

# **Annual Report 1998**

**IAM-98-003**

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# **1 Institut für Informatik und angewandte Mathematik (IAM)**

## **1.1 Address**

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## **1.2 Personnel**

### **Board of directors**

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### **Professors**

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

### **Acting chairman**

Prof. Dr. Hanspeter Bieri

### **Secretaries**

Monika Aberegg; Daniela Heiniger; Isabelle Huber; Sylvia Schaad; Susanne Thüler.

### **Technical staff**

Bernhard Bühlmann; Markus Lumpe; Jürg Stiefenhofer.

### **Scientific staff**

Bernard Achermann; Franz Achermann; Luca Alberucci; Lorenz Ammon; Peter Balsiger; Florian Baumgartner; Thomas Bebie; Hans-Peter Blau; PD Dr. Hans-Heinrich Bothe; Peppo Brambilla; Nissim Buchs; Dr. Bernhard Bühlmann; Andrey Collison; Juan Carlos Cruz; Dr. Serge Demeyer; Dr. Stéphane Ducasse; Hans Einsiedler; Stefan Fischer; Manuel Günter; Pascal Habegger; Dr. Wolfgang Heinle; Alain Heuerding; PD Dr. Xiaoyi Jiang; Mevlyde Kasumi; Guido Kaufmann; Ibrahim Khalil; Josef Kleinle; Markus Lumpe; Urs-Viktor Marti; Dr. Eric

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## 2 Research Group on Computational Geometry and Graphics

### 2.1 Personnel

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### 2.2 Research Projects

- d-dimensional general polyhedra

These polyhedra, now normally called "Nef polyhedra", are those subsets of  $R^d$  which can be obtained by applying finitely many Boolean set operations to a finite number of linear half spaces. The project extends the theory of

Nef polyhedra, develops and analyses appropriate data structures and prepares an object-oriented implementation of the kernel of a solid modeler for working with Nef polyhedra.

**Research staff:** H. Bieri, W. Nef, St. Hoefer

- **SIS creator architecture and system**

Single image stereograms (SIS) have become very popular, especially due to the book series "the magic eye".

The first main goal of this project is to develop an object-oriented component framework for the generation of SIS. SISCA (SIS Creator Architecture) shall meet the following requirements:

- The different known algorithms for generating SIS can be implemented within the same system and therefore realistically compared with each other.
- Different techniques for generating SIS can be combined, i.e. a rendering pipeline can be built.
- New ideas to generate or improve SIS can easily and quickly be implemented.

The second main goal of this project is to develop a user interface to SISCA which makes it possible to generate SIS of high quality in a very simple intuitive way. SISCS (SIS Creator Systems) shall meet the following requirements:

- 3D scenes to be used as inputs for SISCA can be defined easily and intuitively.
- A SIS rendering pipeline can easily be composed by means of components supplied by SISCA.
- SIS can easily be calculated, rendered and saved. SISCS will be implemented as a client/server system. Its client part will be a Java applet, i.e. SIS can then be generated independently of any specific platform. The server part is developed with the aid of BOOGA and SISCA.

Finding new algorithms for generating (better) SIS is the third main goal of this project.

**Research staff:** L.M. Ammon, L.S. Ammon

- **SoccerMan: 3D-reconstruction of soccer games from video sequences**

The goal of this project is to generate three dimensional information from one, two, or more different video sequences of a soccer scene.

The task is subdivided into the following steps:

- Locating key features of the playground in an initial frame
- Tracking these features in subsequent frames
- Calibrating the camera
- Computing the background images of the frames
- Locating the players in subsequent frames
- Computing a player's 3D location at a given time (in a given frame)
- Finding a player's two dimensional shape (so-called texture objects)
- Generating animated scene descriptions consisting of animated texture objects

A tool to visualize animated texture objects has been developed.

**Research staff:** Th. Bebie

- **Extensions and applications of the graphics framework BOOGA**

BOOGA (Berne's Object-Oriented Graphics Architecture) is a framework for computer graphics applications which has been developed at the Institute of Computer Science and Applied Mathematics of the University of Berne.

This project develops important extensions to BOOGA: An interactive renderer and a parallel ray tracing component enhance the rendering facilities. The integration of a graphical user interface can be used to quickly develop applications providing interactive control over BOOGA components.

Based on these extensions, a new type of Internet applications can be developed. Two applications for Web-based geometric modeling and rendering are presented which support users in composing scenes by drag-and-drop operations and rendering images on supercomputers.

The capabilities of the extended BOOGA are illustrated by means of both a large scale and a detailed architectural visualization of the city of Berne.

**Research staff:** B. Bühlmann



## • Graphical Database GSCOPE

The main motivation for this project is to improve the reuse of graphics data and the reuse of graphics functionality. The desired improvements shall be achieved as follows:

- By offering database facilities that can be used together with various existing graphics software.
- By providing a platform for the integration of various graphics functionality.
- By providing Internet accessibility, acting as a multiplier for reuse, enabling remote users to access a common system and to share and exchange data.

An architecture for a system has been developed that combines the improvements described above. The system has to cope with the large variety of data representations typically found in the graphics domain. The idea is to store the data in its original form, without prior conversions, thus conserving the maximum information content. A special type-model, separating semantics from implementation, ensures type-safeness and, at the same time, provides the flexibility and extensibility needed to cope with the multiple data representations. Software components enable seamless integration of existing graphics operations, offered by various software packages. The components, together with a composition mechanism, act as the data manipulation language of the architecture. Remote accessibility of components and data has been achieved by means of CORBA (Common Object Request Broker Architecture). This allows for a new range of promising Web-based graphics applications.

A prototype system GSCOPE (graphics system offering components and persistence) is developed as an implementation of this architecture.

**Research staff:** A. Collison

## • Quality of Service Control

The main field of interest in this project lies in the research of possible extensions of the Internet protocol to support quality of service (QoS). The IETF workgroup diffserv suggests a Differentiated Services architecture within which service providers can offer each customer a range of network services which are differentiated on the basis of performance. Many service examples already exist which haven't been fully evaluated and compared with each other. In this project different types of services are implemented and analyzed by means of simulation. It is also investigated how the underlying

network topology influences the performance of the different services. For simulation purposes the software package OPNET by Mil3 is being used.

**Research staff:** P. Habegger

- **SketchWizard**

The creation of 3D scenes is often a complex process which requires that the scene creator has a good spatial imagination. SketchWizard is a first step towards a system that automatically generates 3D scene descriptions starting from handmade 2D sketches. Its implementation uses state-of-the-art technologies, i.e. Java, Javascript, CORBA and VRML, and is intended to serve as a model for building applications for the Internet.

**Research staff:** T. Wenger, T. Perroud

## **2.3 Diploma Theses**

- L.M. Ammon: Single Image Stereograms – Grundlagen, Algorithmen und Framework
- Th. Wenger: SketchWizard – Eine auf dem Grafikframework BOOGA basierende Client/Server-Anwendung
- M. Zumstein: Computergestützte Auswertung von Klimadaten

## **2.4 Ph.D. Thesis**

- B. Bühlmann: Extensions and Applications of the Graphics Framework BOOGA.

## **2.5 Further Activities**

- Member of the Program Committee for Computer Graphics International '98 (H. Bieri)
- Member of the Program Committee for Computer Graphics International '99 (H. Bieri)

- Co-Organizer of the 1999 Dagstuhl Seminar on Geometric Modelling (H. Bieri)
- Organizer of the 1999 Upper-Rhine-Region Algorithms Workshop (H. Bieri)
- Organizer of the 1999 3ème Cycle Romand d'Informatique seminar "Data Structures for Solid Modelling" (H. Bieri)
- Co-Editor of the 1999 CAGD Special Issue in Honor of Paul de Casteljaeu (H. Bieri)

## 2.6 Publications

- Bebie, Th., Bieri, H.: Soccer Man - Reconstructing soccer games from video sequences. In Proceedings of the 1998 International Conference on Image Processing. Volume 1, 898-902, IEEE Computer Society 1998.
- Bieri, H.: Representation conversions for Nef polyhedra. In Bieri, H., Brunnett, G., DeRose, T., Farin, G. (Eds.): Geometric Modelling. Computing Supplement 13, 27-38, Springer-Verlag 1998.
- Bühlmann, B., Bieri, H.: Supercomputing at the desktop: an improved interface using internet facilities. In Bubak, M., Herzberger, B., Sloot, P. (Eds.): High-Performance Computing and Networking, 617-627. Lecture Notes in Computer Science 1401, Springer-Verlag 1998.
- Collison, A., Bieri, H.: An architecture of a universal DBMS for graphics applications. In Wolter, F.-E., Patrikalakis, N.M., (Eds.): Proceedings of Computer Graphics International 1998, 373-385, IEEE Computer Society 1998.
- Collison, A., Bieri, H.: A component-based system for storing and manipulating graphics objects of different representations. Submitted.
- Habegger, P., Braun, T.: Differentiated Services: Ein neuer Ansatz für Dienstgüte im Internet. Praxis der Informationsverarbeitung und Kommunikation, Saur Verlag, 4/98.
- Habegger, P., Baumgartner, F., Braun, T. : Differentiated Services: A New Approach for Quality of Service in the Internet. IFIP Conference on High Performance Networking, 1998.
- Matthey, Th., Bieri, H.: An object-oriented approach to model scenes of buildings. In Wolter, F.-E., Patrikalakis, N.M., (Eds.): Proceedings of Computer Graphics International 1998, 14-22, IEEE Computer Society 1998.

- Wenger, Th.: The Elegant (and Fast) Skip List. JavaPro 2, April/May, 34-39 (1998).

## 3 Research Group on Computer Networks and Distributed Systems

### 3.1 Personal

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### 3.2 Research Projects

The current research topics of the Computer Networks and Distributed Systems research group are focussing the topics Quality-of-Service (QoS) for the Internet and Virtual Private Networks (VPNs). QoS support in the Internet is required for upcoming multimedia and business applications. In such scenarios, bandwidth and delay guarantees are essential for user acceptance of Internet applications. There are currently two approaches for QoS support being developed by the Internet Engineering Task Force (IETF): Integrated Services (IntServ) and Differentiated Services (DiffServ). Since the DiffServ approach promises better scalability, our research projects are centered around the DiffServ approach.

#### Charging and Accounting Technologies for the Internet (CATI)

The project CATI has been approved within the Swiss Priority Program for Information and Communications Structures by the Swiss National Science Foundation (SNF). CATI consists of two subprojects: "Charging and Accounting in the Internet and in Virtual Private Networks" (CAPIV) and "Management, Evaluation, Demonstrators, and Business" (MEDeB). The main goal of the CATI project is the design and implementation of charging and accounting mechanisms for higher-value Internet services such as integrated services, differentiated services and virtual private networks. Our work focuses on the development of a

flexible VPN service including QoS support that can be configured dynamically by the user. The VPN QoS support will be based on mechanisms similar to that proposed by the Differentiated Services working group of the IETF. Another important topic is how to provide Integrated Services over a QoS-enabled VPN. In the first part of the project an architecture has been developed that allows the user to dynamically setup, modify, and tear down QoS-enabled VPNs over the Internet. During setup and modification the user will also be able to know the costs of the desired VPN configuration. Besides QoS support, security is the major issue of the developed architecture. This architecture will be the basis for the demonstrator to be implemented and evaluated in the future.

**Research Staff:** Manuel Günter, Mevlyde Kasumi, Ibrahim Khalil

**Financial Support:** Swiss National Science Foundation Project No.: 5003-054559 and 5003-054560

### **Scalable Quality-of-Service for the Internet (SQUINT)**

Differentiated Services (DiffServ) are a new approach to support QoS in the Internet which promises better scalability than the Integrated Services Architecture based on the Resource Reservation Setup Protocol (RSVP). The SQUINT project aimed to investigate the potential of the DiffServ concept. First, several services proposed by the DiffServ working group have been analyzed and evaluated. Several prototype implementations and products supporting DiffServ that appeared recently have been studied. An important issue is the behavior of DiffServ in overload conditions. Extensive simulations have been performed in order to evaluate how DiffServ networks behave if the load of certain links exceed the capacity of the assured bandwidth. It has been shown that DiffServ can provide some basic QoS support. However, network engineering becomes very important for DiffServ in order to avoid overload situations. The second part of the project studied the integration of the DiffServ architecture with other QoS-enabling technologies used in the Internet such as Asynchronous Transfer Mode (ATM), Multi-Protocol Label Switching (MPLS), Integrated Services based on RSVP, and Virtual Private Networks. Several synergies but also some problems have been identified if DiffServ is combined with one or more of these technologies.

**Research Staff:** Florian Baumgartner, Manuel Günter, Mevlyde Kasumi, Ibrahim Khalil

**Financial Support:** Deutsche Telekom AG

### **Differentiated Services over ATM**

This project develops and evaluates concepts in order to improve Quality-of-Service for IP networks (Internet and Intranets) over ATM networks. The first goal of the project is to implement Differentiated Services over an ATM-based IP

network. Functions required for DiffServ implementation within routers such as shaping or policing shall be replaced by ATM functionality. The implementation shall also include aggregation mechanisms allowing to negotiate Differentiated Services agreements on an aggregated flow level. The architecture for an UNIX-based implementation of Assured and Expedited Forwarding has been designed and the experimentation network consisting of routers and ATM switches has been set up. Future topics will be the integration of the DiffServ implementation into an ATM/MPLS environment and the detection of aggressive user flows.

**Research Staff:** Hans Einsiedler

**Financial Support:** NEC Europe Ltd.

### **Linux/ATM**

Within this project, a device driver for an ATM network adapter card for the Linux operating system is being developed. Linux has become a very popular UNIX operating system running on standard personal computers.

**Research Staff:** Florian Baumgartner

**Financial Support:** Telscom AG

### **ATM Testbed**

An experimental test network has been setup for the several research projects. This network consists of UNIX-based servers, routers, ATM switches, LAN switches as well as a variety of end systems.

**Research Staff** Florian Baumgartner

**Financial Support:** Swiss National Science Foundation R'Equip Project No. 2160-053299.98/1, Stiftung zur Förderung der wissenschaftlichen Forschung an der Universität Bern, NEC Europe Ltd.

## **3.3 Activities**

### **Program Committee Memberships**

- Member of the Program Committee of the 9th IEEE Workshop on Local and Metropolitan Area Networks, Banff, Alberta, Canada, May 17-20, 1998 (T. Braun)
- Member of the Program Committee of the IEEE Annual Conference on Local Computer Networks (LCN) Lowell, Massachusetts, U.S.A., October 11-14, 1998 (T. Braun)

- Member of the Program Committee of the IFIP Conference on High Performance Networking (HPN'98) Vienna, Austria, September 21-25, 1998 (T. Braun)

#### **Technical Committees**

- SWITCH Stiftungsrat (T. Braun)
- Kommission Informatikdienste of the University of Berne (T. Braun)
- SPEEDUP Society (T. Braun)

#### **Tutorials**

- "IP Version 6", IFIP Conference on High Performance Networking, September 21, 1998, Vienna (T. Braun)
- "Computer Networks", NEC Computer & Communication Research Laboratories Heidelberg, February 9-12, and March 25-27, 1998 (T. Braun)

### **3.4 Publications**

#### **Refereed Papers**

- F. Baumgartner, T. Braun, P. Habegger: Differentiated Services: A New Approach for Quality of Service in the Internet, IFIP Conference on High Performance Networking, September 21, 1998, Vienna, pp. 225-273
- T. Braun, P. Habegger: Differentiated Services: Ein neuer Ansatz für Dienstgüte im Internet, Praxis der Informationsverarbeitung und Kommunikation, Vol. 21, No. 4, 1998, pp. 202-210
- T. Braun, M. Mähler: Implementation of Virtual LANs over ATM WANs, Proceedings Europto Series, Broadband European Networks and Multimedia Systems, SYBEN 98, May 18-20, 1998, Zürich, pp. 310-317
- H. Einsiedler, P. Hurley: Link Weighting: An Important Basis for Charging in the Internet, Third Global Internet Mini-Conference, in conjunction with IEEE Globecom '98, Sydney, Australia, November 8-12, 1998

#### **Unrefereed Papers**

- T. Braun, M. Günter, M. Kasumi, I. Khalil: Virtual Private Network Architecture, CATI Project Deliverable, December 22, 1998



## 4 Research Group on Computer Vision and Artificial Intelligence

### 4.1 Personnel

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\* 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 techniques and methodologies for experimentally evaluating both edge- and region-based range image segmentation algorithms. We are working on complete segmentation based on edge detection. Earlier works on evaluating range image segmentation techniques are extended to the domain of curved surfaces.

**Research staff:** PD Dr. X. Jiang

#### Range Image Sequence Analysis

The purpose of this 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 its applications in postal check reading and general text recognition.

**Research staff:** Dr. G. Kaufmann, U.-V. Marti, M. Zimmermann

**Financial support:** Swiss National Science Foundation

### **Efficient Graph Matching Algorithms**

In this project, efficient algorithms for exact and error-tolerant attributed graph matching are developed. The basic idea in improving the efficiency of graph matching algorithms lies in suitable preprocessing procedures for prototype, or model graphs. By means of these preprocessing procedures, the complexity of the actual matching step can be reduced. Another effort aims at identifying particular classes of graphs that allow matching algorithms of polynomial complexity.

**Research Staff:** PD Dr. X. Jiang, Prof. Dr. H. Bunke and external partners

### **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:** Prof. Dr. H. Bunke

### **Automatic Lipreading**

The basic idea in automatic lipreading is to extract significant features from sequences of lip images. These features are used for model construction and recog-

dition of unknown words. In this project we develop robust methods and study possibilities of their combination.

**Research staff:** K. Yu, PD Dr. X. Jiang

### **Analysis of Human Face Images**

Analysis of human faces with computers is nowadays a very active research area. Though the first activities date back to the sixties, there are still many unsolved problems (e.g., variations of illumination or different head positions). The focus of our investigations is on range images of human faces. Furthermore, we combine different methods in order to get more robust results.

**Research staff:** Dr. B. Achermann, PD Dr. X. Jiang

### **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 image processing techniques will be implemented and their performance will be evaluated in order to obtain the best algorithm to identify unknown diatoms.

**Research staff:** S. Fischer

## **4.3 Diploma Theses**

- von Siebenthal, T.: On-line Erfassung von Handschrift mit einer Videokamera
- Grana, D.: Vergleich kantenbasierter Segmentierungsverfahren für Tiefenbilder
- Widmer-Kljajo, D.: Processing of compressed images – Two selected problems
- Münger, A.: Synthese von Prototypgraphen aus einer gegebenen Stichprobe
- Kronenberg, H.: Textextraktion aus farbigen Buchtitelseiten

## **4.4 PhD Theses**

- Kaufmann, G.: Erkennung von Handschrift mittels Hidden Markov Modellen für das automatische Lesen von Checkbeträgen

- Achermann, B.: Gesichtserkennung mit Tiefenbildern

## 4.5 Awards and Further Activities

### Awards

- Dr. G. Kaufmann received the *Fritz-Kutter-Fonds Award* 1998 for his PhD thesis entitled "Erkennung von Handschrift mittels Hidden Markov Modellen für das automatische Lesen von Checkbeträgen".

### Guests

- Dr. K. Shearer (Curtin University, Perth, Australia) was visiting guest from May to July, 1998.
- Dr. A. Kandel (University of South Florida, Tampa, USA) was visiting professor from June to July, 1998.
- Dr. G. Nagy (Rensselaer Polytechnic Institute, Troy, New York, USA) was visiting professor in June, 1998.
- Dr. S. Venkatesh (Curtin University, Perth, Australia) was visiting professor in June, 1998.

### Editorial Boards and Committees

- 1st Vice 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 Acta Cybernetica (H. Bunke)
- Editor-in-chief of the book series Machine Perception and Artificial Intelligence by World Scientific Publ., Singapore (H. Bunke)

### Organization and Program Committees

- Member of the Program Committee of 11th Conference Vision Interface, Vancouver, Canada, June 18-20, 1998 (H. Bunke)
- Member of the Program Committee of IEEE Conference on Intelligent Processing Systems, Gold Coast, Australia, August 4-6, 1998 (H. Bunke)

- Member of the Program Committee of IAPR Workshop on Structural and Syntactic Pattern Recognition, Sidney, Australia, August 11-13, 1998 (H. Bunke)
- Member of the Program Committee of IAPR 6th Int. Workshop on Frontiers in Handwriting Recognition, Taejon, Korea, August 12-14, 1998 (H. Bunke)
- Member of the Program Committee of IAPR Workshop on Document Analysis Systems, Nagano, Japan, November 4-6, 1998 (H. Bunke)

### **Seminar**

- A Dagstuhl Seminar on "Modelling and Planning for Sensor-Based Intelligent Robot Systems" was held from September 27 to October 2, 1998. This seminar was jointly organized by R. Bolles (SRI Menlo Park, USA), H. Bunke, H. Christensen (KTH Stockholm, Sweden), and H. Noltemeier (University of Würzburg)

### **Further Activities**

- Until August 31, 1998, H. Bunke was serving as Dean of the Faculty of Science of the University of Bern.

## **4.6 Publications**

### **Journal Publications**

- Ha, T.M., Zimmermann, M., Bunke, H.: Off-line handwritten numeral string recognition by combining segmentation-based and segmentation-free methods, *Pattern Recognition*, Vol 31, No 3, 1998, 257 - 272
- Yu, K., Jiang, X., Bunke, H.: Lipreading: A classifier combination approach, *Pattern Recognition Letters*, Vol 18, Nos 11 - 13, 1997, 1421 - 1426
- Lladós, J., Bunke, H., Martí, E.: Finding rotational symmetries by cyclic string matching, *Pattern Recognition Letters*, Vol 18, No 14, 1997, 1435 - 1442
- Messmer, B.T., Bunke, H.: A new algorithm for error-tolerant subgraph isomorphism detection, *IEEE Trans. PAMI*, Vol 20, 1998, 493 - 505
- Bunke, H., Shearer, K.: A graph distance metric based on the maximal common subgraph, *Pattern Recognition Letters*, Vol 19, Nos 3 - 4, 1998, 255 - 259

- Shearer, K., Bunke, H., Venkatesh, S., Kieronska, D.: Efficient graph matching for video indexing, *Computing, Suppl 12 (Graph Based Representations in Pattern Recognition)*, 1998, 53 - 62
- Jiang, X., Bunke, H.: On the coding of ordered graphs, *Computing*, Vol. 61, No. 1, 1998, 23 -38
- Messmer, B.T., Bunke, H.: Error-correcting graph isomorphism using decision trees, *Int. Journal of Pattern Recognition and Art. Intelligence* 12, No. 6, 1998, 721 - 742

### **Refereed Conference Proceedings and Edited Books**

- Powell, M., Bowyer, K., Jiang, X., Bunke, H.: Comparing curved-surface range image segmenters, *Proc. 6th Int. Conference on Computer Vision, Bombay, 1998*, 286 - 291
- Jiang, X., Bunke, H.: Range image segmentation: Adaptive grouping of edges into regions, in R. Chin, T.-C. Pong (eds.): *Computer Vision - ACCV '98, Proc. of the 3rd Asian Conference on Computer Vision, Hongkong, Springer Verlag, Lecture Notes in Computer Science 1352, 1998*, 299 - 306
- Jiang, X., Binkert, M., Achermann, B., Bunke, H.: Detection of glasses in facial images, in R. Chin, T.-C. Pong (eds.): *Computer Vision - ACCV '98, Proc. of the 3rd Asian Conference on Computer Vision, Hongkong, Springer Verlag, Lecture Notes in Computer Science 1352, 1998*, 726 - 733
- Sobottka, K., Bunke, H.: Obstacle detection in range image sequences using radial slope, *Proc. 3rd IFAC Symposium on Intelligent Autonomous Vehicles, Madrid, Spain, 1998*, 535-540
- Messmer, B.T., Bunke, H.: Clustering and error-correcting matching of graphs for learning and recognition of symbols in engineering drawings, in Hull, J., Taylor, S. (eds.): *Document Analysis Systems II, World Scientific Publ. Co., Singapore, 1998*, 102 - 117
- Bunke, H.: Error-tolerant graph matching: A formal framework and algorithms, in Amin, A., Dori, D., Pudil, P., Freeman, H. (eds.): *Advances in Pattern Recognition, Lecture Notes in Computer Science 1451, Springer Verlag, 1998*, 1 - 14
- Jiang, X., Bunke, H.: Marked subgraph isomorphism of ordered graphs, in Amin, A., Dori, D., Pudil, P., Freeman, H. (eds.): *Advances in Pattern Recognition, Lecture Notes in Computer Science 1451, Springer Verlag, 1998*, 122 - 131

- Bunke, H., Zumbuehl, M.: Acquisition of 2-D shape models from scenes with overlapping objects using string matching, in Amin, A., Dori, D., Pudil, P., Freeman, H. (eds.): Advances in Pattern Recognition, Lecture Notes in Computer Science 1451, Springer verlag, 1998, 200 - 209
- Ha, T. M.: Optimum decision rules in pattern recognition, in Amin, A., Dori, D., Pudil, P., Freeman, H. (eds.): Advances in Pattern Recognition, Lecture Notes in Computer Science 1451, Springer Verlag, 1998, 726 - 735
- Jiang, X., Binkert, T., Achermann, B., Bunke, H.: Towards detection of glasses in facial images, Proc. 14th ICPR, Brisbane, 1998, 1071 - 1073
- Kaufmann, G., Bunke, H.: Amount translation and error localization in check processing using syntax-directed translation, Proc. 14th ICPR, Brisbane, 1998, 1530 - 1534
- Shearer, K., Venkatesh, S., Bunke, H.: An efficient least common subgraph algorithm for video indexing, Proc. 14th ICPR, Brisbane, 1998, 1241 - 1243
- Jiang, X., Kuehni, P.: Search-based contour closure in range images, Proc. 14th ICPR, Brisbane, 1998, 16 - 18
- Kaufmann, G., Bunke, H.: Error localization and correction in check processing, Proc. 6th Int. Workshop on Frontiers in Handwriting Recognition, Taejon, Korea, 1998, 77 - 87
- Marti, U.-V., Bunke, H.: Towards general cursive script recognition, Proc. 6th Int. Workshop on Frontiers in Handwriting Recognition, Taejon, 1998, 379 - 388
- Achermann, B., Zumstein, M., Jiang, X., Bunke, H.: Matching of nose profiles using weighted Hausdorff distance, Proc. IEEE Int. Conf. on Intelligent Processing Systems, Gold Coast, Australia, 1998
- Sobottka, K., Bunke, H.: Employing range imagery for vision-based driver assistance, SPIE Conference: Enhanced and Synthetic Vision, Orlando, Florida, USA, 1998, 177-188.
- Kronenberg, H., Sobottka K., Bunke H.: Textextraktion aus farbigen Buchtitelseiten, 4. Workshop Farbbildverarbeitung, Koblenz, Deutschland, 1998, 105-111.
- Marti, U.-V., Bunke, H.: Erkennung handgeschriebener Wortsequenzen, in Levi, P., Ahlers, R.-J., May, F., Schanz, M. (Hrsg.): Mustererkennung 1998, Springer Verlag, Informatik aktuell, 1998, 263 - 270

- Sobottka, K., Bunke, H.: Vision-based driver assistance using range imagery, IEEE International Conference on Intelligent Vehicles, Stuttgart, Germany, 1998, 162 - 167
- Kaufmann, G., Bunke, H.: A system for the automated reading of check amounts - some key ideas, Proc. 3rd IAPR Workshop on Document Analysis Systems, Nagano, Japan, 1998, 302 - 315
- Jiang, X. and Bunke, H.: Performance assessment of edge-based range image segmentation, Proc. of Int. Conf. on Advances in Pattern Recognition, Plymouth, 1998, 83-92
- H. du Buf, H. Bunke, S. Droop, J. Roerdink, S. Juggins, G. Cristobal, B. Ludes: Automatic Diatom Identification and Classification ADIAC, Proc. 3rd European Marine Science and Technology Conference, Lisbon, Portugal, 1998, 1071-1074

#### **Unrefereed Papers and Technical Reports**

- Yu, K., Jiang, X., Bunke, H.: A new approach to lipreading using time-varying signal analysis, Technical Report IAM-98-001, Institut fuer Informatik und angewandte Mathematik, University of Bern, 1998



## 5 Research Group on Theoretical Computer Science and Logic

### 5.1 Personnel

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	Dr. M. Seyfried*	until March	
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	Dr. W. Th. Wolff*	until March	
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<b>Guests:</b>	Prof. Dr. A. Cantini	(April)
	Dr. R. Goré	(May – July)
	Dr. W. Heinle	(June)
	Dr. A. Setzer	(June)
	Dr. U. Kohlenbach	(October)
	Prof. Dr. V. Rybakov	(October – November)

## 5.2 Research Projects

### Logic and Computation

This very general project deals with the close connections between mathematical logic and certain areas 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 such as 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

In collaboration with Prof. Dr. E. Engeler, ETH Zürich.

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 Bern 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:** L. Alberucci, G. Jäger, Ch. Rüede, Th. Strahm, Th. Studer.

**Financial Support:** Swiss National Science Foundation.

### A Frame for Networked Components

In collaboration with Dr. H. Lienhard, IvyTeam, Zug.

*A Frame for Networked Components* is part of the *Virtual Software House (VSH)* project package. The object is to develop a powerful, executable frame for network components that can be used to assemble complex model components from elementary units. In addition to drawing up mathematically based rules of composition, this requires the development of suitable interface definitions to fit the individual parts into the frame. Our project builds upon previous work (supported by the SPP IF) of the IvyTeam and our research group here in Bern concerning the component structure of BusinessSpecs, developed by IvyTeam, Zug. The biggest challenge now is to match components of different providers accessible via the VSH in the simplest possible manner, addressing the end-user (e.g. the organizer of a business process reengineering project) rather than the software engineer.

This goal demands a strictly mathematical approach to the problem, while nonetheless concealing the mathematical mechanisms from the end-user. Instead, the end-user is provided with easy-to-operate composition plans featuring intuitive semantics.

On the practical side algorithms to compute invariants of Petri nets and algorithms based on transition systems that calculate possible responses of a component to a given input are considered.

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

**Financial support:** Swiss National Science Foundation (Schwerpunktprogramm Information und Kommunikation, project ended in September)

### **Non-Deterministic Aspects of Information Refinery in Distributed Environments**

In collaboration with Prof. Dr. B. Schmid, Universität St. Gallen (HSG).

The aim of this project is to investigate non-deterministic algorithms which have practical relevance for defining agents in open system environments. The project will be focused on specific non-deterministic problems occurring in searching, collecting, and integrating information, especially quantitative information, within open system environments.

More specifically, the question is to define the behavior of an information refinery process or agent that acts in a distributed, open environment and delegates specific subtasks to other available information processing agents. In this sense, such an agent can be considered as an information vendor/arbitrageur. Since there is no centralised control in an open system environment, such a cooperation has to deal with non-deterministic behavior of other agents. This interaction can be seen as coordinated by market forces — a perspective taken on from the Competence Center “Electronic Markets” at HSG (IWI4) whose overall research goal is the introduction of market mechanisms into information processing. Practical

applications arise in the fields of information management, information refinery, and data mining.

The project is based on research results achieved in cooperation between the University Bern (Prof. Jäger) and HSG (Prof. Schmid) within the SNF project *Representation and automatic evaluation of empirical, especially quantitative knowledge* (No. 5003-34372).

**Research staff:** G. Jäger, W. Th. Wolff

**Financial support:** Swiss National Science Foundation (project ended in March).

### **Distributed Propositional Proof Systems; the Logics Workbench LWB**

The research project *distributed propositional proof systems* is 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 with respect to 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 taking advantage of available techniques of distributed computing. We make use of existing tools (e.g. PVM), so 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.

The Logics Workbench LWB is currently ported to the Macintosh operating system. While most of the basic algorithms can be reused, the graphical user interface has to be completely rewritten. This is done using object-oriented techniques in conjunction with an Macintosh specific object-oriented GUI library.

At the same time, it was necessary to adjust and modify our implementation details in order to be able to use the same base algorithms for Macintosh and for Solaris versions.

**Research staff:** P. Balsiger, A. Heuerding, G. Jäger, S. Schwendimann, M. Seyfried

**Financial support:** Swiss National Science Foundation (project ended in June).

### **Inference and Deduction: An Approach Integrating Logic and Probability**

In collaboration with Prof. Dr. J. Kohlas and Dr. R. Stärk, University of Fribourg.

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 among the best known examples 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:** P. Balsiger, P. Brambilla

**Financial support:** Swiss National Science Foundation

### 5.3 PhD Theses

- A. Heuerding. Sequent Calculi for Proof Search in Some Modal Logics.
- S. Schwendimann. Aspects of Computational Logic.
- M. Seyfried. Computational Aspects of Fragments of Intuitionistic Propositional Logic.
- W. Wolff. Ein Kalkül zur Verarbeitung quantitativer Information.

## 5.4 Further Activities

### Award

- Th. Strahm received the Theodor-Kocher-Preis 1998.

### Editorial Boards and Technical Committees

- Member of the editorial board of *Theoretical Computer Science* (G. Jäger).
- Member of the editorial board of *The Journal 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 the *Workshop on Operations, Sets, and Types*, Castiglioncello (G. Jäger).

## 5.5 Publications

- P. Balsiger, A. Heuerding, and S. Schwendimann. A benchmark method for the propositional modal logics K, KT, S4. Submitted.
- P. Brambilla. A Calculus for Resource Control of Components. Technical Report IAM-98-002, University of Bern, 1998.
- E. Clarke, M. Fujita, and W. Heinle. Hybrid spectral transform Diagrams. Proceedings of *ICICS'97, Spectral Methods in Hardware Design*. To appear.
- E. Clarke, W. Heinle, and H. Schlingloff. Model Checking. In A. Voronkov (ed.), *Handbook of automated reasoning*, Elsevier. To appear.
- S. Feferman, Th. Strahm. The unfolding of non-finitist arithmetic. Submitted.
- G. Jäger. First order theories for nonmonotone inductive definitions: recursively inaccessible and Mahlo. Technical notes, 1998.
- G. Jäger, R. Kahle, A. Setzer, and Th. Strahm. The proof-theoretic analysis of transfinitely iterated fixed point theories, *Journal of Symbolic Logic*. To appear.

- G. Jäger, R. Kahle, and Th. Strahm. On applicative theories. In A. Cantini, E. Casari and P.L. Minari (eds.), *Logic in Florence '95*, Kluwer. To appear.
- G. Jäger, R.F. Stärk. A proof-theoretic framework for logic programming. In S.R. Buss (ed.), *Handbook of Proof Theory*, North-Holland, 1998.
- G. Jäger, Th. Strahm. Fixed point theories and dependent choice. *Archive for Mathematical Logic*. To appear.
- G. Jäger, Th. Strahm. Bar induction and  $\omega$  model reflection. *Annals of Pure and Applied Logic*. To appear.
- R. Kahle. Frege structures for partial applicative theories. *Journal of Logic and Computation*. To appear.
- R. Kahle. N-strictness in applicative theories. *Archive for Mathematical Logic*. To appear.
- M. Marzetta, Th. Strahm. The  $\mu$  quantification operator in explicit mathematics with universes and iterated fixed point theories with ordinals. *Archive for Mathematical Logic*, 1998.
- S. Schwendimann. A New One-Pass Tableau Calculus for PLTL. In H. de Swart (ed.), *Tableaux 98*, LNAI 1397, Springer, 1998
- Th. Strahm. First steps into metapredicativity in explicit mathematics. In B. Cooper and J. Truss (eds.), *Sets and Proofs*, Cambridge University Press. To appear.
- Th. Strahm. The non-constructive  $\mu$  operator, fixed point theories with ordinals, and the bar rule. Submitted.
- Th. Strahm. Autonomous fixed point progressions and fixed point transfinite recursion. Submitted.

## 6 Research Group on Neurocomputing

### 6.1 Personnel

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\* full financial support from a third party.

§ partial financial support from a third party.



## 6.2 Research Projects

### **BRAINTOOL - A computer supported model of the basic spinal motor control system**

BRAINTOOL is an interdisciplinary and interuniversity neuroscience research project within the priority programme Biotechnology (SPP Biotech, module: Neuroinformatics). The research work is executed by a collaboration group between the IAM, the Departments of Physiology (PHY) of the University of Bern and Freiburg, and the Institute of Mathematics at the University of Freiburg. The goal of the project is to achieve new knowledge about the biological information processing and to transfer this knowledge into new, more powerful technical systems (direct knowledge transfer to FOVEA project at the IAM). The experimental work is focused on the basic spinal motor control.

The obtained results provide the input to define a canonical motoneuron model as a tool for further computational neuroscience research and as a building block for new neuromorphic artificial networks. With the canonical neuron model we can study intrinsic properties in biological networks but also the potential of neuromorphic networks in technical applications (FOVEA Project). In order to understand the muscular control we further need a characterization of movements at the level of canonical networks in the motoneuronal pool (motoneurons controlling one muscle) and at the higher integrated motor control systems. The BRAINTOOL research may also provide the necessary knowledge to progress on these questions.

The research at the IAM is focused on three levels of modeling: (1) synaptical level (diffusion of neuro-transmitter across the synaptical cleft), (2) cell level (information processing in the dendritic apparatus, reduction of modeling complexity by using a fuzzy rule approach), (3) network level (mathematical analysis of size principle in motor unit recruitment, oscillation in excitatory randomly connected neural networks). Another aim of the project is to develop an integrated workbench which supports rapid prototyping in neuronal modeling and provides an extensive set of analysis instruments. We have already implemented a program NeuroTrace in Java, which facilitates computer aided tracing for the morphological reconstruction of nerve cells, a toolbox for computational neuroscience, NeuroToolbox, based on Matlab/Simulink systems to generate computer simulations of reconstructed cells. Currently we are developing a parallelized solver for Simulink systems based on PVM and NAG libraries on the IBM SP2 owned by the university of Bern to accelerate our simulations.

<b>Research staff:</b>	IAM:	H. Mey, N. Buchs, J. Kleinle, L. Müller, A. Schüpbach, W. Senn
	PHY:	H.-R. Lüscher, J. Streit, T. Wannier
	Freiburg:	D. Rüegg, J.-P. Gabriel, R. Nussbaumer, T. Kakebeeke

**Financial support:** Swiss National Science Foundation (SPP Biotech, module: Neuroinformatics)

For further details, see: <http://iamwww.unibe.ch/~brainwww>

## **FOVEA - Focused Operating View Evaluation Architecture**

*Multisensor foveal perception for target detection and tracking using neuromorphic network architectures and dynamic binding*

The FOVEA project is an extended feasibility study for the development of a biology inspired neuromorphic perception system for target detection, selective feature extraction and tracking in a predefined background scenario. The study includes the construction of a prototype system with realized lower level perception and selective attention steering functionality which shall be tested for specific technical applications.

The use of biology inspired ideas and methods for real time target detection and tracking in a natural environment may improve many automatic supervision systems in defense and in civil applications. Such ideas are (a) the combination and sensor fusion of information from several sensor channels (colliculus inspired space representing maps for the different sensor channels), (b) the situation dependent scanning of the perception space with a inhomogeneous (foveal) sensor resolution, (c) the structuring of the perception process in an novelty detection, a characterization (selective attention) and a evaluation (context dependent classification and tracking) stream and (d) the context dependent evaluation and binding of signal features in the different processing pathways. Special emphasis goes to the problem of dynamic binding mechanisms capable to solve the selective attention steering and the sensor fusion tasks.

The project work will be done in two steps. The first is devoted to a feasibility and usability study where a certain number of biology inspired ideas will be implemented, tested and evaluated in functional components and in prototype subsystems. The prototype system consist of a sensor front end (using conventional video and audio sensors in combination with fast data acquisition and preprocessing devices), a laboratory scenario generator and a set of (partially off line) perception analysis tools. In a second step we will use the obtained test results and the gained knowledge of the initial project phase to design and realize a complete perception system which integrates all necessary components for target detection, characterization and tracking in a fixed background environment.

**Research staff:** H.-H. Bothe, E. Mousset, L. Müller, J. Reutimann, H. Zimmermann, M. Heuer (GR)

**Financial support:** Swiss National Science Foundation, Swiss Defence Technology and Procurement Agency (GR)

### **6.3 PhD Thesis**

- Josef Kleinle, Dendritic Processing of Synaptic Signals. May 1998

### **6.4 Master's Thesis**

- Adrian Schüpbach, Spikedetektion in Elektrodenarraydaten, November 1998

### **6.5 Further Activities**

#### **Associations**

- Assoc. Swiss Machinery Manufacturers, Research committee (H. Mey, president)
- Swiss Federation of Commerce and Industry, Research committee (H. Mey, member)

#### **Committees**

- Swiss Federal Commission for Higher Education (H. Mey, president)
- FORUM ENGELBERG, Scientific Committee (H. Mey, member)
- Member of the Academic Committee University of Bern (H. Mey)
- Member of International Computer Science Conventions, Canada, Academic Advisory Board (H.-H. Bothe)

### **6.6 Courses presented at other institutions**

- Postgraduate teaching activities (NDIT/FPIT courses): Information Security and Cryptology (L. Müller), Mathematical Repetitorium (P. Schwab (ISBE), L. Müller (IAM), R. Müller (ISBE), Ch. Meier (ISBE))
- Teaching activities at 'Fachhochschule Bern': Cryptology (L. Müller), Neural Networks (W. Senn, L. Müller, H.-H. Bothe), Basic calculus (W. Senn)
- Teaching activities at Technical University of Berlin: Adaptive Fuzzy Methods (H.-H. Bothe)
- Teaching activities at the 'Swiss Programs for Management Education' (H. Mey)

## 6.7 Publications

### Journal Articles

- W. Senn, I. Segev, M. Tsodyks. Reading neural synchrony with depressing synapses. *Neural Computation* 10, 815-819 (1998)
- W. Senn, T. Wannier, J. Kleinle, H.-R. Lüscher, L. Müller, J. Streit, K. Wyler. Pattern generation by two coupled time-discrete neural networks with synaptic. *Neural Computation* 10, 1251-1275 (1998)
- T. Wannier, W. Senn. Recruitment of reticulospinal neurones and steady locomotion in lamprey. *Neural Networks* 11, 1005-1015 (1998)
- W. Senn, Equilibrium forms of crystals and stable norm. *J. of Appl. Math. und Phys. (ZAMP)* 49, 919-933 (1998)
- W. Senn, Phase-locking in the multidimensional Frenkel-Kontorova model. *Math. Zeitschrift* 227, 623-643 (1998)

### Proceeding Articles

- J. Kleinle, M. Larkum, N. Buchs, W. Senn, H.-R. Lüscher, Cable Properties of Motoneurons in Rat Spinal Cord Slice Cultures, in: *Computational Neuroscience: Trends in Research*, 1998, ed. J. M. Bower
- M. Paulin, W. Senn, D. Cohen, H. Meiri, Y. Yarom, Rapid synaptic weight changes in shark electroreceptive neurons enable the detection of small signals, in: *Computational Neuroscience: Trends in Research*, 1998, ed. J. M. Bower
- J. Tabak, J. Rinzel, W. Senn. Models of rhythmic activity in chicken spinal cord preparations. To appear in: *Computational Neuroscience: Trends in Research*, 1999, ed. J. M. Bower
- E. Mousset. Information theoretic criteria for the integration of auditory and visual spatial information, *Proceedings of the NATO Advanced Study Institute on Computational Hearing*, 1998

## 7 Research Group on Software Composition

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\* financial support from a third party.

### 7.2 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:

“Infrastructure for Software Component Frameworks” (NFS 2000-46947.96) is a basic research project concerned with the development of formal languages and models to specify and reason about reusable software components and frameworks.

“A framework approach to composing heterogeneous applications” (NFS No. 20-53711.98) is a continuation of the previous project, which will investigate the

application of framework technology to the composition of heterogeneous applications.

FAMOOS ("Framework-based Approach for Mastering Object-Oriented Software Evolution") is a European industrial project (Esprit 21975) concerned with reengineering of object-oriented legacy applications.

COORDINA is an Esprit Working Group (Esprit 25412) on technology for coordinating distributed agents.

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

### **Infrastructure for Software Component Frameworks**

**Research staff:** F. Achermann, J. C. Cruz, Dr. S. Demeyer, Dr. S. Ducasse, M. Lumpe, J.-G. Schneider.

**Duration:** 1996-10-01 - 1998-09-30

**Financial support:** Swiss National Science Foundation, grant Nr. 2000-46947.96

"Infrastructure for Software Components Frameworks" addresses the problem of building systems from reusable software components and architectures. The project attacks both formal and practical issues of component reuse: (1) the definition of a formal language for specifying components, architectures and glue; (2) principles and techniques for developing reusable components from existing software; (3) prototype development of glue languages and tools; (4) the development of a framework of coordination components for gluing distributed services.

**A glue calculus:** We have developed a small formal language based on the  $\pi$  calculus, called  $\pi\mathcal{L}$  which can be used to model, objects, components, glue mechanisms, and reusable composition abstractions such as generic synchronization policies. We are using the glue calculus to reason about properties of software compositions.

**Meta-Modelling techniques:** We have studied how tailorable frameworks can be designed. Design patterns that describe solutions at the design level to general problems provide a set of good practices to increase flexibility to support frameworks. As traditional object-oriented languages do not explicitly support design patterns, we have experimented with the reification of such entities at the language level. We are continuing to experiment with a visual approach to framework composition.

**FLO/C: Glue for Active Objects:** An extension of traditional object-oriented languages, named FLO, has been developed to experiment with various forms of connections between components. FLO/C, a further extension of this work, has been developed to glue active objects. In parallel to this experimental approach, we have surveyed the state of the art in frameworks,

components and glue techniques to provide requirements for the development of the composition language.

**Piccola – a small composition language:** A parallel project, Piccola, aims at developing a composition language on top of  $\pi\mathcal{L}$ . Piccola attempts to generalize both scripting languages and so-called “architectural scripting languages” on top of a small, simple formal basis.

**Coco – a Coordination Framework:** In order (i) to provide concrete requirements to our foundational work on component modelling and design, and (ii) to validate our approach, we have been experimenting with component architectures and frameworks in coordination area. Instead of proposing yet another coordination language, we are attempting to address coordination with a component-based approach, by developing an open framework of software components that realize common coordination abstractions.

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

### **A Framework Approach to Composing Heterogeneous Applications**

**Research staff:** F. Achermann, J. C. Cruz, Dr. S. Demeyer, Dr. S. Ducasse, M. Lumpe, J.-G. Schneider.

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

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

### **FAMOOS**

**Research staff:** Dr. S. Demeyer, Dr. S. Ducasse, R. Nebbe, T. Richner, M. Rieger, S. Tichelaar.

**Duration:** 1996-09-01 - 1999-08-30

**Financial support:** Swiss National Science Foundation, ESPRIT project 21975.

FAMOOS is an industrial ESPRIT Project (No. 21975) in the IT Programme of the Fourth ESPRIT Framework Programme. FAMOOS is an acronym for “Framework-based Approach for Mastering Object-Oriented Software Evolution.” The goal of FAMOOS is to support the evolution of first generation object-oriented software towards flexible software frameworks. The partners are Nokia Corporation (Finland), Daimler-Benz (Germany), Forschungszentrum Informatik (Germany), Sema Group (Spain), TakeFive Software (Austria), and The Software Composition Group (Switzerland).

We are developing methods and tools to analyse and detect design problems with respect to flexibility in object-oriented legacy systems and to transform these systems efficiently into frameworks based on flexible architectures.

In addition to the organisation of international workshops on re-engineering, we are currently working on: analysis of dependencies, detection of duplicated code, reorganization of code based on patterns, and use of prototypes for software architecture recovery.

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

## **COORDINA**

**Research staff:** J. C. Cruz, Dr. S. Ducasse, S. Tichelaar

**Duration:** 08.97-08.2000

**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.

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

### **7.3 M.Sc. Theses**

- Manuel Günter, "Explicit Connectors for Coordination of Active Objects," Diploma thesis, University of Berne, March 1998.
- Daniel Kühni, "APROCO: A Programmable Coordination Medium," Diploma thesis, University of Berne, October 1998.
- Roland Loser, "Objekt-orientierter Compilerentwurf," Diploma thesis, University of Berne, January 1998.

### **7.4 Further Activities**

#### **Editorial Boards**

- IEEE Computer Society – Computer Science Engineering Practice Board (O. Nierstrasz)



- Object-Oriented Systems, Chapman & Hall (O. Nierstrasz)
- L'OBJET – Logiciel, réseaux, bases de données (O. Nierstrasz)
- Annals of Software Engineering (O. Nierstrasz)

### 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)

### Program Committees

- ECOOP 98 (European Conference on Object-Oriented Programming) (PC member, O. Nierstrasz)
- OOPSLA 98 (ACM SIGPLAN Object-Oriented Programming Systems, Languages and Applications) (PC member, O. Nierstrasz)
- CTIS 98 (International Workshop on Coordination Technologies for Information Systems) (PC member, O. Nierstrasz)
- FSE-6 (ACM SIGSOFT Foundations of Software Engineering) (PC member, O. Nierstrasz)

### Conference Tutorials

- “Scripting: Higher-Level Programming for Component-Based Systems” presented at OOPSLA 98 (J.-G. Schneider, O. Nierstrasz)

## 7.5 Publications

### Proceedings

- Serge Demeyer and Jan Bosch (Ed.), *Object-Oriented Technology (ECOOP'98 Workshop Reader)*, LNCS 1543, Springer-Verlag, Kaiserslautern, Germany, December, 1998.
- Ducasse Stéphane and Joachim Weisbrod (Ed.), *Proceedings of the ECOOP'98 Workshop on Experiences in Object-Oriented Re-Engineering*, Forschungszentrum Informatik, Karlsruhe, Germany, June, 1998.

## Journal and Conference Publications

- Serge Demeyer, Koen De Hondt and Patrick Steyaert, "Consistent Framework Documentation with Computed Links and Framework Contracts," *Computing Surveys*, ACM, 1998, To appear.
- Serge Demeyer, Matthias Rieger, Theo Dirk Meijler and Edzard Gelsema, "Class Composition for Specifying Framework Design," *Transactions on Programming Languages and Systems (TAPOS)*, 1998, To appear.
- Stéphane Ducasse, Robb Nebbe and Tamar Richner, "Two Reengineering Patterns: Eliminating Type Checking," *Proceedings of Eurolop'98*, 1998.
- Oscar Nierstrasz, "Identify the Champion," Proceedings of PLoP 98, TR #WUCS-98-25., Washington University, 1998.
- Jean-Guy Schneider and Oscar Nierstrasz, *Components, Scripts and Glue*, August 1998, Submitted for Publication.

## Workshop Publications

- Juan Carlos Cruz and Sander Tichelaar, "Managing Evolution of Coordination Aspects in Open Systems," *Ninth International Workshop on Database and Expert Systems Applications*, Roland R. Wagner (Ed.), IEEE Computer Press, Vienna, Austria, August 26-28, 1998, pp. 578-582.
- Serge Demeyer and Harald Gall, "Workshop on Object-Oriented Re-engineering (WOOR'97)," *Software Engineering Notes*, vol. 23, no. 1, ACM, January, 1998, pp. 28-29.
- Serge Demeyer and Stéphane Ducasse, "Do Metrics Support Framework Development ?", *Object-Oriented Technology (ECOOP'98 Workshop Reader)*, Serge Demeyer and Jan Bosch (Ed.), LNCS 1543, Springer-Verlag, 1998.
- Serge Demeyer, "Analysis of Overridden Methods to Infer Hot Spots," *Object-Oriented Technology (ECOOP'98 Workshop Reader)*, Serge Demeyer and Jan Bosch (Ed.), LNCS 1543, Springer-Verlag, 1998.
- Serge Demeyer, Matthias Rieger and Sander Tichelaar, "Three Reverse Engineering Patterns," working paper, April, 1998, Writing Workshop at EuroPLOP'98.
- Stéphane Ducasse and Manuel Günter, "Coordination of Active Objects by Means of Explicit Connectors," *Proceedings of the DEXA workshops*, IEEE Computer Society Press, August, 1998, pp. 572-577.

- Oscar Nierstrasz, Sander Tichelaar and Serge Demeyer, "CDIF as the Interchange Format between Reengineering Tools," *OOPSLA'98 Workshop on Model Engineering, Methods and Tools Integration with CDIF*, September, 1998.
- Pascal Rapicault, Mireille Blay-Fornarino, Stéphane Ducasse and Anne-Marie Dery, *Dynamic Type Inference to Support Object-Oriented Reengineering in Smalltalk*, 1998, Proceedings of the ECOOP'98 International Workshop Experiences in Object-Oriented Reengineering, abstract in Object-Oriented Technology (ECOOP'98 Workshop Reader forthcoming LNCS).
- Tamar Richner "Describing Framework Architectures: more than Design Patterns," *Proceedings ECOOP Workshop on Experiences in Object-Oriented Software Architectures*, Jan Bosch and Helene Bachatene and Görel Hedin and Kai Koskimies (Ed.), Research Report, no. 13/98, University of Karlskrona/Ronneby, 1998.
- Tamar Richner and Stéphane Ducasse and Roel Wuyts "Understanding Object-Oriented Programs with Declarative Event Analysis," *Proceedings ECOOP Workshop on Experiences in Object-Oriented Re-Engineering*, Stéphane Ducasse and Joachim Weisbrod (Ed.), FZI Report, no. 6/7/98, Forschungszentrum Informatik Karlsruhe, 1998.
- Matthias Rieger and Stéphane Ducasse, "Visual Detection of Duplicated Code," *Proceedings ECOOP Workshop on Experiences in Object-Oriented Re-Engineering*, Stéphane Ducasse and Joachim Weisbrod (Ed.), FZI Report, no. 6/7/98, Forschungszentrum Informatik Karlsruhe, 1998.
- Sander Tichelaar and Serge Demeyer, "An Exchange Model for Reengineering Tools," *Object-Oriented Technology (ECOOP'98 Workshop Reader)*, Serge Demeyer and Jan Bosch (Ed.), LNCS 1543, Springer-Verlag, July, 1998.

## **A Teaching Activities**

### **A.1 Winter semester 1997/98:**

<b>H. Bieri:</b>	Datenstrukturen und Algorithmen Geometrisches Modellieren Praktikum Computergrafik Seminar: Computergrafik
<b>H.P. Blau:</b>	Informatik 1C Programmierung 1
<b>H. Bunke:</b>	Automaten und formale Sprachen Künstliche Intelligenz Seminar: Künstliche Intelligenz
<b>S. Ducasse:</b>	Smalltalk: A reflective Language and Environment
<b>H. Hügli:</b>	Informatik 1B
<b>G. Jäger:</b>	Logik und Informatik Lambdakalkül Praktikum Symbolisches Rechnen Blockseminar Bern und Zürich: Logik und Informatik. Seminar: Theoretische Informatik und Logik
<b>G. Jäger, J. Schmid:</b>	Seminar: Mengensysteme
<b>H. Mey:</b>	Informatik 1A
<b>O. Nierstrasz:</b>	Concurrent Programming Datenbanken Programmiersprachen Seminar: Software Composition

## **A.2 Summer semester 1998:**

<b>H. Bieri:</b>	Computergrafik 3D-Grafik Seminar: Computergeometrie und Grafik Seminar: Computergrafik
<b>H.P. Blau:</b>	Informatik 2C
<b>H.-H. Bothe:</b>	Einführung in Künstliche Neuronale Netze und Fuzzy-Methoden
<b>H. Bunke:</b>	Compilerbau Seminar: Künstliche Intelligenz
<b>T. Braun:</b>	Betriebssysteme Computernetze
<b>G. Jäger:</b>	Beweistheorie Einführung in die theoretische Informatik Blockseminar Bern und Zürich: Logik und Informatik Seminar: Theoretische Informatik und Logik
<b>G. Jäger, J. Schmid:</b>	Seminar: Mengensysteme II
<b>H. Mey:</b>	Informatik 2B
<b>O. Nierstrasz:</b>	Informatik 2A Praktikum Software Engineering Programmierung 2 Seminar: Software Composition

### **A.3 Winter semester 1998/99:**

<b>H. Bieri:</b>	Datenstrukturen und Algorithmen Digitale Bilder Modellierung und Simulation Seminar: Computergrafik
<b>H.P. Blau:</b>	Informatik 1C Programmierung 1
<b>T. Braun:</b>	Computernetze Informatik 1B Netze und Protokolle für das Internet Seminar: Rechnernetze und verteilte Systeme
<b>B. Achermann, K. Sobottka: X. Jiang:</b>	Künstliche Intelligenz Automaten und formale Sprachen Seminar: Künstliche Intelligenz
<b>G. Jäger:</b>	Automatisches Beweisen Logik und Informatik Praktikum Symbolisches Rechnen Seminar: Theoretische Informatik und Logik
<b>G. Jäger, J. Kohlas:</b>	Inferenz und Deduktion
<b>G. Jäger, J. Schmid:</b>	Seminar: Mengensysteme III
<b>A. Lüthi, P. Küng:</b>	Datenbanken
<b>H. Mey:</b>	Informatik 1A
<b>O. Nierstrasz:</b>	Seminar: Software Composition
<b>O. Nierstrasz, S. Ducasse:</b>	Smalltalk: A reflective Language and Environment
<b>O. Nierstrasz, S. Demeyer, S. Ducasse:</b>	Object-Oriented Re-engineering

## B Colloquium in Informatics

- 20.01.98 Dr. Oliver Gloor  
Universität Tübingen  
Analysis Alive – interaktives Lernen  
mit einem Computeralgebra-System
- 27.01.98 Prof. Dr. Hartmut Noltemeier  
Universität Würzburg  
Relokalisation autonomer Roboter  
- ein theoretischer Ansatz in der Praxis
- 03.02.98 Prof. Dr. Theo D'Hondt  
Programming Technology Lab,  
Brussels Free University, Belgium  
A framework approach to inheritance
- 14.04.98 Prof. Dr. Martina Zitterbart  
Institut für Betriebssysteme und Rechnerverbund  
Technische Universität Braunschweig  
Aktive Netze zur Unterstützung heterogener Gruppen-  
kommunikation
- 26.05.98 Dr. Jochen Schiller  
Institut für Telematik, Universität Karlsruhe  
Mobilkommunikation: Stand der Technik, Herausforderungen  
an die Forschung
- 09.06.98 Dr. Ronan Boulic  
Computer Graphics Lab, EPFL  
Improving Virtual Human Usability with Balance Control
- 16.06.98 Prof. Dr. George Nagy  
Rensselaer Polytechnic Institute, Troy, NY, USA  
At the Frontiers of OCR
- 23.06.98 Prof. Dr. Abraham Kandel  
University of South Florida, Tampa, USA  
Applied Fuzzy Logic

- 08.07.98 Prof. Bharat Bhargava  
Computer Science Department, Purdue University,  
West Lafayette, USA  
Active Gateway: A Facility for Video Conferencing  
Traffic Control
- 20.10.98 Prof. Dr. Ulrich Kohlenbach  
Department of Computer Science, University of Aarhus, DK  
Beweisinterpretationen: Effektive Daten aus ineffektiven  
Beweisen
- 27.10.98 Dr. Heinrich J. Stüttgen  
NEC Europe Ltd., Research Laboratories, Heidelberg  
Intelligent Internet Telephony (I2N)
- 17.11.98 Prof. Dr. Farhad Arbab  
Centre for Mathematics and Computer Science, Amsterdam  
The Coordination Language Manifold
- 24.11.98 Prof. Dr. Emo Welzl  
Institut für Theoretische Informatik, ETHZ  
j-Facetten endlicher Punktemengen und  
das Upper Bound Theorem für konvexe Polytope



## **C   Institute Events**

01.01.98   Prof. Torsten Braun  
Assumption of office