Institute of Computer Science (ICS-HSG)

Annual report 2024

D. Borth, S. Handschuh, A.-L. Horlemann, S. Mayer, K. Mitrokotsa, G. Salvaneschi, J. Schöning, B. Weber

2025-03-31

University of St.Gallen

Institute of Computer Science

Acknowledgements

The directors of the Institute of Computer Science would like to take this opportunity to express their gratitude for the support that we, as individuals and as an institute, continue to receive from a broad range of individuals and offices affiliated with the University of St.Gallen and beyond.

As an institute, we are supported by an Advisory Board (Geschäftsleitender Ausschuss GLA in German) chaired by *Prof. Ernst Mohr*. The Board comprises of *Doris Albisser*, *Markus Bänziger*, *Prof. Elgar Fleisch*, *Prof. Dietmar Grichnik*, *Prof. Manfred Hauswirth* and *Stephanie Schoss*. We would like to express our gratitude to all members of our Board (GLA) for their precious advice and continuous commitment to the institute's ideals and vision. Due to the Universities Act amendments, this form of advisory board was dissolved on 31.12.2024.

From 01.01.2025, an advisory board may support us in professional matters. We were successful in recruiting Markus Bänziger for this task. Thank you very much for your valuable support and we look forward to continuing to work together.

Contents

Acknowledgements . . . .

Introduction **1**

Artificial Intelligence & Machine Learning (AIML)Damian Borth . . . **3**
- Team Members 3
- Research 4
- Projects 5
- Teaching 5
- Outreach 6

Data Science and Natural Language Processing, Siegfried Handschuh **7**
- Research 7
- Publications 8

Foundations of Computation, Anna-Lena Horlemann **9**
- Team 9
- Research 9
- Projects 10
- Teaching 10

Interactions Research Team, Simon Mayer **12**
- Ongoing PhD Theses 12
- Postdoctoral Researchers 13
- Teaching 14
- Research 14

Cyber Security, Katerina Mitrokotsa **16**
- Team 16
- Research 17
- Teaching 21
- Outreach 21

Programming, Guido Salvaneschi **24**
- Team Members 24
- Projects 24
- Teaching 25
- Research 26

Outreach and Academic Citizenship **27**

Human-Computer Interaction, Johannes Schöning **29**
Team 29
Research 30
GeoHCI and Maps and Spatial Interaction 30
Virtual Reality for Emotional Well-being Support 31
Advances in Haptic Interface Design 32
Teaching 33
Outreach 34

Software Systems Programming and Development, Barbara Weber . **35**
Team 35
Teaching 35
Research 36
Outreach and Academic Citizenship 42

References **45**

Introduction

The Institute of Computer Science (ICS-HSG) includes eight research groups: Artificial Intelligence and Machine Learning, led by *Prof. Dr. Damian Borth*; Data Science and Natural Language Processing, headed by *Prof. Dr. Siegfried Handschuh*; Foundation of Computation, under the guidance of *Prof. Dr. Anna-Lena Horlemann*; Interaction- and Communication-based Systems, directed by *Prof. Dr. Simon Mayer*; Cyber Security, managed by *Prof. Dr. Katerina Mitrokotsa*; Programming Languages, overseen by *Prof. Dr. Guido Salvaneschi*; Human-computer Interaction, chaired by *Prof. Dr. Johannes Schöning*; and Software Systems Programming and Development, led by *Prof. Dr. Barbara Weber*. Since 2023, professors Borth, Handschuh, Mayer, Mitrokotsa, Schöning, Weber, Horlemann, and Salvaneschi have formed the board of Directors of the ICS-HSG. Since February 2024, Prof. Salvaneschi has been the Managing Director ICS-HSG, taking over this role from Prof. Mayer. The role of the Managing Director is a coordinating one and it does not involve any authority to issue directives to other members of the board of Directors.

Figure 1 shows the key figures the Institute has achieved this year. We welcomed 50 more students to our courses, an increase of 30%. We also expanded our range of courses by nine. We are pleased to report that twenty more publications were recorded on the Alexandria platform in the 2024 reporting year.

The research of ICS-HSG spans various areas, including deep neural networks, language models, coding theory, cryptography, ubiquitous computing, autonomous systems, cybersecurity, programming languages, human-computer interaction, and software development. ICS-HSG's research is highly interdisciplinary and resulted in numerous publications in prestigious venues. The details of our research achievements are discussed extensively in the rest of this document.

With this annual report, we provide an overview of the activities of the ICS-HSG and its research groups in 2024. Further details and updated news are presented on our institute website, `https://ics.unisg.ch/`

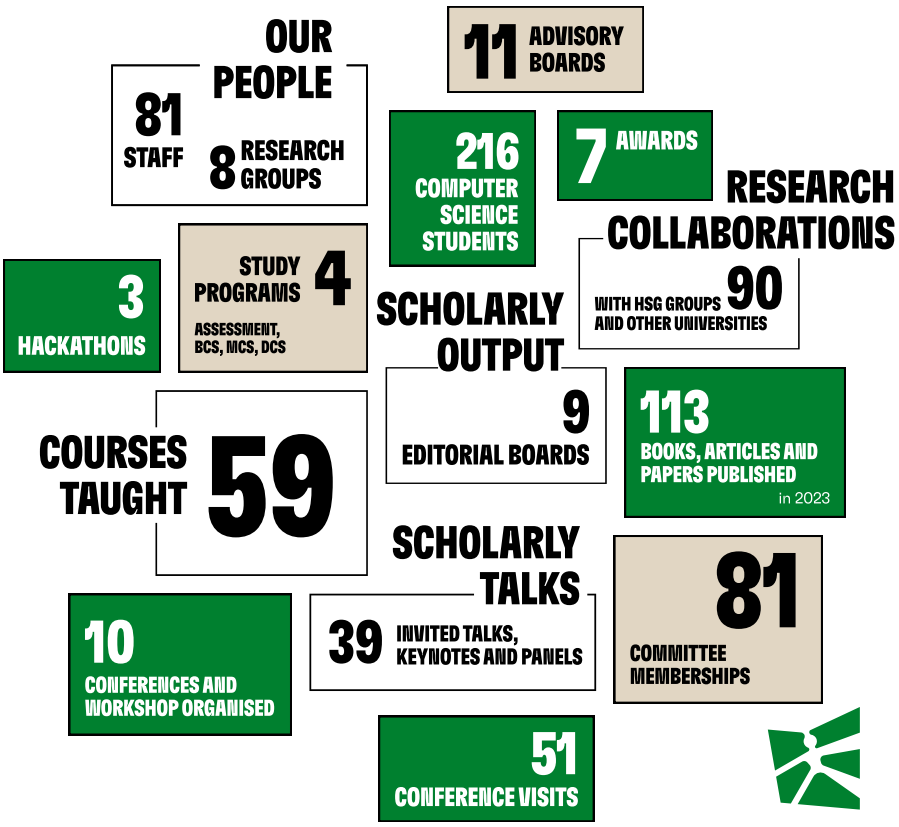

Figure 1: Key Figures of the Institute for Computer Science for the year 2024.

Artificial Intelligence & Machine Learning (AIML)Damian Borth

The **Artificial Intelligence & Machine Learning** lab led by Prof. Damian Borth performs research on deep neural networks to make such models more robust, more performant, and trustworthy when applied to real-world data.

The year 2024 was shaped by Prof. Damian Borth's sabbatical research stay and a further extension of international collaborations. Highlights of 2024 were (i) the nomination of Prof. Damian Borth to become the "Eindhoven AI Systems Institute (EAISI)" Visiting Professor at the Technical University of Eindhoven in the Netherlands (ii) the call to become a visiting professor at the faculty of the Paul G. Allen School of Computer Science & Engineering at the University of Washington, Seattle, (iii) the SNF project acquisitions of the project "Hyper-Representations: Learning from Populations of Neural Networks", and (iv) the successful graduation of two PhD candidates from the lab.

Team Members

The chair of Artificial Intelligence and Machine Learning has 9 members. In 2024, with Dr. Hamed Hemati and Dr. Konstantin Schürholt, two PhD candidates graduated successfully. Dr. Hamed Hemati finished his dissertation on "**Continual Learning from Meta-Learning Perspective: Data Stream, Model Architecture, and Strategy**" and started a position at the Technical University of Applied Sciences in Stuttgart. Dr. Konstantin Schürholt finished his dissertation on "**Hyper-Representations: Learning from Populations of Neural Networks**" and stayed as a post-doc at the lab to continue his research. With Timur Sattarov, one PhD student successfully defended his PhD proposal. In his PhD committee, Prof. Giulia Fanti from Carnegie Mellon University (CMU) serves as an external examiner. In addition, PhD candidate Linus Scheibenreif went for an internship with Google X in Mountain View, USA and Julius Schulte, who graduated in Computer Science from ETH Zurich and USI Lugano, joined the lab in July 2024 as a new PhD student. Finally, Assistant Prof. Michael Mommert, who was affiliated with the lab, got an appointment as a full professor at the Technical University of Applied Sciences in Stuttgart and left the lab.

Research

Given a successfully acquired SNF project, the AIML lab redefines its research focus according to the following research areas (a) **Representation Learning of Deep Neural Networks**, (b) **Remote Sensing and Earth Observation**, and (c) **Representation Learning of Tabular Data**. In 2024, the lab got **7 publications accepted**. This includes 5 conference publications, and 2 workshop publications. Additionally, 4 working papers have been published.

In the research area "Representation Learning of Deep Neural Networks", the lab has made a significant breakthrough in scaling up the processing of neural network weights toward large-scale models such as ResNets. The proposed **Sequential Autoencoder for Neural Embeddings (SANE)** approach does process a windowed sequence of weights and is therefore not constrained by the original length of the neural network model. This work has been published at ICML in Vienna. Additionally, **novel transformer model zoos** have been generated to prepare for the extension of weight space learning to transformer architectures. To foster collaboration in this newly established research area, members of the AIML lab have successfully proposed to **organize a workshop at the ICLR** conference [1] and extended collaborations to LMU Munich and Dartmouth University.

Having seen a significant shift towards foundation models in "Remote Sensing and Earth Observation", we have focused in 2024 on **parameter-efficient fine-tuning** of these foundation models. Our work on light-weight LoRA adapter training has been one of the first works in this area and was published at CVPR in Seattle. With such mechanisms at hand, researchers can easily take advantage of pre-trained foundation models, even if these models are not tailored towards their desired downstream task. We have also published one of the first works on **diffusion** for satellite data, **active learning** for self-supervised learning, and **multi-modal fusion of VQA** systems in remote sensing.

In summary, members of the AIML lab published 11 papers including 5 conference publications, 2 workshop publications, and 4 working papers at top venues such as ICML, IEEE CVPR, and IEEE IGRASS, These papers have been written in collaboration with authors of UC Berkeley and TU Munich. An overview of all published work can be found at the Alexandria platform of the University of St.Gallen [2]. As in the previous year, members of the lab were serving as areas chairs, technical program committee, and reviewers of international conferences (NeurIPS,

[1] https://weight-space-learning.github.io/
[2] https://www.alexandria.unisg.ch/entities/person/Damian_Borth

ICLR, ICML, IEEE CVPR, IEEE ECCV, ACM ICAIF), journals (Nature Communication, IEEE TGSRS, Remote Sensing and Environment, Remote Sensing Letters), and governmental funding programs such as the DFG.

Projects

In 2024, the lab successfully got an SNF project funded titled: **"Hyper- Representations: Learning from Populations of Neural Networks"**. This four-year project will focus on representation learning of neural network models, a newly established research area dubbed "weight space learning". The project aims to exploit such learned representations for multiple downstream tasks like the prediction of model properties directly from the model's weights, or sampling unseen neural network models without training.

The currently running SNF-funded project: **"Self-Supervised Learning for Earth Observation: Leveraging a wealth of multi-modal data"** went into the second year of work. Similar to last year, in 2024 the lab was again invited to organize a tutorial about multi-modal, multi-task, and self-supervised learning at the IEEE IGARSS conference in Athens, Greece. This tutorial was very well-visited and allowed team members of the lab to present the results of the project.

Teaching

Given the sabbatical research stay of Prof. Damian Borth in the fall of 2024, teaching took only place in the spring of 2024. For the Master of Science in Computer Science (MCS), the AIML lab taught the **"Machine Learning"** course. For the Bachelor of Science in Computer Science (BCS), the AIML lab taught the **"Artificial Intelligence"** course for the first time. Both courses took place in the spring of 2024. Like in the previous year, in 2024 the "Deep Learning: Fundamentals and Applications" course of the "Global Summer School for Empirical Research Methods (GSERM)" was held in collaboration with Dr. Marco Schreyer. Concerning bachelor and master thesis work, in 2024, the lab has supervised **six master theses** and co-supervised two more. Out of these, three led to publications at IEEE IGRASS conferences and one led to a publication at an AAAI workshop.

Lastly, members of the lab were active in multiple executive education programs with invited sessions, full days, or full-week electives. In particular, the elective

course “Coding and AI”, which is held in collaboration with Prof. Barbara Weber was executed in 2024 in both, the EMBA and IEMBA program of the University of St.Gallen. Finally, Prof. Damian Borth in collaboration with Prof. Torbjørn Netland from ETH Zurich held their course at the embaX joint executive education program between the University of St.Gallen and ETH Zurich.

Outreach

The scientific work and expertise of the lab was highlighted and outlined in multiple events and articles in public media. One of the highlights of 2024 was the opening discussion about “The Future of Artificial Intelligence” with **Google’s former CEO and Chairman Eric Schmidt** at his finca in Mallorca. Another highlight was the invited keynote at the **ICLR Workshop on Machine Learning for Remote Sensing** aiming to bridge remote sensing and weight space learning. The last highlights of 2024 were the invited keynote at the **German Data Science Society GenAI workshop** at LMU Munich and the invited keynote at the KI Forum der Evangelische Volkspartei St.Gallen.

Additionally, multiple invited lectures or seminars at universities such as TU Eindhoven, University of Washington, University of Michigan, University of Amsterdam, KU Leuven, German Research Center for Artificial Intelligence, (DFKI) and multiple other invited talks at DAAD, Google Research Zurich, KI-Forum der Evangelische Volkspartei St.Gallen, KI-Forum der Evangelische Volkspartei Schaffhausen, Ehemalige Kantonsräte St.Gallen. In total, the AIML lab was able to communicate its research in **17 invited keynotes, lectures, and seminars**.

In 2024, Prof. Damian Borth hold positions at the Ringier AI Advisory Board together with Ringier Group CEO Marc Walder, Anna Mossberg, and Léo Steinacker [3] Similarly, Prof. Damian Borth held elected positions at the board of the German Data Science Society, and the board of Trustees at the Int. Computer Science Institute in Berkeley, the Scientific Advisory Board of the Roman Herzog Institute, and the Scientific Advisory Board of the DAAD IFI Program.

[3] https://www.ringier.com/ringier-nominates-ai-advisory-board/

Data Science and Natural Language Processing, Siegfried Handschuh

In 2024, our research efforts in the field of **Natural Language Processing** continued with a particular emphasis on **Large Language Models** (LLMs) and generative AI in general. These models have the ability to process natural language and are widely used for a variety of purposes, including speech recognition, machine translation, text summarization, and chatbots, among others. A prominent and recent example of this technology is **ChatGPT**. Developed by OpenAI, ChatGPT garnered significant attention towards the end of 2022, further fueling interest in LLM research.

Research

Our focus in research is on the construction, interrogation, investigation, and optimization of **Large Language Models (LLMs)**. Despite their widespread usage and extensive study, LLMs remain incompletely understood, often presenting researchers with unexpected emergent capabilities. This necessitates a wide range of inquiry, demanding substantial experimentation to enhance our understanding of their functions. The effort put into basic research is worthwhile because these models are becoming increasingly ubiquitous and contribute to a homogenisation of the research landscape while offering immense downstream potential.

Large Language Models, such as **ChatGPT**, are closely related to generative AI and are critical tools in generative AI research. They have the ability to understand and produce natural language, making them capable of handling complex tasks like text generation, translation, language processing, and even question-answering systems. By utilizing large amounts of training data and recognizing patterns and relationships in natural language, LLMs can push the boundaries of generative AI and enable new areas of application.

Our research endeavors to offer an in-depth understanding of LLMs, their underlying Transformer architecture, and associated scaling phenomena and prompting roles in model training. We analyse both the benefits and drawbacks of these models, assessing their impact on performance and accuracy. These insights contribute to a comprehensive understanding of LLMs, including their potential

and limitations.

Our investigation shows that model optimization has often been neglected in the past, and the descriptions of Transformer architectures in the literature are often incomplete or different, leading to uncertainties in implementation. However, there are ways to improve and optimize existing architecture decisions. Additionally, systematic probing experiments have explored the performance of current models and highlighted their limitations.

Publications

https://www.alexandria.unisg.ch/entities/person/Siegfried_Handschuh/publications

Foundations of Computation, Anna-Lena Horlemann

The group for **Foundations of Computation** is engaged in research and teaching in the areas of theoretical computer science, coding theory, cryptography and algorithmic mathematics. With our research results we aim to improve digital communication technologies in their reliability, efficiency and security.

Team

In February 2024 Dr. Carlos Vela Cabello joined us as a Postdoctoral researcher and teaching assistant. Furthermore, Dr. Hassan Ou-azzou joined our group as a Postdoctoral researcher in September 2024. He is paid by a Swiss Government Excellence Scholarship. The other team members, i.e., the head of the chair as well as the doctoral researchers Marc Newman, Nadja Willenborg and Adrien Pasquereau remained unchanged.

Research

In the field of coding theory we submitted our results on sequential locally recoverable codes (SLRCs) to the journal *Designs, Codes and Cryptography*. Furthermore, the chair presented the results on the subfield metric and quantum error correction at the international conference *Combinatorics* in Italy. Moreover, we started working on a new project on LCD (linear complementary dual) codes with our project partner Prof. Dr. Javier de la Cruz from Barranquilla, Colombia. In June, Prof. de la Cruz visited us in St. Gallen for three weeks, while our two team members Marc Newman and Dr. Carlos Vela Cabello went to visit him in Colombia in November, to work on the research project together.

In the area of post-quantum cryptography, we derived several results in our project on the connection of lattices in the Manhattan norm (or l_1 norm) and modular integer codes in the Lee metric. We presented the results at the conferences *CBCrypto 2024* (Zurich, Switzerland) and *Combinatorics* (Brindisi, Italy). Together with our coauthors from Quantinuum (UK) and Monash University (Australia) we submitted a paper about these results to the journal *Designs, Codes and Cryptography*.

The chair was invited as plenary speaker at the *attacc* workshop and the *Munich Workshop on Coding and Cryptography (MWCC)*, both in Munich, Germany, to speak about recent results in code-based cryptography in various metrics.

The head of the group was one of the main organizers of *CBCrypto 2024*, an affiliated event of *Eurocrypt 2024* in Zurich, one of the largest and most important annual conferences in cryptography. The conference was very successful with the highest number of participants and submitted talks in the history of CBCrypto. After the conference the organizers edited a conference proceedings volume as part of the Springer Lecture Notes in Computer Science (LNCS) series. Moreover, the chair of the group was one of the supporting organizers of the *Virginia Tech – Swiss Coding Theory and Cryptography Summer School and Collaboration Workshop* in Ticino, Switzerland. This workshop brought together many junior and senior researchers from all over the world to work together on various open questions in coding theory and cryptography.

Projects

We acquired the following grants for our research projects:

- Grundlagenforschungsfond (GFF) project on *Gray maps in code-based cryptography*, by the University of St.Gallen.
- Leading House Latin America – Research Partnership Grant on *Neighbors of linear complementary dual (LCD) codes*.
- SNF-FWO-Weave project on *Finite geometry applications to coding theory and cryptography*.

Teaching

In 2024 the group taught several courses in various degree programs of the University of St.Gallen. These include *Fundamentals of Computer Science* and *Discrete Mathematics* in the Bachelor of Computer Science, as well as *Mathematical Tools for Data Science* as electives for other schools at Bachelor level, and *Introduction to Cryptography and Cybersecurity* as an elective for other schools at Master level. Furthermore, we offered a Master of Computer Science elective

course on *Information Theory and Channel Coding* and a PhD seminar on *Error Correcting Codes and Their Application* in the fall semester.

Additionally, the group supervised two Master's theses (and co-supervised two more) and one Bachelor project at the School of Computer Science, as well as several undergraduate theses at the School of Economics and Political Science (SEPS).

Lastly, the chair taught courses on blockchain technology in the two HSG executive education programs *Innovation in Finance* and *Blockchain Finance*.

Interactions Research Team, Simon Mayer

The Interactions Research Team[4] investigates technology-mediated interactions in complex socio-technical systems. Within this broad field, we are interested in a great many aspects of the interaction of (computer) systems with other systems as well as with people, and specifically in pervasive computing environments.

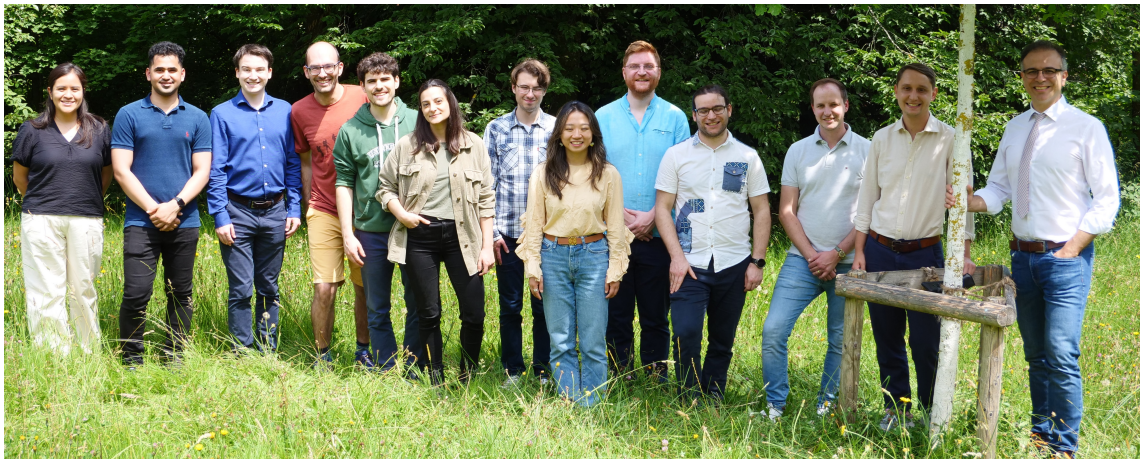

Figure 2: Most members of the Interactions Research Team in 2024.

Ongoing PhD Theses

In our group, the PhD work of Danai Vachtsevanou is on the bridging of affordance-driven and hypermedia-driven interaction in the design of adaptive interfaces for human and artificial agents in Web-based Multi-Agent Systems while Jérémy Lemée studies how heterogeneous agents can combine their own specialized knowledge and cognitive abilities in order to improve collaboration efficiency. Based on a fascination for bio-inspired technology in general and its application to software specifically, Alessandro Giugno is working on socio-technical systems as well, and currently applies this to the design and creation of information management systems for circular economy and sustainability. And Ganesh Ramanathan is striving to achieve autonomy in industrial control systems by making system and domain knowledge accessible to the automation agents, with a specific focus on autonomous buildings.

More autonomous systems might behave in a way that is not so intelligible for their human users, and hard to interpret for other machines—hence, San-

[4] https://interactions.ics.unisg.ch

jiv Jha works towards explaining contextual influences on the behavior of cyber-physical systems using multimodal scene understanding. Turning more towards people, Damian Hostettler investigates how the behavior of an industrial robot can be adapted to the implicit and explicit responses of humans to promote satisfactory human-robot interactions. Such personalization also features heavily in Jannis Strecker's research—Jannis studies how ubiquitous personalization systems can make our interactions with our environment more efficient, safer and more inclusive, and how they can be built in a responsible and societally beneficial way. Luka Bekavac' focuses on understanding and addressing the systemic risks posed by Very Large Online Platforms, combining methods from technology law, computer science, and social sciences to study how platforms' personalized recommender systems influence us, while developing tools to enhance transparency and accountability in their operation. Benefitting individuals and society is also core to Jing Wu: Her research work is about analytics-based behavior interventions to promote human health, specifically in the fields of nutrition and ambient lighting.

To support bringing our research to practice, Lukas Eichelberger is our team's Research Entrepreneur—he is interested in exploring the commercial potential of newly emerging technologies and is particularly engaged in the fields of robotics (e.g., for Understanding Robots) and applications in the field of healthcare. And Jan Albert is a software developer who maintains our lab's infrastructure and supports other team members in their research work wherever possible.

Postdoctoral Researchers

Kimberly Garcia designs and studies systems that we refer to as Digital Companions; these are created to assist and protect their users while being aware of their privacy, and Kim uses a combination of machine-learning systems and symbolic approaches such as Knowledge Graphs in neuro-symbolic ensembles to achieve this. And Kenan Bektas brings in the human eye—quite literally, as since his PhD and during his postdoctoral studies he has been using eye tracking as an interaction mechanism and to study the workload of operators in human-robot interactions. All our work interacts with society and societal processes, and hence regulation is a cross-cutting aspect—Clement Guitton brings in this dimension: He investigates the extent to which regulations (standards, laws, etc.) can and should be turned into an automatically processable format, for instance to automate compliance or facilitate their comprehension via querying possibilities.

Finally, our group is comprised of Andrei Ciortea and Simon Mayer. Andrei is Assistant Professor for Web-based Systems and his research focuses on designing a new class of Web-based multi-agent systems (MAS) that inherit the architectural properties of the Web, preserve the properties of MAS, and are human-centric. And Simon is fascinated by the integration of concepts and approaches from across the fields of pervasive computing, hypermedia, human-computer interaction, and embedded systems to realize ideal interfaces between ubiquitous machines and animals.

Teaching

Our group offers a series of challenging but rewarding courses on the topics of Ubiquitous Computing and Web-based Autonomous Systems as well as introductory courses to Computer Systems, Computer Networks, Distributed Systems, and Computer Science. In addition to the supervision of many Bachelor and Master theses, in the year 2024 our group's teaching comprised 10 courses that were attended by more than 1200 students in total. Overall, we are active in seven different degree programs at the University of St.Gallen and several of our courses are open to all students of the university. Abroad and at HSG, we again received very good student evaluations across all our courses, where specifically our BCS and MCS courses stood out with excellent evaluations.

Research

Our team engages in two overlapping research fields. On the one hand side, we are investigating *Systems and People in Ubiquitous Computing Environments*. During the year 2024, we further deepened our expertise and increased our research output across the topics of novel user interfaces for pervasive computers, reasoning and explainability of (and in) ubiquitous computing environments, and on user trust in pervasive computing systems (especially robotics). We continued our collaboration with Inselspital Bern on the FoodCoach[5] system and application, and deepened our collaboration on automatically processable regulation with Prof. Dr. Aurelia Tamò-Larrieux at Maastricht University. Our second major area of interest are *World-Wide Autonomous Systems*. In this field, we are investigating interactions of autonomous agents with each other, with their environment, and with people, where we continued our exploration of the

[5] `https://foodcoa.ch`

application of concepts from ecological psychology to the interaction of *artificial* agents. Bridging with ubiquitous computing, we furthermore continued our investigation of the deployment of autonomous agents in embedded and low-power systems, and we remain active in the field of interoperable Web of Things systems. Across these research fields and in the context of several funded research projects, our group has in the year 2024 made contributions to publishing 27 research articles at international journals, conferences, and workshops.

Cyber Security, Katerina Mitrokotsa

The **Chair of Cybersecurity** [6] was established in August 2020 and joined the Institute of Computer Science in February 2022. Our main research interests are centered around Information Security and Applied Cryptography, with the larger goal of safeguarding communications and providing strong privacy guarantees. More precisely, we are committed on contributing important advances in several areas of cybersecurity and applied cryptography, a subset of which include: secure multi party computation, verifiable computation and privacy-preserving and reliable authentication.

The Cybersecurity group at the Institute of Computer Science in St. Gallen has made significant contributions to the field of Cybersecurity and Applied Cryptography through their teaching, research, and outreach efforts. Furthermore, the group's commitment to interdisciplinary collaboration has resulted in fruitful collaborations with other leading cybersecurity and applied cryptography labs in the world (e.g., TU Darmstadt and KIT (Germany), EURECOM (France), Aurhrus University (Denmark) and IIT Delhi (India)).

Team

In 2024 the Cybersecurity group at the University of St. Gallen consisted of 12 group members, including Prof. Katerina Mitrokotsa. The group was made up of seven Doctoral Researchers, Nan Cheng, Johannes Ottenhues, Liujun Yu and Jenit Tomy who continued on their work from the previous years, and Florias Papadopoulos, who joined us in January 2024 and Wilson Tsuata and Ioannis Katis who joined in the fall. Furthermore, two post-doctoral researchers continued their work during 2024 i.e. Dr. Uddipana Dowerah until the end of Aug. 2024 and Dr. Novak Kaluderovic, until October 2024. In addition Dr. Subhranil Dutta has joined our group in June 2024 a graduate from IIT in India, who also received the prestigious ESKAS (Swiss Government Excellence Scholarship) postdoctoral fellowship. It is worh mentioning that in Dec. 2024 the doctoral researcher of our group Johannes Ottenhues submitted his thesis on the topic **Cryptographic Protocols for Biometric Authentication**.

[6] https://cybersecurity.unisg.ch

Research

The research of the cybersecurity chair focuses on all aspects of information and security and applied cryptography and especially on the design of efficient and robust cryptographic protocols and primitives that can be employed in realistic settings (e.g. resource constrained devices, smart phones, sensors etc.) and can be employed for outsourcing sensitive data and computations to untrusted cloud servers.

During 2024, our group published **10 research papers and book chapters** that appeared in well-known venues in cybersecurity and cryptography including ACM Asia Conference on Computer and Communications Security (AsiaCCS) 2024, Proceedings of Privacy Enhanced Technology (PETS 2024), IEEE European Symposium on Security and Privacy (Euro S&P) 2024, SAC (International Conference on Selected Areas of Cryptography) 2024, PKC (International Conference on Practice and Theory of Public-Key Cryptography) 2024, SCN (International Conference on Security and Cryptography for Networks) 2024, GI-Sicherheit 2024 while some papers submitted in 2024 were recently accepted papers in PKC 2025 and Theoretical Computer Science (Elsevier, 2025). In these works, we mainly proposed cryptographic protocols and cryptographic primitives that can be employed to guarantee secure and efficient computations when multiple parties are involved in the process and the corresponding data need to remain private, with applications to secure and privacy-preserving inference in machine learning as well as secure and private aggregation statistics and access control, privacy-preserving biometric authentication, and distributed cryptographic primitives such as distributed threshold signatures, and multi-client functional encryption.

More precisely, we focus on designing provably secure cryptographic protocols and primitives:

- to guarantee reliable and privacy-preserving authentication (e.g., access control systems, electronic payments) relying for instance on biometric templates (e.g. fingerprints, voice recordings) and passwords.

- guarantee that data generated by individuals remain private, while still being useful in order to compute values on them (e.g., compute aggregate statistics for health diagnostics, financial transactions etc.).

In more details, we are interested in the design of provably secure cryptographic protocols that can be employed for reliable authentication (i.e., autho-

rise only legitimate users to services and/or places) as well as cryptographic protocols and primitives that can be employed for secure and private cloud-assisted computing and machine learning algorithms. In the latter case, we design cryptographic protocols that allow us to check (control) the computations performed by untrusted cloud servers and make sure that our sensitive data are not leaked. In addition, we are working on network security problems e.g., privacy-preserving routing and detecting attacks in communication networks.

During 2024, we were involved in three main funded research projects: the GFF project "Secure and Private Aggregation for Federated Learning", as well as the project "Enhanced Data Privacy" supported by the Hasler Stiftung and the project "Reinforcing Privacy in Cloud Computing via Unbounded Attribute-based Quadratic Functional Encryption and its Applications" funded by the prestigious ESKAS (Swiss Government Excellence Scholarship) postdoctoral fellowship awarded to Dr. Subhranil Dutta.

In addition we focused on finalising research results relevant to the recently finalised EU-Project TReSPAsS-ETN[7] as well as the recently finalised project "Private, Robust, and Efficient Computation of Aggregate Statistics" funded by Armasuisse. It is worth mentioning that in 2024 a member of the Cybersecurity chair, the doctoral researcher Florias Papadopoulos was awarded the prestigious and competitive **CyberDefence (CYD)** doctoral fellowship in the topic "Privacy-preserving primitives for proximity tracing and collision avoidance" that will run for four years since Feb. 2025.

- In the project supported by the Hasler Stiftung "Enhanced Data Privacy", we aim to address the growing concern of data privacy in today's interconnected world. The implementation of data privacy regulations, like the EU's General Data Protection Regulation (GDPR), highlights the need for privacy-preserving solutions in data analysis and processing. Further, the advent of cloud services has resulted in a significant transformation in the processing and utilization of data. Many applications use cloud services due to its widespread availability and accessibility of resources coupled with a reduction in computationally-intensive tasks. However, with the ever-increasing risk of cyber-attacks, the use of cloud computing also poses a risk of exposing sensitive data to third-party service providers. To mitigate this risk, data is often stored in encrypted form in the cloud. Yet, the major challenge lies in performing computations or processing on this encrypted data without compromising its privacy. Our research will pri-

[7] https://www.trespass-etn.eu

marily focus on exploring the application of Functional Encryption (FE) as a powerful cryptographic tool to address these privacy concerns and enable secure data processing and analysis in such cloud-based scenarios. FE is an advanced cryptographic primitive that offers fine-grained access control over encrypted data. We will use a special type of FE called Inner Product Functional Encryption (IPFE) as our building block. The project focuses on two critical applications of IPFE: (i) privacy preserving proximity testing, and (ii) secure and private aggregation statistics.

- The GFF-project "Secure and Private Aggregation for Federated Learning" started in 2023 and has a duration of two years. The main goal of this project is to provide secure and privacy-preserving aggregation protocols while providing privacy, security and efficiency of the aggregation process and making sure that the involved clients/servers do not tamper with the aggregation process. More precisely, our aim is to make good use of the distributed data without having to compromise user privacy and security. Our goal is to establish a foundation for secure, private and efficient aggregation that enable robustness of the whole process both from the clients' as well as the servers' side. To achieve the latter we investigate post-quantum zero knowledge proofs and how to integrate them in the aggregation process without compromising the efficiency of the designed protocols. Our research results have already been solidified in a paper that is currently under submission and another one that is under preparation.

- The ESKAS funded project "Reinforcing Privacy in Cloud Computing via Unbounded Attribute-based Quadratic Functional Encryption and its Applications" has started in Sept. 2024 and will run for one year. Quadratic Functional Encryption (QFE) is a prominent cryptographic technique that enables authorized users to compute quadratic functions over encrypted data without having access to the underlying plaintext. It has numerous uses in fields including finance, healthcare, and joint research, where it is crucial to do selective data computations without compromising the security of all data. This project aims to design an attribute-based UQFE (UABQFE) to provide finer access control over decryption.

- The EU-Project TReSPAsS-ETN[8] (TRaining in Secure and PrivAcy-preserving biometricS) funded by the Marie-Sklodowska-Curie Innovative Training Network was officially finalised in 2023. Research results of this project where disseminated in 2024. More precisely, as part of this project, we de-

[8] https://www.trespass-etn.eu

signed cryptographic protocols as well as cryptographic primitives (i.e., elementary building blocks from which cryptographic protocols can be built) to make sure that the authentication process is accurate but the biometric information remains private and confidential and hidden from untrusted servers and service providers. More specifically, our group performed research connected to biometric authentication protocols, password based authentication protocols and the modeling of security properties of these. Results of this research project were accepted to multiple venues in 2024, incl. the prestigious ACM AsiaCCS 2024, Sicherheit 2024 a book chapter in the book "Privacy and Security Matters in Biometric Technologies" to be published in Springer as well as an additional relevant research paper that is currently under submission. It is important to mention that the PhD thesis of Johannes Ottenhues a doctoral student at the Chair of Cybersecurity that was funded by the EU-Project TReSPAsS-ETN was also submitted in Dec. 2024 and the PhD defence planned in the beginning of 2025.

- The Armasuisse project "Private, Robust, and Efficient Computation of Aggregate Statistics" was initiated in spring 2023 and was completed by the end of the year. It is worth mentioning though that research results of this project were published in 2024. The main goal of this project was to provide robust, private and efficient computation of aggregate statistics, without centralising the data of the aggregation process. More precisely, our aim was to make good use of the distributed data without having to compromise user privacy and security. Our work was focused on providing efficient, privacy-preserving computation protocols that guarantee robustness against malicious clients and/or servers while minimizing the dependence on a single central authority; thus, reducing many of the systemic privacy and security risks resulting from a centralised setting. Results of this research project were published at the proceedings of the IEEE European Symposium on Security and Privacy 2024.

Teaching

Our Chair offers multiple courses in the area of Cybersecurity and Applied Cryptography. During 2024 the Cybercecurity chair offered five courses for the Master level, two for the Bachelor level and two PhD courses. The courses were taught at the Computer Science Master program and the Master in Business Innovation (MBI) program at the University of St. Gallen as well as the Contextual study program. The courses at the bachelor level are taught at the Bachelor of Computer Science. More precisely, the mandatory course in *Cyber Security* was taught to the Master in Computer Science students for the fourth time. Furthermore, the Chair of Cybersecurity offered the elective course at the Master of Computer Science *Secure and Private Computing*. The group also supervised two students performing their *Integrative Master Project* in the area of Cybersecurity and applied Cryptography. In addition, the mandatory course *Cybersecurity* was taught to the Bachelor in Computer Science students for the first time as well as the elective course *Security Protocols and Applications*. Furthermore, the group offered one course to students of the Master in Business Innovation the *Cybersecurity and Privacy* course as well as the Contextual studies course *Data Security and Privacy*. During 2024, two PhD-level courses were offered to further strengthen the knowledge within Security & Privacy to the PhD-Students at the Doctoral School of Computer Science. Based on the received feedback and course evaluations the courses were well acknowledged and highly appreciated by the students, while one Master student of computer Science finalised his master thesis under our supervision. It is important to note that this master student is currently a doctoral student (Ioannis Katis) at the Chair of Cybersecurity.

Outreach

During 2024, the Chair of Cybersecurity has hosted the **Swiss Crypto Day 2024** [9] hosted at the University of St. Gallen and Prof. Mitrokotsa was the main organiser. Swiss Crypto Day is a high-profile event that allows the exchange of the main research results of prominent researchers and practitioners in cryptography that are active in Switzerland. This event was held for the first time in 2019 at the University of Bern and subsequently in 2023 at ETHZ after a short pause due to the pandemic. Swiss Crypto Day 2024 in St. Gallen included five different sessions focusing on different trends and advances in cryptography such as secure multi-party computation (SMPC), post-quantum cryptography (includ-

[9] https://swisscryptoday.github.io/2024/

Figure 3: Group photo of the participants at the Swiss Crypto Day hosted at the University of St. Gallen in Sept. 2024.

ing code-based and isogeny-based cryptography) as well as operating system and software security, secure and private computing and zero-knowledge proofs. The speakers included academics and industry experts from a variety of universities and organisations such as the University of Zurich, EPFL, ETHZ, University of St.Gallen, USI, IBM and Kudelski.

Furthermore, members of our group have presented our recent results at this Swiss flagship event for the community of Cryptography and Cybersecurity. Members of our group have attended multiple conferences and summer schools related to cryptography and cybersecurity and disseminated our research results i.e., including PETS 2024, AsiaCCS 2024, IEEE Euro S&P 2024, Swiss Crypto Day 2024, TPMPC 2024, and the CISPA Privacy-Preserving Cryptography Summer School 2024, Nordcrypt 2024, PKC 2024 and SAC 2024.

In addition, Prof. Mitrokotsa served as the **track chair** for Applied Cryptography in the flagship conference **ACM CCS 2024**, while she has served as program committee member of multiple top conferences in cybersecurity and applied cryptography including AsiaCCS 2024, NDSS 24, and ACNS 2024. During 2024, Prof. Mitrokotsa has served as evaluation committee member of two PhD theses in area of privacy preservation and applied cryptography: one at NTNU (Norway) and one at Linköping University (Sweden).

Since November 2022, Prof. Katerina Mitrokotsa is a member of the Sounding Board Researchers of the Swiss National Open Research Data Strategy[10]. The

[10] https://akademien-schweiz.ch/en/themen/scientific-culture/open-science/

main task of the Sounding Board Researchers is to advise both the Swiss National Open Research Data Strategy Council and the Open Research Data Coordination Group by responding to their questions and issuing recommendations to enable the participation of research communities in the further development of the Swiss Open Research Data landscape. She continued her work at the Swiss National Open Research Data Strategy in 2024. Furthermore, she joined the Information Security Board of the University of St. Gallen in 2024.

In addition, the Chair of Cybersecurity, has continued the collaboration with the Cyber Defence (CYD) Campus of Switzerland. During 2024, Prof. Mitrokotsa and a PhD student of our group (Mr. Florias Papadopoulos) has been awarded a CYD doctoral fellowship with starting date in Feb. 2025.

Furthermore, Prof. Mitrokotsa and the Chair of Cybersecurity has continued her participation at the SLICES Switzerland Association (SLICES-CH[11] which is established in the context of the European SLICES project to establish a large-scale research infrastructure for information and communication technologies. The Association ambitions to support the participation of the Swiss research community in this initiative and to take part in its governance process. Prof. Mitrokotsa has also joined multiple strategic meetings of the SLICES-CH association.

In addition, the chair of Cybersecurity has hosted several visitors and top researchers in the area of Cybersecurity and Cryptography that have also participated at the CSI seminar hosted at the School of Computer Science at the University of St. Gallen. Among the visitors are included Prof. Patrick Struck (Konstanz University, Germany), Prof. Venkata Koppula (IIT Delhi, India), Dr. Julia Hesse (IBM, Zurich), Dr. Tapas Pal (KIT, Germany), Prof. Giovanni Apruzzese (Univ. of Lichtenstein), Matilda Backendal (ETH Zurich), Dr. James Hsin Yu Chiang (Aarhus University, Denmark).

Finally, in 2024 Prof. Mitrokotsa joined the Ethics Committee of the University of St. Gallen, the Information Security Board of the University of St. Gallen and the Research Committee of the University of St. Gallen (as substitute member). Furthermore in 2024 Prof. Mitrokotsa joined the Review committee of the School of Computer Science for the evaluation of faculty members. In addition throughout 2024, Prof. Mitrokotsa continued to be a part of the Gender & Diversity Commission of the University of St. Gallen, which aims to further develop and ensure equal opportunities, diversity and inclusion within the university.

[11] https://slices-ch.org

Programming, Guido Salvaneschi

The Programming Group at the Institute of Computer Science conducts research on advanced programming techniques aimed at improving the efficiency, maintainability, and security of software systems. Since February 2024, Prof. Salvaneschi has assumed the role of *Institutsleiter*, succeeding Prof. Mayer.

Team Members

The Programming Group at the University of St. Gallen comprises four Ph.D. students and two postdoctoral researchers. In addition, research scientist Christoph Bühler supports the group's activities. A new Ph.D. student, MSc Jahrim Gabriele Cesario, joined the group in May 2024, followed by MSc Alexander Städing in November 2024. Daniel Sokolowski successfully defended his **Ph.D. thesis, titled *Reliable Infrastructure as Code for Decentralized Organizations***, in April 2024 and subsequently joined Amazon Research. The group is also supported by a student programmer who contributes to ongoing research efforts. An additional Ph.D. student, supervised by Prof. Guido Salvaneschi, is currently based at the Technical University of Darmstadt, Prof. Salvaneschi's former institution.

The group's research focuses on two main areas. The first is programming language design and program verification, which are essential for improving the reliability of (distributed) software applications. The second area involves languages and systems for infrastructure as code, contributing to the safety and reliability of cloud computing systems.

Projects

The group successfully acquired several research projects in 2024, reflecting the international recognition of its scientific contributions.

- **SNSF** *Consistency Programming for Local First Software* ($\sim$1M CHF, 4 years) is about developing a programming framework for distributed software that is resilient to intermittent connectivity and still provides the correct functionality if clients operate offline and reconnect later.

- **EU-HORIZON** *CAPE: European Open Compute Architecture for Powerful Edge* (∼750K CHF, 3 years). CAPE aims to achieve European Digital Sovereignty by shaping the next generation of edge-to-cloud computing systems. The project seeks to position Europe as a leader in green cloud-computing infrastructure by reducing waste heat, increasing the reuse of waste heat and cooling capacity, and integrating renewable energy sources

- **Cyber Defense Campus (CYD)** *Systematic Testing of Supply Chain Infrastructure Configuration* (∼75 CHF, 1 year). The project aims to design a testing framework for infrastructure as code which is crucial to guarantee the security and safety of cloud computing environments. The project was concluded in December 2024.

In addition, the **SNSF** project *Multitier Programming Above the Clouds*, which started in 2021 (∼1M CHF, 4 years) entered its last year. The project so far has led to numerous top-tier publications and the graduation of MSc Daniel Sokolowski.

Teaching

The group offers a number of courses in the areas of programming languages and software systems. In 2024, it delivered a total of five courses across various programs at the University of St. Gallen.

In the first semester of the Bachelor's program in Computer Science, the group teaches the course *Introduction to Programming*, where students learn the foundations of programming using the Python programming language. In the second semester, the group teaches the course *Programming Methodology*, which focuses on object-oriented programming in Java.

In Fall 2024, the group offered the course *Introduction to Software Engineering* in the MBI program—an introductory course covering Java programming and basic application engineering. The group also taught a course on *Programming Languages* in the Master's program in Computer Science, providing an overview of foundational concepts in programming language theory.

Additionally, in Fall 2024, the group introduced a new course titled *Coding with AI*, focusing on novel programming techniques enabled by large language models. The course was very well received and gave students the opportunity to explore

cutting-edge methods for software development. It included several successful guest lectures from industry professionals, such as Lize Raes (Naboo.ai) on *A Tour of AI-Powered Development*, Beat Buesser (IBM) on *Software Security with AI*, Florian Georg (Microsoft) on *Building Innovation: How to Be a Software Engineer in the Age of GenAI*.

Finally, Prof. Salvaneschi contributed to the Executive Education program *Data Protection Officer DPO-HSG*, offered by the Executive School of Management, Technology and Law (ES-HSG) at the University of St. Gallen. He delivered lectures in the module *Fundamentals of Data Protection*, specifically covering the topic *Introduction to Data Security*.

Research

The group's main research area lies in programming language techniques and their implications for the development of software systems. More specifically, the group focuses on two interconnected research lines.

The first research area addresses language design and program verification for distributed systems. In this domain, the group develops programming languages that support the creation of distributed software that is more efficient, secure, and maintainable. Additionally, the group is active in the development of automated verification techniques tailored to the specific challenges of distributed systems.

The second research area focuses on a novel class of software applications known as Infrastructure as Code (IaC). These applications are responsible for securely configuring infrastructural elements—such as networks, cloud resources, or other software systems—rather than providing services directly. Given their foundational role, the correctness of these applications is critical: a defect in the configuration process can compromise entire system landscapes. The group is currently investigating techniques for testing and verifying infrastructure as code.

These research efforts have resulted in ten publications in 2024, including journal articles, conference papers, and book chapters. Among others, the group's work has appeared in highly prestigious venues such as PLDI, JSS, and TSE—leading conferences and journals in the fields of programming languages and software systems.

Outreach and Academic Citizenship

The group is highly visible in the scientific community.

In 2024, Prof. Salvaneschi received the Ten-Year Most Influential Paper Award for his paper *REScala: Bridging Between Object-Oriented and Functional Style in Reactive Applications*, presented at the Programming conference.

Prof. Salvaneschi served as Program Co-Chair of the European Conference on Object-Oriented Programming (ECOOP 2024), alongside Prof. Jonathan Aldrich (Carnegie Mellon University). ECOOP is Europe's longest-standing annual conference on programming languages.

Prof. Salvaneschi is also a member of AITO (Association Internationale pour les Technologies Objets), the organization that oversees the ECOOP conference series. Furthermore, he serves as Chair of the AOSA Steering Committee. AOSA is a non-profit organization whose mission is to be the primary sponsor of the Programming conference and to publish the Programming Journal.

In addition, Prof. Salvaneschi has been involved in several program committees in 2024, including: OOPSLA 2024 – ACM International Conference on Object-Oriented Programming, Systems, Languages, and Applications, ISSTA 2024 – ACM SIGSOFT International Symposium on Software Testing and Analysis, ICSME 2024 – IEEE International Conference on Software Maintenance and Evolution, ICSE 2024 – International Conference on Software Engineering (NIER Track).

Prof. Salvaneschi has also served as an external reviewer for several international funding agencies in 2024, including: NSERC – Natural Sciences and Engineering Research Council of Canada (Discovery Grants 2024), NKFIH – National Research, Development and Innovation Office (Hungary), ETH Zurich – Young Researchers' Exchange Programme, Special 2024 Call Japan.

Since February 2021, Prof. Salvaneschi has been a member of the Advisory Board of the Department of Computer Science at OST University of Applied Sciences, Switzerland. As of June 2024, he also serves on the Scientific Committee of DIGITAL SME (Brussels). The European DIGITAL SME Alliance is the largest network of ICT small and medium-sized enterprises in Europe, representing over 45,000 companies.

In 2024, the group had the pleasure of hosting several renowned researchers,

including Dr. Matteo Biagiola (USI), Dr. Thodoris Sotiropoulos (ETH), Dr. Luca Di Grazia (USI), Dr. Zhang Chengyu (ETH).

Human-Computer Interaction, Johannes Schöning

The Human-Computer Interaction (HCI) group at the Institute of Computer Science in St. Gallen has made significant contributions to the field of HCI through their teaching, research, and outreach efforts. With a focus on developing novel user interfaces that empower individuals and communities, they have published high-quality research in various outlets and acquired funding for their projects. The group's commitment to interdisciplinary collaboration has resulted in fruitful collaborations with other leading HCI Labs in Europe and within HSG. Again, their summer workshop, "CHI Together", has promoted interdisciplinary exchange between PhD students, postdocs, and professors across different schools [SRS24]. Johannes Schöning leads the group. The HCI research group officially joined the institute in February 2022, after its establishment at HSG in September 2021. As reported and outlined in the two previous reports, the group has continued to lead HCI research in Switzerland and published a series of high-quality articles [SSGS24, SWA+24, SRP+24, WKR+24, SWS24, SNS+24, SPK+24, KSS24, SMW+24] as outlined below.

Team

Focusing on developing user interfaces that support individuals and communities with the necessary information to make informed, data-driven decisions, the team comprises five PhD candidates and two PostDocs based at HSG in St. Gallen. Additionally, one PhD candidate continues their research at the University of Bremen. Three members, Nadine Wagener, Evropi Stefanidi and Conrad Zeidler, successfully graduated with their PhDs from the University of Bremen in June 2024. Nick von Felten, a psychologist from the University of Basel, joined the team in August 2024 as a new PhD student.

In mid-2023, Dr. Florian Mathis joined the team after graduating from the University of Glasgow, Scotland and spending time at Meta Reality Labs in Toronto, Canada. With support from the HSG International Postdoctoral Fellowships program (previously known as IPF, now Great Minds) and several collaboration partners across Switzerland and Austria (e.g., SZBLIND, Lebenshilfe Vorarlberg), his project focuses on developing assistive technologies aimed at enhancing the daily lives of blind and low vision (BLV) people. His research combines cutting-edge technology with well-established user-centred design methods to ensure these solutions address the daily needs of BLV people. By collaborating with BLV

people and experts in accessibility, engineering, and human-computer interaction, Dr. Mathis is working to bridge the gap between innovation and practical application. This research is a step towards creating an inclusive future where both disabled and non-disabled people have access to the necessary technological resources, enabling them to fully and independently engage in society.

Research

The 2024 research efforts of the HCI group at the University of St. Gallen closely align with the mission to empower individuals and communities by co-creating data-driven interfaces that support meaningful decision-making. This year's research underscores our commitment to developing user interfaces that respond to human needs and enhance interaction with the technology itself, empowering users across diverse activities. Our research explored navigation technology's social impact and VR applications for emotional well-being, reflecting our focus on understanding and supporting user experience in various contexts, including geographic information science and personal well-being. The work on foldable device interfaces and haptic VR shows our dedication to exploring the interplay between rapid technological advancements and human needs, ensuring that digital interfaces are adaptable, accessible, and beneficial to users. We aim to create an understanding of user requirements in a broad range of conditions, from everyday settings to extreme environments, and benefit from interdisciplinary collaboration across AI, computer graphics, and cognitive psychology. This year's research advances our mission to design interfaces that facilitate more informed, empowered interactions with technology by applying rigorous, user-centred methodologies and leveraging mixed methods. Our papers address current topics in HCI through a range of empirical and conceptual methodologies, organised here into three thematic clusters: GeoHCI and Maps and Spatial Interaction, Virtual Reality for Emotional Well-being Support, and Advances in Haptic Interface Design. The published papers can also be found at Alexandria [12].

GeoHCI and Maps and Spatial Interaction

The theme of *GeoHCI and Maps and Spatial Interaction* encompasses research into the socio-spatial impacts of navigation technologies and the adaptation of

[12] https://www.alexandria.unisg.ch/handle/20.500.14171/121076

map apps for foldable device interfaces. The study by Schade et al. [SSGS24] "Traffic Jam by GPS: A Systematic Analysis of the Negative Social Externalities of Large-scale Navigation Technologies," offers a critical analysis of the unintended consequences associated with large-scale GPS use in local communities, including increased traffic congestion, pollution, and accident rates. This study identifies a clear need for new design frameworks to mitigate these externalities, highlighting actionable design implications for navigation technology prioritizing community well-being. Savino et al. [SWS24] optimized mobile map apps for foldable devices by examining the usability of map applications on dual-screen interfaces enabled by foldable mobile devices. This study's findings reveal that adaptable layouts, such as split-screen navigation with turn-by-turn guidance on one screen and a route overview on the other, can enhance user satisfaction and functionality, addressing user needs in navigation and spatial interaction on these novel devices.

Virtual Reality for Emotional Well-being Support

The second theme, *Virtual Reality for Emotional Well-being Support*, explores VR's potential to facilitate emotional resilience, interpersonal understanding, and conflict resolution. The TeenWorlds [SWA+24] framework offers a novel approach to fostering emotional communication among teenagers and their parents or peers. The study demonstrates that VR can be a constructive tool for supporting teenagers in expressing emotions, resolving conflicts, and enhancing familial and peer relationships through immersive, collaborative experiences. Complementing this work, the MoodShaper [WKR+24] system introduces a VR-based approach for managing negative emotions through personalised virtual environments that facilitate emotional regulation. Their findings underscore the efficacy of VR as a technology-mediated space for emotion regulation (ER) that fosters reflection and growth, especially in challenging emotional situations. Both studies underline VR's capacity to promote well-being and strengthen interpersonal relationships by offering users immersive environments where emotional engagement and reflection can occur in a supportive, structured manner.

Advances in Haptic Interface Design

The third theme, *Advances in Haptic Interface Design*, addresses new paradigms in user interaction through innovations in haptic feedback, mixed reality, and personalised behavioural interventions. Stellmacher et al. [SMW+24] investigate using mobile devices as haptic interfaces in mixed reality, aiming to replace traditional controllers to sustain immersive haptic experiences. The study provides valuable insights into users' preferences and intuitive interactions with mobile devices in mixed reality. It reveals three primary haptic exploration modes that guide future mobile haptic interface design. Additionally, Stellmacher [SPK+24] research on pseudo-haptics and vibrotactile feedback in VR explores dynamic weight simulations, establishing effective methods for enhancing tactile realism in VR through continuous control-display (C/D) ratio adjustments. However, vibrotactile feedback alone showed limited efficacy.

The DIY Digital Interventions framework [SRP+24] introduces the BC-TAP model, a novel methodology that enables users to design and implement personalised interventions for behaviour change. This approach to digital interventions allows individuals to engage with technology in a way that directly aligns with their personal goals, thereby offering a promising model for supporting sustainable behaviour change.

Our systematic review of autoethnographies in HCI [KSS24] provides an additional dimension to this theme, examining the role of autoethnographic methodologies in capturing personal perspectives within HCI research. This review identifies key contributions, themes, and methodological practices in autoethnographic studies, advocating for broader adoption of this approach within HCI to deepen the understanding of complex human-technology interactions.

In conclusion, the 2024 research of the HCI group at the University of St. Gallen contributes substantively to the field of HCI by advancing our understanding of technology's socio-spatial impacts, the supportive role of VR in emotional well-being, and innovations in interaction design. Most notably, we have received Honourable Mention awards for two of our recent papers, a recognition that highlights the impact and quality of our research within the academic community.

Furthermore, our group has maintained a continuous presence at ACM CHI, our flagship venue, for over a decade. These contributions demonstrate the group's dedication to addressing critical issues in HCI through user-centred, empiri-

cally grounded research that informs future technological development and design.

Teaching

The HCI group has contributed to the curriculum at both bachelor's and master's levels, teaching mandatory courses that equip students with essential skills. They have also facilitated master's projects and supervised bachelor and master theses in computer science and interdisciplinary programmes such as the Master of Business Informatics (MBI).

One initiative we put forward in 2024 is the SQUALLY project, which began with the Integrative Master's Project by students Atilla Gueven and Phil Natter. We developed an AI-based "soul" for the Navel Robot, a social robot, starting with an interaction concept and progressing to a natural speech interface. By the end of 2023, we successfully integrated their system into the robot. In 2024, SQUALLY was introduced at SQUARE to provide an interactive assistant that enhances communication and efficiency.

Additionally, the *Algorithms and Data Structures* course is a core component of the Bachelor's degree in Computer Science (BCS) at HSG and was taught by the HCI group. This mandatory course integrates computer science education with foundational business management skills, preparing students for technology companies or IT project leadership careers.

The course covers essential concepts for developing efficient and scalable software, including the design of large systems and various sorting algorithms. The SQUARE environment enhances the learning experience, where outdoor lectures encourage dynamic discussions and collaborative problem-solving. Students engage in hands-on exercises to apply algorithms in sorting and searching techniques.

Student feedback highlights a positive learning experience at SQUARE, with many noting that the bright, open spaces contribute to an engaging and productive atmosphere that fosters both engagement and effective learning outcomes.

Outreach

The HCI group actively hosts events throughout the year to encourage interdisciplinary collaboration among PhD students, postdoctoral researchers, and professors from various academic backgrounds. In 2024, we held our annual CHI together, which focused on developing publications for submission to the ACM CHI conference, marking the third consecutive year for this collaborative event. Additionally, we participated in the Open Square event in February 2024, where we showcased two interactive VR demos.

Johannes Schöning stepped down as the president of the ACM SIGCHI chapter in Switzerland. Collaborating with the School of Computer Science, the HCI group coordinated the Computer Science Insights St. Gallen (CSI St. Gallen) talk series. This series has featured nearly 50 speakers from industry and academia who shared insights into computer science and presented their research findings and best practices.

Our research article was featured on the SNF [13] (Swiss National Science Foundation) start page, as well as in Neue Zürcher Zeitung (NZZ) [14] and other prominent media outlets in Switzerland and beyond [15].

[13] https://www.snf.ch/en/wbtr6UOYqfXJbV7O/news/preventing-gps-caused-traffic-chaos

[14] https://www.nzz.ch/panorama/bitte-wenden-wenn-das-navi-chaos-verursacht-ld.1854921

[15] https://techxplore.com/news/2024-10-gps-traffic-chaos-personal-responsibility.html

Software Systems Programming and Development, Barbara Weber

The chair deals with the development of adaptive software systems. This includes the integration of process-oriented information systems with the Internet of Things as well as the development of neuro-adaptive software systems. Furthermore, the chair conducts research on human and cognitive aspects of software and process engineering. Moreover, *Process Mining* is an overarching research area at the chair.

Team

The "Software Systems Programming and Development" chair began operations in February 2019 and has since grown into a strong research team. Dr. Francesca Zerbato, who has been working on process mining, was recently promoted to Assistant Professor at Eindhoven University of Technology (TUE) and left our team–we congratulate her on this achievement and wish her all the best in her new role. Dr. Marco Franceschetti continues his research at the interface between Internet of Things (IoT) and Business Process Management (BPM) as part of the SNSF-funded research project *ProAmbitIon*. Dr. Amine Abbad-Andaloussi strengthens the team's expertise in human and cognitive aspects of software engineering. Dr. Hagen Völzer is Senior Project Manager since 2022, focusing on Process- and Business Rule Mining. Prof. Dr. Ronny Seiger, as an Assistant Professor, conducts research at the intersection of IoT, BPM, and Software Engineering. The team also includes two PhD students: Thierry Sorg, who has been researching neuro-adaptive software systems, and Lisa Zimmermann who has been advancing research in process mining.

Teaching

Our teaching activities included the development and teaching of a mandatory course ("*Advanced Software and System Engineering*") in the Master of Computer Science (since 2021 together with the chair of Interaction- and Communication-based Systems), the two elective courses "Event-driven and Process-oriented Architectures" and "Software Assessment: From Planning to Experimentation".

Moreover, we are responsible for the mandatory course “Entwurf von Softwaresystemen” (Design of Software Systems) taught to 3rd semester Bachelor of Computer Science students and the newly developed mandatory course “Software Engineering” taught to the 4th semester Bachelor of Computer Science students. We also teach a newly developed elective course “Process Mining – Data Driven Improvement of Business Processes” in the Computer Science Bachelor program.

In addition, our teaching portfolio includes a course in the Master of Business Innovation (“*Event-driven and process-oriented applications for the IoT*”) in the Spring 2024 semester, a course in the Entrepreneurial Informatics profile area of the Bachelor of Business Administration (“*Accelerating Digital Transformation with Process Modeling, Automation, and Mining*”) in the Fall 2024 semester, and a Contextual Studies course (“*Skills: Interactive Information Visualization - From Theory to Experiments*”) offered to both Master and Bachelor students in the Fall 2024.

Furthermore, the chair is continuously involved in the supervision of Bachelor and Master thesis inside and outside of the School of Computer Science, as well as in the supervision of Bachelor Projects and Integrative Master Projects at the SCS.

Since 2021, Barbara Weber also teaches the elective *Coding for Executives* in the EMBA and IEMBA together with the chair Artificial Intelligence and Machine Learning as part of the Executive Education. Complementing her teaching in executive education, she has shared her insights over several weeks through a series of key messages on AI and Machine Learning.

Research

Our research is currently focused on the development and evaluation of software artifacts. The research covers topics in process mining, Internet of Things as well as process model and source code analysis to develop event-driven software systems that adapt to the user’s behavior and context. Our research is supported by the Swiss National Science Foundation (SNSF) with two projects *ProMiSE*[16] and *ProAmbitIon*[17].

[16] https://data.snf.ch/grants/grant/197032
[17] https://data.snf.ch/grants/grant/208497

Process Science as a Conceptual Foundation. Our research contributes to Process Science, an interdisciplinary field that studies socio-technical processes—coherent sequences of actions and events involving both humans and digital technologies. In our paper, we discuss the increasing availability of digital trace data and advancements in process analytics as new opportunities to understand, optimize, and intervene in these processes [BAB+24]. This perspective underpins our research across Process Mining, BPM & IoT, and Human and Cognitive Aspects in Software and Process Engineering, highlighting how digital trace data can be leveraged for both automated and human-in-the-loop processes.

Process Mining. In 2024, we expanded our research in process mining, with a particular focus on understanding and supporting analysts in exploratory analysis tasks. The ProMiSE project, funded by the SNF and running since 2020 [ZZVW23], remained central to our efforts, enabling us to generate further insights into analysts' behavior and challenges. Additionally, we worked on developing methodological and software-based solutions to enhance the quality and efficiency of the analysis process.

Our work on the challenges faced by process mining analysts was published in the Software and Systems Modeling (SoSyM) journal [ZZW24], offering an in-depth examination of common hurdles and how they are navigated in practice. Building on this, we are now focusing on proposing solutions for the most critical of the 23 identified challenges.

One key contribution is a tool designed to help analysts systematically assess and refine analysis questions, addressing a critical gap in process mining projects [Zim24a]. Expanding on this, we are working on a conceptual extension of the tool and a taxonomy for characterizing process mining analysis questions in collaboration with Manuel Resinas from the University of Seville.

To address the challenge of losing track during process mining analysis, we developed a framework to document, evaluate, and compare analysis steps [ZFW24]. In exploratory process mining, analysts refine their understanding by forming expectations and testing them through queries. Our framework records queries and results, enabling systematic comparison and validation. Implemented as a flexible Python library, it integrates into existing process mining environments and enhances traceability and reflection on the analytical process.

Beyond these methodological advancements, we collaborated with Andrea Burattin's research team at DTU on developing a distributed platform for process mining [BKD+24]. Our contribution focused on addressing challenges related to process mining pipeline setup, which often involves programming, manual configuration, and concerns around privacy and intellectual property. As part of our joint work we refined the architecture's requirements based on real-world process mining scenarios and validated its practical relevance.

Our collaborations extend to researchers from RWTH Aachen and the Fraunhofer Institute for Applied Information Technology, where we have been working on integrating visual analytics with process mining. A key outcome of this collaboration was the development and evaluation of a new visualization approach to tackle the challenge of representing concurrency in process variant analysis. Unlike previous methods, our visualization accounts for partially ordered events, supporting both interval-based (start and end timestamps) and point-based (e.g., only start timestamps) event representations [SZvZvdA24].

Beyond this specific visualization, we contributed to the broader discussion on the synergy between visual analytics and process mining in the article "Visual Analytics Meets Process Mining: Challenges and Opportunities" [MCSW24]. This work explores how the combination of interactive visual data analysis and process mining algorithms enhances the comprehension of complex information structures and facilitates new insights. Together, these efforts highlight the potential of visual analytics as a powerful complement to process mining, addressing key challenges in data exploration, interpretation, and communication.

As continuation of our work to discover complex business rules in process event logs, we advanced our rule mining technology with a benchmarking study of different rule mining pipelines [VHKO24].Additionally, in an effort to improve the analysis of variety in event logs [SAA24], we have developed a new measurement framework that captures and quantifies structural process variety and supports process standardization. Moreover, we introduced a novel approach to generate two-level process models from UI logs, bridging the gap between task mining and process mining [BVJ+24].

While process mining has traditionally focused on highly structured and automated workflows, our invited paper [WAAF+24] to Evaluation of Novel Approaches to Software Engineering (ENASE) explores how digital trace data can also be leveraged for human-centered processes. These include semi-automated factory operations, healthcare processes, and process analysts'

decision-making workflows.

Business Process Management and Internet of Things. In 2024, we continued our research on integrating Business Process Management (BPM) with the Internet of Things (IoT) as part of the ongoing SNSF-funded ProAmbitIon project (since 2022). The project's goal is to enhance monitoring and validation of business process executions using IoT technologies.

In [SFAA24], we investigated how to leverage BPM technologies and microservices to non-invasively augment legacy IoT systems in the form of a smart factory to accommodate their evolution needs. In the same context, we evolved the existing software architecture used to control our smart factory from a monolithic structure to microservices [SM24].

Moreover, our work in the ProAmbitIon research project significantly contributed to advancing the support to monitoring and tracking of activities, logging of process histories, detecting and handling errors, and enabling human interactions in legacy IoT systems, thereby extending the system functionality and user experience as well as discussing ambiguities of activity detections [FBSW24].

Furthermore, we developed an extensible open-source tool allowing the evaluation of activity and sequence detection methods based on a customizable set of metrics [KSFW24], thereby enabling a sophisticated analysis of IoT-driven process activity detection approaches.

In addition, in September 2024, we organized a data collection workshop with students from the Joint Medical Master (JMM) in our healthcare lab setup. During the workshop, the medical students simulated performing blood donations in an IoT-enriched environment. This allowed us to collect real IoT data recording the execution of the blood donation process, as well as feedback and insights from potential end-users of the monitoring and checking approaches developed within the research project. We will use the collected IoT data to evaluate our activity detection approaches in future studies.

Our work in the context of ProAmbitIon also got featured at HSG's new digital platform "HSG at a Glance"[18].

Expanding our smart factory lab setup, we successfully integrated additional

[18] https://www.unisg.ch/en/hsg-at-a-glance/the-internet-of-things-and-the-real-world/

robots and sensors using GreenBox project funding from HSG. This setup is now actively used in student projects and teaching, including implementation scenarios discussed in [Sei24]. Furthermore, with the upcoming SNSF project on sustainable software architectures for cyber-physical systems of systems, set to begin in May 2025, we anticipate new opportunities for deeper investigations in smart manufacturing software architectures.

Our research at the intersection of BPM and IoT also strengthened international collaborations. As part of the Internet of Things and Processes working group, we contributed to a book chapter discussing open challenges and a framework for integrating IoT data with business processes [MSB+24]. Ongoing work focuses on developing a core metamodel for IoT-driven process monitoring and conformance checking. Furthermore, we remain committed to the community by publishing new datasets publicly[19]. We also contributed to role-based process modeling for IoT processes, developed with TU Dresden [SSFS24], and explored sustainability aspects of IoT-enhanced business processes with the University of Valencia [AMS+24].

Following constructive discussions during the BPM conference, our network of international research partners from other universities expanded further with the exploration of synergies between our research at the intersection of BPM and IoT and ongoing research on BPM and Digital Twin (DT) technologies. This materialized with the publication of a research manifesto outlining challenges and opportunities opened up by the intersection of BPM, IoT, and DT [FCDD+24] and an article on digital twins of organizations and its implications on organizational design [LWBP24].

Human and Cognitive Aspects in Software and Process Engineering. Our research in this area explores how individuals interact with software design artifacts, such as process models and source code, while carrying out different tasks. Our approach is based on a multi-granular approach, integrating task level coarse-grained assessments of cognitive load with fine-grained investigations into users' visual behavior and its evolution over time.

Over the past year, our research has made significant progress in explaining the cognitive challenges associated with process model comprehension. Through a series of eye-tracking studies, we have examined key factors influencing comprehension including the nature of the task being performed [SAAW24, AASW24a],

[19] https://zenodo.org/communities/iopt

the presence of ambiguities in process models [FAAS+24], and the role of model layout [FSW24].

Regarding the task type, we investigated the cognitive and behavioral effects of abstraction and fragmentation in modular process models [SAAW24]. Our study demonstrated that global tasks (addressing several modules) are more challenging to perform on modular process models compared to local tasks (addressing a single module). Furthermore, we found that local and global tasks engage distinct cognitive and behavioral processes. Following up on this research, we incorporated the task perspectives into our analysis, to consider both flow-based tasks (focusing of procedural aspects of process models) and circumstantial tasks (focusing on rules and constraints) [AASW24a]. Our findings revealed that the task perspective influences the cognitive and behavioral effects of abstraction and fragmentation in modular process models. The insights gained from both studies [SAAW24, AASW24a] have provided a comprehensive understanding of the interplay between task type, task perspective, and process modularization.

With regard to ambiguity in process models, we investigated the impact of different types of ambiguity (i.e., pragmatic, semantic, syntactic, and lexical) on users cognitive load and visual behavior [FAAS+24]. Our results demonstrated the negative effects of ambiguity. Moreover, we proposed a set of guidelines to mitigate these negative effects, providing actionable recommendations to improve process model clarity.

As for the role of layout, our collaboration with the University of Innsbruck and the University of Haifa [FSW24], revealed key insights. Therein, our study showed that pattern visibility aids control flow recognition, while directional changes momentarily distract but do not hinder comprehension. The study also proposed guidelines for automated layout tools to enhance readability.

Beyond these studies, we have made significant progress toward developing a new generation of adaptive systems based on eye-tracking. As a key milestone, we proposed a machine learning model capable of predicting users' cognitive processes, specifically, distinguishing between information search and inference [AASW24b]. This model enables real-time detection of these cognitive processes, allowing for targeted interventions to support users when challenges arise in either process.

Additionally, we have launched a new project funded by Leading House MENA[20]. In this initiative, Amine Abbad-Andaloussi and researchers from Cadi Ayyad University in Morocco are exploring innovative approaches to enhancing e-learning processes using eye-tracking technology.

Outreach and Academic Citizenship

The Chair has not only played a key role in the development of HSG, with Barbara Weber serving as Vice-President for Education and Teaching (following her tenure as Dean of Computer Science since 2020), but has also continued to enhance its visibility in 2024, contributing significantly to St. Gallen's growing international reputation as a hub for computer science.

Amine Abbad-Andaloussi was co-organizer of the 1st Workshop on Empirical Research in Process Mining and Publicity Chair at the International Conference on Process Mining (ICPM). Barbara Weber was also invited as keynote speaker at the Research Challenges in Information Science (RCIS) 2024 conference on "BPM in the Era of AI and Generative AI: Opportunities and Challenges" and Cooperative Information Systems (CoopIS) 2024 conference on "Machine Learning and Generative AI in BPM: Recent Developments and Emerging Challenges".

Since 2022, Barbara Weber has been serving on the SNSF evaluation panel for Postdoc.Mobility Mathematics and Engineering (STEM-T). It is highly gratifying that HSG's Computer Science is represented at the national level through her role. With her new position as Vice-President for Education and Teaching, she has stepped back from the HSG-internal research commission.

Barbara Weber is now part of the Editorial Board of the journal "Software and Systems Modeling"[21]. Further, she is an Associate Editor part of the Editorial Board of the journal "Business & Information Systems Engineering (BISE)" for the "Business Process Management"[22], a member of the Editorial Board of the journal "Computers in Industry"[23], part of the Editorial Advisory Board of the journal "Information Systems", and Associate Editor of the journal "Computing". Moreover, since 2023 she is a member of the editorial board of "Process Science". Furthermore, she co-edited a topic on the "Application of neuroscience

[20] See https://www.hes-so.ch/en/hes-so/about-us/international/leading-house-mena
[21] https://www.springer.com/journal/10270/editors
[22] https://www.bise-journal.com/?page_id=20
[23] https://www.journals.elsevier.com/computers-in-industry/editorial-board

in information systems and software engineering" in Frontiers in Neuroscience [PvBR+24].

Barbara Weber and Hagen Völzer are Senior Program Committee Members of the International Conference of Business Process Management (BPM). Barbara Weber is also part of the International Conference on Advanced Information Systems Engineering (CAiSE) Program Board and Steering Committee member of both BPM and CAiSE.

In 2024 we had the pleasure to host several researchers to work together on topics of joint interest. This included professor Luciano Garcia-Bañuelos, Luis Armando Rodriguez Flores, and Astrid Rivera-Partida from the Tecnologico de Monterrey in Mexico, Abel Armas-Cervantes from the University of Melbourne, John Krogstie from the Norwegian University of Science and Technology, professor Manuel Resinas from the University of Seville, and Dr. Daniel Lübke, Lead Software and Business Process Architect, and CEO of Digital Solution Architecture GmbH. In August 2024, Barbara Weber and Marco Franceschetti were hosted by Prof. Luciano Garcia-Bañuelos for a week-long research stay at the Tecnologico de Monterrey - Campus Puebla, Mexico. During their research stay they engaged in joint research activity with the team of Prof. Garcia-Bañuelos and gave a talk at the workshop "Computer Science can be fun" to promote the study of Computer Science with the local students.

University of St. Gallen
Institute of Computer Science (ICS-HSG)
Rosenbergstrasse 30
9000 St.Gallen
https://ics.unisg.ch

Institute Members

- Prof. Dr. Damian Borth (Director)
- Prof. Dr. Siegfried Handschuh (Director)
- Prof. Dr. Anna-Lena Horlemann (Director)
- Prof. Dr. Simon Mayer (Director)
- Prof. Dr. Katerina Mitrokotsa (Director)
- Prof. Dr. Guido Salvaneschi (Director)
- Prof. Dr. Johannes Schöning (Director)
- Prof. Dr. Barbara Weber (Director)

References

[AABS+23] Amine Abbad-Andaloussi, Andrea Burattin, Tijs Slaats, Ekkart Kindler, and Barbara Weber. Complexity in declarative process models: Metrics and multi-modal assessment of cognitive load. *Expert Systems with Applications*, 233:120924, 2023.

[AALW23] Amine Abbad-Andaloussi, Daniel Lübke, and Barbara Weber. Conducting eye-tracking studies on large and interactive process models using eyemind. *SoftwareX*, 24:101564, 2023.

[AASW24a] Amine Abbad-Andaloussi, Clemens Schreiber, and Barbara Weber. On the task-specific effects of fragmentation in modular process models. In *International Conference on Conceptual Modeling*, pages 18–37. Springer, 2024.

[AASW24b] Amine Abbad-Andaloussi, Clemens Schreiber, and Barbara Weber. Using eye-tracking to detect search and inference during process model comprehension. In *International Conference on Cooperative Information Systems*, pages 21–38. Springer, 2024.

[AMS+24] Manoli Albert, Antoni Mestre, Ronny Seiger, Victoria Torres, and Pedro Valderas. Sustainability in and through iot-enhanced business processes. In *Proceedings of the Best Dissertation Award, Doctoral Consortium, and Demonstration and Resources Forum at BPM 2024*, 2024.

[BAB+24] Jan vom Brocke, Wil Aalst, Nicholas Berente, Boudewijn Dongen, Thomas Grisold, Waldemar Kremser, Jan Mendling, Brian Pentland, Maximilian Roeglinger, Michael Rosemann, and Barbara Weber. Process science: the interdisciplinary study of socio-technical change. *Process Science*, 2, 07 2024.

[BDCR+23] Iris Beerepoot, Claudio Di Ciccio, Hajo A Reijers, Stefanie Rinderle-Ma, Wasana Bandara, Andrea Burattin, Diego Calvanese, Tianwa Chen, Izack Cohen, Benoît Depaire, et al. The biggest business process management problems to solve before we die. *Computers in Industry*, 146:103837, 2023.

[BKD+24] Andrea Burattin, Ekkart Kindler, Nicholas Dyhre, Sebastian Vestrup, Francesca Zerbato, and Barbara Weber. Process mining pipelines with controlled sharing of data and algorithms. In *International Conference on Business Process Management*, pages 357–369. Springer, 2024.

[BVJ+24] Irene Barba, Carmelo Del Valle, Andrés Jiménez-Ramírez, Barbara Weber, and Manfred Reichert. Discovering two-level business process models from user interface event logs. In Giancarlo Guizzardi, Flávia Maria Santoro, Haralambos Mouratidis, and Pnina Soffer, editors, *Advanced Information Systems Engineering - 36th International Conference, CAiSE 2024, Limassol, Cyprus, June 3-7, 2024, Proceedings*, volume 14663 of *Lecture Notes in Computer Science*, pages 456–472. Springer, 2024.

[CGM+24] Nan Cheng, Naman Gupta, Aikaterini Mitrokotsa, Hiraku Morita, and Kazunari Tozawa. Constant-round private decision tree evaluation for secret shared data. *Proc. Priv. Enhancing Technol.*, 2024(1):397–412, 2024.

[CMZH24] Nan Cheng, Aikaterini Mitrokotsa, Feng Zhang, and Frank Hartmann. Efficient two-party secure aggregation via incremental distributed point function. In *9th IEEE European Symposium on Security and Privacy, EuroS&P 2024, Vienna, Austria, July 8-12, 2024*, pages 810–827. IEEE, 2024.

[CÖM+24] Nan Cheng, Melek Önen, Aikaterini Mitrokotsa, Oubaïda Chouchane, Massimiliano Todisco, and Alberto Ibarrondo. Nomadic: Normalising maliciously-secure distance with cosine similarity for two-party biometric authentication. In Jianying Zhou, Tony Q. S. Quek, Debin Gao, and Alvaro A. Cárdenas, editors, *Proceedings of the 19th ACM Asia Conference on Computer and Communications Security, ASIA CCS 2024, Singapore, July 1-5, 2024*. ACM, 2024.

[DCWS22] Daniel Diethei, Ashley Colley, Julian Wienert, and Johannes Schöning. Different length, different needs: Qualitative analysis of threads in online health communities. In *2022 IEEE 10th International Conference on Healthcare Informatics (ICHI)*, pages 348–356. IEEE, 2022.

[DDH+24] Uddipana Dowerah, Subhranil Dutta, Frank Hartmann, Aikaterini Mitrokotsa, Sayantan Mukherjee, and Tapas Pal. Sacfe: Secure access control in functional encryption with unbounded data. In *9th IEEE European Symposium on Security and Privacy, EuroS&P 2024, Vienna, Austria, July 8-12, 2024*, pages 860–882. IEEE, 2024.

[DM24] Uddipana Dowerah and Aikaterini Mitrokotsa. Decentralized private stream aggregation from lattices. In Christina Pöpper and Lejla Batina, editors, *Applied Cryptography and Network Security - 22nd*

International Conference, ACNS 2024, Abu Dhabi, United Arab Emirates, March 5-8, 2024, Proceedings, Part II, volume 14584 of *Lecture Notes in Computer Science*, pages 189–214. Springer, 2024.

[FAAS+24] Marco Franceschetti, Amine Abbad-Andaloussi, Clemens Schreiber, Hugo A López, and Barbara Weber. Exploring the cognitive effects of ambiguity in process models. In *International Conference on Business Process Management*, pages 493–510. Springer, 2024.

[FBSW24] Marco Franceschetti, Dominik Manuel Buchegger, Ronny Seiger, and Barbara Weber. Event knowledge graphs with ambiguity, Oct 2024.

[FCDD+24] Fabrizio Fornari, Ivan Compagnucci, Massimo Callisto De Donato, Yannis Bertrand, Harry H Beyel, Emilio Carrión, Marco Franceschetti, Wolfgang Groher, Joscha Grüger, Emre Kilic, et al. Digital twins of business processes: A research manifesto. *Internet of Things*, page 101477, 2024.

[FSG+23] Marco Franceschetti, Ronny Seiger, Mauricio Jacobo González González, Enrique Garcia-Ceja, Luis Armando Rodríguez Flores, Luciano García-Bañuelos, and Barbara Weber. Proambition: Online process conformance checking with ambiguities driven by the internet of things. 2023.

[FSL+23] Marco Franceschetti, Ronny Seiger, Hugo A López, Andrea Burattin, Luciano García-Bañuelos, and Barbara Weber. A characterisation of ambiguity in bpm. In *International Conference on Conceptual Modeling*, pages 277–295. Springer, 2023.

[FSW23] Marco Franceschetti, Ronny Seiger, and Barbara Weber. An event-centric metamodel for iot-driven process monitoring and conformance checking. In *International Conference on Business Process Management*, pages 131–143. Springer, 2023.

[FSW24] Kathrin Figl, Pnina Soffer, and Barbara Weber. Guiding attention in flow-based conceptual models through consistent flow and pattern visibility. *Decision Support Systems*, 185:114292, 2024.

[GKSR23] Florian Gallik, Yusuf Kirikkayis, Ronny Seiger, and Manfred Reichert. An object-centric approach to handling concurrency in iot-aware processes. In *International Conference on Business Process Management*, pages 105–117. Springer, 2023.

[HNA+11] K. Holmqvist, M. Nyström, R. Andersson, R. Dewhurst, H. Jarodzka, and J. van de Weijer. *Eye Tracking: A comprehensive guide to methods and measures*. OUP Oxford, 2011.

[JDS+21] Christopher Martin Jones, Daniel Diethei, Johannes Schöning, Rehana Shrestha, Tina Jahnel, and Benjamin Schüz. Social reference cues can reduce misinformation sharing behaviour on social media. 2021.

[KAB+22] Neha Kumar, Julie Adams, Bill Buxton, Linda Candy, Pablo Cesar, Leigh Clark, Benjamin Cowan, Anind Dey, Phoebe Toups Dugas, Ernest Edmonds, Johannes Schöning, et al. From 1983 to 2022: A chronology of sigchi conferences. 2022.

[KGSR23] Yusuf Kirikkayis, Florian Gallik, Ronny Seiger, and Manfred Reichert. Integrating iot-driven events into business processes. In *International Conference on Advanced Information Systems Engineering*, pages 86–94. Springer, 2023.

[KS23] Annika Kaltenhauser and Johannes Schöning. Reawakening the ghosts from the past? accessibility lessons learned from second life. In *Workshop: Towards an Inclusive and Accessible Metaverse*, 2023.

[KSFW24] Aaron Friedrich Kurz, Ronny Seiger, Marco Franceschetti, and Barbara Weber. Activity and sequence detection evaluation metrics: A comprehensive tool for event log comparison. 2024.

[KSS24] Annika Kaltenhauser, Evropi Stefanidi, and Johannes Schöning. Playing with perspectives and unveiling the autoethnographic kaleidoscope in hci – a literature review of autoethnographies. In *Proceedings of the CHI Conference on Human Factors in Computing Systems*, CHI '24, page 1–20. ACM, May 2024.

[LWBP24] Kalle Lyytinen, Barbara Weber, Markus Becker, and Brian Pentland. Digital twins of organization: implications for organization design. *Journal of Organization Design*, 13:77–93, 2024.

[MCSW24] Silvia Miksch, Claudio Di Ciccio, Pnina Soffer, and Barbara Weber. Visual analytics meets process mining: Challenges and opportunities. *IEEE Computer Graphics and Applications*, 44(6):132–141, 2024.

[MMS+24] Aikaterini Mitrokotsa, Sayantan Mukherjee, Mahdi Sedaghat, Daniel Slamanig, and Jenit Tomy. Threshold structure-preserving signatures: Strong and adaptive security under standard assumptions. In Qiang Tang and Vanessa Teague, editors, *Public-Key Cryptography -*

PKC 2024 - 27th IACR International Conference on Practice and Theory of Public-Key Cryptography, Sydney, NSW, Australia, April 15-17, 2024, Proceedings, Part I, volume 14601 of *Lecture Notes in Computer Science*, pages 163–195. Springer, 2024.

[MSB+24] Jürgen Mangler, Ronny Seiger, Janik-Vasily Benzin, Joscha Grüger, Yusuf Kirikkayis, Florian Gallik, Lukas Malburg, Matthias Ehrendorfer, Yannis Bertrand, Marco Franceschetti, et al. From internet of things data to business processes: Challenges and a framework. *arXiv preprint arXiv:2405.08528*, 2024.

[PS23] Adrian Preussner and Johannes Schöning. Examining the role of" green apps" in fostering community engagement for sustainable hci. 2023.

[PvBR+24] Rüdiger Pryss, Jan vom Brocke, Manfred Reichert, Enrico Rukzio, Winfried Schlee, and Barbara Weber. Editorial: Application of neuroscience in information systems and software engineering. *Frontiers in Neuroscience*, 18, 2024.

[SAA24] Clemens Schreiber and Amine Abbad-Andaloussi. Structural process variety and standardization. In *2024 6th International Conference on Process Mining (ICPM)*, pages 153–160. IEEE, 2024.

[SAAW23] Clemens Schreiber, Amine Abbad-Andaloussi, and Barbara Weber. On the cognitive effects of abstraction and fragmentation in modularized process models. In *International Conference on Business Process Management*, pages 359–376. Springer, 2023.

[SAAW24] Clemens Schreiber, Amine Abbad-Andaloussi, and Barbara Weber. On the cognitive and behavioral effects of abstraction and fragmentation in modularized process models. *Information Systems*, 125:102424, 2024.

[SBKS22] Carolin Stellmacher, Michael Bonfert, Ernst Kruijff, and Johannes Schöning. Triggermuscle: Exploring weight perception for virtual reality through adaptive trigger resistance in a haptic vr controller. *Frontiers in Virtual Reality*, 2:173, 2022.

[Sch22] Johannes Schöning. The german research community: within acm sigchi 2010–2020. *Interactions*, 29(1):90–94, 2022.

[SDB+23] Evropi Stefanidi, Julia Dominiak, Marit Bentvelzen, Paweł W Woźniak, Johannes Schöning, Yvonne Rogers, and Jasmin Niess. Magibricks: Fostering intergenerational connectedness in distributed play with

smart toy bricks. In *Proceedings of the 22nd Annual ACM Interaction Design and Children Conference*, pages 239–252, 2023.

[Sei24] Ronny Seiger. Teaching computer science fundamentals to business students: A sotl experience report on how to increase student engagement via practical programming tasks and ai. In *Gemeinschaften in Neuen Medien (GeNeMe)*, 2024.

[SFAA24] Ronny Seiger, Marco Franceschetti, and Amine Abbad-Andaloussi. A process to non-invasively augment legacy iot systems using business processes and microservices. In *International Conference on the Internet of Things*, 2024.

[SFW23a] Ronny Seiger, Marco Franceschetti, and Barbara Weber. Data-driven generation of services for iot-based online activity detection. In *International Conference on Service-Oriented Computing*, pages 186–194. Springer, 2023.

[SFW23b] Ronny Seiger, Marco Franceschetti, and Barbara Weber. An interactive method for detection of process activity executions from iot data. *Future Internet*, 15(2):77, 2023.

[SKS22] Gian-Luca Savino, Ankit Kariryaa, and Johannes Schöning. Free as a bird, but at what cost? the impact of street networks on the user experience of as-the-crow-flies navigation for cyclists. *Proceedings of the ACM on Human-Computer Interaction*, 6(MHCI):1–24, 2022.

[SM24] Ronny Seiger and Lukas Malburg. Revision of a smart factory software architecture from monolith to microservices. In *International Conference on Enterprise Design, Operations, and Computing*, pages 203–220. Springer, 2024.

[SMW+24] Carolin Stellmacher, Florian Mathis, Yannick Weiss, Meagan B. Loerakker, Nadine Wagener, and Johannes Schöning. Exploring mobile devices as haptic interfaces for mixed reality. In *Proceedings of the CHI Conference on Human Factors in Computing Systems*, CHI '24, page 1–17. ACM, May 2024.

[SNS+24] Yu Sun, Luca Nivini, Gian-Luca Savino, Florian Mathis, and Johannes Schöning. Designing grocery shopping experiences for virtual reality. In *Proceedings of the 2024 International Conference on Advanced Visual Interfaces*, volume 1 of *AVI 2024*, page 1–5. ACM, June 2024.

[SPK+24] Carolin Stellmacher, Feri Irsanto Pujianto, Tanja Kojic, Jan-Niklas Voigt-Antons, and Johannes Schöning. Experiencing dynamic weight

changes in virtual reality through pseudo-haptics and vibrotactile feedback. In *Proceedings of the CHI Conference on Human Factors in Computing Systems*, CHI '24, page 1–13. ACM, May 2024.

[SRP+24] Ava Elizabeth Scott, Leon Reicherts, Aditya Kumar Purohit, Elahi Hossain, Evropi Stefanidi, Nadine Wagener, Johannes Schöning, Yvonne Rogers, and Adrian Holzer. Diy digital interventions: Behaviour change with trigger-action programming. *Proceedings of the ACM on Human-Computer Interaction*, 8(MHCI):1–28, September 2024.

[SRS24] Ava Elizabeth Scott, Leon Reicherts, and Evropi Stefanidi. Doing chi together: The benefits of a writing retreat for early-career hci researchers. *Interactions*, 31(3):8–9, May 2024.

[SSF+22] Evropi Stefanidi, Johannes Schöning, Sebastian S Feger, Paul Marshall, Yvonne Rogers, and Jasmin Niess. Designing for care ecosystems: a literature review of technologies for children with adhd. In *Interaction Design and Children*, pages 13–25, 2022.

[SSFS24] Tarek Skouti, Ronny Seiger, Frank J Furrer, and Susanne Strahringer. Rbpmn: the value of roles for business process modeling. *Software and Systems Modeling*, pages 1–32, 2024.

[SSGS24] Eve Schade, Gian-Luca Savino, Yasemin Gunal, and Johannes Schöning. Traffic jam by gps: A systematic analysis of the negative social externalities of large-scale navigation technologies. *PLOS ONE*, 19(8):e0308260, August 2024.

[SSH+23] Elizaveta Sorokina, Pnina Soffer, Irit Hadar, Uri Leron, Francesca Zerbato, and Barbara Weber. Pem4ppm: A cognitive perspective on the process of process mining. In *International Conference on Business Process Management*, pages 465–481. Springer, 2023.

[SSK+23] Yu Sun, Carolin Stellmacher, Annika Kaltenhauser, Nadine Wagener, Daniel Neumann, and Johannes Schöning. Alt text and alt sense in vr: Engaging screen reader users within the metaverse through multisenses. 2023.

[SSNS23] Eve Schade, Gian-Luca Savino, Jasmin Niess, and Johannes Schöning. Mapuncover: Fostering spatial exploration through gamification in mobile map apps. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*, pages 1–13, 2023.

[SSRN23] Evropi Stefanidi, Johannes Schöning, Yvonne Rogers, and Jasmin Niess. Children with adhd and their care ecosystem: Designing beyond symptoms. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*, pages 1–17, 2023.

[STSS22] Carolin Stellmacher, Jette Ternieten, Daria Soroko, and Johannes Schöning. Escaping the privacy paradox: Evaluating the learning effects of privacy policies with serious games. *Proceedings of the ACM on Human-Computer Interaction*, 6(CHI PLAY):1–20, 2022.

[SWA+24] Evropi Stefanidi, Nadine Wagener, Dustin Augsten, Andy Augsten, Leon Reicherts, Paweł W. Woźniak, Johannes Schöning, Yvonne Rogers, and Jasmin Niess. Teenworlds: Supporting emotional expression for teenagers with their parents and peers through a collaborative vr experience. In *30th ACM Symposium on Virtual Reality Software and Technology*, volume 27 of *VRST '24*, page 1–14. ACM, October 2024.

[SWS24] Gian-Luca Savino, Jana Wahls, and Johannes Schöning. Mobile map applications for foldable devices. In *Proceedings of the 2024 International Conference on Advanced Visual Interfaces*, AVI 2024, page 1–5. ACM, June 2024.

[SZN+23] Carolin Stellmacher, André Zenner, Oscar Javier Ariza Nunez, Ernst Kruijff, and Johannes Schöning. Continuous vr weight illusion by combining adaptive trigger resistance and control-display ratio manipulation. In *2023 IEEE Conference Virtual Reality and 3D User Interfaces (VR)*, pages 243–253. IEEE, 2023.

[SZvZvdA24] Daniel Schuster, Francesca Zerbato, Sebastiaan J van Zelst, and Wil MP van der Aalst. Defining and visualizing process execution variants from partially ordered event data. *Information Sciences*, 657:119958, 2024.

[TAAL23] Dung My Thi Trinh, Amine Abbad-Andaloussi, and Hugo A López. On the semantic transparency of declarative process models: The case of constraints. In *International Conference on Cooperative Information Systems*, pages 217–236. Springer, 2023.

[TAATLA23] Lucien Kiven Tamo, Amine Abbad-Andaloussi, Dung My Thi Trinh, and Hugo-Andrés López-Acosta. An open-source modeling editor for declarative process models. In *International Conference on Cooperative Information Systems 2023*, 2023.

[VCP+23] Johannes Villmow, Viola Campos, Jean Petry, Amine Abbad-Andaloussi, Adrian Ulges, and Barbara Weber. How well can masked language models spot identifiers that violate naming guidelines? In *2023 IEEE 23rd International Working Conference on Source Code Analysis and Manipulation (SCAM)*, pages 131–142. IEEE, 2023.

[VHKO24] Hagen Völzer, Daniel Horn, Yusik Kim, and Greger Ottosson. A benchmark for rule induction in automated business decisions. In Sabrina Kirrane, Mantas Simkus, Ahmet Soylu, and Dumitru Roman, editors, *Rules and Reasoning - 8th International Joint Conference, RuleML+RR 2024, Bucharest, Romania, September 16-18, 2024, Proceedings*, volume 15183 of *Lecture Notes in Computer Science*, pages 159–175. Springer, 2024.

[VZSW23] Hagen Völzer, Francesca Zerbato, Timothy Sulzer, and Barbara Weber. A fresh approach to analyze process outcomes. In *2023 5th International Conference on Process Mining (ICPM)*, pages 97–104. IEEE, 2023.

[WAAF+24] Barbara Weber, Amine Abbad-Andaloussi, Marco Franceschetti, Ronny Seiger, Hagen Völzer, and Francesca Zerbato. Leveraging digital trace data to investigate and support human-centered work processes. In Hermann Kaindl, Mike Mannion, and Leszek A. Maciaszek, editors, *Evaluation of Novel Approaches to Software Engineering*, pages 1–23, Cham, 2024. Springer Nature Switzerland.

[WAS+22] Nadine Wagener, Alex Ackermann, Gian-Luca Savino, Bastian Dänekas, Jasmin Niess, and Johannes Schöning. Influence of passive haptic and auditory feedback on presence and mindfulness in virtual reality environments. In *Proceedings of the 2022 International Conference on Multimodal Interaction*, pages 558–569, 2022.

[WKR+24] Nadine Wagener, Arne Kiesewetter, Leon Reicherts, Paweł W. Woźniak, Johannes Schöning, Yvonne Rogers, and Jasmin Niess. Moodshaper: A virtual reality experience to support managing negative emotions. In *Designing Interactive Systems Conference*, volume 24 of *DIS '24*, page 2286–2304. ACM, July 2024.

[WNRS22] Nadine Wagener, Jasmin Niess, Yvonne Rogers, and Johannes Schöning. Mood worlds: A virtual environment for autonomous emotional expression. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems*, pages 1–16, 2022.

[WSRN23] Nadine Wagener, Johannes Schoning, Yvonne Rogers, and Jasmin Niess. Letting it go: Four design concepts to support emotion regulation in virtual reality. In *2023 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW)*, pages 763–764. IEEE, 2023.

[ZBV+23] Francesca Zerbato, Andrea Burattin, Hagen Völzer, Paul Nelson Becker, Elia Boscaini, and Barbara Weber. Supporting provenance and data awareness in exploratory process mining. In *International Conference on Advanced Information Systems Engineering*, pages 454–470. Springer, 2023.

[ZFW24] Francesca Zerbato, Marco Franceschetti, and Barbara Weber. A framework to support the validation of process mining inquiries. In *International Conference on Business Process Management*, pages 249–266. Springer, 2024.

[Zim24a] Lisa Zimmermann. The process mining question forge. In *Proceedings of the Best Dissertation Award, Doctoral Consortium, and Demonstration and Resources Forum at BPM 2024*, 2024.

[Zim24b] Lisa Zimmermann. Understanding and supporting process mining analyses at the individual level. In *Proceedings of the Best Dissertation Award, Doctoral Consortium, and Demonstration and Resources Forum at BPM 2024*, 2024.

[ZKCS23] Conrad Zeidler, Lennart Kuhr, Jordan Callaham, and Johannes Schöning. Mobile plant health visualizer based on si-ndvi imaging and augmented reality visualization for space greenhouses. 2023.

[ZKW+23] Conrad Zeidler, Matthias Klug, Gerrit Woeckner, Urte Clausen, and Johannes Schöning. Archie 2: An augmented reality interface with plant detection for future planetary surface greenhouses. In *2023 IEEE International Symposium on Mixed and Augmented Reality (ISMAR)*, pages 601–610. IEEE, 2023.

[ZRB+22] Nima Zargham, Leon Reicherts, Michael Bonfert, Sarah Theres Völkel, Johannes Schöning, Rainer Malaka, and Yvonne Rogers. Understanding circumstances for desirable proactive behaviour of voice assistants: The proactivity dilemma. In *Proceedings of the 4th Conference on Conversational User Interfaces*, pages 1–14, 2022.

[ZZVW23] Francesca Zerbato, Lisa Zimmermann, Hagen Völzer, and Barbara Weber. Promise: Process mining support for end-users. In *CAiSE Research Projects Exhibition*, pages 60–67, 2023.

[ZZW+23a] Hui Zhou, Francesca Zerbato, Barbara Weber, Marta Indulska, and Shazia Sadiq. Do process analysts care about the metadata of event logs? In *ACIS 2023 Proceedings*, 2023.

[ZZW23b] Lisa Zimmermann, Francesca Zerbato, and Barbara Weber. What makes life for process mining analysts difficult? a reflection of challenges. *Software and Systems Modeling*, pages 1–29, 2023.

[ZZW24] Lisa Zimmermann, Francesca Zerbato, and Barbara Weber. What makes life for process mining analysts difficult? a reflection of challenges. *Software and Systems Modeling*, 23(6):1345–1373, 2024.