Informatik 5
Information Systems

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  - The MRS Consultancy Ltd, Grafia s.r.o, Asset Technology Ltd, Greta du Velay, triagens AG, Zalando,
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  - Universitätsklinikum Düsseldorf.
Overview

Today, the field of Information Systems does not include only structured databases, but at least equally important the semi-structured and unstructured data on the web. The Chair of Information Systems addresses both domains, with the management of metadata (data about data) in the kernel of its research interest. Current major themes include mobile web services and metadata model management, but also applications such as personal mobility, life science data management, and lifelong technology-enhanced learning.

In 2015, we celebrate the 20th Anniversary of SUNSite Central Europe (CEUR). Being one of the first large-scale public web servers after Tim Berners Lee introduced the World Wide Web. CEUR was a catalyst for making the web a mass phenomenon in central Europe, as almost ten million users downloaded their first Netscape or Internet Explorer web here. CEUR also supported the first websites of the German track and field organization, of the city of Aachen, and numerous web community initiatives, such as the worldwide largest board game database, the mirroring of DBLP and Dagstuhl websites, and perhaps most importantly, the CEUR workshop proceedings series, with over 1.300 published volumes one of the earliest and largest Open Access publishers in the computer science arena. In its 20th year, CEUR still enjoys over 35 million accesses per month, even though its original name- (and server-)giving organization no longer exists.

A second and at least equally important highlight came in the last month of the academic year: Professor Stefan Decker joined Informatik 5 as a second full professor on September 1, 2015, from the Digital Engineering Research Institute (DERI) in Galway, Ireland. He will lead the group jointly with Matthias Jarke for the next few years, and also joins Prof. Jarke as second institute leader at Fraunhofer FIT.

The year 2014-2015 also saw the successful completion of a record number of nine doctoral defenses at Informatik 5, including six by researchers from Fraunhofer FIT. Among the others, Anna Hannemann (Zalando AG) and Konstantin Vandikas (Ericsson) both accepted senior management resp. Research positions in industry following their defense, whereas our postdoc Dr. Michael Derntl took a senior research position at Tübingen University. New doctoral researchers include Arnab Chakrabarthy and Rihan Hai, further increasing the internationality of the team to 15 countries in four continents, even without considering the student assistants. The share of women among scientific personnel remains at 20%, well above the female share of Aachen informatics students, among the doctoral defences it was even a bit higher, including the only “summa cum laude”.

Informatik 5 researchers continued to be active in co-chairing international conferences (ICWL G, ICGSE, SmartGreens) and editing special issues of leading international journals (Information Systems, Data&Knowledge Engineering, ACM TMIS, Parallel and Distributed Database Systems, Pervasive and Mobile Computing). For individual publications, they received awards for best paper (Sun et al., BUSTECH 2015), best demo/Poster (Nicolaescu et al., ICWE 2015) and best bachelor theses (Sebastian Krott, 2014; Fabian Ohler, 2015).

On administrative matters, we were involved in a host of strategy processes and audits at Fraunhofer FIT, Fraunhofer ICT Group, and the Bonn-Aachen International Center for Information Technology (b-it), fortunately all with positive results, but also enormous effort. In addition, Minister Gabriel appointed Prof. Jarke to the National IT Summit Platform Committee of the BMWi, “Innovative Digitalization of Business”, and EU Commissioner Oettinger and Director General Roberto Viola re-appointed him to the CONNECT Advisory Forum of the program HORIZON 2020 for the period 2015-2017.
As a new member of the RWTH Aachen Community and Informatik 5 I am happy to have the opportunity to introduce myself. I grew up in Vreden, part of Westmünsterland in North Rhine-Westphalia. RWTH Aachen University was well known in Computer Science then, so I wanted to study Computer Science in Aachen, but like many Computer Science students at the time the ZVS (Zentralstelle zur Vergabe von Studienplätzen) assigned me to Kaiserslautern (also an excellent University!), where I focused on everything “Logic”. In the end I wasn’t sure if I had a degree in Logic or in Computer Science. The exam board wasn’t sure either. During my studies I worked as a student in IBM in Heidelberg and Böblingen, and published my first paper with the lengthy title “Universally Quantified Queries in Language with Order-Sorted Logics” and did my diploma thesis on Integrity Checking in Deductive Databases. During my diploma thesis in IBM the World Wide Web happened – as I discovered when I emerged from IBM, noticing the excitement on campus among the Computer Science students.

The Web became my focus ever since, in particular how to realise a Web of Data – in combination with topics fitting for a PhD Degree at the Economics Faculty (like Knowledge Management and Business Process Modelling) with Prof. Rudi Studer. In 1998 I participated in a Workshop at W3C in Boston, at which I met Tim Berners-Lee for the first time, and realised what potential the Web of Data has. In 1999 (while procrastinating finishing my PhD) I moved to Stanford University to work with Prof. Gio Wiederhold in the Database group. DARPA cited my work as one of the inspirations for a program, so together with Prof. Wiederhold I applied for a grant, and then had the resources to continue my work and build a group for three years (with the consequence of further procrastinating finishing my PhD – there were simply much more important and interesting things to do). In Stanford I initiated the first larger Semantic Web meeting (aiming at a small workshop, which turned out to attract 250 people. Imagine my panic.), which evolved into the International Semantic Web Conference. But I eventually had to move, prompting me to stop procrastinating on my PhD (it’s amazing how motivating the search for a new job can be) and joined the staff of ISI at the University of Southern California. There a former colleague from Karlsruhe – Dieter Fensel – asked me to move to the NUI Galway, Ireland, to help build a research institute in my area. (from a climate perspective a questionable improvement, as we noticed). Two years later I became the Director of DERI. I am very grateful for the opportunity given in Ireland, and enjoyed, together with many other people, building up DERI to about 130 people and one of the core contributors in the field, with many industry collaborations. But after 12 years in Ireland, it was time to move again, and I am very happy to be given the opportunity for work side-by side with Prof. Jarke here at i5 at RWTH Aachen University and Fraunhofer FIT.

I am still excited by the idea to turn the World Wide Web into a Network of globally interconnected, integrated, and accessible machine readable knowledge¹, vastly improving human problem solving capabilities in business, science and society and there is still a lot of work left. Having wanted to study at RWTH Aachen, moving to RWTH Aachen University and Fraunhofer FIT feels like having finally arrived, and I am grateful for the warm welcome.

¹ With the Linked Data Cloud as its first incarnation – see http://lod-cloud.net.
In eConnect Germany, the BMWi lighthouse project in the field of ICT for electromobility, seven regional utilities together with software houses and researchers are developing applications for sustainable personal mobility based on electric energy. The objectives of the project include smart grids for renewable energy, mobility concepts for urban areas, smart parking for vehicle to grid scenarios, information systems for public transportation, and finally, smart charging for electric vehicles. Informatik 5 coordinates the project activities of the seven participating institutes of RWTH Aachen University. In four workshops with academic and industrial participants, we focused on knowledge acquisition, requirements engineering, and conceptual modelling for mobility concepts in urban and rural areas. For a new mobility concept of the City of Osnabrück, the current public transport situation was analysed and the city master plan was consulted to detect actual conceptual drawbacks and system operation bottlenecks. Near and medium term objectives for urban mobility were defined to improve the public transport infrastructure and mobility efficiency supported by electric vehicles.

The new mobility plan for the City of Osnabrück requires a higher integration of mobile transport systems, e.g. trains, busses, shared e-bikes, shared e-cars, and redesigned mobility points, e.g. integrated bus, e-bike and e-car station, while reducing the usage complexity of this new public transportation system. Representative mobility scenarios were used for use case deduction, requirements analysis for planning and navigation in the new system, and finally, the technical specification of an intuitive smartphone application supporting the user in pre- and on-trip planning and navigation.

IXSI (Interface for X-Sharing Information) is a standardization proposal for an interface between travel information systems and ride sharing systems, e.g. car sharing. IXSI enables travel information to combine public transport and ride sharing to intermodal itineraries. The interface is based on a XML schema and uses Websockets for asynchronous transfers. IXSI is collaboratively developed by cantamen GmbH, HaCon Ing.-Ges. mbH and Informatik 5. In eConnect Germany, IXSI is used to connect the carsharing service provided by Stadtteilauto Osnabrück and the travel information system CityNavigator.

In collaboration with Smartlab GmbH, Informatik 5 developed a prototype for a parking lot management systems for electric charging stations. Because of the relative low number of charging stations, the utilization should be as efficient as possible. This requires to prevent vehicles blocking the station by parking without charging. This case is detected by the developed system using sensors. In this case the charging station warns the driver with signaling LEDs and eventually informs the management system in order to take further steps.

eConnect Germany ended successfully in December 2014.
Aim of the BMWi project MobilityBroker, started in October 2013, is the first-time combination of all mobility services in a region on a single virtual marketplace. Instead of having to use, e.g. different applications for different services, the system will function as a single point of contact for regional travels offering intermodal travel. By combining different mobility services (Bus, Train, Carsharing, Bikesharing, Cab etc), users will be able to easily select the best route based on his personal preference, e.g. best price or fastest travel. The routing incorporates real-time schedule and vehicle availability data. As an user interface to this marketplace, both a mobile and a web platform are being developed.

Informatik 5 designs the overall system architecture and develops two key components. One is responsible for the information exchange among participating mobility providers and the other one for the integration of sharing systems into the routing. Informatik 5 also supports the project partners with requirements engineering, e.g., of the mobile application.

In August 2015, the mobility station at RWTH University Campus Hörn successfully opened. Accordingly to one focal point of the project, the mobility station locally combines electronic sharing services and public transportation. As part of an initial test phase, users are able to query, book and utilize heterogeneous modes of transportation with the help of a comprehensive travel information system.

UFO: Urban Future Outline

K.-H. Krempels, M.C. Beutel, M. Jarke,
M. Ziefle (Communication Science), C. Schröder (Linguistics)
HumTec Program within
RWTH Excellence Concept „RWTH 2020“

UFO is an interdisciplinary research project on quality of life in city quarters in the context of mobility, city structure and Energiewende. It consists of three subprojects: FuMob (Future
Mobility), FuEco (Future Ecosystem) and FuEne (Future Energy). Informatik 5 participates in FuMob and FuEne. FuMob addresses requirements, capabilities and limitations of public communication and information when planning and implementing new mobility concepts. New approaches for planning and realizing infrastructure decision-making will be developed with systematic stakeholder involvement (citizens, decision makers, experts, etc.) in a sustained manner. The tasks of Informatik 5 comprise requirements engineering, analysis of perspectives with relation to mobility chain and designspace, selection of suitable prototypical mobility scenarios and a user-centered, adequate communication and information concept.

FuENE focuses on roadmapping sustainable and environmentally suitable energy turnaround. A comprehensive model and methodology for the realization of sustainable resilient energy systems will systematically integrate social factors (customer perception of energy systems) into the technical, economical and informational process of identification, planning and realization of energy scenarios. Informatik 5 will develop of parameters, strategies and solution spaces along with analysis and modeling of future scenarios.

### Future Mobile Internet Services

M. Jarke, R. Klamma,
D. Kovachev, I. Koren, D. Renzel, P. Nicolaescu,
M. Jansen (Sbg), G. Toubekis (Sbg)

http://dbis.rwth-aachen.de/cms/projects/virtualCampfire

This project within excellence cluster UMIC which ended in late 2014, aimed to provide professional communities such as researchers’ communities for cultural heritage management an advanced framework to create, search, and share multimedia artifacts with context awareness easily and fast. Requirements from professional communities are analyzed based on real research scenarios in cultural heritage management in Afghanistan together with researchers from Aachen Center for Documentation and Conservation. Research based on those requirements dealt with problems and challenges of mobile multimedia management for professional communities. We have established a research framework for mobile multimedia management with metadata standards and hybrid tagging approaches, cloud computing for mobile multimedia processing and mobile communities, convergence research on mobile and Web 2.0, social network analysis for mobile communities, and prototyping and engineering of complex community information systems. Research on different levels was carried out:

- On the system level: the scalability and flexibility of our cloud framework for fostering cross-domain mobile multimedia services have been demonstrated with approaches to seamless mobile device augmentation with cloud resources, cloud-based video processing and enhancement of user experience with mobile video streams. Requirements and design guidelines of multimedia clouds that enable the execution of web-scale multimedia applications with a few efforts are well considered and analyzed. Research work also includes a hybrid architecture and realization of i5Cloud, which serves as a substrate for scalable and fast time-to-market mobile multimedia services.

- On the mobile multimedia level: focus is placed on advanced collaborative multimedia applications utilizing multimedia metadata standards like MPEG-7 and real-time communication protocols like XMPP. Mobile cloud computing strategies at the convergence of web and mobile endpoints have been applied, too. A variety of mobile devices (Android smartphones & tablets, iPhones & iPads) access different multimedia services via i5Cloud. Even advanced 3D laser scanners and gigapixel image equipment have been integrated within professional workflows powered by i5Cloud services.
On the user/community level: validation of the research is conducted in different application domains e.g. in technology enhanced learning, mobile community recommender systems with scalable SNA methods to visualize and discover development of mobile communities, and distributed user interfaces over a federation of multiple mobile personal computing devices.

Research results have been published in proceedings of international conferences and workshops, along with many Virtual Campfire and i5Cloud system demonstrations. The ground-laying work was extended in successor projects like Learning Layers (i5Cloud), Nefertiti and Direwolf 2.0. They were all demonstrated at the UMIC day in 2014.

B-IT Research School: Multimedia Cloud Computing
M. Jarke, R. Klamma, D. Kovachev, A. Rafique

http://dbis.rwth-aachen.de/cms/projects/i5cloud

Cloud computing envisions the notion of delivering software services and customizable hardware configurations to public access, similar how public utilities (electricity, water, etc.) are available to the common man. The cloud abstracts infrastructure complexities of servers, applications, data, and heterogeneous platforms, enabling users to plug-in at anytime from anywhere and utilizes storage and computing services as needed at the moment. The goal of our mobile multimedia cloud (i5Cloud, now Tethys) is to provide infrastructure as a service (IaaS) and platform as a service (PaaS) for diverse services and applications in the domain of (mobile) multimedia and large-scale social network analysis. A dissertation project by D. Kovachev was successfully defended in 2014.
Cooperative Cars – CoCar

M. Jarke, C. Quix, S. Geisler, S. Schiffer (Knowledge-based Systems Group)

http://dbis.rwth-aachen.de/cms/projects/CoCar

The Cooperative Cars (CoCar) project, supported by the German Federal Ministry for Research and Education and Ericsson EuroLabs, tested the suitability of UMTS technologies and their foreseeable extensions (such as LTE) for direct, targeted transmission of traffic data arising from both stationary and vehicle-based sensors. The CoCar project was a part of the research initiative Adaptive and Cooperative Technologies for the Intelligent Traffic (aktiv) led by the German automotive industry. Several partners from telecommunications and automobile industry identified which traffic management and driver assistance applications are suitable for use of this technology.

Informatik 5 cooperated in this project with Ericsson in Aachen and Fraunhofer FIT and develops data models, algorithms and systems for the data processing of CoCar applications. A data stream-based evaluation framework has been developed which features especially a data quality component enabling the continuous monitoring of multiple data quality measures during data processing. This allows not only to produce new traffic information such as queue-end warnings, but also to add a reliability value for this information. Furthermore, countermeasures can be activated if the data quality drops below a certain threshold. For example, if there is not a sufficient number of CoCars to produce reliable traffic messages, additional sources, such as floating phone data or road-side units can be taken into account.

External Cloud Provider (Eg. Amazon AWS)
BOOST provided a platform and a methodology for small and micro enterprises to set up, deploy and utilize learning processes according to their critical business needs. The platform is based on the ROLE SDK and therefore open source. It can be hosted by national Vocational Education Providers (VET) as demonstrated in the project with the roll-out to more than 40 companies in five European countries. The BOOST project has been carried out by partners with expertise in vocational education and training and e-learning development and its provision. The results of the BOOST project lead to changes in thinking and practice particularly in the area of VET methodological approaches to small and micro enterprises and associated software / tools. The full impact of the BOOST project on SMEs, MSEs, VET providers and other target groups can be in many respects assessed depending on the future switching from a prototype platform to a general availability tool, provided the partnership can obtain further resources. Taking into account all the above evidenced results there is no doubt that the BOOST project has achieved its main aims and objectives in creating a cross-border and cross-cultural approach to increasing participation by micro and small enterprises in vocational education and training. We already secured funding for an ERASMUS+ project for establishing Virtual Training centers based on ROLE, BOOST and Learning Layers technologies. On September 10th, 2015 the BOOST Conference “Supporting Learning in SME” took place in Schloss Birlinghoven.
SAGE: Serious Games Pathway within the Undergraduate IT Programs
EU Tempus IV Joint Project

M. Jarke, R. Klamma, M. Derntl, M. Kravcik, A. Hannemann, P. Nicolaescu

http://sage.ps

SAGE aims to enhance the capacity of the four partner universities in Tunisia and Palestine by enabling them to develop a sustainable curriculum in Serious Games and integrate this curriculum into their existing Computer Science programs. The chair leads two work packages in SAGE: the WP on Teaching Material for Serious Games and Gamification Courses and the WP on Quality Control and Monitoring. In addition we contribute expertise and coordination activities in the other content production WPs, in the setup of the SG lab, in conceiving cross-course case studies, as well as in staff and student exchange. We will deliver tutor training, teach pilot courses at the partner universities, and host students of partner universities for study visits.

During the two project years, we have produced the project quality framework, which guides quality management and reporting in the project. Also, the courses under WP5 were defined and specified under i5 lead; these courses are “Gamification” and “Serious Gaming Fundamentals.” We also hosted a project meeting with all partners in Aachen in June, 2015.

Learning Layers: Scaling up Technologies for Informal Learning in SME Clusters
EU FP7 Integrated Project


http://learning-layers.eu

Learning Layers develops a set of modular and flexible technological layers for supporting workplace practices that unlock peer production and scaffold learning in networks of SMEs, thereby bridging the gap between scaling and adaptation to personal needs. Building on mobile learning research, we situate learning into physical work places and practices to support situated, faster and more meaningful learning. Learning Layers provides a shared conceptual foundation independent of the tools people use and the context they are in. Learning Layers is based on a common light-weight, distributed infrastructure that allows for fast and flexible deployment in highly distributed and dynamic settings. We apply these technologies in two sectors that have been particularly hesitant to take up learning technologies, i.e. health care and building and construction.

Our main responsibility in the Layers project is to lead the work package on “Architecture and Integration” with the overall objective being to co-ordinate all technology development tasks across the project. Technically the main objective is to conceive, develop and maintain a
distributed, federated Layers architecture for fast and flexible deployment of network communication infrastructure and storage/editing of user-generated multimedia content in testbed environments.

During the previous year, the key objective of our work in Layers was to develop the methodologies and implementation details which can be employed in order to reach the large scaling of informal learning by identification of best practices, experts and boundary objects in communities of practices. The obtained infrastructure builds upon multiple “Layers Boxes”, which can be imagined as a bundle of software and hardware artifacts that provide services and tools in particular application environments. A reference implementation integrating the services of several European companies and research institutes is hosted in our Tethys cloud environment. The fully transparent and configurable access to all Layers services is achieved by the Layers Adapter. This component was designed as a Reverse Proxy following the established enterprise architecture pattern. Along with the Adapter, a single-sign-on solution for all current and future Layers apps was deployed to support data protection and privacy using the cutting edge standard OpenID Connect. Within the Layers project, we developed our DevOpsUse methodology as extension of the DevOps method including users. The success of our approach is reflected by the involvement in another upcoming H2020 project on wearable-enhanced learning called WeKIT. Alongside, we have co-founded the SIG on Wearable-Enhanced Learning (SIG WELL).

*Inauguration Meeting of SIG WELL at the iLRN Conference 2015 in Prague, Czech Republic*
The project, which ended successfully in 2015, brought together partners from the higher education, vocational training, and adult education levels, as well as institutions with expertise in learning design research. Below are the main project goals:

1. Provide an Integrated Learning Design Environment (ILDE) based on existing free and open source solutions, including authoring tools; co-design support for teacher communities; and deployment of learning designs on mainstream VLEs;

2. Run a series of workshops for teachers using ILDE to train teachers in learning design and the orchestration of ICT-based learning environments according to innovative pedagogies;

3. Disseminate the project's outcomes in the form of workshops for learning design training, and to promote the creation and maintenance, beyond the project's financial period, of a teacher community using learning design.

Our main tasks in the METIS project focus was the specification and development of the Integrated Learning Design Environment (ILDE), as well as the adaptation of the open-source IMS Learning Design authoring tool OpenGLM to interoperate with ILDE. This year, we disseminated the results of our open source framework called SyncMeta and improved it with additional functionality. The framework allows real time collaborative editing of conceptual models on the Web based on arbitrary, visually defined metamodels. The pilot application was to use SyncMeta to implement the metamodel of IMS LD, and offer it as a collaborative IMS LD editor (see picture below). We further developed of the desktop-based IMS LD tool OpenGLM with ILDE integration features.
This work provides a solution to continuous modeling of informal learning communities that appear in social media and are not defined by institutions.

Existing modeling solutions use either perspectives of learning theories, or analysis of learner or community data captured in social media but rarely combine both approaches. Therefore, current solutions produce community models that supply only a part of community stakeholders with information that can hardly describe community success and failure. We also claim that community models must be created based on community data analysis integrated with our learning community dimensions. Moreover, the models need to be adapted according to environmental changes.

In particular, this work makes the following contributions: 1. A metamodel of learning communities and its specific cases in social media. 2. A process of continuous community model creation that consists of four phases that model, refine, monitor and analyze learning communities. The phases and their realizations can be used to model any learning community with the purpose to support community evolution and to improve social media facilities to satisfy community needs. 3. Methods for community data analysis and storage have been exploited for retrieving learning community states to manage competences in a collaborative space and specifying culturally sensitive requirements of communities towards social media. 4. Our formal representation of a learning community has been used to model early requirements of learning communities and their evolution and to validate the effectiveness of possible community changes through multi-agent simulation.

Projects on Near Real-Time Social Computing

Near Real-time Community Information System

R. Klamma, D. Renzel, I. Koren

joint work with D. Schuster, P. Grubitzsch (TU Dresden)

http://xmppresearch.org

In 2015 we continued our fruitful collaboration with TU Dresden towards a comprehensive collection of research works around the Extensible Messaging and Presence Protocol, thereby following prior motivation by the XSF during XMPP Summit 15 in 2014. As a result, we launched the Web site http://xmppresearch.org dedicated to the collection and presentation of international scientific research works based on XMPP. Core contribution of this Web site is a high-quality and up-to-date bibliography collection of currently more than 250 XMPP-based scientific works published since 2004. The site additionally features demos and comments on latest scientific works to make XMPP-based research more accessible to the broader XMPP
Near real-time shared editing of shared artifacts in the browser has become popular for many applications like text writing, drawing, sketching and others. These applications require protocols for exchanging messages among user agents and for resolving editing conflicts. The available frameworks mostly rely on operational transformation and often expose drawbacks like failing to scale, restriction to linear data structures and client-server architectures.

In order to cope with client-side collaboration in P2P environments, we have developed Yjs, a lightweight open-source JavaScript framework that can be used for collaborative editing of arbitrary data types in P2P settings. The framework enables a fast and efficient way to add NRT collaboration features to Web applications without the need of a central server. It is based on a new operational transformation-like approach and supports communication protocols like XMPP and WebRTC. It offers a customizable approach for collaboration on any required shared abstract data type. Based on a modular design, Yjs contains a collaboration engine that resolves editing conflicts, ensures shared data integrity across peers and has various connectors for propagating collaboration-related updates across the network.

Yjs is currently available as a collection of open-source JavaScript libraries on GitHub. The project was rewarded with the Best Demo and Best Poster Awards at this year’s International Conference on Web Engineering (ICWE 2015) in Rotterdam, Netherlands. Presented also in a lightning talk at the European open source conference in Brussels (FOSDEM'15), Yjs is already garnering interest from the open-source community. As such, the library has already been included into other OSS projects. For example, OSS developers contributed to Y-richtext, a P2P collaborative text editor implemented by of Veeting and Linagora with the help of our student, K. Jahns. The modular construction of the Yjs project makes it easy to develop new components. Moreover, the project gathered between August 1st, 2014 and the current date more than 11000 page views from more than 3900 individual viewers.

Yjs will contribute in the near future to the improvement of our DireWolf framework with near real-time collaboration features built over the peer-to-peer model. DireWolf is a framework for rich Web applications with Distributed User Interfaces (DUIs) over a federation of heterogeneous commodity devices supporting modern Web browsers such as laptops, smart phones and tablet computers. The DUIs are based on widget technology coupled with cross-platform inter-widget communication and seamless session mobility.
As a follow-up to our Virtual Campfire project together with the latest developments from the Learning Layers project, we reengineered our semantic annotation services and implemented a collaborative video drawing application using Yjs for near real-time collaboration.

We have developed a Web-based toolkit for collaborative annotation of video data that is both reusable and extendable on the frontend and backend sides. The application was presented this year as a demo in the International Conference on Web Engineering (ICWE15) and consists of a video player that is overlaid by a drawing canvas onto which vector graphics can be collaboratively drawn on the frame level of the video. A master client, automatically designated by its technical profile, persists the annotations using a backend microservice. The video drawing prototype is a seminal advancement of the DireWolf2 framework by using the underlying peer-to-peer communication technology with the Yjs standalone real-time collaboration framework, refining the user interface widgets as reusable components and adding a microservice-based backend for a scalable distribution.

In the context of the Learning Layers project and an ETS project at RWTH Aachen University, we have redesigned the SeViAnno video annotation services and ported them from LAS to las2peer. The new annotation microservice is built on top of ArangoDB, a non-SQL hybrid (i.e. graph, document, relational) database written in Javascript. As such, the annotations are stored inside the service as a graph. We use two main graph vertex types (i.e. collections), which have unique object identifiers (e.g. for the video objects data stored after transcoding in the cloud) that represent objects and annotations, with their full JSON representation. If an annotation is added to an object, a vertex will be added to the graph and an edge will be created to link the annotation with its corresponding multimedia object (e.g. a video). The contextual data concerning the annotation and the respective object (i.e. annotation time, duration, position where the annotation is added in the video canvas, coordinates, etc.) is stored in the edge, also as a JSON representation. Annotation types can be easily added upon learner's needs and rapidly included into the user interface.

SyncMeta

R. Klamma, M. Derntl, P. Nicolaescu, M. Rosenstengel, A. Tebart
supported by Learning Layers and METIS

http://dbis.rwth-aachen.de/cms/research/ACIS/SyncMeta

SyncMeta is a framework for near real-time collaborative (meta-)modeling. The framework enables the definition of the conceptual and visual aspects of a modeling language and allows generating model editors for these metamodels. The diagram editors used for modeling and metamodelling support synchronous, real-time collaborative creation of models.
SyncMeta was built fully based on open source libraries (like ROLE SDK or OpenCoweb OT Engine) and open widely implemented protocols like XMPP and HTTP, and open, well-supported formats like JSON and SVG. The SyncMeta framework implementation is offered as a widget-based application, where each widget offers a certain functionality (like modeling canvas, palette, awareness of remote edits, property editor, export scripting, etc.).

During this year, we have enhanced the initial framework for supporting views during modeling and with an intelligent assistant for the collaborative work. During the implementation of these extensions we have kept the generic approach of SyncMeta, i.e. the framework still supports arbitrary (meta) models.

In the view extension, users are able to define views for certain parts or characteristics on the meta-model in a graphical real-time collaborative manner. They can redefine entities - e.g. Objects and Relationships of the meta-model - and then apply the changes to the model. This means the entities of the model are transformed according to the aspects defined in the meta-modeling process, and then the resulting model reflects the changes defined by the users. The framework allows the user to flexibly generate and embed particular views of the model.

The assistant aids users in the process of collaborative modeling. The assistance framework offers modelers suggestions on actions they can perform during the modeling process. It considers the collaborative environment for the suggestions and steers user behavior accordingly. To do that it has to oversee the actions of all active modelers and give each individual modeler different modeling suggestions to avoid conflicts. Furthermore, it considers typical steps in the modeling process and can offer suggestions based on the current context of the modelers actions. This is especially useful for beginners who are not familiar with the modeling language, but can be used also for complex modeling languages.
las2peer is the ACIS reference platform for Open Source Peer-to-Peer (P2P) community information systems (CIS). Each node in a las2peer P2P overlay network functions as a small-scale CIS, featuring secure end-to-end encrypted communication, distributed storage, federated service access for agents across the network, and a complete P2P community application development API. With this design, a CIS service ecosystem can evolve as a P2P network of interrelated CIS in a much more flexible and scalable way than with standard cloud-based social software. Since 2013, the las2peer Working Group (WG) pursues its goal to establish las2peer as a full-fledged Open Source P2P-based CIS platform.

In this year, las2peer core development mutually benefited from close collaborations with multiple las2peer service development teams (Requirements Bazaar, SeViAnno, etc.). As a result, las2peer is now fully integrated into our DevOpsUse methodology and our Docker-based continuous innovation infrastructure. las2peer was also employed and continuously refined in lab course teaching, thesis work, and project research. Successful previous LAS-based projects such as Requirements Bazaar, MPEG-7 Annotation, SeViAnno, and MobSOS were ported to las2peer, and as development platform for an array of new algorithms and services, e.g. for i* modeling, overlapping community detection and expert identification. Worth mentioning is the Community Application Editor (CAE) in its role of a las2peer scaffolding tool. With CAE, the major part of las2peer service development is now automated, lowering entry barriers for new developers. In the next year, las2peer will serve as major contribution to the Layers project in form of a highly scalable and secure federation infrastructure reasonably combining P2P and cloud computing paradigms.

Anatomy 2.0 - Development of an online pool for digital 3D study objects in anatomy education

G.Toubekis, R. Klamma, P. Nicolaescu, A. Herrler, S. Behrens, A. Brunnmeier, D. Studer, T. Paffen
funded by Exploratory Teaching Space

The RWTH Aachen Exploratory Teaching Space (ETS) promotes creative ideas of blended learning and teaching. Anatomy2.0 enables ubiquitous access to 3D digital replicas of a selection of real anatomical study objects used in several medicine undergraduate course modules. It is the continuation of the ongoing efforts to make high quality digital 3D artefacts available to specialized user communities. A high-resolution scan (Breuckmann Smart Scan
duo system) of various objects was realized and professional high-quality images were created for later texturing of optimized digital models. The digital objects are accessible with contemporary Internet browsers without any additional third-party plug-in based on current HTML5 specification for declarative 3D content with the Java-Script library X3DOM. The system allows interactive 3D navigation at runtime and individual and group annotation on the 3D object itself. The digital artefacts are usable for self-study or group lectures for an unlimited amount of users using collaborative real-time environment based on standard web communication (XMPP-WebRTC) with ROLE SDK developed in various research projects at the chair and therefore open source. The various models are selected to explore different degrees of complexity: surface structure, perspective depth, different colors, effect of shadows, material texture, all for training the awareness for physical properties of unique originals among the user groups. The system has been evaluated with good results by the target community at RWTH Aachen Medical University Anatomy course. The transferability to other faculties with similar use cases has been explored and tested (e.g. Engineering, Architecture and Cultural Heritage) with good results.

Widget based course room for 3D digital objects with ROLE SDK

Life Science Informatics

SEKT - Spezifische Detektion von einzelnen Keimen in Rein- und Trinkwasser

T. Berlage, S. Fang

The overall goal of the project funded by the BMBF is to detect bacteria in drinking water by filtering the water and microscopically analyzing the filter surface for a small number of bacteria. The work of RWTH is focused on image analysis, the recognition and discrimination of bacteria, which are labelled with fluorescent antibodies or in-situ hybridization.

In the final phase of the project, we implemented and validated a three-step approach that includes contrast-based segmentation of bacteria, segment combination (joining small segments, separating bacteria clusters), and classification (type and viability). The software has been integrated with the actual detection device developed in the project.
**Toponomics in Cholestatic Liver Diseases**

*T. Berlage, P.H. Nguyen*

Transporter protein topology influences numerous cellular processes. As a part of the DFG-funded Clinical Research Group 217 "Hepatobiliary Transport and Liver Diseases (Speaker: Prof. Dr. D. Häussinger, University Düsseldorf) a workflow for an automatic data analysis was developed.

We have continued our development towards an approach for protein colocalization in vesicles that has been evaluated with a new set of images. Furthermore, we have implemented overall statistics of individual structures to quantitatively characterize liver segments.

**Virtual Microscopy in Geoscience**

*T. Berlage, S. Fang*

In collaboration with Fraunhofer FIT, an automated scanning microscope has been developed that is able to scan thin sections of rock automatically in multiple polarization angles. We have refined our approach of regional segmentation based on intensity and phase information. The hardware and software are being used for research applications within the Institute of Structural Geology, Tectonics and Geomechanics (Prof. Dr. Janos Urai). Further co-development towards an instrument for industrial applications is planned.

**Other Research Projects**

**SunSITE Central Europe**

*R. Klamma, R. Linde*

[http://sunsite.informatik.rwth-aachen.de/](http://sunsite.informatik.rwth-aachen.de/)

Since 1995, Informatik 5 is active in the field of internet-based community support, both in terms of research on community and web service tools and in terms of providing infrastructures for scientific communities worldwide. For example, Informatik 5 hosted the first website for the city of Aachen in 1995 and, since the same year, manages one of the most successful public-domain Internet servers in the German science net, SunSITE Central Europe. Supported by Sun Microsystems with powerful hardware and base software, SunSITE Central Europe focuses on scientific community support, including mirrors of some of the most important research literature indexes, workspaces for Internet cooperation, and about 8 TB of open source software. Typically, the SunSITE enjoys around 35 million accesses per month.

As additional scientific publication services, the SunSITE hosts the Central Europe (CEUR) Workshop Proceedings (CEUR-WS.org) with now over 1000 volumes and acts as a mirror for the Dagstuhl Research Online Publication Server. Ralf Klamma was appointed for the newly created advisory board of CEUR-WS.org in 2014.
Social Network Analysis (SNA) is a well-established method in sociology. With the advent of the World Wide Web and growing computational power interests grow in analyzing large sets of network data over time. We apply graph algorithms, dynamic network analysis methodologies and advanced approaches in Web Science to analyze dynamic patterns of human interaction expressed by traces left large-scale information systems. Our annual lecture "Web Science" and seminar course "Web Science" contributes to a sound theoretical basis for student and research work. In 2015 we continued our work on community analytics by developing new algorithm for overlapping community detection (OCD) for un-signed social networks (Shahriari et al. 2015b). Moreover, we extended the proposed algorithm to the case of signed social networks and investigated the significance of overlapping members in social media by considering machine learning models such as logistic regression (Shahriari and Klamma 2015). Additionally, all of the proposed algorithms are implemented as RESTful Web services in generalized and extendible framework named WebOCD which researchers can use this framework for comparison of their new algorithms for research purposes (Shahriari et al. 2015a). Not only discovering community structures are investigated but as well their applications have been considered by agent-based simulation of learning communities and expert identification in Q&A forums. We applied community detection for agent-based simulation of learning communities with two well-known network strategies called reciprocity and preferential attachment (Paper submitted to GESIS 2015). Moreover, community structures were applied to devise novel community-aware ranking algorithms in expert identification (Shahriari et al. 2015c).

The Minaret of JAM located in the province of Ghur (Afghanistan) has been inscribed in the UNESCO World Heritage List in 2002. The 64m tall minaret was constructed in the 12th century AD and its delicate ornamentation made of bricks and glazed tiles is one of the very few examples of early Islamic architecture to survive in its original form until our time. The minaret suffers from occasional flooding of the nearby river and is very difficult to access. UNESCO has requested for support to develop methods to successfully monitor the effectiveness of measures undertaken for the long-term preservation of this outstanding cultural heritage using remote sensing techniques. For that purpose a digital topographic 3D model was generated out of stereo High Resolution satellite imagery to determine the correct extent of the site as important perquisite for any management system to be implemented successfully in the future. Apart from the successful mapping the digital topographic model will serve also as simulation model to evaluate dangers arising from the river system and to assess the requirements for river protection measures. The project is realized in collaboration with the Oman Center for Documentation and Conservation (Prof. Michael Jansen) and the Institute of Hydraulic Engineering and Water Resources Management (Prof. Holger Schüttrumpf) at RWTH Aachen University.
Complex innovations in medical engineering are not possible without collaborative co-operations today. However, the assembly of suitable experts is usually left to the initiating innovators themselves or fortuity. To tackle this problem a new integrative competence model of medical engineering based on data mining algorithms has been conceptualized by the institute of Applied Medical Engineering (AME). It identifies suitable actors based on published texts for a given project by matching experts from medical, technological and product-related fields to the project. Specifically, the product-related dimension of the approach faces the problem of the correct assignment of patents (and the corresponding inventors) to designated competence fields in medical engineering. In the mi-Mappa project we try to tackle this challenge by two different but complementary ways: on the one hand a relation between information from medical products and patents is searched for, because medical products are easily assignable to competence fields and hence, the related patents are assignable to competence fields. On the other hand, we try to find publications of the patent innovators related to the project topics which are more easily assignable to competence fields than the patents themselves.

Informatik 5 implements especially solutions for the second way using patent analysis techniques, text mining, ontology design, and ontology matching. At the moment, we supervise three thesis in the context of this project. A vision paper has been accepted for the 7th Knowledge Engineering and Ontology Design Conference in Lisbon, Portugal, November 12-14, 2015.

The project started on February 1, 2015 and will end on January 31, 2017.
Big data is a new buzzword that summarizes various aspects of handling large amounts of heterogeneous data. The goals are (among others) to perform efficient analytics and to derive new information from the base data. The heterogeneity of data is an important issue in big data: data is not only large in volume and produced at a high speed (velocity), it has also a high variety. Therefore, it is also necessary to address the challenges in terms modelling and integration of big data.

The research group has a long experience in developing systems and applications for handling complex, heterogeneous data. The model management system GeRoMeSuite has been developed as a platform for generic model management. This means that the heterogeneous modeling languages (e.g., XML Schema, the Relational Data Model, OWL) are represented in a generic metamodel (GeRoMe) in order to enable the integration and mapping of models represented in different modeling languages.

In general, model management aims at developing technologies and mechanisms to support the integration, merging, evolution, and matching of complex data models. This support is required for the management of complex, integrated, distributed, heterogeneous information systems. Basic concepts in model management are models, mappings and operators. Models describe the structure of data. Mappings represent relationships between elements from different models. Operators are operations on models and mappings (e.g., merging & matching of models, composition of mapping).

**Architecture of a Data Lake System**

- **User**
- **Data Scientist**
- **DL Admin**

**Metadata Manager**
- Schema Manager
- Enrichment

**Data Exploration**
- Query Formulation
- Data Interaction

**Data Access Interface**
- Query Rewriting
- Data Transformation

**Data Ingestion**
- Metadata Extraction
- Data Ingestion

**Storage Layer**
- Raw Data Stores

**Ingestion Layer**
- Metadata Store
- Metadata Model
- Schemas, Mappings, DQ Lineage

**Interaction Layer**
- Application-specific Data Marts

**Architecture of a Data Lake System**
The management of metadata is of particular importance for information integration, model management, and big data applications. Data lakes have been proposed as a solution to deal with the heterogeneity of big data, as they should provide a storage system for any kind of raw data. Metadata is of particular importance in such a system to have information about the structure and semantics of the data. The group has been working on a metadata management system for data lakes and developed an architecture model for data lake systems. Future work will address the problem of incrementally defining schemas and mappings in a data lake system, and to enable query rewriting over a heterogeneous collection of data.

**ConceptBase - A deductive object manager for meta databases**

*M. Jarke, C. Quix, M.A. Jeusfeld (University of Skövde, Sweden)*

ConceptBase is a multi-user deductive object manager mainly intended for conceptual modelling, metadata management and model management. The system implements the knowledge representation language Telos which amalgamates properties of deductive and object-oriented languages. ConceptBase is available as an open-source system under FreeBSD license on SourceForge. In 2015, version 7.8 of the system has been released, which is also part of a pre-configured virtual appliance that allows easy installation and usage of the system.

**HUMIT – Human-centered Support for incremental-interactive Data Integration for High Throughput Processes in the Life Sciences**

*M. Jarke, T. Berlage, C. Quix, S. Harmata (FIT), A.Pippow (FIT), Y. Seok (FIT)*

*Joint work with Fraunhofer FIT, Fraunhofer IME, DZNE, and soventec GmbH*

*Funded by BMBF in their “Big Data” Competition*

Data analysis in biomedical high throughput screening requires the integration of large and heterogeneous data sources (e.g., experiments archives, biomedical databases). Existing tools for data integration and analysis for biomedical data do not provide the required flexibility and expressive power, as the research questions and sources are continuously evolving and the provided information has to be semantically interpreted and adapted by the user.

The goal of the HUMIT project is the development of a big data approach that enables researchers to do cross-domain analysis of high throughput screening data. This will have a significant positive effect for the life science research, because the value of the data is increased as well as the potential to detect causes of diseases and new forms of treatment.

The main idea of the proposed approach is an incremental definition of data models and mappings, and a separation of the storage systems for raw data and analytical data. The user interaction is a key element in the data integration process.

The group at i5 develops basic methods for data integration, schema and mapping evolution that will be applied in this project.
Other Activities

Service

- Matthias Jarke’s major service activities in 2014-2015 included
  - Executive Director, Fraunhofer FIT, Birlinghoven
  - Chairman, Fraunhofer ICT group, and Member Presidential Board, Fraunhofer Society
  - Chairman of Institute Leader Board, Fraunhofer Institute Center Birlinghoven Castle
  - Deputy Speaker, Fraunhofer Alliance Big Data
  - Founding Director, Bonn-Aachen Intl. Center for Information Technology (B-IT)
  - Member of Management Board (Hauptvorstand), BITKOM
  - Hon. Adjunct Professor, Applied Information Technology, GUtech German University of Technology in Oman
  - Member, IT Summit Platform “Innovative Digitalization of Business”, BMWi
  - Member, CONNECT Advisory Forum (CAF) on the HORIZON 2020 Program of the European Commission
  - Member, Strategy Expert Council, Austrian Ministry of Traffic, Innovation and Technology (bmvIt), Vienna
  - Deputy Chairman, Hochschulrat, FH Köln
  - Member, Program Board, LOEWE Excellence Initiative Hessia
  - Member, CeBIT-Messeausschuss
  - Member, Expert Commission Digitalization Center Bavaria (EZ.B)
  - Chairman, ICT Evaluation Board, Vienna Science and Transfer Fund
  - Member, QANU Business&Economics University Evaluation Board, Netherlands
  - Member, Engineering Faculty Advisory Board, University of Duisburg-Essen

- Ralf Klamma is WP leader in the EU IP Learning Layers, senior researcher in the EU projects SAGE, METIS and BOOST. He is founding member of the European Association on Technology Enhanced Learning (EATEL) and SIG co-chair of the newly founded SIG on Wearable-Enhanced Learning (SIG WELL). He is head of the steering committee of the European Conference on Technology Enhanced Learning (SIG EC-TEL) and steering committee member of the International Conference on Web-based Learning (ICWL). He is member of the advisory board of the CEUR-WS open access proceedings series.

- István Koren and Dominik Renzel became managers of our XMPP Research Website (http://xmppresearch.org).

- Milos Kravcik was the coordinator of the BOOST project and senior researcher in the international projects Learning Layers, METIS, and SAGE. He is serving as manager of the JTEL Summer School web site (http://jtelsummerschool.eu) as well as editor of the BOOST portal (http://www.boost-project.eu/) and its social media. He served as external reviewer at UNED Doctoral Consortium in Madrid.

- Dominik Renzel continued to be manager of the i* Wiki (http://istar.rwth-aachen.de).
Thomas Rose acted as reviewer for several EU funded projects on “ICT for Energy and Water Efficiency” and “ICT for Low Carbon Economy and Smart Mobility” for the European Commission after serving as evaluation expert for EU Project Proposals on "ICT for Energy and Water Efficiency in Public Housing" in 2010/11.

Editorial Boards and Journal Reviews


- Ralf Klamma serves as associate editor for IEEE Transactions on Learning Technologies (TLT), Springer Journal on Social Network Analysis and Mining (SNAM). In 2015 he was appointed as a member of the Editorial & Scientific Board of IxD&A. He is section editor for the Springer Encyclopaedia of Social Network Analysis and Mining (ESNAM) and editor for the IEEE Special Technical Committee on Social Networks (STCSN). He is editor-in-chief for the SunSITE CEUR and several community information systems. He also served as reviewer for Social Network Analysis and Mining (SNAM), IEEE Transactions on Learning Technologies (TLT), Multimedia Tools and Applications (MTAP), Journal of Networks and Applications (JNCA), and Journal of Universal Computer Science (JUCS).

- István Koren was reviewer for the open access journal Interaction Design and Architectures.

- Milos Kravcik serves on the editorial board of the International Journal of Technology Enhanced Learning and is editing a special issue for it as well as for the International Journal of Artificial Intelligence in Education. He is executive reviewer of Educational Technology & Society and IEEE Transactions on Learning Technologies. He also served as reviewer for IEEE MultiMedia, New Review of Hypermedia and Multimedia, and Learning and Individual Differences.

- Dominik Renzel serves as reviewer for the International Journal on Multimedia Tools and Applications (MTAP), and for the 2015 International Conference on Design Science Research in Information Systems and Technology (DESRIST 2015).

- Thomas Rose has been Program Committee member of the workshop for "IT-support of rescue forces", GI conference 2015, Cottbus.
Conference Organization


- Matthias Jarke served on the program committees of the 27th International Conference on Advanced Information Systems Engineering (CAiSE’15), Stockholm, Sweden; the 22nd International Symposium on Methodologies for Intelligent Systems (ISMIS 2015), Lyon, France; the 10th International Conference on Design Science Research in Information Systems and Technology (DESRIST 2015), Dublin, Ireland; and 33rd International Conference on Conceptual Modelling (ER 2015) in Stockholm, Sweden.

- Ralf Klamma was program co-chair of the International Conference on Web-based Learning (ICWL), Guangzhou, China, November 2015. He was track co-chair at Immersive Learning Research Network Conference (iLRN) and co-organized workshops at the 10th Joint European Summer School on Technology Enhanced Learning (JTEL 2015, Ischia, Italy). He served as program committee member / reviewer for the following conferences: ACM CSCW’16, 1st IEEE International Conference on Collaboration and Internet Computing (CIC’15), IEEE International Conference on Advanced Learning Technologies (ICALT’15), International Conference on Information Systems (ICIS’15), Wirtschaftsinformatik’15, Immersive Learning Research Network Conference (iLRN’15), IEEE International Conference on Collaborative Computing: Networking, Applications and Worksharing (CollaborateCom’15), International Conference on Web-based Learning (ICWL’15), European Conference on Technology Enhanced Learning (EC-TEL’15), Games and Learning Alliance Conference (GALA’15), 10th International Conference on Design Science Research in Information Systems and Technology (DESRIST’15), International Conference on Applied Research in Computer Science and Engineering (ICAR’15), Conference on Learning Analytics & Knowledge (LAK’15), DELFI’15, I-KNOW’15, CRIWG Conference on Collaboration and Technology (CRIWG’15), IEEE Workshop on Content Based Multimedia Indexing (CBMI’15), 8th Workshop on Social and Human Aspects of Business Process Management (BPMS2’15), Workshop on Pervasive Collaboration and Social Networking (PerCol’15), Workshop on Visual Approaches to Learning Analytics (VISLA’15).

- István Koren served as a reviewer for the 28th International Conference on Advanced Information Systems Engineering (CAiSE 2015) and International Conference on Collaborative Computing: Networking, Applications and Worksharing (CollaborateCom 2015).
• Milos Kravcik was program co-chair of International Conference on Smart Learning Environments (ICSLE), track co-chair at Immersive Learning Research Network Conference (iLRN), program co-chair and workshops co-organizer at 11th Joint European Summer School on Technology Enhanced Learning (JTEL), organizer of BOOST Conference, co-organized 5th Workshop Personalization Approaches in Learning Environments (PALE at UMAP), and 5th Workshop on Awareness and Reflection in Technology-Enhanced Learning (ARTEL at EC-TEL). He was programme committee member of the following conferences and workshops: 14th International Conference on Web-based Learning (ICWL), 10th European Conference on Technology Enhanced Learning (EC-TEL), and its Doctoral Consortium, 14th IEEE International Conference on Advanced Learning Technologies (ICALT), 3rd Games and Learning Alliance Conference (GALA), International Workshop on Social Personalisation & Search (38th Annual ACM SIGIR Conference), 2nd International Workshop on Human Aspects ofMaking Recommendations in and for Social Ubiquitous Networking Environments, 8th International Workshop on Social and Personal Computing for Web-Supported Learning Communities, and 2nd International Workshop Peer Review, Peer Assessment, and Self Assessment in Education.

• Karl-Heinz Krempels was conference co-chair of the 4th International Conference on Smart Cities and Green ICT Systems (SMARTGREENS 2015) and of the 4th International Conference on Web Information Systems and Technologies (WEBIST 2015).

• Petru Nicolaescu served as a subreviewer for the International Conference on Computer-Supported Cooperative Work (CSCW 2015), and the International Conference on Collaborative Computing: Networking, Applications and Worksharing (CollaborateCom 2015).

• Zinayida Petrushyna was a program committee member of the 10th European Conference on Technology Enhanced Learning (EC-TEL 2015), IADIS Web Based Communities and Social Media 2015 (WBC 2015), 5th International Conference on Social Eco-Informatics (SOTICS 2015). She continues to serve as a member of program committee of European Summer School on Technology Enhanced Learning and Doctoral Consortium at the European Conference for Technology Enhanced Learning.

• Christoph Quix was a member of the program committee of the 34th International Conference on Conceptual Modeling (ER 2015), of the 4th International Conference on Data Management Technologies and Applications (DATA 2015), and of the 7th Asian Conference on Intelligent Information and Database Systems (ACIIDS 2014).

Software Demonstrations

• “DireWolf - A Peer-to-Peer Approach for Distribution and Migration of User Interfaces for Cultural and Educative Web Widget Applications”, Demo at the UMIC Day in Aachen, Germany, October 21, 2014, Aachen, Germany.


• “A Near Real-Time Application for Twitter Data Analysis”, Demo at the General Online Research Conference (GOR), March 19, 2015, Cologne, Germany.
Open Source Community Involvement

Since a couple of years, the Advanced Community Information Systems group at Informatik 5 commits to Open Source Software (OSS) development. We share code bases resulting from our own developments on our OSS repositories on GitHub (https://github.com/rwth-acis). The Learning Layers project maintains and shares its complete code base on GitHub (https://github.com/learning-layers). Our projects include results from Bachelor/Master/PhD theses and project work. Besides hosting own code bases, we also contribute code to existing OSS projects and communities in the form of patches.

Furthermore, we increasingly learn and adopt best practices and tools for OSS development from established organizations such as the Apache Foundation. Common examples are the communication via mailing lists, issue tracking and agile development with professional tools such as Atlassian JIRA and continuous integration with tools like Jenkins. We also increasingly integrate the use of such tools and practices into our teaching activities, in particular in our practical lab courses. We also constantly learn about new tools, e.g. GitHub’s built-in issue tracker or Travis CI as alternative to Jenkins. Besides, we research OSS communities themselves and build tools that help open source practices, such as the Requirements Bazaar for end user engagement in the course of our DevOpsUse methodology.

Our experience until now is that OSS development is not in contradiction with research policies. We pursue a very open licensing policy with the use of BSD-like permissive Open Source Software licenses and Creative Commons content licenses. The involvement and active participation in OSS developer communities gave us a lot of insights, which would not have been retrievable from research papers. Furthermore, we experience that sharing our code bases publicly raises the quality of our code and creates new ways of disseminating research outcomes.

The flagships of ACIS OSS development are the group’s own Community Information System platform las2peer (https://github.com/rwth-acis/LAS2peer), the Continuous Innovation platform Requirements Bazaar (https://github.com/rwth-acis/RequirementsBazaar) and importantly the client-side library Yjs (https://github.com/y-js). Below, we compiled a list of our most influential open source projects.

- M. Derntl, P. Nicolaescu, S. Erdtmann, M. Rosenstengel: SyncMeta, a near real-time collaborative modeling framework: https://github.com/rwth-acis/syncmeta
• M. Derntl, K. Jahns: DVITA, a Web-based tool for building and exploring dynamic topic models: https://github.com/rwth-acis/DVITA2

• S. Gökay, W. Kluth, C. Samsel, K.-H. Krempels: Steve was developed at Informatik 5 for project eConnect Germany and continued in project MobilityBroker to support the deployment and popularity of electric mobility. SteVe provides basic functions for the administration of charge points, user data, and RFID cards for user authentication. It supports the Open Charge Point Protocol (OCP) and was tested successfully in operation with charging stations by multiple manufacturers. SteVe is considered as an open platform to implement, test and evaluate novel ideas for electric mobility, like authentication protocols, reservation mechanisms for charge points, and business models for electric mobility. Besides its primary use as test and development platform, it is also used to operate various smaller electric charging installations across Europe. SteVe is distributed under GPL and is free to use. https://github.com/RWTH-i5-IDSG/steve.

• W. Kluth, S. Gökay, S. Samsel und K.-H. Krempels: Bikeman is an open source solution for managing eBike-Sharing systems. On the one hand, it offers the administration and maintenance of bike stations, eBikes and customers. On the other hand, it provides an API for the integration into a Travel Information System. The development has started in 2014 as a component for MobilityBroker and found application in a local eBike sharing provider, Velocity GmbH. With an extended version of IXSI, we used state-of-the-art technology to connect Bikeman with the MobilityBroker.

• I. Koren: Video Drawing Demo, a Web Components based application for collaborative annotation of Web videos with drawings: https://github.com/rwth-acis/VideoDrawingDemo


• I. Koren, A. Guth, J. Manolov: LayersBox, a command line script to setup and configure a self-hosted cloud system for community services called Layers Box: https://github.com/learning-layers/LayersBox

• P. Nicolaescu, K. Jahns: Yjs, a peer-to-peer framework for near real-time shared editing based on JavaScript: https://github.com/v-jis/yjs

• P. Nicolaescu, P. de Lange: Community Application Editor for collaborative modeling and generation of community applications: https://github.com/rwth-acis/CAE-Code-Generation-Service

• P. Nicolaescu, A. Siddiqui: Cloud Video Transcoder, a cloud based video transcoder: https://github.com/learning-layers/Cloud-Video-Transcoder

• Z. Petrushyna, A. Ruppert: i*-REST services are based on las2peer and allows other services to create, store and visualize i* models: https://github.com/rwth-acis/LAS2peer-iStarMLModel-Service, https://github.com/rwth-acis/LAS2peer-iStarMLVisualizer-Service

• Z. Petrushyna, A. Chueva: an application developed for a near-real time for Twitter analysis allows to investigate and analysis information about events like conferences or marketing campaigns: https://github.com/rwth-acis/Twitter-Analysis
• M. C. Pham, M. Shahriari, C. Ogut, S. Krott: AERCS, Academic Event Recommender system for Computer Scientists: https://github.com/rwth-acis/AERCS


• M. Shahriari, S. Gunashekar: PATEOC, a framework for predictive analysis of time evolving and overlapping communities: https://github.com/rwth-acis/PATEOC

• M. Shahriari, S. Krott: WebOCD: a generalized and extendible las2peer based RESTful Web service for detection, analysis and evaluation of overlapping community detection algorithms: https://github.com/rwth-acis/REST-OCD-Services


• G. Toubekis, P. Nicolaescu, D. Studer, A. Brunnmeier, F. Zwilling, A. C. Demiralp, D. Sharma, L. Liehner, A. Woerner: Blended Learning with 3D models in anatomy education, Anatomy 2.0: https://github.com/rwth-acis/Anatomy2.0
Talks and Publications

Talks


M. Jarke: Wearable information management at Fraunhofer. German-Korean Future Technology Conference on Smart Textiles (Textronics), Seoul, Korea, 13.10.2015

M. Jarke: History and Perspectives of the Faculty of Computer Science at the University of Vienna. Keynote, Computer Science Day 2015: 650 Years University of Vienna, 28.9.2015


M. Jarke: Arbeiten 4.0 in einer datengetriebenen Wirtschaft und Gesellschaft. Workshop with Minister of Labor Andrea Nahles, Sankt Augustin, 20.5.2015

M. Jarke: Big Data and the digitalization of life. International Conference on Information Management, Taipei, Taiwan, 17.5.2015

M. Jarke: Von Information und Internationalität – Begegnungen in der ABC-Region. Laudatio, emeritation celebration for Professor Armin B. Cremers, Bonn, 4.3.2015


R. Klamma: Technical Challenges for Realizing Learning Analytics. LEARNTEC, 27.3.2015, Karlsruhe, Germany.

R. Klamma: Scaling up digital learning support for smart workforce development in clusters of innovation driven SMEs in the North-German construction industry. 4th Research Forum on Small and Medium Sized Enterprises, February 9-10, 2015, Chur, Switzerland.


I. Koren: *Requirements Bazaar powered by AngularJS and Polymer*. Google Developer Group, April 21, 2015, Brussels, Belgium.


M. Kravcik, P. Nicolaescu: *From Semantic Annotation to Adaptive Video Presentation*. Joint European Summer School on Technology Enhanced Learning, 9.7.2015, Ischia, Italy


Z. Petrushyna, A. Chueva: *A Near Real-Time Application for Twitter Data Analysis*. General Online Research Conference (GOR), March 19, 2015, Cologne, Germany.


W. Prinz: "HOMO DIGITALIS" Hält die schöne neue Welt, was sie verspricht?, Business +/- Ethics Dialog zum Thema "Digitalisierung", Bad Honnef, 18.6.2015.

W. Prinz: *Was macht aus einem Unternehmen ein Enterprise 2.0 und kann man das dann messen?*, Heinrich Nixdorf Forum, Paderborn, 28.5.2015.

W. Prinz: *Und welche Use Cases noch?, Location Based Services: Von GSM und GPS zum Durchbruch mit Beacons?*, deutsche ict + medienakademie, Köln, 22.4.2015.


W. Prinz: *Cologne IT-summit*, Köln, 24.11.2014.


C. Quix: *Data Stream Processing and Data Analysis in Car2X Communication* Big Data Seminar for Chinese Managers, St. Augustin, December 2014.


D. Renzel: *IS Success Awareness in Community-Oriented Design Science Research*. 10th International Conference on Design Science Research in Information Systems and Technology (DESRISt), May 21, 2015, Dublin, Ireland.


M. Shahriari: *Disassortative Degree Mixing and Information Diffusion for Overlapping Community Detection in Social Networks (DMID)*. Temporal Web workshop, 18.5.2015, WWW Conference, Florence, Italy.

**Publications**

*Book and Edited Volumes*
A. Al-Akkad: Working around disruptions of network infrastructures - Design and evaluation of mobile ad-hoc systems for resilient communication in disasters. RWTH Aachen, Diss. 2015.


S. Schiffer: Integrating Qualitative Reasoning and Human-Robot Interaction for Domestic Service Robots. RWTH Aachen, Diss., 2015.

K. Vandikas: A fine-grained approach towards asynchronous service composition of heterogeneous services. RWTH Aachen, Diss., 2014.


Journal Articles and Special Issues


C. Quix, S. Geisler: *Special Issue on Large-scale Data Management for Mobile Applications*, Distributed and Parallel Databases, 2015


**Conference Papers, Book Contributions, Patents**


Oya Deniz Beyan, P. J. Mealy, Dolores Grant, Rebecca Grant, Natalie Harrower, Ciara Breathnach, Sandra Collins, Stefan Decker: *Historical Data Preservation and Interpretation Pipeline for Irish Civil Registration Records*. OTM Workshops 2015: 466-475.


Technical Reports


Master Theses

Alexandra Chueva: Cloud-based Near Realtime Event Analysis for Twitter (Jarke, Klamma)

Lucas Dohmen: A Declarative Web Framework for the Server-side Extension of the Multi Model Database ArangoDB (Klamma, Edlich)

Tobias Funke: Social Media Metrics in a Corporate Expert Networking Platform at Siemens (Klamma, Jarke)

Gerrit Garbereder: Personalisiertes und kontextsensitives Empfehlungssystem fur Reiseketten (Jarke, Rose)

Volkan Günl: Redesigning Web Applications for Collaboration: A Widgetizing Methodology (Jarke, Klamma)

Markus Harmsen: A Presentation Semantic for the Operational Data Model (ODM). (Jarke, Deserno)

Ter-Minasyan Harutyun: Location-based Shopping Experience on Google Glass (Prinz, Rose)

Houran Ketabdar: Developing a Mapping Model Between Commonly-used Demand-Response Protocols OpenADR and MIRABEL for Electric Mobility Optimization (Jarke, Monti)

Peter de Lange: A Framework for Near Realtime Modeling and Generation of Community Applications (Jarke, Klamma)

Sebastian Krott: A RESTful Web-based Framework for Overlapping Community Detection Algorithms (Jarke, Klamma)
Fabian Ohler: Randomized Optimization of Discrimination Networks Considering Node Sharing (Jarke, Quix)

Ankit Ramani: Touchless Public Display Authentication (Jarke, Klamma)

Walter Omar Sanchez: Electronic Payment for Multimodal Traveling – An Evaluation of Technology Acceptance (Jarke, Rose)

Lusine Stepanyan: Mobile Shopping Experience and Purchases on Google Glass (Prinz, Rose)

Srivatsan Sundararajan: Design and Implementation of a Schema Comparison System in a Business-to-Business Scenario (Jarke, Quix)

Nevena Tacheva: Simplifying the Understanding of Trust Management for Non-Security Experts (Jarke, Christin)

Ahmed Tauqeer: A Cloud-based Approach for Parallel Video Transcoding and Object Recognition (Jarke, Klamma)

Alexander Tritthart: Optimizing common algorithms of community evolution to the multi-core architecture GPU (Jarke, Klamma)

Dragomir Yankov: Design and Development of a Model Repository for Model Management (Jarke, Quix)

Bachelor Theses

Sebastian Addicks: Agentenbasierte Simulation von Anreizsystemen zur Förderung alternativer Mobilitätsmodi (Jarke, Rose)

Hoai Dao: Evaluierung und Vergleich von Datenintegrations-Plattformen für Scientific Data Management (Quix, Berlage)

Tristan Döhl: Aktive Beteiligung der Bürger in der Stadt- und Verkehrsentwicklung durch Informationssysteme (Jarke, Rose)

Marven von Domarus: Pregel -- Parallel Implementation of Overlapping Community Detection Algorithms (Klamma, Seidl)

Igor Dudschenko: Evaluation of Wearables for Mobility Assistance (Jarke, Rose)

Denis Golovin: Web-based Collaborative Video Drawing (Jarke, Klamma)

Andreas Guth: Near Real-time Visual Community Analytics for XMPP-based Networks (Jarke, Klamma)

Andreas Heuvels: Anfragebasierte Busroutenplanung (Jarke, Rose)

Kevin Jahns: Near Realtime Peer-to-Peer Group Editing on Tree-Like Data Structures (Jarke, Klamma)

Marko Kajzer: Learning Analytics and Motivation for Serious Games in Medical Education (Klamma, Herrler)

Kirsten Kern: Development of a Domain Specific Language for Supporting Data Consistency of Clinical Trials (Quix, Kabino)

Sebastian Krott: A RESTful Web-Based Framework for Overlapping Community Detection Algorithms (Jarke, Klamma)
Florian Oboloer: Mapping i* Learning Community Models to Java-based Agents (Jarke, Klamma)

Heiner Oßwald: Entwicklung eines generischen Augmented Reality Scripting und Authoring Tools (Prinz, Rumpe)

Mario Rosenstengel: View-based Modeling in the SyncMeta Metamodeling Framework (Jarke, Klamma)


Barna Zajzon: A Presence Framework for SIP User Agent Components (Klamma, Schulzrinne/Columbia University, Jarke)

Awards

Sebastian Krott (December 5, 2014) won the itestra award for best Bachelor Thesis in Computer Science at the “Day of Informatics”. “A RESTful web-based framework for overlapping community detection” was co-supervised by Prof. Matthias Jarke and PD Dr. Ralf Klamma, with doctoral candidate Mohsen Shahriari as an advisor.

Petru Nicolaescu, K. Jahns, M. Derntl, R. Klamma: Best Demo Award and Best Poster Award at the 15th International Conference on Web Engineering (ICWE 2015) for “Yjs: A Framework for Near Real-Time P2P Shared Editing on Arbitrary Data Types”.

F. Obeloer (June 26, 2015) won the award for best Bachelor exam in Computer Science at the “Day of Informatics”. “Mapping of i* learning community models to Java-based agents” was co-supervised by Prof. Matthias Jarke and PD Dr. Ralf Klamma, with doctoral candidate Zinayida (Petrushyna) Kensche as an advisor.

C. Sun, H. Ehm, S. Heilmeyer, and T. Rose received the best paper award at the BUSTECH 2015 conference in Nice, France, for their paper: A System Model for Complexity Measurement and Evaluation on the Example of Supply Chain.
End-user integration in the software development process has been advocated for at least two decades in different forms ranging from requirements engineering (RE) to agile requirements methods. In Open Source Software (OSS), the inherent instability of development communities outside classical organizations makes end-user integration in the form of community especially success-critical, and particularly challenging. Nevertheless, the methods and impacts of community integration in OSS development processes up to the present have hardly been studied at all. To design methods for community integration in the development process, we considered current trends in RE research and practice. We focused on intuitiveness and enjoyment as they are intended to encourage dialogue between developers and end-users, whereas from the technological perspective social software is a trend-setter in RE. In this context, we designed concepts and realized prototypes for community-oriented RE. However, our evaluation showed that it is not enough just to provide services for community-oriented RE in that additional forces and rewards are also required for motivating people to become active participants.

To explore possible motivating forces, we investigated the success factors of the community-oriented development process. We performed a longitudinal analysis of three large-scale interdisciplinary OSS projects in bioinformatics. First, we designed models and methods to facilitate knowledge mining within OSS histories. Next, with the help of our established methods, we identified five internal and two external events, i.e. stimuli, which significantly influenced evolution of the OSS projects. Finally, to evaluate our results, we designed a dashboard and filled it with the information on detected stimuli. Then we provided the resulting dashboard to the corresponding OSS communities. Positive feedback and high interest in our dashboard from OSS project members validated both our technological and conceptual approaches. The main finding of this thesis, that is the detected stimuli, does not only bring new insights in community-oriented software development, but also defines new challenges for its organization. Specifically, a stimulus of generation change within an OSS project after five years since the beginning of a project, postulates questions to areas of sustainability and management. A stimulus of core-periphery proportion uncovers the importance of an intermedia layer within OSS communities for the success of the RE process. This finding leads to the question of how we can encourage and support the intermedia layer of user participation. Other detected stimuli define new challenges for moderation, modification planning, data analysis, data consolidation and management.
Konstantinos Vandikas

Title: A fine-grained approach towards asynchronous service composition in heterogeneous services

Examiners: Matthias Jarke, Mike Papazoglou (Tilburg, Netherlands), Wolfgang Prinz

Date: 03.12.2014

Abstract:

In software design, a service-oriented architecture is a set of principles and methodologies used for designing and developing software in the form of interoperable services. Each service encapsulates well-defined business functionality and it is built as a reusable component. Thereafter, new services can be generated as a coordinated aggregate of pre-existing functionality by means of service composition.

Common practice in the Information and Communication Technology domain (ICT) is the usage of standardized workflow languages in order to describe the interaction between such services. Examples of such languages are the Web Services Business Process and Execution Language (WS-BPEL) and the Business Process Modelling Language (BPMN). At runtime, a framework interprets the workflow and performs the actions mandated by the semantics of its constructs. Even though, a workflow language contains a sufficient amount of constructs to qualify as Turing complete, the usage of existing workflow languages along with their corresponding frameworks renders them cumbersome for rapid application development where one needs to combine services from heterogeneous domains and in particular when re-using pre-existing services originating from the telecommunications domain.

More specifically, the limitations in the state of the art for workflow languages are encountered in aspects such as tight-technological coupling; interaction is limited to particular technologies, usage of static type systems - that hinder experimentation and finally yet importantly in terms of parallelism and concurrency, where the designer of a workflow is forced to manually define execution order in an attempt to utilize multiple cores which are commonly found in most computer systems nowadays.

This dissertation introduces a novel language for service composition and a technology agnostic composition framework suitable for developing and executing service compositions of heterogeneous services. The proposed service composition language is concurrent by default; parallel execution of actions is determined by their corresponding data dependencies. The proposed framework allows for an optional type system permitting both typed and untyped variables. Un-typed variables can be used while designing and experimenting with the composition in a trial and error fashion; while typed can be used once the model of the service composition matures and becomes production-ready. Moreover, the proposed composition framework employs a fine level of granularity while interpreting the constructs of the proposed language.

Our qualitative evaluation of the proposed language has shown that it is capable of expressing a wide set of workflow patterns, making it as expressive as rival workflow languages. Empirical evaluations of the proposed fine-grained composition framework have shown that is scalable; limited only by the amount of available memory and not by the number of available processing threads.
Stefan Schiffer

Title: Integrating Qualitative Reasoning and Human-Robot Interaction for Domestic Service Robots

Examiners: Gerhard Lakemeyer, Maren Bennewitz

Date: 17.12.2014

Abstract:

The last decade has seen an increasing interest in domestic service robots. Particular challenges when performing complex tasks are deliberation, robust execution of actions, and flexible human-robot interaction. Despite progress in qualitative reasoning and human-robot interaction their integration is an open issue.

In this thesis, we build on an existing cognitive mobile robot platform and make a series of contributions to integrate qualitative representations, high-level reasoning and human-robot interaction for an intelligent domestic service robot. We start by introducing the domestic service robotics domain and parts of the RoboCup@Home methodology that we contributed to. Before we can actually turn to our main focus, we equip the system with a set of basic capabilities that are required for a service robot in human environments. As a bridge between perception and symbolic reasoning we provide a semantic mapping scheme that allows to centrally manage information about the environment. With a novel hierarchical object recognition method we are further able to classify even yet unseen objects.

Then we move on to the main contributions of this thesis. First, we extend the robot with important modes for human-robot interaction by adding components for speech, face, and gesture recognition as well as for speech synthesis and a virtual facial display. After speech recognition we proceed with a simple form of natural language understanding that allows a limited form of error recovery. Second, we introduce qualitative representations and control to our high-level control system. After integrating a general account for qualitative information based on fuzzy sets into our high-level language we also add means to specify and use fuzzy controllers for behaviour specification.

Then we focus on spatial data and provide a formalization that allows for representing and reasoning with qualitative positional information in our high-level language. Lastly, we increase the robustness of the robot against internal errors and add to the flexibility in dealing with possibly faulty external input. We integrate a basic form of self-maintenance that allows the robot to recover from internal errors by itself.
The thesis investigates the ubiquitous computing domain regarding similarities in visualization methods. The identification and classification of the most important approaches reveal a recurring concept: Real world objects are visually augmented by virtual information. We call this novel umbrella concept ubiquitous annotation visualization (ubiAV). As advantage of knowing of commonalities among these visualization methods, application developers can choose from similar visualization options for their application. If they want to evaluate visualization’s effect on a particular application, they have to try different ubiquitous annotation visualization approaches. The thesis specifies the UbiVis software framework, which aims at facilitating this kind of rapid prototyping. Furthermore, the specification of a technical environment allows developers to apply UbiVis in practice. A major contribution is the delivery of a set of libraries for supporting the most important ubiquitous annotation visualization approaches. The provided libraries can be used for exchanging ubiquitous annotation visualization approaches without having to change application code, which is shown by applying them in several examples. Finally, a set of practical user workshops evaluates to which degree the framework is easy to apply.
Ferry Pramudianto

Title: Rapid Application Development in the Internet of Things: A Model-Based Approach

Examiners: Matthias Jarke, Djamel Sadok (Recife, Brazil)

Date: 15.02.2015

Abstract:

The Internet of Things (IoT) is a vision in which physical and digital objects are connected and cooperate to achieve particular goals. Unfortunately, the extent of expertise required to incorporate intelligent hardware, software, and computer network still presents a significant challenge. Service-oriented IoT middleware have been proposed quite often to solve this problem. However, they are mostly designed for professional developers with a high degree of flexibility and extensive features. Consequently, tool’s simplicity is often sacrificed, and they present a steep learning curve for entry-level developers. This dissertation aims at addressing this gap by elaborating the state-of-the-art in IoT developments and proposing IoTLink, a rapid IoT software development tool for novice developers. For designing IoTLink, the author reviewed the available IoT architectures. A typical pattern suggests that a physical object must be uniquely identifiable, has physical qualities that partly can be sensed by sensors, and has some capabilities or services that could affect the environment. Virtual entities may act as proxies to execute services and retrieving information about the physical objects. IoTLink is designed for enabling inexperienced developers to develop proxies representing domain objects and abstracting individual sensors and actuators. IoTLink design concept comprises a five layered architecture. The first layer is responsible for abstracting communication with heterogeneous data sources. The second layer deals with sensor fusion components to process and fuse sensor data into useful information. The third layer is concerned with the definitions of domain models and the concrete objects. The fourth layer provides output components, including interfaces to the application logic, distributed applications, and databases to store the information about the virtual objects. The fifth layer abstracts the application logic that access the domain objects. IoTLink employs a model driven approach for wiring these components visually. The visual model is then serialized into XML data and used to generate a Java implementation which can be executed as proxies. In addition, IoTLink offers a discovery broker allowing developers to share and discover IoT resources within the internet. The key advantage of IoTLink discovery is the ability to detect if similar devices are described with synonymous terms. This approach increases the discoverability of similar devices described with diverse terms. The author evaluated the practicability of IoTLink and model-driven approach within three distinct case studies in European research projects. The result shows that it could reduce approximately 2/3 of the development efforts. In addition, the author compared IoTLink’s usability to a Java middleware approach in a controlled experiment performed by 24 participants. The results show that IoTLink could on average reduce 44% of the development time and 48% of mistakes. Moreover, when used by developers with less than five years object-oriented experience, IoTLink was able to reduce up to 57% of mistakes compared to Java development.
Recommender systems already are a consistent part in the life of most people regularly using the internet. They get recommendations when they shop at Amazon.com, when they watch video clips on Youtube.com, or when they listen to music on Spotify.com etc. There are still many challenges in recommender systems research, though. One challenge that is present in almost all application domains is data sparsity, i.e. missing information about items or users. In very sparse application domains, data sparsity can completely hinder the creation of recommendations. In more diverse application domains, where few items are heavily used while most items are rarely used, the popular items tend to be recommended over-proportionally often. In contrast, the niche items tend to be excluded from the recommendation lists. This thesis therefore aims to contribute to the state-of-the-art in handling data sparsity in recommender systems by investigating techniques to find similarities between the items solely by analysing their usage. This approach is based on the assumption stemming from context-aware computing that the users' contexts and knowledge influence their activities and, thus, are inherent in the items' usage. Hence, no additional information like content or social metadata are required to find relations between the items. The discussed techniques are evaluated on four data sets, two of them were collected in web portals that support learners in finding suitable learning materials while the other two data sets were collected in web portals that recommend movies to users. The evaluation results show that by exploiting the items' usage, usage-based relations between the items can be discovered that indeed give a hint at their similarity. Furthermore, the usage-based recommender systems are able to create more recommendations in application domains holding predominantly rarely used items than the presented state-of-the-art recommendation approaches. In application domains holding heavily used items that are recommended over-proportionally often in addition to many rarely used items, the usage-based recommender systems are able to recommend more niche items than the presented state-of-the-art recommendation approaches without lowering the accuracy of the recommendations. Thus, the usage-based approaches are better suited to provide users with accurate recommendations for idiosyncratic items than the recommendation approaches presented in literature so far that do not require additional metadata either.
Abstract:

Trust is a fundamental building block of human behavior for dealing with complex situations. The world of distributed computer systems and especially the Internet have become increasingly complex, resulting in the proposition of using trust in them as well. Current results in trust management focus on the establishment of procedures for various threats and different domains, including e-commerce, networked systems, sensor networks, etc. These frameworks are still theoretical, and there are only limited possibilities to compare the performance of various solutions. To learn more about the possibilities of trust management it is necessary to deploy trust management frameworks into real-world settings. This work addresses these problems and provides the TrustMUSE system as a solution approach. The TrustMUSE system applies a meta model to decrease the complexity of individual trust management frameworks and modularize them into clearly defined functional elements. Through our process, available implementations can be annotated with standardized attributes that translate trust management functionality into architectural qualities and services. We integrated the individual components of our approach into a tool that helps narrowing down the number of trust management implementations applicable to specific application scenarios, and helps browsing and comparing them until specific implementations can be added to the target software. Our tool not only decreases the time necessary to find an applicable solution for specific application scenarios but also provides extensive information regarding trust management procedures and possibilities, thereby helping the tool's users to gain a better understanding of the domain and the capabilities of trust management. In our final evaluation the participating users were able to provide trust management framework designs similar to those of domain experts, thereby illustrating the soundness of our approach.
Amro Al-Akkad

Title: Working around disruptions of network infrastructures - Design and evaluation of mobile ad-hoc systems for resilient communication in disasters

Examiners: Matthias Jarke, Volker Wulf

Date: 17.04.2015

Abstract:

The use of information and communication technology services can be constrained in disaster situations, when it is important for affected persons to receive and send up-to-date information on current incidents and their evolution. Previous studies have shown the importance of propagating disaster-relevant information over the World Wide Web. In such situations, users without Internet access find themselves in an “information vacuum” until the network infrastructure is restored. This thesis addresses the exploitation of cell phones in disaster situations which cause the disruption of network infrastructure. The first part of this thesis collects empirical material on how people creatively use remnants of technology to communicate in disasters. The empirical data is drawn from primary and secondary sources: interviews with domain experts and people who have experienced a disaster situation, as well as external reports and scientific literature. Based on this empirical foundation, this work develops a conceptual framework that comprises a collection of quality attributes. When exploiting cell phones to create ad-hoc systems in disaster situations, the implementation of such quality attributes can potentially support the resilience of mobile ad-hoc systems. The second part of this thesis focuses on the iterative design and evaluation of two such mobile ad-hoc systems, showing how these quality attributes can be implemented. To explore the feasibility of the systems and their implications for the work practices in the emergency response domain, they are deployed under close-to-real disaster conditions. The developed systems distinguish themselves from the state of the art in two essential aspects: first, they are independent from preexisting network infrastructure, and second, they run on off-the-shelf devices. Thus, this work addresses the following research questions: • How do people creatively use remnants of technology in disaster situations? • Which quality attributes for ubiquitous computing systems can support resilience in such situations? • How can such quality attributes be implemented for smartphones?
Abstract:

Since January 2000, Fraunhofer FIT at Birlinghoven Castle, Sankt Augustin, is associated with RWTH Aachen University by joint appointment of Institute Director Professor Matthias Jarke of Informatik 5. FIT is part of the Fraunhofer ICT Group, a consortium of 19 Fraunhofer Institutes with over 4000 researchers, also coordinated by Professor Jarke. In September 2015, Professor Stefan Decker (formerly Director of the Digital Enterprise Research Institute DERI in Galway, Ireland) joined as second institute leader.

In 2014-2015, the institute underwent its regular strategy audit with very positive feedback. With currently about 210 employees (including about 50 student assistants), Fraunhofer FIT supports the digitization of business and society by sustainable business informatics under the three perspectives of human-centered design, high-tech process support, and financial, managerial, and technological risk management.

The institute is organized in four research divisions:

- Cooperation Systems (Prof. Wolfgang Prinz) focuses on cooperation and innovation management using social media, continuing technology-enhanced learning technologies, and advanced visualization technologies such as augmented reality. As one example, FIT won a 2014 innovation award of the Bayer conglomerate, for its
innovative wearable computing infrastructure for Healthcare research labs which was also demonstrated to Federal Minister of Labor, Andrea Nahles, during her visit at FIT in May 2015. There is a close cooperation with Informatik 5 in the area of social computing and lifelong learning.

- User-Centered Computing (Dr. Markus Eisenhauer) studies systems engineering by humans for humans, i.e. a user-centered and participative approach to the design of software-intensive systems in the context of the Internet of Things. FIT’s LinkSmart middleware has been highly successful in supporting energy-saving cyber-physical systems in contexts ranging from sports to energy management to factory collaboration. Our Certified Usability Engineer courses are among the most successful of the Fraunhofer Academy of continuing education, and the Accessibility and Web Compliance group closely cooperates with the SignGes Center on Sign Languages and Gesture Research to improve the education and job situations of deaf citizens.

- Life Science Informatics (Prof. Thomas Berlage) offers rich image-integrated information for the health sector. Applications include high-content high-throughput analysis and other life science big data themes down to the level of individual molecules. The Fraunhofer Foundation project Ribolution which studies novel markers for early cancer recognition, and the BMBF Big Data project HUMIT in cooperation with the national DZNE Center for Neuro-Degenerative Diseases are recent examples which address some of the most wide-spread and deadly diseases. The micro-to-nano level bio-optical methods used in such projects besides big data analytics also feed into industrial cooperations in other areas, e.g. through FIT’s recently opened Application Center SYMILA at Hamm-Lippstadt.
Risk Management and Decision Support (Prof. Thomas Rose) supports sustainability by evaluating, minimizing, and managing different kinds of risks. One group specializes on managerial and technological emergency management particularly for fire departments by modeling support and new mobile technologies, a second one assists German federal ministries in financial impact analyses of proposed law changes. The third one, our project group in Augsburg (see image of the FIT building there) and Bayreuth, offers financial value analyses for top management, combining expected income and cost estimates with precise risk profiles and associated management strategies. This latter group grew by two associate professors and almost 20 people in the last academic year, supported by seed funds of the Bavarian state government and industrial third-party funding mostly from the financial sector.

Three of the division leaders (Berlage, Prinz, Rose) have joint appointments as professors at RWTH Aachen. In addition, several renowned colleagues from other universities are linked to Fraunhofer FIT as department co-leaders or consultants: Hans-Ulrich Buhl (Augsburg University), one of the best-known finance informatics professors in Germany, with a project group in financial information management, social informatics specialist Volker Wulf (University of Siegen) with a group focusing on usability issues, and Thomas Hoeren (University of Münster), a well-known leader in the field of Media and Internet Law.

In 2014, the institute grew to a a record third-party funding of almost 9 m€, representing close to 80% of the budget. Industrial contract research accounted for 34% of the budget, European projects 24%.
Since 2003, the B-IT has been pioneering the brain gain of much needed IT specialists from all over the world by offering top-level international master programs in applied informatics. In a unique cooperation between RWTH Aachen University, the University of Bonn, the Bonn-Rhein-Sieg University of Applied Sciences, and the Fraunhofer Center Birlinghoven Castle, these master programs address Media Informatics, Life Science Informatics, and Autonomous Systems, respectively. Students from over 40 countries worldwide are studying in the beautiful b-it Building on the Rhine River in Bonn-Bad Godesberg. Since the retirement of Founding Co-Director Armin B. Cremers in 2014, b-it is directed by Professors Matthias Jarke (RWTH Aachen and Fraunhofer FIT), Kurt-Ullrich Witt (Hochschule Bonn-Rhein Sieg), and Stefan Wrobel (Bonn University and Fraunhofer IAIS). Eight endowed professorships are funded by the b-it Endowment, plus matching funds by NRW State.

In the academic year 2014-2015, 61 master degrees were awarded, 30 of them in the Media Informatics program under the responsibility of RWTH Aachen University. Since 2014, the program is coordinated by Prof. Ulrike Meyer, who continues to be supported by long-term study advisor Dr. Jürgen Rapp. 37 new students were accepted into the program from about 270 applicants. We were also happy to observe that over twenty early b-it graduates have already completed a doctorate, and at least five have accepted professor position.

Careful placement tracking of the B-IT graduates show that the dual goal of strengthening German business and science by young promising international graduates, and of improving further the linkages to their home countries by returning well-educated graduates for their local commercial and scientific job markets, has been impressively reached. The quality of the program was confirmed once again by an external evaluation of the b-it Foundation in 2015.