INF Annual Report 2017/2018
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7 Administration
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Board of directors
Prof. Dr. Torsten Braun; Prof. Dr. Paolo Favaro; Prof. Dr. Gerhard Jäger; Prof. Dr. Oscar Nierstrasz

Managing director
Prof. Dr. Oscar Nierstrasz

Director of studies
Prof. Dr. Paolo Favaro
Administration
Bettina Choffat; Dragana Esser; Daniela Schroth

Technical staff
Dr. Peppo Brambilla; Tiziano Portenier
2. Teaching Activities

2.1 Courses for Major and Minor in Computer Science

Autumn Semester 2017

- Bachelor 1st Semester
  
  Einführung in die Informatik (Die Dozenten der Informatik, 5 ECTS)
  
  Grundlagen der Technischen Informatik (T. Studer, 5 ECTS)
  
  Programmierung 1 (T. Studer, 5 ECTS)

- Bachelor 3rd Semester
  
  Diskrete Mathematik und Logik (G. Jäger, 5 ECTS)
  
  Computernetze (T. Braun, 5 ECTS)
  
  Einführung in Software Engineering (O. Nierstrasz, 5 ECTS)

- Bachelor 5th Semester
  
  Computergrafik (P. Berholet, 5 ECTS)
  
  Mensch-Maschine-Schnittstelle (K. Riesen, 5 ECTS)
  
  Machine Learning (P. Favaro, 5 ECTS)
  
  Anleitung zu wissenschaftlichen Arbeiten (Die Dozenten der Informatik, 5 ECTS)

- Master Courses
  
  Concurrency: State Models and Design Patterns (O. Nierstrasz, 5 ECTS)
  
  Internet of Things (T. Braun, 5 ECTS)
  
  Description Logic (T. Studer, 5 ECTS)
Structural Pattern Recognition (K. Riesen, 5 ECTS)
Computer Vision (P. Favaro, 5 ECTS)
Working Group: Operations, Sets, and Types (G. Jäger, 5 ECTS)
Seminar: Software Composition (O. Nierstrasz, 5 ECTS)
Seminar: Communication and Distributed Systems (T. Braun, 5 ECTS)
Seminar: Computer Vision (P. Favaro, 5 ECTS)
Seminar: Logic and Theoretical Computer Science (G. Jäger, 5 ECTS)
Graduate Seminar Logik und Information (G. Jäger, G. Metcalfe, K. Stoffel, U. Ultes-Nitsche)

- Service Courses

  Anwendungssoftware (M. Marti, 3 ECTS)

Spring Semester 2018

- Bachelor 2nd Semester

  Datenbanken (S. Bucheli, 5 ECTS)
  Datenstrukturen und Algorithmen (P. Brambilla, 5 ECTS)
  Computer Architecture (P. Favaro, 5 ECTS)
  Programmierung 2 (O. Nierstrasz, 5 ECTS)

- Bachelor 4th Semester

  Praktikum in Software Engineering (T. Staub, 5 ECTS)
  Betriebssysteme (T. Braun, 5 ECTS)
  Berechenbarkeit und Komplexität (J. Walker, 5 ECTS)
  Automaten und formale Sprachen (G. Jäger, 5 ECTS)
2. Teaching Activities

- Bachelor 6th Semester
  Anleitung zu wissenschaftlichen Arbeiten (5 ECTS)

- Master Courses
  Programming Languages (O. Nierstrasz, 5 ECTS)
  Mobile Communications (T. Braun, 5 ECTS)
  Advanced Topics in Machine Learning (P. Favaro, 5 ECTS)
  Working Group: Operations, Sets and Types (G. Jäger, 5 ECTS)
  Seminar: Software Composition (O. Nierstrasz, 5 ECTS)
  Seminar: Communication and Distributed Systems (T. Braun, 5 ECTS)
  Seminar: Computer Vision (P. Favaro, 5 ECTS)
  Seminar: Logic and Theoretical Computer Science (G. Jäger, 5 ECTS)
  Graduate Seminar Logik und Information (G. Jäger, G. Metcalfe, K. Stoffel, U. Ultes-Nitsche)

- Service Courses
  Anwendungssoftware (J. Walker, 3 ECTS)

2.2 Students

- Major Subject Students: AS 2017: 226, SS 2018: 214
- Ph.D. Candidates: AS 2017: 30, SS 2018: 32

2.3 Degrees and Examinations

- PhD: 8
- Master: 18
- Bachelor: 18
• Completion of Minor Studies: 24 (90E:0, 60E:4, 30E:9, 15E:11, 675 ECTS)
• Semester Examinations AS 2017: 724 (2554 ECTS)
• Bachelor's/Master's Theses AS 2017: 18 (360 ECTS)
• Semester Examinations SS 2018: 462 (1755 ECTS)
• Bachelor's/Masters Theses SS 2018: 24 (440 ECTS)

2.4 Activities
• Contribution to “Schweizer Jugend Forscht”, Bern, September 10-16, 2017
• Contribution to the “National Future Day for Girls”, Bern, November 9, 2017
• Contribution to the “Bachelor Infotage”, December 6 and 7, 2017
• Contribution to the “Master Infotage”, March 7, 2018
• Taster course for female students, Bern, March 22, 2018
• Visitor Program, Gymnasium Thun, Bern, July 4, 2018

2.5 Awards
• Alumni Award PhD INF for “Contributions to Intuitionistic Epistemic Logic”, by Michel Marti
• Alumni Award Master INF for “From Cartoons to Real Images – An Approach to Unsupervised Visual Representation Learning”, by Simon Jenni
• Alumni Award Bachelor INF for “Machine Learning for Indoor Positioning”, by Joel Niklaus
• Faculty Prize (INF, Masterarbeit) for “Nullable Method Detection — Inferring Method Nullability From API Usage” by Manuel Leuenberger
3 Communication and Distributed Systems Group

3.1 Personnel

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* with financial support from a third party

3.2 Overview
The research group “Communication and Distributed Systems” has been investigating how multimedia applications and cloud computing services with high demands on the quality, reliability and energy efficiency can be supported by mobile communication systems and networks. Moreover, we are investigating localization mechanisms for wireless devices and new Future Internet paradigms such as Information-Centric Networking (ICN). We are also working on mobility and trajectory prediction of mobile users and vehicles using advanced machine learning mechanisms.

3.3 Research Projects
SwissSenseSynergy
The SwissSenseSynergy project established a synergistic platform that consists of a testbed, based on mobile crowd-sensing and Internet of Things, a data model for representing the various types of collected data, and a machine learning-driven real-time localization and mobility prediction engine for producing insights. By end of March 2018, the SwissSenseSynergy project concluded successfully with all the proposed ideas and system components implemented and validated. Research activities have been conducted in four sub-projects, and integration efforts were made to combine all the sub-projects into one integrated, secure and privacy-preserving synergistic crowd-sensing framework.

The CDS group was leading the sub-project of “mobility, localization and tracking”, in which our tasks are indoor localization/tracking, and mobility
3. Communication and Distributed Systems Group

prediction. We first apply individual and ensemble machine learning algorithms to derive the correlation between smartphones’ received sensor values and their indoor locations. Our real-world experiment results show that the Voting ensemble predictor outperforms individual predictors and it achieves the best indoor room recognition accuracy of 94% in office-like indoor environments [Zhao et al., 2018e]. We further developed an efficient ensemble learning method to provide room level localization in smart buildings. Our proposed method achieves high room-level localization accuracy by combining Hidden Markov Models with simple discriminative learning methods. Experimental results show that our system can overcome traditional individual machine learning and ensemble learning approaches [Carrera et al., 2018b]. Thanks to the accurate room recognitions, we use the detected room to further improve our indoor positioning system. We then integrate room detection and an enhanced ranging model to achieve high and stable indoor positioning performance. Experiment results in an office-like indoor environment show that our system outperforms traditional localization approaches considering stability and accuracy. The localization method can achieve performance with an average localization error of 1.26 m [Carrera et al., 2018a]. Moreover, we have designed a positioning system using narrowband signals, particularly ZigBee signals, based on an enhanced fingerprinting algorithm by fusing received signal strength (RSS) and time information. We designed a feature-based fusion approach to fuse and standardize time and RSS fingerprints, and adopt a random forest regression model to design an enhanced pattern matching algorithm for fingerprinting. Experimental results show that the system achieves a mean positioning accuracy of 1.61 m, which represents a 36.1% improvement over traditional RSS-based fingerprinting [Li et al., 2018a].

In the task of mobility prediction, our goal is to predict the future locations and trajectories of mobile users or vehicles based on their historical and current context, such as GPS locations, frequency and duration of visiting a place, and smart-phone system information, such as WLAN connections, movement acceleration, running applications, etc. In [Zhao et al., 2018b], we modelled the location and trajectory prediction problem as a supervised learning task and proposed to use ensemble learning methods with hybrid features to solve it. We characterized the properties of users’ visited locations and movement patterns and then extracted feature types (temporal, spatial, and system) to quantify the correlation between locations and features. Finally, we applied ensemble methods to predict users’ future locations with extracted features. Moreover, we designed an adaptive Markov Chain model to predict users’ trajectories.
between two locations. We used a real-life dataset from the Nokia Mobile Data Challenge to validate the system performance, and experimental results unveil interesting findings: (1) For individual predictors, Bayes Networks outperform all others when data quality is good, while J48 delivers the best results when data quality is bad; (2) Ensemble predictors outperform individual predictors in general under all conditions; and (3) Ensemble predictor performance depends on the user movement patterns. To further validate the effectiveness of our mobility prediction approach, we applied our prediction algorithm to vehicle location prediction scenarios by collaborating with another partner. We designed a multi-tier caching mechanism with an over-the-top (OTT) content popularity estimation scheme to forecast the content request distribution. We implemented a learning-based algorithm to proactively prefetch the user content to VANET edge caching at RSUs. We implemented a prototype using Raspberry Pi emulating RSU nodes to prove the system functionality. Extensive experiment results prove that the system can bring benefits for both end users and OTT service providers, which help them to optimize network resource utilization and reduce bandwidth consumption [Zhao et al., 2018a]. To further make our system resistant to traces with different qualities, we proposed a hybrid Markov model that constantly adapts to available user trace quality to select either the first order or the second order Markov chain. Compared to existing solutions, our model is adaptive to discrete gaps in data trace. In addition, we implemented a proper mechanism to predict congestion in city areas. To help us understanding complex user behaviors, we have also proposed a technique benefiting from both temporal and spatial parameters to extract Zone of Interests (ZOIs). Intuitively, a ZOI is a city area that a user visits frequently and the user spends considerable time in this region. Evaluation results show that the system can achieve a satisfactory user future location prediction accuracy of 70-84% and area congestion prediction accuracy of 65-73% for the vehicles [Karimzadeh et al., 2018b]. In addition to our own individual research progress, the CDS group has collaborated with other project partners. In [Luceri et al., 2018a], we have successfully integrated our indoor positioning system with the works of the other project partners and developed a secure, privacy-preserving and real-time crowd-sensing framework for the Internet of Things applications.

Social influence is recognized as a key factor that governs human behavior. It indicates the attitude of certain individuals to be affected by other subjects’ actions and decisions. The understanding of how influence propagates among subjects in a social network opens the way to a growing number of applications. Many efforts have been made to quantitatively
measure the influence probability between pairs of subjects. Existing approaches have two main drawbacks: 1) they assume that the influence probabilities are independent of each other, 2) they do not consider the actions not performed by the subject (but performed by her/his friends) to learn these probabilities.

We proposed to address these limitations by employing a deep learning approach [Luceri et al., 2018b]. We introduced a Deep Neural Network (DNN) framework that has the capability for both modeling social influence and for predicting human behavior. To empirically validate the proposed framework, we conducted experiments on real-life datasets from event-based and location-based social networks. Results indicate that our approach outperforms existing solutions, by efficiently resolving the limitations previously described. Moreover, we investigated the trade-off between performance and scalability of the proposed framework. In particular, we introduced three approaches by considering different network structures at varying granularity: ego networks, communities, and the entire social network. We showed that the whole social network achieves better performance but it needs more computational effort if compared to the ego networks approach, which in turn achieves lower performance. Finally, communities approach closely approach the performance of the entire social network scenario while requiring less computational effort.

To extend and validate our approach on different scenarios, we consider to collect data from a large number of individuals’ portable sensing devices, such as smartphones. However, collecting such crowd-sensed data for research is not simple; contributors need to be actively enrolled in a campaign, and thus issues related to device heterogeneity, security, and privacy need to be considered. To this aim, we implemented VIVO [Luceri et al., 2018a], an open framework for crowd-sensed big data gathering, where security and privacy are managed within the framework at the client side. VIVO allows to collect social, physical, and environmental information, and thus, opens the way to multiple application scenarios.

**Research staff:** J. Carrera, M. Karimzadeh, L. Luceri, Z. Zhao, T. Braun.

**Financial support:** Swiss National Science Foundation Sinergia project number 154458

**Context Awareness Engine**

The Context Awareness Engine project funded by Orange focuses on exploring network context awareness in order to discover, reason, and pre-
dict situations (context sensing) by appropriate computation and information modelling based on collected network data in nearly real-time from various data sources (network nodes, devices, applications). The purpose is to propose recommendations or request actions (context awareness) using advanced machine learning algorithms. We aim to find insights from observed phenomena and infer the root causes, such that future situation prediction can be achieved and further exploited to optimize network performance. The project is broken into 2 phases: Phase 1 includes use case definition (WP1) and functional architecture definition (WP2). Phase 2 includes implementation architecture definition (WP3) and software development and demonstration (WP4).

By the end of July 2018, the CDS group has successfully delivered the first project deliverable. The goal of the first deliverable is to find insights from observed phenomena and infer the Root Causes (RCs) so that the future situation prediction can be achieved and exploited using input provided by relevant customers (internal Orange Core Networks (CNs), operations-administration-management, applications, external platforms, etc.). This will allow us to guide network behaviours and optimize the network performance. The purpose of the first deliverable is to define and provide a Proof of Concept (PoC) related to the Context Sensing and Awareness Engine (CSAE). The first deliverable provides the results of the architecture design and use cases definition that have been proposed within project proposal (WP1). A general 5G-compatible architecture has been proposed, and concrete use cases have been defined. Currently, the CDS group is working closely with Orange to define the functional architecture of the project to analyze key issues of context sensing and awareness engine. We have proposed concrete system components and machine learning algorithms that might be used for the project implementation.

**Research staff:** Z. Zhao, E. Schiller, T. Braun.

**Financial support:** Orange Research Contract Number H09194

**Testbeds**

The CDS group possesses a cloud infrastructure based on Dell Power Edge Servers. We have four machines R320, R520, and 2xR530 supporting 164 parallel threads (82 cores) and 640 GB RAM. Moreover, two external storage Dell PowerVault md3800i provides disk space of 20.6 TB in Raid 5 and Raid 6. The network backbone is based on Dell N4032 switches with 48x10 GbE-T ports and 80 Gb/s backbone connection. The
3. Communication and Distributed Systems Group

infrastructure supports the following services perfectly integrated with the Lightweight Directory Access Protocol (LDAP) of the institute.

- Mirantis OpenStack 8.0 (IaaS research cloud)
- OwnCloud (shared storage)
- Wiki (information dissemination)
- Etherpad (collaborative real-time editor)
- SVN (collaborative version management system)

For collaborative administration and monitoring, we use:

- Teampass (password management system)
- Nagios (monitoring)

CDS owns an IoT testbed of 40 MEMSIC Telsob nodes deployed in the building of the Institute of Computer Science of the University of Bern. We have extended the IoT testbed with SDN functions to evaluate various types of SDN-based WSN applications and to enhance their performance. The testbed consists of the following sensor nodes:

- 40 TelosB by Crossbow (now Willow)
  - Texas Instruments 16 bit microprocessor (TI MSP 430)
  - 802.15.4 radio interface
  - Fixed Power Supply via the USB Interface
  - Temperature, humidity and light sensor
  - 1 MB external flash

- 7 MSB-430 Sensor Nodes
  - Texas Instruments 16 bit microprocessor (TI MSP 430)
  - CC1020 radio interface
  - Temperature, humidity and acceleration sensor
  - SD memory interface

The CDS testbed hence consists of 47 sensor nodes. The network spans across 4 floors of one building of the Institute of Computer Science of the University of Bern. The 7 MSB430 nodes are placed indoors, in rooms or corridors of the building, and one node is an outdoor node placed on the top window sill of the small tower.
Popularity-based Caching for Network Coding enabled Named Data Networking

PopNetCod (Popularity-based caching policy for Network Coding enabled Named Data Networking) [Saltarin et al., 2018] is a distributed caching policy, in which each router measures the local popularity of the content objects by analyzing the Interests that it receives. It then uses this information to decide which Data packets to cache or evict from its content store [Saltarin et al., 2018]. Since network coding is used, partial caching of content objects is supported, which facilitates the management of the content store. The routers decide the Data packets that they cache or evict when they receive Interests for Data packets. Since the first routers to take a decision are the ones closer to the clients, the most popular Data packets are cached at the network edges. The evaluation of PopNetCod shows an improved cache-hit rate compared to the widely used Leave Copy Everywhere placement policy and the Least Recently Used eviction policy. The improved cache-hit rate helps the clients to achieve higher goodput, while it also reduces the load on the source servers. In future work, PopNetCod could be extended to improve video streaming, by considering features related to adaptive video streaming, like popular video representations and the adaptation policies used by the video streaming clients [Saltarin et al., 2018].

Research staff: J. Saltarin, T. Braun.

Financial support: Swiss National Science Foundation project number 149225

Bloom Filter-based Content Discovery for Information-Centric Networks

During the considered period of this report, we aimed at comparing the performance of our previously proposed BFR routing protocol with other Bloom Filter (BF)-based routing protocols for Information-Centric Networks (ICNs). Further, we studied BF-based routing with large content universes and we proposed pull-based BFR as a new routing protocol for ICN with large content universe.

To comparatively analyze BFR with other BF-based routing protocols, we compared the performance of BFR with COntent-driven, Bloom filter-based intra-domain Routing Algorithm (COBRA). We described that BFR is a proactive routing protocol that works based on BF-based
content advertisements, while COBRA is a reactive routing protocol that uses Stable Bloom Filters (SBFs) to store the route traces left from already retrieved content objects for routing. We showed that COBRA requires significantly more memory space for storing route traces in SBFs compared to BFR that stores content advertisements in BFs. Therefore, BFR is a more appropriate routing protocol for IoT scenarios that use devices with constrained capacity. We also showed that BFR outperforms COBRA in terms of average round-trip delay, normalized communication overhead, total Interest communication overhead, and mean hit distance [Marandi et al., 2018].

To study BF-based routing with large content universes, we showed that the required communication and storage overhead for propagating and storing BFR content advertisements linearly grows with content universe size, i.e., the number of provided file names, because BFR advertises all the provided file names. To deal with this problem, we proposed pull-based BFR that permits servers to only advertise the requested file names rather than all the file names. We used BFs to inform the servers about the available requests in the network and we proposed BF aggregation strategies to further decrease the required communication overhead for propagating content advertisements. We conducted experiments in the ndnSIM environment and we showed that pull-based BFR outperforms BFR in terms of average roundtrip delay, the required communication overhead for content advertisements, the required memory space for storing content advertisements, and the impact of false positive errors on routing. We also compared pull-based BFR with a flooding-assisted routing protocol and we showed that pull-based BFR performs better in terms of average round-trip delay, in particular when the bandwidth resources is scarce [Marandi et al., 2019].

Research staff: A. Marandi, T. Braun.

Financial support: Swiss National Science Foundation project number 149225

Service-Centric Networking

In ICN, the content is the main building block of the architectural design. However, the ICN paradigm does not consider service support in its design. We believe that the future Internet will be more and more
service-oriented, which requires a service-oriented future Internet architecture. Service-Centric Networking (SCN) is a future Internet architecture paradigm derived from ICN. SCN extends the ICN approach by integrating service support. Our research focusses on SCN requirements such as load-balancing and session support. Based on Named Data Link State Routing Protocol (NLSR), we have designed and evaluated an SCN intra-domain routing architecture named IaDRA-SCN [Gasparyan et al., 2018]. NLSR is a link-state routing protocol for ICN. We have extended ICN and NLSR with the ability to support services. We have extended our designed SCN session support mechanism with fault-tolerance capabilities. We have designed and evaluated three distinct strategies to recover from node and link failures. The first mechanism uses Bloom filters for session identifier propagation, the second mechanism is based on service provider identifier propagation, and the third mechanism uses a piggybacking technique for provider identifier propagation.

We built the L-SCN (Layered-SCN) architecture to support services over CCN. L-SCN uses a two-layer forwarding scheme combined of nodes and Bloom filters. L-SCN aims to minimize protocol overhead and maximize the shared information about services and resources available in the network. We have extended the existing NDN implementation in ndnSIM with new data structures and forwarding techniques. The default CCN routing mechanism was not changed. Therefore, traditional CCN traffic can be forwarded as usual. We have implemented and evaluated our design in ndnSIM by comparing its processing time performance against available forwarding strategies in ndnSIM. The results show that our architecture outperforms the three existing strategies in ndnSIM, which are the Best Route, Multicast, and Random forwarding strategies.

**Research staff:** M. Gasparyan, T. Braun.

**Financial support:** Swiss National Science Foundation Project No. 146376

**Vehicular Ad Hoc Networks (VANETs)**

VANET characteristics include unpredictable vehicle location and high mobility. This leads to intermittent connectivity between nodes, since the path between source and destination nodes changes in an unexpected way. VANETs applications should meet their Quality of Service (QoS) requirements to be deployed in vehicles. Thus, in the CONtext and conTent Aware
Communications for QoS support in VANETs (CONTACT) project, we investigate how to achieve the QoS requirements in VANETs applications by combining three paradigms: Named Data Networking (NDN), Floating Content (FC) and Software Defined Networking (SDN).

To make opportunistic communication between vehicles available, we enable the Vehicle to Vehicle (V2V) communication by addressing content via name, and exploit different changing routes that are established between vehicles. To define paths for content retrieval we either let the vehicles decide for themselves where the request for content should be sent, or we use available infrastructure that exists in the road. By using V2V and/or Vehicle to Infrastructure (V2I) communication we develop paths between source and destination in a VANET. We study the delay that each path provides and establish three different techniques for path selection. Moreover, we develop three different content retrieval techniques based on the infrastructure available in the area. First, we use V2V communication to retrieve messages and we develop iMMM-VNDN (improved Multihop Multipath and Multichannel NDN for VANETs routing protocol) [Kalogeiton et al., 2018a]. Then we use infrastructure, i.e. Road Side Units (RSUs) and we develop a centralized routing protocol to forward all traffic through the RSUs [Kalogeiton et al., 2018b]. Finally, we study a combination of V2V and V2I communication and we create a hybrid routing protocol, where we use available infrastructure as a back-up mechanism for content retrieval when a vehicle does not have any available information about the content's location [Kalogeiton et al., 2018b]. Our results indicate that the centralized protocol creates a bottleneck around the RSUs and thus is not ideal for a VANET environment. In contrast, iMMM-VNDN and the hybrid routing protocol retrieve more content faster than other state of the art and established routing protocols.

Please note that content V2V exchange is location-based (i.e., the information broadcast is interested within a limited area). In this context, of main interest is opportunistic communication model such as FC that geographically constrain vehicles content exchange. Our primary results, concerning the dimensioning of the communication area, show a significant improvement to the State-of-The-Art in terms of resource usage and content storage.

The significant node mobility together with the unreliability of wireless communications make it very challenging to achieve high communication performance in VANETs. Several problems arise in this context and shall be addressed. We investigated such problems and have proposed efficient solutions to overcome their effects including degradation of communica-
tion performance due to source mobility [Duarte et al., 2017a], and low vehicle densities [Duarte et al., 2017b], in addition to our previous works on receiver mobility. We have also integrated all our proposed solutions in a single framework [Duarte et al., 2018] to improve VANET communication performance in highly mobile, complex, and realistic traffic scenarios.

Research staff: E. Kalogeiton, J. Duarte, T. Braun.

Financial support: Swiss National Science Foundation Project No. 146376

Mobile Edge Computing

CDS-MEC [Schiller et al., 2018] is one of the first open-source Network Function Virtualization (NFV)/Software Defined Networking (SDN)-based Mobile Edge Computing (MEC) platforms. Our platform solves the Mobile Edge (ME) management issues with respect to Application (App) provisioning and traffic management. ME Apps are managed as Virtual Network Functions (VNFs) on top of the virtual environment through the Juju VNF Manager (VNFM). We developed an SDN controller to manage traffic on the ME System. Unlike other relevant architectures of ME systems, we use the control plane, i.e., S1 interface, to derive appropriate states for traffic management. We run three use-cases: ME caching, Information Centric (ICN)/Delay Tolerant (DTN) Public Safety communication (PS), and Dynamic Adaptive Streaming over HTTP (DASH)-based video streaming. The MEC caching framework displays improved user Quality of Experience, e.g., latency, in comparison to direct communication, the PS solution provides a residual mean of communication for rescue teams, when the network core (EPC) and a Public Data Network (PDN) are unavailable. The MEC-assisted video delivery improves the video qualities delivered to the mobile video consumer, e.g., representations, buffer fill level.

Research staff: E. Schiller, T. Braun.

Financial support: Context Awareness Engine Orange Research Contract No: H09194

Intelligent Transportations Systems (ITS)

ITS integrates advanced sensing, processing and communication technologies and derive services to improve the vehicles’ mobility as well as
the safety, and comfort of drivers and passengers. In this research topic, we focus on the development of services to improve the mobility and the public safety.

To improve the mobility, we extract knowledge about traffic conditions from the information provided by the vehicles using vehicular networking. Thus, based on this knowledge we can recommend fastest routes to the vehicles. We study data dissemination protocols and network approaches to provide the information about traffic mobility properly and routing algorithms in graphs to recommend better routes to each vehicle [Souza et al., 2018]. On the other hand, to improve the public safety we extract knowledge about criminal activities over the city to identify risky areas. In this way, we can also recommend alternative routes to avoid dangerous neighborhoods and risky areas, while dealing with mobility issues. We use machine learning techniques for estimating and forecasting risky areas and also optimization techniques for multi-objective routing algorithms.

Our early results have shown substantial improvements concerning traffic mobility and public safety compared to State-of-The-Art approaches.

Research staff: A. M. Souza, T. Braun.

3.4 Ph.D. Theses

- João Duarte “Mobility Support in Vehicular Named-Data Networking” (Joint-supervision doctorate), January, 2018
- Jonnahtan Saltarin “Network Coding Enabled Named Data Networking Architectures”, November, 2017

3.5 Master’s Theses


3.6 Bachelor’s Theses

- Remo Roethlisberger “Video Delivery with Multi-Access Edge Computing”, May, 2018
- Dominic Kohler “Predicting future locations of mobile users using hybrid features”, February, 2018
• Joel Niklaus “Machine Learning for Indoor Positioning”, November, 2017

3.7 Further Activities

Memberships

Torsten Braun

• Erweitertes Leitungsgremium Fachgruppe “Kommunikation und Verteilte Systeme”, Gesellschaft für Informatik

• SWITCH Stiftungsrat

• SWITCH Stiftungsratsausschuss

• Vice President of SWITCH foundation

• Kuratorium Fritz-Kutter-Fonds

• Expert for Bachelor Theses at Fachhochschule Bern

• Expert for Diploma and Matura Exams at Gymnasium Burgdorf, Hofwil, Langenthal

• Management committee member of COST Action IC1303 Algorithms, Architectures and Platforms for Enhanced Living Environments (AAPELE)

• Management committee member of COST Action CA15127 Resilient communication services protecting end-user applications from disaster-based failures (RECODIS)

• Management committee substitute member of the COST Action CA15104 Inclusive Radio Communication Networks for 5G and beyond (IRACON)

• Chair of thesis award committee of GI-KuVS
3. Communication and Distributed Systems Group

Editorial Boards

Torsten Braun

- Editorial Board Member of Informatik Spektrum, Springer
- Editorial Board Member of MDPI (Multidisciplinary Digital Publishing Institute) Journal of Sensor and Actuator Networks

Conference and workshop organization

Torsten Braun

- ICC Workshop on 5G and Cooperative Autonomous Driving, Program Chair, Kansas City, MO, USA, May 20-24 2018
- Wired/Wireless Internet Communications 2018, Steering committee, Boston, MA, USA, June 18-20, 2018
- Summer School, Hasliberg, Switzerland, August 15-17 2018

Zhongliang Zhao

- Organising committee of KuVS EToL 2018: Expert Talk on Localization, Lübeck, Germany July 12-13 2018

Public events organization

Torsten Braun

- **Kinderuniversität**: At this event, Prof. Braun gave a lecture about *Die Welt des Internets*. In an additional workshop, our group showed multiple demos of indoor positioning, adaptive video streaming, and IoT programming to the audience. Further details are available at [http://www.kinderuni.unibe.ch/programm/archiv/](http://www.kinderuni.unibe.ch/programm/archiv/)

- **Nacht der Forschung**: At this event, our group had a booth of indoor positioning at the main university building, and we showed live demos to public. Some hundreds of people visited our booth, and tried out our indoor positioning system, which covered two floors of the university main building. Further details are available at [http://www.nachtderforschung.unibe.ch/](http://www.nachtderforschung.unibe.ch/)
• **Study Week on Fascinating Informatics:** At this event, Zhongliang Zhao and Jose Carrera taught three high school students how to program in Android and they implemented a indoor localization application. Further details are available at: [https://sjf.ch/review-studienwoche-fascinating-informatics/](https://sjf.ch/review-studienwoche-fascinating-informatics/)

## Conference Program Committees

**Torsten Braun**

- 17th International Conference on Next Generation Wired/Wireless Advanced Networks and Systems (NEW2AN 2017), St. Petersburg, Russia, August 28-30, 2017
- 9th ICT Innovations Conference 2016, Skopje, Macedonia, September 18-23, 2017
- 1st International Conference in Networking Science and Practice (ITC30 2017), Vienna, Austria, September 27, 2017
- The Communications Network Annual Conference (ComNet 2017), Miami Beach, USA, September 27-29, 2017
- 42th IEEE Local Computer Networks Conference (LCN 2017), Singapore, October 9-12, 2017
- 14th IEEE International Conference on Mobile Ad Hoc and Sensor Systems (MASS 2017), October 22-25, Orlando, Florida, USA
- 9th International Congress on Ultra Modern Telecommunications and Control Systems (ICUMT 2017), Munich, Germany, November 6-8, 2017
- Asian Internet Engineering Conference (AINTEC 2017), Bangkok, Thailand, November 20 - 22, 2017
3. Communication and Distributed Systems Group

- IEEE Global Communications Conference (GLOBECOM 2017), Singapore, December 4-8, 2017
- 15th IEEE Consumer Communications and Networking Conference (CCNC 2018), Las Vegas, USA, January 12-15, 2018
- 33st ACM Symposium on Applied Computing (SAC 2018), Pau, France, April 9-13, 2018
- 2nd IEEE INFOCOM Workshop on Integrating Edge Computing, Caching, and Offloading in Next Generation Networks (IECCO 2018), Honolulu, HI, USA, April 15-19, 2018
- IEEE/IFIP Network Operations and Management Symposium (NOMS 2018), Taipei, Taiwan, April 23-27, 2018
- IFIP Networking Conference 2018 (Networking 2018), Zurich, Switzerland, May 14-16, 2018
- IEEE International Conference on Communications (ICC 2018), Kansas City, MO, USA, 20-24 May 2018
- IEEE/ACM International Symposium on Quality of Service (IWQoS 2018), Banff, Alberta, Canada, June 4-6, 2018
- 4th Smart Cloud Networks and Systems Conference (SCNS 2018), Paris, France, June 6-8, 2018
- 7th IEEE WoWMoM Workshop on the Internet of Things: Smart Objects and Services (IoT-SoS 2018), Chania, Greece, June 12, 2018
- IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM 2018), Chania, Greece, June 12-15, 2018
- IFIP International Conference on Wired and Wireless Internet Communications (WWIC 2018), Boston, MA, USA, June 18-20, 2018
- 10th IFIP Latin American Networking Conference (CLEI 2018-LANC), Sao Paulo, Brazil, October 3-4, 2018
- 9th International Workshop on Wireless Networking and Control for Unmanned Autonomous Vehicles (Wi-UAV 2018), Abu Dhabi United Arab Emirates, December 9, 2018


**Project and Person Reviewing Activities**

**Torsten Braun**

- Chair of Review Panel, Beyond 5G Systems, Academy of Finland
- Deutsche Forschungsgemeinschaft, DFG
- Excellence in Research for Australia, Australian Research Council

**Journal Article Reviewing Activities**

**Torsten Braun**

- IEEE Journal on Selected Areas in Communications (JSAC)
- Elsevier Future Generation Computer Systems
- Elsevier Computer Networks
- IEEE Communications Magazine
- IEEE Access
- IEEE Transactions on Network and Service Management

**Thiago Genez**

- Springer Journal of Network and Systems Management
- Springer Journal of Automated Software Engineering
- Wiley Journal of Software: Practice and Experience
- Elsevier Future Generation Computer Systems

**Mostafa Karimzadeh**

- IEEE Transactions on Vehicular Technology
Talks and Tutorials

Torsten Braun


- Invited talk: “Information-Centric Networking in Wireless and Mobile Networks”, IIT Delhi, India, December 15, 2017

- Invited talk: “Information-Centric Networking in Wireless and Mobile Networks”, Universidade Federal do Amazonas, Manaus, Brazil, January 12, 2018


- Invited talk: “Caching and Computing in Mobile Edge Networks”, Universidade Cabo Verde Info-Telecom Workshop, Praia, Cape Verde, May 17, 2018

- Invited talk: “Vehicular Networking in RINA”, 5th international RINA Workshop, Barcelona, May 22, 2018

- Keynote talk: “Caching and Computing in Mobile Edge Networks”, IEEE Symposium on Computers and Communications, June 25, 2018

- Keynote talk: “Autonomic Communications in Software-Driven Networks”, IEEE Symposium on Computers and Communications, June 26, 2018

PhD Committee Memberships

Torsten Braun

- Hasan Islam (Pre-examination of PhD Thesis), Aalto University, Finland
• João Duarte (PhD Jury), Unicamp, Brazil, January 2018
• Noor Abani (PhD Jury), UCLA, USA, May 2018
• Aleksandar Karadimce (Reviewer of PhD Thesis), Faculty of Computer Science and Engineering, Ss. Cyril and Methodius University in Skopje, R. Macedonia

3.8 Awards


3.9 Publications

Disclaimer: The publication list only includes publications published during the academic year, but does not include submitted and not yet published papers.

Journal Papers


3. Communication and Distributed Systems Group


Book Chapters


Conference Papers

3. Communication and Distributed Systems Group


4 Computer Vision Group

4.1 Personnel

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4.2 Overview

Prof. Dr. P. Favaro joined the Institute of Computer Science and established the Computer Vision group in June 2012. The Computer Vision group conducts research on the broad areas of machine learning, computer vision, image processing, and imaging and sensor design by employing models, algorithms and analysis tools from optimization theory, probability theory, and applied mathematics. Our general aim is to extract high-level information from images by using digital processing. Such high-level information can be in the form of geometric or photometric quantities about objects in the scene, or semantic attributes such as their category, their function, etc. In order to achieve this aim, we use a systematic approach based on three pillars: modeling, inference and experimental validation. The first step in digital processing requires modeling sensors
and distortions of their measured signals such as optical aberrations (defocus and motion blur), noise, spatial loss of resolution and quantization. Moreover, a careful analysis of models allows us to design novel imaging architectures that can more efficiently and accurately capture visual data. For instance, light field cameras (recently become a commercial product) allow for single-snapshot digital refocusing (i.e., the ability to change the focus plane of an image after capture via digital processing) by incorporating a microlens array in conventional cameras. Models also allow us to infer their parameters or a distribution of their parameters by assuming some stochastic description of the data. Parameter estimation can then be performed via optimization techniques, which require a careful selection of suitable algorithms and understanding of their behavior. Finally, both sensor and data models are validated experimentally by using both synthetic and real data. Currently, our efforts have been devoted to problems in: inverse imaging (deblurring, blind deconvolution, super resolution), 3D estimation (multi view stereo, photometric stereo, coded aperture photogaphy), motion estimation (structure from motion, tracking). We are also working extensively in unsupervised learning with the purpose of building useful feature representations of images. In our approaches a good representation is one that makes future learning easier. Currently, we use neural networks to solve tasks and because of their compositional architecture, a feature is naturally identified as one of many possible intermediate outputs of the trained model. The questions we focus on are then: How do we build a feature that can be used as input to a weak classifier or regressor for different unknown tasks? How do we use the least amount of annotation to build general purpose features?

4.3 Research Projects

Learning to Extract a Video Sequence from a Single Motion-Blurred Image

We present a method to extract a video sequence from a single motion-blurred image. Motion-blurred images are the result of an averaging process, where instant frames are accumulated over time during the exposure of the sensor. Unfortunately, reversing this process is nontrivial. Firstly, averaging destroys the temporal ordering of the frames. Secondly, the recovery of a single frame is a blind deconvolution task, which is highly ill-posed. We present a deep learning scheme that gradually reconstructs a temporal ordering by sequentially extracting pairs of frames. Our main
contribution is to introduce loss functions invariant to the temporal order. This lets a neural network choose during training what frame to output among the possible combinations. We also address the ill-posedness of deblurring by designing a network with a large receptive field and implemented via resampling to achieve a higher computational efficiency. Our proposed method can successfully retrieve sharp image sequences from a single motion blurred image and can generalize well on synthetic and real datasets captured with different cameras.

Research staff: Meiguang Jin, Givi Meishvili, Paolo Favaro

Financial support: Swiss National Science Foundation Project No. 153324 and No. 165845

Normalized Blind Deconvolution

We introduce a family of novel approaches to single-image blind deconvolution, i.e., the problem of recovering a sharp image and a blur kernel from a single blurry input. This problem is highly ill-posed, because infinite (image, blur) pairs produce the same blurry image. Most research effort has been devoted to the design of priors for natural images and blur kernels, which can drastically prune the set of possible solutions. Unfortunately, these priors are usually not sufficient to favor the sharp solution. In this paper we address this issue by looking at a much less studied aspect: the relative scale ambiguity between the sharp image and the blur. Most prior work eliminates this ambiguity by fixing the L1 norm of the blur kernel. In principle, however, this choice is arbitrary. We show that a careful design of the blur normalization yields a blind deconvolution formulation with remarkable accuracy and robustness to noise. Specifically, we show that using the Frobenius norm to fix the scale ambiguity enables convex image priors, such as the total variation, to achieve state-of-the-art results on both synthetic and real datasets.

Research staff: Meiguang Jin, Paolo Favaro

Financial support: Swiss National Science Foundation Project No. 153324
Learning to See through Reflections

Pictures of objects behind a glass are difficult to interpret and understand due to the superposition of two real images: a reflection layer and a background layer. Separation of these two layers is challenging due to the ambiguities in assigning texture patterns and the average color in the input image to one of the two layers. In this paper, we propose a novel method to reconstruct these layers given a single input image by explicitly handling the ambiguities of the reconstruction. Our approach combines the ability of neural networks to build image priors on large image regions with an image model that accounts for the brightness ambiguity and saturation. We find that our solution generalizes to real images even in the presence of strong reflections. Extensive quantitative and qualitative experimental evaluations on both real and synthetic data show the benefits of our approach over prior work. Moreover, our proposed neural network is computationally and memory efficient.

Research staff: Meiguang Jin, Paolo Favaro

Financial support: Swiss National Science Foundation Project No. 153324

Learning Face Deblurring Fast and Wide

Portrait images and photos containing faces are ubiquitous on the web and the predominant subject of images shared via social media. Especially selfie images taken with lightweight smartphone cameras are susceptible to camera shake. Despite significant progress in the field of image deblurring over the last decade, the performance of state-of-the-art deblurring methods on blurry face images is still limited. In this work, we present a novel deep learning architecture that is designed to be computationally fast and exploits a very wide receptive field to return sharp face images even in challenging scenarios. Our network features an effective resampling convolution operation that ensures a wide receptive field from the very first layers, while at the same time being highly computationally efficient. We also show that batch normalization prevents networks from yielding high-quality image results and introduce instance normalization instead. We demonstrate our architecture on face deblurring as well as other more general scenes. Extensive experiments with state-of-the-art methods demonstrate the effectiveness of our proposed network, in terms
of run-time, accuracy, and robustness to ISO levels as well as gamma correction.

**Research staff:** Meiguang Jin, Paolo Favaro

**Financial support:** Swiss National Science Foundation Project No. 153324

**Understanding Degeneracies and Ambiguities in Attribute Transfer**

We study the problem of building models that can transfer selected attributes from one image to another without affecting the other attributes. For example, we would like to transfer only the viewpoint of a car between the images of two different car models. As data we use a weakly labeled training set, where labels indicate what single factor has changed between two data samples, although the relative value of the change is unknown. This labeling is of particular interest as it is often readily available without annotation costs. Towards this goal, we develop analysis and training methodology for autoencoding models, whose encoded features aim to disentangle factors of variation. These features are explicitly split into two components: one that should represent attributes in common between pairs of images, and another that should represent attributes that change between pairs of images. We show that achieving this objective faces two main challenges: One is that the model may learn degenerate mappings, which we call shortcut problem, and the other is that the attribute representation for an image is not guaranteed to follow the same interpretation on another image, which we call reference ambiguity. To address the shortcut problem, we introduce novel constraints on image pairs and triplets and show their effectiveness both analytically and experimentally. In the case of the reference ambiguity, we formally prove that a model that guarantees an ideal feature separation cannot be built. We validate our findings on several datasets and show that, surprisingly, the trained models often do not exhibit the reference ambiguity.

**Research staff:** Qiyang Hu, Attila Szabó, Paolo Favaro

**Financial support:** Swiss National Science Foundation Project No. 156253
Disentangling Independent Factors of Variation

The aim of this project is to propose a learning method to build models that disentangle independent factors of variation on a given unlabelled training set. These models can discover what factors determine the images. We assume that these factors are statistically independent and we fix their number before training. We encoded the factors into features, then decoded them to images again in an autoencoder setting. The main idea is to mix the features of two different images to obtain a mixed one. This image should look realistic, which we can enforce with a generative adversarial net. Then we use the mixed image and one of the original input image to “demix” the features, and the resulting image should look like the input image. This is enforced by the L2 loss. We show this setup is not enough for disentanglement, as a shortcut can occur, when all the information is encoded in only one feature. Therefore we added a classifier that decides, which input image originates the features of the mixed image for any given feature. Experiments show the setup with the three components disentangles factors of variation on datasets like CelebA, MNIST and Sprites.

**Research staff:** Qiyang Hu, Attila Szabó, Paolo Favaro

**Financial support:** Swiss National Science Foundation Project No. 156253

Deep Sketch-based Face Image Editing

We present a novel system for sketch-based face image editing, enabling users to edit images intuitively by sketching a few strokes on a region of interest. Our interface features tools to express a desired image manipulation by providing both geometry and color constraints as user-drawn strokes. As an alternative to the direct user input, our proposed system naturally supports a copy-paste mode, which allows users to edit a given image region by using parts of another exemplar image without the need of hand-drawn sketching at all. The proposed interface runs in real-time and facilitates an interactive and iterative workflow to quickly express the intended edits. Our system is based on a novel sketch domain and a convolutional neural network trained end-to-end to automatically learn to render image regions corresponding to the input strokes. To achieve high quality and semantically consistent results we train our neural network on two simultaneous tasks, namely image completion and image translation.
To the best of our knowledge, we are the first to combine these two tasks in a unified framework for interactive image editing. Our results show that the proposed sketch domain, network architecture, and training procedure generalize well to real user input and enable high quality synthesis results without additional post-processing.

**Research staff:** Tiziano Portenier, Qiyang Hu, Attila Szabó, Siavash Arjomand Bigdeli, Paolo Favaro, Matthias Zwicker

**Financial support:** Swiss National Science Foundation Project No. 156253

### Unsupervised Learning of Visual Representations

Information processing tasks can be either very easy or very difficult depending on how the information is represented. This general principle is applicable to daily life as well as to machine learning and computer science. In computer vision, we are interested in a representation space in which the semantically related tasks, like classification, detection, are easier. The representations learned by Convolutional Neural Networks (CNN) have demonstrated an impressive performance in many computer vision tasks when trained on large labeled datasets. However, we often have a very large amount of unlabeled training data and relatively little labeled data. Training with supervised learning techniques on the labeled subset often results in severe overfitting. The goal of this project is to develop methods to learn efficient representations from large scale unlabeled training data.

In self-supervised learning, one trains a model to solve a so-called pretext task on a dataset without the need for human annotation. The main objective, however, is to transfer this model to a target domain and task. Currently, the most effective transfer strategy is fine-tuning, which restricts one to use the same model or parts thereof for both pretext and target tasks. In this paper, we present a novel framework for self-supervised learning that overcomes limitations in designing and comparing different tasks, models, and data domains. In particular, our framework decouples the structure of the self-supervised model from the final task-specific fine-tuned model. This allows us to: 1) quantitatively assess previously incompatible models including handcrafted features; 2) show that deeper neural network models can learn better representations from the same pretext task; 3) transfer knowledge learned with a deep model to a shallower one
and thus boost its learning. We use this framework to design a novel self-supervised task, which achieves state-of-the-art performance on the common benchmarks in PASCAL VOC 2007, ILSVRC12 and Places by a significant margin. Our learned features shrink the mAP gap between models trained via self-supervised learning and supervised learning from 5.9% to 2.6% in object detection on PASCAL VOC 2007.

**Research staff:** Mehdi Noroozi, Paolo Favaro

**Exploiting Videos to Learn Object Detection and Categorization in Images**

We assume that a category is defined by its characteristic textures/colors (if any) and its characteristic 3D shape (up to local or articulated deformations). Images and videos are space-time instances of an object category with additional transformations (e.g., pose, viewpoint, intraclass variation, illumination, occlusions, clutter and so on) that do not characterize the category. Given a model of the object category (textures and 3D shape), the removal of these transformations is relatively well defined. However, when the model is unknown, the problem becomes extremely challenging. The biggest problem is how to relate the content of one image instance with another image instance. In other words one needs to find correspondences between parts of different instances of an object. Because of the high variability of the appearance of instances of an object, this task is extremely difficult. To simplify this step we propose to use short videos instead of images. Our objective is first to learn high-performance visual representations (feature vectors) from videos and then such visual representations can be transferred to other tasks such as object detection/categorization, action recognition, pose estimation and so on.

**Research staff:** Xiaochen Wang, Paolo Favaro

**Financial support:** China Scholarship Council

**Blind 3D Face Deblurring**

The aim of this project is to restore images depicting blurred faces. Parents like to capture pictures of important events of their little ones: a birthday party, the first day at school, the first time on a bicycle and so on. However, these ever so special memories are often completely spoiled by motion
blur. Typically, the details that matter the most to parents, such as the face, are completely blurred. This blurriness is not caused by the shaky hands of the photographer, but by the subjects, with whom cooperation cannot always be established.

The main difficulty with removing blur from an articulated or deforming body is that blur is typically non-smooth, space-varying and characterized by occlusions. Consider for example the picture of a rotating head. The area around the nose will be the combination of a partial occlusion and disocclusion process. Another issue is that the blurry input image provides limited and low-quality data to make decisions about the 3D geometry of an object, its 3D motion trajectory, and its texture. Thus, the challenge is that the process is highly nonlinear, one needs to determine its model with high precision, and there is only limited and ambiguous information (the blurry input image) to make such decisions.

We study this category of blind deconvolution problems with a model-based approach by exploiting user interaction and efficient search in parameter space. We envision a system where the user can help select and align (to different degrees) a 3D model on top of the blurry image. Given the 3D model, we then design an efficient algorithm to find the motion parameters of the model and to recover its texture. To cope with the data limitations and to break down the parameter search complexity, we consider building and using datasets of sharp images of faces.

**Research staff:** Givi Meishvili, Paolo Favaro

**Financial support:** Swiss National Science Foundation Project No. 165845

### Generalization in Deep Learning

A core objective in machine learning is to build models that generalize well, i.e., that have the ability to perform well on new unseen data. However, recent work has shown that common regularization methods applied to neural networks often fail to achieve good generalization. For example, it has been shown that neural networks can learn to map data samples to arbitrary labels despite using regularization techniques such as weight decay, dropout, and data augmentation. We developed a novel regularization approach to train neural networks that enjoys better generalization and test error than standard stochastic gradient descent. Our approach is based on the principles of cross-validation, where a validation set is used to limit the
model overfitting. We formulate such principles as a bilevel optimization problem. This formulation allows us to define the optimization of a cost on the validation set subject to another optimization on the training set. The overfitting is controlled by introducing weights on each mini-batch in the training set and by choosing their values so that they minimize the error on the validation set. In practice, these weights define mini-batch learning rates in a gradient descent update equation that favor gradients with better generalization capabilities. We evaluate extensively our proposed algorithm on several neural network architectures and datasets, and find that it consistently improves the generalization of the model, especially when labels are noisy.

Research staff: Simon Jenni, Paolo Favaro

Financial support: Swiss National Science Foundation Project No. 169622

Stabilizing the Training of Generative Adversarial Networks

Since the introduction of the generative adversarial network (GAN), GANs have been widely used and analyzed due to the quality of the samples that they produce, in particular when applied to the space of natural images. Unfortunately, GANs still prove difficult to train. In fact, a vanilla implementation does not converge to a high-quality sample generator and heuristics used to improve the generator often exhibit an unstable behavior. We developed a simple regularization method to stabilize generative adversarial training that results in accurate generative models. Our method is rather general and can be applied to other GAN formulations with an average improvement in generated sample quality and variety, and training stability. Since GAN training aims at matching probability density distributions, we exploit additive noise to extend the support of the densities and thus facilitate the matching through gradient descent. More importantly, we show that using multiple loss terms with different additive noise (including the no-noise case) is necessary to achieve a highly accurate match of the original data distribution. We demonstrate the proposed training method on several common datasets of real images.

Research staff: Simon Jenni, Paolo Favaro
Feature Learning

Recent developments in deep learning have demonstrated impressive capabilities in learning useful features from images, which could then be transferred to several other tasks. These systems rely on large annotated datasets, which require expensive and time-consuming human labor. To address these issues self-supervised learning methods have been proposed. These methods learn features from images without annotated data by introducing a pretext task. As a new pretext task, we propose to learn features by classifying images into real or corrupt (with artifacts). We aim at creating image artifacts, such that a model capable of spotting them would require an accurate representation of objects and thus build features that could transfer well to tasks such as object classification, detection and segmentation.

To generate artifacts we first train an autoencoder to reproduce images. Then, we randomly drop entries from the encoded feature (at the bottleneck) so that some information about the input image is lost. We then add a repair neural network to the decoder to help it render a realistic image. The repair network inpaints the feature representations at every layer of the decoder, but its limited capacity does not allow it to fully recover the missing information. In this way we obtain an image with artifacts that cannot be detected through local analysis. We then train a discriminator to distinguish real from corrupt images. The repair network and the discriminator are then trained in an adversarial fashion. However, in contrast to other adversarial schemes, notice that our repair network is designed not to completely confuse the discriminator. Finally, we transfer features from the discriminator, since this is the model that learns an approximation of the distribution of images and achieve state of the art performance on several transfer learning evaluations (ILSVRC2012, Pascal VOC and STL-10).

Research staff: Simon Jenni, Paolo Favaro

Financial support: Swiss National Science Foundation Project No. 169622
Learning Structure from Motion

Structure from motion (SfM) is the problem of reconstructing the 3D geometry and camera parameters given a set of photographs of a scene. State-of-the-art SfM systems assume that all observed motion in the measurements are caused by the camera's motion, and objects that move in the scene are considered noise. Handling this type of noise is indeed one of the main difficulties in SfM. Occlusions, change of lighting and specular reflections are other examples of noise that challenge the robustness of a SfM system. In our research, we consider a temporal sequence of images (video) instead of an unordered set. This makes it suitable for real-time applications where the input is a continuous video stream. We aim to build a system that incrementally outputs the estimated 3D and camera parameters as it reads the video frames one after the other, and are investigating several Deep Learning approaches to solve the aforementioned challenges for this type of sequential data. One of them are Recurrent Neural Networks (RNNs). Prior works have shown that RNNs can perform well on sequence tasks such as translation, speech recognition, speech synthesis and more. However, the higher the complexity between input and output space, the harder it is to train them on long sequences. We are investigating the suitability of RNN's for SfM and how they could be applied or extended.

Research staff:  Adrian Wälchli , Paolo Favaro

4.4 Master’s Theses

- Bernard Swart, “Crime location and timing prediction”, 2018 (Visiting Student from University of Stellenbosch).


4.5 Bachelor’s Theses


4.6 Further Activities

Ph.D. Thesis Examiner

Paolo Favaro


Invited Talks

Paolo Favaro


- “Beyond supervised learning”, University of Zurich, July 2, 2018.


• “Beyond Supervised Learning”, Novartis Pharma AG, March 2018.
• “Beyond supervised learning”, PAVIS Italian Institute of Technology, January 2018.
• “Apprendimento automatico di rappresentazioni semantiche senza supervisione”, Coscienza di sè e intelligenza artificiale, November 18, 2017.

Conference Program Committees
Paolo Favaro
• Area chair of ECCV 2018 and ICCV 2017

Journal Committees
Paolo Favaro
• Associate Editor for IEEE Transactions on Pattern Analysis and Machine Intelligence 2018
• Associate Editor for Computer Vision and Image Understanding 2018

Reviewing Activities
Paolo Favaro
• CVPR 2018
• ICCP 2018

4.7 Publications

Journal Publications
Refereed Conference Proceedings


Technical Reports


# 5 Logic and Theory Group

## 5.1 Personnel

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5.2 Overview

The LTG research group (logic and theory group) focuses on theoretical computer science and mathematical logic, especially proof theory, computational logics and theory of computation. We have been dealing for many years with formal methods, analysis of deductions, general computations and, in particular, applications of mathematical logic to computer science. During the previous year the main subject areas have been the following:

**Computational Logic:** Logical formalisms are perfectly suited to the specification of complex systems, the representation of knowledge and information, the description of processes (e.g. in distributed multi-agent systems) and for providing formal proofs of important system properties such as, for example, correctness and fairness. The research group has long been interested in the deductive, procedural and dynamic aspects of the corresponding formalisms and in the design of modern deductive systems. New approaches are being developed for information update purposes. In addition, the way in which simple, logical formalisms can be extended to become genuine multi-user systems taking into account the dynamic aspects of ontologies in the data mining context and in connection with the semantic web is being investigated.

**Proof Theory:** This research topic focuses on the development and analysis of formal systems of first and second order arithmetic, set theory and of what are known as logical frameworks (type and set theoretical, explicit, constructive, extensional, intentional). Our interests range from feasible subsystems of arithmetic to highly impredicative set and type theories and
deals with the interplay between constructive, recursive and operational approaches. In addition, abstract computations and computable knowledge are being investigated.

5.3 Research Projects

Algebraic and Logical Aspects of Knowledge Processing

The general framework of this project is the proof-theoretic analysis of systems of second order arithmetic, of explicit mathematics, and of operational set theories. In particular, we examine wellordering proofs in connection with higher types and suitable inductive definitions. A further aspect of research is related to abstract computability theory in an operational setting, thus aiming towards an operational descriptive set theory.


Financial support:  Swiss National Science Foundation (No. 137678)

Justifications and Non-Classical Reasoning

In most situations, the exact actual state of our environment is unknown and we only have incomplete information available when we have to make decisions. Therefore, we often use some form of reasoning under uncertainty in order to make inferences or to plan actions. This project seeks to develop novel probabilistic justification logics and corresponding non-classical reasoning procedures to model epistemic situations with incomplete information.

Research staff:  E. Lehmann, N. Savić, T. Studer

Financial support:  Swiss National Science Foundation (No. 165549)

The Operational Paradigm: its Mathematical and Philosophical Frontiers

This project assesses the limits of mathematical knowledge inherent in and provided by an operational approach – an approach which plays a central role in Feferman's explicit mathematics and operational set theory.
5. Logic and Theory Group

– from various mathematical and philosophical perspectives. The notion of predicativity goes back to Russell and Poincare and was formally made precise by Feferman and Schütte, who were also able to exactly characterize predicative mathematics.

The first part of this proposal is about an extension of predicativity, which we call metapredicativity, in taking a more liberal approach to “building up set-theoretic universes from below”. We aim at a conceptually and technically convincing classification of those formal systems that are no longer predicative in the sense of Feferman-Schütte but whose proof-theoretic analysis can be carried through by purely predicative methods. Our solution should unravel this dichotomy by providing a foundationally convincing explanation. In addition, we aspire to determine the limit of metapredicativity.

The second part is concerned with the design and analysis of strong operational systems and independence results making use of those. For this purpose, new extensions or generalizations of forcing and realizability techniques will be developed. The main products will be scientific results, documented in research articles. In addition, presentations of our results at international conferences, exchange visits, and the training of graduate students are envisaged. The long term impact of this project will provide convincing answers concerning the foundational relevance of an alternative approach to formalizing mathematics which, however, is closer to mathematical practice.


Financial support: John Templeton Foundation

Logic and Computation

This very general project deals with the close connections between mathematical logic and certain parts of computer science, and emphasis is put on a proof-theoretic approach to some of the central questions in this area of research. These include the development of perspicuous and feasible logical frameworks for studying typical questions in computer science like termination and correctness of functional programs, properties of distributed systems and the like.

We study applicative theories as well as strongly typed formalisms and are interested in the connections to constructive and explicit mathemat-
ics. Furthermore, we are interested in analyzing the close connections between the complexities of computations and proofs in suitable formalizations, ranging from propositional calculi up to abstract frameworks for computations (in higher types).

**Research staff:** All members of the research group

### 5.4 Habilitation Theses

- D. Probst: A Modular Ordinal Analysis of Metapredicative Subsystems of Second Order Arithmetic

### 5.5 Master’s Theses

- R. Imhof: JassBot – Learning to Play Schieber with Reinforcement Learning
- S. Matter: Extension of the Logic of Probabilistic Evidence to Nested Evidence

### 5.6 Bachelor’s Theses

- P. Allemann: Entwicklung einer mikroprozessorgesteuerten Voice Coil Schutzschaltung
- R. Beck: Beweissuche für Modallogik und linearer $\mu$-Kalkül
- L. Bosshart: Komplexität der Logic of Common Knowledge
- S. Furrer: Eine gefühlsbezogene Analyse von Rezensionen
- A. Jaha: Eine algorithmische Annäherung an das Briefträgerproblem
- K. Meister: Implementing a Finite-State Machine in Unreal Engine 4
- F. Trübner: Unreal Engine 4: Dynamische Daten im Raum
5. Logic and Theory Group

5.7 Further Activities

Editorial Boards

Gerhard Jäger

- Member of the Editorial Board of Archive for Mathematical Logic
- Member of the Editorial Board of Logica Universalis

Thomas Strahm

- Member of the Consulting Board of Dialectica
- Member of the Editorial Board of Journal of Symbolic Logic

Thomas Studer

- Member of the Editorial Board of Springer book series on Progress in Computer Science and Applied Logic

Invited Talks

Michael Bärtschi

- Uniform fixpoints and relatives in second order arithmetic, Arbeitstagung Bern-München, University of Bern, April 2018.

- Theories around $\Gamma_0$, OST18: Operations, Sets, and Types, University of Bern, March 2018.

- Uniform fixpoint variants in second order arithmetic, 1st Swiss-Italian Workshop on Proof and Computation, University of Verona, January 2018.

- Arithmetical transfinite recursion and relatives, Logic Colloquium, Stockholm University, August 2017.

Lukas Jaun


Gerhard Jäger

• About fixed points of monotone $\Sigma_1$ operators in Kripke-Platek environments, Logic Colloquium, University of Gothenburg, April 2018.

• $\Delta^1_1$ transfinite recursion and its relatives, Logic Seminar, University of Munich, January 2018.

• Theories around $\Gamma_0$ – again, 1st Swiss-Italian Workshop on Proof and Computation, University of Verona, January 2018.


Timotej Rosebrock

• Recursion theory in applicative theories, Arbeitstagung Bern-München, University of Bern, April 2018.

Kentaro Sato

• Making a detour via intuitionistic theories: Applications to SOSOA, Proof and Computation, University of Bonn, July 2018.

• Hierarchy of formula-classes in the intuitionistic second order setting, Arbeitstagung Bern-München, University of Bern, April 2018.

• Conservations of second order $\Sigma^1_1$ collection and $\Sigma^1_1$ closure, OST18: Operations, Sets, and Types, University of Bern, March 2018.


• Inductive dichotomy and determinacy of difference hierarchy, Logic Colloquium, Stockholm University, August 2017.

Silvia Steila
• SCT through the reverse mathematical looking glasses, Workshop on Ramsey Theory and Computability, University of Rome, July 2018.

• An overview over least fixed points in weak set theories, Proof and Computation, University of Bonn, July 2018.

• SCT through the reverse mathematical looking glasses, Logic Seminar, University of Leeds, May 2018.

• A first order approach to almost-fullness, Computational Approaches to the Foundations of Mathematics, Ludwig-Maximilians-Universität München, April 2018.

• Fixed point statements in the locally predicative and impredicative spotlights, OST18: Operations, Sets, and Types, University of Bern, March 2018.

• When the reals form a proper class, IIIM: Incontro Italiano Insiemi e Modelli, University of Torino, February 2018.

• SCT through the reverse mathematical looking glasses, 1st Swiss-Italian Workshop on Proof and Computation, University of Verona, January 2018.

• How large are proper classes?, Arbeitstagung Bern-München, Ludwig-Maximilians-Universität München, December 2017.

• Playing with equivalent forms of CH, XXVI incontro AILA, University of Padova, September 2017.

• On some fixed point statements over Kripke Platek, Minisymposium: Applied Proof Theory and the Computational Content of Mathematics, University of Salzburg, September 2017.

• On some fixed point statements over Kripke Platek, Logic Colloquium, Stockholm University, August 2017.

**Thomas Studer**

• The proof theory of modal fixed point logics, Chinese Mathematical Logic Conference, Duyun, May 2018.

• Common knowledge from a proof-theoretic perspective, Department of Philosophy, Tsinghua University, May 2018.
• I know that you know that I know – epistemic logic in computer science, Mini Symposium of Computer Graphics, Data Science, Logic and Security, University of Bern, February 2018.

• A Logic of Blockchain Updates, Logical Foundations of Computer Science, Deerfield Beach, Florida, January 2018.

• Justification Logic with Approximate Conditional Probabilities, LORI 2017, Hokkaido University, September 2017.

Technical and Research Committees

Gerhard Jäger

• Swiss Delegate to the International Federation for Information Processing Technical Committee 1 (Foundations of Computer Science)

• Member of the Ambizione Panel of the Swiss National Science Foundation

• Member of the Scientific Council of the European Association for Computer Science Logic

• Member of the Kantonale Maturitätskommission

• Expert for Maturitätsprüfungen Mathematik und Informatik

Thomas Strahm

• Board Member of the Swiss Society for Logic and Philosophy of Science

Thomas Studer

• President of the Swiss Society for Logic and Philosophy of Science

• Swiss Delegate to the International Union of History and Philosophy of Science and Technology

• Board Member of the Platform Mathematics, Astronomy and Physics of the Swiss Academy of Sciences

• Member of the Jury for Prix Schläfli 2018

• Expert for Maturitätsprüfungen Mathematik und Informatik
Jan Walker

- Board Member of the Swiss Graduate Society for Logic and Philosophy of Science

Organized Events

Michael Bärtschi


Gerhard Jäger


- Together with Kentaro Sato and Michael Bärtschi. OST18: Operations, Sets, and Types, University of Bern, March 2018.

Kentaro Sato

- Together with Gerhard Jäger and Michael Bärtschi. OST18: Operations, Sets, and Types, University of Bern, March 2018.

Silvia Steila

- 11th Young Set Theory Workshop, EPFL Lausanne, June 2018.

- 1st Swiss-Italian Workshop on Proof and Computation, University of Verona, January 2018.

Thomas Studer

- Logic and Application, Inter University Centre Dubrovnik, September 2018.

5.8 Awards


- Paul Bernays Award 2017 for Silvia Stella’s outstanding contribution in the area of logic and philosophy of science
5.9 Publications


6 Software Composition Group

6.1 Personnel

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*with financial support from a third party

6.2 Overview

Software systems that are used in practice must evolve over time to maintain their relevance, yet as systems evolve, they become more complex and harder to evolve. The Software Composition Group carries out re-
search into tools, techniques and programming language mechanisms to enable the graceful evolution of complex software systems.

6.3 Research Projects

Agile Software Analysis

*SNSF project #200020-162352*

Software developers actually spend much of their time not just producing new code, but analysing the existing code base. Integrated Development Environments (IDEs) however are mostly glorified text editors, and offer only limited support for developers to query and analyse software systems. In this continuation of our SNF project *Agile Software Assessment*, we proceed to explore new ways to enable developers to efficiently answer detailed questions about the software system under development.

The project is organized into four orthogonal tracks. We summarize briefly our progress in each track over the past year:

- **Agile Model Extraction.**

  Modelling is an important activity in software development, as it enables all the technical and non-technical stakeholders of a project to understand and communicate underlying problems in a mutually understandable way. Hence, a model has to be communicative, understandable, and, as the Object Management Group (OMG) suggests, also transformable into executable code. Domain modelling is a special area of modelling where a model represents possible relevant aspects of the problem domain, in particular the entities involved in that domain, their structure, and their behaviour. There are various approaches people have tried for modelling, notably UML modelling which is used for general purpose modelling, Domain Specific Languages (DSLs), which are high level languages intended to be used by non-programmers, Domain specific Modelling Languages (DSMLs), which abstract further from DSLs and mostly provide domain specific visual notations, and Domain Driven Design (DDD) where the code itself is written in a systematic way that represents the underlying model. Our initial contribution in the field is a mobile tool called Vision Backlog that helps to elicit requirements in situ, and is thus more suitable for domain modelling. On modelling itself we take a different perspective, and we imagine that a model should be
part of the final running system. Our initial attempts are creating a visual scenario builder in Pharo, and automatically generating code for it. The Pharo environment itself can provide various opportunities such as executable model documentation. These initial research ideas were presented at SATToSE 2018.

- **Context-Aware Tooling.**

  To identify common problems in the evaluation of software visualizations with the goal of formulating guidelines to improve future evaluations, we conducted a systematic review of papers published in the software visualization literature. We identified several pitfalls, and elaborated on guidelines to support researchers who need to evaluate their software visualization approaches.

  We used our proposed guidelines in a recent controlled experiment and case study in which we evaluated two 3D visualization techniques that support comprehension of structure and behavior of software systems. In the experiment, we investigated how usability issues of 3D visualizations can be minimized by displaying them in an immersive augmented reality environment. We found that immersive augmented reality eases navigation and reduces occlusion. Nevertheless, selection and text readability remain issues.

  Software systems continuously evolve and present multiple challenges for performing an analysis. To deal with the expanding size and complexity of software systems, developers employ reverse engineering methods and tools to extract information. In order to analyze the software using these tools, developers need to learn the query language of the tool which poses a burden for novice developers. Furthermore, starting the analysis process is itself a challenging task for novices like what questions they shall ask and how to formulate such questions in the tool to get the correct answer.

  We constructed a corpus of common software analysis questions that can serve as examples to start the analysis process. We started to develop a tool which can take a developer’s question in natural language, i.e., English. We compared different natural language processing techniques to capture the maximum information from a natural language sentence. Combining different approaches, we performed a semantic and structural analysis on the questions present in the corpus. Using this tool, we can find the composition of a question and how two questions are related to each other structurally and semantically. We aim to translate the question to the query language
of the tool. In order to do this, we are performing an extensive study on neural networks.

- **Ecosystem Mining.**

  Based on our previous finding that a missing null check of returned values from methods is one of the most prevalent bug patterns in Java systems, we had mined the usage of specific APIs to identify methods that potentially return null. We published the tool to collect usage data as well as an empirical study on the usage of Apache Lucene, which showed how this information can be harvested by hinting developers at potentially missing or unnecessary null checks. We are currently working on improving the evaluation of our empirical approach by comparing our inferred categorization of a method as nullable or non-null with their respective specification given by the API experts. As another extension, we are investigating whether the same approach can be applied to determine the expected nullness of a method parameter.

  The analysis of mobile applications can often greatly benefit from separating library from application code, for example to improve the performance of the analysis by excluding all library code. Existing approaches try to detect indexed libraries within an application, which requires the index to be continuously updated in order to avoid missing the detection of a new library. We are currently investigating whether we can work around the need for a maintained index by grouping code by their different authors, using a machine learning approach based on stylistic code features that are inherent to and distinctive between individuals and organizations.

  The lack of static type information in dynamically-typed language poses an obstacle to software analysis. The field of type inference has been heavily researched during the last several decades. However, for a type inference algorithm to be precise, it is necessary to be complex and hence not scalable. Simpler algorithms scale well, but pay the price in losing the precision. We demonstrated that the precision of a simple type inference algorithm may be ameliorated by exploiting the programming idioms of the language under analysis. More precisely, we have used type hint information hidden in method argument names to augment a type inference algorithm. We are now investigating the ways of using string similarity metrics and machine learning models to predict the type of a variable.

  In previous research, we showed that numerous security vulnerabil-
ities are prevalent in mobile applications distributed over app stores, which put the digital life of millions of users at risk. During recent years, mobile development platforms continuously tried to innovate; however, security is one major opponent of innovation as its proper assessment is very time demanding. In addition, mobile platforms receive increasing attention from self-made developers; people that lack any educational background in computer science, and thus are prone to estimate potential risks that come with a security-related decision inaccurately. A plethora of static, dynamic, and hybrid analysis tools have been proposed, but the vast majority of those tools only target some specific aspects, such as data flow analysis, or features for malware detection, and does not provide generic bad practices for the use of security-related features that could cause future threats. Hence, the available tools do not sufficiently support developers in making secure mobile apps. We perform literature reviews to compile a diverse set of security issues published in scientific work. We develop tools to assess the collected security issues in byte- and source-code. We evaluate these issues on large corpora in order to determine the common mistakes developers encounter and subsequently propose guidelines and mitigation strategies to avoid any security issues. The obtained results are promising; we were able to predict security issues on par with state of the art approaches, while still providing immediate responses and efficient system resource usage, properties that are currently not found in competing approaches.

• Evolutionary Monitoring.

Recent efforts in research on static analysis of Android applications have yielded many approaches and ideas to detect security issues. In their respective works, the ideas are often evaluated by implementing a tool or prototype of the approach, and by comparing them to other similar works. To benefit from past research efforts, tools need to be made publicly available and are ideally kept up to date. However, there are several reasons why this can be difficult. For example, the Android platform and other dependencies evolve quickly over time; tools need to be updated accordingly. Furthermore, researchers may want to focus on different things once the works have been published. In our work, we investigate the state of static analysis tools for detecting data leaks in Android applications. We review the state-of-the-art and focus on prototypes and tools. We report on availability and usability in a modern, up-to-date setting. To stream-
line the analysis and run tools in a common setting, we implemented a benchmark that provides a common interface to tools and generates normalized reports from a tool's output. This makes comparisons between those tools easy and fair. Furthermore, adding new and emerging tools in the domain is straightforward. Consequently, our benchmark can be used instead of performing custom analysis to compare approaches.

By analyzing applications before they are deployed, companies can discover and fix software vulnerabilities to avoid exploitation. To achieve an acceptable level of software code security, several solutions could be used such as a Secure Software Development Life Cycle (S-SDLC), or static and dynamic analysis tools.

In SATToSE 2018, we presented initial research concerning how to design a custom Secure Software Development Life Cycle (S-SDLC) for in-house Android developers. This research is in the initial stage, and we plan to employ Pharo to design a threat-modeling tool. Moreover, we did research on how WebRTC IP leakage could impact users' privacy and how this vulnerability could be prevented. The corresponding paper was presented at ESSoS 2018. Currently, we are exploring ways in which DNS-rebinding attack can benefit from our findings in infringing users' privacy by WebRTC IP leakage. A large-scale analysis of Java projects on GitHub is also being performed to discover Java Cryptography Architecture (JCA) usage. We intend to identify developers whose projects are correctly using JCA.

**Research staff:** All members of the research group.

**Duration:** Jan 1, 2016 – Dec. 30, 2018

**Financial support:** Swiss National Science Foundation

For further details, please consult:
http://scg.unibe.ch/asa2

### 6.4 Ph.D. Theses


6.5 Master’s Theses


6.6 Bachelor’s Theses and Computer Science Projects


### 6.7 Awards

• Faculty Prize for Manuel Leuenberger’s MSc thesis, “Nullable Method Detection — Inferring Method Nullability From API Usage”

### 6.8 Further Activities

#### Invited Talks

**Oscar Nierstrasz**

• Invited Speaker at Simula 50 Years: “Great Moments in the History of OOP (50 years anniversary of Simula, the first object-oriented programming language — Oslo, Norway, Sept. 27, 2017)

**Mohammad Ghafari**

• Invited Course Lecture at Brunel University: “Java Arrays” – London, UK, May 24, 2018
● Invited Speaker at Brunel University: “Towards quality software development” – London, UK, May 24, 2018

Leonel Merino

● Invited Speaker at University of Chile: “The Medium of Visualization for Software Comprehension” – Santiago, Chile, Dec 15, 2017

● Invited Speaker at Austral University of Chile: “The Medium of Visualization for Software Comprehension” – Valdivia, Chile, Jan 18, 2018

● Invited Speaker at German Aerospace Center (DLR): “The Medium of Visualization for Software Comprehension” – Cologne, Germany, Feb 16, 2018

Editorial Boards and Steering Committees

Oscar Nierstrasz

● AITO – Association Internationale pour les Technologies Objets (Member)

● CHOOSE – Swiss Group for Object-Oriented Systems and Environments (Board member)

● Elsevier Science of Computer Programming (Advisory Board Member, Software Section)

● JOT – Journal of Object Technology (Steering Committee Member)

● Moose Association (Board Member)

● PeerJ Computer Science Journal (Editorial Board member)

● SATTSe – Seminar Series on Advanced Techniques & Tools for Software Evolution (Steering Committee Member)

● SI – Swiss Informatics Society (Board Member)

● SIRA – Swiss Informatics Research Association (Board Member)

● SNF – Swiss National Science Foundation (Member of the Research Council)
Program Committees

Oscar Nierstrasz

- Invited Speaker at Simula 50 Years: “Great Moments in the History of OOP (50 years anniversary of Simula, the first object-oriented programming language — Oslo, Norway, Sept. 27, 2017)
- PC Member of SANER 2018 (International Conference on Software Analysis, Evolution, and Reengineering — Campobasso, Italy, March 19-23, 2018) 2017
- PC Member of BENEVOL 2017 (16th BElgian-NEtherlands software eVOlution symposium — University of Antwerp, Belgium, Dec 4-5, 2017)
- PC Member of ICSME 2017 (International Conference on Software Maintenance and Evolution — Shanghai, China, Sept. 17-23, 2017)
- PC Member of SANER 2017 (International Conference on Software Analysis, Evolution, and Reengineering — Klagenfurt, Austria, Feb. 21-24, 2017)

Mohammad Ghafari

- PC member of ICSME 2018 (34th International Conference on Software Maintenance and Evolution — Madrid, Spain, Sep 23-29, 2018)
- PC member of VST 2018 (2nd Workshop on Validation, Analysis and Evolution of Software Tests – Campobasso, Italy, March 20-23, 2018)

Leonel Merino

- PC Member of VISSOFT 2018 – Artifact Evaluation Committee (6th IEEE Working Conference on Software Visualization — Madrid, Spain, September 24-25, 2018)

Yuriy Tymchuk

- PC Member of VISSOFT 2018 – NIER and Tool Demo Track (6th IEEE Working Conference on Software Visualization — Madrid, Spain, September 24-25, 2018)
Nevena (Milojković) Lazarević

- PC member of SATToSE 2018 (11th Seminar Series on Advanced Techniques & Tools for Software Evolution – Athens, Greece, July 4-6, 2018)
- PC Member of IWST 2018 – (10th International Workshop on Smalltalk Technologies – Cagliari, Italy, September 10-14, 2018)

Reviewing Activities

Oscar Nierstrasz

- IEEE Transactions of Software Engineering
- Israel Science Foundation

Mohammad Ghafari

- Journal of Software: Evolution and Process (JSEP)
- ICSME 2018
- SCAM 2018

Haidar Osman

- IEEE Transactions on Software Engineering (TSE Journal)

Leonel Merino

- VR 2018
- SANER 2018
- VISSOFT 2018

Claudio Corrodi

- SATToSE 2018

Manuel Leuenberger

- SATToSE 2018
- SCAM 2018

Yuriy Tymchuk
6. Software Composition Group

- VISSOFT 2017

Pooja Rani
- SCAM 2018
- SATToSE 2018

Nevena (Milojković) Lazarević
- SANER 2018
- SATToSE 2018
- IWST 2018

Pascal Gadient
- SCAM 2018

6.9 Publications

Journal Papers


Conference Papers


Book Chapters

7 Administration

University:

T. Braun: Member of the Committee for Computing Services (Kommission für Informatikdienste)
Representative of University of Bern in SWITCH Stiftungsrat
G. Jaeger: Member of Kantonale Maturitätskommission

Faculty:

T. Braun: Faculty Board Natural Sciences
G. Jaeger: Member Faculty Strategy Committee (until December 2017)
P. Favaro: Member of the Board of Studies
Joint Master in Computer Science of the Universities of Bern, Fribourg and Neuchâtel: Member of the Branch Committee
Faculty delegate
O. Nierstrasz: Chair, Teaching Evaluation Committee, Faculty of Natural Sciences
Joint Master in Computer Science of the Universities of Bern, Fribourg and Neuchâtel: Member of the Branch Committee
Member Faculty Strategy Committee (as of January 2018)
Member Digitalisation Strategy Working Group
Member Precision Medicine Working Group
Th. Studer: Member of the Strategy Board

Institute:

O. Nierstrasz: Managing Director of INF
Member of Hauskommission Engehalde
President CUSO Doctoral School in Computer Science
T. Braun: Deputy Director of INF
P. Favaro: Director of Studies
N. Lazarević: Member of Library Committee Exakte Wissenschaften
Th. Studer: Member of Hauskommission Exakte Wissenschaften