linear Models and Online Learning	Alexander	Richard
	Online Interval Scheduling	Sven	Schneider
Konzeption und Entwicklung einer Webapplikation zur Verwaltung und Visualisierung von Energiedaten	Conception and Development of an Energy Reporting Web Application	Benjamin	Meyer
Ein kollaboratives Lernwerkzeug für Sortieralgorithmen auf Multitouch Tischen	A Collaborative Learning Tool for Sorting Algorithms on Multitouch Tables	Torsten	Sehy
	A Mobile Payment Architecture for Samll Scales	Jan	Rüth
Automatenmodelle und Logiken für Wortrelationen	Automata and Logics for Relations over Words	Annette	Huhn
Syntaktische und semantische Analyse von Hyperkantenersetzungsgrammatiken zur Heapabstraktion	Syntactic and Semantic Analysis of Hyperedge Replacement Grammars for Heap Abstraction	Gereon	Kremer
Entwicklung eines Systems zur Spezifikation und Auswertung von Kennlinien für den Energiennavigator	Development of a characteristics specification and evaluation system for the energy navigator	Tuan Dung	Nguyen
Evaluation von Heuristiken zur Erkennung von Kryptoroutinen in Software	Evaluating Heuristics for Detection of Cryptography in Software	Felix	Matenaar

Title German	Title English	First Name	Last Name
Quellcodenavigation anhand von Callstack-Kontexten	Navigating Source Code via Call Stack Contexts	Joachim	Kurz
Entwicklung einer DSL für Modelle von virtuellen Systemen	Development of an DSL for models of virtual systems	Christian	Theis
Adaptives Filter-Framework für die MediaBase	Adaptive Filter-Framework for the MediaBase	Michael	Hackstein
Ein Codeanalysetool für RubySicherheitsaudits	A Code Analysis Toolkit for Ruby Security Audits	Cornelius	Aschermann
Entwicklung eines Tarifauswahlverfahrens für einen WLAN Roaming Client unter Android	Development of a Tariff Selection App for a WLAN Roaming Client for Android	David	Sosnitza
Erkennung von Ereignissen in Videos anhand von Objektpfaden	Event Detection in Videos Based on Object Trajectories	Anne	Kathrein
Projekterfassung für das Audiovisuelle Medienzentrum (AUMZ)	Project Management Tool for the audio-visual Media Center	Alexandra	Linden
Fortschritte in lateinischer Handschrift-Erkennung	Advances in latin script recognition	Hendrik	Pesch
Zustandspartitionierung für das Model-Checking von Binärcode	State Partitioning for Model Checking Binary Code	Florian	Caron
	Action Detection in Video with Local Self-Similarities	Sebastian	Mühr
Eine visuelle Erweiterung von digitalen Vinyl-Systemen zur Navigation in Musikstücken	An augmented In-Track Navigation Display for Digital Vinyl Systems	Justus	Lauten
	Enabling Runtime Migration of Application Context between iOS Devices	Christopher	Blum
Strombasierte Spezifikation in Isabelle/HOLCF	Stream-Based Specification in Isabelle/HOLCF - towards ALICE 2.0	Andreas	Krüger
Datenbankgestützte Analyse von Prozessartefakten in der modellbasierten Software-Produktlinien-Entwicklung	Database-Supported Analysis of Process Artefacts in Model-Based Software Product Line Development	Jeannette	Kraemer
TinyOS zur Frühwarnung vor Endrutschen	TinyOS for early landslide detection	Lucas	Braun
Touch-Studie: Ein Software Rahmen für die Gestaltung von Multi-Touch Nutzer Studien	Touch-Study: A Software Framework for Designing Multi-Touch User Studies	Thomas	Mauzer
Zustandsmodellierung technischer Anlagen am Anwendungsbeispiel des Energie-Navigators	State-based modelling of technical facilities using the example of the Energie-Navigator	Sebastian	Roidl
Eine Analyse sicherheitsrelevanter und hochverfügbarer Kommunikationsprotokolle im Kontext signaltechnisch sicherer	An Analysis of safe and highly available Communication Protocols in the context of Railway Signaling Systems and a Prototype	Sebastian	Löwenhag

Title German	Title English	First Name	Last Name
Bahnanwendungen und eine Prototypimplementierung in eingebetteten Sysemen	Implementation in embedded Systems		
Ähnlichkeitssuche in Datenbanken von Bildfolgen	Similarity Search in Image Series Databases	Manfred	Smieschek
Eine Erweiterung der GiNaCRA Bibliothek für die zylindrische algebraische Zerlegung	An Extension of the GiNaCRA Library for the Cylindrical Algebraic Decomposition	Joachim	Redies
Verbesserung der Benutzbarkeit von Klassendiagrammvergleichen	Improving the Usability of Class Diagram Differencing	Jonathan	Reece
Die Überwachung und Koordination von verteilten S²E Instanzen	Monitoring and Coordination of Distributed S²E Instances	Russ	Jukic
Parallele symbolische verteilte Ausführung für skalierbares Testen in der Cloud	Parallalizing Symbolic Distributed Execution for Scalable Testing in the Cloud	Xinyu	Ge
Erweiterung von S²E für das Testen von verteilten Systemen		Philipp	Kaiser
Erstellung und Evaluation einer Hardwareplattform zur präzisen Ladezustandserfassung von Blei-Gel-Akkumulatoren	Design of Hardware Platform to evaluate precise Charging States of Lead-Acid-Batteries	Dominik	Poppe
Clusterbasierte Suchstrategien für hohe Codeabdeckung in symbolischer verteilter Ausführung	Cluster Based Search Strategies for High Code Coverage in Symbolic Distributed Execution	Johannes	van der Giet
YUI-Prototyp zur Orchestrierung von cloud-basierten Services, Apps und Geräten	YUI-Prototype for Orchestrating Cloud-Based Services, Apps and Devices	André	Küpper
VisiCut: Ein Anwendungsgenre für Lasercutter in der persönlichen Fabrikation	Visicut: An Application Genre for Lasercutting in Personal Fabrication	Thomas	Oster
FabScan: Kostengünstiges 3D-Laserscannen physikalischer Objekte	FabScan: Affordable 3D Laser Scanning of Physical Objects	Francis	Engelmann
Analyse von Verhaltensspezifikationen von interaktiven verteilten Systemen mit Mona	Analysis of Behavioral Specifications for Distributed Interactive Systems with Mona	Dennis	Kirch
Visualisierung abstrahierter Zustände der Java Virtual Machine	Visualization of Abstracted States of the Java Virtual Machine	Jonas	Dederichs
Konzeptuelles Design und Implementierung einer mobilen Applikation für personalisierte Webdienste an Hochschulen auf Basis von Windows Phone 7 und Sharepoint 2010	Conceptual Design and Implementation of a Mobile Application for personalized Webservices in Higher Education based on Windows Phone 7 and Sharepoint 2010	Wjatscheslaw	Belopolski
Implementierung personalisierter karten- und ortsbasierender Dienste für Universitätsstudierende auf Basis von Windows Phone 7	Implementation of personalized Map and location based Services for students in higher education based on Windows Phone 7	Konstantin	Ostrovsky

Title German	Title English	First Name	Last Name
Entwicklung Web-basierter Editor und Simulationsumgebung für vernetzte Produktstrukturen	Development of a web-based editor and simulation environment for interconnected product structures	Paul	Chomicz
Entwicklung eines erweiterbaren Generator-Frameworks für Modelldokumentationen	Development of an extendable Modeldocumentation Generator Framework	Christoph	Hommelsheim
Community-Basierte Prozedurale Modellierung Moderner Architektur	Community-Based Procedural Modeling of Modern Architecture	Sebastian	Landwehr
Entwicklung einer Managementsoftware zum Hardwareeinsatz in der medienunterstützten Lehre	Development of a Software Application for Managing Hardware Equipment in Medical Education	Roland	Doepke
Konstruktion und Effizienz eines hierarchischen, topologischen Overlays für WMNs	Construction and Performance of a Hierarchical, Topological Overlay for WMNs	Martin	Serror
Aufbau und Nutzung von dienstleistungsorientierten Drahtlosnetzwerken	On-demand content-centric Wi-Fi provisioning	David	Martin
Entwicklung einer wiederverwendbaren Komponentenbibliothek zur Überwachung von Online-Systemen	Development of a reusable component library to monitor online systems	Tim	Ix
Smartphone-basierte Gebäudekartenerstellung	Smartphone-based Indoor Mapping	André	Pomp
Erweiterung des Gargoyle Codegenerators um semantische Beziehungen	Extending the Gargoyle Codegen with semantic relationships	Tristan	Langer
Fehlertoleranz für das Real-Time Transport Protocol (RTP)	Error Tolerance for the Real-Time Transport Protocol (RTP)	David	Orlea
Ein web-basiertes Dashboard für große Mengen von Web 2.0 Artefakten	A Web-Based Reporting Dashboard for Large-Scale Collections of Web 2.0 Artifacts	Stephan	Erdtmann
Konzeption einer Internetplattform zur Dokumentation von Metriken	Cenception of an Internet Platform for the Documentation of Metrics	Michael	Schlimnat
Generierung von SSF-basierten grafischen Benutzeroberflächen für Web-basierte Informationssysteme	Generation of SSF-based Graphical User Interfaces for Web-based Information Systems	Claude	Mangen
Generierung von Systemtests für Web-basierte Informationssysteme	System Test Generation for Web-Based Information Systems	Michael	Krein
	Emulating BitTorrent swarms using a discrete-event based simulator	Alexander	Hocks
Verwendung von diskontinuierlichen Phrasen in der statistischen maschinellen Übersetzung	Discontinuous Phrases for Statistical Machine Translation	Erik	Scharwächter
	Advanced Trace-Based Analysis of Hybrid Programs	Felix	Voigtlaender
Unterstützung der	Autocompletion supoort for DSL	Alexander	Kogaj

Title German	Title English	First Name	Last Name
Autovervollständigung für IDEs von domainspezifischen Sprachen	IDEs		
Strombasierte Modellierung von Robotern unter Verwendung von I/O^(omega) Automaten und MontiArc	Action-Stream-Based Modeling of Robots using I/O^(omega)-automata and MontiArc	Philip	Martzok
Automatische Komplexitätsanalyse für Integer-Termersetzungssysteme	Automated Complexity Analysis for Integer Term Rewrite Systems	Marcel	Klinzing
Bewertung von Diskriminierungsnetzwerken für regelbasierte Systeme	Rating of Discrimination Networks for Rule-Based Systems	Fabian	Ohler
Integration von Hardwareabstraktion und Hardwareansteuerung im eingebetteten Echtzeitbetriebssystem ChibiOS	Integration of hardware abstraction and hardware control in the embedded real-time operating system ChibiOS	Florian	Sehl
Sichere Überquerung einer Kreuzung mit einer Fahrzeugkolonne	Safe crossing of an intersection with a platoon of wehicles	Ali	Tarzan
Effiziente Überquerung einer ampelgesteuerten Kreuzung mit einer Fahrzeugkolonne	Efficient Crossing of a Signalized Intersection with a Platoon of Vehicles	Lars	Tholen
Erstellung einer modellbasierten Engineering Software für ACPLT/csHMI	Building a model-based engineering software for process control environments with ACPLT/csHMI	Yannick	Rocks
Erhebungsinstrument auf Basis von Tablet-Geräten	Tablet-based survey instrument	Simon	Bruns
Eine Studie zur Produktivität und Performanz von modernen Vektorprozessoren	A Study on Productivity and Performance of Modern Vecotr Procesors	Paul	Springer
Echtzeitfähige bildbasierte Reflektionen	Real-time Image-Based Reflections	Christian	Hamm
	Folio: Augmenting books on interactive tabletops	Christian	Cherek
Entwicklung eines Dokumenten-Transformations-Services für die Online Software Transformation Plattform	Development of a document transformation service for the Online Software Transformation Platform	Daniel	Meckenstock
	Automated Termination Analysis for Java programs on cyclic data	Richard	Musiol
Optimierung einer oktagonbasierten Wertebereichsanalyse durch Lokalisierung abstrakter Speicherstellen	Optimization of an octagon based value range analysis using localization of abstract memories	Sebastian	Schmitz
Interaktive Visualisierung von Telekommunikations-Protkoll-Spezifikationen	Interactive Visualization of Telecommunication Protocol Specs	Mirko	Hartmann

Title German	Title English	First Name	Last Name
	Development and Integration of a Statistical Evaluation Framework for a Collaborative Web Platform	Michael	Hennings
Analyse des Privatsphäreverlustes bei der Nutzung des World Wide Web	Analysing the Privacy Leakage of Web Usage	Andreas	Kirmse
Unterstützung der Entwicklung von sensorbasierten Smartphone Anwendungen	Assisting the Develpment of Sensor-based Smartphone Applications	Vadim	Kraus
Auswertung von MSO-Formeln über Hypergraphsprachen	Deciding MSO over Languages of Hypergraphs	Max	Görtz
Support Vector Maschine Klassifikation basierend auf Kreuzkorrelation Prototypen in der Knochenalterbestimmung	Support Vector Machine Classification based on Correlation Prototypes applied to Bone Age Assessment	Markus	Harmsen
	Gossipmule: Scanning and Disseminating Information between Stations in Cooperative WLANs	Alexander	Paulus
	Low Memory Program Reversal	Bo	Wang
Verbesserung der Reisesicherheit im ÖPNV durch mobile Anwendungen		Stefan	Wüller
Zielbasierte Priorisierung von Verbesserungsmaßnahmen - nicht abgegeben	Goal based Ranking of Improvement Practices	Hong Minh	Dinh
	Recent and Future Botnet Techniques	Felix	Glaser
	A P2P Shared Storage System based on XMPP	Nicolas	Inden
	SMT-based termination analysis for integer rewrite systems	Matthias	Hoelzel
Datenbankgestützte Analyse von Signalflüssen in Simulink-Modellen	Database-Supported Analysis of Signal Flow in Simulink Models	Robert	Gleis
Visualisierung von Clusteringergebnissen in Graphen mit Knotenattributen	Visualization of Clustering Results in Graphs with Node Attributes	Roman	Haag
Gröbner Basen in SMT-konformen Entscheidungsverfahren	On Gröbner Bases in SMT-Compliant Decision Procedures	Jan	Junges
Gewichtete Aggregation von Markov Ketten	Weighted Lumpability on Markov Chains	Christoph	Worreschk
Reverse Engineering des Windows Phone Process Execution Models	Reverse Engineering of the Windows Phone Process Execution Model	Norman	Hansen
Kontextsensitive Autovervollständigung in der UML/P	context-sensitive autocompletion in the UML/P	Bao Loc	Nguyen Ngo
Regelbasierte Initialisierung von	Rule based Initialization of Project	Elena	Emelyanova

Title German	Title English	First Name	Last Name
Projektdashboards	Dashboards		
	Designing an Energy Consumption Visualization for an End User Home Automation Display	Konstantinos	Tsoleridis
Ein mobiles Dashboard für L2P	A mobile dashboard for L2P	Walter	Sanchez Ibrahim
Modellbasierte Komponententests mit Sequenzdiagrammen	Model-based testing of components using sequence diagrams	Roland	Moers
Verhaltensmodellierung von Robotern mit Iow Automaten	Behavioral Modeling of Robots with Iow Automata	Lidia	Lang
	Algorithms for Large Networks in the NoSQL Database ArangoDB	Lucas	Dohmen
Prozedurale Fassaden mit Kameraabhängigem Geometrischem Detail	View-Dependent Geometric Detail for Procedural Facades	Janis	Born
Zwei-Wege-Transducer über Wörtern	Two-Way Transducers over Words	Christoph	Matheja
Virtuelle Bildflächenvergrößerung mittels Blickverfolgungs-Technologie	Virtual Screen Enlargement using Gaze Tracking Technology	Max	Lyon
FPGA-Implementierung eines Algorithmus zur Ratenanpassung für IEEE 802.11	Implementing On-Demand Rate Adaption for IEEE 802.11	Erwin	Fang
Lastverteilungsverfahren für parallele ereignisorientierte Simulation auf Mehrprozessorsystemen	Load balancing mechanisms for parallel discrete event simulation on multiprocessor systems	Marc	Peiter
Einsatz von Metrik-Dashboards im industriellen Umfeld		Nils	Hans
Laufzeitumgebung für cloud-basierte Fahrzeuganwendungen	Runtime environment for cloud-based automotive applications	Peter	Damm
	Using Satisfiability Checking for Automated Return Oriented Programming	Felix	Wilhelm
Modulare und Boolesche Abstraktion von SPS-Programmen	Modular and Boolean Abstraction of PLC-Programs	Dimitri	Bohlender
Abstraktionsverfeinerung mittels Gegenbeispielen für die Verifikation hybrider SFCs	Counterexample-Guided Abstraction Refinement for Hybrid SFC Verification	Kai	Driessen
Bimaschinen und ihre Minimierung	Bimachines and their Minimization	Jera	Hensel
Typtheorie, Zertifizierte Programmierung und Compilerverifikation	Type Theory, Certified Programming and Compiler Verification	Jens	Katelaan
	City-Reconstructions by crowdsourcing	Ole	Untzelmann
Mesh-Entfaltungsstrategie für leichten Papiermodellbau	Mesh Unfolding Strategy for Easy Papercrafting	Frederic	Schiltz

Title German	Title English	First Name	Last Name
RF Jamming Interferenzen in WLAN basierten 802.11p Fahrzeugnetzwerken	RF Jamming in 802.11p-Based Vehicular Networks	Oliver	Kotulski
Entwicklung eines Abrechnungssystems für Cloud-basierte Anwendungen	Development of an Accountingsystem for cloud-based Applications	Martin	Lang
Visuelle Parameter-Exploration für Prozedurale Texturen	Visual Parameter Space Exploration for Procedural Textures	Markus	Over
Verifikation und Synthese für Parametrische Markow-Ketten	Verification and Synthesis for Parametric Markov Chains	Matthias	Volk
	Traffic Characterization in Wireless Cooperative Networks	Robert	Echelmeyer
Generative Entwicklung von User-Interfaces für Smart-Cars	Generative Engineering of User Interfaces for Smart-Cars	Alex	Tritthart
Lokale Suche in Globaler Optimierung mittels McCormick-Relaxationen	Local Search in Global Optimization by McCormick Relaxations	Angelika	Schwarz
Effiziente Approximative geodätische Berechnungen auf Dreiecksnetzen	Efficient Approximate Geodesics on Triangle Meshes	Martin	Heistermann
Implementierung des HIP DEX und Optimierungen für Sensornetzwerke	Implementation of the HIP Diet Exchange and Optimizations for Smart Object Networks	Jens	Hiller
Markierungsloses Tracking mit synthetisch trainierten Modellen	Markerless Tracking with synthetically trained Models	Florian	George
Inferenz von Grammatiken zur Heapabstraktion	Inferring Heap Abstraction Grammars	Alexander	Weinert
	Hacklt!-Framework	Florian	Kerber
Entwicklung einer Rollenspezifischen Benutzerschnittstelle zur Konfiguration von Metrik-Dashboards	Development of a Role-specific User Interface for the Configuration of Metric Dashboards	Stefan	Guha
	Simulation and Visualization of compressible fluids interacting with rigid bodies	Philip	Trettner
Entwicklung eines adaptiven Frameworks zum automatischen Import von Sensordaten in Cyberphysical Systems am Beispiel des Energie Navigators	Development of an adaptable framework for automatic sensor data import in cyber-physical systems exemplified by the Energy Navigator	Rui	Ruhrländer
Entwicklung von Web-Demonstratoren für OSTP-Services	Development of Web-Demontrators for OSTP-Services	Paul	Wiedeking
	Wireless Network Virtualization on Android Devices	Julian	Becker
Preprocessing für das Lösen nicht-linearer algebraischer Formeln	Preprocessing for Solving Non-Linear Algebraic Formulas	Dennis	Scully

Computer Science Colloquium – Talks

28 September 2012	Dr. Maurizio Bocca, Signal and Processing Across Networks Lab, University of Utah *Device-Free Localization from Wireless Network Signal Strength Measurements*
10.August 2012	Prof. Dr. Dariu M. Gavrila, Daimler R&D und University of Amsterdam *Human-Aware Intelligent Systems*
26 July 2012	Professor Deok-Soo Kim, Ph.D., Hanyang University, Seoul, Korea *Understanding molecular geometry*
17 July 2012	Prof. Dr. Rainer Spurzem, National Astronomical Observatory Beijing and University of Heidelberg *GPU Supercomputing on Three Continents and Application to Supermassive Black Holes and Gravitational Waves from Galactic Nuclei*
5 July 2012	Dr. Sebastian Theophil, think-cell AG *LaTeX-less Layout*
27 June 2012	Hans Meinhardt, Max-Planck-Institut Tübingen *Aufbau und Abbau von Mustern in der Biologie*
31 May 2012	Dr. Ralf Huuck, NICTA / UNSW / Red Lizard Software *Software Bug Detection in Millions of Lines of C/C++ Code*
23 May 2012	Wolfgang Coy, Humboldt-Universität Berlin *Turing Test Revisited*
18 May 2012	Prof. Dr. Chris J. Myers, University of Utah, USA *Formal Verification of Genetic Circuits*
25 April 2012	Johannes Blömer, Universität Paderborn *Alan Turing, die Enigma und die Geburt der modernen Kryptographie*
20.April 2012	Dr. Christoph Quix, Lehrstuhl Informatik 5, RWTH Aachen *Ein generischer Ansatz zur Verwaltung von komplexen, heterogenen Datenmodellen*
16 April 2012	Wolfgang Thomas *Alan Turing und die Grundfrage der Informatik: Was können Algorithmen?*
30 March 2012	Prof. Torsten Hoefler *Performance Modeling for Systematic Performance Tuning*
16 March 2012	Prof. Martin Ester, Simon Fraser University, Vancouver, Kanada *Probabilistic Models for Data Mining in Social Media*
2 February 2012	Dr. Carsten Weise (IVU Traffic Technologies AG) *Das Smartphone steuert den Bus*

25 January 2012	Thomas Noll *Correctness, Safety and Fault Tolerance in Aerospace Systems: The ESA COMPASS Project*
8 November 2011	Martin Jaensch (Daimler AG) *Modulorientierter Ansatz für den modellbasierten Elektrik/Elektronik-Architekturentwurf*

Research

Algorithms and Complexity

Staff

- **Faculty**
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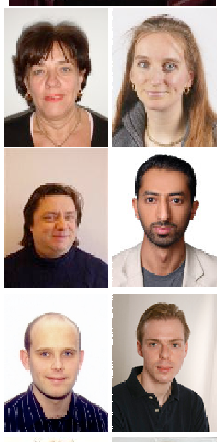
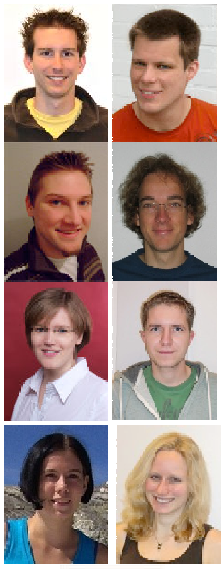
  Dipl.-Inform. Sascha Geulen
  Dipl.-Inform. Oliver Göbel
  Dipl.-Inform. Thomas Kesselheim
  Dipl.-Inform. Marcel Ochel
  Dipl.-Math. Klaus Radke
  Dipl.-Inform. Rebecca Reiffenhäuser (since December 2011)
  Dipl.-Inform. Benjamin Ries
  Lisa Wagner, M.Sc. (since January 2012)
  Dipl.-Inform. Melanie Winkler



- **Technical Staff**
  Math.-Techn. Ass. Viktor Keil

- **Student Researchers and Teaching Assistants**
  Felix Canavoi
  Sebastian Freitag
  Russ Lucas Jukic
  Benjamin Kaminski
  Jens Katelaan
  Jonathan Meyer
  Thomas Schleiden
  Michael Tegethoff
  Andreas Tönnis
  Svenja Schalthöfer



- **Guests**
  Matthias Englert (University of Warwick)
  Tobias Harks (Maastricht University)
  Chien-Chung Huang (TU Berlin)

Piotr Krysta (University of Liverpool)
Xavier Munoz (Universitat Politécnica de Catalunya)
Thomas Sauerwald (MPI für Informatik)
Alexander Skopalik (TU Dortmund)
Chaitanya Swamy (University of Waterloo)

Overview

Many technological innovations and achievements of the recent decades rely on algorithmic ideas facilitating new applications in science, medicine, production, logistics, traffic, and communication. The algorithms and complexity group works on the design and analysis of algorithms, especially

- approximation and online algorithms
- algorithmic game theory and mechanism design
- randomized algorithms and probabilistic analysis of algorithms
- algorithms for graphs and interconnection networks

A focus of our work during the last year was lying on approximation and online algorithms for mechanism design. In this field, algorithmic problems are studied in a game theoretic setting in which the input of the algorithm is not publicly known but distributed among a set of participants which only reveal their private valuations if it is in their best interest. A mechanism aggregates the preferences of the participants towards a joint decision. It is called incentive compatible if it is designed in such a way that it is a dominant strategy for each bidder to report preferences in a truthful manner. The general relevance of this research field is highlighted by this year's Nobel Prize in economics which is awarded to Alvin Roth and Lloyd Shapley for their work in mechanism design, especially "for the theory of stable allocations and the practice of market design".

One highlight of our research was, e.g., the design and analysis of an incentive-compatible approximation scheme for multi-unit auctions which was presented at SODA 2012, the top-ranked conference on algorithm analysis. Our mechanism is truthful in the universal sense, that is, it is a randomized mechanism corresponding to a distribution over deterministically truthful mechanisms. Previously known approximation schemes were truthful in expectation which is a weaker notion of randomized truthfulness assuming risk neutral bidders. The existence of such a mechanism was questioned by previous work showing that certain technical variants of multi-unit auctions do not admit a universally truthful approximation scheme.

The following report describes our research results and lists our publications and presentations. The scientific relevance of our work is, e.g., documented by an invited plenary talk given by Berthold Vöcking at ICALP, the leading European conference in theoretical computer science, and an invited keynote talk given by Thomas Kesselheim at the ALGOSENSORS symposium. The latter invitation is even more remarkable as Thomas Kesselheim received this honour as a Ph.D. student. As another highlight, we received a best paper award at ICALP 2012 for the paper "Online Mechanism Design (Randomized Rounding on the Fly)" by Piotr Krysta and Berthold Vöcking.

Research Projects

Competitive Buffer Management for QoS Networks

K. Al-Bawani

In this project, we design and analyze online algorithms for the problem of buffer management in QoS networks. This problem is briefly stated as follows. A sequence of data packets, each with a non-negative value (priority), arrive one by one at a network switch, and are to be stored temporarily in a buffer (queue) inside the switch. While infinitely many packets may arrive in any time step t, only one packet can be sent out of the switch at t. Provided that the queue is limited in capacity, that gap between the arrival and transmission rates often results in buffer overflow. Upon the arrival of a packet, we want to decide whether to insert the packet into the queue or drop it, so that the total value of the sent packets (the weighted throughput) is maximized. We consider the preemptive variant of this problem, i.e., enqueued packets can be dropped before they are sent. The main handicaps to deal with when tackling this problem are uncertainty of future arrivals and that packets must be sent in the order of their arrival (FIFO).

Since it was introduced a decade ago, no online algorithm has solved this problem with a competitive ratio less than 1.73. We say that an online algorithm is c-competitive if, for any sequence of packets, the optimum throughput is at most c times the throughput of the online algorithm. It is also known that any algorithm cannot be better than 1.414-competitive. Exploiting the fact that all previous attempts to solve this problem were memoryless algorithms, we study online algorithms that store information from the past and use it to assess the process of preempting (dropping) enqueued packets. We focus on a special class of algorithms, the comparison-based algorithms, which do not address the actual values of packets, but rather the relative order between them. This restriction reduces general-valued sequences to sequences of values 0 and 1 only, a property that significantly simplifies the algorithm analysis.

Distributed Algorithms for Wireless Networks

J. Dams, M. Hoefer

Funded by DFG.

In this project we develop distributed protocols and analyze the resulting dynamics for coordination problems in large networks. The goal is to derive a general understanding of distributed algorithms and dynamics in problems with rational agents and locality of computation and information.

In the previous year we most prominently analyzed the scheduling of transmissions under Rayleigh-fading interference in which selfish agents in a wireless network scenario have to decide whether to transmit. Here simultaneous transmissions interfere with each other in a stochastic manner.

For the following years we plan to address further questions related to wireless networks. We plan to analyze aspects like scheduling transmissions for broadcasting a message to all nodes and problems dealing with unavailable channels and channels blocked by adversarial jammers. The main challenge here is the design of simple and reliable algorithms, which cope with local information, asymmetric interference relations and dynamically adjusting request structure.

Economical Caching: Online Learning for Buffering Problems

S. Geulen, B. Vöcking, M. Winkler

Funded by AlgoSyn.

In recent years the development of systems combining the advantages of two or more power sources efficiently was motivated by economical, ecological, and political progress. The main challenge in these systems is to manage the interaction between the different power sources in such a way that the advantages of both can be exploited and their disadvantages compensate each other. One example of such a system is a hybrid car which has two engines, one combustion engine operated with petrol, and one electrical engine using a battery. The control unit of the hybrid car has to manage the battery, e.g., it has to decide at which time the battery should be recharged by the combustion engine. Furthermore, the control unit has to manage the torque distribution between the two engines provided that the battery is charged sufficiently.

Today, engineers use mainly heuristic algorithms for this kind of power management problems. These heuristics were developed using realistic test cases. Indeed, in these test cases these algorithms achieve a good performance, but in general they do not have any guarantees on the quality of the solution. In the case of a hybrid car, a heuristic algorithm for a battery control unit can be optimized, e.g., for city scenarios (slow speed and stop-and-go traffic). If this condition is not fulfilled, the performance of this heuristic can be very bad.

This insight led us to a new research direction based on online learning: Consider a set of these heuristics and call each of them an expert. Based on this set, an online learning algorithm chooses in each time step an expert whose decision it wants to follow, under the objective of achieving an accumulated cost at most in the order of that of the best expert chosen from this set in hindsight. This cost difference is called the regret. There are algorithms whose regret per time step converges against zero if the set of experts is finite. We have used this algorithm as starting point for the battery management in a hybrid car.

In cooperation with the Institute for Control Engineering and the Hybrid Systems Group we have build a Simulink model of a hybrid car to simulate different algorithms for the battery management and to compare the results. Basis to compare the algorithms we have developed

is the equivalence factor strategy which is used in todays hybrid cars. We have furthermore implemented a no-regret learning algorithm which uses algorithms for the management of the battery which have theoretically proved bounds on its performance as well as algorithms which are used by the engineers in todays hybrid cars, as for example the equivalence factor strategy or heuristics used for the management of the battery. The performance of the no-regret learning algorithm shall then be compared to the results of the equivalence factor strategy used as reference value.

Approximation Algorithms for Combinatorial Auctions

O. Göbel, B. Vöcking

Funded by AlgoSyn.

A combinatorial auction is a setting where bundles of items are sold to agents which give bids for item sets, according to their valuation of these sets. After collecting all bids, an allocation of items to agents as well as payments for the bidders are determined. The agents aim at maximizing their benefit. This might result in giving strategical bids instead of bidding according to their true valuation. In contrast to the agents, an auctioneer is interested in all participant's overall benefit (social welfare), so that he wants the agents to report their true valuation instead of any strategical value. For this purpose, we aim at finding mechanisms which ensure this desired behavior. Such mechanisms are called incentive compatible or truthful. Allocating items to the bidders often results in the need to solve the Independent Set problem, as bidder's overlappings with respect to their desired items can be represented in a conflict graph. A set of bidders without conflicts is then an Independent Set. The problem is not only known to be NP-complete, but cannot be approximated within a factor being smaller than n^(1-\epsilon) in the general case.

In this project, we want to take advantage of structural properties of the auction's underlying conflict graph to obtain better approximation guarantees for item allocation. In disk graphs, for example, where the graph's nodes are composed of circles in the plane, polynomial time approximation schemes exist. Our current work focuses on allocation in online auctions, that is when bidders are not known in advance but appear one after another. In online scenarios, it can be differentiated between items arriving in adversarial (i.e. worst-case) and in stochastic order. Basically, we consider the second one to be appropriate in our work.

The results of our work in the last year are approximation algorithms for the unweighted and the weighted case. Furthermore, by giving lower bounds, we show that with weighted disks, algorithms cannot do much better than the performance of our result. Ongoing work considers lower bounds for variations of disk graphs, e.g. such with equal diameter. In future research we try to transfer our results to conflict graphs which do not consist of disks, but rather have a bounded inductive independence number. This property is a generalization of the graphs considered so far and covers a more general class.

Design and Analysis of Algorithms in Wireless Networks

M. Hoefer, T. Kesselheim, B. Ries, B. Vöcking

Funded by DFG, UMIC Research Cluster in the Excellence Initiative.

For communication in a wireless network it is vital that concurrent transmissions do not interfere. To avoid collisions, one can assign multiple channels or different time intervals to the communication requests.

In research dealing with this problem of scheduling in wireless networks there is often a large gap between different approaches. On the one hand theoretical computer scientists analyze algorithms considering only simple interference models. This tends to oversimplify the physical aspect that for example result from different transmission powers used. On the other hand, engineers study heuristics under complex, more realistic models. However, they do not derive general performance guarantees.

The project aims at narrowing this gap. We use the interference models based on the signal-to-interference-plus-noise ratio (SINR) that are common among engineers. Applying techniques from analysis of algorithms allows us to prove that our algorithms calculate near-optimal solutions in arbitrary network topologies (that is, not only random or regular ones).

In the last year, we were able to transfer most of our results from previous years to more sophisticated scenarios. For example, we considered a setting in which communication requests arise over time, for which we could give a general transformation of previously developed algorithms. We also considered more advanced models, in which transmissions are able to adapt to different interference conditions or in which signal propagation is modeled more accurately. In each of these cases, results obtained in simpler cases turned out to be the key to understanding the advanced scenarios.

We also made a very first step towards application of our results in practice. We evaluated algorithms we developed in simulations on realistic networks that were generated randomly. Many theoretical results could be observed in these simulations as well. Altogether, this gives rise to the hope that this project can contribute to the fundamental understanding of designing scheduling algorithms for wireless networks.

Decentralized Matching Problems in large Networks

M. Hoefer, L. Wagner

Funded by DFG

In large networks it is a challenging task to compute (and administer) centralized solutions for a variety of coordination problems. This motivates the design and analysis of multi-agent

systems with decision-making under local information. In these cases agents act independently, they have to dynamically react and adjust their behavior. This raises stability and convergence problems. Furthermore, it is important to analyze social welfare criteria for stable states.

In this project, we analyze simple network design problems when actors in a network are rational selfish agents. We focus on fundamental matching problems, where agents want to match in a way that maximizes their own profit and have limited information about the network. Their information changes dynamically depending on the current matching. Our focus is on the question of convergence to a stable state where no agent has an incentive to deviate and the quality of such a state.

For locally stable matchings we showed a number of NP-hardness results regarding the reachability of given or even arbitrary stable matchings. In addition, there are games in which an exponential number of local changes to the matching are necessary until a stable state is reached. Additionally, we explored how the presence of different kinds of memory influences reachability. We also obtained NP-hardness and inapproximability results for computing maximum locally stable matchings.

In the future we want to focus on matchings in contribution games, where we analyze how agents can be motivated to ensure that the results of selfish behavior do not harm the social welfare too much. We aim at strategies to stabilize the social optimum and as well strategies which rule out the worst matchings and thus lower the price of anarchy.

Online Packing with Gradually Improving Estimations on the Packing Constraints

M. Ochel, K. Radke, B. Vöcking

We introduce and analyze a new online model for optimization problems that can be described in terms of a linear packing problem.

In previous online models, capacities of a packing instance are assumed to be totally known from the start, where the online information is given over time by gradually revealing new objects together with their respective capacity requirements and profits, that have to be rejected or added instantly (possibly multiple times) to the packing with respect to the capacity constraints.

Our model addresses the complementary case of an a priori fixed set of objects, defined by their requirements and profits, that may be packed while the exact capacities are initially unknown. Only by exploiting a resource, an improving estimation on the respective capacity can be derived in terms of lower and upper bounds (that differ at most by a factor alpha) on the remaining capacity. However, reallocation of already blocked capacities is not allowed.

A practical problem which fits naturally into this framework is the one of network lifetime maximization of sensor networks. There, sensor nodes have battery capacities which are not exactly known a priori, whereas the structures that may be packed are fixed from the beginning (e.g. broadcast trees). Only estimates of the sensor's battery capacities are known

and these estimates become more and more accurate while using the capacities. In particular, the exact capacity of a sensor node is known only ex post, when it is completely used up.

When designing competitive online algorithms for our online model, one can see that a trivial 1/alpha-competitive solution can be achieved by just optimizing the packing program with respect to the initial lower bounds. By recursively applying the same approach to exploit possible remaining capacties, one could hope to improve this competitive factor. However, it can be shown that this is not the case. This raises the question of whether it is possible at all to exploit the gradually improving capacity estimates?

In our study we could answer this question positively by developing an online algorithm with a competitive ratio of ln(alpha)/(alpha-1) on general linear packing problems. Also we have proven a complementary upper bound of O(1/sqrt(alpha)) on the best possible competitive ratio showing the limits of online algorithms using gradually improving capacity estimations.

Randomized methods in algorithmic mechanism design

K. Radke, R. Reiffenhäuser, B. Vöcking

In this recently initiated project, we want to advance the state of the art in randomized mechanism design for combinatorial auctions with multi-dimensional bidders. Towards this end, we explore innovative algorithmic approaches for various kinds of combinatorial auctions in online and offline settings with the objective to improve upper and lower bounds on approximation ratios that can be guaranteed by incentive compatible mechanisms. Furthermore, we investigate whether randomness is crucial for obtaining incentive compatible approximation schemes for multi-unit auctions and related problems. The goal of this study is to gain a better understanding of the role of randomization in algorithmic mechanism design.

Motivated by our recent work about priority and online algorithms, we will develop and analyze secretary-type algorithms that consider bidders in random arrival order and use those bidders arriving first for computing prices for the remaining bidders. Within a competitive analysis we intend to derive upper and lower bounds on the approximation (competitive) ratio for combinatorial auctions with different classes of valuation functions. For example, we want to tackle the challenging question whether a constant factor approximation for combinatorial auctions with submodular or XOS valuations can be achieved by an incentive compatible online algorithm. Our goal is not only to derive upper and lower bounds on the approximation ratio for one particular variant of combinatorial auctions but to identify the properties and parameters that determine the quality of approximation in different problem variants.

In addition, we investigate whether and to which extend randomization is essential for the design of incentive compatible approximation schemes. Our study focuses on multi-unit auctions and related problems for which previous work yields an interesting landscape of different degrees of approximation achievable for different notions of incentive compatibility. We plan to tackle this question from two sides: On the one hand, we investigate which of the computational tasks solved by known approximation schemes can be solved without randomization. On the other hand, we want to sharpen the known characterizations imposed

by different notions of incentive compatibility. In particular, we aim at lower bounds on approximation ratios that can be achieved without randomization.

Algorithms for Covering Special Structures in Graphs

B. Ries, W. Unger

We consider the problem of covering special structures, e.g., paths of a certain length k. Our research is motivated by security issues in wireless sensor networks. A wireless sensor network can be modeled as graph, in which vertices represent sensor devices and edges represent communication channels between pairs of sensor devices. We aim to guarantee data integrity in the network. This can be done, for example under the assumption that there exists at least one node on every path of length k in the communication graph. The problem of covering all paths of length k with at least one node is known as the k-path vertex cover problem.

So far, we focused our research on the k-path vertex cover problem, which is a generalization of the well-studied vertex cover problem. Hence, most of the negative results for general graphs can be transferred. We consider special graph classes like d-regular graphs or circle graphs. For d-regular graphs we achieve different approximation factors depending on k and d. Moreover we have found a polynomial time algorithm for fixed but arbitrary k on circle graphs. In future we want to find out, whether there exists a polynomial time algorithm for arbitrary k, or if the problem is NP-hard. Furthermore, we would like to consider other graph classes or different variations of the k-path vertex cover problem, e.g., the set of nodes should be connected. In addition we change the topic from considering paths of length k to, e.g., circles of length k or other, more complex structures. Hence, our approximation factors result from worst case instances. We perform experiments on random generated graphs, in order to see, how the algorithms perform in arbitrary instances.

Online-Algorithms With Advice

W. Unger

A new model of online-algorithms is investigated. In this model the online-algorithm may read a limited number of bits given by an adviser. The adviser has the same computing power and knowledge as the adversary. The focus of research lies in the comparison of the number of read bits with the competitive ratio of the online-algorithm.

For the colouring of outer-planar, SP and bounded tree-width graphs we already did achieve good results. For these algorithms, precise upper bounds on the number of advice bits are introduced. Furthermore, we got first results on matchings of bipartite graphs in this model.

Other Activities

Courses

Our group offered the following lectures and seminars:

Winter semester 2011/12

- Lecture on Computability and Complexity Theory
- Lecture on Methods in Network Analysis
- Lecture on Algorithmic Graph Theory
- Seminar on Game-theoretic Mechanisms and Auctions
- Proseminar on Online Algorithms

Summer semester 2012

- Lecture on Efficient Algorithms
- Lecture on Algorithmic Game Theory
- Lecture on Theory of Distributed Systems
- Seminar on The Probabilitstic Method
- Proseminar on Algorithms on Graphs
- Proseminar on Network Algorithms
- Proseminar on Randomized Algorithms

Berthold Vöckings scientific activities

- DFG-Fachkollegiat for Theoretical Computer Science
- Co-Chair of the Steering Committee of the Symposium on Theoretical Aspects of Computer Science (STACS)
- Speaker of GI Fachausschuss Theoretische Informatik
- Member of the editorial board of ACM Transactions on Computation Theory (TOCT)
- Member of the editorial board of Distributed Computing
- Member of the program committee of 4th Symposium on Algorithmic Game Theory (SAGT), Salerno, Italy, October 17-19, 2011
- Member of the program committee of 26th IEEE International Parallel and Distributed Processing Symposium (IPDPS), Shanghai, China, May 21-25, 2012
- Member of the program committee of 13th ACM Conference on Electronic Commerce (EC), Valencia, Spain, June 4-8, 2012
- Member of the program committee of 39th International Colloquium on Automata, Languages and Programming (ICALP), Track C, Warwick, UK, July 9-13, 2012
- Member of the program committee of 31st Annual ACM SIGACT-SIGOPS Symposium on Principles of Distributed Computing (PODC), Madeira, Portugal, July 16-18, 2012

- Member of the program committee of 53rd Annual IEEE Symposium on Foundations of Computer Science (FOCS), New Brunswick, New Jersey, USA, October 20-23, 2012
- Organisation of the session "Polynomial-time algorithms for mechanism design" at the 21st International Symposium on Mathematical Programming (ISMP), Berlin, Germany, August 19-24, 2012

Martin Hoefers scientific activities

- Member of the program committee of 8th International Conference on Algorithmic Aspects of Information and Management (AAIM), Beijing, China, May 14-16, 2012
- Member of the program committee of 13th ACM Conference on Electronic Commerce (EC), Valencia, Spain, June 4-8, 2012
- Member of the program committee of 24th ACM Symposium on Parallelism in Algorithms and Architectures (SPAA), Pittsburgh, Pennsylvania, USA, June 25-27, 2012
- Member of the program committee of 20th European Symposium on Algorithms (ESA), Ljubljana, Slovenia, September 10-12, 2012
- Member of the program committee of 10th Workshop on Approximation and Online Algorithms (WAOA), Ljubljana, Slovenia, September 13-14, 2012
- Member of the program committee of 5th International Symposium on Algorithmic Game Theory (SAGT), Barcelona, Spain, October 22-23, 2012
- Member of the program committee of 8th Workshop on Internet and Network Economics (WINE), Liverpool, UK, December 9-12, 2012

Talks and Publications

Talks

Johannes Dams: Scheduling in Wireless Networks with Rayleigh-Fading Interference. ACM Symposium on Parallelism in Algorithms and Architectures (SPAA), Pittsburgh, Pennsylvania, USA, June 2012.

Johannes Dams: Distributed Wireless Capacity Maximization with Stochastic Channel Availabilities. Workshop on Realistic models for Algorithms in Wireless Networks (WRAWN), Warwick, UK, July 2012.

Martin Hoefer: Local Matching Dynamics in Social Networks. Universität Freiburg, Germany, November 2011.

Martin Hoefer: Local Matching Dynamics in Social Networks. University of Warwick, UK, February 2012.

Martin Hoefer: Local Matching Dynamics in Social Networks. Max-Planck-Institut für Informatik, Saarbrücken, Germany, May 2012.

Martin Hoefer: Local Matching Dynamics in Social Networks. Google Research, New York City, USA, May 2012.

Martin Hoefer: Secondary Spectrum Auctions with Symmetric and Submodular Bidders. ACM Conference on Electronic Commerce (EC), Valencia, Spain, June 2012.

Martin Hoefer: Algorithms for Strategic Interaction in Networks. Universität des Saarlandes, Saarbrücken, Germany, June 2012.

Martin Hoefer: Strategic Aspects in Wireless Networks. Summer School on Algorithmic Game Theory, Samos, Greece, July 2012.

Martin Hoefer: Contribution Games in Networks. International Symposium on Mathematical Programming (ISMP), Berlin, Germany, August 2012.

Martin Hoefer: Local Matching Dynamics in Social Networks. Blankensee Colloquium "Neighborhood Technologies", Berlin, Germany, August 2012.

Thomas Kesselheim: Approximation Algorithms for Capacity-Maximization Problems. Tutorial at the Workshop on Realistic models for Algorithms in Wireless Networks (WRAWN), Warwick, UK, July 2012.

Thomas Kesselheim: Approximation Algorithms for Wireless Link Scheduling with Flexible Data Rates. Workshop on Realistic models for Algorithms in Wireless Networks (WRAWN), Warwick, UK, July 2012.

Thomas Kesselheim: Dynamic Packet Scheduling in Wireless Networks. ACM SIGACT-SIGOPS Symposium on Principles of Distributed Computing (PODC), Madeira, Portugal, July 2012.

Thomas Kesselheim: Wireless Scheduling Algorithms with Rate Adaptation (Invited to Special Session on Interesting New Research Directions). ACM SIGACT International Workshop on Foundations of Mobile Computing (FOMC), Madeira, Portugal, July 2012.

Thomas Kesselheim: Approximation Algorithms for Wireless Link Scheduling with Flexible Data Rates. European Symposium on Algorithms (ESA), Ljubljana, Slovenia, September 2012.

Thomas Kesselheim: Approximation Algorithms for Wireless Spectrum Allocation with Power Control. Opening Keynote at the International Symposium on Algorithms for Sensor Systems, Wireless Ad Hoc Networks and Autonomous Mobile Entities (ALGOSENSORS), Ljubljana, Slovenia, September 2012.

Thomas Kesselheim: Comparative Study of Approximation Algorithms and Heuristics for SINR Scheduling with Power Control. International Symposium on Algorithms for Sensor Systems, Wireless Ad Hoc Networks and Autonomous Mobile Entities (ALGOSENSORS), Ljubljana, Slovenia, September 2012.

Klaus Radke: Online Packing with Gradually Improving Capacity Estimations and Applications to Network Lifetime Maximization. International Colloquium on Automata, Languages, and Programming (ICALP), Warwick, UK, July 2012.

Berthold Vöcking: A universally-truthful approximation scheme for multi-unit auctions. Annual ACM-SIAM Symposium on Discrete Algorithms (SODA), Kyoto, Japan, January 2012.

Berthold Vöcking: A universally-truthful approximation scheme for multi-unit auctions. Stanford University, USA, June 2012.

Berthold Vöcking: Randomized Mechanisms for Multi-unit Auctions. Keynote Talk at the International Colloquium on Automata, Languages, and Programming (ICALP), Warwick, UK, July 2012.

Berthold Vöcking: A universally-truthful approximation scheme for multi-unit auctions. International Symposium on Mathematical Programming (ISMP), Berlin, Germany, August 2012.

Berthold Vöcking: Randomized Mechanism Design: Approximation and Online Algorithms. Tutorial at the Max Planck Advanced Course on the Foundations of Computer Science (ADFOCS), Saarbrücken, Germany, August 2012.

Publications

Elliot Anshelevich and Martin Hoefer. Contribution Games in Networks. Algorithmica 63(1):51-90, 2012.

Lukas Belke, Thomas Kesselheim, Arie M. C. A. Koster, and Berthold Vöcking. Experimental study of approximation algorithms and heuristics for SINR scheduling with power control. In Proceedings of the 8th International Symposium on Algorithms for Sensor Systems, Wireless Ad Hoc Networks and Autonomous Mobile Entities (ALGOSENSORS), Ljubljana, Slovenia. To appear.

Patrick Briest, Luciano Gual·, Martin Hoefer, and Carmine Ventre. On Stackelberg Pricing with Computationally Bounded Customers. Networks 60(1):31-44, 2012.

Patrick Briest, Martin Hoefer, and Piotr Krysta. Stackelberg Network Pricing Games. Algorithmica 62(3-4):733-753, 2012.

Patrick Briest, Piotr Krysta, and Berthold Vöcking. Approximation Techniques for Utilitarian Mechanism Design. SIAM Journal on Computing 40(6):1587-1622, 2011.

Johannes Dams, Martin Hoefer, and Thomas Kesselheim. Scheduling in Wireless Networks with Rayleigh-Fading Interference. In Proceedings of the 24th ACM Symposium on Parallelism in Algorithms and Architectures (SPAA), Pittsburgh, Pennsylvania, USA, pp. 327-335, 2012.

Andreas Emil Feldmann, Heiko Röglin, and Berthold Vöcking. Computing approximate Nash equilibria in network congestion games. Networks 59(4):380-386, 2012.

Martin Hoefer and Thomas Kesselheim. Secondary Spectrum Auctions for Symmetric and Submodular Bidders. In Proceedings of the 13th ACM Conference on Electronic Commerce (EC), Valencia, Spain, pp. 657-671, 2012.

Martin Hoefer and Siddharth Suri. Dynamics in network interaction games. Distributed Computing 25(5):359-370, 2012.

Thomas Kesselheim. Approximation Algorithms for Wireless Link Scheduling with Flexible Data Rates. In Proceedings of the 20th European Symposium on Algorithms (ESA), Ljubljana, Slovenia, pp. 659-670, 2012.

Thomas Kesselheim. Dynamic Packet Scheduling in Wireless Networks. In Proceedings of the 31st Annual ACM SIGACT-SIGOPS Symposium on Principles of Distributed Computing (PODC), Madeira, Portugal, pp. 281-290, 2012.

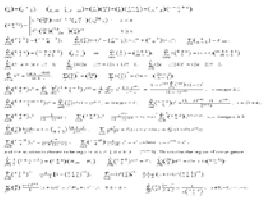
Piotr Krysta and Berthold Vöcking. Online Mechanism Design (Randomized Rounding on the Fly). In Proceedings of the 39th International Colloquium on Automata, Languages, and Programming (ICALP), Part II, Warwick, UK, pp. 636-647, 2012.

Marcel Ochel, Klaus Radke, and Berthold Vöcking. Online Packing with Gradually Improving Capacity Estimations and Applications to Network Liftime Maximization. In Proceedings of the 39th International Colloquium on Automata, Languages, and Programming (ICALP), Part II, Warwick, UK, pp. 648-659, 2012.

Berthold Vöcking. A universally-truthful approximation scheme for multi-unit auctions. In Proceedings of the 23rd Annual ACM-SIAM Symposium on Discrete Algorithms (SODA), Kyoto, Japan, pp. 846-855, 2012.

Berthold Vöcking. Randomized Mechanisms for Multi-unit Auctions (Extended Abstract). In Proceedings of the 39th International Colloquium on Automata, Languages, and Programming (ICALP), Part II, Warwick, UK, pp. 27-29, 2012.

Theoretical Computer Science



Staff

- **Group head**
  Prof. Dr. Peter Rossmanith

- **Secretary**
  Birgit Willms

- **Research Assistants**
  Dipl.-Inform. Alexander Langer
  Dipl.-Inform. Felix Reidl
  Dipl.-Inform. Fernando Sanchez Villaamil (since May 2012)
  Somnath Sikdar, Ph.D.

- **Student Assistants**
  Fred Grossmann

Overview

Our teaching and research profile mainly consists of

- Efficient Algorithms
- Parameterized Algorithms
- Moderately Exponential Time Algorithms
- Structural Graph Theory
- Complexity Theory
- Formalizing Mathematics
- Analysis of Algorithms

with an emphasis on the design and analysis of efficient algorithms.

We are particularly interested in solving NP-hard problems. Many problems relevant in practice are in this category, and hence often solved by inexact methods that do not necessarily output the optimal solution, although in the case of approximation algorithms, there still is a guarantee of how close the computed solution is to the exact one. While approximation algorithms are often very useful, they frequently have a very large running time even for rather bad approximation ratios. On the other hand, sometimes exact solutions are asked for, and we concentrate on such exact algorithms.

Preprocessing of the input is an important step in computation. A preprocessing algorithm, also called a kernelization algorithm, is a computer program that takes as input an instance, applies a set of well-defined reduction and preprocessing rules and finally outputs a new instance whose size can be bounded by a certain parameter of the original input. For example, if one wants to decide whether a graph admits a vertex cover of size k, the application of a rather simple set of reduction rules reduces the original input instance to a graph with at most 2k vertices, called a linear kernel. For several problems we were able to show that there are linear kernels on large classes of graphs. Fix, for instance, an arbitrary graph H. Then for any graph G that does not contain H as a topological minor there exists preprocessing algorithm that outputs a linear kernel for the INTERVAL VERTEX DELETION and CHORDAL VERTEX DELETION problems, two well-known graph modification problems.

Research Projects

Algorithms for Graphs of Small Treewidth

Alexander Langer, Felix Reidl, Peter Rossmanith

Funded by DFG under grant RO 927/8

In 1990, Courcelle showed that all problems definable in Monadic Second-Order logic can be solved in linear time on graphs of bounded treewidth. His important theorem (and its extension to Extended MSO) is the foundation for many further results, where an algorithm for an (E)MSO-definable problem, which by Courcelle's Theorem is known to exist, is used as a black box. Surprisingly, there still is no implementation of this important theoretical result available, although such an implementation would be useful for a broad range of decision and optimization problems.

The major goal of this project is to close this gap and implement algorithms for Courcelle's Theorem that can compete with specific algorithms for the respective problems. Due to the hardness and complexity of the underlying model-checking problem with non-elementary lower-bounds, a naive and straight-forward implementation will most probably not be of any practical relevance. Therefore, this task includes inventing new advanced techniques to circumvent the arising difficulties and obstacles.

Theoretical and Practical Aspects of Kernelization

Alexander Langer, Somnath Sikdar, Felix Reidl, Peter Rossmanith

DFG-funded under grant RO 927/12

Kernelization is an area of parameterized complexity that deals with the study of preprocessing algorithms. A kernelization algorithm essentially strips away the easy parts of a problem instance exposing the core or the kernel. This is an area that has attracted the attention of both theoreticians and practitioners for the interesting mathematical problems it poses and the practical utility of many of the solutions.

The objective of this project is to study both theoretical and practical aspects of kernelization algorithms. On the theoretical side, we plan to investigate topics such as kernelization using non-standard parameters where some structural aspect of the input (other than the solution size) is used as parameter. Other topics include strong polynomial kernels, Turing kernels, and the connection between kernelization and approximability. On the practical side, we plan to design kernelization algorithms for concrete problems with the aim of implementing these algorithms. In particular, we want to investigate the possibility of improving kernels for several problems on planar graphs (among others).

Other Activities

Courses

Our group offered the following lectures and seminars:

Winter 2011/2012

- Lecture on "Parameterized Algorithms"
- Lab Course on "Design and Implementation of a Router Planner"
- Seminar on "Medizinische Bildverarbeitung" (with Deserno, Kobbelt, Ney, Seidl, Spitzer)

Summer 2012

- Lecture on "Analysis of Algorithms"
- Seminar on "Kompressionsalgorithmen"

Talks and Publications

Talks

Somnath Sikdar: Lower Bounds on the Complexity of MSO1 Model-Checking. LAMSADE, Université Paris Dauphine, Paris, November 2011.

Somnath Sikdar: Linear Kernels for Problems on Sparse Graphs. LAMSADE, Université Paris Dauphine, Paris, November 2011.

Felix Reidl: Linear kernels for graphs excluding a topological minor. DIAMANT TACO workshop on Treewidth and Combinatorial Optimization, Maastricht University, Maastricht, The Netherlands, January 2012.

Somnath Sikdar: Lower Bounds on the Complexity of MSO1 Model-Checking. DIAMANT TACO workshop on Treewidth and Combinatorial Optimization, Maastricht University, Maastricht, The Netherlands, January 2012.

Alexander Langer: Evaluation of an MSO-Solver. Meeting on Algorithm Engineering & Experiments (ALENEX), The Westin Miyako, Kyoto, Japan, January 2012.

Peter Rossmanith: Wie können Roboter Hindernisse in einem Labyrinth finden: Ein Schülerpraktikum. HSGYM - Hochschultag der Zürcher Mittelschulen, ETH Zürich, Zürich, Schweiz, February 2012.

Felix Reidl: Linear Kernels on Graphs Excluding Topological Minors. International Workshop on Approximation, Parameterized and Exact algorithms (APEX), Paris, France, February 2012.

Somnath Sikdar: Lower Bounds on the Complexity of MSO1 Model-Checking. Symposium on Theoretical Aspects of Computer Science (STACS), University Pierre et Marie Curie, Paris, France, March 2012.

Peter Rossmanith: Implementing Courcelle's Theorem. Department of Software Engineering and Theoretical Computer Science, TU Berlin, Berlin, German, May 2012.

Somnath Sikdar: Linear Kernels on Graphs Excluding Topological Minors. Dagstuhl Workshop on Data Reduction and Problem Kernels, Schloss Dagstuhl, Germany, June 2012.

Peter Rossmanith: Practical Approach to Solving Hard Graph Problems. Department of Computer Science and Information Engineering, Hungkuang University, Taiwan, July 2012.

Peter Rossmanith: Solving MSO-definable Graph Problems Efficiently. Graduiertenkolleg "Methods for Discrete Structures", TU Berlin, Berlin, October 2012.

Publications

Sounaka Mishra, Venkatesh Raman, Saket Saurabh, Somnath Sikdar, C. R. Subramanian: The Complexity of König Subgraph Problems and Above-Guarantee Vertex Cover. Algorithmica 61(4): 857-881 (2011)

Philipp Kranen, Felix Reidl, Fernando Sanchez Villaamil, Thomas Seidl: Hierarchical Clustering for Real-Time Stream Data with Noise. Proceedings of SSDBM 2011, LNCS 6809, pages 405-413, Springer, 2011.

Alexander Langer, Felix Reidl, Peter Rossmanith, Somnath Sikdar: Evaluation of an MSO-Solver. Proceedings of ALENEX 2012, pages 55-63, SIAM / Omnipress, 2012.

Dániel Marx, Peter Rossmanith (Eds.): Parameterized and Exact Computation – 6th International Symposium, IPEC 2011, Saarbrücken, Germany, September 6-8, 2011. Revised Selected Papers, LNCS 7112, Springer, 2012.

Robert Ganian, Petr Hlinený, Alexander Langer, Jan Obdrzálek, Peter Rossmanith, Somnath Sikdar: Lower Bounds on the Complexity of MSO_1 Model-Checking. Proceedings of STACS 2012, LIPIcs 14, pages 326-337, Schloss Dagstuhl - Leibniz-Zentrum für Informatik, 2012.

Hans-Joachim Böckenhauer, Dennis Komm, Richard Královic, Peter Rossmanith: On the Advice Complexity of the Knapsack Problem. Proceedings of LATIN 2012, LNCS 7256, pages 61-72, Springer, 2012.

Michael Dom, Michael R. Fellows, Frances A. Rosamond, Somnath Sikdar: The Parameterized Complexity of Stabbing Rectangles. Algorithmica 62(1-2): 564-594 (2012)

Neeldhara Misra, Geevarghese Philip, Venkatesh Raman, Saket Saurabh, Somnath Sikdar: FPT algorithms for Connected Feedback Vertex Set. J. Comb. Optim. 24(2): 131-146 (2012)

Technical Reports

Alexander Langer, Felix Reidl, Peter Rossmanith, Somnath Sikdar: Linear Kernels on Graphs Excluding Topological Minors CoRR abs/1201.2780: (2012)

Eun Jung Kim, Alexander Langer, Christophe Paul, Felix Reidl, Peter Rossmanith, Ignasi Sau, Somnath Sikdar: Linear kernels and single-exponential algorithms via protrusion decompositions CoRR abs/1207.0835: (2012)

Software Modelling and Verification

Staff

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  Prof. em. Dr. Klaus Indermark
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- **Secretary**
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- **Technical Staff**
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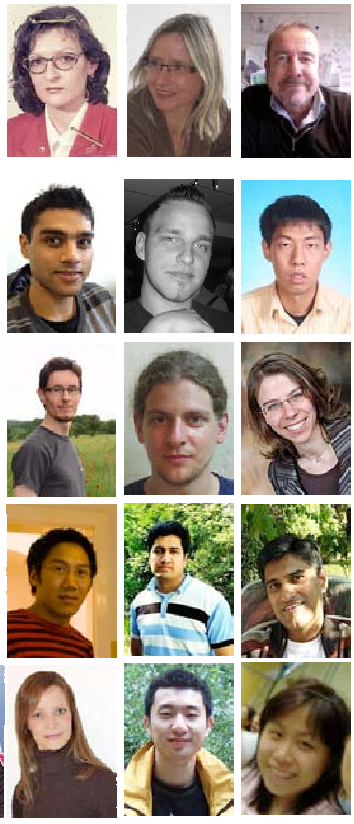
  Dipl.-Inform. Friedrich Gretz
  Dipl.-Inform. Jonathan Heinen
  Dipl.-Inform. Christina Jansen
  Viet Yen Nguyen, M.Sc.
  Arpit Sharma, M.Sc.
  Falak Sher, M.Sc.
  Dr. Balaguru Srivathsan (since July 2012)
  Dipl.-Inform. Sabrina von Styp
  Dipl.-Inform. Hao Wu
  Dipl.-Inform. Haidi Yue



- **Diploma/Bachelor/Master Students**
  Hussein Hamid Baagil
  David Clermont
  Bernhard Ern
  Florian Göbe
  Max Görtz
  Dennis Guck
  Jasper Heuser
  Tobias Hoffmann
  Jens Katelaan
  Tim Lange
  Bart Postma
  Tim Rohlfs
  Sebastian Staack
  Alexander Dominik Weinert
  Christoph Worreschk

- **Student Researchers**
  Henrik Barthels
  Philipp Berger
  Thomas Heinemann
  Sergey Sazonov
  Lisa von Büttner

- **Visiting Scientists**
  Pedro D'Argenio (University of Cordoba, ARG)
  Peter Höfner (NICTA Sydney, AUS)
  Ian Larson (Michigan University, USA)
  Prof. Dr. Chris J. Myers (University of Utah, USA)
  Nils Müllner (University of Oldenburg, GER)
  Johann Schuster (Universität der Bundeswehr München, GER)
  B. Srivathsan (LaBRI, Bordeaux, FRA)
  Daniel Stan (ENS Cachan, FRA)
  Gerjan Stokkink (University of Twente, NED)
  Mark Timmer (University of Twente, NED)

Overview

2012 has been an exciting year. New projects, several new group members, and several successes in terms of prizes and awards. Several changes occurred in the personnel. Maximilian Odenbrett left our group, whereas Souymodip Chakraborthy, Christian Dehnert and Hao Wu joined our group. Souy, Chris, and Stephen welcome to the chair! In July, Balaguru Srivathsan joined our group as a postdoctoral researcher. He received his PhD degree from LaBRI Bordeaux, France, for his dissertation on Timed Automata. Prior to this, he studied at IIT Bombay in India. In autumn of 2012, Sri gave a successful 10-hour lecture series on Timed Automata. Sri, welcome to our group!

Thomas Noll received this year the title of "außerplanmäßiger Professor" (shortly apl. Prof.). We congratulate Thomas with this great achievement! Dino Distefano received the prestigious Roger Needham Award for his work on software verification. This award is for a distinguished research contribution in computer science by a UK based researcher who has completed up to 10 years of post-doctoral research. Dino Distefano was one of the first PhD students supervised by Joost-Pieter Katoen and is currently professor at Queen Mary University, London. Marijn Jongerden received the German MMB (Messung, Modellierung und Bewertung von Rechensystemen) Award 2012 of the GI/ITG-Committee for Measurement, Modelling and Evaluation of Computing Systems for his PhD-thesis on "Model-based energy analysis of battery powered systems". His work was co-supervised by Boudewijn Haverkort (Twente). Finally, Joost-Pieter Katoen has been elected as Chairman of the QEST Steering Committee. QEST is an international annual conference on the Quantitative Evaluation of Systems.

We have successfully acquired two new European projects that started in autumn. SENSATION (Self Energy-Supporting Autonomous Computation), coordinated by the CISS Embedded System Institute in Aalborg (Denmark), aims at devising energy-centric modelling and optimisation tools for the design of resource-optimal reliable systems. The D-MILS (Distributed MILS for Dependable ICT) project, coordinated by The Open Group in Brussels, focuses on component-based modelling, as well as exploiting the compositional structure in the analysis.

We provided courses on Theoretical Foundations of the UML, Static Program Analysis, Advanced Model Checking, Compiler Construction, and Data Structures and Algorithms. In addition, we organised seminars on Foundations of Multi-Core Memory Models, Turing Award Winners, and Success Stories in Formal Methods. Numerous students completed their bachelor, master and diploma thesis at our chair in 2012.

Joost-Pieter Katoen

Research Projects

CARP: Correct and Efficient Accelerator Programming

J.-P. Katoen, C. Dehnert, F. Gretz, C. Jansen

EU FP7 project, coordinator: Imperial College London (A. Donaldson)

In recent years, massively parallel accelerator processors, primarily GPUs, have become widely available to end-users. Accelerators offer tremendous computing power at a low cost, and tasks such as media processing, simulation, medical imaging and eye-tracking can be accelerated to beat CPU performance by orders of magnitude. Performance is gained in energy efficiency and execution speed, allowing intensive media processing software to run in low-power consumer devices.

However, accelerators present a serious challenge for software developers. A system may contain one or more of the plethora of accelerators on the market, with many more products anticipated in the immediate future. Applications must exhibit portable correctness, operating correctly on any configuration of accelerators, and portable performance, exploiting processing power and energy efficiency offered by a wide range of devices.

The aim of CARP is to design techniques and tools for correct and efficient accelerator programming. In particular, a new portable programming language is to be developed, which can be both easily written and efficiently compiled to a lower level programming language for accelerator programming such as OpenCL and CUDA. With this new language, programmers can achieve portability of their applications, because the same source code may be compiled into efficient code for a number of accelerators, each having its own capabilities and limitations. Besides, programmers can focus on writing code without having to worry about hardware-specific effects of certain code optimisations.

Our main contribution in this EU-funded project is to provide the compiler backend with techniques to estimate quantitative aspects of accelerator programs. That is, given a program and an accelerator architecture, we aim for estimating the runtime and energy consumption of this program executing on this specific accelerator. The main motivation is that it is not at all obvious whether a program is well-suited for an accelerator, because of platform-dependent details, i.e. a program running well on one target platform might produce a poor performance on another. We aim for developing a (quantitative) formal model of an application executing on an accelerator, which is to be analysed using formal techniques. Integrating these techniques into the compiler will provide it with a means to evaluate the quality of generated low-level code with respect to multiple objectives and hence with a technique to select the most suited generated code for the target device and intended purpose.

Furthermore within the scope of the CARP project we aim at developing static verification techniques for automated analysis of software for accelerators. Due to a high degree of parallelism occurring especially in the case of highly optimised accelerator code, the error potential of this software is enormous. We focus on techniques allowing to analyse pointer manipulating behaviour of accelerator programs for both the portable programming language developed in CARP as well as low-level applications written in OpenCL.

Invariant Generation for Probabilistic Programs

F. Gretz, J.-P. Katoen,

A. McIver (Macquarie Univ, Sydney)

Verification of sequential programs rests typically on the pioneering work of Floyd, Hoare and Dijkstra in which annotations are associated with control points in the program. For probabilistic programs, quantitative annotations are needed to reason about probabilistic program correctness. We generalise the method of Floyd, Hoare and Dijkstra to probabilistic programs by making the annotations real- rather than Boolean-valued expressions in the program variables. The crucial annotations are those used for loops, the loop invariants. Thus in particular we focus on real-valued, quantitative invariants: they are random variables whose expected value is not decreased by iterations of the loop.

One way of finding annotations is to place them speculatively on the program, as parameterised formulae containing only first-order unknowns, and then to use a constraint solver to search for parameter instantiations that would make the associated "verification conditions" true. In this project, we aim to generalise and extend constraint-solving techniques for invariant generation to probabilistic programs. This allows for the verification of probabilistic programs that cannot be treated with currently available automated techniques such as abstraction refinement together with model checking. This work includes theory development as well as prototypical tool development to illustrate the feasibility.

Verifying Pointer Programs with Unbounded Heap Structures

J. Heinen, C. Jansen, J.-P. Katoen, Th. Noll

The incorrect use of pointers is one of the most common sources of software errors. Proving the correctness of pointer-manipulating programs with unbounded heap, let alone algorithmically, is a highly non-trivial task. This project attempts to develop automated verification techniques and accompanying tool support for programs with memory allocation that handle linked data structures which are potentially unbounded in their size.

We developed a novel abstraction framework that is based on graph grammars, more precisely context-free hyperedge replacement grammars, as an intuitive formalism for abstractly modelling dynamic data structures. The key idea is to use the replacement operations which are induced by the grammar rules in two directions. By a backward application of some rule, a subgraph of the heap can be condensed into a single nonterminal edge, thus obtaining an abstraction of the heap. By applying rules in forward direction, certain parts of the heap which have been abstracted before can be concretised again. This avoids the necessity for explicitly defining the effect of pointer-manipulating operations on abstracted parts of the heap.

While in past years our focus was set on correctness and efficiency of the state space creation, we concentrated on the actual analysis this year. We developed an algorithm to check languages defined by graph grammars against MSO-formulae, allowing us to express complex properties of heap structures, such as reachability and shape properties. To express temporal properties we extended CTL* to quantified CTL*. While using CTL* allows to express temporal properties of the entire heap, quantified CTL* allows us to track objects over time and describe how their relation to other objects on the heap changes during the execution. We developed an on-the-fly algorithm for Quantified CTL*.

Another research topic was the investigation of the relations between our approach and Separation Logic. In Separation Logic heap structures are represented as formulae, which are strongly related to our abstract graph representation. We formalised the relation which will give us the possibility to carry over results from one approach to the other in the future.

Formal Models of Microcontroller Systems

Th. Noll,

J. Brauer (Chair of Software for Embedded Systems)

Embedded systems usually operate in uncertain environments, giving rise to a high degree of nondeterminism in the corresponding formal models. Moreover they generally handle data spaces whose sizes grow with the memory and the word length of the respective microcontroller architectures. This, together with other effects, leads to the well-known state-space explosion problem, meaning that the models of those systems grow exponentially in size as the parameter values increase. Careful handling of both nondeterminism and large data spaces is therefore crucial for obtaining efficient methods and tools for analysis and verification.

The goal of this project, carried out in close cooperation with the Embedded Software Laboratory of our department, is to develop abstraction techniques to tackle this problem. With regard to control structures, a technique for refining loops in microcontroller programs has been developed. It is based on abstract interpretation using octagons and affine equalities in order to identify infeasible sequences of loop iterations. Our approach naturally integrates wrap-around arithmetic during the generation of abstractions. Abstract interpreters operating on a refined control structure then typically derive strengthened program invariants without having to rely on complicated domain constructions.

With regard to data spaces, activities have been concentrating on static analysis methods for approximating the possible run-time values of data values. For this purpose, intervals have successfully been used for decades. Binary code on microcontroller platforms, however, is different from high-level code in that data is frequently altered using bit-wise operations and that the results of operations often depend on the hardware configuration. We therefore came up with a method that combines word- and bit-level interval analysis and that integrates a hardware model by means of abstract interpretation in order to handle these peculiarities. Both techniques have successfully been applied to a suite of benchmark examples.

Model-Based Energy Optimization of Automotive Control Systems

J.-P. Katoen, Th. Noll, H. Wu,

joint project together with Th. Santen, D. Seifert
(Microsoft Research, Advanced Technology Labs Europe)

funded by Microsoft Research and RWTH Aachen University Seed Fund

Reducing the energy consumption of controllers in vehicles requires sophisticated regulation mechanisms. Better power management can be enabled by allowing the controller to shut down sensors, actuators or embedded control units in a way that keeps the car safe and comfortable for the user, with the goal of optimising the (average or maximal) energy consumption. In this project, we develop an approach to systematically explore the design space of software-to-hardware mappings to determine energy-optimal deployments. It employs constraint-solving techniques for generating deployment candidates and probabilistic analyses for computing the expected energy consumption of the respective deployments. The feasibility and scalability of the method have been demonstrated by several case studies. Current efforts are concentrating on transferring the results to other application domains, such as the analysis of service-level requirements in cloud computing environments.

COMPASS: Correctness, Modelling and Performance of Aerospace Systems

C. Dehnert, J.-P. Katoen, V.Y. Nguyen, Th. Noll,

joint project together with the groups of Alessandro Cimatti
(Fondazione Bruno Kessler, Centre for Scientific and Technological Research, Trento, Italy),
and Xavier Olive (Thales Alenia Space, On Board Software Department, Cannes, France)

funded by European Space Agency (ESA), Thales Alenia Space and EU FP7 Programme

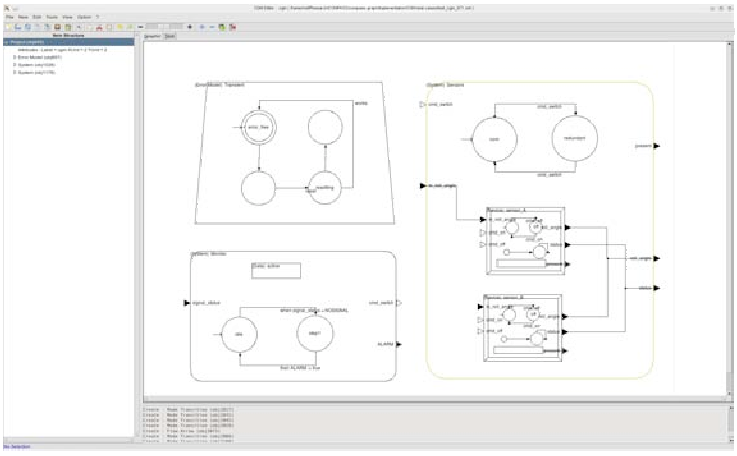
The size and complexity of software in spacecraft is increasing exponentially, and with that comes a strong need to validate it more effectively within the context of the overall (spacecraft) system. Current validation methods are labour-intensive as they rely on manual analysis, review and inspection. In the past four years we developed, with requirements from the European space industry, a novel modeling language and toolset to (semi-)automate validation activities. The AADL modeling language enables engineers to express the system, software and their reliability aspects, and the COMPASS toolset analyses them on correctness, safety, dependability and performance requirements using state-of-the-art model checking techniques and probabilistic versions thereof.

The results and experiences gained from this project have triggered follow-up activities to drive the further development of the overall technology. Several case studies have been performed with industrial involvement, of which two were conducted on a spacecraft in

development at system-level, namely a satellite platform. These efforts were carried out in parallel with the conventional software development for this system. The whole effort revealed numerous inconsistencies in the early design documents, and the use of formal analyses provided additional insight on discrete system behaviour (comprising nearly 50 million states), on hybrid system behaviour involving discrete and continuous variables, and enabled the automated generation of large fault trees (66 nodes) for safety analysis that typically are constructed by hand. The model's size pushed the computational tractability of the algorithms underlying the formal analyses, and revealed bottlenecks for future theoretical research. Additionally, the effort led to newly learned practices from which subsequent formal modelling and analysis efforts shall benefit, especially when they are injected in the conventional software development lifecycle. The case demonstrates the feasibility of fully capturing a system-level design as a single comprehensive formal model and analyse it automatically using a toolset based on (probabilistic) model checkers.

A more research-oriented follow-up activity is a PhD project on "Extending and Improving Formal Methods for System/Software Co-Engineering" within ESA's Networking Partnering Initiative that started in 2010 and aims to extend the currently used formal methods to cover a broader class of models in terms of expressiveness and scalability. This particularly applies to systems that exhibit complex characteristics in terms of non-determinism, timed and hybrid behaviour, and discrete and continuous-time probabilistic errors. Our goal is to specify formal semantics for such models, and to develop novel and advanced techniques to support their analysis. In particular, compositional techniques exploiting the hierarchical structure of component-based models will be required to combat the state-space explosion problem.

Another closely related project named Distributed MILS (Multiple Independent Layers of Security), funded by the European Union in the framework of the FP7 programme, has recently been started. It aims to to investigate and develop models and certification techniques for security architectures in heterogeneous, networked, service and computing environments. The AADL modelling language is also a cornerstone in this project, and it is aimed to leverage (parts of) the COMPASS toolset to provide analyses that support the assessment and certification of security aspects.



More information on COMPASS is available at http://compass.informatik.rwth-aachen.de.

Efficient Reachability Analysis for Probabilistic Timed Automata

J.-P. Katoen, B. Srivathsan

Soon after the success of conventional model-checking in the 80's where qualitative temporal properties of systems could be automatically verified, people started considering real-time properties. This gave birth to the timed automaton (TA) model in the early 90's. Timed automata are finite automata extended with clocks whose values can be compared with constants and can be set to zero during transitions. They model systems where events happen according to certain timing constraints, for instance a car-brake controller system which has to accentuate the hardware within a fixed number of seconds.

A timed automaton expresses a system model purely in terms of non-determinism. However, in some situations, it is desirable to express the probability of a system exhibiting a certain behaviour. To model such behaviour in systems, the model of probabilistic timed automata (PTA) has been introduced and has been implemented in the tool PRISM. Advances in timed automata technology have a direct influence on probabilistic timed automata.

A fundamental property in verification is state reachability. This problem is known to be decidable both for these automaton models and has been an active subject of research for over two decades now. Currently, there are mature tools implementing efficient reachability algorithms and have been used for industrial case studies.

The standard solution to the reachability problems for both TA and PTA involve the so-called abstractions of zones. A very recent work on TA has proposed a new reachability algorithm that involves non-convex abstractions and an on-the-fly learning of parameters for abstraction. Prototype implementation has shown a three-fold gain in some standard benchmarks.

The goal of this project is to understand to what extent the new results on abstractions for timed automata apply to probabilistic timed automata. The work would involve theory development as well as implementation to validate the gains.

Infinite-State Probabilistic Systems

H. Fu, J.-P. Katoen,

funded by China Scholarship Council (CSC)

Verification of infinite structures has been extensively studied in the past two decades. The motivation of this study is that (i) typical system components are often infinite-state (e.g., counters, buffers), which cannot be modelled by a finite-state system; and (ii) adding timed information to a finite-state system will also induce an infinite-state system.

The difference between finite-state and infinite-state verification lies in the fact that exhaustive traversal of the state space which is effective on finite-state systems cannot be applied to infinite-state systems. Thus new techniques should be developed. Currently, the study of infinite-state verifications is divided into two sub-areas: equivalence checking and model checking. In equivalence checking, the task is to decide if two given system are equivalent under a pre-established equivalence relation. In model checking, the task is to verify that a given system satisfies a certain property encoded by a logical formula.

In the non-probabilistic setting, namely on labeled transition systems, verification of infinite structures has been well studied. Various results have been obtained on infinite-state models such as Pushdown Automata, Petri Nets, etc. The aim of this project is to investigate infinite-state verification in a probabilistic setting. Probability is a mechanism to model uncertainty, which can be caused by randomised algorithms, unpredictable errors, or simply underspecification in system design.

Our main work is to study probabilistic model checking and probabilistic equivalence checking on probabilistic infinite-state systems. To do so, we may extend existing techniques on discrete infinite-state system to the probabilistic setting, or instead discover new techniques if necessary.

UMIC: Ultra High Speed Mobile Information and Communication

J.-P. Katoen, H. Yue

The evaluation of the quality-of-service of Wireless Sensor Networks is mostly done by simulation. In the context of the UMIC project, and in cooperation with the company CHESS, Haarlem, NL, we evaluated the second generation of a gossiping MAC protocol (GMAC), a TDMA protocol for completely unconfigured wireless networks, which aims to maintain message propagation with minimal energy demand.

The new GMAC protocol is modelled with a specific radio model, the SINR model of Gupta Kumar. And as network topology, we considered three different node arrangements: grid, uni-formed distribution and Gaussian distribution.

Simulations, carried out with the MoDeST/Möbius tool set, show that comparing to the simple slotted Aloha protocol, the new GMAC has indeed a significant beneficial influence on energy consumption for all the three types of networks. However, it also delayed message propagation. Besides that, we discovered that GMAC with constant sending power may cause a lot of interference in dense area, and in sparse area, nodes may disconnect to each other. Hence we proposed a dynamic energy scheduling schema, so that a node can regulate its sending power with respect to its current number of neighbours. Simulation results show that for Gaussian networks, our dynamic power management not only improved energy consumption, but also accelerated message propagation. Furthermore, we observed the existence of the Pareto Principle in the system, i.e., 20% of the nodes consumes 80% of the energy of the system.

Our current research aims at gathering evidence that the SINR model is in fact realistic enough to allow the derivation of reliable measures for wireless sensor networks using

simulation. For that we try to explain measurement data from CHESS by means of the SINR model.

In cooperation with the UMIC Mobile Network Performance Group, we modelled and examined a newly developed Wireless Token Ring Protocol (WTRP), which aims to establish robust wireless communication for real-time applications, such as the braking system in vehicles. Due to the high requirement on correctness from the application layer, the protocol should be ultra reliable and robust to all possible failures. Traditional evaluation techniques like simulation provide essential characteristics of the WTRP, and model checking gives evidence on the correctness of the protocol.

We model the WTRP as a PTA (probabilistic timed automaton) in PRISM, a tool for formal modelling and analysis of systems that exhibit random, probabilistic, or timed behaviour. The WTRP has several components, and our starting point is the core part, the normal ring module, and the ring consists of five stations. With PRISM, we not only verified the "eventually" path property of the protocol under reliable channel assumption, but also calculated the probability of token missing when the channel is unreliable.

Since the latter situation is more common and almost inevitable in real applications, our future research will focus on the relation between channel failure rate and the number of necessary retransmissions of messages, to obtain a wireless communication as reliable as possible.

SYRUP: SYmbolic RedUction of Probabilistic Models

J.-P. Katoen

M. Timmer, M. Stoelinga, J. van de Pol (all three from University of Twente, NL)

funded by the Dutch Research Council (NWO)

Efficient model-checking algorithms exist for qualitative and quantitative properties for a range of probabilistic models. Their popularity is due to the presence of powerful software tools, and their wide applicability; security, distributed algorithms, systems biology, dependability and performance analysis, to mention a few. The main deficiencies of probabilistic model checking are the state explosion problem and the restricted treatment of data.

The state space grows exponentially in the size of system components and data domains. Whereas most abstraction techniques obtain smaller models by collapsing sets of concrete states at the model level, this project takes a radically different approach. We will develop and implement symbolic reduction techniques for probabilistic models. These techniques aim to reduce models by model transformations at the language level in order to minimise state spaces prior to their generation while preserving functional and quantitative properties. Our symbolic reductions will support data as first-class citizens, i.e., we will develop techniques to symbolically reduce formalisms for modelling probabilistic systems that are equipped with rich data types, allowing, e.g., probabilistic choices parameterised with data.

Our approach is based on successful symbolic transformation techniques in the traditional and timed setting, viz. linear process equations (LPEs). We will generalise and extend these techniques to probabilistic automata (PA), a model akin to Markov Decision Processes that is tailored to compositional modelling. The LPE technique is applicable to large or even infinite systems, and will be equipped with symbolic transformations such as confluence reduction, bisimulation minimisation and static analysis for PA.

MoVeS: Modeling, Verification and Control of Complex Systems

S. Chakraborty, J.-P. Katoen, F. Sher

EU FP7 project, coordinator: ETH Zurich (J. Lygeros)

In the context of the EU FP7 project "Modelling, verification and control of complex systems: From foundations to power network applications" (partners: ETH Zurich, TU Delft, University of Oldenburg, Politecnico Milano, and Honeywell), we propose novel methods for modelling, analysis and control of complex, large scale systems. Fundamental research is motivated by application problems in power networks. We adopt the framework of stochastic hybrid systems (SHS), which allows one to capture the interaction between continuous dynamics, discrete dynamics and probabilistic uncertainty. In the context of power networks, SHS arise naturally: continuous dynamics model the evolution of voltages, frequencies, etc. Discrete dynamics reflect changes in network topology, and probability represents the uncertainty about power demand and (with the advent of renewables) power supply. More generally, because of their versatility, SHS are recognised as an ideal framework for capturing the intricacies of complex, large scale systems.

Motivated by this, considerable research effort has been devoted to the development of modelling, analysis and control methods for SHS, in both computer science (giving rise to theorem proving and model checking methods) and in control engineering (giving rise to optimal control and randomised methods). Despite several success stories, however, none of the methods currently available is powerful enough to deal with real life large scale applications. We feel that a key reason for this is that the methods have been developed by different communities in relative isolation, motivated by different applications. As a consequence, synergies between them have never been fully explored.

In this project, we systematically explore such synergies. Our multi-disciplinary team, which brings together experts on all the state of the art SHS methods, will establish links between model checking, theorem proving, optimal control and randomised methods. Leveraging on their complementary strengths we will develop combined strategies and tools to enable novel applications to complex, large scale systems. Common power networks case studies will provide a testing ground for the fundamental developments, motivate them, and keep them focused.

Minimisation of Markov Models

J.-P. Katoen, A. Sharma

funded by the India4EU Programme

Markov chains are widely used for the evaluation of performance and dependability of information processing systems. Extending Markov chains with rewards results in Markov reward models which are useful for analysing the average behaviour of executions in Markov chains. Equivalence relations are used to reduce the state space of Markov chains, by combining equivalent states into a single state. The reduced state space obtained under an equivalence relation called a quotient can then be used for analysis provided it preserves a rich class of properties of interest. Various branching-time relations on Markov chains have been defined such as weak and strong variants of bisimulation equivalence and simulation pre-orders. Their compatibility with (fragments of) stochastic variants of CTL has been thoroughly investigated. Stochastic model checking tools such as PRISM and MRMC have been used to model check interesting properties on Markov chains and Markov reward models, respectively.

The goal of this project is to explore and investigate the linear-time equivalence relations and interesting properties that are preserved under these equivalences for Markov chains. During the course of this project we also plan to study and explore if these linear-time equivalences are compatible with compositional modelling of systems. Next step would involve developing quotienting algorithms and implementing tools for computing these equivalences. Finally, we plan to extend the minimisation techniques developed for Markov chains to other more expressive models, for example Markov automata, Interactive Markov chains and Markov decision processes and also to non-probabilistic systems.

Synthesising of Model Based Testing for Process Control Engineering

S. von Styp, J.-P. Katoen,

L. Yu, U. Epple (Chair of Process Control Engineering)

In Process Control Engineering, controller for plants that are not correct to their specification can cause fatal disasters, i. e. when tanks with acid run over people get injured or to high pressure leads to explosions. Therefore an intensive testing of the controller is crucial but it consumes a lot of time and money.

Model based testing is one promising technique allowing the automatic generation of test-cases from a given formal model. In Model based testing the specification is given by a transition system. A conformance relation formally defines under which circumstances an implementation is correct with respect to the specification. Based on this relation, test-cases are derived automatically and are used to for testing the real implementation. In this project,

which is a cooperation with the institute for process control engineering, we apply the methods of model based testing on the plant controller to automate and systematise the testing process in order to reduce costs and time.

In oder to apply model based testing, first the specifications of controllers, given as sequential function charts, are translated to transition systems. Hence first rules for the systematic translation had to be developed. We started testing using simple controller, i.e. a motor controller, which allow us to use the already existing theories such as ioco and sioco including the testing tool JTorX. This test-cases are still in an early stage and therefore only allow testing for a restricted set of programs. Future research shall loosen this restriction.

Data-dependent control flow in combination with real-time behaviour is an important feature of the plant controllers, i.e. the next action depends on the current filling level of a tank and it may crucial that certain actions are executed within a certain time. Therefore this project looks at extending the existing test theory to allow real-time behaviour together with data-dependent control flow. We start by giving a formal definition in form of a transition system for representing systems that allow data-dependent control flow for inputs and outputs and real-time behaviour. Afterwards a symbolic trace semantics is defined. This semantics then is employed to define the conformance relation, which describes under which conditions an implementation is correct with respect to a given specification. Future steps will include to look at the application such as on the fly testing. This then shall be implemented in the test tool JTorX and finally be used to test controllers in process control engineering.

Model Based Testing for AADL Models

S. von Styp, S. Sazonov, J.-P. Katoen

The COMPASS toolset allows model checking the specification given as an AADL model. To verify whether the actual implementation conforms to this specification model based testing is needed. So far model based testing using an AADL model for specification is not possible. Therefore a translation from AADL to transition systems with data and data-dependent control flow is developed. This transition system then is used by the test tool JTorX which finally will be integrated into the COMPASS toolset. Furthermore a theory is developed, allowing testing single components and its composition providing an method of simply adding components without regenerating the hole transition system again.

ROCKS: Rigorous Dependability Analysis using Model Checking Techniques for Stochastic Systems

S. Chakraborty, H. Fu, F. Gretz, J.-P. Katoen, A. Sharma, F. Sher

funded by the Dutch Research Council (NWO) and DFG

Today's society relies increasingly on the correct and timely functioning of a large variety of information and communication technology systems. Can this reliance be justified? Dependability analysis answers this question. Rigorous and systematic dependability analysis must then play an important role in the design of such systems. Since many dependability properties are stochastic in nature, stochastic analysis techniques are crucial in developing reliable and safe computer systems.

The ROCKS project focuses on two system classes which are gaining prominence in the world of computing but which are not amenable to classic stochastic analysis techniques. Large scale homogeneous systems, such as wireless sensor networks and gossiping protocols, provide a challenge because of the sheer size of the systems involved. Safety-critical heterogeneous systems, such as production plants and automotive control systems, on the other hand consist of a number of very different components. The challenge here is to handle the diversity of system modalities.

Within ROCKS we further study how, given a system configuration or parameter set, the optimal design can be synthesised automatically. Attention will also be given to the study of architectural description languages which are increasingly being used to describe complex systems, but for which analysis techniques are often lacking. The members of the ROCKS project cooperate in four different research areas: Modelling, analysis, synthesis and case studies. In modelling we study how complex systems can be represented concisely, accurately and hierarchically. Analysis techniques to study the properties of such models are developed as well as synthesis techniques in order to automatically generate optimal models. Finally the applicability of the newly developed models and techniques is studied in a number of industrial case studies.

Other Activities

Joost-Pieter Katoen

- Deputy Chair of the Steering Committee of ETAPS (European Joint Conferences on Theory and Practice of Software).
- Member of the Steering Committee of FORMATS (Formal Methods and Analysis of Timed Systems)
- Chair of the Steering Committee of QEST (Quantitative Evaluation of Systems), since September 2012.
- Member of the Steering Committee of TACAS (Tools and Algorithms for the Construction and Analysis of Systems).
- Member of the Editorial Board of the Journal on Software Tools for Technology Transfer (STTT), Springer Verlag.
- Member editorial board The Scientific World Journal, Hindawi Publishers.
- Board Member of the Dutch Society on Theoretical Computer Science (NVTI).
- Senior member of the Association of Computing Machinery (ACM)
- **Member of the Program Committees of the following events:**
  - 15th International Conference on Foundations of Software Science and Computation Structures (FoSSaCS 2012)
  - 17th International Workshop on Formal Methods for Industrial Critical Systems (FMICS 2012)
  - 17th International Conference on Implementation and Application of Automata (CIAA 2012)
  - 9th International Conference on Quantitative Evaluation of SysTems (QEST 2012)
  - 10th International Symposium on Automated Technology for Verification and Analysis (ATVA 2012)
  - 10th Summer School on Modelling and Verifying Parallel Processes (MOVEP 2012)
- **Invited speaker at:**
  - Workshop on the 15th Anniversary of LSV, ENS Cachan, France
  - Tutorial at Joint Conference iFM & ABZ 2012, Pisa, Italy
  - 33rd International Joint Conference Petri Nets & ACSD 2012, Hamburg, Germany
  - NATO Summer School on Engineering Dependable Software Systems, Marktoberdorf 2012
  - Tutorial at Automated Software Engineering (ASE), Essen, Germany
  - ROCKS Autumn School, Vahrn, Italy
- Member of the IFIP Working Group 1.8 on Concurrency Theory.
- Member of the IFIP Working Group 2.2 on Programming Concepts.
- Member of several external international PhD committees.
- Member Selection Committee of Professorship at Free University of Brussels, Belgium.

- Member Selection Commitee of Associate Professor DTU Lyngby, Denmark.
- Chairman of Selection Committee of Full Professorship on Logics and Automata Theory.
- Chairman of the Examination Board of Department of Computer Science (until April 2012).
- Head of Computer Science Department (since April 2012).

Thomas Noll

- Student advisor for the following applied subjects within CS:
  Electrical Engineering, Civil Engineering, and Medicine
- Member of the examination board for Computer Science
- Member of CS Commission for Teaching Service
- **Member of the Program Committees of the following events:**
  - Software Engineering Track at the 28th Annual ACM Symposium on Applied Computing (SAC 2013)
  - 3rd Analytic Virtual Integration of Cyber-Physical Systems Workshop (AVICPS 2012) at the 33rd IEEE Real-Time Systems Symposium (RTSS 2012)
  - 1st International Workshop on Formal Techniques for Safety-Critical Systems (FTSCS 2012) at the 14th International Conference on Formal Engineering Methods (ICFEM 2012)
  - 6th International Conference on Software Security and Reliability (SERE 2012)

Talks and Publications

Talks

Marco Bozzano, and Joost-Pieter Katoen. Safety, Dependability and Performance Analysis of Extended AADL Models. Tutorial at 9th Int. Conf. on Integrated Formal Methods (iFM), 2012.

Marco Bozzano, Joost-Pieter Katoen, and Thomas Noll. Safety, Dependability and Performance Analysis of Extended AADL Models. Tutorial at 27th IEEE/ACM Int. Conf. on Automated Software Engineering (ASE), 2012.

Pierre Dissaux, Viet Yen Nguyen, and Thomas Noll. Tutorial on COMPASS Toolset. AADL Standards Meeting at SAE AeroTech Congress & Exhibition, Toulouse, France, 2011.

Hongfei Fu. Computing Game Metrics on Markov Decision Processes. Talk, ICALP, Birmingham, 2012.

Hongfei Fu. Computing Game Metrics on Markov Decision Processes. Talk, Oxford University, Oxford, 2012.

Friedrich Gretz. Prinsys - A Software Tool for the Synthesis of Probabilistic Invariants. Talk, WING workshop, Manchester, 2012.

Friedrich Gretz. PRINSYS – Probabilistic INvariant SYnthesiS . Talk, GRK Workshop, Dagstuhl, 2012. Gemeinsamer Workshop der DFG Informatik-Graduiertenkollegs.

Friedrich Gretz. Towards Analysis of Sequential Probabilistic Programs. Talk, Oxford, 2012.

Friedrich Gretz. Average Runtime Estimation. Talk, CARP, Cambridge, 2012. CARP Project Meeting at ARM .

Friedrich Gretz. Operational versus Weakest Precondition Semantics for the Probabilistic Guarded Command Language. Talk, QEST, London, 2012.

Jonathan Heinen. Analysis and Verification of Heap-Manipulating Programs. Talk at D-CON, Kaiserslautern, 2012.

Jonathan Heinen. Juggrnaut: The Analysis of Object Oriented Programs. Talk at mac, Uni Bamberg, 2012.

Christina Jansen. Verifying Pointer Programs Using Hyperedge Replacement Grammars. Talk, ULB Bruxelles, 2012. Invited Presentation.

Joost-Pieter Katoen. Towards Trustworthy Aerospace Design Using Formal Methods: An Experience Report. Talk at PUMA Graduiertenkolleg, TU Munich,, 2012.

Joost-Pieter Katoen. Analyzing Probabilistic Programs: Pushing the Limits of Automation. Invited Talk at Workshop on 15 Years of LSV, ENS Cachan, 2012.

Joost-Pieter Katoen. One Can Do Much More With Model Checking Than You Think! . Invited Talk at Opening of the FUNDP Research Centre Fundamentals of Computer Science (FOCUS). Namur, Belgium, 2012.

Joost-Pieter Katoen. Towards Trustworthy Aerospace Design Using Formal Methods: An Experience Report. Talk at Embedded Systems Institute, Eindhoven, NL, 2012.

Joost-Pieter Katoen. Revisiting GSPNs: New Semantics and Analysis Algorithms. nvited Talk at 33rd International Conference on Application and Theory of Petri Nets and

Concurrency (ICATPN) and 12th International Conference on Application of Concurrency to System Design (ACSD), Hamburg, Germany, 2012.

Joost-Pieter Katoen. Performance Analysis by Model Checking. Five Lectures at NATO Summer School on Engineering Dependable Software Systems. Marktoberdorf, Germany, 2012.

Joost-Pieter Katoen. Revisiting GSPNs: New Semantics and Analysis Algorithms. Talk at IFIP WG 2.2 Meeting, CWI Amsterdam, NL, 2012.

Joost-Pieter Katoen. Revisiting GSPNs: New Semantics and Analysis Algorithms. Kolloquium at IMT Lucca, Italy, 2012.

Joost-Pieter Katoen. Towards Trustworthy Aerospace Design Using Formal Methods: An Experience Report. Invited lecture at ROCKS Autumn School, Vahrn, Italy, 2012.

Viet Yen Nguyen. COMPASS Graphical Modeller. Talk at ESTEC Final Presentation Days, 2012.

Viet Yen Nguyen. Formal Correctness, Safety, Dependability and Performance of a Satellite. Talk at ICSE 2012, 2012.

Viet Yen Nguyen. Satellite Platform Case Study With SLIM and COMPASS. Talk, Dagstuhl Seminar on Architecture-Driven Semantic Analysis of Embedded Systems, 2012.

Thomas Noll. Correctness, Safety and Fault Tolerance in Aerospace Systems: The ESA COMPASS Project. Talk, RWTH Aachen University, 2012. CS Colloquium.

Thomas Noll. Correctness, Safety and Fault Tolerance in Aerospace Systems: The ESA COMPASS Project. Talk, Dagstuhl Seminar on Architecture-Driven Semantic Analysis of Embedded Systems, 2012.

Arpit Sharma. Weighted Probabilistic Equivalence Preserves ω -Regular Properties. MMB/DFT Conference, Kaiserslautern, Germany, 2012.

Falak Sher. Compositional Abstraction Techniques for Probabilistic Automata. Talk, TCS, Amsterdam, 2012.

Publications

Christel Baier, E. Moritz Hahn, Boudewijn R. Haverkort, Holger Hermanns, and Joost-Pieter Katoen. Model Checking for Performability. Mathematical Structures in Computer Science. pages 1–42. 2013.

Kamal Barakat, and Thomas Noll. A Native Approach to Modeling Timed Behavior in the Pi-Calculus (short paper). In Proc. of 6th IEEE Int. Symp. on Theoretical Aspects of Software Engineering (TASE). pages 253–256. IEEE, 2012.

Marco Bozzano, Alessandro Cimatti, Joost-Pieter Katoen, Viet Yen Nguyen, Thomas Noll, and Marco Roveri. Safety, Dependability, and Performance Analysis of Extended AADL Models. The Computer Journal, 54(5):754–775, 2011.

Alessandro D'Innocenzo, Alessandro Abate, and Joost-Pieter Katoen. Robust PCTL Model Checking. In Hybrid Systems: Computation and Control (HSCC). pages 275–286. ACM Press, 2012.

Marie-Aude Esteve, Joost-Pieter Katoen, Viet Yen Nguyen, Bart Postma, and Yuri Yushtein. Formal Correctness, Safety, Dependability and Performance Analysis of a Satellite. In 34th

International Conference on Software Engineering (ICSE). pages 1022–1031. ACM and IEEE CS Press, 2012.

Hongfei Fu. Computing Game Metrics on Markov Decision Processes. In 39th International Colloquium on Automata, Languages and Programming (ICALP). pages 227–238. Volume 7392 of LNCS. Springer-Verlag, 2012.

Hongfei Fu, and Joost-Pieter Katoen. Deciding Probabilistic Simulation between Probabilistic Pushdown Automata and Finite-State Systems. In Foundations of Software Technology and Theoretical Computer Science (FSTTCS). LIPIcs. Schloss Dagstuhl, 2011.

Friedrich Gretz, Joost-Pieter Katoen, and Annabelle McIver. Operational versus Weakest Precondition Semantics for the Probabilistic Guarded Command Language. In Quantitative Evaluation of Systems (QEST). IEEE CS Press, 2012.

Dennis Guck, Tingting Han, Joost-Pieter Katoen, and Martin R. Neuhäußer. Quantitative Timed Analysis of Interactive Markov Chains. In NASA Formal Methods Symposium (NFM). pages 8–23. Volume 7226 of LNCS. Springer-Verlag, 2012.

Jonathan Heinen, Christina Jansen, and Henrik Barthels. Juggrnaut - An Abstract JVM. In 2nd Int. Conf. on Formal Verification of Object-Oriented Software (FoVeOOS). Volume 7421 of LNCS. Springer-Verlag, 2012.

Frédéric Herbreteau, B Srivathsan, and Igor Walukiewicz. Efficient emptiness check for timed Büchi automata. Formal Methods in System Design, 40(2):122–146, 2012.

Frédéric Herbreteau, B Srivathsan, and Igor Walukiewicz. Better abstractions for timed automata. In LICS. pages 375 –384. IEEE, 2012.

Nils Jansen, Erika Abraham, Matthias Volk, Ralf Wimmer, Joost-Pieter Katoen, and Bernd Becker. The COMICS Tool - Computing Minimal Counterexamples for DTMCs. In Proc. of the 10th Int. Symp. on Automated Technology for Verification and Analysis (ATVA). pages 349–353. Volume 7561 of LNCS. Springer-Verlag, 2012.

Joost-Pieter Katoen, Jaco van de Pol, Marielle Stoelinga, and Mark Timmer. A linear process-algebraic format with data for probabilistic automata. Theoretical Computer Science, 413:36–57, 2012.

Joost-Pieter Katoen, Daniel Klink, Martin Leucker, and Verena Wolf. Three-Valued Abstraction for Probabilistic Systems. Journal on Logic and Algebraic Programming, 81(4):356–389, 2012.

Joost-Pieter Katoen. Model Checking: One Can Do Much More Than You Think!. In Fundamentals of Software Engineering (FSEN). pages 1–14. Volume 7141 of LNCS. Springer-Verlag, 2012.

Joost-Pieter Katoen. GSPNs Revisited: Simple Semantics and New Analysis Algorithms. In Applications of Concurrency to System Design (ACSD). pages 6–12. IEEE CS Press, 2012.

Etienne Lozes, Florent Jacquemard, Jules Villard, and Ralf Treinen. Multiple Congruence Relations, First-Order Theories on Terms, and the Frames of the Applied Pi-Calculus. In Theory of Security and Applications (TOSCA 2011). pages 166–185. Volume 6993 of LNCS. Springer-Verlag, 2012.

Thomas Noll. Correctness, Safety and Fault Tolerance in Aerospace Systems: The ESA COMPASS Project (Abstract). In Architecture-Driven Semantic Analysis of Embedded Systems (Dagstuhl Seminar 12272). pages 42–42. Volume 2 of Dagstuhl Reports. Schloss Dagstuhl–Leibniz-Zentrum für Informatik, 2012.

Arpit Sharma, and Joost-Pieter Katoen. Weighted Lumpability on Markov Chains. In 8th Ershov Informatics Conference (PSI) . pages 322–339. Volume 7162 of LNCS. Springer-Verlag, 2012.

Arpit Sharma. Weighted Probabilistic Equivalence Preserves ω-Regular Properties. In 16th Measurement, Modeling, and Evaluation of Computing Systems and Dependability and Fault Tolerance Conference (MMB/DFT). pages 121–135. Volume 7201 of LNCS. Springer Verlag, 2012.

Falak Sher, and Joost-Pieter Katoen. Compositional Abstraction Techniques for Probabilistic Automata. In IFIP Conference on Theoretical Computer Science (TCS). pages 325–341. Volume 7604 of LNCS. Springer-Verlag, 2012.

B Srivathsan, and Igor Walukiewicz. An alternate proof of Statman's finite completeness theorem. Information Processing Letters, 112(14-15):612–616, 2012.

Mani Swaminathan, Joost-Pieter Katoen, and Ernst-Rüdiger Olderog. Layered Reasoning for Randomized Distributed Algorithms. Formal Aspects of Computing, 24(4–6):477–496, 2012.

Bart Theelen, Joost-Pieter Katoen, and Hao Wu. Model Checking of Scenario-Aware Dataflow with CADP. In Design, Automation, and Test in Europe (DATE). pages 653–658. IEEE CS Press, 2012.

Mark Timmer, Joost-Pieter Katoen, Jaco van de Pol, and Marielle Stoelinga. Efficient Modelling and Generation of Markov Automata. In Concurrency Theory (CONCUR). pages 364–379. Volume 7454 of LNCS. Springer-Verlag, 2012.

Ralf Wimmer, Nils Jansen, Erika Abraham, Joost-Pieter Katoen, and Bernd Becker. Minimal Critical Subsystems as Counterexamples for ω-Regular DTMC Properties. In Methoden und Beschreibungssprachen zur Modellierung und Verifikation von Schaltungen und Systemen (MBMV). pages 169–180. Verlag Dr. Kovac, 2012.

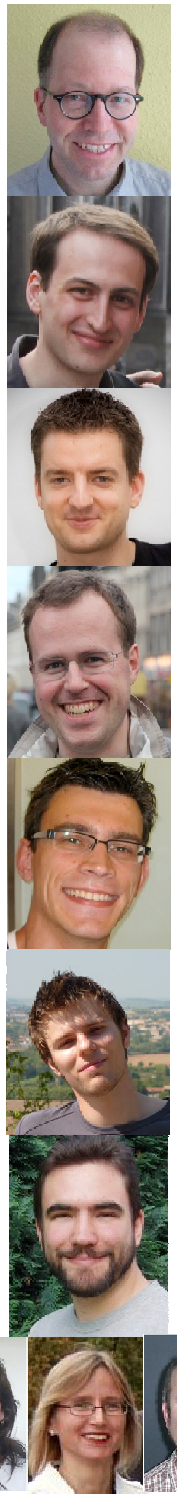
Ralf Wimmer, Nils Jansen, Erika Abraham, Bernd Becker, and Joost-Pieter Katoen. Minimal Critical Subsystems for Discrete-Time Markov Models. In Tools and Algorithms for the Construction and Analysis of Systems (TACAS). pages 299–314. Volume 7214 of LNCS . Springer-Verlag, 2012.

Technical Reports

Ralf Wimmer, Nils Jansen, Erika Abraham, Joost-Pieter Katoen, and Bernd Becker. Minimal Counterexamples for Refuting ω-Regular Properties of Markov Decision Processes. Technical Report 88, Reports of SFB/TR 14 AVACS, 2012. ISSN: 1860-9821.

Programming Languages and Verification

Staff



- **Faculty**
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  http://verify.rwth-aachen.de/

- **Secretary**
  Elke Ohlenforst, Birgit Willms

- **Research Assistants**
  Dipl.-Inform. Marc Brockschmidt
  Dipl.-Inform. Fabian Emmes
  Dipl.-Inform. Carsten Fuhs *(funded by GIF, until December 2011)*
  Dipl.-Inform. Carsten Otto *(funded by DFG)*
  Dipl.-Inform. Martin Plücker
  Dipl.-Inform. Thomas Ströder *(funded by DFG)*

- **Student Assistants**
  Tim Enger
  Florian Frohn
  Albert Helligrath
  Jera Hensel
  Matthias Hoelzel
  Patrick Kabasci
  Marcel Klinzing
  Christian Kuknat
  Richard Musiol
  Janine Repke

- **Technical Staff**
  Arnd Gehrmann

Overview

Our research group is concerned with several topics from the area of *programming languages and verification*. In particular, we are interested in the application of formal methods in order to increase the reliability of programs:

To guarantee the correctness of software, testing is not sufficient, but a formal verification is required. Program verification is a highly relevant aspect of software technology and correctness issues are especially important for safety-critical and distributed applications. However, in general correctness proofs are very expensive and time-consuming. Therefore, program verification should be automated as much as possible.

Thus, a main topic of our research is the development of methods for mechanized analysis and verification of algorithms and systems. For that purpose, we use approaches from areas like term rewriting, automata theory, mathematical logic, computer algebra, and artificial intelligence in order to facilitate the task of correct software development.

A central problem in the design of reliable software is the proof of termination. We have developed the "dependency pair" method, which extends the applicability of classical techniques for automated termination analysis significantly.

Moreover, we work on methods and systems for proving partial correctness of programs. These techniques check if a program meets its specification provided that it terminates. In particular, we are interested in applying such techniques for several types of programming languages and paradigms.

Other important topics of our research are concerned with SAT solving, evaluation strategies, modularity aspects of programs, and formal specification languages.

In the winter term 2011/12, we held the first-year course on *Programming Concepts* for more than 500 students, a seminar on *Automated Termination Analysis*, and a seminar on *Satisfiability Checking* (together with the group of Prof. Dr. E. Ábrahám). In the summer term 2012, we held the lecture on *Functional Programming*, a proseminar on *Advanced Programming Concepts in Java, Haskell, and Prolog*, and again a seminar on *Satisfiability Checking* (with the group of Prof. Dr. E. Ábrahám).

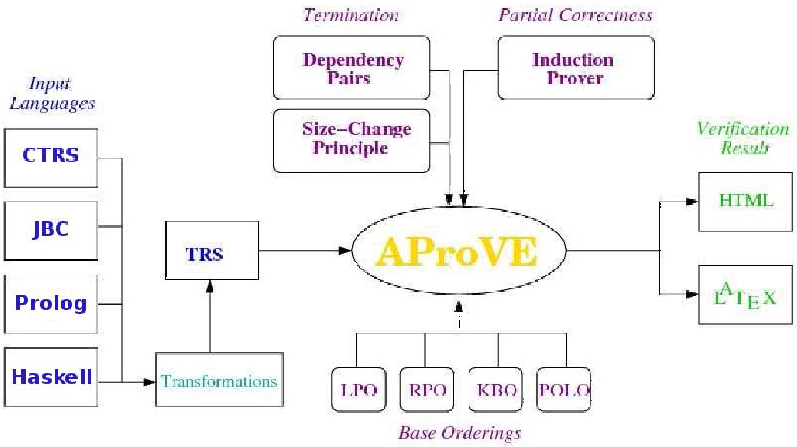
In January 2012, Carsten Fuhs left our research group and took up a postdoc position in the group of Prof. Dr. Byron Cook at Queen Mary University resp. University College London, UK. He defended his PhD thesis on December 21, 2011.

Research Projects

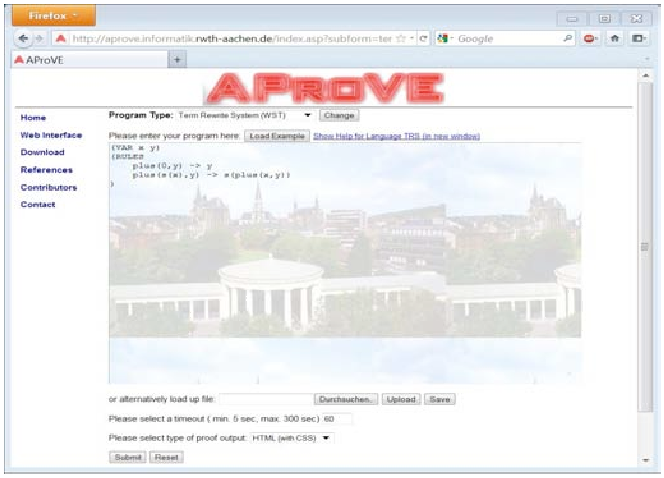
AProVE: Automated Program Verification Environment

J. Giesl, M. Brockschmidt, F. Emmes, C. Fuhs, C. Otto, M. Plücker, T. Ströder

We are developing a verification environment which allows a fast and easy implementation of new approaches and techniques for program verification. In this way, their practical applicability can be evaluated and experiments can be performed to develop heuristics which increase their degree of automation. The system is designed in a modular way such that the implemented tools can be extended and modified easily.



Our verification framework is also applicable for teaching purposes in courses on formal methods, term rewriting, or program verification. The tool is written in Java and verification can be performed fully automatically.



In particular, we design and implement a powerful automated termination prover within our system AProVE. Experiments on large benchmarks and AProVE's success at the annual *International Competition of Termination Tools* show that our system is currently among the most powerful termination provers available. The system can be obtained from

http://aprove.informatik.rwth-aachen.de/

Termination and Complexity Analysis for Logic Programs

J. Giesl, T. Ströder, F. Emmes, P. Schneider-Kamp, C. Fuhs

In this project we cooperate with the University of Southern Denmark and the University College London, funded by the DFG. Techniques for automated termination analysis have mainly been developed for term rewriting and for definite logic programming. Our goal is to adapt these techniques such that they can be used for "real" logic languages. This includes the handling of "non-logical" features such as *cuts* in Prolog. To this end, we work on new approaches to transform logic programs into term rewrite systems such that termination of the resulting term rewrite system implies termination of the original program. Then all existing techniques and systems for termination analysis of term rewriting can also be used to verify termination of Prolog programs. Our goal is to develop this approach into a general methodology for analyzing logic programs. For example, we have shown how to use this technique to also analyze properties like complexity and determinacy in addition to termination.

Termination Analysis for Imperative Programs

J. Giesl, M. Brockschmidt, C. Otto, T. Ströder, M. Plücker

The goal of this project (funded by the DFG) is to use a similar approach as for logic languages also for the termination analysis of imperative languages like Java or C. In our approach, imperative programs are first transformed into so-called termination graphs by symbolic evaluation. These graphs take care of all aspects of the language that cannot easily be expressed by term rewriting (e.g., side effects due to aliasing, pointers, object-orientation, etc.). Afterwards, one generates term rewrite systems from the termination graphs whose termination can be analyzed by existing techniques and tools. To handle pre-defined data structures like integers, here we regard a special variant called *integer term rewriting,* where integers and their operations are pre-defined. Moreover, we investigate how to use termination graphs for other program analyses besides termination analysis. To handle languages like C, we also work on an extension of our approach to deal with operations for direct heap manipulation and pointer arithmetic.

Satisfiability Checking for Termination Analysis and Program Synthesis

J. Giesl, M. Brockschmidt, C. Fuhs, B. Cook, M. Codish, A. Ben-Amram, P. Schneider-Kamp, R. Thiemann

This project is partially funded by the GIF and is a collaboration with the Ben-Gurion University (Israel), the University College London, the University of Innsbruck, and the University of Southern Denmark. Here, we work on new efficient algorithms to tackle the search problems arising in automated termination proofs. In particular, our goal is to encode them as SAT problems in a suitable way and to investigate the use of SAT solvers in automated termination analysis. This also includes the coupling of different approaches to generate ranking functions or well-founded orders for termination proofs.

Certified Termination Proofs

J. Giesl, C. Fuhs, A. Krauss, R. Thiemann, C. Sternagel

Complex systems like automated termination provers typically contain bugs. To increase the reliability of automatically generated proofs, it is desirable to certify them by a well-known theorem prover. In this project with the TU Munich and the University of Innsbruck, we try to couple existing termination provers like AProVE with the popular theorem prover Isabelle such that termination of Isabelle functions can be proved by AProVE and the obtained proof is automatically certified by Isabelle afterwards.

Automated Complexity Analysis

J. Giesl, F. Emmes, T. Ströder, L. Noschinski

Together with the TU Munich, our aim is to adapt the successful techniques developed for automated termination analysis in order to analyze the complexity of term rewrite systems automatically. This is a promising approach, since usually the termination proof allows us to draw conclusions on the maximal runtime of a program. While we start with developing suitable analysis techniques for term rewrite systems, our aim is to extend automated complexity analysis to several different programming languages afterwards.

Other Activities

J. Giesl:

- Joint Invited Speaker of the *14th International Symposium on Principles and Practice of Declarative Programming (PPDP '12)* and the *22nd International Symposium on Logic-Based Program Synthesis and Transformation (LOPSTR '12)*, Leuven, Belgium, September 2012
- Invited Speaker of the *Summer School 2012 on Verification Technology, Systems & Applications (VTSA '12)*, Saarbrücken, Germany, September 2012
- Chair of the *IFIP Working Group 1.6* on *Term Rewriting*
- PC-Member and participant of the *6th International Joint Conference on Automated Reasoning (IJCAR '12)*, Manchester, UK, June/July 2012
- Member of the Steering Committee of the *Federated Logic Conference (FLoC)*
- Member of the Steering Committee of the *ACM/IEEE Symposium on Logic in Computer Science (LICS)*
- Member of the Steering Committee of the *International School on Rewriting (ISR)*
- Member of the Steering Committee of the *Annual Termination Competition*
- Participant of the *AlgoSyn Meeting*, Rolduc, The Netherlands, November 2011
- Participant of the *TeReSe* Workshops in Utrecht (December 2011) and Aachen (March 2012)
- Participant of the *12th International Workshop on Termination*, Obergurgl, Austria, February 2012
- Participant of the *24th International Conference on Computer Aided Verification (CAV '12)*, Berkeley, CA, USA, July 2012
- Member of the Committee for the PhD thesis of Matthias Raffelsieper (Technical University Eindhoven, The Netherlands), 2011
- Reviewer for the PhD thesis of Andreas Schnabl (University of Innsbruck, Austria), 2012
- Project reviewer for the DFG (several projects)
- Reviewer for many international journals and conferences

M. Brockschmidt:

- Research visit and participant of the *Deduktionstreffen der GI-Fachgruppe Deduktionssysteme*, KIT, Karlsruhe, Germany, October 2012
- Participant of the *TeReSe* Workshops in Utrecht (December 2011) and Aachen (March 2012)
- Participant of the *12th International Workshop on Termination*, Obergurgl, Austria, February 2012
- Participant of the *24th International Conference on Computer Aided Verification (CAV '12)*, Berkeley, CA, USA, July 2012
- Research visit to the University College London, September 2012
- Reviewer for several international journals and conferences

F. Emmes:

- Participant of the *Deduktionstreffen der GI-Fachgruppe Deduktionssysteme*, KIT, Karlsruhe, Germany, October 2012
- Participant of the *TeReSe* Workshops in Utrecht (December 2011) and Aachen (March 2012)
- Participant of the *12th International Workshop on Termination*, Obergurgl, Austria, February 2012
- Participant of the *6th International Joint Conference on Automated Reasoning (IJCAR '12)*, Manchester, UK, June/July 2012
- Participant of the *Summer School 2012 on Verification Technology, Systems & Applications (VTSA '12)*, Saarbrücken, Germany, September 2012
- Reviewer for several international journals and conferences

C. Fuhs:

- Editor of the *Department Of Computer Science Technical Reports* of RWTH Aachen (until December 2011)
- Participant of the *TeReSe* Workshop in Utrecht (December 2011)
- Reviewer for several international journals and conferences

C. Otto:

- Participant of the *TeReSe* Workshops in Utrecht (December 2011) and Aachen (March 2012)
- Participant of the Workshop *Entwicklung und Evolution von Forschungssoftware (EEFSW)*, Rolduc, The Netherlands, November 2011
- Reviewer for several international journals and conferences

M. Plücker:

- Participant of the *TeReSe* Workshops in Utrecht (December 2011) and Aachen (March 2012)

T. Ströder:

- Editor of the *Department Of Computer Science Technical Reports* of RWTH Aachen (since January 2012)
- *Friedrich-Wilhelm Award* for excellent diploma thesis, November 2011
- Organizer and participant of the *TeReSe* Workshop in Aachen, March 2012
- *Chair* of the *AlgoSyn Scholarship Holders and Collegiates Steering Committee*, October 2011-September 2012
- Participant of the Workshop *Entwicklung und Evolution von Forschungssoftware (EEFSW)*, Rolduc, The Netherlands, November 2011
- Participant of the *AlgoSyn Meeting*, Rolduc, The Netherlands, November 2011
- Participant of the *TeReSe* Workshop in Utrecht (December 2011)
- Research visit to the University of Southern Denmark, Odense, January 2012
- Member of the Organization Team of the *Girls' Day*, RWTH Aachen, April 2012

- Participant of the *Joint Workshop of the German Research Training Groups in Computer Science*, Dagstuhl, Germany, June 2012
- Research visit to the University College London, September 2012
- Reviewer for several international journals and conferences

Talks and Publications

Talks

- J. Giesl: *Detecting Non-Looping Non-Termination, 12th International Workshop on Termination*, Obergurgl, Austria, February 2012
- J. Giesl: *Detecting Non-Looping Non-Termination, TeReSe* Workshop, Aachen, Germany, March 2012
- J. Giesl: *Programmiersprachen und Verifikation*, Ringvorlesung für Oberstufenschülerinnen und –schüler, RWTH Aachen, June 2012
- J. Giesl: *Detecting Non-Looping Non-Termination, 6th International Joint Conference on Automated Reasoning (IJCAR '12)*, Manchester, UK, June 2012
- J. Giesl: *Automated Termination Analysis, Summer School 2012 on Verification Technology, Systems & Applications (VTSA '12)*, Saarbrücken, Germany, September 2012
- J. Giesl: *Symbolic Evaluation Graphs and Term Rewriting - A General Methodology for Analyzing Logic Programs*, *14th International Symposium on Principles and Practice of Declarative Programming (PPDP '12)* and *22nd International Symposium on Logic-Based Program Synthesis and Transformation (LOPSTR '12)*, Leuven, Belgium, September 2012
- M. Brockschmidt: *Automated Detection of Non-Termination and NullPointerExceptions for Java Bytecode*, KIT, Karlsruhe, October 2011
- M. Brockschmidt: *Termination Graphs for Java Bytecode*, *Deduktionstreffen der GI-Fachgruppe Deduktionssysteme*, KIT, Karlsruhe, Germany, October 2011
- M. Brockschmidt: *Statische Analyse von Java-Programmen*, RWTH Aachen, Tag der Informatik, December 2011
- M. Brockschmidt: *Proving Termination of Java Bytecode with Cyclic Data*, *12th International Workshop on Termination*, Obergurgl, Austria, February 2012
- M. Brockschmidt: *Proving Non-Termination of Java Bytecode*, *12th International Workshop on Termination*, Obergurgl, Austria, February 2012
- M. Brockschmidt: *Automated Termination Proofs for Java Programs with Cyclic Data*, *24th International Conference on Computer Aided Verification (CAV '12)*, Berkeley, CA, USA, July 2012
- M. Brockschmidt: *Reducing the Ugly to the Bad,* University College London, September 2012
- F. Emmes: *A Dependency Pair Framework for Innermost Complexity Analysis of Term Rewrite Systems*, *Deduktionstreffen der GI-Fachgruppe Deduktionssysteme*, KIT, Karlsruhe, Germany, October 2011
- F. Emmes: *Automatically Analyzing Runtime Complexity via Term Rewriting*, *AlgoSyn Seminar*, RWTH Aachen, October 2011
- F. Emmes: *Automated Runtime Complexity Analysis for Prolog by Term Rewriting*, *12th International Workshop on Termination*, Obergurgl, Austria, February 2012
- C. Fuhs: *Harnessing First Order Termination Provers Using Higher Order Dependency Pairs*, *TeReSe* Workshop, Utrecht, The Netherlands, December 2011
- C. Fuhs: *SAT Encodings: From Constraint-Based Termination Analysis to Circuit*

Synthesis, PhD Talk, RWTH Aachen, December 2011

- T. Ströder: *Benchmarking in Computer Science: Requirements and Problems*, *AlgoSyn Meeting*, Rolduc, The Netherlands, November 2011
- T. Ströder: *Synthesis of Term Rewrite Systems for Automated Runtime Complexity Analysis of Prolog Programs*, *AlgoSyn Seminar*, RWTH Aachen, April 2012
- T. Ströder: *Graph-Based Methods for Analysis and Synthesis of Programs*, *AlgoSyn Seminar*, RWTH Aachen, June 2012
- T. Ströder: *Graph-Based Methods for Analysis and Synthesis of Programs*, *Proceedings of the Joint Workshop of the German Research Training Groups in Computer Science*, Dagstuhl, Germany, June 2012
- T. Ströder: *Graphbasierte Terminierungsanalyse*, *Schüleruniversität*, RWTH Aachen, August 2012
- T. Ströder: *Programmiersprachen - Überblick und Konzepte*, *Schüleruniversität*, RWTH Aachen, August 2012
- T. Ströder: *Automated Termination Analysis of Imperative Programs with Pointer Arithmetic and Heap Manipulations*, University College London, September 2012
- S. Falke: *Termination Analysis of Imperative Programs Using Bitvector Arithmetic*, Lehrstuhlseminar, RWTH Aachen, April 2012
- S. Falke: *A Theory of Arrays with Set and Copy Operations*, Lehrstuhlseminar, RWTH Aachen, September 2012
- J. Repke: *Automatische Terminierungsanalyse von LLVM Programmen*, Lehrstuhlseminar, RWTH Aachen, December 2011.
- P. Kabasci: *Automated Program Verification Using SAT- and SMT-Encodings of Diophantine Constraints*, Lehrstuhlseminar, RWTH Aachen, February 2012.
- R. Musiol: *Automated Termination Analysis for Java Programs on Cyclic Data*, Lehrstuhlseminar, RWTH Aachen, March 2012
- M. Klinzing: *Automated Complexity Analysis for Integer Term Rewrite Systems*, Lehrstuhlseminar, RWTH Aachen, April 2012
- M. Hoelzel: *SMT-based Termination Analysis of Integer Rewrite Systems*, Lehrstuhlseminar, RWTH Aachen, August 2012

Publications

- J. Giesl, T. Ströder, P. Schneider-Kamp, F. Emmes, and C. Fuhs. Symbolic Evaluation Graphs and Term Rewriting - A General Methodology for Analyzing Logic Programs. In *Proceedings of the 14th International Symposium on Principles and Practice of Declarative Programming (PPDP '12)*, Leuven, Belgium, pages 1-12, ACM Press, 2012.
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- T. Ströder. Graph-based Methods for Analysis and Synthesis of Programs. In *Proceedings of the Joint Workshop of the German Research Training Groups in Computer Science*, Dagstuhl, Germany, 2012.
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- M. Brockschmidt, R. Musiol, C. Otto, and J. Giesl. Automated Termination Proofs for Java Programs with Cyclic Data. Technical Report AIB-2012-06, RWTH Aachen, Germany, 2012.
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- J. Repke. Automatische Terminierungsanalyse von LLVM Programmen, Diploma Thesis, LuFG Informatik 2, RWTH Aachen, November 2011.
- P. Kabasci. Automated Program Verification Using SAT- and SMT-Encodings of Diophantine Constraints, Diploma Thesis, LuFG Informatik 2, RWTH Aachen, January 2012.
- R. Musiol: Automated Termination Analysis for Java Programs on Cyclic Data, Bachelor Thesis, LuFG Informatik 2, RWTH Aachen, March 2012.
- M. Klinzing. Automated Complexity Analysis for Integer Term Rewrite Systems, Bachelor Thesis, LuFG Informatik 2, RWTH Aachen, April 2012.
- Matthias Hoelzel, SMT-based Termination Analysis of Integer Rewrite Systems, Bachelor Thesis, LuFG Informatik 2, RWTH Aachen, July 2012.

Theory of Hybrid Systems

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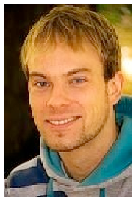

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  Daniela Lepri (University of Oslo, N)
  Anne Remke Ph.D. (University of Twente, NL)
  Dipl.-Inform. Karsten Scheibler (Albert-Ludwigs-University Freiburg, D)
  Dr. Tobias Schubert (Albert-Ludwigs-University Freiburg, D)
  Dr. Johann Schuster (University of the Federal Armed Forces Munich, D)
  Dr. Olga Tveretina (Karlsruhe University, D)
  Dr. Ralf Wimmer (Albert-Ludwigs-University Freiburg, D)

Overview

Our junior research group "Theory of Hybrid Systems", led by Erika Ábrahám, was set up 2008 in the context of the Excellence Initiative as part of the Software Modeling and Verification chair (Informatik 2).

Our main *research* interests cover

- the modeling, synthesis and analysis of hybrid systems,
- the analysis of probabilistic systems, and
- decision procedures for real algebra, especially Sat-Modulo-Theories (SMT) solving, and their application in the above two areas.

These research areas are currently supported by four third-party-funded projects: In the AlgoSyn Research Training Group (DFG) and the OASys project (DFG) we focus on hybrid-systems-related topics, joining knowledge and effort from the Engineering Sciences and from Computer Science. Our work in the projects CEBug (DFG) and ROCKS (DFG/NWO) could successfully improve state-of-the-art techniques for the generation of counterexamples for probabilistic systems.

Whereas in the last years we concentrated on developing the theoretical foundations for different projects, we are happy that in 2012 we could make several implementations publicly available. We made a big step in improving the state-of-the-art in satisfiability checking by releasing the GiNaCRA C++ library for real-algebraic computations and the SMT-RAT tool box for the support of the development of SMT-solvers for real arithmetic. Our HyTMAn tool offers the reachability analysis of hybrid systems, using Taylor models to over-approximate state sets. Finally, our COMICS tool can be used to specify, visualize and analyze probabilistic systems and to compute and to visualize counterexamples for violated properties.

Besides research, we attach great importance to *teaching*. The evaluation of our courses by the students (average mark 1.7) shows that they enjoy our lectures and find them helpful for their education. In the tradition of the last years, we have also organized different events (Schüleruniversität Informatik, RWTH MINT Camp, Ringvorlesung "Was ist Informatik?", Aachener Informatiktage) for high-school students to inform them about the contents of computer science and its study at RWTH Aachen University.

Besides research and teaching, we took active part in the life of our Department and of our university. We participated in the exciting process of preparing and presenting the successfull RWTH proposal for the second round of the Excellence Initiative. Furthermore, Erika Ábrahám was elected this year to deputy equal opportunity commissioner of the RWTH Aachen University, and Johanna Nellen and Nils Jansen to a steering committee member of the AlgoSyn Reseach Training Group. Johanna Nellen and Nils Jansen also support as mentors the TANDEMkids and TANDEMschool mentoring programs.

Erika Ábrahám.

Research Projects

Counterexample Generation for Probabilistic Systems

E. Ábrahám, N. Jansen, J.-P. Katoen,
B. Becker, and R. Wimmer (Albert-Ludwigs-University Freiburg, D)

For the correction of erroneous systems it is crucial to provide detailed information about errors in the form of so-called counterexamples. Such counterexamples are system runs which lead to erroneous behavior and may - in the case of probabilistic systems - consist of large or even infinite sets of paths through the system. Although there already exist efficient algorithms and tools for the analysis of probabilistic systems, there is still no tool available for the generation of counterexamples. We develop new methods and tools that both apply model checking and compute counterexamples. To handle the state explosion problem, we provide abstract representations of counterexamples which are computed in a hierarchical manner.

Our work is embedded into the DFG project CEBug (Counterexample Generation for Stochastic Systems using Bounded Model Checking), the NWO-DFG bilateral cooperation program ROCKS (Rigorous Dependability Analysis using Model Checking Techniques for Stochastic Systems) and the DFG Research Training Group AlgoSyn (Algorithmic Synthesis of Reactive and Discrete-Continuous Systems).

Modular Synthesis and Analysis in Process Control Engineering

E. Ábrahám, J. Nellen, U. Epple (ACPLT), and D. Kampert (ACPLT)

Sequential function charts (SFCs) are a popular formalism to specify programmable logic controllers. In this research project we want to develop a verification tool for the analysis and synthesis of SFCs. However, in the absence of the controlled system, SFC verification can only consider the controller's behavior, but cannot tell anything about the controlled system.

Our method will be able to check properties concerning the plant system as well, so that we integrate the dynamic behavior of the plant in our verification method.

We extend the SFC model with additional information about the dynamic behavior of the plant and automatically transform the resulting HSFCs to hybrid automata. For the analysis, we use the SpaceEx tool that computes an over-approximation of the reachable states. Therefore we adapted our theoretical work to be compatible with the SpaceEx tool. As a result of the analysis, SpaceEx either returns that the model is safe or returns a counterexample that we can use for abstraction refinement.

We plan to integrate other verification tools for hybrid automata into our implementation for a comparison and to extend our verification method to the synthesis of SFCs. When the plant is

extended by some components we want to reuse previous correctness proofs and extend them for the integration of the new behavior.

SMT Solving for Real Algebra

E. Ábrahám, F. Corzilius, and U. Loup

Propositional logic is widely used in verification. E.g. for the verification of Boolean circuits, their behavior and required properties can be encoded in propositional logic and checked using efficient SAT solvers. Intense research in the field of SAT solving even brought SAT solvers to the industrial sector. However, the analysis of more complex systems such as real-time, probabilistic, or even hybrid systems requires more expressive logics. A sufficiently expressive and still decidable logic is (non-linear) real algebra. A real-algebraic formula is a Boolean combination of polynomial constraints over multiple, real-valued variables.

Deciding real algebra is NP hard and, even worse, many decision procedures for real algebra have a doubly exponential complexity bound. Our research aims at integrating different real-algebraic decision procedures into the Satisfiability-Modulo-Theories (SMT) context.

In order to integrate real algebraic solvers into an efficient SMT solver, some adaptations of the original decision procedures have to be done. In this project, we tackle the virtual substitution method, the cylindrical algebraic decomposition method, Gröbner-bases based methods, and methods relying on interval arithmetic.

We implemented and published the modular toolbox SMT-RAT for the development of SMT compliant theory solvers for real algebra, offering modules for the above-listed decision procedures. The efficiency of these modules can be further increased by combining them according to a user-defined strategy.

As a by-product of these developments, we established the rich C++ library GiNaCRA providing functionalities regarding real algebra, required for the implementation of the decision procedures.

Reachability Analysis for Hybrid Systems

E. Ábrahám, X. Chen, and S. Sankaranarayanan (University of Colorado Boulder)

Since the reachability problem for hybrid systems is not decidable, we over-approximate the exact reachable sets in the property verification work. A significant task is to compare the current over-approximation representations. Since different representations are adept at different cases, combining them in reasonable ways can handle a wide class of systems, and

improvements can be derived from such comparison. We use a combination of Taylor model and geometric representations for the reachable sets such that we can handle the continuous dynamics defined by highly non-linear ODEs, and achieve a reasonable trade-off between accuracy and efficiency.

We developed a tool named Hybrid Taylor Model Analyzer (HyTMAn) with Prof. Sriram Sankaranarayanan from the University of Colorado at Boulder. HyTMAn is an open source tool which computes the Taylor model flowpipes for a given nonlinear hybrid system. In the future, the tool will be extended by adding the following modules: (1) stability analysis for nonlinear differential dynamical and hybrid systems, (2) reachability based controller synthesis for nonlinear hybrid systems. We will also apply the tool to analyze some medical devices such as infusion pumps.

Other Activities

Erika Ábrahám

- Project reviewer for the City University of Hong Kong
- Reviewer for 5 journals (Computers and Mathematics for Applications, IEEE Transactions on Automatic Control, Journal of Computational and Applied Mathematics, Optimization Letters, Science of Computer Programming)
- Reviewer for 13 conferences and workshops (ATVA'12, FACS'12, FMOODS-FORTE'12, FORMATS'12, FTSCS'12, HSCC'12, IJCAR'12, NSV'12, QEST'12, RP'12, SAC/RVT'12, SIMULTECH'12, WRLA'12)
- Program committee member:
  - Hybrid Systems: Computation and Control (HSCC'12)
  - 9th Int. Conference on Quantitative Evaluation of SysTems (QEST'12)
  - 9th Int. Symposium on Formal Aspects of Component Software (FACS'12)
  - 1st Int. Workshop on Formal Techniques for Safety-Critical Systems (FTSCS'12)
  - 5th Int. Workshop on Numerical Software Verification (NSV'12)
  - 5th Int. Conference on Simulation and Modeling Methodologies, Technologies and Applications (SIMULTECH'12)
- Co-organizer of the ROCKS Autumn School "RigorOus Dependability Analysis for Stochastic Systems" 2012
- Examiner for Theoretical Computer Science in two Ph.D. defenses
- Member of two appointment committees at RWTH Aachen University
- Member of the Computer Science Department commission "High-school activities"
- Member of the Computer Science Department commission "Numerus Clausus"
- Deputy equal opportunity commissioner (Vertreterin der Gleichstellungsbeauftragten) of RWTH Aachen University
- Member of the RWTH commission "Gender measures of the RWTH research training groups"
- Deputy faculty board member
- Participant of the RWTH Strategy Workshops

Nils Jansen

- Mentor in the TANDEMschool and TANDEMkids mentoring programs
- Member of the comission for teaching of the Computer Science Department

Ulrich Loup

- Member of the Steering Commitee of the AlgoSyn Research Training Group
- Mentor in the TANDEMschool mentoring program
- Member of the comission for service teaching of the Computer Science Department

Johanna Nellen

- Member of the Steering Commitee of the AlgoSyn Research Training Group
- Mentor in the TANDEMschool mentoring program

Courses

Winter semester 2011/12

- Lecture: Satisfiability checking
- Seminar: Satisfiability checking
- Practical course: Explorative Suche mit Lego Mindstorms Robotern

Summer semester 2012

- Lecture: Modeling and analysis of hybrid systems
- Seminar: Satisfiability checking
- Practical course: Simplex in SMT
- Practical course: Modeling of a solar power plant

RWTH Events Organized for Highschool Pupils

- Organization of the Aachener Informatiktage 2012
- Organization of the Schüleruniversität Informatik 2012
- Organization of the Ringvorlesung "Was ist Informatik?" 2012
- Organization of the RWTH MINT Camp 2012
- Demo "Roboterprogrammierung mit Lego Mindstorms' for the Girls" Day 2012
- Vortrag "Rechnen mit Nullen und Einsen" for Helle Köpfe 2012

Talks and Publications

Talks

Erika Ábrahám. SMT Solving Mechanisms for Non-Linear Real Arithmetic. Invited talk, Albert-Ludwigs-University, Freiburg, Germany, 2012.

Erika Ábrahám. Hybrid Systems. Invited talk, University of Twente, Enschede, The Netherlands, 2012.

Erika Ábrahám. Computing Counterexamples for Discrete-Time Probabilistic Systems. Tutorial, ROCKS Autumn School "Rigorous Dependability Analysis for Stochastic Systems", Vahrn, Italy, 2012.

Erika Ábrahám. Rechnen mit Nullen und Einsen. Talk, Helle Köpfe in der Informatik, 2012.

Erika Ábrahám. Eine kurze Einführung in die Unentscheidbarkeit. Talk for students of a Greek high-school, RWTH Aachen University, Aachen, Germany, 2012.

Erika Ábrahám. Eine kurze Einführung in die Unentscheidbarkeit. Talk, Ringvorlesung "Was ist Informatik?", 2012.

Xin Chen. Taylor Model Over-approximations for Flowpipe/Guard Intersections. Talk in the 5th Int. Workshop on Numerical Software Verification (NSVü12), 2012.

Xin Chen. Using Taylor Models in the Reachability Analysis of Non-linear Hybrid Systems. Talk in the 5th Small Workshop on Interval Methods (SWIMü12), 2012.

Nils Jansen, and Matthias Volk. The COMICS Tool - Computing Minimal Counterexamples for DTMCs. Talk, AlgoSyn seminar, 2012.

Nils Jansen, and Matthias Volk. The Comics Tool - Computing Minimal Counterexamples for DTMCs. Talk, ROCKS Meeting, 2012.

Nils Jansen. The COMICS Tool - Computing Minimal Counterexamples for DTMCs. Talk, ATVA, 2012.

Nils Jansen. Symbolic Counterexample Generation for Discrete-time Markov Chains. Talk, FACS, 2012.

Nils Jansen. Symbolic Counterexample Generation for Discrete-time Markov Chains, Talk, AlgoSyn Seminar, 2012.

Ulrich Loup. SMT-RAT: An SMT-Compliant Nonlinear Real Arithmetic Toolbox. Talk, AlgoSyn seminar, 2012.

Ulrich Loup. SMT-RAT: An SMT-Compliant Nonlinear Real Arithmetic Toolbox. Talk, SAT, Trento, 2012.

Ulrich Loup and Johanna Nellen. OASys: An Interdisciplinary DFG Project with Roots in AlgoSyn. Talk, AlgoSyn seminar, 2012.

Publications

Xin Chen, Erika Ábrahám, and Sriram Sankaranarayanan. Taylor Model Flowpipe Construction for Non-linear Hybrid Systems. In Proc. of the 33rd IEEE Real-Time Systems Symposium (RTSS'12). IEEE Computer Society, 2012.

Florian Corzilius, Ulrich Loup, Sebastian Junges, and Erika Ábrahám. SMT-RAT: An SMT-Compliant Nonlinear Real Arithmetic Toolbox (Tool Presentation). In Int. Conf. on Theory and Applications of Satisfiability Testing (SAT'12). pages 442-448. Volume 7317 of Lecture Notes in Computer Science. Springer-Verlag, 2012.

Muhammad Fadlisyah, Peter Csaba Ölveczky, and Erika Ábrahám. Some Like It Very Hot: Formal Modeling and Analysis of Extreme Heat Exposure to the Human Body in HI-Maude. In Proc. of the 9th International Workshop on Rewriting Logic and its Applications (WRLA'12). LNCS. Springer-Verlag, 2012.

Nils Jansen, Erika Ábrahám, Matthias Volk, Ralf Wimmer, Joost-Pieter Katoen, and Bernd Becker. The COMICS Tool - Computing Minimal Counterexamples for DTMCs. In Proc. of the 10th Int. Symp. on Automated Technology for Verification and Analysis (ATVA'12) . pages 349-353. Volume 7561 of LNCS. Springer-Verlag, 2012.

Nils Jansen, Erika Ábrahám, Barna Zajzon , Ralf Wimmer, Johann Schuster, Joost-Pieter Katoen, and Bernd Becker. Symbolic Counterexample Generation for Discrete-time Markov Chains . In 9th International Symposium on Formal Aspects of Component Software (FACS'12). LNCS (to appear). 2012.

Daniela Lepri, Erika Ábrahám, and Peter Csaba Ölveczky. Timed CTL Model Checking in Real-Time Maude. In Proc. of the 9th International Workshop on Rewriting Logic and its Applications (WRLA'12). LNCS. Springer-Verlag, 2012.

Johanna Nellen, and Erika Ábrahám. Hybrid Sequential Function Charts. In Methoden und Beschreibungssprachen zur Modellierung und Verifikation von Schaltungen und Systemen (MBMV'12). 2012.

Ralf Wimmer, Nils Jansen, Erika Ábrahám, Joost-Pieter Katoen, and Bernd Becker. Minimal Critical Subsystems as Counterexamples for omega-Regular DTMC Properties. In Methoden und Beschreibungssprachen zur Modellierung und Verifikation von Schaltungen und Systemen (MBMV'12). 2012.

Ralf Wimmer, Nils Jansen, Erika Ábrahám, Bernd Becker, and Joost-Pieter Katoen. Minimal Critical Subsystems for Discrete-Time Markov Models. In Tools and Algorithms for the Construction and Analysis of Systems (TACAS'12). pages 299-314. Volume 7214 of LNCS . Springer, 2012.

Technical Reports

Ralf Wimmer, Nils Jansen, Erika Ábrahám, Joost-Pieter Katoen, and Bernd Becker. Minimal Counterexamples for Refuting ω-Regular Properties of Markov Decision Processes. Technical Report 88, Reports of SFB/TR 14 AVACS, 2012. ISSN: 1860-9821.

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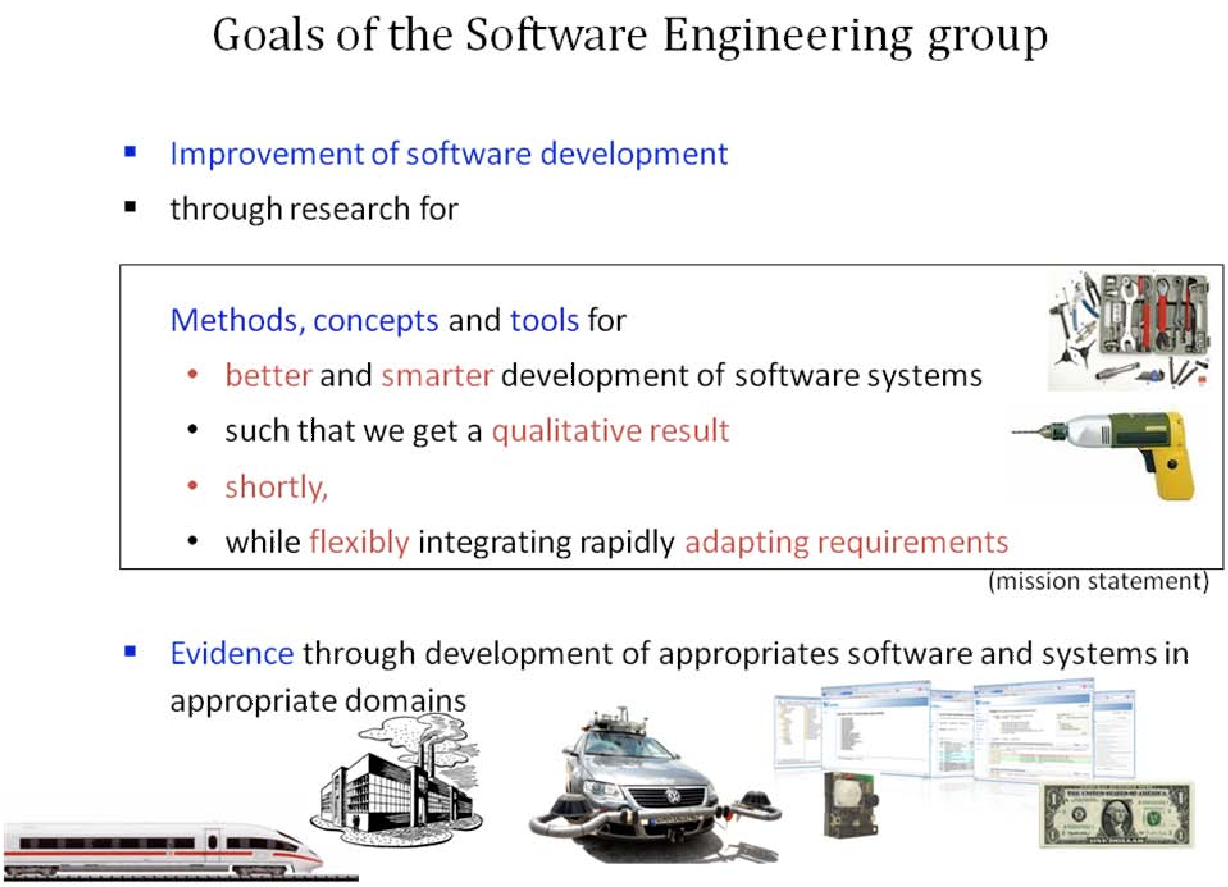
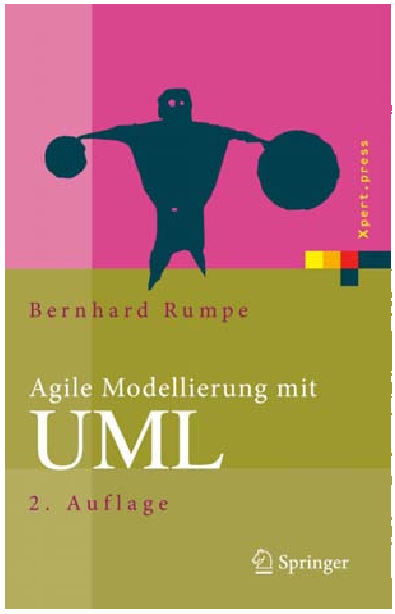
Overview

In our fourth year with Bernhard Rumpe as Head of Chair for Software Engineerin, we have been able to strongly extend our cooperation and research activities in all four fields: automotive, cloud computing, energy optimization and model-based software development.



Our core research domains are the application of UML as well as domain specific languages (DSLs) and models for software development. At the heart of research lays the question, how to improve software development based on well founded modelling techniques, either based on UML or on domain specific languages. While using and extending tools developed in-house, these tools as well as software engineering principles, practices and methods were applied in the following application domains: e-homes, business processes, web systems, energy optimization, autonomous driving of cars, trucks and trains, requirements management, product line engineering and management of complex function nets. Our recent work “Semantically Configurable Consistency Analysis for Class and Object Diagrams” has been awarded the Springer Best Paper Award MoDELS 2011 and the ACM SIGSOFT Distinguished Paper Award on the International Conference on Model Driven Engineering Languages and Systems.

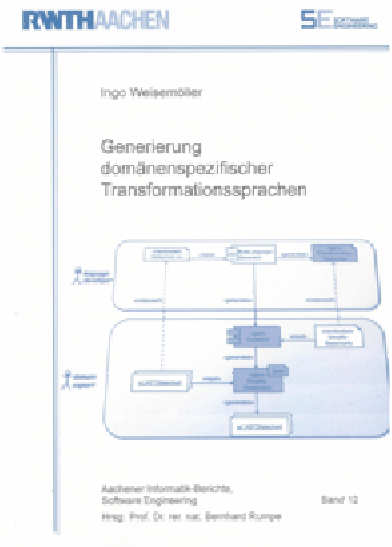
On the one hand we were focussing on a good quality of our lessons, exercises and practicals. Besides the already existing lectures that are well received, we extended our range of lectures with two new lectures “Generative Software Engineering for the Automotive Domain” and “Innovations in Software Engineering”. We reissued the second version of the second book concerning the topics of the lecture Model Based Software Development “Agile Modellierung mit UML: Codegenerierung, Testfälle, Refactoring”. It was continuously revised and is now based on UML 2.3 and Java 6.

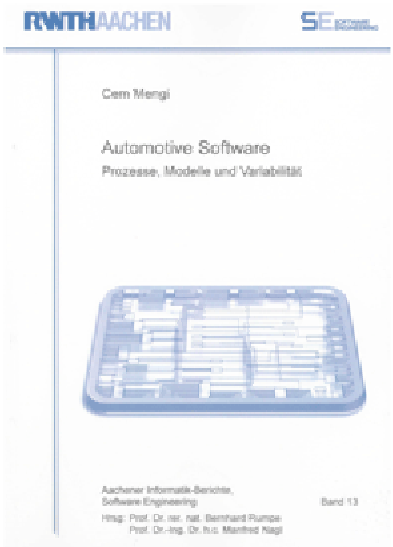


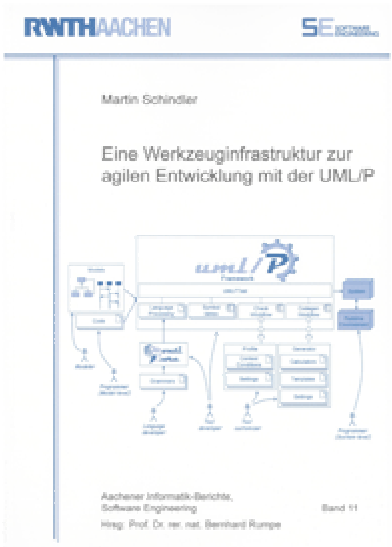
On the organisational side, we are involved in the Commission for Teaching (“KfL”) that deals with strategic issues for the computer science curricula and the Commission for Service Teaching (“KfSL”) that deals with lessons exported to other curricula. Both have the duty to ensure a good quality of the relatively new Bachelor/Masters programs, we are dealing with. Additionally we are part of the Prüfungsausschuss Informatik, that deals with objects and questions concerning examinations. We took over the speaker’s position for the Forum Informatik and organized some very interesting talks. On the industrial side, our working group on Cloud Computing within REGINA is ongoing.

In this year we received several fundings from the BMWI, BMBF and EU that will further expand our group substantially. Furthermore, our Software Engineering Laboratory (SE Lab) has started some projects, partly in combination with industry, partly on our own projects, to deliver industrial strength software.

We also had the pleasure to see the completion of three doctoral dissertations. Namely Martin Schindler, Ingo Weisemoeller and Cem Mengi finished their work and started their careers We thank them, assuming they have learned and explored the proper techniques, concepts and gained appropriate management skills for their future work. We wish them good luck in their new positions. All three Ph.D. theses are available at the book series “Aachener Informatik-Berichte, Software Engineering” by Shaker publishing, Aachen.







Funding comes from various sources, including DFG, EU, BMBF, BMWI and a number of industrial partners like e.g. Daimler, DSA and Volkswagen.

We expect an interesting and challenging forthcoming next academic year.

Link to research activities of the group:	http://www.se-rwth.de/
Book series “Aachener Informatik-Berichte, Software Engineering”:	http://www.se-rwth.de/books/
Forum Informatik:	http://www.fi.rwth-aachen.de/
Book “Modellierung mit UML”, 2nd edition:	http://www.se-rwth.de/mbse/

Teaching

During the winter term 2011/2012 and the summer term 2012 we consolidated and slightly extended our teaching activities on undergraduate and graduate level for computer science students as well as students in electric engineering and information technology.

In the winter semester we established two new lectures "Generative Software Engineering for the Automotive Domain" and "Innovations in Software Engineering". Apart from that we offer several courses including lectures, proseminars, and practicals on a regular basis on undergraduate level. In Addition to this, on graduate level the group offered specialised courses focussing on "Software Engineering" during the last year. We updated our lecture Generative Software Development to include state-of-the-art approaches and to show the students recent developments in this field. With the lecture "Generative Software Engineering for the Automotive Domain" we created a lecture that imparts the challenges from another domain on the one hand and the applicability of the learnt concepts from other lectures to this new domain on the other hand. The new lecture "Innovations in Software Engineering" shows the participating students new research activities and approaches in software engineering. Using the foundations learnt in other courses we offer this lecture to show how they relate to open questions and how different research problems can be tackled.

Namely, the following lectures were held:

- Software-Engineering (L3+E2), winter
- Model-Based Software Engineering (L3+E2), winter
- Applied Software Engineering within the lifecycle of Automotive Electronics (L1), winter
- Generative Software Engineering for the Automotive Domain (L2), winter
- Innovations in Software Engineering (L2), winter and summer
- Software Architectures (L3+E2), winter
- Generative Software Development (L3+E2), summer
- Processes and Methods for Software Testing (L2), summer
- The SE Programming Language Ada 95 (L3+E2), summer

Apart from that, several practicals and seminars were offered every semester including practicals in cooperation with other research groups.

- Graduate Lab Project in Software Engineering (E2), every semester
- Seminar on "New Topics of Software Engineering" (E2), every semester
- Working group for graduate and postgraduate students, during the whole year

We offered two practicals over the year, one coping with current problems from the energy domain and the other focusing on mobile & location based augmented reality. In addition to this two seminars have been held focussing on model based software engineering.

For the undergraduate course "Software Engineering" we doubled the amount of our exercise courses to cope with the higher number of students due to a shift within the curriculum.

Link to education activities of the group: http://se-rwth.de/teaching/

Research Projects

Algorithmic Synthesis of Reactive and Discrete-Continuous Systems

Dr. S. Maoz, J.O. Ringert and B. Rumpe

DFG Graduiertenkolleg AlgoSyn

The DFG Graduiertenkolleg 1298 AlgoSyn is an interdisciplinary research project aiming at the automated synthesis of software and hardware systems. AlgoSyn is working on bridging the gap between engineering and theory as well as developing new methods in both fields. Working on bringing these two directions of research closer together and applying results from both areas has proven fruitful in AlgoSyn's previous years.

We support these efforts with our modeling and software systems engineering experience in taming the complexity of the specification and development of distributed reactive systems. Part of our contribution to this goal is the development of languages and tools for specification, verification and synthesis. We currently focus on modeling languages for distributed components with asynchronous communication via message passing.

We presented some early results of joint work with other members of the software engineering group and discussed these in AlgoSyn's scientific meetings. Our presentations covered work on the development of a language for the specification of partial views for the structure of component and connector architectures, algorithms to check whether an architecture satisfies a view or a views specification, and an approach for the synthesis of architectures from views specifications. Many interesting discussions with other AlgoSyn researchers have emerged from these talks.

Semantically Configurable Consistency Analysis for Class and Object Diagrams

Shahar Maoz, J.O. Ringert and B. Rumpe

Our work on checking the consistency of class diagrams and object diagrams received the Springer Best Paper Award MODELS 2011 and the ACM SIGSOFT Distinguished Paper Award at the international conference on Model Driven Engineering Languages and Systems (MoDELS) in Wellington, New Zealand.

Class and object diagrams (CDs and ODs) are popular modeling languages for describing the structure of object oriented systems. While class diagrams capture possible instantiations of objects in a generic way, object diagrams typically describe instances in an exemplary way. Applications of these languages throughout the development of a software system have shown to interpret the meaning of CDs and ODs in differing ways (i.e., employ semantic variability) according to the purpose of their use. We have developed an automated and

configurable analysis technique parameterized with semantic choices to adapt to the desired semantics.

Evaluation of Driving Safety Simulation Frameworks and their Usage

A. Haber and B. Rumpe

N. Landa

In cooperation with VOLKSWAGEN AG

Main task is the evaluation of driving safety simulation frameworks for VOLKSWAGEN AG in Wolfsburg. The project is split into two phases. In the first phase the tools Virtual Test Drive (*VTD*) and the Automotive Date- and Time-Triggered Framework (*ADTF*) are evaluated using a set of simulation specific criteria.

Task in the second phase is to develop a concept for signal flow evaluation in ADTF to prepare automatic test scenario evaluation. Two different concepts are tested and prototype demonstrators are developed.

Automotive Software
Processes, Models and Variability

C. Mengi, M. Nagl

Software is indispensable and a primary innovation driver for the development of functionality in the development of cars. But it is also a serious complexity and cost factor. An essential reason for that is the insufficient application of adequate methods and concepts for systematically capturing and handling software variants.

At the chair of Software Engineering this variant problem was addressed[1]. Thereby, three development phases with their resulting documents are consulted: (1) the conceptual design with function nets, (2) the architectural design with Simulink models, and (3) the implementation with C code. For all three phases or document types different approaches are developed. They allow the design of software in a way that it can be adapted to different variants.

The solutions range from the identification of commonalities and variability to the realization of variation point with their binding through variants. New processes and models are proposed to support reusability.

Out of the solutions a set of tool was developed and applied to modeling tasks to make use of variation modeling. Both form a proof-of-concept for the described approaches.

The dissertation project was successfully finished this year (cf. the section Dissertation descriptions).

COMPASS – Safety Management in Complex ATM System of Systems using ICT approaches

A. Horst and B. Rumpe

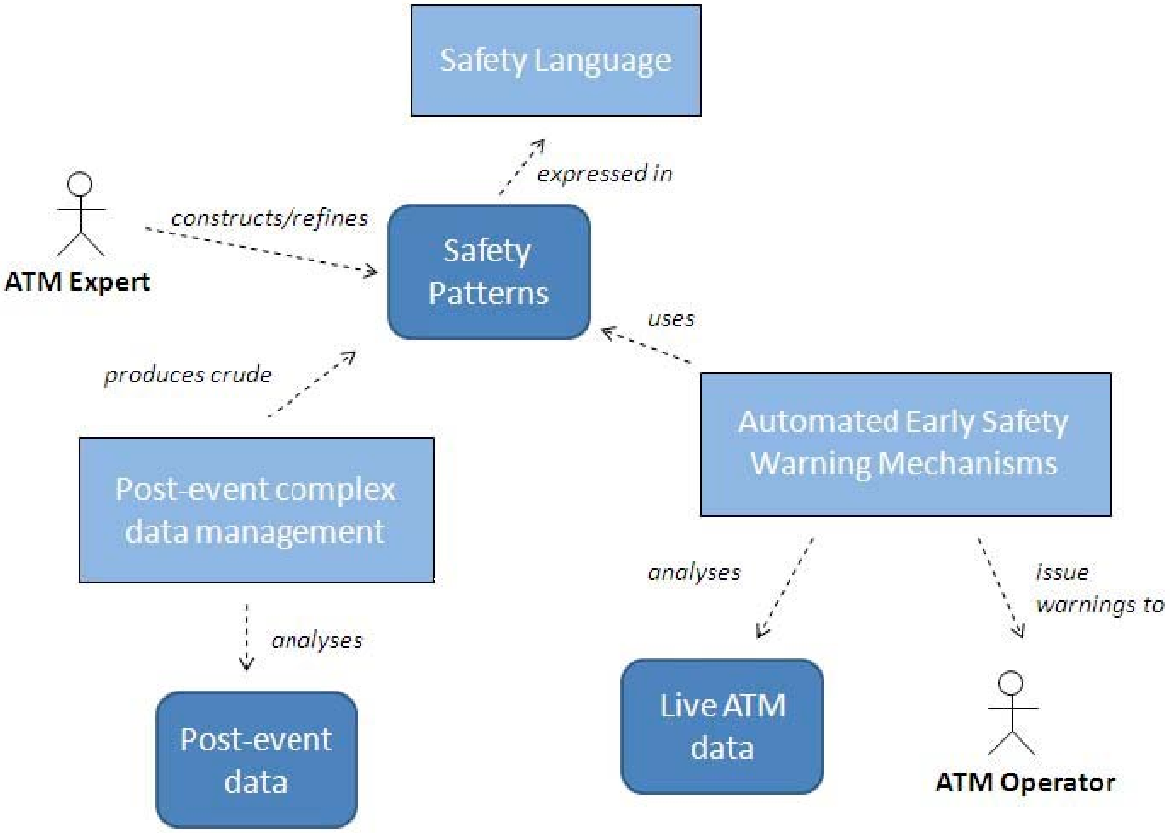
In cooperation with University of York, THALES Information Systems, INNAXIS Research Institute

Air Traffic Management (ATM) systems are complex and heterogeneous; they comprise a large number of communicating and interdependent components and sub-systems. They are also predominantly safety-related systems; failures can result in major accidents, loss of property, or loss of life. During the operation of an ATM system, its constituent parts produce a high volume of system-level events (such as the health status of individual devices). Of interest in terms of safety management are those combinations of events that *predictably* and

[1] This research was carried out in the context of the Graduate School GRK 643 „Software for mobile communication systems“ and in cooperation with several companies from 2007 to 2012.

with a *high degree of probability* lead to a situation where safe operation is compromised. The challenge that we address in this project is how to identify combinations of events as they are happening and issue warnings to operators early enough to take action and prevent catastrophic failures.

The objective of this project is to provide powerful and more automated safety management support to human operators of complex ATM systems. This will be done by taking a *pattern-based approach* and by combining state-of-the-art technology from data mining, intelligent modeling and complex event processing. The combination will allow engineers to mine *safety patterns* from past data, filter and enrich these patterns using their expertise and domain knowledge, and then use these patterns to monitor running ATM systems in an automated manner. Monitoring will help to identify, and report to human operators, situations which could compromise the safe operation of the ATM system.



The project will deliver new and novel *scientific techniques* for identifying, encoding and exploiting safety information, along with new technical applications of these techniques. The delivered techniques and applications go beyond the nominal SESAR timescales, i.e., for exploitation by 2020. Specifically:

- It will deliver novel automated safety warning technology and techniques that offer substantial promise in reducing the amount of human intervention in identifying potentially hazardous situations and generating warnings to ATM experts.
- It will exploit and bring within the scope of SESAR research and development several novel technologies and theories from the ICT community specifically targeted at management of complex systems.
- It will deliver novel intelligent modeling techniques for safety management in ATM systems.

Delta-Modeling Simulink Models

Arne Haber, Pedram Mir Seyed Nazari and Bernhard Rumpe

In cooperation with

Daimler AG, TU Braunschweig

The diversity of today's software systems lead to the need of new modeling languages for handling the variability. One technique is delta modeling where a designated core model is specified and a set of deltas, which define modifications for the core model. A new variant is created by applying these deltas to the core model in a specific order.

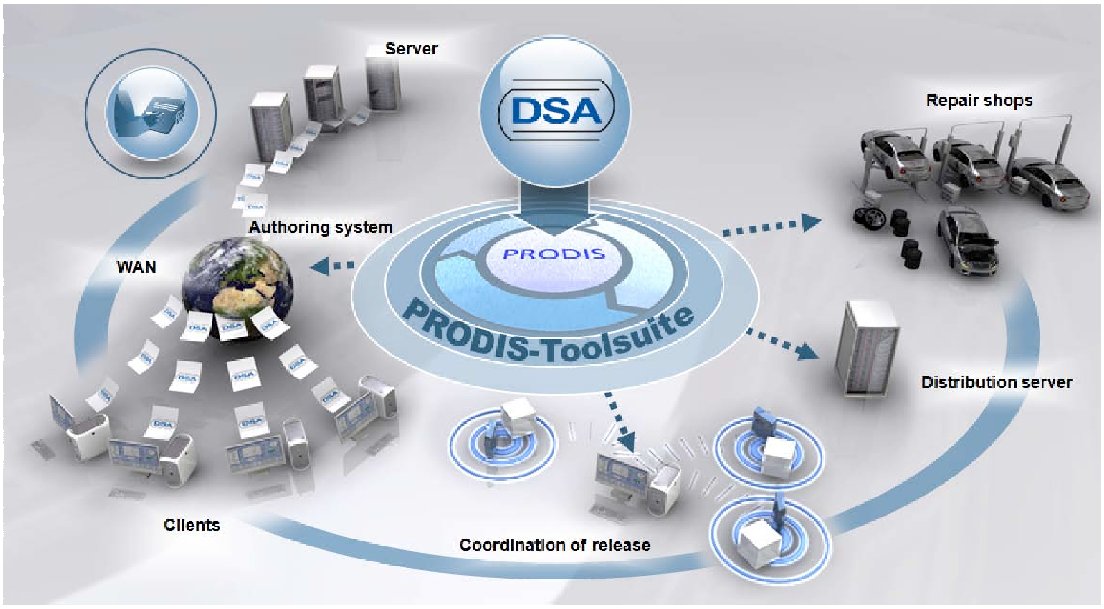
Matlab/Simulink is an environment for graphical modeling and simulation of embedded systems. Because variability is an important factor in the automotive industry, we developed an approach for using delta modeling in Matlab/Simulink. We also developed a prototype to prove our concept.

Domain specific configuration of systems using the example of vehicle diagnostics and vehicle programming

K. Müller and B. Rumpe

In cooperation with DSA GmbH, Aachen

DSA Daten- und Systemtechnik GmbH, Aachen/Germany, is a leading supplier of automotive hardware and software test systems. In more than 30 years of close cooperation with automotive manufacturers and their system suppliers, DSA has developed an extensive family of electrical and electronic diagnostic systems for use in electronic component design, vehicle production, and servicing. Today, DSA technology can be found in production at more than 130 automobile assembly plants, at more than 18.000 dealerships, and at many other locations of well-know automobile manufacturers worldwide.



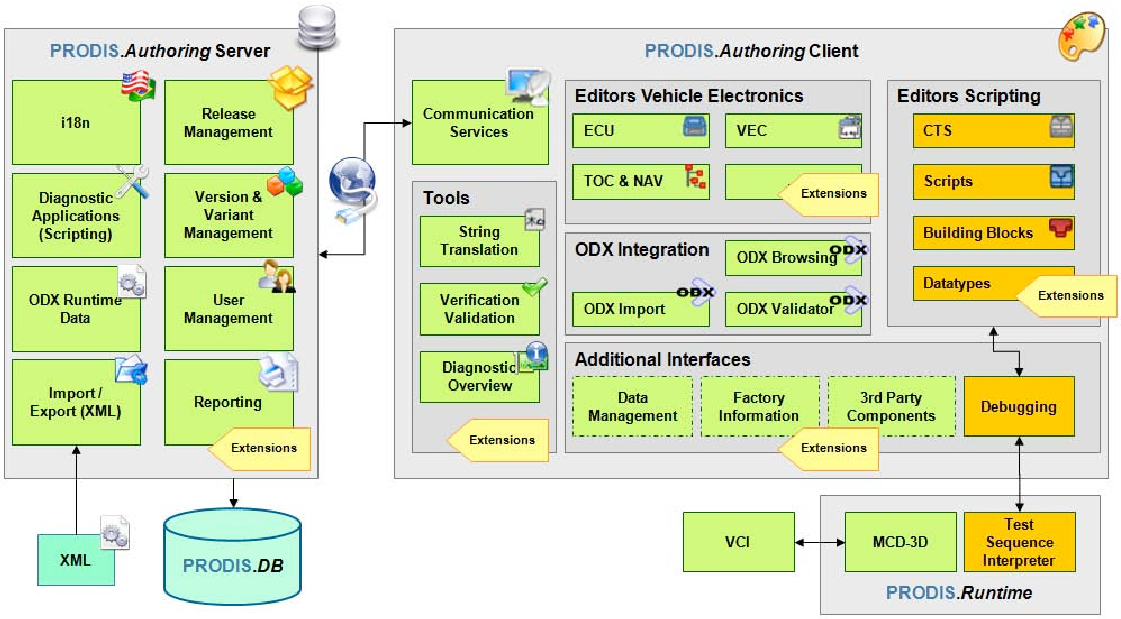
One of the most prominent DSA software solutions is PRODIS.*Authoring*. It is a comprehensive system for the creation and maintenance of diagnostic data and test sequences. As the focal point of corporate automotive diagnostic data, PRODIS.*Authoring* offers multi-user collaboration, integrated version management, versatile variant management, and embraces automotive standards like ODX, OTX, and many more. PRODIS.*Authoring* relies on latest software technology like the Java Platform, Enterprise Edition (JEE), the Eclipse Rich Client Platform (RCP), and the Open Standards Gateway Initiative (OSGi), to name just a few. PRODIS.*Authoring* is very actively being developed and extended, its software code comprising now more than two million lines in more than 600 Eclipse plug-ins.

The goal of this project is to develop model-based concepts and strategies to refine the product development and the software development processes. Project results are based on first-hand process experience. Results are fed-back into the product lifecycle activities. Hence, the project has an immediate positive effect on current and further product development efficiency and accompanying operations. New concepts are assessed with regards to quality enhancement and reduced work effort. The project covers several core topics, some of them are briefly introduced subsequently.

Potentials in the area of modeling and generation identifies areas for the use of modeling languages, how the present usage of modeling languages can be adapted, how the current generator can be adapted and extended.

Quality assurance mechanisms aim at the inception of strategies that lead to an even more cost-efficient quality assurance. A focus is on activities that can be automated.

Support of the system evolution in general looks into supporting system evolution through automation. Certain changes in the system require specific system evolution activities to be performed. These activities are scrutinized and strategies are being revised facilitating the leaner execution of these activities.



Database migration and persistence seeks for streamlining the current approach for executing database updates.

Harmonization of system architecture seeks-out software synergies among PRODIS.*Authoring* and its peer product in the automotive production and manufacturing arena: PRODIS.*Automation*. The project investigates approaches for unifying tooling, lifecycle activities, and software reuse.

Energie Navigator – A software framework for optimizing energy efficiency of buildings

G. Bürvenich , C. Herrmann, T. Kurpick, A. Lindt, M. Look, C. Pinkernell, B. Rumpe, M. Tran, M. Uzunov

J. Gräfen, T. Greifenberg, A. Hutter, W. Kluth, P. Krantz, L. Krause, M. Lang, S. Roidl, P. Ruhrländer, V. Serebro, K. Thissen, D. Wolf

Nowadays new buildings are equipped with a lot of technical facilities, e.g. block-unit heating power plants or concrete core activation. These facilities are monitored by a multitude of sensors, which produce measured data. The measured data is typically used to control the facility itself (control circuit), but not for integrated monitoring and controlling.

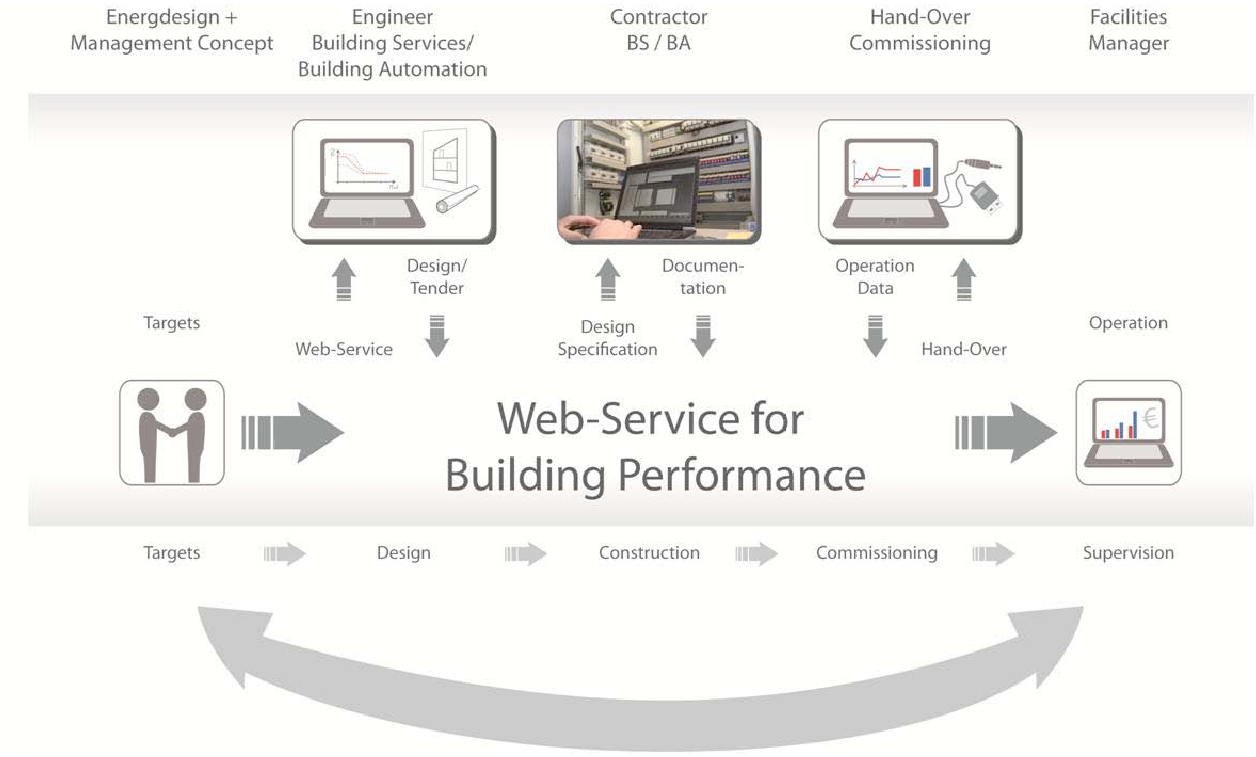
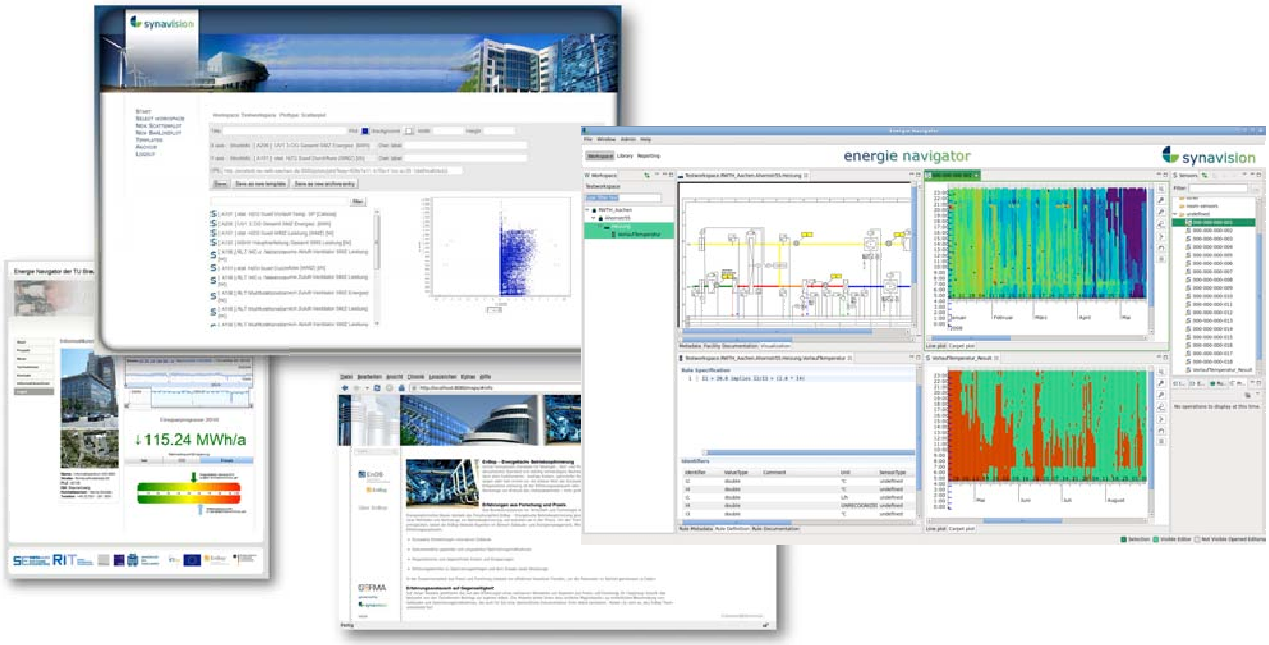


Figure 1: Quality Process based on Energie Navigator Platform

The Energie Navigator project focuses on importing data from different types of buildings and facilities. After the data import quality of measured data has to be improved, e.g. by transforming them to equidistant timestamps or by filtering outliers. Based on the data that is stored in the backend, several tools (frontend) are implemented, e.g. a data visualization toolkit that displays data as line-, scatter- or carpet-plots. The Energie Navigator application addresses three groups of persons:

- energy experts and consultants
- building- and facility managers
- building occupants.

A main aspect of the expert tool is a rule- and metric-toolkit, which is used to define logical rules on sensors to define a target state of a facility or a building. These rules can automatically be checked by the framework. A rules- and metric-language is implemented as a domain specific language (DSL) according to the Object Constraint Language (OCL) of the Unified Modeling Language (UML) with the help of MontiCore, a framework for designing DSLs. The system is deployed locally as a common server application, but it optionally uses cloud infrastructure to optimize load balancing.



Fgure 2: Expert tool and web interfaces

In addition to these expert functions the Energie Navigator also focuses on raising the energy awareness of end-users, e.g., by providing web based applications for current energy consumption status. A prototype of this application is implemented at the Center for Computer Science at University of Technology Braunschweig and replicated at National Theatre Prague.

A Web 2.0 energy community platform is implemented as an innovative web system based on Google Web Toolkit. Users can register their buildings and report and comment optimization tasks. The platform provides a wide-spread energy expert knowledge network.

The interdisciplinary workgroup of the project consists of members of Department of Software Engineering (CS3), RWTH Aachen University, Institute of Building Services and Energy Design TU Braunschweig, Ingenieurgesellschaft für energieeffiziente Gebäude mbH (energydesign- braunschweig), synavision GmbH and Rumpe Information Technologies GmbH.

Some of the subprojects are promoted, e.g. by the Bundesministerium für Wirtschaft und Technologie (BMWi) and the European Commission (CIP ICT PSP).

Global Software Engineering (GloSE)

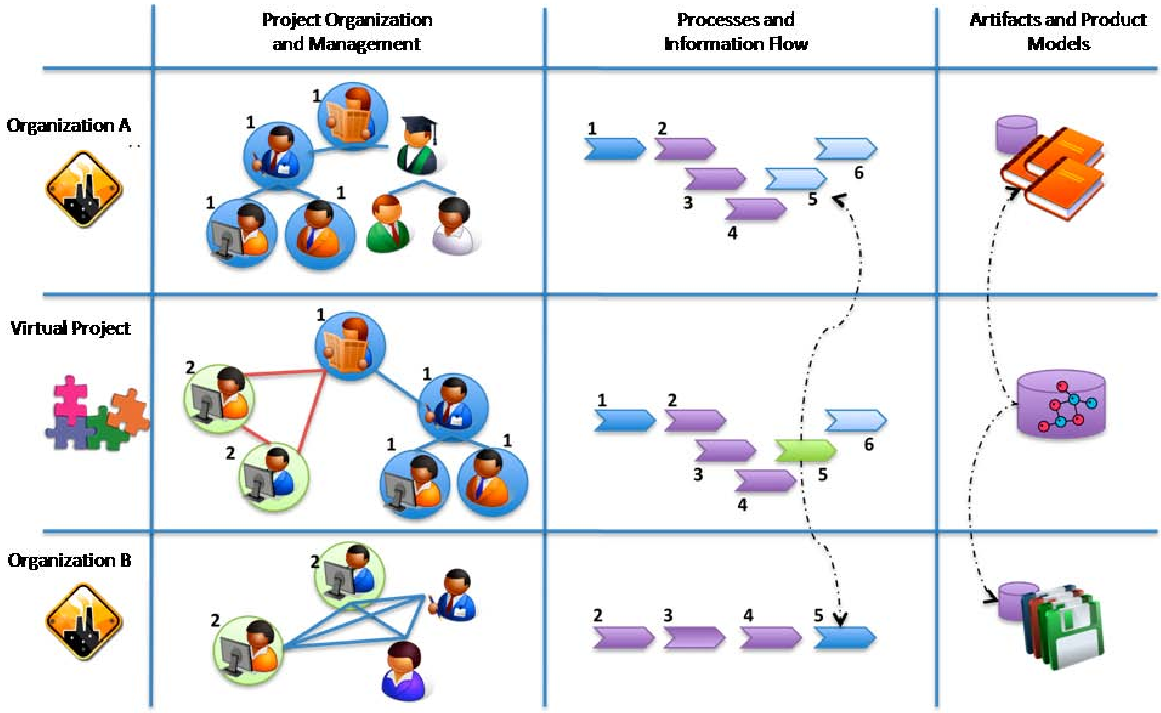
C. Herrmann, T. Kurpick and B. Rumpe

P. Chomicz, R. Eikermann and Z. Mansouri

In cooperation with:

TU München, Leibniz Universität Hannover, and TU Clausthal and several industrial partners

Global software engineering has become a common practice in many companies, as few can afford to produce software on their own and at a single location. But this leads to number of new challenges in software development projects. Based on the identified challenges, the partners of the GloSE project aim to produce technical, socio-technical and organizational improvements and solutions for distributed software development projects. Especially aspects of communication, information flow, and infrastructure in global projects as well as processes and methods are considered for all the tasks in software development: from requirements engineering to architecture design to implementation and testing.



In the last year the focus has been on utilizing social networking information in distributed development projects as well as effective customer feedback, especially in cases where the customers are not co-located with the development team. Personal information that has been stored in several social networks by the members of a global software engineering project can be aggregated and used in the context of such projects to reduce the socio-cultural distance among the team members. For this reason a supporting infrastructure has been developed that allows the aggregation and usage of such information. Customer feedback is essential for a

project to be successful. In the context of the GloSE project, the effective application of feedback systems in requirements engineering and acceptance tests has been researched.

Mobile Campus Project

M. Akbari, J.O. Ringert and B. Rumpe

To ease the parking situation and the traffic flow in and around the RWTH Aachen, new services can be created to simplify the change to public transport in everyday life. By a set of mobile applications and web services, the journey and travel planning, booking of various mobility options and the navigation are enabled on and within the campus and simplified. The applications of the Mobile Campus Projects will bring sustainable benefits to the students, employees, partners and visitors of the RWTH Aachen and the city of Aachen.

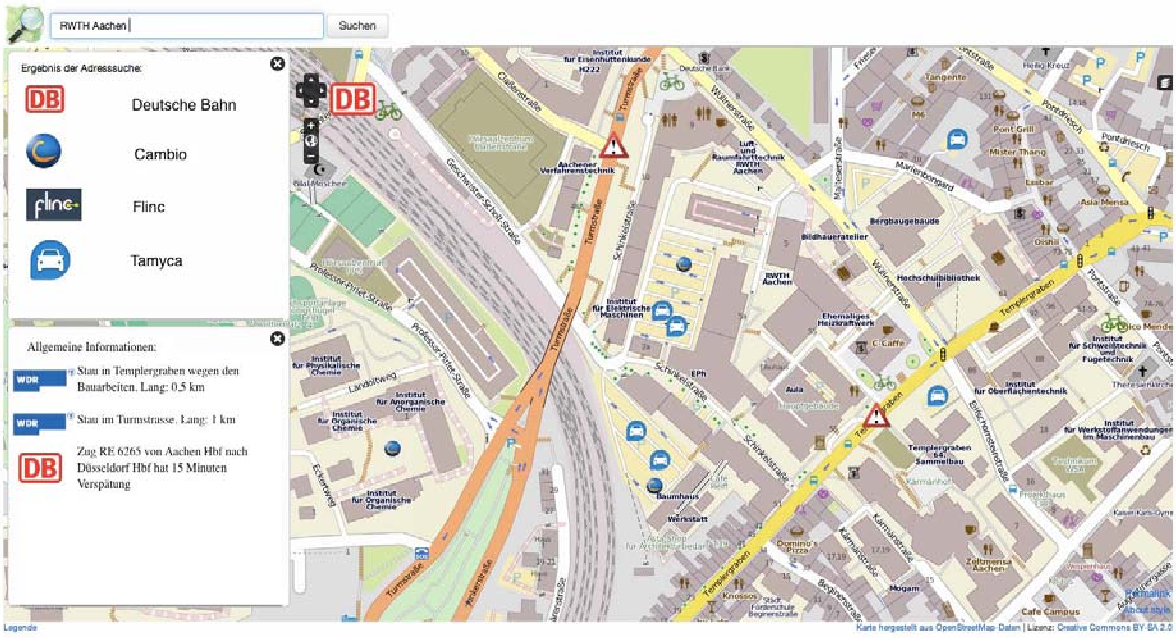
The Mobile Campus Project supports the plans at RWTH Aachen University to relax the parking situation at the various campuses. This is achieved in that the transition is simplified to alternative mobility concepts through mobile applications and web services. The results are a sustainable profit not only for the RWTH, but for the entire city of Aachen and the partners involved. The advantages are:

- RWTH Aachen University can reduce the cost of parking provision and management.
- The Job Ticket of the RWTH Aachen finds more takers among the employees of the university.
- Updated building, space infrastructure and databases for the central university administration
- The quality of services to our students is increasing with new and improved offerings.
- Guests and partners find it easier and more targeted to their appointments at the RWTH Aachen.
- Service Partners such as Cambio, Tamyca or Wabe Association consolidating their presence in Aachen and form together a model for other cities and universities.

By a set of mobile applications and web services, the journey and travel planning, booking of mobility offerings and navigate to and on campus significantly.

Such an integrated approach is unique in Germany and represents an outstanding innovation in the field of mobility for businesses and cities. Regional and national partners such as German Rail Rent, Cambio, Tamyca, the Wabe Flinc Association and are therefore willing to enrich this approach with their offers and services and support.

To develop a customer-focused product over the past months students, staff and partners of the RWTH Aachen were questioned about their wishes and ideas for improving the city and university life. On this basis, the existing usage scenarios were validated and supplemented with new ideas from further interviews. This made it possible to test and evaluate various technical implementation possibilities. The result of these studies was noted in a detailed requirements document, including project and development plan.



Development of Domain Specific Languages with MontiCore

M. Breuer, A. Haber, C. Herrmann, K. Hölldobler, A. Horst, F. Leppers, M. Look, P. Mir Seyed Nazari, A. Navarro Pérez, C. Pinkernell, J. O. Ringert, B. Rumpe, M. Schindler, P. Schütze, G. Volkova, I. Weisemöller, and A. Wortmann

Domain Specific Languages (DSLs) have recently become increasingly important for software developers and tool builders in several areas of application. Object oriented programming, which has been the most important programming paradigm since the 1990s, is supplemented by methods and languages that are tailored to a specific domain. The growing number and complexity of such languages is accompanied by the need to develop DSLs efficiently and to reuse artifacts from previous language development processes.

The MontiCore Framework allows for efficient, agile, modular, and compositional development of languages and tools as well as for the combination of DSLs and general purpose languages (GPLs) as shown in Figure 1. It supports an integrated definition of the concrete and the abstract syntax of languages and language modules, and the automatic generation of language processing infrastructure such as lexers and parsers. It also allows for efficient development model analysis and for development of code generators.

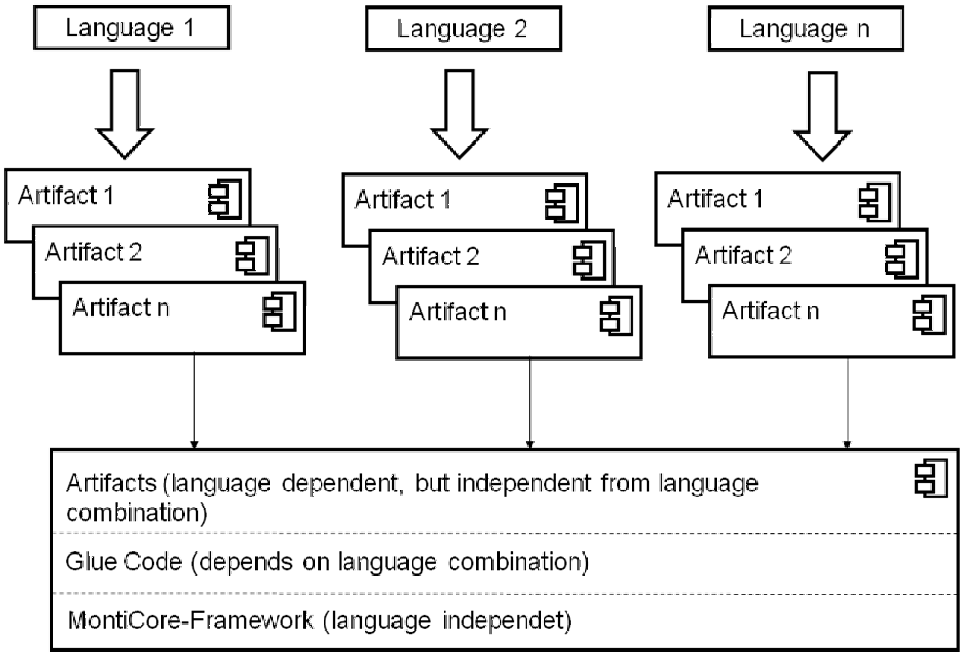


Figure 1: Compositional Development of Languages with MontiCore

MontiCore provides coherent compositionality in language development, including concrete and abstract syntax, symbol table computation, context conditions, and template-based code generation, as well as compliance to the wide spread Eclipse Modeling Framework (EMF). Furthermore a model transformation engine has been developed and integrated into

MontiCore which allows the generation of transformation languages for any defined language.

DSLs developed with MontiCore are used in a variety of projects at the department, e.g., the MODELPLEX project, AlgoSyn, rUML, UML/P, ENA, MontiArc, and MontiWIS. At the time being, this set of languages developed with MontiCore contains modeling languages of general applicability such as UML/P, GPLs such as C++ and Java, and specific modeling or constraint languages, for instance languages used in automotive software engineering and commonly used languages like XML and SQL. As future work we plan to extend this library of languages and languages components.

O(SC)²ar

A. Navarro Pérez, P. Nazari, A. Roth and B. Rumpe

L. Lang and M. Mades

In cooperation with StreetScooter GmbH, Dräxlmaier GmbH, FEV GmbH, FIR e.V., Hans Hess Automotive, regio IT

The *O(SC)²ar* project (Open Service Cloud for the Smart Car), incorporating partners from industry and academia, is a member of the project cluster *IT for E-mobility: Smart Car, Smart Grid, Smart Traffic* which is funded by the Federal Ministry of Economics and Technology (Bundesministerium für Wirtschaft und Technologie). The goal of *O(SC)²ar* is to reinvent the combined EE and IT architecture of modern, inexpensive mobility via cloud-connected electric vehicles. Taking a fresh approach, two existing e-car prototypes will be extended with a cloud-based IT infrastructure that has components both in and outside the actual car. This IT infrastructure will enable car manufacturers, car fleet operators and the cars themselves to provide innovative new values in the areas of car customization, infotainment, car maintenance, fleet management and car-to-car communication.

The architecture of *O(SC)²ar* is decomposed into (1) an open extensible cloud-based platform and (2) an open extensible in-car software platform. This architecture allows the car to provide services based on up-to-date information from the cloud as well as to itself provide information about itself to the cloud. In addition, the car can dynamically download software extensions from the cloud to extend and upgrade its own software. This architecture allows the car to be customized towards hardware variations, individual fleet operator demands, individual regional electric vehicle infrastructure demands and driver preferences. Customization affects the car's infotainment capabilities as well as its technological capabilities, like battery management and hardware monitoring. Due to its openness, the *O(SC)²ar* infrastructure will enable third-party service providers to develop own service and car software additions and provide them for *O(SC)²ar*-based cars.

The Department of Software Engineering will develop the in-car software platform that connects the car to the cloud and enables it to dynamically extend itself with software additions downloaded from the cloud. This platform will consist of an integrated, high-performance electronic control unit that integrates with the car's EE architecture and its communication infrastructure. In addition, the platform will provide a touch-based, extensible user interface. The department will tackle the challenges of dynamically extensible, cloud-based car software and its security and quality assurance. Thereby, *O(SC)²ar* serves as a testbed for generic *Internet of Things* concepts.

SensorCloud

L. Hermerschmidt, A. Navarro Pérez and B. Rumpe

M. Lüger and K. Tsolediris

In cooperation with QSC AG, University of Applied Sciences Cologne, symmedia GmbH and Dillenburger Group

The *SensorCloud* project, incorporating partners from industry and academia, is a member of the project cluster *Trusted Cloud* which is funded by the Federal Ministry of Economics and Technology (Bundesministerium für Wirtschaft und Technologie). Trusted Cloud aims to develop and evaluate innovative, robust, secure and law conform cloud computing solutions. Pilot projects will apply those solutions to industrial demands and thus demonstrate the benefits and trustworthiness of cloud computing. These pilots will especially address the current skepticism towards cloud computing observable in small and medium enterprises and their consumers.

The goal of *SensorCloud* is to develop a cloud-based platform that integrates basically every kind of distributed internet-connected sensor and actuator devices. Such devices may be located at a variety of places like personal homes, offices, cars, industrial plants, outdoor areas and so forth. *SensorCloud* serves as a central hub to which such devices can be connected via internet connection. It aggregates their data and controls their functions. Thereby, it manages devices and data from different domains, places and owners at the same time.

On top of its base of devices and data, *SensorCloud* provides an extensible and flexible service platform that is populated by "apps" from third-party developers. Those apps leverage the potential of the centrally aggregated devices and data, providing a rich, diverse and innovative supply of end user functionality. Bringing together owners and suppliers of internet-connected sensors and actuators, developers of services working on these devices, and the provider of the integrating cloud platform, the *SensorCloud* project enables a marketplace for innovative customer solutions that minimizes costs and hurdles for all involved players.

Data transparency is a major aspect of *SensorCloud*. The platform inherently secures and monitors the usage of devices and data based on customer-preferences. It allows the customer to track the usage of his devices and data, get notified or asked about single usages and define usage constrains.

The Department of Software Engineering uses *SensorCloud* as a pilot project to develop and evaluate new software engineering methodologies and tools specific to cloud software. Our approach integrates agile development principles with model-based development techniques. At its core is a set of cloud-specific architecture-oriented modeling languages. Those languages allow for the formal specification of the software architecture of cloud software as well as properties of that architecture like distribution, elasticity, robustness and monitoring. Based on these languages, we develop a set of tools that allow for analysis/simulation, code generation and testing.

Software Platform Embedded Systems XT (SPES-XT)

Arne Haber, Pedram Mir Seyed Nazari and Bernhard Rumpe

In cooperation with

Siemens AG, Airbus Operations GmbH, Audi Electronics Venture GmbH, Berner & Mattner Systemtechnik GmbH, Robert Bosch GmbH, Cassidian, Daimler AG, EADS-Deutschland GmbH Innovation Works, INCHRON GmbH, Itemis AG, Liebherr Aerospace Lindenberg GmbH, Pure-Systems GmbH, Technische Universität München, Fortiss GmbH, Fraunhofer-Institut, OFFIS e.V., Technische Universität Kaiserslautern, Universität Duisburg-Essen, TU Braunschweig

The current challenges faced by industrial companies in the development of embedded systems emerge among other things from the dramatically increasing volume and increasing complexity of individual systems. Mastering the development of such systems is critical to the competition in terms of improvement of innovation potential, time-to-market and competitive costs structures. Deficiencies or material weaknesses in the design and the development process for such systems lead to significant financial losses or even threats to the physical safety of people.

Building on SPES 2020 the current project SPES-XT has the goal to expand and deepen the seamless, methodological and technical integration of modeling and analysis techniques for embedded systems.

As a subcontractor of Daimler AG, this year we worked out the state of the art techniques for variability modeling in model-based development and developed concepts for expanding the SPES meta-model.

Concepts for Variant- and Compatibility Management

Supporting Software Evolution

Arne Haber, Bernhard Rumpe, Christoph Schulze

In cooperation with DAIMLER AG

Today's automotive systems are very complex structures, which consist of many subsystems delivering different kinds of functionalities, like parking support, driving assistance, wiper control or car-theft protection.

In the automotive industry, instead of single products, large product lines and product families are established. In addition mostly every newly designed car is a further

development of an older version instead of a redesign. As the evolution of features is hard to predict, older components needs to be adaptable to new interfaces or contexts to minimize the costs of further developments.

In this project the most important architecture description languages of the last decades are evaluated in context of the variability and evolution management of function components. The most promising approaches are compared based on criteria derived from context related use cases.

Productline aware Toolchain

Carsten Kolassa and Bernhard Rumpe

In cooperation with VOLKSWAGEN AG

Using modeling languages that allow modeling of product lines is a start but comes nowhere close to being able to apply it to development product lines and development lifecycle. The goal of this project is to create methodologies as well as tools that help in the implementation of a product line and that aid along the development process.

In order to achieve this, the lifecycle is divided into several phases and every phase is analyzed individually to improve its tool support focusing on product lines.

WATTALYST

Modeling and Analyzing Demand and Response Systems

EU-FP7 STREP – Grant Agreement 288322

T. Kurpick, A. Lindt, M. Look, C. Pinkernell and B. Rumpe

In cooperation with
AUEB, Athens (GR); EFPL, Lausanne (CH); IBM, Bangalore (IN);
LTU, Lulea (SE); tecnalia, Bilbao(ES); SAMPOL, Mallorca (ES)

The *WATTALYST* (*WATT anALYST*) project is an international research project funded by the European Commission's FP-7 program. The consortium consists of seven universities, research institutes and companies residing in Sweden, Greece, Spain, Switzerland, India and Germany. The project started on October 1st 2011 with a duration of three years.

The target of the project is the development of a Demand and Response (DR) infrastructure which will be used to influence and optimize energy consumption of users in private homes. The overall target is the reduction of peak loads (see Fig. 1) by homogenizing the energy consumption of city quarters. The project will produce design recommendations for DR-Systems which focus on appropriate technical infrastructures, incentive schemes for participants and overall economic models.

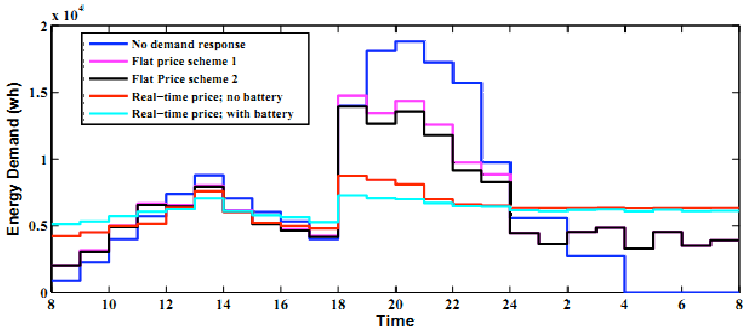


Fig. 1 - Peak loads in a daily base line profile

A DR-System requires frequent and real-time interactions with the participants. Therefore a closed loop approach is used as depicted in Fig 2.

Observe:

The premises will be equipped with sensors and intelligent meters which frequently collect dedicated energy consumption data on appliance level. This data will be uploaded to a cloud based evaluation platform. In addition to these probably fine grained sensor data, information from public available channels like weather reports, events and holidays are aggregated.

Fig. 2 - ,,DR-Loop

Infer:

Data-Mining techniques allow now the generation of reports including an energy consumption prediction. This will be used as input for economical models which will produce possible suggestions for shiftable loads according to the customers comfort and profile.

Inform:

These suggestions will be transferred as DR-Signals back to the end users. Electronic displays and internet applications will be used for the feedback channel.

Influence:

The private are now able to reflect and adjust their energy usage, decide on those suggestions and react to the DR-Signal. By this means regional peak loads are going to be equalized. Again, the user's reactions to the DR-Signal will be observed and used as new input to optimize the models in the DR-System. This step closes the loop.

The implemented infrastructure will be tested in field trails including several private homes in Spain and India.

In the first part of the project, the chair of Software Engineering has developed a software architecture including a design of a central cloud storage system for the sensor mass-data (see *Observe*). A overall view of the architecture is shown in Fig.3

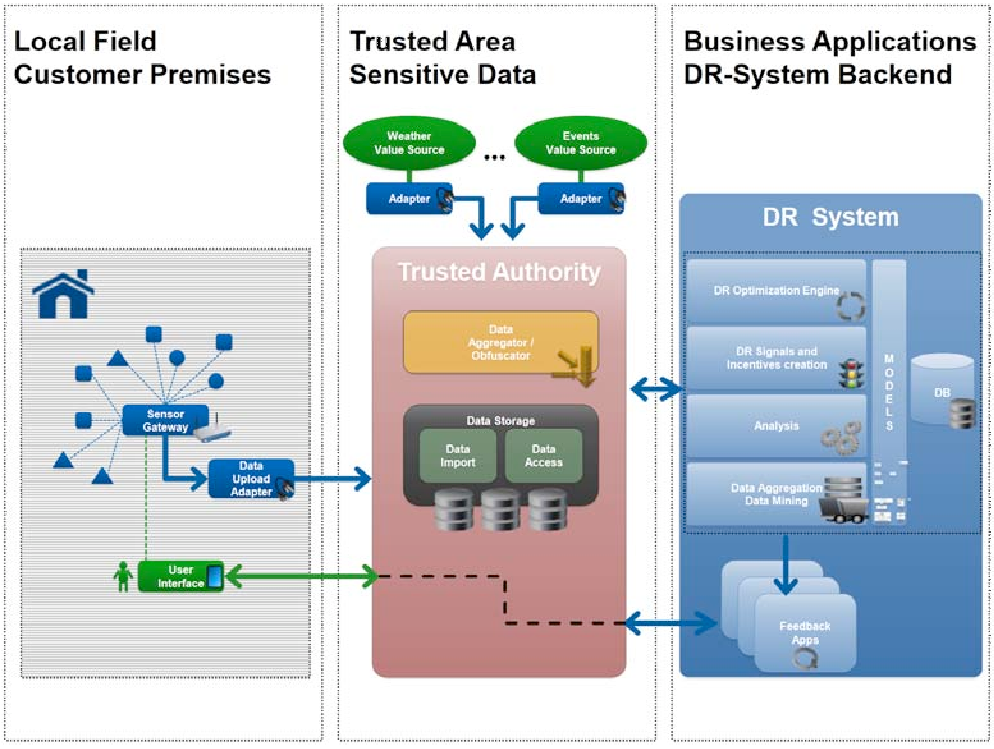


Fig. 3 - Conceptual Software Architecture

The software infrastructure consists of several layers and architecture components. On the bottom level, a communication infrastructure between the sensor nodes is established based on WiFi and IEEE 802.15.4 infrastructures. The data from these sensors will be collected locally and temporarily stored in a small gateway, which is installed within the private premises. The data will be periodically transferred into globally available cloud storages. This

raises the need for an encrypted transfer and a privacy aware, secured storage for the sensitive customer data. To this end, a trusted authority service will be implemented which manages the access to this data. The data will be processed and analyzed in the DR-System (see Fig.3). The results need to be available again for the end users. For this reason the architecture will contain a feedback channel. The available information on these feedback channels can be displayed by user Interfaces which are accessible from the private homes.

Other Activities

Software Engineering Lab

The Software Engineering Lab was founded in 2009 by Prof. Rumpe to cultivate the link of research and industry around Software Engineering topics. It aims to *connect* by *contents* and by *people*. The SE Lab creates a *great network* of industrial partners and of high potentials which consist of associates of the chair of software engineering as well as excellent, highly motivated students. They perform *joint projects, talks, lectures,* and *workshops*. In that way, industry initiates research and receives up-to-date and innovative technology know how and custom made solutions. Simultaneously, research keeps in touch with present industrial needs and gets realistic application scenarios. In SE Lab projects, our excellent students can work in the context of their thesis, student jobs, or practical courses on practical tasks and solutions.

There are three innovative long-term in house development projects at the SE Lab which gain more and more attention in industry. The MontiCore framework as well as the framework MontiArc for Software Architectures and the SSE Lab provide basic software solutions for efficient and fast development of high-quality software. These tools are already used by software developing organizations at different universities and demanded by several software houses. The Energie Navigator is a tool to monitor and optimize energy consumption of large buildings and plants and is elaborated in various industrial projects. The cooperation project Compass targets providing more automated safety management support to human operators of complex Air Traffic Management systems. We analyze the development and usability of software interface on mobile devices within different of our projects. WATTALYST

is a Strategic Research Project funded by the European Commission's 7th Framework Program (FP-7). The project aims to develop a prototype and implementation guidelines for Demand-Response-Systems to optimize energy consumption and distribution and to reduce CO2 emissions. To learn more about the projects at SE Lab, please see the dedicated project reports below.

Additionally the SE Lab initiated the *Technology Forum*. Here, members of the SE Lab network, industry partners, students, and members of the chair, talk about innovative technologies and trends and exchange knowledge. We welcomed talks from industry partners, such as Thales, SAP, DSA, Ericsson, EMIC, Audi, Daimler, and BMW. Research assistants and their students presented new technologies in developing android and iPhone applications as well as web applications with Google Web Toolkit. Also Cloud Computing technologies were introduced here.

The connection to industry could be tightened by gaining lecturers from BMW AG, Daimler AG, Volkswagen AG, local and supra-regional IT companies as well as nameable universities. Last winter Prof. Dr.- Ing. B. Wolff from University Paris-Sud (Orsay) and Laboratoire de Recherche Informatique (CNRS) gave a lecture on the Isabelle Platform: "A Perspective for Collaborative and Fine-grained Parallel TestCase-Generation". In summer Prof. Robert B. France from Computer Science Department of, Colorado State University gave a lecture about "Why Modeling is Essential to Software Engineering". This winter Carsten Busse, department manager Development Steering Electronics at Volkswagen AG will give a lecture about Innovations in Electronic Engineering. This concept of interaction is very promising and will be followed up. In reverse, we plan offer advanced and special trainings to software developers in enterprises.

Besides lectures, we enabled students in the *SE Research Camp* and also in practical courses to learn how to build smart phone applications and web services first and to apply them in the following by realizing software in a team. Here, several nice software products were generated such as the building information system GISELA with an Android and iPhone interface or the autonomous driving system within the CarOLO project for DARPA Challenge.

Astonished by the demand of all SE Lab activities, projects, Technology Forum, lectures and SE Research Camp, we will go on and further extend our offerings.

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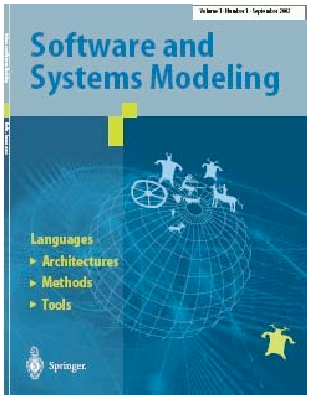
Software and Systems Modeling (SoSyM) Journal



Since 2001, Software and Systems Modeling (SoSyM) is an international journal that focuses on theoretical and practical issues pertaining to the development and application of software and system modeling languages and techniques. The aim of the journal is to publish high-quality works of further understanding about theoretical underpinnings of modeling languages and techniques, to present rigorous analyses of modeling experiences, and to present scalable modeling techniques and processes that facilitate rigorous and economical development of software.

The journal is unique in its emphasis on theoretical foundations of modeling languages and techniques and on rigorous analyses of "real-world" modeling experiences. The balance of theoretical work and work based on in-depth analyses of experiences provides researchers with insights that can lead to better modeling languages and techniques and provides practitioners with a deeper understanding of modeling languages and techniques that can lead to more effective application.

The journal targets researchers, practitioners and students that are interest in results generated by high-quality modeling research and by rigorously analyzing modeling experiences.

GI-QFAM: Joint Interest Groups on Modeling

The Joint Interest Groups on Modeling (Querschnittsfachausschuss Modellierung, QFAM) of the German Informatics Society (Gesellschaft für Informatik, GI), which was founded in 1998, is an association of developers and users of model based software development approaches. It serves as a platform for the exchange of experiences and discussion of new ideas. As such, it hosts the annual convention *Modellierung*, which takes place either as a workshop or as a conference.

QFAM is unique as it brings people together from various disciplines of computer science that are related to modeling. Currently, there are 12 other groupings of the GI clustered in QFAM, which cover a wide area of topics such as formal methods, knowledge representation and management, or business information systems. The members of QFAM come from almost all areas of the German-speaking countries.

In March 2010, Prof. Dr. Bernhard Rumpe took over the chairmanship of the QFAM. As the highlight of the 2010/11 academic year, Prof. Rumpe and staff hosted the 2011 edition of the workshop *Modellierung* from March 2nd to 4th. It was our pleasure to welcome 30 of the most renowned experts on modeling at Rolduc abbey, Kerkrade.

In 2012, the *Modellierung* took place as a full conference in Bamberg from March 14th to 16th.

Also since 2012 Bernhard Rumpe is invited to the regular meetings of the GI Präsidium.

Conference Activities and Academic Administration

M. Nagl:

- Member of the Board of Informatics Europe
- Chair of the Department Evaluation Committee of Informatics Europe
- Vice Chair of the Accreditation Committee of EQANIE (European Quality Assurance Network for Informatics Education)
- Advisory Board of the European ULAB Project (Partners: Universidad Politecnica de Madris, TU Munich, University of Oxford, Paris Tech, Politecnico die Torino)
- Chairperson of the Audit Team of Informatics Programs Accreditation at TU Riga, Latvia (2011)
- Chairperson of the Audit Team of Informatics Study Programs' Accreditation at University of Latvia, Riga, Latvia (2011)
- Reviewers Board of the Innovation Alliance SPES of the German Minister for Research
- Member of the chair of the „Verbandsgruppe Aachen des Deutschen Hochschulverbands"
- Coach of numerous big research activities (Collaborative Research Centers, projects within the Excellence Initiative) at RWTH Aachen University
- Member of the Finding Commissions for the Professorships "Institut für Kunststoffverarbeitung" and "Production Engineering of E-Mobility Components", both of the Mechanical Engineering Faculty at RWTH Aachen University
- Chairperson of the Audit Team of all Informatics Programs at Tartu University and Technical University of Talinn, Estonia (2012/13)
- Chairperson Team Mentoring for the First Year of Computer Science Studies at RWTH (2010 – 2012)
- Member of the Advisory Board of BMBF-Spitzencluster OWL "Intelligente Technische Systeme Ostwestfalen-Lippe", 2012 -
- Member of the Appraisal Commitee of David-Kopf-Preis 2011
- Member of the Program Committee of the Intl. Conf. on Engineering and Meta Engineering (ICEME 2011)
- Member of the Steering Committee and Member of the Applications Track Program Committee of the International Conference on Graph Transformations 2012 (ICGT 12), Bremen, Germany, September 24 – 29, 2012
- Member of the Program Committee of South African Workshop on Software Architectures SAWOSA 12
- Member of the Program Committee of European Computer Science Summit 2012, Annual Conference of Informatics Europe
- Member of the Program Committee of the Intl. Conf. on Engineering and Meta Engineering (ICEME 2012)

- Member of the Program Committee of the 18th International Conference on Reliable Software Technologies, Ada-Europe 2013, June 10-14, 2013, Berlin, Germany
- Member of the Program Committee Doktorandensymposium SE 2013
- Member of the Appraisal Commitee of David-Kopf-Preis 2012

B. Rumpe:

- Member of the Präsidium der Gesellschaft für Informatik (GI)
- Member of the Program Committee of the 14th International Conference on Model Driven Engineering Languages and Systems, from 16.10.11 to 21.10.11, Wellington, New-Zealand
- Member of the Program Committee of the 4th International Workshop on Model Based Architecting and Construction of Embedded Systems, from 18.10.11 to 18.10.11, Wellington, New-Zealand
- Member of the Program Committee of The 11th Workshop on Domain-Specific Modeling, from 23.10.11 to 24.10.11, Portland, USA
- Member of the Program Committee of Complex Systems Design & Management (CSDM) 2011, from 07.12.11 to 09.12.11, Paris, France
- Member of the Program Committee of ERTS2 2012 - Embedded Real Time Software and Systems, from 01.02.12 to 03.02.12, Toulouse, France
- Member of the Program Committee of the 8. Dagstuhl-Workshop MBEES 2012 - Modellbasierte Entwicklung eingebetteter Systeme, from 06.02.12 to 08.02.12, Dagstuhl, Germany
- Member of the Program Committee of SE 2012 - Software Engineering, from 27.02.12 to 02.03.12, Berlin, Germany
- Member of the Program Committee of MOD 2012 - Modellierung 2012, from 14.03.12 to 16.03.12, Bamberg, Germany
- Member of the Program Committee of MONTEREY 2012 - 17th Monterey Workshop on Development, Operation and Management of Large-Scale Complex IT Systems, from 19.03.12 to 21.03.12, Oxford, UK
- Member of the Program Committee of the 19th Annual IEEE International Conference and Workshops on the Engineering of Computer Based Systems - ECBS 2012, from 11.04.12 to 13.04.12, Novi Sad, Serbia
- Member of the Program Committee of ICMT 2012 - 5th International Conference on Model Transformation, from 28.05.12 to 29.05.12, Prague, Czech Republic
- Chair of FormSERA2012 - Formal Methods in Software Engineering: Rigorous and Agile Approaches, from 02.06.12 to 02.06.12, Zurich, Switzerland
- Chair of MiSE 2012 - ICSE Workshop on Modeling in Software Engineering 2012, from 02.06.12 to 03.06.12, Zurich, Switzerland
- Member of the Program Committee of FMOODS-FORTE 2012 - Joint International Conference of 14th Formal Methods for Open Object-Based Distributed Systems and 32nd Formal Techniques for Networked and Distributed Systems, from 13.06.12 to 16.06.12, Stockholm, Sweden

- Member of the Program Committee of ISARCS 2012 - 3rd International ACM Sigsoft Symposium on Architecting Critical Systems, from 26.06.12 to 28.06.12, Bertinoro, Italy
- Member of the Program Committee of ECMFA-2012 - Eight European Conference on Modelling Foundations and Applications, from 02.07.12 to 05.07.12, Kgs. Lyngby, Denmark
- Member of the Program Committee of ICECCS 2012 - 17th IEEE International Conference on Engineering of Complex Computer Systems, from 18.07.12 to 20.07.12, Paris, France
- Member of the Program Committee of FOSD'12 - 4th International Workshop on Feature-Oriented Software Development, from 24.09.12 to 25.09.12, Dresden, Germany
- Member of the Program Committee of SLE 2012 - 5th International Conference on Software Language Engineering, from 25.09.12 to 28.09.12, Dresden, Germany
- Member of the Program Committee of ME 2012 - 6th International Workshop on Models and Evolution, from 30.09.12 to 30.09.12, Innsbruck, Austria
- Member of the Program Committee of ACES-MB-12 - 5th International Workshop on Model Based Architecting and Construction of Embedded Systems, from 30.09.12 to 30.09.12, Innsbruck, Austria
- Workshop Organizer of the 4th ICSE Workshop on Models in Software Engineering (MiSE), June 2-3, 2012, Zurich, Switzerland
- Workshop Organizer of Formal Methods in Software Engineering: Rigorous and Agile Approaches (FormSERA). ICSE Workshop, June 2, 2012, Zurich, Switzerland
- Workshop Organizing Chair of Software Engineering 2012 Workshop Proceedings, GI-Edition - Lecture Notes in Informatics (LNI). P-199.
- Workshop Organizer of Science and Engineering of Cyber-Physical Systems (Dagstuhl Seminar 11441), Schloss Dagstuhl - Leibniz-Zentrum für Informatik
- Vice Chair of Kommission für Lehre der FG Informatik (KfL)
- Vice Chair of Kommission für Servicelehre der FG Informatik (KfSL)
- Vice Chair of Prüfungsausschuss Informatik (PA)
- Chairperson of Querschnittsfachausschuss Modellierung (QFAM) der Gesellschaft für Informatik
- Chairperson of the commitee for „Re-Akkreditierung und Modernisierung der Studiengänge Informatik Bachelor und Master“
- Chairperson of the appointments commitee for the professorship "High Performance Computing" and the associated leadership of the computer center
- Chairperson of the appointments commitee for the professorship "Dienstinformatik" ("E-Services")

Talks and Publications

Talks

M. N. Fisch, C. Pinkernell, S. Plesser and B. Rumpe: *The Energy Navigator – A Web-Platform for Performance Design and Management,* 7th International Conference on Energy Efficiency in Commercial Buildings (IEECB), Frankfurt a. M., Germany, April 2012.

M. N. Fisch, M. Look, C. Pinkernell, S. Plesser and B. Rumpe: *State-Based Modeling of Buildings and Facilities,* 11th International Conference for Enhanced Building Operations (ICEBO' 11), New York City, USA, October 2011.

C. Herrmann, T. Kurpick, B. Rumpe: SSELab: *A Plug-In-Based Framework for Web-Based Project Portals,*In: Proceedings of the 2nd International Workshop on Developing Tools as Plug-Ins (TOPI 2012) at ICSE 2012, June 3, Zurich, Switzerland, 2012.

T. Kurpick, C. Pinkernell, B. Rumpe: *Der Energie Navigator*, Workshop des Forums Informatik: Entwicklung und Evolution von Forschungssoftware (EEFSW), Kerkrade, Netherlands, November 2011

S. Maoz, J. O. Ringert, B. Rumpe: *Semantically Configurable Consistency Analysis for Class and Object Diagrams*, AlgoSyn annual Workshop, Rolduc, Netherlands, Nov. 17, 2011

S. Maoz, J. O. Ringert, B. Rumpe: Architectural Synthesis: From Partial Views to an Architecture, AlgoSyn Presentation, RWTH Aachen, Dec. 7, 2011

S. Maoz, J. O. Ringert, B. Rumpe: *An Interim Summary on Semantic Model Differencing*, Comparison and Versioning of Software Models (CVSM 2012), Co-located with the 27th IEEE/ACM International Conference On Automated Software Engineering (ASE2012), Essen, Germany, Sep. 3, 2012

S. Maoz, J. O. Ringert, B. Rumpe: *ArcV: A Formal Views Specification Language for the Structure of Component and Connector Architectures*, AlgoSyn Presentation, RWTH Aachen, Sept. 12, 2012

C. Mengi: *Refactoring of Automotive Models to Handle the Variant Problem*, Workshop: Modellbasierte und Modellgetriebene Softwaremodernisierung (MMSM), Conference "Modellierung 2012", March 2012

M. Nagl/ M. Akbari: *Mentoring in der Informatik: Motivation, Probleme, Erfahrungen, Lösungsansatz, Kick-off-Veranstaltung "Aachener Mentoring Modell"*, Aachen, 26. Oktober 2011

M. Nagl: *Continuous Professional Development Programs: Motivation, Problems, Accreditation*, Meeting of GRIN (Italian Association of Computer Science Professors), Milan, Nov. 7, 2011

M. Nagl: *Department Evaluation: A New Initiative of Informatics Europe*, European Computer Science Conference 2011, Milan, November 9, 2011

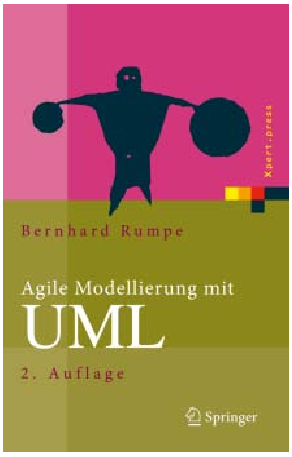
M. Nagl: *40 Jahre Informatik an der RWTH: Die zweite Hälfte 1992 – 2012*, Feier zum 40jährigen Bestehen der Fachgruppe Informatik und Ehrenpromotion John Mylopoulos, May 9, 2012

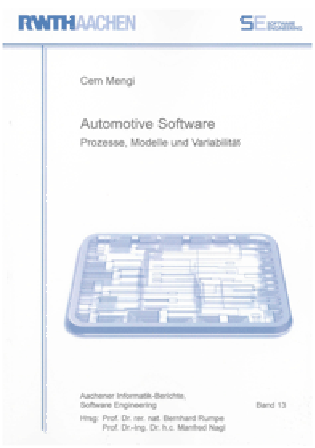
B. Rumpe: *Modularity from Code for Models,* Beitrag for a panel at Models 2011. Wellington, NZ, October 2011.

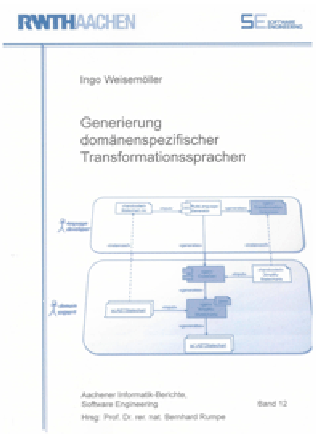
B. Rumpe: *Evolving and Synthesis of Delta-oriented Software Product Line Architectures*, TU Wien, invited speech, May 15, 2012.

B. Rumpe: *Evolving Delta-oriented Software Product Line Architectures*, Monterey Workshop, Oxford, UK, March 19-21, 2012

Books


Bernhard Rumpe
Agile Modellierung mit
UML
2. Auflage
Springer


RWTH AACHEN
Cem Mengi
Automotive Software
Prozesse, Modelle und Variabilität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Ingo Weisemöller
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Lecture Notes
in Informatics
Stefan Jähnichen, Bernhard Rumpe,
Holger Schlingloff (Hrsg.)
Software
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27. Februar – 2. März 2012
in Berlin
Proceedings

RWTH AACHEN
Erhard Herbert Weinell
Ein Rahmenwerk für operationale
Spezifikationssprachen
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mittels Graphtransformationen

RWTH AACHEN
Martin Schindler
Eine Werkzeuginfrastruktur zur
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AutoUni
Frank Schuren
Probabilistische Situationsanalyse
für eine adaptive automatisierte
Fahrzeugführung

AutoUni – Schriftenreihe

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M. Nagl, M. Akbari, Th. Leonhardt, M. Frickenschmidt, S. Schalthöfer: *Mentoring in der Studieneingangsphase – Erfahrungen aus der Informatik der RWTH Aachen*, 22 pp., Sept. 2012

Th. Leonhardt, M. Akbari, M. Nagl, S. Schalthöfer, M. Frickenschmidt: *Mentoring Informatik RWTH – Auswertung einer Umfrage*, 5 pp., Sept. 2012

MentoringTeam Informatik (M. Akbari, Th. Leonhardt, M. Nagl, M. Frickenschmidt, S. Schalthöfer): *Mentoring für die Studieneingangsphase, Programm für das erste Semester*, 26 pp., Sept. 2012

MentoringTeam Informatik (M. Akbari, Th. Leonhardt, M. Nagl, M. Frickenschmidt, S. Schalthöfer): *Mentoring für die Studieneingangsphase, Programm für das zweite Semester*, 12 pp., Sept. 2012

S. Maoz and Y. Sa'ar: *Two-Way Traceability and Conflict Debugging for AspectLTL Programs* In Proc. 11th Int. Conf. on Aspect Oriented Software Development (AOSD), 2012, ACM, pp. 35-46.

A. Haber, H. Rendel, B. Rumpe, and I. Schaefer: *Evolving Delta-oriented Software Product Line Architectures,* In: Large-Scale Complex IT Systems. Development, Operation and Management, 17th Monterey Workshop 2012, Oxford, UK, March 19-21, 2012. LNCS Vol. 7539, pp. 183-208.

O. Liskin, C. Herrmann, E. Knauss, T. Kurpick, B. Rumpe, and K. Schneider: *Supporting acceptance testing in distributed software projects with integrated feedback systems: Experiences and requirements,* In: Proceedings of 7th International Conference on Global Software Engineering (ICGSE'12), Puerto Alegre, Brazil, pp.84-93, 2012.

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Software Construction

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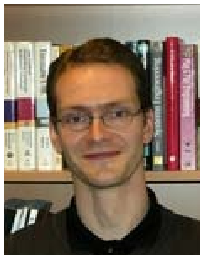

- **Student Researchers**
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  Christian Charles
  Elena Pyatkova
  Claude Mangen
  Andrej Dyck

Overview

Our research focuses on the development of new and advanced methods, tools, and techniques in the broad area of software construction. Since software engineering is done in software developing organizations, we always try to develop and deliver software engineering support that is applicable under industrial software development conditions. Hence, most of our research projects are performed in close cooperation with industrial partners. Currently we are actively working in the following areas:

- *Metric-based Project and Process Management*. Like in other engineering disciplines, measuring is a prerequisite to determine the performance of processes and products. We are aiming to develop an integrated highly customizable measurement infrastructure.
- *Goal-based Process Improvement*. Reference models (e.g. CMMI, SPICE) are used by organizations to improve software processes. A systematic approach is developed to decide which combinations of them are best suited for the intended improvement.
- *Interactive Use Case based Prototyping*. Since prototypes are typically created manually we develop a generative approach to automatically create interactive prototypes from use case based requirements specifications.
- *Reusing Domain Engineered Artifacts for Code Generation.* Model driven engineering uses certain diagrams to foster code generation. But these diagrams are rarely reused; overcoming this is one goals of this project.
- *Architecture Evolution and Evaluation.* Software tends to evolve independently from their architecture description. We are developing an approach to monitor and evaluate the state of the architecture and to support the goal-based evolution of the software system.

Since appropriate tools are often the door opener to transfer research ideas to practice we are developing dedicated tool support for those areas. Currently we offer the following tools:

- ViPER (Visual Tooling Platform for Model-Based Engineering, www.viper.sc)
- QMetric and BugzillaMetrics (www.qmetric.org)
- OpenUMF (Use Case based Requirements Modeling Framework)
- MeDIC (Metric - Documentation, Integration, and Configuration)
- MoCCa (Model Composition and Combination Vault)

In 2012 we received the Best Paper Award of EuroSPI 2012, Vienna for the paper *"Towards an Integration of Multiple Improvement Reference Models based on Automated Concept Extraction"* written by Simona Jeners, Horst Lichter and Ana Dragomir.

Teaching

We offer the following courses on graduate level:

- Lecture Software Quality Assurance
- Lecture Object-Oriented Software Construction
- Lecture Software Project Management
- Seminars and Practical Labs

Research Projects

Reusing Domain Engineered Artifacts for Code Generation

A. Ganser, H. Lichter

Model driven architecture (MDA), and model driven engineering (MDE) are promising approaches to increase reuse and to reduce development time and effort.. Both comprise of several methods which include a domain specific modeling (DSM). This methodology brings about figures which maps the objects under consideration to models. Among these models are class diagrams as know from UML which are called domain models in these contexts.

While both approaches take these domain models as inputs for code generation, only MDE includes reuse in DSM. But this reuse remains rather rudimentary. Taking a closer look at model repositories one might suppose that these repositories are meant to store models so they can be reused rather easily in different projects. But the goals for these tools are totally different! All the available repositories (by and large) only consider versioning, migration, transformation, conflict detection, merging and search. This means, models are not related to each other, there is barely a description of models, no examples are present how the models could be used or no interfaces are defined which point to the most important aspects that could help reusing a particular model.

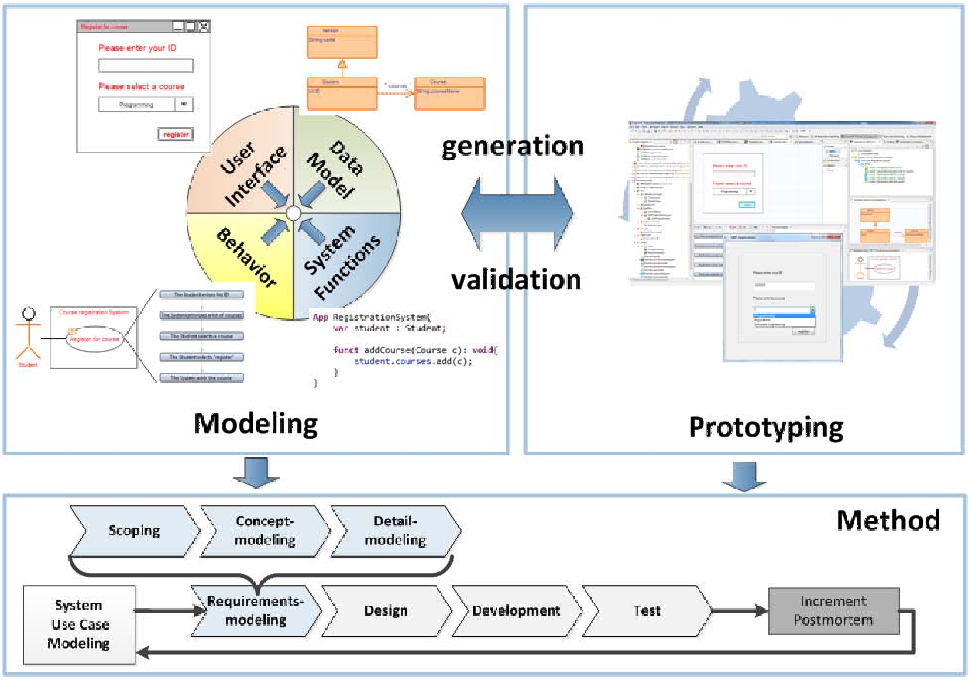
The goal of this research project is to bolster model reuse by providing interfaces attaching descriptions and providing examples and models by means of recommender systems. Furthermore, models should not be treated as in an isolated world, but related to each other, knowing not only that these models worked out together but even how they did. These relationships cross borders and overcome the usual reuse obstacles and unleash the full power of previously modeled knowledge.

Interactive Use Case based Prototyping

V. Hoffmann, H. Lichter

Nowadays prototypes are typically created manually and they are not directly connected to other requirements specification documents. Therefore we have devised a generative approach to derive interactive prototypes automatically from a use case based requirements specification.

Our approach is based on an integrated requirements model that combines functional use case models with user interface prototypes and domain concept models. Additionally we have defined a formal token-flow based execution semantic for this model.



Based on this requirements model we have created a fully automated transformation approach that is able to generate interactive behavior prototypes. The simulation runs are performed on UI mockups derived from user interface prototypes. This enables non technical stakeholders to experience the behavior in a simple intuitive fashion and can additionally be used as basis for feasibility studies. Because of a specific structure of our generation approach we are moreover able to use the simulation proactively during requirements modeling.

Goal-based Process Improvement

S. Jeners, H. Lichter

External cooperation: Generali Informatik Services, Aachen

Nowadays, the software market is expanding and clients are requesting better, faster, and cheaper software products. One important impact factor to project success is the quality of the applied IT-processes. Hence, more and more organizations are obligated to identify, structure, and improve their processes systematically. There is a variety of improvement reference models (IRMs) known as maturity-, process- and quality-models as well as standards, norms, etc. that can be used. Organizations have to decide which of these models they want to use. The adoption of multiple IRMs allows an organization to exploit synergy effects between them. On the one hand organizations can address co-coordinately different and common areas. On the other hand the weaknesses of a single IRM can be overcome by the strengths of others.

The aim of this project is to develop a model based approach that provides an objective and semiautomatic selection of improvement practices of multiple IRMs that best fit to an

organization. To select the best suited practices the organizations' internal processes, wishes, problems, environment etc. have to be considered. The selected practices have to address the improvement potentials of the internal processes and the organizations' wishes. These are reflected by the goals of the organization. The selected practices should also be evaluated and filtered according to their return on investment. According to goals and on this analysis improvement practices can be selected that are extracted from similar or standalone practices from a build-in repository of all considered IRMs. For an efficient implementation of the IRMs, the traces between the improvement practices and their corresponding IRM' practices and the dependencies between the improvement practices are also given. For efficient adoption and further selection of improvement practices, the implementation of the improvement practices should be continuously monitored considering the given goals.

Model-based Testing of Web Applications

T. Sattaya-aphitan, H. Lichter

External cooperation: TOT Public Company Limited, Bangkok

In contrasts to traditional software, there are many aspects of web applications that are different. First, web applications typically implement a 3-tier-architecture comprising web browser, web server and database tier which are communicating by stateless protocols such as HTTP request and HTTP response. Second, each tier is implemented using a diversity of programming languages (e.g. HTML, JavaScript, JSP, PHP, ASP). Third, web pages are often generated from prior dynamic web pages which depend on their previous inputs and server's states.

There are many published approaches to test Web application. However, none of these approaches reflects the complete behavior of web applications. This project aims to develop a new model-based testing approach using structural analysis methods, called white–box testing. The basic idea is to transform the source code into an intermediate model which is used to generate test cases, test setup information and test oracle information. In addition, our proposed approach introduces a novel coverage metric called "Content Coverage". The generation procedure ensures that there are no duplicated and no un-executable test cases as well as 100% content coverage. The approach should guide testers to setup the test environment before running the test cases (e.g. selecting input data and parameters needed to run the tests) and aims to produce expected results which can be automatically compared to the actual program execution.

Strategic Release Management of Platform-based Architecture

M. Firdaus Harun, H. Lichter

To deliver software products on schedule, development teams struggle focusing on the build, deploy, test, and release process. In general, development teams employ ad hoc release plans or reuse release processes that are based on personnel experiences and previous projects. This practice can lead to severe problems.

As software systems and their development processes grow more complex, the release processes also become complicated. The structure of the software can be modeled by components and modules and their interdependences. Sometimes components are built from different platform for e.g. .Net, EJB, J2EE, etc. Therefore, a deep understanding of the designed architectures and the constraints of the applied software development is a must to specify and set up appropriate release processes in order to always ship the right version of components or elements into deployment environments and to release the software on time.

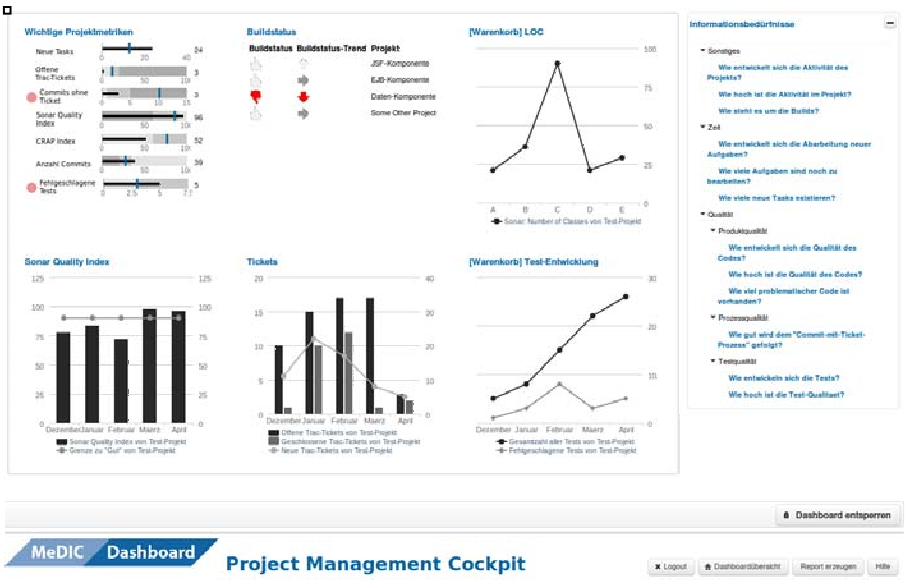
This research project aims to investigate what are factors and constraints that influence release processes. Finally, we want to propose a strategic and holistic approach to release management to deal with the multifaceted constraints.

Metric-Based Project and Process Management

M. Vianden, H. Lichter

External cooperation: Generali Informatik Services, Aachen

It is commonly known, that projects management greatly benefit by the application of metrics. However, research shows that it is demanding to find the right metrics; 58% of all project managers and 50% of all senior managers find it difficult to collect, analyze, and use the right metrics. On the one hand, metric frameworks like GQM help to derive metrics from abstract goals for the project. On the other hand, defining measures just for one project (in a multi project organization with a lot of similar projects) is costly and ineffective. Hence, it is wise to reuse metric experience (metric definitions, evaluations, and models) as all experience can and should be reused.



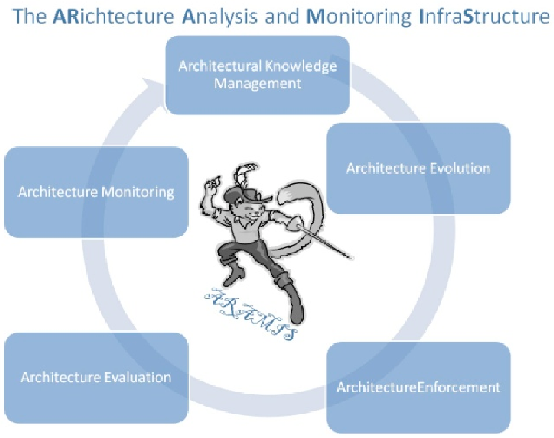
Although considerable research has been devoted to the modeling of metrics and metric frameworks, rather less attention has been paid to investigating how the results of this research (metric meta models, metric frameworks, and metric experience bases) can lead to a sound concept for metric reuse. Therefore, the aim of this project is to develop such a concept for metric reuse. The concept should be enriched by metric processes which include metric reuse as well as dedicated tool support for metric documentation, metric reuse and metric calculation.

Model-based Software Architecture Evolution and Evaluation

A. Dragomir, H. Lichter

External cooperation: Generali Informatik Services, Aachen

The architecture of software systems directly influences crucial quality attributes and therefore should be considered whenever important decisions regarding their evolution must be taken. However, up-to-date descriptions that correctly reflect the static, dynamic and deployment view of the system's architecture rarely exist. On the one hand, architecture descriptions are usually elaborated at the beginning of a software project. On the other hand, after the initial version of the system has been constructed, it tends to evolve independently from its architecture description. Changes to the system are rarely documented properly and originally imposed rules are gradually violated. In extreme cases, it can become completely unclear how the software system performs its use-cases.



The aim of the ARAMIS project is to develop an approach that supports the model-based evolution and evaluation of the architecture of a software system. To achieve this, a method to continuously monitor the state of the software architecture will be employed. This will produce up-to-date architecture descriptions at various levels of abstraction and from various points of view, to support the needs of all the involved architecture stakeholders. Also, we will investigate how to enable stakeholders to easily create rules that should be imposed on the software architecture and then use these rules to periodically check if the architecture is still conformant with them. Furthermore, we will research if currently existing metrics can be used to regularly evaluate the state of the architecture, or if new ones should be developed. As a result, we plan to offer a continuous overview of the quality evolution of the architecture of the software system. Finally, we intend to develop a method for defining architecture variants and then employ the previously-mentioned metrics to analyze which of the evolution variants is better.

Special Events

Workshop – Entwicklung und Evolution von Forschungssoftware (EEFSW)

Rolduc, November 10-11, 2012

Many research projects use software systems to solve problems and perform tasks in order to successfully work on the research goal. However, these software systems are influenced by a lot of factors. Some of the systems are just used for a short time and are not needed after that. At the same time, a lot of systems grow over years and become important research platforms or even become products which are used in the industry. Consequently, we need to organize research oriented software development different than classic product focused software development.

The workshop started with the introduction of 12 different research projects from different domains and different software engineering backgrounds. On the one hand, some of the software systems are very established and maintained for a long time (older than 25 years). On the other hand, we got introduced to the problems associated with very young projects.

Based on the (good and negative) experiences from these presentations we decided what topics we like to address and discuss in the working sessions on the second day. The results of these sessions were presented to all participants of the workshop and thoroughly discussed. The most interesting result of the workshop was the development of a process framework for the integration of thesis into a standard development process.

DER Semesterplaner

Based on the task of our lab in summer term 2012 we started the Semesterplaner project with 6 student volunteers from the lab. The goal is to provide a tool that assists students with the planning of their upcoming courses. This assistance is provided by showing an integrated view of the average week in the next semester and an overview of the exam months. Hence, the student can check if an exam is too close to another one as well as being aware of collisions of weekly events like lectures or exercises. In a later version of the tool we also want to include an overview of the progress of the student in his/here field of study, therefore, enabling the student to quickly get an overview of the courses that are currently missing to complete a curtain field of study.

Other Activities

- Organization of Forum Informatik Workshop Entwicklung und Evolution von Forschungssoftware, Rolduc, November 10-11, 2012, *H. Lichter, V. Hoffmann, M. Vianden, A. Ganser*.
- Member of the international program committee, 3rd International Workshop on Formal Methods and Agile Methods, Thessaloniki, Greece, October 2, 2012, *H. Lichter*
- Member of the international program committee, 2tth Annual ACM Symposium on Applied Computing, Software Engineering Track, Riva del Garda (Trento), Italy, March 26-30, 2012, *H. Lichter*
- Member of the international program committee, 6th IEEE International Conference on Software Security and Reliability (SERE),Washington D.C., June 20-22, 2012 *H. Lichter*
- Member of the program committee, Software Engineering 2012, Berlin, February 27 – March 2, 2012, *H. Lichter*
- Member of the program committee PhD Symposium at Software Engineering 2012, Berlin, *H. Lichter*
- Member of the program committee Modellierung 2012, March 14.-16, 2012, Bamberg, *H. Lichter*
- Head of program committee and organization of International Workshop on CMMI based Software Process Improvement in Small and Medium Sized Enterprises (SPISME 2011), December 11, 2011, Johor Bahru, Malaysia, *H. Lichter*
- Member of the international program committee of 5th International Malaysian Conference on Software Engineering, December 12-14, 2011, Johor Bahru, *H. Lichter*
- Panel Member of 3rd Software Engineering Postgraduates Workshop, December 12, Johor Bahru, Malaysia, *H. Lichter*
- Visiting Professor at Universiti Teknologi Malaysia, Johor Bahru, Malaysia, December 2011, *H. Lichter*
- Reviewer for dpunkt-Verlag Heidelberg and computing reviews, *H. Lichter*
- Organization of the Computer Science Department's mentors program, *H. Lichter*
- Member of the Computer Science Department's committee for Lehre and Service-Lehre, *H. Lichter*
- Member of the examination board of Computer Science, *H. Lichter*
- Member of workgroup "Zusammenarbeit Hochschule und Industrie", GFFT, Gesellschaft zur Förderung des Forschungstransfers, *H. Lichter*
- Member of the board of management AFST, Association for Social Technologies e.V., Aachen, *H. Lichter*
- Organization of the Universal / Specialized Preparatory Courses in Computer Science 2012, *H. Lichter, A. Ganser*
- Project lead conducting "Personalisiertes Lernen von fachlichen Grundlagen und Studientechniken in Vorkursen" (Exploratory Teaching Space), 2012, *H. Lichter, A. Ganser*

- Member of Preparatory Course Task Force, 2012, *A. Ganser*
- Member of Computer Science Faculty Committee, 2012, *A. Ganser*
- Member of RWTH Aachen University Scientific Staff Committee, 2012, *A. Ganser*
- Member of Steering Committee Computational Science Center RWTH, 2012, *A. Ganser*
- Member of Steering Committee ZLW/IMA, 2012, *A. Ganser*
- Contributor to Mentoring Program for beginners in Computer Science, 2012, A. Ganser
- Member of workgroup "Qualität von textuellen Anforderungen", GI, Gesellschaft für Informatik – Fachgruppe Requirements Engineering , *V. Hoffmann*

Talks and Publications

Talks

H. Lichter: Software Processes in an Agile World. Proceedings of International Workshop on CMMI based Software Pr.ocess Improvement in Small and Medium Sized Enterprises (SPISME 2011), Johor Bahru, Dec-12, 2011.

H. Lichter: Software Engineering Research and Industry Cooperations, Department Software Engineering, Chulalongkorn University, Bangkok, February 9, 2012.

S. Jeners: Towards an Integration of Multiple Improvement Reference Models based on Automated Concept Extraction. 19th EuroSPI Conference, BENA Business Base Nineteen, Vienna, Austria, 25.-27. 06. 2012.

M. Vianden: MeDIC - Eine Infrastruktur zum Verwalten, Dokumentieren und Visualisieren von Metriken. Workshop Entwicklung und Evolution von Forschungssoftware, Rolduc, November 10-11, 2012.

C. Piyabunditkul,: SPI through Process Tailoring Framework with Objective-based Scoring Metric. 19th EuroSPI Conference, BENA Business Base Nineteen, Vienna, Austria, June 25-27, 2012.

Publications

Simona Jeners, Horst Lichter, Ana Dragomir (2012): Towards an Integration of Multiple Improvement Reference Models based on Automated Concept Extraction. 19th EuroSPI Conference, BENA Business Base Nineteen, Vienna, Austria, 25.-27. 06.2012, in Winkler, Dietmar, O'Connor, Rory V., Messnarz, Richard (Eds) Systems, Software and Services Process Improvement, Communications in Computer and Information Science, vol 301, 978-3-642-31199-4, Springer Berlin Heidelberg, pp 205-216,

Tisanai Krisanathamakul, Chayakorn Piyabunditkul, Apinporn Methawachananon, Pawarat Nontasil (2012): SPI through Process Tailoring Framework with Objective-based Scoring Metric. 19th EuroSPI Conference, BENA Business Base Nineteen, Vienna, Austria, 25.-27. 06.2012, R. Messnarz et al. (Eds.), Industrial Proceedings, DELTA, Denmark, pp 11.23-11.31, ISBN 978-87-7398-154-2.

T. Thanarukvudhikorn, A. Ganser, H. Lichter, T. Anwar (2011): RIOT: Rapid, Iterative and Off-The-Shelf Tool-Evaluation, 5th Malaysian Conference on Software Engineering, MySEC 2011, 12-14 December, Johor Bahru, Malaysia, pp. 489-494, doi: 10.1109/MySEC.2011.6140722.

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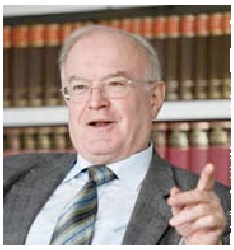
H. Lichter (2011): Software Processes in an Agile World. Proceedings of International Workshop on CMMI based Software Process Improvement in Small and Medium Sized Enterprises (SPISME 2011), Johor Bahru, Dec-12, 2011, ISBN 978-967-0194-14-1, pp 7-12.

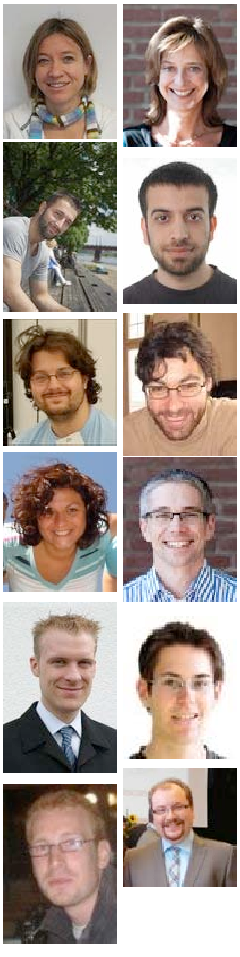
Meiliana, M. Vianden, H. Lichter (2011): Variability Model towards a Metric Specification Process. International Conference on Computer Science and Information Technology (ICCSIT'2011), Pattaya Dec. 17-18, PSRC – Planetary Scientific Research Center, ISBN 978-81-922428-2-8, pp 76-79.

O. Sarkoses, M. Vianden, H. Lichter (2011): Evaluating Presentation Layer Development Frameworks for EJB Applications in J2EE Architecture. International Conference on Computer Science and Information Technology (ICCSIT'2011), Pattaya Dec. 17-18, PSRC – Planetary Scientific Research Center, ISBN 978-81-922428-2-8, pp 37-41.

Communication and Distributed Systems

Staff





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