

Annual Report 2000

IAM-00-003

January, 2001

Contents

1	Institute of Computer Science and Applied Mathematics (IAM)	2
1.1	Address	2
1.2	Personnel	2
2	Research Group on Computational Geometry and Graphics	4
2.1	Personnel	4
2.2	Research Projects	4
2.3	Diploma Theses	6
2.4	Further Activities	7
2.5	Publications	7
3	Research Group on Computer Networks and Distributed Systems	8
3.1	Personnel	8
3.2	Research Projects	8
3.3	Diploma Thesis	14
3.4	Further Activities	14
3.5	Publications	16
4	Research Group on Computer Vision and Artificial Intelligence	20
4.1	Personnel	20
4.2	Research Projects	20
4.3	Diploma Theses	22
4.4	Ph.D. Theses	22
4.5	Further Activities	23
4.6	Publications	24
5	Research Group on Theoretical Computer Science and Logic	28
5.1	Personnel	28
5.2	Research Projects	29
5.3	Diploma Theses	31
5.4	Ph.D. Thesis	32
5.5	Further Activities	32
5.6	Publications	32

6	Research Group on Software Composition	34
6.1	Personnel	34
6.2	Research Projects	35
6.3	Diploma Thesis	38
6.4	Further Activities	38
6.5	Publications	39
A	Teaching Activities	42
A.1	Winter semester 1999/2000	42
A.2	Summer semester 2000	43
A.3	Winter semester 2000/2001	44
B	Colloquium in Informatics	45

1 Institute of Computer Science and Applied Mathematics (IAM)

1.1 Address

Neubrückstrasse 10, CH-3012 Bern, Switzerland
Telephone: +41 31 631 86 81, Telefax: +41 31 631 39 65
www: <http://www.iam.unibe.ch>

1.2 Personnel

Board of directors

Prof. Dr. Hanspeter Bieri; Prof. Dr. Torsten Braun; Prof. Dr. Horst Bunke;
Prof. Dr. Gerhard Jäger; Prof. Dr. Oscar Nierstrasz.

Docents

Prof. Dr. Hanspeter Bieri; Lektor Hans Peter Blau; Prof. Dr. Torsten Braun;
Prof. Dr. Horst Bunke; Prof. Dr. Gerhard Jäger; PD Dr. Xiaoyi Jiang; Prof.
Dr. Oscar Nierstrasz.

Acting chairman

Prof. Dr. Gerhard Jäger.

Administration

René Berliat; Ruth Bestgen; Isabelle Huber (until August); Sylvia Schaad
(until October); Therese Schmid (since September); Susanne Thüler; Terri
Weibel (since August).

Librarian

Michael Gianfreda (since June); Barbara Winkelmann (until Mai).

Technical staff

Florian Baumgartner (since February); Peppo Brambilla (since February);
Markus Lumpe (until August); Jürg Stiefenhofer (until February).

Scientific staff

Franz Achermann; Luca Alberucci; Lorenz Ammon; Gabriela Arévalo; Roland Balmer; Peter Balsiger; Florian Baumgartner; Hans-Peter Blau; Peppo Brambilla; Thomas Buchberger; Juan Carlos Cruz; Dr. Stéphane Ducasse; Stefan Fischer; Manuel Günter; Simon Günther; Pascal Habegger; Christophe Irniger; PD Dr. Xiaoyi Jiang; Ibrahim Khalil; Michele Lanza; Linqing Liu; Daniel Margreth; Urs-Viktor Marti; Dr. Geoffrey Ostrin; Dieter Probst; Tamar Richner; Matthias Rieger; Li Ru; Dr. Christian Rüede; Karin Sobotka; Günther Stattenberger; Marc-Alain Steinemann; Dr. Thomas Strahm; Thomas Studer; Sander Tichelaar; Dr. Sergei Tupailo; Markus Volkmer; Thomas Wenger; Marc Wirz; Dr. Roel Wuyts; Matthias Zimmermann.

Number of students in computer science

- Major subject: 204
- Minor subject: 177

2 Research Group on Computational Geometry and Graphics

2.1 Personnel

Head:	Prof. Dr. H. Bieri	Tel.: +41 31 631 8670 email: bieri@iam.unibe.ch
Office Manager:	R. Berliat	Tel.: +41 31 631 4914 email: berliat@iam.unibe.ch
Scientific Staff:	L. Ammon	Tel.: +41 31 631 8676 email: ammon@iam.unibe.ch
	Th. Buchberger	Tel.: +41 31 631 4864 email: buchberg@iam.unibe.ch
	P. Habegger	Tel.: +41 31 631 4679 email: habegger@iam.unibe.ch
	Th. Wenger	Tel.: +41 31 631 4990 email: wenger@iam.unibe.ch

2.2 Research Projects

d-dimensional general polyhedra

These polyhedra, now called "Nef polyhedra", are those subsets of the d-dimensional Euclidean space that can be obtained by applying a finite number of Boolean set operations to a finite number of linear halfspaces. The project extends the theory of Nef polyhedra, develops and analyses convenient data structures and lays the foundation of an object-oriented implementation of the kernel of a solid modeler for working with Nef polyhedra.

Research staff: H. Bieri, W. Nef

A database system for 3D graphics objects

This project continues previous research done by Andrey Collison (cf. A component-based system for storing and manipulating graphics objects of different representations, in *The Visual Computer* 16(6), 2000). The database system is intended to support the following features: persistency for hierarchically structured 3D objects and textures, integration of different representations and various kinds of 3D graphics functionality, multiuser cooperation based on heterogeneous 3D objects, content-based object retrieval, and web integration.

Research staff: L. Ammon

Generic geometric 3D city modelling for multimedia applications

This project continues previous research done by Thierry Matthey (cf. An object-oriented approach to model scenes of buildings, in Proceedings of Computer Graphics International 1998). Its goal is the development of a generic city model to be used in miscellaneous multimedia applications. The main focus is put on real-time visualization and interaction abilities. An object-oriented approach is chosen to provide flexibility and extensibility. A main problem is the acquisition of the underlying geometric data. Most known methods are time-consuming and expensive. Therefore methods are developed that support semi-automatic generation of the model data from easily accessible data, e.g. maps. High accuracy of the model is not considered a mandatory requirement. As an example application, the development of the city of Berne as a function of time shall be visualized and animated.

Research staff: Th. Buchberger

Modelling of computer networks with Internet properties

One main goal of this project is the design and implementation of a "topology generator" that can be used to generate graphs representing network topologies according to different kinds of properties that are assumed to be characteristic for the Internet. The topology generator is based on a flexible graph framework implemented in Java which contains different basic algorithms operating on graphs. The second main goal consists in the development of a new topological model for the Internet, i.e. a hierarchy of graphs growing as a function of time. Available Internet data shall be used to validate both, the topology generator and the proposed Internet model.

Research staff: P. Habegger

JMesh: A mesh library in Java

There is much research done at present dealing with triangular meshes in 3D. This project intends to build a uniform but flexible framework for experimenting with different kinds of mesh data structures and algorithms. The most important basic algorithms will be included in JMesh, and several applications will be implemented to investigate the extensibility, the efficiency, and the reliability of the framework.

Research staff: Th. Wenger

Project "O"

Project "O" is a collaboration of three diploma projects to create a computer game world. Real-time rendering, artificial intelligence and physical simulation are the topics of the project. As a reference implementation, a 3D jump-and-run game called "Serphillion" is implemented to combine all the elements of the different works into a single whole that will offer a fun and intuitive way to experiment with the underlying structure. This structure is in the form of several frameworks which can be used in part or as a whole to produce many different real-time applications. The entire architecture is open and flexible and can be expanded in several directions. Level editing, character animation or other useful additions are possible to round out the functionality of the architecture.

Research staff: J.M. Hutchison, P.C.D. Robert, S. Wyssmann

A virtual reality orientation guidance to the IAM

This project extends a predecessor, i.e. an application in VRML consisting of a model of certain parts of the institute building, and real-time animations that simulate some of the possible walkthroughs. The new project intends to add humans, i.e. models of the members of the IAM staff. Several known techniques to model and animate humans will be adapted and implemented in order to obtain a usable orientation system for practical purposes.

Research staff: M. Cobo

2.3 Diploma Theses

- L. Ammon: SIS-Creator System
- Th. Buchberger: Einbetten von robusten Wasserzeichen in digitalen Bildern
- M. Bürki: BalanceIK: A 3D Studio Max Plug-in for Inverse Kinematics
- Th. Oexl: Computer-gestützte Visualisierung des Pulfrich-Phänomens
- B. Rigazzi: VoiceMapping

2.4 Further Activities

- Member of the Programme Committee Eurographics 2000: H. Bieri
- Reviewing for Computer Graphics International 2000: H. Bieri
- Reviewing for Computational Geometry - Theory and Applications: H. Bieri
- Area Editor (Geometric Modeling) of The Visual Computer: H. Bieri
- Computeranimation for the exhibition "Bildersturm", Bernisches Historisches Museum: D. Bukovac, C. Glauser, M. Helmers
- Project "Art History, 1300-2000", Virtual Campus Switzerland. Project partner: H. Bieri

2.5 Publications

- T. Bebie and H. Bieri: A video-based 3D-reconstruction of soccer games. Computer Graphics Forum (Eurographics 2000), 19(3), C-391 - C-400, 2000
- A. Collison and H. Bieri: A component-based system for storing and manipulating graphics objects of different representations. The Visual Computer 16(6), 322-338 (2000)
- B. Rigazzi and H. Bieri: VoiceMapper - A PC-based system for mapping human voices. Proceedings of the IASTED conference Signal Processing and Communications 2000, Marbella, 228 - 232.
- H. Bieri: An elementary introduction to Nef polyhedra. Course notes. Géométrie algorithmique 2000. CIRM (Marseille)

3 Research Group on Computer Networks and Distributed Systems

3.1 Personnel

Head:	Prof. Dr. T. Braun	Tel.: +41 31 631 4994 email: braun@iam.unibe.ch
Office Manager:	R. Bestgen	Tel.: +41 31 631 8957 email: bestgen@iam.unibe.ch
	S. Schaad (until September)	
Scientific Staff:	R. Balmer *	Tel.: +41 31 631 8646 email: balmer@iam.unibe.ch
	F. Baumgartner *	Tel.: +41 31 631 8646 email: baumgart@iam.unibe.ch
	M. Günter *	Tel.: +41 31 631 8691 email: mguenter@iam.unibe.ch
	I. Khalil *	Tel.: +41 31 631 8692 email: ibrahim@iam.unibe.ch
	L. Liu *	Tel.: +41 31 631 8668 email: liu@iam.unibe.ch
	L. Ru *	Tel.: +41 31 631 3403 email: liru@iam.unibe.ch
	G. Stattenberger *	Tel.: +41 31 631 3404 email: stattenb@iam.unibe.ch
	M.-A. Steinemann (since April)	Tel.: +41 31 631 8691 email: steine@iam.unibe.ch

* with financial support from a third party

3.2 Research Projects

Charging and Accounting Technologies for the Internet (CATI)

The main goal of the CATI project has been the design, evaluation and implementation of charging and accounting mechanisms for value-added Internet services such as Integrated Services, Differentiated Services and Virtual Private Networks (VPNs). CATI was a CNEC (Competence Network Electronic Commerce) project within the Swiss Priority Program for Information and Communications Structures (SPP ICS) of the Swiss National Science Foundation (SNF) running from July 1998 to March 2000. The RVS

group developed a flexible VPN service system including Quality-of-Service (QoS) support. The user can set up, modify and tear down VPN connections on-line and choose from IP Security features for the VPN service as well as QoS features similar to the IETF's Differentiated Services. The developed system supports both Cisco and Linux routers and handles accounting of VPN connections considering bandwidth, duration of the reservation, time of day, security parameters etc. To support Integrated Services applications, a gateway has been implemented on Linux for mapping Integrated Services to Differentiated Services reservations. Automatic set up and management of VPNs between the universities of Genève and Bern as well as the Integrated / Differentiated Services gateway using an RSVP capable video application have been demonstrated successfully during the final SNF CNEC workshop in March 2000 at Bern. In addition, bandwidth broker protocols have been developed and implemented in order to support multi-provider VPN services.

Research staff: M. Günter, I. Khalil, L. Liu, R. Balmer, E. Granges

Financial support: Swiss National Science Foundation Projects No. 5003-054559/1 and 5003-054560/1

Advanced Network and Agent Infrastructure for the Support of Federations of Workflow Trading Systems (ANAISSOFT)

ANAISSOFT is a project in the framework of the 2nd phase of the SNF CNEC programme. Academic project partners are the Universities of Zürich and Genève, EPF Lausanne, and ETH Zürich. In addition, several non-academic partners collaborate within the project: Etat de Vaud, SER Systeme A.G., Swisscom, Swissmetro, TheNet - Internet Services AG. The RVS group continues the CATI work into two directions: First, an architecture to enhance the VPN services for mobile users has been designed and will be implemented. Mobile IP VPN services enable Mobile IP users that are roaming in the Internet to access the VPN of their organization. Second, monitoring functions are required to make sure that the service contracts established between customers and ISPs for a VPN service, are really met. This includes both security functions and Quality-of-Service (QoS). These monitoring functions have been implemented on the basis of mobile agent technology. Mobile Java agents can be executed in measurement environments located at the ISP's premises. The environments offer a secured interface for direct and generic IP network measurements to customers, peer providers or the ISPs own network management crew.

Research staff: M. Günter, I. Khalil, M. Danzeisen

Financial support: Swiss National Science Foundation Project No. 5003-057753/1

Commercialization of Streamed Information (StreamCom)

StreamCom is another 2nd phase SNF CNEC project. Its main goal is to study various problems and issues related to the commercialization of streamed information. Project partners are EPF Lausanne, and the Universities of Genève, St. Gallen, and Zürich. The RVS group focuses on the development of Quality-of-Service (QoS) support for streamed information such as video streams. The provider of the StreamCom service can set up and tear down the QoS support for the data streams by delivering the corresponding parameters to a bandwidth broker of the ISP. The bandwidth broker receives and processes these requests and configures the ISPs routers appropriately. The data streams are distributed using multicast, and, therefore, the Differentiated Services based QoS support must be able to support IP multicast streams. A protocol has been designed on the basis of the bandwidth broker protocol developed in CATI which allows the StreamCom service provider to negotiate the desired service with the ISPs bandwidth broker. This protocol will be implemented in Java.

Research staff: R. Balmer

Financial support: Swiss National Science Foundation Project No. 5003-057755/1

Mobile IP Telephony (MIPTel) and Mobile IP Quality-of-Service (MobiQoS)

The Mobile IP Telephony project funded by SNF aims to develop an architecture supporting IP telephony applications over DiffServ IP networks. The project is directly linked with the Mobile IP Quality-of-Service (MobiQoS) research activity performed in collaboration with INRIA Rhône Alpes and ENST (Ecole National Supérieure de Telecommunication) Bretagne. The first goal of MIPTel is to develop adaptive audio applications that can make use of Differentiated Services provided in home / foreign networks with wireless access. The basic framework of the Differentiated Services Internet Telephone (dsphone) has been implemented and is running on Linux end systems. The implementation includes a graphical user interface to configure the system,

and start / stop connections. It also displays the current network transmission status. A simplified version of RTP/RTCP, which omits certain functionalities only used in applications with more than two participants, has been developed. An audio application can select the DiffServ Codepoint of an outgoing packet dynamically. Two audio encoding schemes with different sampling rates are currently being supported (PCM and μ Law). The second issue investigated in MIPTel is the determination of the desired service level of a mobile user visiting a foreign network provider. A comprehensive architecture has been developed to support authentication, service level detection, service provisioning as well as charging and accounting. The architecture is based on AAA servers (AAA: Authentication, Authorization, and Accounting) and a protocol running between AAA servers located in home and foreign networks. Mobile nodes make use of the IETF's Service Location Protocol (SLP) for the discovery of network services such as Differentiated Services. The architecture enables a mobile user to use the same service levels in a foreign network as used to in the home network.

Research staff: L. Ru, G. Stattenberger, M. Scheidegger

Financial support: Swiss National Science Foundation Project No. 2100-057077.99/1, Institut National de Recherche en Informatique et en Automatique (INRIA)

QoS Support for the Internet based on Intelligent Network Elements

Active Networking (AN) is a promising technology for flexible and powerful service provisioning in future telecommunications and computer networks. The project includes a collaboration with a research group at Purdue University that already gained experience with this rather new AN technology. AN shall be applied for management related tasks, i.e. so-called AN capsules (packets carrying programs that can be executed in network nodes such as IP routers) are used to reconfigure routers in order to provide QoS for specific flows in the Internet. This includes topics like traffic conditioning components (especially for Differentiated Services), signaling, QoS routing and the development of appropriate multimedia applications, capable to exploit the AN benefits. A prototypical AN system and a special hybrid network simulator have been designed and implemented, allowing to emulate larger Active Networks and to study their behaviour using real applications simultaneously. This environment is being used to evaluate different AN based methods of

resource reservation mapping (Integrated to Differentiated Services) and network management.

Research staff: F. Baumgartner

Financial support: Swiss National Science Foundation Project No. 2100-055789.98/1

Virtual Telecommunications Laboratory Switzerland

This project is one of a first series of Virtual Campus Switzerland (VCS) projects. The goal is to develop a course that provides practical exercises in the area of telecommunications / computer networks to the students. The course language is English. The exercises shall be performed by students remotely. Students do not need to be present in particular laboratory rooms. In addition, supplementary tutorial material and theoretical online exercises are under development. In total, seven modules and the authentication/authorization infrastructure will be developed and maintained by the different involved institutes (Universities of Bern, Fribourg, Genève, Neuchâtel and Engineering School Fribourg) and integrated into a common web environment. Two of these modules are developed at Bern: IP Network Simulation Configuration and Management of Virtual Private Networks. Several design activities addressing the accessibility and restorability of the laboratory equipment have been started in 2000. Valuable experiences have already been gained during the development of a traditional network laboratory course.

Research staff: M.-A. Steinemann, L. Liu

Financial support: Bundesamt für Bildung und Wissenschaft (BBW), Virtual Campus Switzerland Project No. 991043

Differentiated Services over ATM

The Differentiated Services implementation on a Linux-based router has been extensively tested and detailed performance measurements have been performed. Both, Expedited and Assured Forwarding implementations have proven their ability to protect traffic against aggressive flows and congestion. The implementation has also been extended to support IPv6 traffic. Those extensions have been tested and initial results are similar as for IPv4. The

second part of the project focuses on the development of a platform independent Quality of Service (QoS) management API, that enables an application programmer to develop QoS management software to be used in heterogeneous network environments. An interface for addressing the Linux DiffServ router by calling the API functions has been implemented. The main goal of this part of the project is the design of a generic bandwidth broker architecture that can be used on Linux router test beds.

Research staff: G. Stattenberger, M. Scheidegger, A. Dasen

Financial support: NEC Computer & Communication Research Laboratories, Heidelberg, Germany

Virtual Private Network Management

TBD Networks provides a management application for of all types of VPNs (site-to-site, remote access and extranet) throughout the entire VPN life cycle. It enables an enterprise's security policy information, created during the design phase, to feed a fully automated provisioning, where device configurations are interpreted directly from the security policy and are automatically deployed to the VPN devices in the network. An intelligent device driver for VPN device provisioning has been developed by University of Bern. The device driver includes audit capabilities and is intended for Nortel routers. It automatically verifies the appropriate network configuration at any given time and raises the necessary alarms when a security break has been identified.

Research staff: I. Khalil

Financial support: TBD Networks Inc., Fremont, California, USA

ISDN/MBone-Gateway

The ISDN/MBone-Gateway is a solution to enable ISDN/PSTN users to join IP multicast (MBone) sessions using (mobile) ISDN/PSTN telephones. Gateway control mechanisms allowing users to select and join those conferences easily have been developed. With the comprehensive gateway control implementation on a Linux platform integrated with available public domain software components such as for audio forwarding, a mobile user with a WAP capable mobile phone or with a regular web browser can select current available multicast sessions and conferences, create new conferences, register to

the gateway and then dial up to the gateway for joining the sessions. All of the session information and gateway contact information can be distributed using several communication channels such as HTML / WML pages or SMS / email.

Research staff: L. Liu

Financial support: Bundesamt für Berufsbildung und Technologie (BBT) / Kommission für Technologie und Innovation (KTI) Project No. 4486.1 KTS and Telscom AG, Bern

Testbed for Mobile and Internet Communications

An experimental test network serves for the implementations performed within the various research projects mentioned above. The network consists of UNIX servers, Linux and commercial routers, ATM switches, LAN switches as well as a variety of multimedia end systems. Two experimental subnetworks, one for Mobile IP implementation tests and one for DiffServ / IPv6 experiments have been established additionally. The two networks include Linux routers and hosts based on publicly available Mobile IP and IPv6 implementations. In addition, several traffic generators for DiffServ and IPv6 tests have been developed.

Research staff: R. Balmer, F. Baumgartner, I. Khalil, G. Stattenberger, Th. Bodenmann, A. Weyland

Financial support: Stiftung zur Förderung der wissenschaftlichen Forschung an der Universität Bern

3.3 Diploma Thesis

- E. A. Granges: Bandwidth Broker für Differentiated Services, March 2000

3.4 Further Activities

Conference Program Committee Memberships

- IEEE Conference on High Performance Switching and Routing (HPSR), Heidelberg, Germany, June 26 - 29, 2000 (T. Braun)

- 1st IEEE European Conference on Universal Multiservice Networks, ECUMN'2000, Colmar, France, October 2-4, 2000 (T. Braun)
- 6th IFIP Conference on Intelligence in Networks (SmartNet 2000), Vienna, Austria, September 18 - 22, 2000 (T. Braun)
- 25th IEEE Annual Conference on Local Computer Networks (LCN), Tampa, Florida, USA, November 8-10, 2000 (T. Braun)
- GI/ITG-Fachtagung Kommunikation in Verteilten Systemen, Hamburg, Germany, February 20-23, 2001 (T. Braun)
- 11th IEEE Workshop on Local and Metropolitan Area Networks, Boulder, Colorado, USA, March 18-21 2001 (T. Braun)

Technical Committees

- SWITCH Stiftungsrat (T. Braun)
- SWITCH Stiftungsratsausschuss (T. Braun)
- SPEEDUP Society Committee (T. Braun)

Reviewing Activities

- Journal on Integrated Computer-Aided Engineering, IOS Press
- Computer Networks Journal, Elsevier
- International Conference on Communications (ICC), Helsinki, Finland, June 11-15, 2001
- IEEE Infocom, Anchorage, Alaska, USA, April 22-26, 2001

Invited Talks

- T. Braun: Service Broker für globale Internet-Dienste, Informatikkolloquium, University of Karlsruhe, Germany, January 7, 2000
- T. Braun: Service Broker for Global Internet Services, Cisco, San Jose, California, USA, February 16, 2000
- I. Khalil: Implementation of a Service Broker for Management of QoS Enabled VPNs, VPNcon, San Jose, California, March 2, 2000

- T. Braun: A Broker-Architecture for Value-Added Internet Services, Dagstuhl Seminar “Quality-of-Service”, Dagstuhl, Germany, May 10, 2000
- T. Braun: Virtual Telecommunications Laboratory Switzerland, Dagstuhl Seminar “Multimedia for Multimedia”, Dagstuhl, Germany, June 12, 2000
- T. Braun: MPLS and Computer Networking Research at University of Berne, TBD Networks, Fremont, California, USA, November 7, 2000

Tutorials

- T. Braun: Quality-of-Service and Traffic Engineering in IP Networks, IEEE Workshop on IP-oriented Operations & Management (IPOM), Cracow, Poland, September 4-6, 2000
- T. Braun: Next Generation Internet Protocols for Optical Network Environments, SPIE Photonics East, Boston, Massachusetts, USA, November 6, 2000
- F. Baumgartner, T. Braun, M. Günter: Sicherheit im Internet, Sicher2000, Bern, November 16-19, 2000.

Organized Events

- Swiss National Science Foundation symposium on Research Results of the Competence Network for Applied Research in Electronic Commerce (CNEC), Bern, February 22, 2000
- Séminaire de Printemps du 3ème Cycle Romand d’Informatique on Agent Technology, Lenk im Simmental, March 6-10, 2000

3.5 Publications

Journal and Conference Papers

- B. Stiller, T. Braun, B. Plattner, R. Balmer, F. Baumgartner, D. Billard, G. Dermler, G. Fankhauser, N. Foukia, M. Günter, I. Khalil, H. Kneer, S. Leinen, C. Matt, P. Reichl, D. Schweikert, N. Weiler and U. Zurfluh: Charging and Accounting Technology for the Internet, in: Schweizerischer Verband der Informatikorganisationen SVI/FSI (ed.): INFORMATIK/ INFORMATIQUE 1/2000, pp. 66-68, ISSN 1420-6579

- M. Günter: Virtuelle Private Netze für das Internet, Bulletin des Schweizerischen Elektrotechnischen Vereins, 7/2000, pp. 23-27, ISSN 1420-7028
- G. Dermler, M. Günter, T. Braun and B. Stiller: Towards a Scalable System for Per-Flow Charging in the Internet, Applied Telecommunication Symposium, in B. Bodnar, A. Sharon (eds.): Simulation Series, Vol. 32, No. 4, The Society for Computer Simulation International, ISBN:1-56555-196-6
- T. Braun, A. Dasen, M. Scheidegger, K. Jonas and H. Stüttgen: Implementation of Differentiated Services over ATM, Proceedings of the IEEE Conference on High Performance Switching & Routing, June 26-29, 2000, Heidelberg, Germany, pp. 317-322, ISBN 1098-7789
- I. Khalil, M. Günter and T. Braun: Implementation of a Service Broker for Management of QoS Enabled VPNs, IEEE Workshop on IP-oriented Operations & Management (IPOM 2000), September 4-6, 2000, Cracow, Poland, pp. 13-23, ISBN 83-88309-00-5
- M. Günter and T. Braun: Service Delivery Control with Mobile Code, in H. van As (ed.): Telecommunication Network Intelligence, 6th International IFIP Conference on Intelligence in Networks (SmartNet 2000), September 18-22, 2000, Vienna, Austria., pp. 3-19, ISBN 0-7923-7932-2
- F. Baumgartner and T. Braun: Virtual Routers: A Novel Approach for QoS Performance Evaluation, in: J. Crowcroft, J. Roberts, M. Smirnov (eds.): Quality of Future Internet Services, First COST 263 International Workshop, QofIS'2000, September 25-26, 2000, Berlin, Germany, Lecture Notes in Computer Science 1922, Springer, pp. 336-347, ISBN 3-540-41076-7
- T. Braun, M. Scheidegger, H. J. Einsiedler, G. Stattenberger, K. Jonas and H. J. Stüttgen: A Linux Implementation of a Differentiated Services Router, in S. Rao, K. I. Sletta (eds.): Next Generation Networks (Networks and Services for the Information Society), INTERWORKING' 2000, October 3-6, 2000, Bergen, Norway, Lecture Notes in Computer Science 1938, pp. 302 - 315, ISBN: 3-540-41140-2
- R. Balmer, F. Baumgartner, T. Braun and M. Günter: A Concept for RSVP over DiffServ, in T. Engbersen, E. Park: Proceedings of the 9th International Conference on Computer Communication and Network

(ICCCN 2000), October 16-18, 2000, Las Vegas, USA, pp. 412-417, ISBN 0-7803-6494-5

- I. Khalil and T. Braun: Edge Provisioning and Fairness in VPN-Diffserv Networks, in T. Engbersen, E. Park: Proceedings of the 9th International Conference on Computer Communication and Network (ICCCN 2000), October 16-18, 2000, Las Vegas, USA, pp. 424-431, ISBN 0-7803-6494-5
- F. Baumgartner and T. Braun: Quality of Service and Active Networking on Virtual Router Topologies, in H. Yasuda (ed.): 2nd International Working Conference on Active Networks, IWAN 2000, October 16-18, 2000, Tokyo, Japan, Lecture Notes in Computer Science 1942, pp. 211-224, ISBN 3-540-41179-8
- I. Khalil and T. Braun: Implementation of a Bandwidth Broker for Dynamic End-to-End Resource Reservation in Outsourced Virtual Private Networks, 25th IEEE Conference on Local Computer Networks (LCN 2000), November 9-10, 2000, Tampa, Florida, pp. 511-519, ISBN 0-7695-0912-6
- T. Braun: Multicast-Kommunikation im Internet, in: Elektrotechnik und Informationstechnik (e&i), Zeitschrift des Österreichischen Verbandes für Elektrotechnik, Heft 6 / 2000, pp. 389-398, ISBN 0932-383X

Posters and Workshop Abstracts

- M. Günter and T. Braun: Extended Abstract: Internet Service Delivery Control with Mobile Agents, 2nd International Symposium on Agent Systems and Applications / Mobile Agents (ASA/MA 2000), September 13-15, 2000, Zürich, Switzerland
- F. Baumgartner and T. Braun: Active Networking, QoS and Virtual Routers, Extended Abstract for the ASA/MA 2000, September 13-15, 2000, Zürich.
- F. Baumgartner and T. Braun: Virtual Routers Supporting Active Networking, Extended Abstract, Stockholm Active Networks Day (SANDay), August 28, 2000, Stockholm, workshop organized by Uppsala University, Sweden, held in conjunction with ACM SIGCOMM 2000

Technical Reports

- A. Dasen: Implementation of Differentiated Services over ATM. Informatikprojekt, January 2000
- M. Brogle: Active Networking mit ANTS. Informatikprojekt, May 2000
- M. Günter, M. Brogle and T. Braun: Secure Communication: a New Application for Active Networks, Technical Report, IAM-00-007, July 2000
- T. Braun: Multicast for Small Conferences, Technical Report, IAM-00-008, July 2000.
- L. Ru, T. Braun and G. Stattenberger: An AAA based Architecture for Providing Differentiated Services to Mobile IP Users, Technical Report, IAM-00-009, November 2000.
- G. Stattenberger and T. Braun: Implementation and Configuration of a Linux Differentiated Services Router, Technical Report, IAM-00-010, November 2000.
- A. Weyland: Evaluation of Mobile IP Implementations under Linux. Informatikprojekt, December 2000

4 Research Group on Computer Vision and Artificial Intelligence

4.1 Personnel

Head:	Prof. Dr. H. Bunke	Tel: +41 31 631 44 51 email: bunke@iam.unibe.ch
Office Manager:	S. Thüler	Tel.: +41 31 631 86 81 email: thueler@iam.unibe.ch
Scientific staff:	S. Fischer*	Tel: +41 31 631 86 99 email: fischer@iam.unibe.ch
	S. Günter	Tel: +41 31 631 85 74 email: sguenter@iam.unibe.ch
	Ch. Irniger*	Tel: +41 31 631 49 87 email: irniger@iam.unibe.ch
	PD Dr. X. Jiang* (until March)	
	Dr. U.-V. Marti*	Tel: +41 31 631 85 74 email: marti@iam.unibe.ch
	K. Sobottka* (until February)	
	M. Volkmer* (until February)	
	M. Zimmermann*	Tel: +41 31 631 48 65 email: zimmerma@iam.unibe.ch
Guests:	Prof. A. Kandel	University of South Florida, Tampa, June – July
	Prof. S. Venkatesh	Curtin University, Perth Australia, April

* with financial support from a third party

4.2 Research Projects

Range Image Analysis

The research in range image analysis is continued by the development of new segmentation and surface representation techniques. We are working on qualitatively decomposing a range image into convex parts and efficient

least-square methods for surface approximation.

Research staff: X. Jiang

Range Image Sequence Analysis

The purpose of the MINORA project is to develop reliable presence detection systems based on range image sequences. Due to low resolution (16x64), incompleteness and ambiguity of the data, the interpretation needs novel approaches and innovative techniques in the field of image sequence processing. As application we consider the problem of obstacle detection and tracking in traffic scenes, but there are many more areas, e.g. surveillance and security, that would benefit from the availability of such systems.

Research staff: K. Sobottka

Financial Support: Swiss National Science Foundation (Schwerpunktprogramm OPTIQUE II)

Document Image Analysis and Understanding

A variety of problems occurring in the context of document image analysis are being investigated. These include the processing and recognition of both machine printed and handwritten documents. Current focus is on handwriting recognition, particularly on general text recognition and the use of natural language processing techniques. Also multiple classifier systems and their application to handwriting recognition are under investigation.

Research staff: S. Günter, U.-V. Marti, M. Zimmermann

Financial support: Swiss National Science Foundation

Graph Matching Algorithms and Applications

Graphs are a flexible and powerful representation mechanism that has been successfully applied in computer vision, pattern recognition and related areas. When graphs are used to represent objects of a particular domain, the recognition problem turns into the task of graph matching. In this project we study a variety of issues, including efficient algorithms for graph matching, the adaptation of concepts and techniques based on vector representations to the domain of graphs, and special classes of graphs that allow matching with

polynomial complexity.

Research Staff: Ch. Irniger, X. Jiang, H. Bunke

Structural and Syntactic Pattern Recognition

The key idea in structural and syntactic pattern recognition is the representation of patterns by means of symbolic data structures such as strings, trees, and graphs. In order to recognize an unknown pattern, its symbolic representation is compared with a number of prototypes stored in a database. In this project, we aim at developing new symbolic matching and parsing algorithms for a variety of applications.

Research staff: H. Bunke

Automatic Diatom Identification and Classification

The ADIAC project is a pilot study concerning the application of image processing and pattern recognition tools to the automation of diatom identification by computer processing. The project is divided into several subtasks which are solved by different European institutes. At the IAM a solution is searched to identify the shapes in a first step based on their valve outline, and in a second step based on the valve ornamentation. Several feature extraction methods have been implemented and the performance of different classification approaches is evaluated in order to obtain robust algorithms to identify unknown diatoms.

Research staff: S. Fischer

4.3 Diploma Theses

- Ch. Irniger: Design of Image Data Sets for Segmentation Performance Evaluation
- R. Messerli: Personenidentifikation mit Schriftmerkmalen
- C. G. Cris: Fusion von Tiefen- und Intensitätsdaten zur Objektverfolgung
- S. Günter: Clustering von Graphen mit dem Kohonenverfahren

4.4 Ph.D. Theses

- R. Bächler: Oberflächenbasierte Registrierung für orthopädische und HNO-Anwendungen

- K. Sobottka: Analysis of low resolution range image sequences
- U.-V. Marti: Off-line recognition of handwritten texts

4.5 Further Activities

Editorial Boards and Committees

- Acting President of the Int. Association for Pattern Recognition, IAPR (H. Bunke)
- Editor-in-charge of the International Journal of Pattern Recognition and Artificial Intelligence by World Scientific Publ., Singapore (H. Bunke)
- Member of the editorial board of the International Journal on Document Analysis and Recognition (H. Bunke)
- Member of the editorial board of Pattern Analysis and Applications (H. Bunke)
- Member of the editorial board of Acta Cybernetica (H. Bunke)
- Editor-in-chief of the book series Machine Perception and Artificial Intelligence by World Scientific Publ., Singapore (H. Bunke)

Program Committees

- 4th IAPR Int. Workshop on Document Analysis Systems, DAS '2000, Rio de Janeiro, Brazil, December 10-13, 2000 (H. Bunke)
- Symposium Advanced Concepts for Intelligent Vision Systems, Baden-Baden, Germany, July 31- August 4, 2000 (H. Bunke)
- 2nd Workshop on Empirical Evaluation Methods in Computer Vision, Dublin, Ireland, July 1, 2000 (H. Bunke)
- Workshop on Multiple Classifier Systems, Cagliari, Italy, June 21-23, 2000 (H. Bunke)
- Joint IAPR Int. Workshops on Structural and Syntactic Pattern Recognition, and Statistical Pattern Recognition, Alicante, Spain, August 30 - September 1, 2000 (H. Bunke)
- 3rd Int. Conference on Multimodal Interfaces, Beijing, China, October 14 - 16, 2000 (H. Bunke)

4.6 Publications

Books

- H. Bunke and A. Kandel: Neuro-Fuzzy Pattern Recognition, World Scientific Publ. Co., 2000

Journal Publications

- X. Jiang and H. Bunke: Optimal vertex ordering of graphs, Information Processing Letters 72, 1999, 149 - 154
- H. Bunke and A. Kandel: Mean and maximum common subgraph of two graphs, Pattern Recognition Letters 21, 2000, 163 - 168
- X. Jiang, M. Binkert, B. Achermann and H. Bunke: Towards detection of glasses in facial images, Pattern Analysis and Applications 3, 2000, 9 - 18
- W. Rodriguez, H.-N. Teodorescu, F. Grigoras, A. Kandel and H. Bunke: A fuzzy information space approach to speech signal non-linear analysis, Int. Journal of Intelligent Systems 15, No 4, 2000, 343 - 363
- B. Messmer and H. Bunke: Efficient subgraph isomorphism detection: a decomposition approach, IEEE Trans. on Knowledge and Data Engineering 12, No 2, 2000, 307 - 323
- X. Jiang, H. Bunke, U. Meier: High-level feature based range image segmentation, Image and Vision Computing 18, No 10, 2000, 817 - 822
- G. Kaufmann and H. Bunke: Automated reading of cheque amounts, Pattern Analysis and Applications 3, 2000, 132 - 141
- K. Sobottka, H. Kronenberg, T. Perroud and H. Bunke: Text extraction from colored book and journal covers, Int. Journal of Document Analysis and Recognition, Vol 2, No 4, 2000, 163 - 176
- G. Kaufmann and H. Bunke: Detection and correction of recognition errors in check reading, Int. Journal of Document Analysis and Recognition, Vol 2, No 4, 2000, 211 - 221
- E. Bokshtein, D. Shmaltz, O. Herbst, H. Bunke and A. Kandel: Monopulse amplitude direction-finding using neuro-fuzzy approach, Robotics and Autonomous Systems 33, 2000, 125 - 134

- H. Bunke, X. Jiang and A. Kandel: On the minimum common supergraph of two graphs, *Computing* 65, No 1, 2000, 13 - 25
- X. Jiang: An adaptive contour closure algorithm and its experimental evaluation, *IEEE Trans. on Pattern Analysis and Machine Intelligence*, Vol.22, 2000, 1252 - 1265
- H. Bunke: Graph matching for visual object recognition, *Spatial Vision* 13, 2000, 335 - 340

Refereed Conference Proceedings and Edited Books

- H. Bunke and X. Jiang: Graph matching and similarity, H.-N. Teodorescu, D. Mlynek, A. Kandel and H.-J. Zimmermann (eds.): *Intelligent Systems and Interfaces*, Kluwer Academic Publishers, 2000, 281 - 304
- X. Jiang, L. Schiffmann and H. Bunke: Computation of median shapes, *Proc. 4th Asian Conference on Computer Vision*, Taipei, Taiwan, 2000, 300 - 305
- K. Shearer, S. Venkatesh and H. Bunke: Graph sequence matching by decision tree navigation, *Proc. 2nd IAPR-TC-15 Workshop on Graph-based Representations*, GbR'99, Austria, Austrian Computer Society, 2000, 99 - 108
- X. Jiang, A. Munger and H. Bunke: Computing the generalized mean of a set of graphs, *Proc. 2nd IAPR-TC-15 Workshop on Graph-based Representations*, GbR'99, Austria, Austrian Computer Society, 2000, 115 - 124
- H. Bunke and M. Vento: Benchmarking of graph matching algorithms, *Proc. 2nd IAPR-TC-15 Workshop on Graph-based Representations*, Austria, GbR'99, Austrian Computer Society, 2000, 109 - 114
- H. Bunke: Graph matching: Theoretical foundations, algorithms, and applications, in *Proc. Vision Interface 2000*, Montreal, 2000, 82 - 88
- X. Jiang, K. Yu and H. Bunke: Classifier combination for grammar-guided sentence recognition, in Kittler, J., Roli, F. (eds.): *Multiple Classifier Systems*, Springer, LNCS 1857, 2000, 383 - 392
- X. Jiang, C. Irniger and H. Bunke: Design of training/test data sets for empirical performance evaluation, in Phillips P.J., Christensen H. (eds): *Proc. 2nd Workshop on Empirical Evaluation Methods in Computer Vision*, Dublin, 2000, 25 - 36

- M. Lazarescu, H. Bunke and S. Venkatesh: Graph matching: fast candidate elimination using machine learning techniques, in Ferri, F.J., Inesta, J.M., Amin, A., Pudil, P.: Advances in Pattern Recognition, LNCS 1876, Springer Verlag, 2000, 236 - 245
- H. Bunke: Recent developments in graph matching, Proc. 15th Int. Conf. on Pattern Recognition, Barcelona, 2000, Vol 2, 117 - 124
- K. Yu, X. Jiang and H. Bunke: Combining acoustic and visual classifiers for the recognition of spoken sentences, Proc. 15th Int. Conf. on Pattern Recognition, Barcelona, 2000, Vol 2, 491 - 494
- B. Achermann and H. Bunke: Classifying range images of human faces with the Hausdorff distance, Proc. 15th Int. Conf. on Pattern Recognition, Barcelona, 2000, Vol 2, 813 - 817
- S. Fischer, M. Binkert and H. Bunke: Symmetry based indexing of diatoms in an image database, Proc. 15th Int. Conf. on Pattern Recognition, Barcelona, 2000, Vol 2, 899 - 902
- U.-V. Marti and H. Bunke: Handwritten sentence recognition, Proc. 15th Int. Conf. on Pattern Recognition, Barcelona, 2000, Vol 3, 467 -470
- X. Jiang: Qualitative decomposition of range images into convex parts/objects, Proc. IAPR Workshop on Machine Vision Applications, Tokyo, 2000, 123 - 126
- X. Jiang: A decomposition approach to geometric fitting, IAPR Workshop on Machine Vision Applications, Tokyo, 2000, 467 - 470
- U.-V. Marti and H. Bunke: Unconstrained handwriting recognition: language models, perplexity and system performance, Proc. 7th Int. Workshop on Handwriting Recognition, Amsterdam, 2000, 463 - 468
- S. Fischer, M. Binkert and H. Bunke: Merkmalsbasierte Suche von Diatomeen in Bilddatenbanken unter Verwendung von Entscheidungsbaeumen, in G. Sommer, N. Krueger, Ch. Perwass (eds.): Mustererkennung 2000, Informatik Aktuell, 2000, 444 - 451
- S. Fischer, M. Binkert and H. Bunke: Feature based retrieval of diatoms in an image database using decision trees, in J. Blanc-Talon, G. Lasker, D. Popescu (eds.): Advanced Concepts for Intelligent Vision Systems, ACIVS, Proc. of the 2nd Int. Symposium on Intelligent Vision Systems, Baden-Baden, 2000, 67 - 72

- M. Bayer, H. du Buf, H. Bunke, A. Ciobanu, G. Cristobal, S. Fischer, R. Head, S. Juggins, B. Ludes, D. Mann, J. Pech-Pacheco, J. Roeerdink, L. Santos and M. Wilkinson: ADIAC: Diatoms go digital, Proc. The European Conference on Marine Science and Ocean Technology, EUROCEAN, 2000, 546 - 551
- X. Jiang, A. Münger and H. Bunke: Synthesis of representative graphical symbols by computing generalized means, in A. Chhabra, D. Dori (eds.): Graphics Recognition, Springer Verlag, LNCS 1941, 2000, 183 - 192
- K. Shearer, S. Venkatesh and H. Bunke: Rapid similarity retrieval from image and video, in L. Guan, S.-Y. Kung, J. Larsen (eds.): Multimedia Image and Video Processing, CRC Press, 2000, 437 - 466
- X. Jiang, K. Bowyer, Y. Morioka, S. Hiura, K. Sato, S. Inokuchi, M. Bock, C. Guerra, R.E. Loke and J.M.H du Buf: Some further results of experimental comparison of range image segmentation algorithms. Proc. 15th Int. Conf. on Pattern Recognition, 2000, Vol.4, 877 - 881
- U.-V. Marti, D. Wymann and H. Bunke: OCR on compressed images using pass codes and hidden Markov models, Proc. 4th IAPR Int. Workshop on Document Analysis Systems, DAS'2000, 2000, 77 - 86

Technical Reports

- K.Y. Lim, S. Venkatesh, M. Kumar and H. Bunke: Using clustering for change detection in dynamic communication networks, Technical Report, School of Computing, Curtin University, Perth, Australia, 2000
- S. Fischer, M. Binkert and H. Bunke: Feature based retrieval of diatoms in an image database using decision trees, Technical Report IAM-00-001, 2000

5 Research Group on Theoretical Computer Science and Logic

5.1 Personnel

Head:	Prof. Dr. G. Jäger	Tel: +41 31 631 8560 email:jaeger@iam.unibe.ch
Office Manager:	I. Huber (until August) T. Weibel (since August)	Tel.: +41 31 631 8426 email: weibel@iam.unibe.ch
Scientific Staff:	L. Alberucci*	Tel.: +41 31 631 39 84 email: albe@iam.unibe.ch
	P. Balsiger	Tel.: +41 31 631 49 80 email: balsiger@iam.unibe.ch
	P. Brambilla*	Tel.: +41 31 631 33 19 email: brambi@iam.unibe.ch
	Dr. G. Ostrin* (since November)	Tel.: +41 31 631 49 89 email: ostrin@iam.unibe.ch
	D. Probst*	Tel.: +41 31 631 35 45 email: probst@iam.unibe.ch
	C. Rüede* (until June)	
	Dr. Th. Strahm	Tel.: +41 31 631 49 98 email: strahm@iam.unibe.ch
	Th. Studer*	Tel.: +41 31 631 49 76 email: tstuder@iam.unibe.ch
	Dr. S. Tupailo* (until November)	
	M. Wirz*	Tel.: +41 31 631 46 83 email: wirz@iam.unibe.ch
Guests:	Dr. R. Goré Dr. C. Jonker Dr. J. Bradfield	(September) (June) (November–December)

* with financial support from a third party

5.2 Research Projects

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 mathematics. 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).

Some of the relevant key-words are: Proofs as computations, formulas as types, polymorphism, flexible typing, explicit and constructive mathematics, universes of types, theories of types and names, functional programming, distributed computing.

Research staff: All members of research group

Algebraic and Logical Aspects of Knowledge Processing

Several research problems from the general area of knowledge representation are being investigated. They are directed toward the mathematical foundations of this area and refer to algebraic and logical questions. The work of the group in Berne emphasizes the logical basis of knowledge representation. One of the first and most important steps in a logical approach to knowledge representation is the development and analysis of adequate formal frameworks, both from a declarative and procedural point of view. Depending on the context, various logical formalisms (e.g. applicative theories, type theories, modal logics, etc.) have turned out to be extremely useful. We focus on questions involving structural properties of suitable logical formalisms, and the interplay between logic and computation.

Research staff: G. Jäger, G. Ostrin, D. Probst, Ch. Rüede, Th. Strahm, Th. Studer, S. Tupailo, M. Wirz

Financial Support: Swiss National Science Foundation

The Logics Workbench LWB

The Logics Workbench LWB is a powerful computer logic system. It offers the possibility to work in a user-friendly way in classical and non-classical propositional logics, including nonmonotonic approaches. The LWB provides a sophisticated user interface to handle logical formulae for the different logics. Formulas can be simplified, transformed into a normal form, or tested for provability. It is also possible to use embeddings, generate random formulae, or to manipulate strings, among other things.

Another powerful feature of the LWB is its programming language. It allows the user to combine all available functions into own programs. It is even possible to write own functions that can then be used just like a built-in function.

The Logics Workbench has a graphical user interface featuring multiple regions for input, output and comments. It has menus to control program behavior and allows to adjust the various configuration values. It supports different fonts, including fonts with logical operators. The LWB is available for Solaris (Sparc), Linux (Intel), and MacOS (PowerPC). Each of these versions features a native graphical user interface and installation method.

One important research aspect of our group in context with the LWB deals with distributed propositional proof systems, centered around the concept of distribution in a logical context and comprises a theoretical as well as a practical component. In the theoretical part we study the structure of logical algorithms modulo a distributed environment. Special emphasis is put on questions concerning non-classical deductive systems and (distributed) proof search in those, and in developing new and more powerful methods, which form the basis of our practical work.

On the practical side we produce an extension of our present Logics Workbench LWB, which improves its performance by making advantage of available techniques of distributed computing. We make use of existing tools (e.g. PVM), such that we can concentrate on the logical and foundational aspects. An important aspect is to shift the emphasis from worst-case behavior to some realistic form of average case behavior in the field of distributed logical environments.

Research staff: P. Balsiger, P. Brambilla, G. Jäger

Financial support: Swiss National Science Foundation

Inference and Deduction: An Approach Integrating Logic and Probability

In collaboration with Prof. Dr. J. Kohlas and Dr. R. Stärk, University of Freiburg and Prof. Dr. R. Stärk, ETH Zürich.

Inference in its general setting subsumes reasoning under uncertainty. This is a domain of great importance in the actual development of information technology. Correspondingly big and growing interest in this field and impressive progress can be observed. Different, symbolic and numerical formalisms for inference under uncertainty have been elaborated. Among symbolic approaches nonmonotonic logics of different kinds play a predominant role. Probability theory, belief functions and fuzzy systems are the best known representants of numerical approaches to uncertainty.

Inference is closely related to deduction. Inference under uncertainty involves an appreciation of the reliability of the deductions. This points to a close interaction of logic (for deduction) and probability (for reliability). Several propositions have been made so far as to how combine logic with probability. The project presented here proposes to study a particular way to do this, which is different to the other formalism presented in the literature: it is a theory of the reliability of deduction with probable (not fully reliable) arguments and can be labeled as probabilistic argumentation.

The project proposes to study three themes: the first is a comparison of inference and deduction mechanisms for dealing with uncertainty, partial and distributed information. This will help to situate our proposed approach of probabilistic argumentation systems in terms of descriptive power and computational efficiency with respect to other formalisms of nonmonotonic logic, probabilistic logic, Bayesian networks, belief functions, etc. The second theme concerns the inference architecture of probabilistic argumentation and treats basic questions such as modularity, focusing of deduction, distributed reasoning and reasoning with temporal information. The third subject finally is computational logic. This is the basic ingredient for the deductive part of inference under uncertainty.

Research staff: L. Alberucci, P. Balsiger, P. Brambilla

Financial support: Swiss National Science Foundation

5.3 Diploma Theses

- M. Graf: Darstellung der Kripke Strukturen in der Situation Semantics
- M. Krebs: Einige Aspekte der Modallogik $S5_n$ mit Allgemeinwissen

- C. Stucki: Eine beweistheoretische Untersuchung von Kunens *PRA**

5.4 Ph.D. Thesis

- C. Rüede: Metapredicative Subsystems of Analysis

5.5 Further Activities

Editorials Board and Technical Committees

- Member of the editorial board of *Theoretical Computer Science* (G. Jäger)
- Member of the editorial board of *The Bulletin of Symbolic Logic* (G. Jäger)
- Member of the *CICUS* (*Commission pour l'informatique, conférence universitaire suisse*) (G. Jäger)

Program Committees

- Member of the program committee of the *Swiss Computer Science Society* (G. Jäger, Th. Strahm)
- Member of the program committee of *Computer Science Logic CSL 2000* (G. Jäger)

5.6 Publications

- P. Balsiger, A. Heuerding and S. Schwendimann: A benchmark method for the propositional modal logics K, KT, S4. *Journal of Automated Reasoning* 24, 2000
- S. Feferman and Th. Strahm: The unfolding of non-finitist arithmetic. *Annals of Pure and Applied Logic* 104, 2000
- G. Jäger: Metapredicative and explicit Mahlo: a proof-theoretic perspective. *Proceedings Logic Colloquium 2000*, to appear
- G. Jäger and Th. Strahm: Fixed point theories and dependent choice. *Archive for Mathematical Logic* 39, 2000

- R. Kahle and Th. Studer. A theory of explicit mathematics equivalent to ID_1 , in P. Clote, H. Schwichtenberg, editors, *Computer Science Logic CSL 2000, Lecture Notes in Computer Science 1862*, 2000
- R. Kahle and Th. Studer: Formalizing non-termination of recursive programs, submitted.
- D. Probst and Th. Studer: How to normalize the jay. *Theoretical Computer Science*, to appear
- C. Rüede: Metapredicative Subsystems of Analysis, submitted
- C. Rüede: The proof-theoretic analysis of Σ_1^1 transfinite dependent choice, submitted
- C. Rüede: Universes in metapredicative analysis, submitted
- C. Rüede and Th. Strahm: Intuitionistic fixed point theories for strictly positive operators, submitted
- Th. Strahm: Autonomous fixed point progressions and fixed point transfinite recursion. In S. Buss, P. Hajek, P. Pudlak (eds.), *Logic Colloquium '98*, ASL Lecture Notes in Logic 13, 2000
- Th. Strahm: The non-constructive μ operator, fixed point theories with ordinals, and the bar rule. *Annals of Pure and Applied Logic 104*, 2000
- Th. Strahm: Wellordering proofs for metapredicative Mahlo, submitted
- Th. Studer: A semantics for $\lambda_{str.}^{\{\}}$: a calculus with overloading and late-binding. Submitted, abstract to appear in *Journal of Logic and Computation*
- Th. Studer: Impredicative overloading in explicit mathematics. *Bulletin of Symbolic Logic*, to appear
- Th. Studer: Constructive Foundations for Featherweight Java, submitted
- S. Tupailo: Finitary reductions for local predicativity, I: recursively regular ordinals. In S. Buss, P. Hajek, P. Pudlak (eds.), *Logic Colloquium '98*, ASL Lecture Notes in Logic 13, 2000
- S. Tupailo: On non-wellfounded constructive set theory, preprint

6 Research Group on Software Composition

6.1 Personnel

Head:	Prof. Dr. O. Nierstrasz	Tel: +41 31 631 46 18 email: oscar@iam.unibe.ch
Office Manager:	I. Huber (until August) T. Schmid (since September)	Tel: +41 31 631 46 92 email: tschmid@iam.unibe.ch
Scientific staff:	F. Achermann *	Tel: +41 31 631 33 13 email: acherman@iam.unibe.ch
	G. Arévalo *	Tel: +41 31 631 4868 email: arevalo@iam.unibe.ch
	J.-C. Cruz *	Tel: +41 31 631 3315 email: cruz@iam.unibe.ch
	Dr. S. Ducasse *	Tel: +41 31 631 49 03 email: ducasse@iam.unibe.ch
	D. Margreth *	Tel: +41 31 631 3315 email: margreth@iam.unibe.ch
	T. Richner	Tel: +41 31 631 33 13 email: richner@iam.unibe.ch
	M. Rieger	Tel: +41 31 631 35 47 email: rieger@iam.unibe.ch
	S. Tichelaar *	Tel: +41 31 631 35 68 email: tichel@iam.unibe.ch
	M. Lanza *	Tel: +41 31 631 35 47 email: lanza@iam.unibe.ch
	Dr. R. Wuyts *	Tel: +41 31 631 33 14 email: wuyts@iam.unibe.ch

* financial support from a third party.

Staff that left during the period.

Scientific staff:	Dr. S. Demeyer *	email: demeyer@iam.unibe.ch
	Dr. M. Lumpe *	email: lumpe@iam.unibe.ch
	Dr. J.-G. Schneider *	email: schneidr@iam.unibe.ch

6.2 Research Projects

The Software Composition Group conducts research into languages, tools and methods for constructing flexible software systems from components.

The SCG is involved in four federally funded projects:

- “A framework approach to composing heterogeneous applications” (NFS No. 20-53711.98) investigates the application of framework technology to the composition of heterogeneous applications. This project formally ended in September 2000.
- “Meta-models and Tools for Evolution Towards Component Systems” (NFS 20-61655.00) investigates the application of meta-modeling repositories, reengineering tools, and high-level composition languages to the problem of evolving software systems. This project formally started in October 2000.
- PECOS (“Pervasive Components”) is a European project (IST-1999-20398) concerned with the development of components for embedded systems, and started in October 2000.
- COORDINA is an Esprit Working Group (Esprit 25412) on technology for coordinating distributed agents. This project ended in November 2000.

For further details, see: <http://www.iam.unibe.ch/~scg/Research/>

A Framework Approach to Composing Heterogeneous Applications

Research staff: F. Achermann, G. Arevalo, J.-C. Cruz, Dr. S. Ducasse, T. Richner, Dr. R. Wuyts

Duration: 1998-10-01 - 2000-09-30

Financial support: Swiss National Science Foundation, grant Nr. 20-53711.98

“A framework approach to composing heterogeneous applications” addresses the problem of building systems from heterogeneous applications. On the one hand it focuses on the problems related to the formal aspects of composition by proposing a Form-based calculus that serves as a glue specification between the applications. On the other hand it focuses on concrete experiences in composing applications. Two prototypes of languages, Piccola and CoLaS, have been implemented and are currently being further developed, and guidelines for composing software have been documented.

Piccola: Piccola is a small *composition language* that embodies the paradigm “Applications = Components + Scripts”. Piccola models components and composition abstractions by means of a unifying foundation of communicating concurrent agents. Flexibility and extensibility are obtained by modelling both interfaces to components and the contexts in which they live by extensible records, or *forms*. Piccola supports software composition by means of *compositional styles* which express the kind of components and connectors that are relevant to a particular application domain.

Colas: We have specified and implemented a language named Colas that allows us to express the coordination of active and distributed objects as first class entities. Colas is based on a minimal set of abstractions necessary to support coordination. Instead of developing an entirely new language, we decided to extend an existing object-oriented language, Smalltalk, by introducing suitable coordination abstractions.

In Colas the coordination is based on the notion of *Coordination Groups* that encapsulate all the information necessary for coordinating active objects. A group specifies the participants of the coordination in terms of participant roles, the coordination state, and the protocol for coordinating the participants.

Meta-models and Tools for Evolution Towards Component Systems

Research staff: F. Achermann, G. Arevalo, M. Lanza, M. Rieger, S. Tichelaar, Dr. S. Ducasse, T. Richner, Dr. R. Wuyts

Duration: 2000-10-01 - 2002-09-30

Financial support: Swiss National Science Foundation, grant Nr. 20-61655.00

In this project we propose to develop: (i) a component meta model for modelling software systems that extends existing standards (such as UML) with concepts required to support evolution, focusing on such issues as non-functional requirements and software dependencies. Based on this meta model, we will develop (ii) component migration tools and methods that will help to identify candidate components, identify and resolve architectural and design drift, and support transformation to component-based software structures. We will focus on software metrics and visualization to support analysis, and language-independent refactorings to support transformation.

Component migration methods will be documented as reverse and reengineering patterns. Finally, we propose to develop (iii) a compositional infrastructure to support architectural specification, and run-time configuration and evolution, using the agent-based framework of the Piccola composition language.

PECOS

Research staff: Dr. S. Ducasse, G. Arevalo, M. Lanza, Dr. R. Wuyts

Duration: 2000-10-01 - 2002-09-30

Financial support: Swiss National Science Foundation, IST project 1999-20398

PECOS is an industrial IST European research project that aims to enable component-based software development for embedded systems. While focusing on architectural issues it touches upon the whole software development life cycle and addresses the major technological deficiencies of state-of-the-art component technology with respect to embedded systems by developing:

- a Component Model for embedded system components addressing behaviour specification and non-functional properties and constraints,
- a Component Repository utilising this model, supporting a composition environment and interfacing to a component specification environment,
- an interactive Composition Environment for composing embedded applications from components, validating functional (e.g., interfaces) and non-functional compositional constraints (e.g., power-consumption, code size), generating the application executable for the embedded device and monitoring their execution,
- an Ultra-light Component Environment to install, run, test, and tune component-based applications on resource limited embedded systems and enable their management.

COORDINA

Research staff: F. Achermann, J.-C. Cruz, Dr. S. Ducasse, S. Tichelaar

Duration: 08.97-11.2000

Financial support: Swiss National Science Foundation, Working Group
ESPRIT 24512

So-called “coordination languages” make it possible to specify how multiple, distributed agents should coordinate their activities to achieve a common goal. Coordination, then, is a form of composition (or configuration) for distributed agent systems.

The goal of the COORDINA Working Group is to establish European leadership in such a critical field, by joining theoreticians and practitioners in a collaborative assessment of diverse problems and approaches, with a view towards consolidating the foundational work and identifying promising technological avenues worth exploring in more focused ESPRIT projects.

We implemented, Open Spaces, a framework for building families of tuple spaces based applications. Open Spaces defines a minimal but extensible core for building tuple-space based applications. Hotspots can then be specialized to introduce new functionality.

For further details, see: <http://www.iam.unibe.ch/~coordina/>

6.3 Diploma Thesis

R. Blum: Entwicklung eines Prototypen für die aktive Schicht ALFRED.
Diploma thesis, University of Bern, May 2000

6.4 Further Activities

Editorial Boards

- L’OBJET – Logiciel, réseaux, bases de données (O. Nierstrasz)
- Annals of Software Engineering (O. Nierstrasz)
- Technique et Sciences Informatiques – Numéro spécial Réutilisation (S. Ducasse)

Associations

- CHOOSE – Swiss group for Object-Oriented Systems and Environments (Executive Board member, O. Nierstrasz)
- AITO – Association Internationale pour les Technologies Objets (Manager, O. Nierstrasz)

- ESEC, the European Software Engineering Conference (Member of Steering Committee, O. Nierstrasz)
- ESUG (European Smalltalk User Group) (Member of Steering Committee, S. Ducasse)
- SSUG (Swiss Smalltalk User Group) (Member of Steering Committee, S. Ducasse)

Program Committees

- LMO'00 (Langages et Modèles à Objets) (PC member, S. Ducasse)
- ECOOP'00 (European Conference on Object-Oriented Programming) (PC member, S. Demeyer)
- OOPSLA'00 (ACM SIGPLAN Object-Oriented Programming Systems, Languages and Applications) (PC member, O. Nierstrasz)
- ICSE'00 (The 22d International Conference on Software Engineering) (PC member, O. Nierstrasz)
- XP'00 (International Conference on eXtreme Programming and Flexible Processes in Software Engineering) (PC member, S. Ducasse)

Conference Tutorials

- “Reengineering Object-Oriented Systems” presented at OOPSLA'00 (S. Demeyer, S. Ducasse and O. Nierstrasz)

6.5 Publications

Journal and Conference Publications

- F. Achermann, S. Kneubühl and O. Nierstrasz: Scripting coordination styles. In António Porto and Grúia-Catalin Roman, editors, *Coordination Languages and Models*, LNCS 1906, pages 19–35, Limassol, Cyprus, September 2000
- F. Achermann and O. Nierstrasz: Explicit Namespaces. In Jürg Gutknecht and Wolfgang Weck, editors, *Modular Programming Languages*, LNCS 1897, pages 77–89, Zurich, Switzerland, September 2000

- S. Ducasse and F. Ducasse: De l'enseignement de concepts informatiques. *Journal de l'association EPI Enseignement Public et Informatiques*, 4(97), September 2000
- S. Demeyer, S. Ducasse and O. Nierstrasz: Finding refactorings via change metrics. In *Proceedings of OOPSLA'2000, ACM SIGPLAN Notices*, pages 166–178, 2000
- S. Ducasse, T. Hofmann and O. Nierstrasz: Openspaces: An object-oriented framework for reconfigurable coordination spaces. In António Porto and Gruia-Catalin Roman, editors, *Coordination Languages and Models*, LNCS 1906, pages 1–19, Limassol, Cyprus, September 2000
- O. Nierstrasz and F. Achermann: Supporting Compositional Styles for Software Evolution. In *Proceedings ISPSE 2000*. IEEE, 2000. to appear
- S. Tichelaar, J. C. Cruz and S. Demeyer: Design guidelines for coordination components. In Janice Carroll, Ernesto Damiani, Hisham Haddad, and Dave Oppenheim, editors, *Proceedings ACM SAC 2000*, pages 270–277. ACM, March 2000
- S. Tichelaar, S. Ducasse, S. Demeyer and O. Nierstrasz: A meta-model for language-independent refactoring. In *Proceedings ISPSE 2000*. IEEE, 2000

Book Chapters

- F. Achermann, M. Lumpe, J.-G. Schneider and O. Nierstrasz: Piccola – a small composition language. In Howard Bowman and John Derrick., editors, *Formal Methods for Distributed Processing, an Object Oriented Approach*. Cambridge University Press., 2000 to appear.
- F. Achermann and O. Nierstrasz: Applications = Components + Scripts – A tour of Piccola. In Mehmet Aksit, editor, *Software Architectures and Component Technology*. Kluwer, 2000 to appear.
- M. Lumpe, F. Achermann and O. Nierstrasz: A Formal Language for Composition. In Gary Leavens and Murali Sitaraman, editors, *Foundations of Component Based Systems*, pages 69–90. Cambridge University Press, 2000
- O. Nierstrasz: Identify the champion. In N. Harrison, B. Foote, and H. Rohnert, editors, *Pattern Languages of Program Design*, volume 4, pages 539–556. Addison-Wesley, 2000

Workshop Publications

- F. Achermann: Language support for feature mixing. In *Workshop on Multi-Dimensional Separation of Concerns in Software Engineering (ICSE 2000)*, Limerick, Ireland, June 2000
- S. Demeyer, S. Ducasse and O. Nierstrasz: A reverse engineering pattern language. In *Proceedings of Europrop'2000*, 2000
- S. Demeyer, S. Ducasse and O. Nierstrasz: Tie code and questions: a reengineering pattern. In *Proceedings of Europrop'2000*, 2000
- S. Demeyer, S. Ducasse and O. Nierstrasz: Transform conditional: a reengineering pattern language. In *Proceedings of Europrop'2000*, 2000
- S. Ducasse, M. Lanza and L. Steiger: A query-based approach to support software evolution. In *ECOOP'2000 International Workshop of Architecture Evolution*, 2000
- S. Ducasse, M. Lanza and S. Tichelaar: Moose: an extensible language-independent environment for reengineering object-oriented systems. In *Proceedings of the Second International Symposium on Constructing Software Engineering Tools (CoSET 2000)*, June 2000
- O. Nierstrasz and F. Achermann: Separation of concerns through unification of concepts. In *ECOOP 2000 Workshop on Aspects & Dimensions of Concerns*, 2000
- O. Nierstrasz, J.-G. Schneider and F. Achermann: Agents everywhere, all the time. In *ECOOP 2000 Workshops on Component-Oriented Programming and Pervasive Component Systems*, 2000
- S. Tichelaar, S. Ducasse and S. Demeyer: FAMIX: Exchange experiences with CDIF and XMI. In *Proceedings of the ICSE 2000 Workshop on Standard Exchange Format (WoSEF 2000)*, June 2000

Technical Reports

- M. Freidig. XMI for FAMIX. Informatikprojekt, University of Berne, June 2000
- D. Schweizer. Exporting MOOSE models to Rational Rose UML. Informatikprojekt, University of Bern, April 2000

A Teaching Activities

A.1 Winter semester 1999/2000

H. Bieri:	Einführung in die Informatik Geometrisches Modellieren Seminar: Computergeometrie und Grafik Seminar: Datenstrukturen und Algorithmen 2
H.P. Blau:	Anwendungssoftware Programmierung 1
T. Braun:	Computernetze Grundlagen der technischen Informatik Mobilkommunikation Seminar: Rechnernetze und verteilte Systeme
H. Bunke:	Automaten und formale Sprachen Künstliche Intelligenz Seminar: Künstliche Intelligenz Praktikum Bildanalyse
G. Jäger:	Datenbanken Logik und Informatik Seminar: Logiklabor Seminar: Theoretische Informatik und Logik
G. Jäger, J. Kohlas:	Seminar: Inferenz und Deduktion
O. Nierstrasz:	Concurrent Programming Einführung in Software Engineering Seminar: Software Composition
O. Nierstrasz, S. Demeyer, S. Ducasse:	Object-Oriented Re-Engineering

A.2 Summer semester 2000

L. Ammon:	3D-Grafik
H. Bieri:	Seminar: Computergeometrie und Grafik
H.P. Blau:	Datenstrukturen und Algorithmen Einführung in die Programmierung
H. Bunke:	Compilerbau Seminar: Künstliche Intelligenz Mustererkennung
T. Braun:	Betriebssysteme Netze und Protokolle für das Internet Rechnerarchitektur Seminar: Rechnernetze und verteilte Systeme
G. Jäger:	Applikative Theorien Einführung in die theoretische Informatik Seminar: Logiklabor Seminar: Theoretische Informatik und Logik
G. Jäger, J. Kohlas:	Inferenz und Deduktion
X. Jiang:	Computergrafik
O. Nierstrasz:	Praktikum Software Engineering Programmiersprachen Programmierung 2 Seminar: Software Composition
O. Nierstrasz, S. Ducasse:	Smalltalk
Th. Strahm:	Komplexitätstheorie

A.3 Winter semester 2000/2001

H. Bieri:	Einführung in die Informatik 3D-Grafik Praktikum Computeranimation Seminar: Computergeometrie und Grafik
H.P. Blau:	Anwendungssoftware Programmierung 1
T. Braun:	Computernetze Grundlagen der technischen Informatik Multimediakommunikation Seminar: Rechnernetze und verteilte Systeme
H. Bunke:	Automaten und formale Sprachen Künstliche Intelligenz Seminar: Künstliche Intelligenz
G. Jäger:	Datenbanken Logik und Informatik Seminar: Logiklabor Seminar: Theoretische Informatik und Logik
O. Nierstrasz:	Seminar: Software Composition
O. Nierstrasz, S. Ducasse:	An introduction to Reflective Programming
M. Rieger:	Einführung in Software Engineering

B Colloquium in Informatics

- 01/11/2000 Walter Meier
Grundbuch- und Vermessungsamt Basel-Stadt
Das virtuelle 3D-Stadtmodell Basel-Stadt
- 02/08/2000 Steven Willmott
Laboratoire d'Intelligence Artificielle, EPF Lausanne
The Benefits of Environment Adaptive Organisations for
Agent Coordination and Network Routing Problems
- 02/09/2000 Yves Cosendai
Lucent Technologies, Zürich
LAN technologies present and future
- 04/18/2000 Prof. Dr. Martin Odersky
Laboratoire des Méthodes de Programmation, EPF Lausanne
Functional Nets
- 05/02/2000 Dr. Claude Castelluccia
INRIA Rhône-Alpes, Grenoble
Mobility Management in IP-Based Cellular Networks
- 05/16/2000 Prof. Dr. Karl Lieberherr
College of Computer Science, Northeastern University
Sustainable Software
- 05/30/2000 Prof. Dr. Jean-Pierre Hubaux
Communication Systems Department, EPF Lausanne
Toward self-organized mobile ad-hoc WANs: Terminodes
- 06/27/2000 Prof. Dr. Beat Brüderlin
Fakultät für Informatik und Automatisierung, TU Ilmenau
Deklaratives Geometrisches Modellieren
- 11/21/2000 Dr. Julian Bradfield
Department of Computer Science, University of Edinburgh
Model-checking: from real life to mathematics

- 11/28/2000 Prof. Dr. Johann Blatter
Institut für Theoretische Physik, ETH Zürich
At the Limit: Quantum Computing
- 12/12/2000 Prof. Dr. Christian Tschudin
Department of Computer Systems, Uppsala University
Stored Program Routers