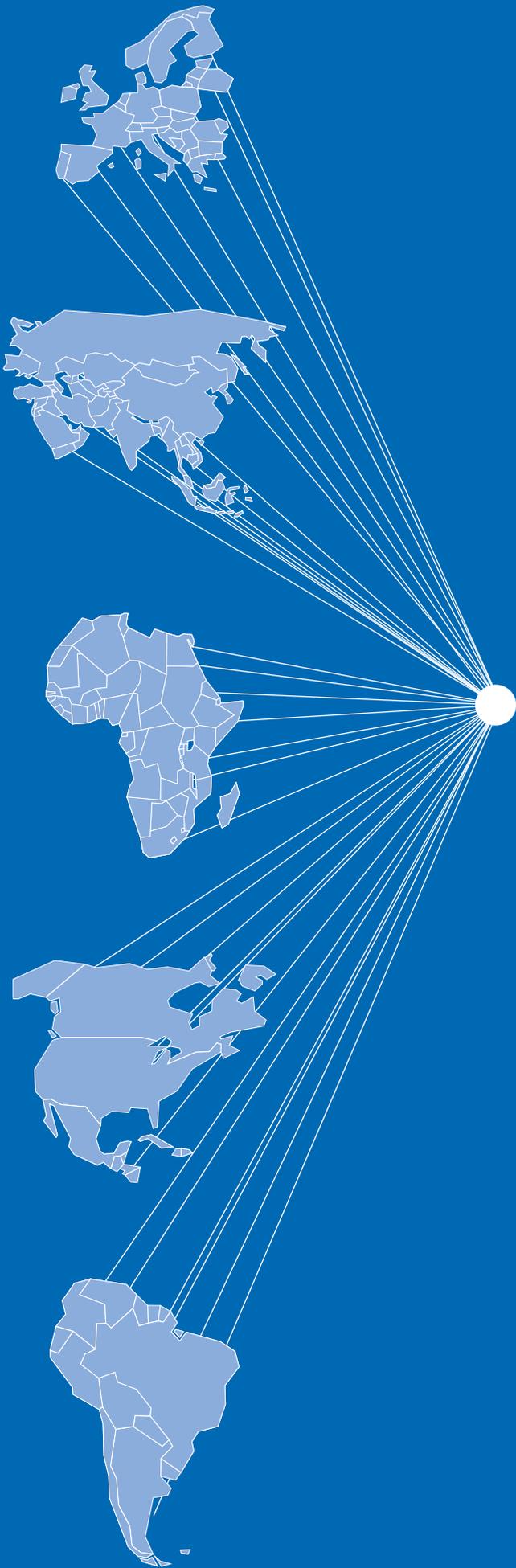# 2018

Annual Report

b-it

**Bonn-Aachen
International Center for
Information Technology**

Foreword by the Chair of the b-it Foundation

Annette Storsberg

A few days before the end of the Academic Year 2017-2018, the evaluation committee for the German National Excellence Initiative in Research made the final decisions on the proposed large-scale Excellence clusters that will define much of the structure of research for at least the next seven years. In this third round of the Excellence Initiative, North Rhine-Westphalia significantly strengthened its relative position among German states, and made first place with 14 accepted clusters, 8 of them just by the b-it universities. While RWTH Aachen defended their co-lead among the technical universities, University of Bonn sensationally jumped to the first position of all universities – thus, the Bonn-Aachen axis got more clusters than whole "excellence regions" such as Munich or Berlin. Four of the clusters involve b-it professors and associated Fraunhofer institutes, addressing issues around Media Informatics (Internet of Production), Life Science Informatics (ImmunoSensorics), Autonomous Systems (Farming Robots), and their shared Data Science core.

These successes once again strengthen the attractiveness of the Bonn-Aachen International Center for Information Technology (b-it) for valuable top international talent joining the b-it Master Programs, but also the Doctoral Schools associated with the excellence clusters, expanding the earlier b-it Research School effort. The Ministry of Culture and Science NRW appreciates b-it's continued emphasis on fruitful cultural diversity among the more than 40 nations of origin, combined with academic excellence through the deep integration between research and teaching in all b-it programs. The investment in a new b-it building will further deepen the university linkages.

Public visibility of b-it has been further improved by providing spectacular media innovations to public events, such as the "Dom leuchtet" lightshow for which over 8,000 admission tickets were completely sold out every single night at the week-long 40-year celebration of Aachen Cathedral as the first UNESCO World Cultural Heritage Site.

In Bonn, the preparations of the 250-year celebration of Beethoven's birthday provide a focal point for similar activities.

Systematically pursuing the recently renewed mission statement, b-it has further strengthened its Data Science core by electing Prof. Emmanuel Müller, formerly Hasso Plattner Institute Potsdam, to the b-it Chair for Data Science and Engineering. In addition, I would like to welcome several important new members of the international b-it Advisory Board, including former ACM President Dame Prof. Wendy Hall and industrial members Dr. Christian Illek, Dr. Thomas Ogilvie, and Dr. Simone Rehm.

I would like to congratulate the b-it leadership – directors, study coordinators, faculty and study advisors – on the progress in the past academic years and look forward to the next steps.

Annette Storsberg
State Secretary, Ministry of Culture and Science NRW
Chair of the b-it Foundation Council

b-it Mission Statement

b-it is an international center for information technology. It is jointly carried by the leading universities and research institutes of the information technology region Bonn-Aachen. At b-it, a team of excellent scientific leaders attracts the best students from all over the world. At the same time, b-it is a strategic partner of the regional economy.

At b-it, research and teaching form an integrated unit at the highest level. International orientation and diversity are a particular asset and strength of our institution. In our teaching, we build on the complementary strength of our participating institutions.

Graduates of b-it are sought after as specialists and experts, regionally and internationally. They transport know-how and innovation into science and economy.

We are shaping the digital change in a dialog between economy and society. Our focus is Data Science in the application areas Media, Life Sciences and Autonomous Systems.

Report by the Scientific Directors

b-it offers highly selective graduate education to top international students in a unique cooperation between leading research universities and the Fraunhofer Society of Applied Research. The just completed German Excellence Competition confirmed once again the leading position of the Bonn-Aachen region. b-it directors and faculty are directly involved in four excellence clusters (each funded with up to € 50 million for 7 years): Internet of Production, PhenoRob for Sustainable Crop Production, ImmunoSensorics, and Advanced Computational Mathematics. These clusters will also include PhD training groups for graduates with ambitions beyond the master degree. A key event in 2018 was b-it's relocation into the new b-it building centrally close to other university departments and Bonn Central Station. Many thanks to all helpers in this enormous effort, especially to coordinator Thomas Bode.

We are happy to welcome Emmanuel Müller as the new b-it Endowed Professor of Data Science and Data Engineering, and were glad to keep Prof. Holger Fröhlich as an Adjunct Professor. Prof. Sven Behnke's prestigious million dollar award in humanoid robotics once more confirmed once again the strength of the b-it partner universities in applied robotics. b-it is a big team effort. We are grateful for the continued support by our three mother universities through the recent rectorate transitions at RWTH Aachen and Bonn University, and for the intensifying networking with the regional industry. Our study advisors assist the international students from over 40 countries worldwide with many of the questions arising during applications, arrival, social networking and of course sometimes unfamiliar study regulations, backed up by the professors of the study coordination and examination boards. Many thanks to all of them.

In this report, you find some highlights of b-it research and teaching from the academic year, as well as some general information about the b-it study programs. Enjoy the reading!

Matthias Jarke,
RWTH Aachen University and Fraunhofer FIT
Paul G. Plöger,
Bonn-Rhein-Sieg University of Applied Sciences
Stefan Wrobel,
University of Bonn and Fraunhofer IAIS

Prof. Dr. Matthias Jarke
RWTH Aachen University and Fraunhofer FIT

Prof. Paul G. Plöger
Bonn-Rhein-Sieg University of Applied Sciences

Prof. Dr. Stefan Wrobel
University of Bonn and Fraunhofer IAIS

b-it in Profile

The southwest of North Rhine-Westphalia is one of the largest, most vibrant locations in the European media and telecom industry. It is also one of the most innovative and fast-growing biotech regions in Germany, and there is much interest in the emerging fields of mechatronics and robotics. To make it the optimal place to study for professional work in these fields, the Bonn-Aachen International Center for Information Technology (b-it) has been established as a joint venture of RWTH Aachen University, University of Bonn, Bonn-Rhine-Sieg University of Applied Science (BRSU) and the research institutes of the Fraunhofer Institute Center Birlinghoven Castle.

b-it offers highly selective International Master Programs in Applied IT, as well as summer / winter schools for qualified undergraduate computer science students. The b-it Research School offers doctoral training. Since 2018, most courses take place in the newly erected b-it building on the Poppelsdorf Campus for Mathematics and Computer Science of Bonn University. Admission to the b-it Master Programs is linked to, and conditional upon, placement in research lab courses at the participating Fraunhofer institutes. Students
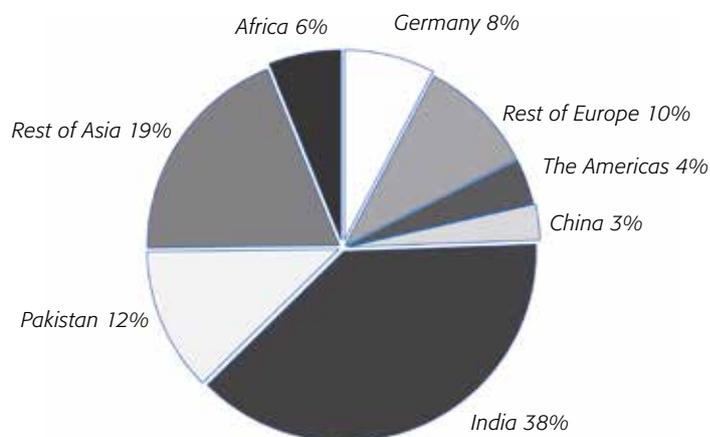
in good standing are offered financial support during these lab courses.

The b-it Universities Institute offers English language Master of Science (M.Sc.) programs in Media Informatics and Life Science Informatics, whereas the University of Applied Sciences offers a Master Program in Autonomous Systems. The Master Programs prepare students for successful international careers that require technical excellence and leadership, creativity and the ability to innovate. b-it master programs are distinguished by their international orientation (structured according to the European ECTS standard), their focus on IT competence, and the deep integration of teaching and research.

For the participating universities, the b-it programs have also helped pave the way towards a smooth transition from the traditional German diploma system to the Bachelor-Master system following the Bologna accord; for example, the b-it master programs were the first to be accredited within the participating universities in 2004-2005, and re-accredited in 2010-2011. A comprehensive external evaluation in 2015 confirmed the very positive developments and stimulated a few new accents. The success of the b-it programs is also demonstrated by a very good placement record, both in science and industry.

b-it is financially supported by a 56 M€ Foundation initiated through the Bonn-Berlin program of the German federal government, as well as by matching NRW state funds.

Home countries of new b-it students.

Africa 6%
Germany 8%
Rest of Asia 19%
Rest of Europe 10%
The Americas 4%
China 3%
Pakistan 12%
India 38%

Honors and Awards

Award for MI Researchers at Top International HCI Conference

Christian Corsten, Dr. Simon Voelker, Andreas Link, and Prof. Dr. Jan Borchers received an Honorable Mention Award for their paper "Use the Force Picker, Luke: Space-Efficient Value Input on Force-Sensitive Mobile Touchscreens" at the ACM CHI 2018 Conference in April. Their work presents a new interaction technique that leverages the "force touch" capability of modern smartphones to shrink down the space taken up by frequently used elements in the user interface, like the Date & Time Picker Wheel. ACM CHI is the world's most prestigious and impactful conference in Human-Computer Interaction. The Honorable Mention Award is bestowed upon the most highly reviewed 5% of submitted papers only.

Prof. Jarke Elected Chairman of TH Cologne Governing Board

In its inaugural session on March 2, 2018, the new Governing Board (Hochschulrat) of the Cologne Technical University of Applied Sciences (TH Köln) elected Prof. Matthias Jarke as the new Board Chairman. According to NRW law, the Hochschulrat is responsible for giving strategic advice, overseeing major personnel, financial and structural decisions of the University Presidency, as well as organizing the election of new members of the Presidency.

MAS Alumnus Wins Thesis Prize

MAS alumnus Ahmad Drak was awarded a prize for his research thesis by the Hochschulgesellschaft Bonn-Rhein-Sieg. The thesis, supervised by Prof. Alexander Asteroth (H-BRS) and Dr. Simon Julier (University College London), examines the application of drone technology to extract airflow models from tufts attached to the surface of the aerodynamic body of an electrically assisted vehicle known as the velomobile. The drone autonomously performs a side-by-side tracking and following of the velomobile and captures high quality (HQ) video footage under realistic outdoor conditions in order to extract airflow models which are used to improve the design of the vehicle and thereby increase its efficiency.

Prof. Jarke Receives Prestigious Fraunhofer Award

In June 2018, Fraunhofer FIT celebrated 50 years of human-centered computing research at the institute and its predecessor groups in Birlinghoven Castle. During this event in which NRW State Secretary Annette Storsberg also spoke about the successful regional cooperation in the b-it initiative, Fraunhofer President Prof. Reimund Neugebauer awarded long-term institute director and b-it founding director Prof. Matthias Jarke the "Fraunhofer Coin", the highest award for Fraunhofer institute leaders and researchers.

(from left) Prof. Stefan Decker, Prof. Matthias Jarke with "Fraunhofer Coin", and Fraunhofer President Prof. Reimund Neugebauer.

B-IT MI Chair Selected for BMBF Roadshow

The TABULA research project at Prof. Jan Borchers' b-it Endowed Chair for Media Informatics and Human Computer Interaction has been selected as one of four flagship projects in the Tangible Learning Initiative of the German Ministry of Science and Education (BMBF). TABULA uses an original invention of the chair's – graspable, physical "tangibles" that are tracked by a large, modern capacitive touch table display – to help student teams learn fundamental computer science concepts more easily together. The BMBF has organized a roadshow that travels to four university locations in Germany with TABULA and three other core research demonstrators.

TABULA touch table display.
© www.joergkochfoto.de

Events and Visits

We Are Vice World Champion!

The RoboCup team b-it bots came in second at the RoboCup@Work Competition held in 2018 in the Palais de Congres in Montreal, Canada on June 16-22, 2018, thus continued their series of successes in the past years. The team also scored high in two technical disciplines, the arbitrary surface test (second place) and the line following test (first place). The Montreal team consisted of four students of the international master degree program "Autonomous Systems". Their coaches Deebul Nair and Santosh Thoduka are both research associates in European research projects and successful alumni of the AS program. Prof. Kraetzschmar and Prof. Plöger support the team with scientific as well as administrative advice.

IDEA League Doctoral School ECS-BIT'18 Held at b-it Research School

The IDEA League is a focused network of leading European universities of science and technology (TU Delft, RWTH Aachen University, ETH Zurich, Chalmers University Göteborg and Politecnico di Milano). Over the spring and summer of 2018, Prof. Barbara Pernici (Politecnico di Milano) together with Prof. Matthias Jarke (b-it) organized a distributed Doctoral School on "Engineering Complex Systems with IT and Big Data" (ECS-BIT'18) in which 32 doctoral candidates from all member universities and other research institutes including Fraunhofer attended two- to four-day compact classes in each IDEA League site. The Aachen meeting at the b-it Research School focused on fundamental concepts and practical experiences including process mining (Prof. Wil van der Aalst), knowledge graphs for research information management (Prof. Stefan Decker), social network analytics (PD Ralf Klamma), Industry 4.0 integration (Prof. Thomas Gries), and safety and security (Prof. Stefan Kowalewski). This inspired lively debates with the doctoral students who represented many disciplines and rich cultural backgrounds from over 15 home countries in Europe, Africa, the Americas, and several parts of Asia. In addition to the scientific program, participants also took home memories of the hospitality in Aachen's historic old town, including a surprise encounter with German President Walter Steinmeier and NRW Prime Minister Armin Laschet in front of Charlemagne's historic Cathedral.

✝ b-it is deeply saddened by the untimely death of Dr. Shilva Kayastha from Nepal. Shilva joined the LSI program in the winter term of 2011/2012 with a Bachelor's Degree in Biotechnology from Koneru College of Engineering, India. For her Master Thesis, she joined Prof. Bajorath's group in 2013 and graduated with a Master's Degree. Shilva continued PhD studies in Prof. Bajorath's group, which involved a close collaboration with the laboratory Prof. Alexandre Varnek at the University of Strasbourg, France. Shilva brilliantly finished her PhD in 2017 and received a permanent position as a Chemoinformatics Scientist at BASF. Shortly after finishing her thesis, Shilva was diagnosed with late stage cancer and ultimately lost her brave battle in August of 2018. Shilva will always be remembered as one of us, for her academic accomplishments, and even more so for her gentle and kind personality, her enthusiasm, and friendship.

Research @ b-it

b-it involved in four Clusters of Excellence

The Cluster of Excellence "Internet of Production", conducted by RWTH Aachen University in cooperation with several Fraunhofer Institutes, brings together Aachen's internationally renowned Production Research community with a strong group of eight computer science chairs in the domains of data and communication management as well as systems engineering. It is coordinated by Professors Christian Brecher, Matthias Jarke, and Günther Schuh from RWTH Aachen and Fraunhofer. Through an elaborate novel infrastructure concept of multi-layered "Digital Shadows", model-driven and data-driven approaches to material science, production technology, production engineering, agile production management, and novel work and business models, will be enabled to collaborate in a world-wide Lab of Labs. Application domains range from machine tools to steel- and plastics-based continuous production processes to large-scale innovation.

Secondly, the "PhenoRob" Cluster of Excellence at University of Bonn is comprised of researchers from both the agricultural faculty as well as from computer science. Bonn b-it director Prof. Stefan Wrobel is involved as a Principal Investigator, b-it Prof. Christian Bauckhage is an associated Principal Investigator, both also bringing in their roles at b-it partner institution Fraunhofer IAIS. The PhenoRob cluster addresses one of today's central challenges for humanity, the production of sufficient food, feed, fiber, and fuel for an ever-growing world population while simultaneously reducing the environmental footprint of agricultural production. Its main hypothesis is that a major shift toward sustainable crop production can be achieved via a combination of plant monitoring using autonomous robots with automated and individualized intervention and assessing, modeling, and optimizing the implications of the developed technical innovations in a systemic manner.

Thirdly, b-it is linked to the Cluster of Excellence "Hausdorff Center for Mathematics" via Prof. Michael Griebel (Fraunhofer SCAI and University of Bonn). It was established 2006 at the University of Bonn under the title "Mathematics: Foundations, Models, Applications". Its work thematically comprises a broad spectrum of mathematics as well as mathematical economics: from topics from the classical core areas of mathematics through mathematical modeling and numerical simulation in the natural and social sciences to industrial applications in chip design.

Finally, b-it cooperates with the "ImmunoSensation" Cluster of Excellence that is dedicated to investigating innate immunity beyond the boundaries of classical immunology. The University of Bonn, the Max-Planck-associated Center of Advanced European Studies and Research (caesar) and the German Center for Neurodegenerative Diseases within the Helmholtz Association (DZNE) jointly exploit the new research space.

Participation in the Competence Center Machine Learning

Since autumn of 2018, b-it is the anchor for University of Bonn's participation in the National German Competence Center Machine Learning Rhein-Ruhr ML2R. This center, along with only three others, is part of Germany's strong push towards furthering excellence and applications in Machine Learning. Its joint speakers are Prof. Katharina Morik (TU Dortmund), b-it scientific director Prof. Stefan Wrobel, and b-it Prof. Christian Bauckhage is the Principal Investigator for b-it and University of Bonn. The goals of the ML2R center are to establish cutting-edge research, support young scientists and strengthen technology transfer in companies. The close integration of basic and application-oriented research builds the ideal foundation for innovation in ML2R. In this way, the center aims to actively shape Germany's future and contribute to securing the digital sovereignty of the country.

Hausdorff Center for Mathematics.

Prof. Dr. Jan Borchers,
Media Computing

Prof. Dr. Thomas Rose,
Media Processes

List of employers of MI Alumni
(Universities & Research):
Airport Research Center GmbH,
b-it, b-it Research School, Centro
Nacional de Investigaciones
Cardiovasculares, CERTH, Cha-
rité Berlin, Chinese Academy of
Science, COSBI, Czech Technical,
ETH Zurich, Fraunhofer FGAN,
FIT, FKIE, FOKUS and IAIS, FSU
Jena, Hasso-Plattner-Institut, HHI
Berlin, Imperial College, INRIA,
Institute of Molecular Medicine,
Karlsruhe Institute of Technology
(KIT), K. U. Leuven, Max Planck,
Microsoft Research (Cairo),
National University of Computer
& Emerging Sciences, National
University of Ireland Maynooth,
National University of Sciences
and Technology, Research Center
Jülich, Robert Bosch Foundati-
on, RWTH Aachen, Suez Canal
University, Swiss Federal Institute
of Technology, Uniklinik Aachen,
Uniklinikum Bonn, Universidad
Tecnologica de Panama, Univer-
sitätsspital Basel, University Clinic
Carl Gustav Carus; Universities
of Agder, Arab American Jenin,
Asia and the Pacific, Atma Jaya
Yogyakarta, Augsburg, Bahria,
Bonn, Cambridge, Düsseldorf-
Essen, Dresden, Duisburg-Essen,
Edinburgh, Engineering & Techno-
logy Peshawar Pakistan, Ghent,
Göttingen, Hamburg, Hasselt,
Heidelberg, Houston, Oldenburg,
Ireland, Maynooth, Ienes Kepler,
Kiel, Leipzig, Mainz, Münster,
Paris, Rotterdam, Sud, Stuttgart,
Tilburg, Tirana, Toronto, Trento,
Tübingen, Washington, Waterloo,
Western Australia, West Indies,
Zurich; TU Darmstadt, TU Dres-
den, TU Eindhoven, TU Munich

b-it Programs

Master Program in Media Informatics

Computer scientists with an applied focus have been in great demand in the past, and this is expected to continue for the foresee-able future. Graduates of the Master Program in Media Informatics will be well-prepared for the challenges faced when working in computer systems engineering and for creative work with audio-visual media. The Aachen – Bonn – Cologne region is home to many prospective employers, including global players such as Philips, Microsoft, Telekom, Vodafone, Bertelsmann Group, as well as many television stations including RTL, WDR etc.

While a Bachelor degree in Computer Science typically qualifies to participate in large software projects, the Master degree provides the qualifications for project leadership. Graduates of the program in Media Informatics can be expected to be technically innovative, to work as system architects, and to manage large projects. Students who excel during their master program will also have the necessary qualification to pursue a doctoral degree in Germany or abroad.

The Master Program in Media Informatics educates the students to successfully meet the novel technical and economic challenges at the intersection of computer science, software engineering, next-generation communication systems, and the media. It is offered as a joint program of RWTH Aachen University and University of Bonn.

The program is characterized by a significant portion of lab courses embedded in research of the participating Fraunhofer Institutes for Applied Information Technology FIT and for Intelligent Analysis and Information Systems IAIS. The degree is conferred by RWTH Aachen University. Cooperation partners from industry and research contribute to a rich teaching program.

The course contents are structured according to the ECTS (European Credit Transfer System) and consist of three main blocks: Computer Science and its mathematical foundations, Multimedia Technology, and Media Science and business aspects. Major topics include: Internet Infrastructures, Data Communication, Digital Interactive Media, Management of Information, Computer Graphics, Animation, Visualization, Speech / Image / Video Processing, Game Design, Security and Cryptography, Designing Interactive Systems, Cooperative Work Environments, E-Business, Knowledge Management, Virtual and Augmented Reality, and Software Engineering.

Thirty three Media Informatics students have completed their degree in the academic year 2018-2019. The graduates quickly found interesting positions either as doctoral students in Germany and abroad, or in attractive companies. The incoming class of 2018 comprises 35 students, selected from 352 applications. The new students come from 19 countries, and include 42% females and 58% males.

b-it-chain

The blockchain lab course at b-it has become a regular teaching event and is offered each summer term. Hence, blockchain technology as core ingredient for trust management amid business collaboration is taught in a theoretical stance inside lectures such as eBusiness & Digitalization and CSCW as well as in a practical stance with experience labs.

This summer's topic has been the development of a modular blockchain. The result of this course is b-it-chain, which is a full-fledged blockchain. It is available publicly via GitHub (https://github.com/putschli/LabChain). Moreover, it serves as testbed for further Master topics and other experiments by students. Its modular design allows experiments on the interchangeability of functional components. The storage of transactions by a chain of blocks is for instance one questionable decision of the original blockchain proposals. Graph-like structures might be more attractive at first sight with regard to parallelism of updates and search efficiency. However, our experiments unveiled a tight linkage with components for consensus finding. Hence, b-it-chain might furnish a basis for the identification of core elements of blockchain technologies and their implementation alternatives.

A blockchain chooser (https://blockchain-assistent.fit.fraunhofer.de) is available in parallel. The chooser is based on key attributes of blockchain projects and guides interested parties through a structured decision process for the selection of a specific implementation platform.

News from Media Informatics Alumni

SIDDARTH MEHROTRA

joined Media Informatics in 2017. He showed his passion for innovative User Experience Design already at Siemens Bangalore, following his Bachelor degree from Galgotias University, India. He has already published several papers at top HCI conferences, e.g. CHI, and won a bronzemedal at 2018 the ACM ASSETS Competition in Galway, Ireland. Also, he filed a patent. In 2018, he was accepted to the "Heidelberg Laureate Forum" among 100 top young computer researchers worldwide selected for scientific interaction with Nobel Laureates. He was also selected for ACM UIST School 2018 & with his team in the highly competitive UIST 2018 Student Innovation Contest, with their work on a robot that can help physically impaired people to wear socks. The team won the UIST School Hackathon and was among the top 5 in the UIST Student Innovation Contest.

Prof. Dr. Jürgen Bajorath, Life Science Informatics

Prof. Dr. Martin Hofmann-Apitius, Life Science Informatics

List of employers of LSI Alumni (Business):

4GATC Biotech, Accenture, Alcimed, Arbern GmbH, Asahi Kasei, ASI Data Science, Astra Seneca, BASF SE, Bayer, BenevolentAI, Clariant, Ericsson, carpooling.com GmbH, Clue Points, Comma Soft AG, Coty Germany, Curetis, DFind Science and Engineering, DHL, ecSeq Bioinformatics, Freeletic, Galilleo Press, Gamomat GmbH, GAMOMAT Development GmbH, GATC Biotech, Genestack, Glaxo Smith Kline, Hamilton Medical, HealthCare Global, Heraeus, Hoffmann-La Roche, Hype Innovation, IBM, IIT Bangalore, ITTM S.A., Interpretomics, KWP Inside HR, LabVantage Solutions Inc., Land of Lakes Inc., Leaf Bioscience, LHS Telecommunications, LinkTechnica, L'Oréal, MacKinsey, MarAnCon, Max Dellbrück Center Berlin, Medtronic, Miltenyi Biotec, Molecular Devices, Molecular Health GmbH, Molecular Connections Private Limited, Merck, Monsanto, msg systems ag, Nestlé Institute of Health Science, Novartis, Omnicom Media Group, Pfizer, parlamind GmbH, Postbank, Philips Research North America, ProfileXpert, Protagan AG, quintly Inc., real.digital, Sciex, Seassoon Information Technology, Syngene Ltd., United Brands Marketing, Tubs System LLP

Master Program in Life Science Informatics

The Master Program in Life Science Informatics (LSI) is offered by the University of Bonn and RWTH Aachen University in cooperation with the Fraunhofer Institutes of Scientific Computing (SCAI) and Applied IT (FIT). The degree is conferred by the University of Bonn. This interdisciplinary program educates the participants to successfully master the novel technical and economic challenges at the crossroads of biotechnology, medicine, pharmaceutics and computer science. The curriculum consists of three main blocks: Computer Science and Mathematics for life scientists; Basic principles of Life Science Informatics; Biology of the cell and systems biology.

Major topics include biomedical database systems, data mining and machine learning, statistical genetics, drug design, medical imaging and visualization, computational neuroscience, computational modeling of regulatory and metabolic networks, cheminformatics, bioinformatics, molecular modeling, molecular biology, pharmaceutical chemistry, biotechnology and systems biology. The program emphasizes a profound understanding of biological structures (such as proteins, nucleic acids, genes, metabolic, neural networks and organisms) as well as the appropriate application of methods of computer science to this field. It also includes training designed to sensitize students to the ethical implications of emerging biotechnologies. This combination will enable the successful students to understand biological or medical problems and to find appropriate and valid solutions that bioinformatics can offer. The program is characterized by a significant share of research lab courses embedded in both basic and applied research of the participating Fraunhofer Institutes as

well in labs of CEMBIO (Center for Molecular Biology) and LIMES (LIfe and MEdical Sciences Research Biocenter Bonn). The final six months of the program are dedicated to the master thesis which can be done in cooperation with industry.

Graduates of the program are well prepared for the typical professional tasks in applied data analysis, systems biology and data modeling, in industrial functional genomics, drug design and pharmacology. The Aachen-Bonn-Cologne-Düsseldorf region is home to many prospective employers, including excellent academic institutes and research driven companies. The regular and well attended meetings of the LSI Series "The ABC of Life Science Informatics" in the last years have contributed to strengthen ties with scientists of the region. Several interesting master thesis have been carried out in collaboration with them. LSI students were also instrumental in this process. This has increased the visibility of the program considerably, also on a larger geographical scale.

This year 17 students successfully graduated from the program. Top students received excellent placements again. They started PhDs Berlin Institute of Health or became groups leaders at the Helmholtz Zentrum München. Or they started new positions at BASF or leading positions at Miltenyi Biotec or GlaxoSmithKline Asia.

Twenty three new students from countries ranging from Bosnia to the United States will take up their studies in Winter Semester 2018/2019 carefully selected from 150 applications.

LSI Success Stories

PAURUSH PRAVEEN

joined LSI in 2007 from Visvesvaraya University, India. He graduated with a Master of Science degree in 2009 and was accepted to b-it Research School where he graduated with a PhD in the group of Prof. Fröhlich in 2013. Paurush then joined Microsoft Research in Italy from 2013-2015 and was then hired as researcher by CluePoints in Belgium. In 2018, he joined Miltenyi Biotec in Bergisch Gladbach, Germany, as Group Lead Bioinformatics and Biostatistics.

SHWETA BAGEWADI KAWALIA

joined LSI with a Bachelor's Degree in Biotechnology from Sir. M. Visvesvaraya Institute of Technology, Bangalore, India, in 2007. After studies she was offered a position as Programmer Analyst at Coginzant Technologies, Bangalaore, India. In 2009, she came back to LSI and obtained her Master's Degree in 2012. She continued her education in the group of Prof. Hofmann-Apitius. In 2018, she graduated with a PhD and joined BASF as a Knowledge Engineer. During her PhD, she had her first baby and she did not only manage her PhD thesis but she is doing an impressive career in industry alongside with her family. Shweta is an example, that a career in science as a women and young mother is possible.

DANIEL DOMINGO FERNANDEZ

started his studies in LSI 2014. He obtained a Bachelor's Degree in Biotechnology of the University of Leon, Spain. In his time as an undergraduate student he spent an exchange year at the University of Wisconsin-Green Bay, USA. During his studies at b-it he joined the group of Prof. Hofmann-Apitius. He had carried out his Master thesis with a focus on a new approach: "NeuroMMSigDB: a Mechanism Enrichment Server for Neurodegenerative Diseases". This work was published in BIOINFORMATICS. Daniel now carries out his PhD and will apply the work of his master thesis on complex patient-level data such as the referential Alzheimer Study ADNI.

ALPHA TOM KODAMULLIL

obtained a Bachelor's Degree in Biotechnology from Vinayaka Mission's Research Foundation in Tamil Nadu, India, when she joined LSI in 2010. She completed the program in 2012 with a Master thesis carried out in Prof. Hofmann-Apitius' group. She continued her education in the same group with a PhD in 2013. During her PhD, she also worked in the EU project AETIONOMY from where the data analyzed in a Nature Reviews Drug Discovery paper was taken from. Alpha was first author of this paper. She successfully obtained her PhD in 2018 and works now at Fraunhofer SCAI. Besides her studies, she had her first baby two weeks after her PhD defense and started her own company in India. She is a prime example for a truly "translational" and "entrepreneurial" young researcher. Fraunhofer is supporting her with a TALENTA fellowship.

CHARLES TAPLEY HOYT

joined LSI in autumn 2015. Before, he studied Chemistry at Northeastern University and did internships at Novartis, Pfizer and GlaxoSmithKline. He was accepted into the group of Prof. Hofmann-Apitius in 2016 and completed his Master Thesis in 2017. Now, he continues his education working on his PhD. After one year of his PhD thesis work, he is already author of four different papers, including an application note in BIOINFORMATICS and a full paper in the Database Journal.

List of employers of LSI Alumni:

Berlin Institute of Health, Biotech Research & Innovation Centre (BRIC), b-it Research School, Boston Children's Hospital, Centro Nacional de Investigaciones Cardiovasculares, Charité Berlin, Christian-Albrechts-Universität Kiel, Czech National Centre for Biomolecular Research, ELI Beamlines, European Molecular Biology Laboratory, ETH-Domain, ETH Zürich, European Bioinformatics Institute, European Bioinformatics Institute, Fraunhofer FIT, Fraunhofer IAIS, Fraunhofer SCAI, Fundación Centro Nacional de Investigaciones Cardiovasculares, German Center for Cancer Research (DKFZ), German Center for Neurodegenerative Diseases, German Institute of Human Nutrition, Hasso Plattner Institute, Heidelberg Institute of Theoretical Studies (HITS), Helmholtz Centre for Infection Research, Helmholtz Zentrum München, Hertie Institute for Clinical Brain Research, Hospital of the University of Bale, IFOM, Imperial College London, Leibniz Institut für Ostseeforschung, Max Planck Institute for Biophysical Chemistry, Max Planck Institute for Molecular Biomedicine, Max-Planck-Institute for Molecular Genetics, Max Planck Institute for Neurological Research, Max Planck Institute for Plant Breeding Research, Max Planck Institute for the Biology of Ageing, Max Planck Institute Tübingen, Microsoft Research-University of Trento Centre for Computational and Systems Biology (COSBI), National Centre for Biological Sciences, National Centre for Biomolecular Research, National University of Ireland, National Technical University of Singapore, Philipps University of Marburg, Princess Nora Bint Abdulrahman University, Radboudumc – University Clinic Centre of the University of Nijmegen, Research Center Jülich, RWTH Aachen, South University of Science and Technology of China, Swiss Federal Institute of Aquatic Science and Technology, TU München, Twincore – Centre for Experimental and Clinical Research, University Clinic Gustav Carus Dresden, University College London (UCL), Western University, ZBMed, and the universities of Amsterdam, Bonn, Bern, Cambridge, Cologne, Copenhagen, Dresden, Düsseldorf, Ghent, Kiel, Leipzig, Leon, Luxemburg, Macquerie, Mainz, Münster, Oxford, Sheffield, Tübingen, Utrecht, Western Australia, Vienna, Wageningen, Western Onatario, Würzburg, Zürich.

Prof. Dr. Gerhard Kraetzschmar,
Autonomous Systems

Prof. Dr. Paul Plöger,
Autonomous Systems

Prof. Dr. Erwin Prassler,
Autonomous Systems

b-it Programs

Master Program
in Autonomous Systems

The Master's program in Autonomous Systems is an international program, taught entirely in English, offering multi-faceted training in the fields of robotics and artificial intelligence. Various robot platforms are used for educational and research purposes, including the Care-O-Bot 3, and the youBot. The focus is on enabling and integrating the necessary intelligence behind the autonomous behavior of artificial agents rather than on the hardware-related aspects of robotics. Students get a solid theoretical background in autonomous mobile robots, advanced control methods, robot manipulation, learning and adaptivity, hardware-software co-design of embedded systems, probabilistic reasoning, and planning and scheduling. The courses are combined with research work conducted at the Fraunhofer Institute for Intelligent Analysis and Information Systems (IAIS) and other partner institutions.

Students take a number of core courses in the first semester as well as compulsory seminars, and practical courses throughout their studies. The Winter Semester 2012 saw the first students study under the new curriculum, which received ASIIN accreditation in April 2012. In addition to the accreditation certificate from the German Accreditation Board, the program got the special ASIIN accreditation label and the Euro Inf Label from the European Quality Assurance Network for Information Education (EQANIE). Students now choose one of two tracks to specialize in at the end of their first semester: the Intelligent Robots track and the Robot Systems Design track.

In the academic year 2018, 34 students joined the MAS program from an applicant pool of 609 candidates. The MAS program has always attracted the interest of students all over the globe. The 10 different nationalities of the 34 students who joined the program in the 2018 academic year is proof of this fact.

The program is offered by the b-it Applied Science Institute (b-itAS) in the Department of Computer Science at the Bonn-Rhein-Sieg University of Applied Sciences (BRSU). b-itAS cooperates closely with the Fraunhofer IAIS in implementing the program, which started in the winter of 2002. Two dual degree programs exist with both the University of New Brunswick in Canada and the German-Jordanian University in Amman, Jordan.

The program is managed by three professors (Gerhard Kraetzschmar, Paul G. Ploeger and Erwin Prassler), three research associates (Iman Awaad, Anastassia Kuestenmacher and Sven Schneider) as well as researchers who have been recruited through the SciRoc, RO-POD and RoboLand projects (Alex Mitrevski, Argentina Ortega, Santosh Thoduka, Maximilian Schoebel, Deebul Nair, Patrick Nagel, and Djordje Vukcevic).

The faculty and staff are actively involved in many scientific activities, including memberships in technical committees of IEEE or in the RoboCup Federation trustee board, the euRobotics aisbl board, numerous program committees of workshops and scientific conferences such as IROS, ICRA, ICAR, ICMA, and AAMAS.

MAS Success Stories

AHMAD DRAK

Research Associate and PhD Candidate
Hochschule Bonn-Rhein-Sieg, Sankt Augustin, Germany

I joined MAS in 2014 as a naive robotics enthusiast with an Electrical Engineering degree. A blink of an eye later, the adversity faced in the program coupled with the challenges of RoboCup propelled me several steps further in my career pursuits. The MAS program also served as a portal to the next stage of academic achievements, where I received the Förderpreis der Hochschulgesellschaft prior to graduating. The cultivated efforts of the master's thesis resulted in a Research Associate position at H-BRS and a collaborative PhD project with University College London (UCL). My current doctoral research is concerned with deployment and control of aerial robots.

SHEHZAD AHMED

Software Developer
TBA – Software Solutions & Services for Ports, Terminals & Warehouses, Rawalpindi, Pakistan

Studying AS at b-it was a dream come true. Aside from learning theoretical concepts of robotics, hands-on experience on cool robots was most exciting and motivating. I feel very fortunate to have worked in the EmoRobot project that aimed to investigate an technical system using robots as caretakers of Alzheimer's patients. As a member of the "b-it-bots" team, I participated in RoboCup and RoCKIn competitions and practically realized the learned concepts to strengthen my professional skills. The multicultural environment of the program also helped me to improve my personal skills.

DIEGO ENRIQUE RAMOS AVILA

Fellow Researcher
Fraunhofer FKIE, Wachtberg, Germany

Being part of the MAS program was a great experience that not only gave me the opportunity of finally building a career in robotics, but also allowed me to meet a lot of interesting and fun characters. Since robotics is such an interdisciplinary field, MAS ends up bringing together people from several different academic and cultural backgrounds. From this, one can only learn and grow and become a much more adaptive person and professional. I got my master's degree in 2016 and I have been working as a Fellow Researcher at the Cognitive Mobile Systems Department of Fraunhofer FKIE ever since.

YOUSSEF MAHMOUD YOUSSEF

Research Associate and PhD Candidate
Fraunhofer FKIE, Wachtberg, Germany

Completing my master's in MAS has given me a good overview of robotics from a computer science / artificial intelligence point of view. During my studies, I attended the class fault detection and diagnosis (FDD). In my R&D project, I applied FDD methods to robotic platforms and was able to publish papers at the "DX-Principals of Diagnosis" workshop. This led me to take a position at Fraunhofer FKIE, where I completed my master's thesis on a project also focused on fault diagnosis for robots. My work at Fraunhofer led to a paper at an IEEE conference. Having gained all this experience, I was able to start my current position as a research associate. I am now developing a lab for FDD for distributed robotic systems and preparing to start my PhD.

List of employers of MAS Alumni *(Business)*:

Ableton, ASIMOV Robotics, Banksoft, BMW cyber:con GmbH, Delphi, Exciera Technologies, Faro GmbH, Fetch Robotics, Gade Autonomous Systems Private Limited, Google/Alphabet, GPS, IBM , Ingen Robotics, Kuka Robotics, M2P Consulting, Magazino, MesaX, Rapyuta Robotics, RBOT, Recogizer, Robots Alive Consulting, Shadow Robot Company, Siemens, Systemantics, TBA Group, The MathWorks, Trivago, VMware

List of employers of MAS Alumni *(Universities & Research)*:
DFKI, DLR, Fraunhofer FGAN, Fraunhofer IAIS, Freie Universität Berlin, Heriot-Watt University, Hochschule Bonn-Rhein-Sieg, Hochschule Bonn-Rhein-Sieg (Graduate Institute), Hochschule Bonn-Rhein-Sieg (Institut für Sicherheitsforschung), Instituto Superior Técnico (IST) - Universidade de Lisboa, Jacobs University LAAS-CNRS, Norwegian University of Life Sciences, Örebro University, Osnabrück University, Rhine-Waal University of Applied Sciences, RWTH Aachen, TU Wien, TUBITAK-UZAY Space Technologies Research Institute, Universidad Anáhuac Mayab in Mérida, University Jaume I, University of Bonn, University of Erlangen, University of Hertfordshire, University of Louvain, University of Western Australia

International Program of Excellence in Computer Science

Prof. Dr. Emmanuel Müller

Prof. Dr. Christian Bauckhage

The International Program of Excellence in Computer Science (IPEC) at b-it offers compact courses primarily during the semester break and at the highest educational level. This results in faster studies and advanced quality in selected subject areas. These courses apply to a limited number of highly qualified students of the University of Bonn, the RWTH Aachen University and, in the future, other German or foreign universities. Undergraduate IPEC courses are planned in a way that the time required for the bachelor degree will be reduced up to one year.

Additionally there are cross-cutting courses that accelerate the master studies at the b-it as well as regular summer and winter schools that are designated for selected topics of computer science. These courses are held in cooperation with international guest scientists. Applications of foreign students are welcome.

The expected impact of the Program of Excellence is not limited to a significant acceleration of undergraduate and graduate studies in conjunction with an international visibility. It also brings together outstanding students with internationally noted scientists and with fellow students from abroad and activates new forms of encouraging competition among students. The IPEC courses usually comprise a mix of lecture classes, seminars, and lab courses, such that students can make best use of the compressed time schedule. Currently, this part of the program is being restructured as to provide an „honors class" supplement to the top 10% bachelor students in Aachen and Bonn, loosely linked to the NRW public-private scholarship programs the Ministry of Innovation has initiated for this group of students.

Excellence in Big Data Analytics

The b-it partner universities are among the leading German, even European, organizations in the field of Data Science, Data Engineering, and Machine Learning. For example, the three Fraunhofer institutes at Birlinghoven Castle coordinate the Fraunhofer Big Data Alliance, have started the international Industrial Data Space Initiative aiming at more data sovereignty in business, and lead numerous national and European projects in this rapidly expanding field.

One of the key results of the b-it Evaluation in 2015-2016 was the decision to strengthen this aspect also in the b-it teaching offers. While the b-it mission statement already rightly emphasizes the role of data science and AI aspects in all three existing b-it Master Programs, we also consider the introduction of a dedicated joint b-it master program.

In preparation for this move, it was decided to dedicate the currently vacant b-it full professorships formerly filled by Prof. v.z. Gathen explicitly to the field of Data Science. In 2017, an intense faculty search resulted in several excellent candidates. We are happy to report that we were able to attract the internationally renowned data mining researcher Emmanuel Müller to accept this position.

The new colleague, as well as future b-it students, can expect an even more exciting research context than now, as the rather small team of b-it faculty has become one of the most successful groups in the present German Excellence Competition. Four of their excellence clusters – all topically related to b-it study programs – are among the 57 out of originally 195 proposals that were selected for seven-year funding from 2019-2026.

Professor Emmanuel Müller joins b-it

Prof. Müller is head of the new chair for Data Science and Data Engineering at b-it and lead scientist for data science at the Fraunhofer Institute IAIS. Before he was full professor for computer science at the Hasso Plattner Institute in Potsdam (2015-2018), he was independent research group leader at the Karlsruhe Institute of Technology (2010-2015), and Postdoctoral Fellow at the University of Antwerp (2012-2015). He received his Diploma (2007) and his PhD (2010) both with distinction from RWTH Aachen University. His research interests cover knowledge discovery, data mining, big data systems, and data exploration for high dimensional data, graph data, time series, and data streams. He is leading the open-source initiative OpenSubspace enabling repeatability and comparability for the research community. Prof. Müller has organized several tutorials and workshops at major data mining, database, and machine learning conferences, and edited a special issue for the Machine Learning Journal. In the past few years, he has coordinated multiple education programs for "Data Science" and "Data Engineering": One on the level of university education (M.Sc. program), two graduate schools (PhD programs) and multiple executive education programs for industry.

Schüler-Krypto 2018

On two days in March 2018, 123 high school students as well as six teachers met for the seventeenth Schüler-Krypto to learn@bit on secret messages, encryption and decryption. They came from Eitorf, Hennef, Königswinter, Morsbach, Neustadt, Oppenheim and Bonn.

After an introduction to the topic by Michael Nüsken the students got to the nitty-gritty. Everybody was asked to take up the role of James Bond and program RSA on the laptop built-in to Bond's BMW Z8. We used Sage on it, a free open-source computer algebra system which among many other things is capable of calculating with arbitrarily large numbers. The students sent emails to Moneypenny and decrypted answers from her, set up a public-key infrastructure and exchanged encrypted messages with each other. As a sidetrack, in a game-like setting the students could experimentally find out how the main step in the encryption and decryption of RSA, namely the modular exponentiation, can be executed in a jiffy.

In the outro Bastian Hafer, Postbank, and Christian Berghoff, BSI, presented facets of security from different real world perspectives. On the one hand side, Bastian Hafer represents the view of a bank that aims at profit and tries to balance risks and costs. On the other hand side, Chistian Berghoff presented ways to protect all our privacy.

crypt@b-it 2018

b-it hosted the summer school crypt@b-it 2018. In its pleasant atmosphere students and researchers from all over the country and beyond took the opportunity to crypt a bit. The summer school was organized jointly with the Ruhr-Universität Bochum and the Technische Universität Darmstadt, in cooperation with the IACR (International Association for Cryptologic Research) and the GI (Gesellschaft für Informatik). It took place on 23 – 27 July 2018 in the new rooms of the b-it and invited to exploration of some fundamental areas of cryptography: Proof techniques for symmetric cryptography by Stefano Tessaro, Practical Techniques for Secure 2-party Computation by Mike Rosulek, and the Enigma machine by Max Gebhardt.

Bond's Thursday crew.

On Bond's tracks.

The Enigma machine.

b-it Universities Institute

ABC – three letters that stand for a veritable "magic triangle": the region between Aachen, Bonn and Cologne, which is not only economically strong, but also a leader in science, education and research. The large number of research establishments based here make the area one of Europe's biggest and most important science landscapes. Almost 10 percent of all German students – around 130,000 people – are studying at the Rheinisch-Westfälische Technische Hochschule in Aachen, the Rheinische Friedrich-Wilhelms-Universität Bonn and the Universität zu Köln, which together constitute one of the most important higher education locations in Europe. The three ABC institutions are closely linked and collaborate in many fields of teaching and research.

University of Bonn

The University of Bonn is a research-oriented university with currently about 38,000 students. Its research tradition of 200 years is closely linked to the names of Hermann von Helmholtz, Heinrich Hertz and Friedrich August Kekulé who carried out seminal work at the University of Bonn. This strong academic tradition has been continued until present with the more recent Nobel laureates Wolfgang Paul and Reinhard Selten. Bonn cooperates with numerous other universities and research institutions around the globe. The specializations it has developed enjoy worldwide recognition. More than 5,000 students from 130 countries are enrolled in Bonn. Their presence underlines the international character of the university and enriches both academic and social life in Bonn. Living up to its long tradition as a classical university with a full range of academic disciplines, the University of Bonn offers 200 different subjects and degrees. Students can choose from a wide and modern spectrum of subjects that allows a multiplicity of combinations.

RWTH Aachen University

RWTH Aachen University was founded as a Polytechnic in 1870 with considerable support from local industry. In 1948 it was established as Rheinisch-Westfälische Technische Hochschule Aachen (RWTH), the Institute of Technology of the State of North Rhine-Westphalia. Today, RWTH is one of the most renowned technical universities in Europe with around 45,400 students. RWTH offers 157 courses of study (undergraduate and postgraduate). The RWTH master programs educate engineers who are keen to engage in R & D, innovation, and entrepreneurship. In 2007, RWTH Aachen was elected as one of nine "elite universities" within the German excellence program. In the current Times Higher Education Ranking, RWTH Aachen University is placed 87th among the several thousand evaluated universities.

The spacious Hofgartenwiese is a major summer attraction on the University of Bonn campus.
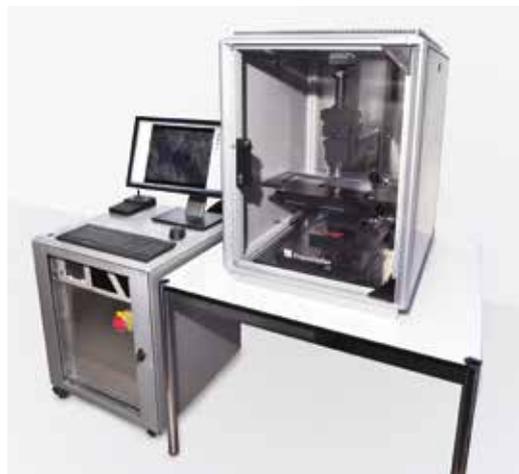
Entrance of Birlinghoven Castle.

The Birlinghoven Castle campus is one of the largest and most influential computer science research sites in Germany. About 500 researchers work in the IZB institutes. That represents a quarter of the Fraunhofer ICT Group, Europe's largest IT research organization. The institutes collaborate closely with the European ERCIM network of national IT research centers as well as with leading research establishments in the USA, Eastern Europe and Asia. Three IZB institutes contribute to the b-it master programs Media Informatics and Life Science Informatics:

Fraunhofer FIT

FIT, the Fraunhofer Institute of Applied Information Technology, investigates human-centered computing in a business or engineering process context. The usability and usefulness of information and cooperation systems is optimized in their interplay between human work practice, organization and process. In Life Science Informatics the institute focuses on protein analysis, visual support for navigation in micro surgery, and assistive information technology. In Media Informatics innovative information visualization systems, mixed and augmented reality environments for industrial planning, pervasive gaming applications, and value chains for public-sector information services are main research topics.
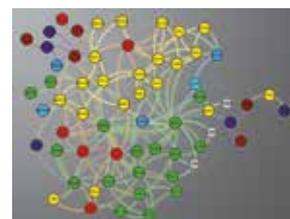
Fraunhofer SCAI

The Fraunhofer Institute for Algorithms and Scientific Computing SCAI conducts research in the area of computational science and is a valued corporate partner for industry and academia. SCAI designs and optimizes industrial applications, implements custom solutions for production and logistics, and employs high-performance computers. The Department of Bioinformatics at Fraunhofer SCAI carries out applied research and development in three areas:

1. Techniques for information extraction in the life sciences, including recognition of named entities and relationships in text as well as large-scale, automated information extraction.
2. Integrative biology, with a particular focus on modeling neurodegenerative diseases.
3. eScience, Grid and Cloud Computing as well as technologies for the operation of HPC (Clusters) with a focus on SLA, security, and license management.

The Department of Bioinformatics is partner in major funded projects at national and EU level. Software tools for information extraction developed at SCAI BIO are used in the vast majority of pharmaceutical companies worldwide.

Fraunhofer SCAI: A hormonal network underlying dementia and Alzheimer's disease.

b-it Applied Science Institute

Bonn-Rhine-Sieg University of Applied Sciences (BRSU)

Founded in 1995, the Bonn-Rhine-Sieg University of Applied Sciences significantly extends the range of applied research and teaching in the greater Bonn area. It specializes in business administration, natural sciences, engineering and computer science, strongly encouraging cooperation with industrial partners and a focus on use-driven and interdisciplinary research and teaching.

The three campuses at Sankt Augustin, Rheinbach and Hennef are well equipped with modern laboratories, studios, workshops and facilities for cooperative research. By 2018, the different departments accommodate more than 9,000 students.

The Department of Computer Science offers a Bachelor and a Master program in Computer Science and in cooperation with the Departments of Business Administration a Bachelor program in Business Information Systems. The Master program Autonomous Systems is offered by the b-it Applied Science Institute, a cooperation between the Department of Computer Science and the Fraunhofer Institute for Intelligent Analysis and Information Systems IAIS.

Campus of the Bonn-Rhine-Sieg University of Applied Sciences.

Fraunhofer IAIS

The Fraunhofer Institute for Intelligent Analysis and Information Systems IAIS develops tailor-made IT solutions to support companies and organizations optimize products, services and processes, as well as to implement intelligent information management. There is a particular focus on the analysis, access and targeted use of Big Data, new media technologies and solutions for innovative business and security processes.

In order to support customers in their information management and decision-making processes, the scientists use innovative technologies such as knowledge extraction, visual analytics and data mining to provide them with holistic analyses of large amounts of data. Semantic and adaptive media applications open up new possibilities for linking data and knowledge and for making them accessible via the Internet. By utilizing business intelligence solutions the Fraunhofer IAIS team is able to optimize its customers' business, IT and security processes and so improve their business success. The institute's research and development activities are defined by the business areas Big Data Analytics, Business Modeling & Analytics, Content Technologies & Services, Enterprise Information Integration, Image Processing, Intelligent Media & Learning, Marketing, Market Research & Media Analysis and Preventive Security. Fraunhofer IAIS and its 230 strong team combine in-depth industry knowledge with expertise in a full range of technical disciplines, most notably computer science but also mathematics, natural sciences, business management, geo sciences and social sciences.

General Information

General Admission Requirements

- A first university-level degree (B.Sc., B.Eng.), as specified for the individual programs, with grades well above average is required. The Graduate Record Examination (GRE) is strongly recommended;
- All courses are held in English, thus fluency in English in vital. It is evaluated on the basis of TOEFL 550 paper-based, 213 computer-based, or IELTS 6.0;
- Working knowledge of German is necessary to take up some of culture that the Aachen – Bonn – Cologne region has developed over the last 2,000 years. Therefore, a basic German language course is offered before start of the program and during the first year.
- Admission is coupled to placement in the Fraunhofer lab courses and therefore strictly limited. Application deadline has been March 1 for Fall admission but may change from year to year; check www.b-it-center.de for current admission details.

Fees and Finances

As of 2018, a student union fee of ca. 275 € per semester covers student activities, subsidized meals, and free public transportation in the whole state of North Rhine-Westphalia.

A student's monthly expenses, including study material, will be about 800 €. b-it does not offer formal scholarships but several student assistantships are available on a competitive basis. For information on funding from German sources please contact the DAAD – German Academic Exchange Service www.daad.de.

Studying in Bonn

Most of the teaching in b-it is concentrated in Bonn and its eastern neighbor, Sankt Augustin. Newcomers to Bonn soon grow very fond of the city – a fact confirmed by thousands of students and academics, German and foreign, who have come here to learn, teach or research. Since the German Bundestag moved its seat and parts of the Federal Government to Berlin in 1999, Bonn attracted a number of international organiza-tions, especially United Nations bodies, and some major corporations. Among others, Deutsche Telekom and Deutsche Post have their headquarters there. Now Bonn is evolving into an internationally recognized science region – with the university as one of the dynamic forces driving this change. In addition, Bonn offers a wide variety of attractions and amenities. The city's most famous son, Ludwig van Beethoven, is the star attraction of a lively and varied arts and culture scene. The city boasts an opera house, several theatres, concert halls and other venues, as well as a range of fascinating museums.