

Faculty of Computer and
Information Science
University of Ljubljana
Survey of Activities in 2005

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Prof. Dr. Boštjan Vilfan

Foreword

A note on nomenclature at the University of Ljubljana: Most Central European universities are divided into "faculties", which are sometimes, in turn, divided into departments, and the latter (or the former) into "chairs" presided by a professor who covers a certain field of teaching and research. This scheme prevails at the University of Ljubljana as well, except that "chairs" are not associated with individual professors, but represent a group of professors with related areas of teaching and research. Therefore in the present booklet we use the term "group" instead of "chair" for the latter subdivision.

The present booklet provides some basic facts about the Faculty of Computer and Information Science of the University of Ljubljana pertaining to the year 2005. Henceforth, the faculty will be designated by its Slovenian initials, FRI.

FRI is the leading teaching and research institution in the field of Computer Science in Slovenia, and in spite of its comparatively short history it has a number of active research groups, as well as a lengthy roster of alumni, some of whom have achieved distinction in various fields of computer science in Slovenia and abroad.

Due to a continued high demand for graduates in the area of Computer Science and "Informatics" (business applications which generally rely on the use of data bases) as well as a continued high regard for Computer Science in the public's perception, FRI has avoided the trend of declining enrolment in the engineering and science disciplines up to now. However, we are definitely not complacent, and we hope to continue to attract promising students to our various educational and research programs.

There is no doubt that in the age of globalization FRI faces increasing competition in all areas; however I might note that we have made encouraging progress in attracting EU Commission's funding for our research groups, our members are involved in some interesting cutting-edge applications, and we are on our way to solving our most pressing problem, the shortage of space.

This booklet is a contribution to forging new links to the international Computer Science community, which is a prerequisite for FRI to successfully continue its mission. I hope that readers will find some interesting material and be motivated to establish contacts with our members.

*Boštjan Vilfan,
Professor of Computer Science and Dean*

About FRI

General Information

Dean **Prof. Dr. Boštjan Vilfan**

Associate Dean for Education **Prof. Dr. Viljan Mahnič**

Associate Dean for Research **Prof. Dr. Blaž Zupan**

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FRI

The Faculty of Computer and Information Science was established in 1996 after the former Faculty of Electrical Engineering and Computer Science split up into two faculties. However, the undergraduate program in computer science at the University of Ljubljana was established in 1973, first as an elective program after the second year of electrical engineering study, and since 1982 as an independent four year program.

Up to now more than 1800 students have completed the undergraduate program in computer science and obtained the Ing. or Dipl. Ing. degree. At the graduate level more than 280 Master's degrees (M.Sc.) and 85 the Doctoral degrees (Ph.D.) in Computer and Information science have been awarded. Currently, there are about 1536 undergraduate and 94 graduate students at the Faculty. The Faculty has 104 employees, of which 93 are teaching and research staff.

The building which houses FRI is shared with the Faculty of Electrical Engineering. FRI has 7 teaching laboratories equipped with a total of about 135 networked personal computers and shares with the Faculty of Electrical Engineering 19 lecture halls. The research laboratories are equipped with about 530 personal computers or workstations. The Faculty's central computer serves as the main e-mail and web server. The Faculty's local network is connected to the Internet through the University of Ljubljana network, "Metulj" (Butterfly), and the Academic Research Network of Slovenia (ARNES). Practically all classrooms are covered by wireless network. The Faculty has a joint library with the Faculty of Electrical Engineering. It houses a large collection of books, textbooks and journals and offers access to several on-line services and databases. Both faculties also share a publishing department which is engaged primarily in publishing textbooks for students in the Slovenian language (original and translated).

How to Reach Ljubljana

BY AIR

The Ljubljana airport at Brnik is about 20 km North-West from the center of Ljubljana (see Figure 2). It has fairly good connections with other European airports (Frankfurt, Munich, London, Zurich, Copenhagen, Paris, etc.) and is by Adria, the national Slovenian air carrier, as well as number of other major European airlines.

BY PASSENGER CAR

Ljubljana is connected to all neighbouring countries with a good road system and visitors should not encounter problems on their trip.

BY AIR AND RAIL

Via Austria: By plane to Vienna, Graz or Klagenfurt airport and by train or car to Ljubljana (direct trains go twice daily on weekdays)

Via Germany: By plane to Munich and by train or car to Ljubljana (a direct train goes once every day)

Via Croatia: By plane to Zagreb and by train or car to Ljubljana

Via Italy: By plane to Venice or Trieste and by train or car to Ljubljana

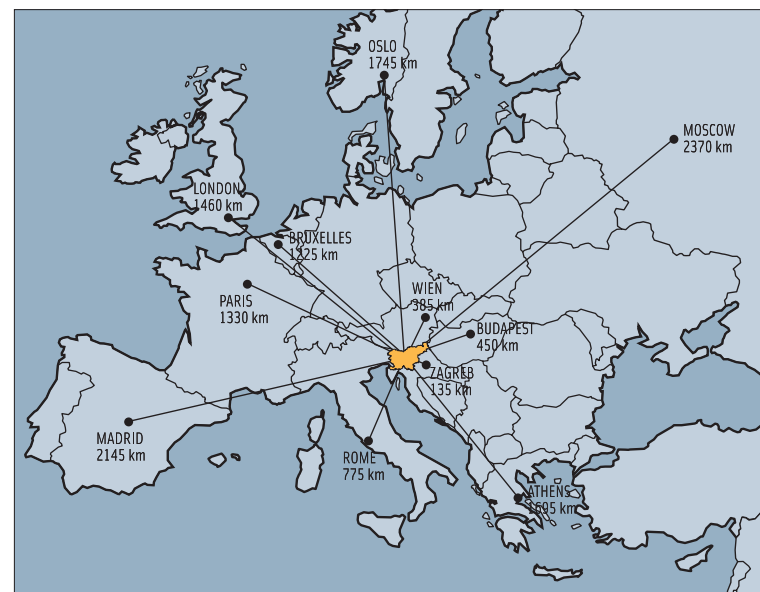


Figure 1: Slovenia in Europe

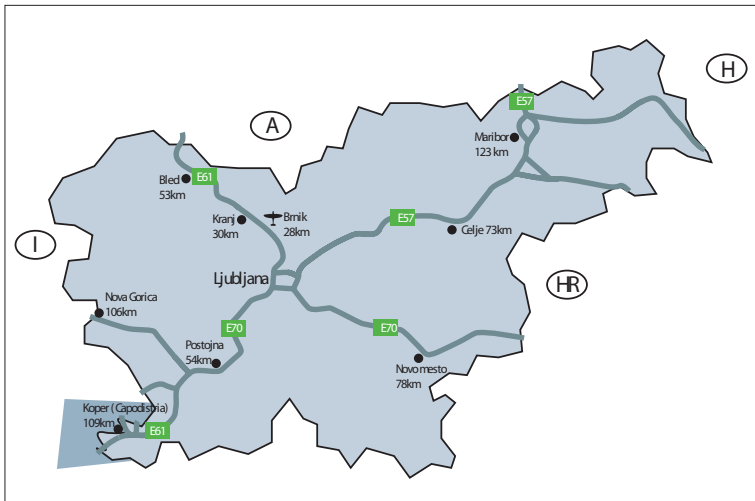


Figure 2: Map of Slovenia

BY RAIL

Ljubljana has good railway links with Austria (Vienna, Klagenfurt, Graz), Germany (Munich), Croatia (Zagreb, Rijeka), Hungary (Budapest) and Italy (Trieste). The above mentioned cities have good international connections with all of the large European cities. Traveling to Slovenia by rail from places further afield, is of course less comfortable and not necessarily cheaper than air travel.



Figure 3: Ljubljana – the Faculty is located within the highlighted area (detailed in Figure 4)

LOCATION OF FRI IN LJUBLJANA

FRI is located in the South-West of Ljubljana (Figure 3) within walking distance of most hotels in the center of Ljubljana. To reach the Faculty from the center take bus lines 1 (direction “Mestni log”) or 6 (direction “Dolgi most”). How to reach FRI by car and where to park your car is shown in Figure 4.

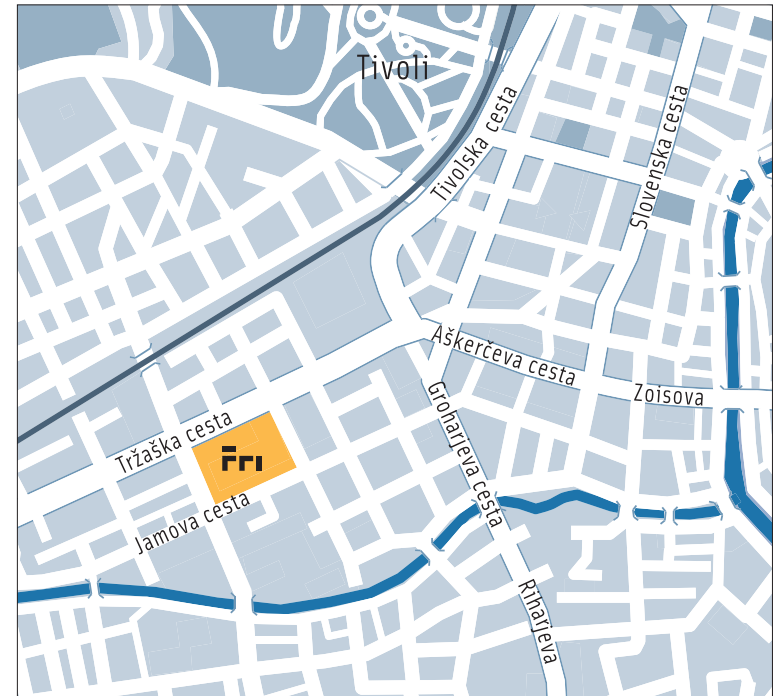


Figure 4: Detailed map of Ljubljana – the location of the Faculty is indicated by the highlighted yellow square

Educational Programs

The academic year at the University of Ljubljana is divided into fall and spring semesters. The courses in the fall semester begin on October 1st and end on January 15th. The spring semester courses start on February 15th and end on May 30th. There are three examination periods: winter (January 15th to February 15th), spring (June) and fall (September). Courses consist of lectures, problem solving classes (tutorials), and laboratory work. The weekly numbers of hours for each course shown in the following tables correspond to lectures, problem solving classes, and laboratory work, respectively. The average weekly course load for undergraduate students is cumulatively 25 hours. In the 2004/05 academic year an updated curriculum of the 8-semester (so called "university") programs is starting and the data refers to that program.

FRI participates in several international educational programs, such as the European Union SOCRATES/ERASMUS program and the CEEPUS program which encourage student and teacher mobility between European universities. The study programs of the Faculty of Computer and Information Science are registered with the European Federation of National Engineering Associations (FEANI) and meet the criteria for the title EUR ING.

UNDERGRADUATE PROGRAMS

FRI offers three undergraduate educational programs:

A three-year program (six semesters of lectures, 15 weeks of work in industry, 6 months of Diploma thesis work), which leads to the degree "Dipl. Ing. Of Computer and Information Science",

A four-year "university" program (eight semesters of lectures, 6 months of Diploma thesis work), which leads to the degree "University Dipl. Ing. Of Computer and Information Science", and

A four year interdisciplinary "university" program (eight semesters of lectures, 6 months of Diploma thesis work), which leads to the degree "University Dipl. Ing. of Computer Science and Mathematics".



The entry requirement for the three-year program is completion of a four-year secondary education. For the four-year “university” programs the national secondary school baccalaureate is mandatory. The three-year program is application oriented, while the four-year program offers more extensive and in depth theoretical knowledge. Only graduates of the four-year program can continue their education at the postgraduate level.

The first two undergraduate programs consists of a core-curriculum, which contains mainly mathematics and theoretical foundations of computer and information science courses, and three elective modules, entitled,

Information Science,

Computer Systems, and

Computer Software.

Students must choose one of the three modules after the first year in the three-year program and after the second year in the four-year “university” program.

POSTGRADUATE PROGRAMS

Postgraduate programs at the Faculty of Computer and Information Science consist of four semesters of, followed by a Masters thesis, leading to a M.Sc. degree and subsequently by a Doctoral thesis leading to a Ph.D. degree in Computer and Information Science. Under specified conditions students can proceed from the required postgraduate courses to working directly on their Doctoral thesis, thus bypassing the Masters thesis. The Faculty offers two postgraduate programs:

Computer and Information Science,

Information Systems and Decision Making.

Four-Year Undergraduate Program

FIRST YEAR

General Courses	Fall			Spring			Credits
Discrete Mathematics	3	3	0	3	3	0	14.5
Introduction to Programming I	3	0	3	-	-	-	7
Introduction to Computer Architecture I	3	0	3	-	-	-	7
Application Software	1	0	4	-	-	-	5.5
Foreign Language (English)	0	3	0	-	-	-	3.5
Calculus I	-	-	-	3	1	2	7.5
Introduction to Programming II	-	-	-	3	0	3	7.5
Introduction to Computer Architecture II	-	-	-	3	0	3	7.5
Total	10	6	10	12	4	8	60

SECOND YEAR

General Courses	Fall			Spring			Credits
Calculus II	3	3	0	-	-	-	7.5
Introduction to Algorithms and Data Structures I	3	1	2	-	-	-	7.5
Introduction to Algorithms and Data Structures II	-	-	-	3	1	2	7
Business Economics	-	-	-	2	2	0	4.5
Total	6	4	2	5	3	2	26.5

Courses in Information Science	Fall			Spring			Credits
Information Systems	3	0	3	-	-	-	7.5
Databases I	3	0	3	-	-	-	7.5
Databases II	-	-	-	3	0	3	7
Statistics and Data Analysis	-	-	-	2	2	0	4.5
Information Systems Design	-	-	-	3	0	3	7
Total	6	0	6	8	2	6	33.5

Courses in Computer Logic and Systems	Fall			Spring			Credits
Logic Structures and Systems I	3	0	3	-	-	-	7.5
Digital Electronics I	3	1	2	-	-	-	7.5
Digital Electronics II	-	-	-	3	1	2	7
Input-Output Devices	-	-	-	3	1	2	7
Computer Systems Organization	-	-	-	2	2	0	4.5
Total	6	1	5	8	4	4	33.5

Courses in Computer Software	Fall			Spring			Credits
Programming Languages	3	1	2	-	-	-	7.5
Introduction to Databases	3	0	3	-	-	-	7.5
Introduction to Information Systems	-	-	-	3	0	3	7
Introduction to Probability and Statistics	-	-	-	2	2	0	4.5
User Interfaces	-	-	-	3	0	3	7
Total	6	1	5	8	2	6	33.5

THIRD YEAR

General Courses	Fall			Spring			Credits
System Software	3	0	2	-	-	-	6
Business Functions	2	2	0	-	-	-	5
Computer Communications	-	-	-	3	0	3	7
Total	5	2	2	3	0	3	18

Courses in Information Science	Fall			Spring			Credits
Organization Theory	2	2	0	-	-	-	5
Accounting	2	2	0	-	-	-	5
Application Development Tools and Techniques	3	1	2	-	-	-	6.5
Legal and Social Aspects of Informatics	2	0	0	-	-	-	2.5
Project Management and Organiz. of Inform. Syst.	-	-	-	3	1	2	7
Inform. Syst. Standards and Quality Assurance	-	-	-	2	0	1	4
Communication Methods	-	-	-	2	2	0	5
Decision Systems	-	-	-	3	0	3	7
Total	9	5	2	10	3	6	42

Courses in Computer Logic and Systems	Fall			Spring			Credits
Introduction to Computer Graphics	2	0	2	-	-	-	5
Introduction to Modelling and Simulation	3	0	3	-	-	-	7
Digital Signal Processing	3	1	2				7
Real Time Systems				3	0	3	7
Logic Structures and Systems II				3	0	3	7
Computer Equipment Evaluation	-	-	-	2	1	1	5
Distributed Structures	-	-	-	2	0	1	4
Total	8	1	7	10	1	8	42

Courses in Computer Software	Fall			Spring			Credits
Numerical Methods	3	2	0	-	-	-	6
Introduction to Modelling and Simulation	3	0	3	-	-	-	7
Programming Systems Design I	3	0	2	-	-	-	6
Programming Systems Design II	-	-	-	3	1	2	7
Introduction to Computer Graphics	-	-	-	2	0	2	5
Applications Development	-	-	-	1	0	2	4
Methods of Artificial Intelligence	-	-	-	3	0	3	7
Total	9	2	5	9	1	9	42

FOURTH YEAR

General Courses	Fall	Spring
Practice	15 weeks	-
Diploma Thesis	-	6 months
Total	15 weeks	6 months

Four-Year “University” Undergraduate Program

FIRST YEAR

General Courses	Fall			Spring			Credits
Calculus I	3	3	0	-	-	-	6.5
User Application Software	1	0	3	-	-	-	4.5
Discrete Structures	3	2	0	-	-	-	5.5
Physics	3	3	0	-	-	-	6.5
Programming I	3	0	3	-	-	-	7
Calculus II	-	-	-	3	3	0	6.5
Computer Technologies	-	-	-	3	2	0	5.5
Linear Algebra	-	-	-	2	2	0	4.5
Programming II	-	-	-	3	0	3	7
Switching Circuits and Systems	-	-	-	3	0	3	6.5
Total	13	8	6	14	7	6	60

SECOND YEAR

General Courses	Fall			Spring			Credits
Algorithms and Data Structures I	3	0	3	-	-	-	7
Computer Systems Architecture I	3	0	3	-	-	-	7.5
Foreign Language (English)	0	3	0	-	-	-	3.5
Introduction to Information Theory	3	2	0	-	-	-	6
Probability Theory and Statistics	3	2	0	-	-	-	6
Algorithms and Data Structures II	-	-	-	3	0	3	6.5
Computer Systems Architecture II	-	-	-	3	0	3	6.5
Computer Communications and Networks	-	-	-	3	0	2	5
Modeling and Simulation	-	-	-	3	0	3	6
Numerical Methods	-	-	-	3	0	3	6
Total	12	7	6	15	0	14	60

THIRD YEAR

Common Courses	Fall			Spring			Credits
Business Economics	2	1	0	-	-	-	3.5
Total	2	1	0	-	-	-	3.5

Information Science Module	Fall			Spring			Credits
Databases I	3	1	2	-	-	-	6.5
Information Systems	3	1	2	-	-	-	7
Operating Systems Fundamentals	3	0	3	-	-	-	6.5
Software Development							
Project Management	3	1	2	-	-	-	6.5
Information Systems Development	-	-	-	3	1	2	6
Decision Models and Systems	-	-	-	3	3	0	6
Operations Research	-	-	-	2	0	2	4.5
Multimedia Systems	-	-	-	2	0	1	3.5
Theory of Organization	-	-	-	2	0	0	4.5
Databases II	-	-	-	3	1	2	6.5
Total	12	3	9	15	5	7	57.5

Computer Systems Module	Fall			Spring			Credits
Graphic Techniques and Procedures	3	0	3	-	-	-	6.5
Logic Design Methods	3	0	3	-	-	-	7
Computer Organization	3	0	3	-	-	-	6.5
Operating Systems	3	0	3	-	-	-	6.5
Digital Electronics	-	-	-	3	0	3	6.5
Distributed Systems and Technologies	-	-	-	3	1	2	7
Input-Output Devices and Systems	-	-	-	3	0	3	6.5
Fundamentals of Information Systems	-	-	-	2	0	1	3.5
System Software	-	-	-	3	0	3	6.5
Total	12	0	12	14	1	12	56.5

Computer Software Module	Fall			Spring			Credits
Operating Systems I	3	0	3	-	-	-	6.5
Fundamentals of Databases	3	1	2	-	-	-	6.5
Theoretical Fundamentals							
of Computer Science I	3	3	0	-	-	-	7
Project Management	3	1	2	-	-	-	6.5
Operating Systems II	-	-	-	3	0	3	6.5
Principles of Programming Languages							
and Symbolic Programming	-	-	-	3	3	0	7
Computer Graphics	-	-	-	3	0	3	6.5
Fundamentals of Information Systems	-	-	-	2	0	1	3.5
Theoretical Fundamentals							
of Computer Science II	-	-	-	3	3	0	6.5
Total	12	5	7	14	6	7	56.7

FOURTH YEAR

Common Courses	Fall			Spring			Credits
Computer Systems Performance and Evaluation	3	0	3	-	-	-	6.5
Business Functions	-	-	-	2	1	0	3.5
Total	3	0	3	2	1	0	10

Information Science Module	Fall			Spring			Credits
Methods of Communication Design and Management of Information Systems	3	0	3	-	-	-	6.5
Business Analysis	3	1	2	-	-	-	6.5
Electronic Business	2	0	2	-	-	-	4
Distributed Information Systems	3	0	3	-	-	-	6.5
Information Systems Technology	-	-	-	3	0	3	7
Artificial Intelligence	-	-	-	3	0	3	7
Information Society	-	-	-	3	2	1	7
Total	11	1	10	12	2	9	50

Computer Systems Module	Fall			Spring			Credits
Soft Computing Methods	3	3	0	-	-	-	6.5
Optical- and Nanotechnologies-	3	0	3	-	-	-	6.5
Digital Signal Processing Seminar	3	0	3	-	-	-	7
Parallel Architecture of Computers	0	0	3	-	-	-	3.5
Process Informatics	-	-	-	3	0	3	7
Computer Reliability and Diagnostics	-	-	-	3	0	3	6.5
Telematics	-	-	-	3	3	0	6.5
Total	9	3	9	12	3	9	50

Computer Software Module	Fall			Spring			Credits
Digital Signal Processing	3	0	3	-	-	-	6
Machine Perception	3	0	3	-	-	-	6
Artificial Intelligence I	3	2	1	-	-	-	6
Compilers	3	0	2	-	-	-	5.5
Intelligent Distributed Software Technologies	-	-	-	3	0	3	7.5
Software Technology	-	-	-	3	0	3	7
Knowledge Engineering	-	-	-	3	2	0	6
Artificial Intelligence II	-	-	-	3	1	1	6
Total	12	2	9	12	3	7	50

Four-Year “University” Interdisciplinary Program “Computer Science and Mathematics”

FIRST YEAR

Course	Fall			Spring			Credits
Calculus 1	3	3	0	-	-	-	8
Discrete Mathematics 1	3	2	0	-	-	-	7
Computer Lab	1	0	3	-	-	-	6
Introduction to Programming 1	2	0	2	-	-	-	6
Calculus 2	-	-	-	3	3	0	8
Discrete Mathematics 2	-	-	-	3	3	0	8
Introduction to Programming 2	-	-	-	2	0	2	6
Linear Algebra 1	-	-	-	2	2	0	6
Tutorial	0	0	2	0	0	2	5
Total	9	5	7	10	8	4	60

SECOND YEAR

Course	Fall			Spring			Credits
Linear Algebra 2	2	2	0	-	-	-	5
Numerical Methods 1	2	0	2	-	-	-	5
Algorithms and Data Structures 1	3	0	3	-	-	-	7
Computer Architectures 1	3	0	3	-	-	-	7
Theory of Programming Languages	2	0	2	-	-	-	5
Algorithms and Data Structures 2	-	-	-	3	0	3	7
Calculus 3	-	-	-	3	3	0	7
Combinatorics	-	-	-	3	3	0	7
Numerical Methods 2	-	-	-	2	0	2	5
Declarative Programming	-	-	-	2	0	2	5
Total	12	2	10	13	6	7	60

THIRD YEAR

Course	Fall			Spring			Credits
Introduction to Data Bases	3	1	2	-	-	-	6
Probability and Statistics	3	3	0	-	-	-	7
Computability Theory	3	3	0	-	-	-	7
Operating Systems	3	0	3	-	-	-	7
Optimization	-	-	-	3	0	3	7
Computational Complexity	-	-	-	3	3	0	7
Computational Geometry	-	-	-	3	0	3	7
Computer Graphics	-	-	-	3	0	3	7
Elective*	-	-	-	2	2	0	5
Total	12	7	5	14	5	9	60

FOURTH YEAR

Course	Fall			Spring			Credits
Cryptography and Coding Theory 1	2	2	0	-	-	-	5
Artificial Intelligence 1	3	2	1	-	-	-	6
Communication Theory	2	2	0	-	-	-	4.5
Elective*	6	6	0	-	-	-	15
Cryptography and Coding Theory 2	-	-	-	2	2	0	5
Artificial Intelligence 2	-	-	-	3	1	1	5
Alternative Models of Computation	-	-	-	2	2	0	4.5
Elective*	-	-	-	6	6	0	15
Total	13	12	1	13	11	1	60

ELECTIVE COURSES

Course	Fall			Spring			Credits
Symbolic Computing	2	0	2	-	-	-	5
Algorithms for Discrete Structures	2	0	2	-	-	-	5
Topics in Data Analysis	2	0	2	-	-	-	5
Logic in Computer Science	2	2	0	-	-	-	5
Scientific Communication	2	2	0	-	-	-	5
Computer Perception	2	0	2	-	-	-	5
Real Time Systems	2	0	2	-	-	-	5
Soft Computing	2	2	0	-	-	-	5
System Performance Analysis	2	0	2	-	-	-	5
Case Studies in Data Mining	2	0	2	-	-	-	5
Approximative Algorithms	-	-	-	2	2	0	5
Graph Theory	-	-	-	2	2	0	5
Operational Research	-	-	-	2	0	2	5
Dynamical Systems	-	-	-	2	2	0	5
Topics in Data Structures	-	-	-	2	0	2	5
Computer Architectures 2	-	-	-	2	0	2	5
Machine Learning	-	-	-	2	2	0	5
Pattern Recognition	-	-	-	2	0	2	5
Computer Vision	-	-	-	2	0	2	5
Human Machine Interaction	-	-	-	2	2	0	5
Modeling and Simulation	-	-	-	2	0	2	5
Fault Tolerance	-	-	-	2	2	0	5
and Computer System Diagnostics	-	-	-	2	0	2	5
Distributed Systems and Technologies	-	-	-	2	0	2	5
Distributed Information Systems	-	-	-	2	0	2	5

Computer and Information Science Postgraduate Program

The postgraduate curriculum in Computer and Information Science is comprised of:

six required courses (30 hours, 6 ECTS each),

four elective courses (30 hours, 6 ECTS each),

two seminars (75 hours, 15 ECTS each).

The total postgraduate course work consists of 450 hours.

FIRST YEAR

Courses	Fall	Spring
Selected Topics in Symbolic Computation and Computer Arithmetics	30 hours	
Analysis of Algorithms	30 hours	
Theory of Computer Languages		30 hours
Theory of Computational Procedures		30 hour
Elective Course	30 hours	
Elective Course		30 hours

SECOND YEAR

Courses	Fall	Spring
Architecture and Organization of Computers	30 hours	
Theory of Information Systems		30 hours
Elective Course	30 hours	
Elective Course		30 hours
Seminar	75 hours	75 hours

ELECTIVE COURSES (30 HOURS, 6 ECTS EACH)

Selected Topics in Computer Architecture
 Reliability of Computer Systems
 Multiprocessor Architectures and Parallel Algorithms
 Artificial Intelligence Methods
 Digital Signal Processing
 Cellular Automata and Parallel Processing
 Neural Networks

Integrated Computer Support of Manufacturing
 Databases
 Concepts for Modeling of Visual Information
 Special Course in Information Science
 Special Course in Operations Research
 Special Course in Programming Technology
 Methods of Applied Mathematics
 Selected Topics in Combinatorial Mathematics
 Machine Learning
 Logic
 Approximation and Randomized Algorithms
 Cryptography and Computer Security
 Differential and Computational Geometry
 System Methods
 Distributed and Decentralized Information Systems
 Decision Systems
 Interpersonal Relations and Communication
 Information Systems Development Tools
 Project Management
 Multimedia Techniques
 Selected Topics of Economics
 Automation of New Public Management
 Information Systems in Natural Sciences and Technology
 Information Systems and Public Administration
 Reengineering of Business Processes
 Information Systems Quality and Standardization
 Information Systems Sociology – Information Society
 Statistical Information Systems
 Reliability of Computer Systems
 Visual Information Handling
 Operational Research in Information Science
 Fuzzy Logic Based Decision Making
 Portfolio Management
 Macroeconomics Modeling
 Computer Networks with Services

Computer Supported Cooperative Work
 Data Mining and Knowledge Discovery in Databases
 Evolutionary Computing
 Intelligent Agents
 Electronic Business
 Computer Structures and Nanotechnologies
 Embedded Systems
 Numerical Linear Algebra
 Topology in Computer Science
 One- and Multi-Dimensional Biomedical Signal Processing

Information Systems and Decision Making Postgraduate Program

The program (a total of 450 hours) is comprised of the following: two required courses (60 hours, *12 ECTS* each),

a combination of three to five elective courses (Main elective courses of 60 hours, *12 ECTS* each, other elective courses 30 hours, *6 ECTS* each),

seminar (150 hours, *30 ECTS*).

Semester	Courses
1	Functions and Decision Making (Required course) Elective courses
2	Information Systems (Required course) Elective courses
3	Information Systems Development (Main elective course) Management and Theory of Organization (Main elective course) Information Systems Management in Business Systems (Main elective course) Elective courses Seminar
4	Master's thesis (30 ECTS)

ELECTIVE COURSES (30 HOURS EACH)

Elective courses (see page 24) are common to both postgraduate programs, i.e., Computer and Information Science and Information Systems and Decision Making.

Research

Research activities (as well as most Diploma, Master, and Doctoral theses research) at FRI are performed in fifteen research laboratories which are organized in six groups.

The main sources of research funding are the Ministry of Higher Education, Science and Technology, Slovenian Research Agency, Ministry of Defense, European Union programs (6th FP, COST), various bilateral programs: USA-Slovenian, French-Slovenian (Proteus), Austrian-Slovenian, Czech-Slovenian, Norwegian-Slovenian, Portuguese-Slovenian, and UK-Slovenian (ALINK). The Ministry of Higher Education, Science and Technology, together with the Slovenian Research Agency, also supports the majority of postgraduate students by means of individual scholarships. Many application projects are financed by Slovenian companies.

For more information consult the Web pages of individual laboratories which are all accessible from the Faculty's home page.

SOFTWARE GROUP

Laboratory for Computer Graphics and Multimedia
Laboratory for Biomedical Computer Systems and Imaging

COMPUTER LOGIC, SYSTEMS AND NETWORKS GROUP

Laboratory for Adaptive Systems and Parallel Processing
Laboratory for Computer Architecture
Computer Communications Laboratory
Computer Structures and Systems Laboratory

INFORMATICS GROUP

Information Systems and Database Systems Laboratory

THEORETICAL COMPUTER SCIENCE GROUP

Laboratory for Algorithms and Data Structures
Laboratory for Architecture and Signal Processing
Software Engineering Laboratory

ARTIFICIAL INTELLIGENCE GROUP

Computer Vision Laboratory
Visual Cognitive Systems Laboratory
Artificial Intelligence Laboratory
Laboratory for Cognitive Modeling

MATHEMATICS AND PHYSICS GROUP

Laboratory for Mathematical Methods in Computer and Information Sciences



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RESEARCH ACTIVITIES

The Laboratory of Computer Graphics and Multimedia is involved in several activities related to multimedia technologies, computer-based education and learning, human-computer interaction, and virtual and augmented reality. The laboratory is a member of the international consortium CoLoS, together with 18 European and some other Universities. The main area of interest of CoLoS consortium is computer supported conceptual learning of natural sciences. The laboratory also cooperates with Microsoft in introducing new software technologies.

The main ongoing research activities in the laboratory are dedicated to development of multimedia tools and applications, grid computing, and educational applications, especially interactive learning and didactic simulation of natural phenomena.

Several studies were started as part of Ph.D. researches, including emergent multi-agent systems, music information retrieval and adaptive hypermedia systems in education. Research on emergent multi-agent systems focuses on construction of cooperative behaviour in complex systems using evolutionary computation and emergence to design global behaviour of the systems. In music information retrieval researches, the focus is on extraction of higher-level cognitive parameters (melody, harmony, rhythm) from audio signals. The research from the field of adaptive hypermedia deals with the problems of describing user's knowledge considering the uncertainty in its description and focuses on educational systems, which can adapt their functional features to the individual user.

In the past, members of the laboratory cooperated with other research groups in the development of military training systems, medical imaging applications, various simulation tools for computer

supported industrial automation, including robotized environments, and computer supported quality control and management systems.

TEACHING

Faculty of Computer and Information Science: Programming II (C and Java), Operating Systems, Computer Graphics, Software Technology, System Software, Multimedia Techniques.

Academy of Fine Arts: Computing I, Computing CAD II, Computing III.

EQUIPMENT

The laboratory is equipped with several computers, printers, scanners, presentation and videoconferencing equipment, and some virtual reality equipment. Professional software tools for 3D design, visualization, animation, and video editing are also available.

CURRENT PROJECTS

Hands on Science (Socrates Comenius, 110157-CP-1-2003-1-PT-COMENIUS-C3)

Conceptual Learning of Natural Sciences CoLoS

AgentGrid: Design of multi-agent systems using GRID (CRP, V2-0129)

GRIDForum.SI: Grid infrastructure for virtual organizations (CRP, V2-0890)

Technologies for education and development of innovative environments (Centres of excellence)

First Click on Slovene, a multimedia CD for learning Slovene as a foreign language (interdisciplinary project under supervision of American Embassy in Ljubljana)

Digital archive OSNP (with Science Research Centre of the Slovenian Academy of Sciences and Arts)



Exploring a 3D World by means of virtual reality

SOME PAST PROJECTS

Informatization of educational institutions (CRP, V5-0668-02)

Didactical aspects of the use of information technologies - IKT (teaching and learning) (CRP, V5-0638-02)

Chemistry through computer simulations (CRP, V5-0646-02)

Teaching using new technologies for persons with special needs (hearing impaired) (CRP, V5-0639-02)

Thematic Network European Computing Education and Training (213871-CP-1-2001-1-BG-ERASMUS-TN)

WebKit, Intuitive Physical Interface on the Web (IST-2001-34171-WEBKIT)

Partial music transcription for searching collections of musical samples (Z2-4443-1539-02)

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RESEARCH ACTIVITIES

The laboratory is involved in basic research connected to biomedical signal and imaging data. The main research goals are summarized as following:

understanding and describing the physiological phenomena,

use of the computer in modeling and understanding of physiologic relationships,

locally and remotely monitoring physiologic events, graphically displayed anatomic details and physiologic functions, visualizing and representing biomedical signal and imaging data,

developing standardized databases to study physiologic mechanisms and to evaluate performance and robustness of recognition techniques,

characterizing data, and establishing the detection criteria and recognition techniques to automatize as much as possible the analysis of bioelectric patterns, examinations, procedures, and medical practice, in order to improve the quality and reliability of the examinations,

interpret the data and the results qualitatively and quantitatively,

develop performance measures and protocols to evaluate detection techniques,

develop biomedical information technologies and software.

The principal research topic currently underway is the development and evaluation of recognition algorithms for accurate detecting of transient ischaemic events in biomedical data using the LTST DB (Long-Term ST Database).

The second research topic is maintaining, updating and distribution of standardized international reference-annotated ECG database LTST DB. The database is result of a multinational research effort and contains 86 24-hour ambulatory recordings with a number of human-annotated transient ischaemic and non-ischaemic ST events.

The database is intended to serve as a reference set in evaluating the performance of ST analyzers, and as a reference set to study physiologic mechanisms responsible for ischaemia. See:

<http://www.physionet.org/physiobank/database/ltstodb/>

and

<http://www.physionet.org/challenge/2003/>.

The next research topic is development of interactive graphic user interface editing tools (SEMIA - semi-automatic) to visualize, display and annotate long-term electrocardiograms. SEMIA, version 3.0.1, to view diagnostic and morphology feature-vector time series, and to examine human annotations of the LTST DB is under GNU General Public Licence and is available from

<http://www.physionet.org/physiobank/database/ltstodb/semia/>.

The next research topic is the characterization of temporal patterns of transient ischaemic events and time-frequency representations of diagnostic parameters in ambulatory ECG signals. The goals are to differentiate physiologic mechanisms generating ischaemia and predicting impending ischaemia.

Another important contribution of the laboratory to the world community is interactive graphic tool EVAL_ST to evaluate performance and robustness of ischaemia analysers. The tool is under GNU General Public Licence and is available from

http://www.physionet.org/physiotools/eval_st/.

Another topic concerns the investigation and assessment of effective methods for monitoring patients affected by cardiovascular diseases, outside the specialized cardiac units, through computer analysis and the interpretation of non-invasive bio-signal data, with the ultimate goal of cardiac telemonitoring via the Internet.

The Laboratory supports a Web mirror site (<http://physionet.fri.uni-lj.si>) for a part of Europe to the PhysioNet Web site (<http://www.physionet.org>) which is located at the Massachusetts Institute of Technology in Cambridge, USA. Maintaining of the PhysioNet Web site is supported by the U.S. National Institutes of Health. Physionet offers free access via the Web to large collections of recorded physiologic signals and related open-source software.

TEACHING

Graphic Techniques and Procedures, User Interfaces, Basics of Computer Graphics, and System Software.

EQUIPMENT

The equipment currently consists of two SUN SPARC workstations running UNIX Solaris, IBM RS/6000 server B50 running UNIX AIX, Apple PowerMac G4 running MacOS X and MacOS 9, several PC computers running Windows XP and LINUX, and other standard laboratory equipment (printers, CD and DVD writers, DAT tape unit).

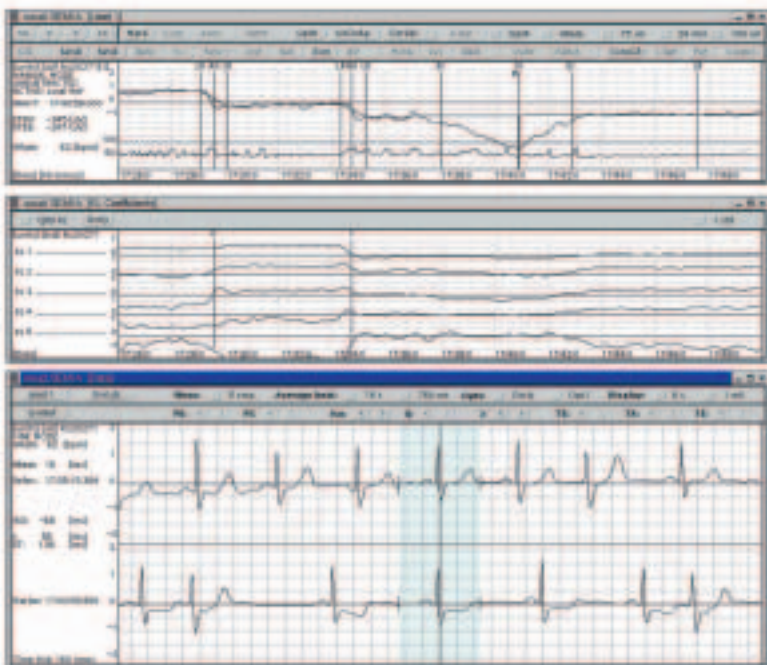
PROJECTS

Automated detection of Transient ST-Segment Changes During Ambulatory ECG-Monitoring, U.S.-Slovenian Joint Project, Project #95-158 (1995-98); funded by the National Institutes of Health, USA, and the Slovenian Ministry of Science and Technology; research partner: Biomedical Engineering Center, Massachusetts Institute of Technology, Cambridge, USA.

Development of Long Term ST Database (LTST DB) funded by the Medtronic, Inc., Mineapolis, USA, (1997-2002), and by the Zymed, Inc., Camarillo, USA (1999-2002); research partners: Massachusetts Institute of Technology, Cambridge, USA, Beth Israel Deaconess Medical Center, Boston, USA, CNR Institute of Clinical Physiology, Pisa, Italy, University Medical Center, Ljubljana, Slovenia, and Department of Systems & Informatics, Firenze, Italy. See also: <http://www.physionet.org/physiobank/database/ltstadb/>

Maintaining, updating and distribution of the Long Term ST Database (LTST DB), (2002-); research partners: Beth Israel Deaconess Medical Center, Boston, USA, and CNR Institute of Clinical Physiology, Pisa, Italy; (Data-base is available from: Laboratory of Biomedical Computer Systems and Imaging, Faculty of Computer and Information Science, Ljubljana, contact: Dr. Franc Jager); Samples of the database are available from:

<http://www.physionet.org/physiobank/database/ltstadb/>.



SEMIA, Version 3.0, semi-automated interactive graphic editing tool to annotate ambulatory ECG records.

Metabolic and inborn factors of reproductive health, birth, Research program B3-0124 (2004-2009); funded by the Ministry of education, science and sport of the Republic Slovenia; research partner: University Medical Center, Ljubljana, Slovenia.

VISITS

September 2005: Franc Jager visited the Massachusetts Institute of Technology, Cambridge, USA, for one week working on current joint collaborative research topics.

June and July 2005: Ana Minchola, a Ph.D. student from the University of Zaragoza, Zaragoza, visited the laboratory in order to conduct some researches.

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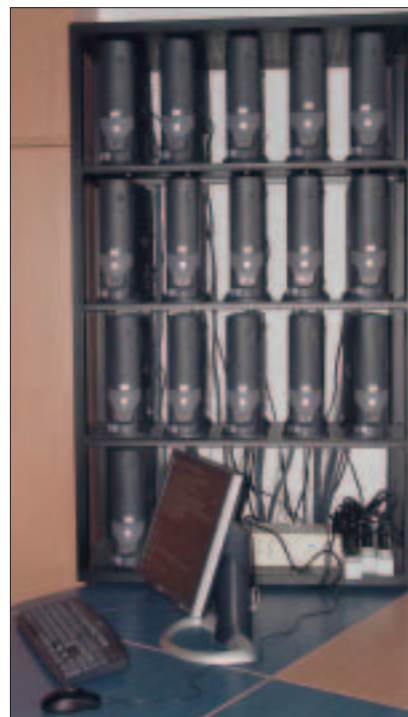
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RESEARCH ACTIVITIES

Main research activities are concentrated around the following topics:

Neural networks in data mining, prediction, recognition and control problems,

Evolutionary algorithms in optimization problems,



Computing cluster

Identification of real dynamic systems with Recurrent Neural networks,

Fuzzy and Neuro-Fuzzy Controllers,

Process Informatics and Programmable Technologies,

Cellular structures and Complex Systems,

Knowledge extraction from large databases

Parallel processing/programming in GRID environments

TEACHING

Logical Structures and Systems I, II, Elements of Information theory, Cellular Structures and Systems, Adaptive Systems, Neural Networks, Cellular Automata and Parallel Processing, Digital Structures, Digital Electronics II, Distributed Structures, Digital Logic, Logical Circuits and Structures, Computer Basics and Programming I

EQUIPMENT

Cluster of 16 powerful Pentium IV computers, ten PC (Pentium IV) computers, five notebooks (Pentium III, IV), four HP laserjet printers (BW, colour), HP scanners (BW, colour), digital camera, SW-HW tool ViewLogic Office for FPGA design, Khepera mobile robot, Siemens Simatic SW-HW equipment.

PROJECTS

Intelligent data mining in GRID technology, A Slovenian-Portugal Intergovernmental Science and Technology Cooperation Project (2006-2008).

Data mining of rubber mixing and testing data bases with soft computing methods, Slovenian Research Agency (2004-2007).

Relating the Physical Properties of Polymeric Materials by Parallel Implementation of Soft Computing Methods, Slovenian Research Agency (2004-2007).

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RESEARCH ACTIVITIES

Research activities cover computer architectures, software-hardware co-design, parallel processing, embedded systems and programmable logic.

The main research work is dedicated to short SIMD processing and the integration of these new processing facilities into high-level programming languages. Currently, the most significant activities are development of syntax and semantics extensions to the ANSI C in such a way that we could use short SIMD processing facilities in C programming language and development of its vectorizing compiler which is capable to automatically extract short SIMD parallelism from loops. We call it MMC (multimedia C) language. We have also introduced a new data-dependence test for array references with linear subscripts. We have named this test the D-test. It is appropriate for the vectorization for modern SIMD microprocessors and is more accurate than existing tests. The test takes into account the architectural properties of modern SIMD microprocessors and allows the existence of those data dependences in the loops that do not prohibit the vectorization for SIMD microprocessors.

The part of research work is directed toward the development of special computer hardware which, through its programmable ALU, is capable of performing custom selected functions. We are also working on two RISC architecture microprocessors, which are programmed with VHDL, and then realized with field-programmable gate array (Xilinx FPGA Spartan II and III).

TEACHING

Undergraduate level: Digital Structures, Computer Organization and Microprogramming, Organization of Computer Systems, Introduction to Computer Graphics, Programmable Logic Systems, Architecture and Organization of Computer Systems.

Postgraduate level: Parallel Systems, Architecture and Organization of Computers, Selected Topics in Computer Architecture.

EQUIPMENT

The computing equipment currently consists of several personal computers (PC) running Windows XP and Linux, Alpha workstation DEC 3000 AXP running Unix 4.0 and SUN SPARC workstation running UNIX Solaris. Almost all PC computers have frame grabbers and video cameras. There is also other standard equipment (HP colour scanner, printers, CD writers, DAT tape unit, and special Xilinx development boards.

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V. Guštin, P. Bulič. Introducing the vector C. *Proceedings of the 5th Inter-national Meeting on High Performance Computing for Computational Science VECPAR 2002, Part I, Porto, Portugal, 26–28 June, 2002*. pp. 253–266. 2002.

V. Guštin. Designing the Microprocessor with Abel-HDL, *Computer Applications in Engineering Education*, vol. 9, number (2), pp. 87–92, 2001.

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P. Bulič, V. Guštin. How to Exploit Multiprocessing Features of the SGI Origin 200, *Electrotechnical Review*, vol. 67, number (5), pp. 275–280, 2000.

V. Guštin. An FPGA extension to ALU functions. *Microprocessors and Microsystems*, Vol. 22, No. 9, pp. 501–508, 1999.

V. Guštin, A. Lapajne, R. Kodrič, T. Žitko. Measurement of ski jump distances by the use of fuzzy pattern comparator. *Neural Network World*, Vol. 9, No. 1–2, pp. 43–56, 1999.

P. Bulič, V. Guštin. Realization of reconfigurable P4 microprocessor. *Electrotechnical Review*, vol. 66, number (4–5), pp. 327–331, 1999.

V. Guštin, M. Čufer. Motion detection using fuzzy logic comparator. *IEEE Trans. on Consumer Electronics*, Vol. 41, No. 2, pp. 360–366, 1995.

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RESEARCH ACTIVITIES

Main research interests of laboratory members are distributed systems design and development - especially grid architectures, communication security and policies and other security issues, formal validation and testing techniques of communication protocols and distributed processes, computer networks design, content networks and peer-to-peer systems, mobile computing, agile methodologies in development of software and information systems and service oriented architecture with related technologies.

In 2005, we have researched most actively the following three areas:

In the area of grid systems we were researching protocol analysis and the possibilities of executing some popular data-mining algorithms in grid environment.

In the area of software development methodologies, we were researching the properties of agile methodologies, especially test-driven development. Within a group of our students, we conducted some experiments, comparing the efficiency of test-first and test-last programming and statistically evaluated the results.

In the area of distribute systems architecture, we studied the suitability of Service Oriented Architecture for use in the military systems and possibilities of integrating these services with location awareness and different sensors for developing a next generation sensor mesh. We have also studied usability of these architectures in Network Centric Operations and Warfare.

EQUIPMENT

Hardware: 24-port Gigabit Switch Dell PowerConnect 2624, Gigabit local network within the Laboratory, Dell Power Vault NAS 745 (4 x 250 GB), 2 Dell Power Edge SC 1425 Servers, IBM eServer xSeries 336, 2 dual AMD Athlon Servers, Linksys Wireless LAN Access Point

and several Wireless LAN network cards, Bluetooth Access Point and several Bluetooth adapters, 8 personal computers with Windows XP or Linux, 2 Dell D-600 notebooks, 2 Dell D-610 notebooks, 1 Panasonic Toughbook Notebook, digital still camera and digital video camera, 2 Compaq/hp Pocket PC, 3 Dell Axim handhelds, several Java-enabled mobile phones, ActiveCard SmartCard readers and smart cards, modems, Web cameras, printers, scanner and other office equipment, etc.

Software: Several network management tools and utilities, firewalls, sniffers; Oracle 10g and PostgreSQL database and development tools, SharePoint Portal Server, Web server, Microsoft development tools and utilities; several open-source Java development tools and utilities including Mobile Phone development utilities, Alchemi grid, Activ Pack for Windows, Windows Virtual Server R2 running several virtual machines with Windows Server 2003, Windows XP or Linux, VMWare GSX virtualization software running Linux virtual machines, IBM Tivoli NetView and IBM Tivoli Enterprise Console ...

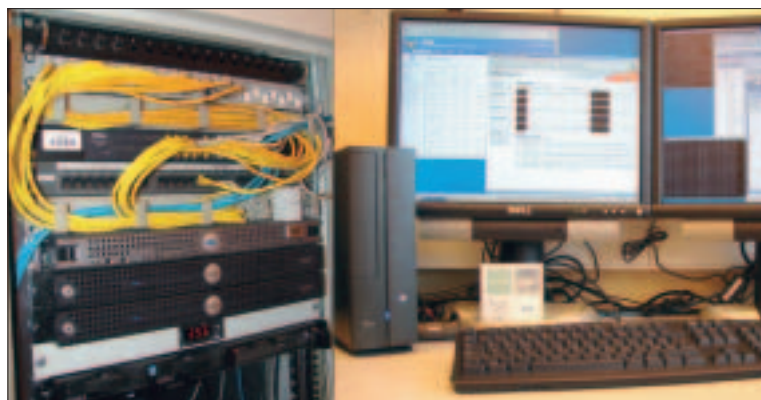
TEACHING

Computer Communications, Computer Communications and Networks, Planning and Managing Information Systems, Telematic Systems. Introduction to Computer Networks, Computer Networks and Services, Distributed and Decentralized Information Systems.

Communications in Distributed Systems (Faculty of Electrical Engineering), Introduction to Information Systems and Informatics II (Faculty of Social Sciences), Distributed Information Systems and Data Integrity (Faculty of Electrical Engineering), Computer Networks (Faculty of Mechanical Engineering), Management Information Systems (School of Business and Management Novo Mesto).

PROJECTS

In the past, Laboratory of Computer Communications members have been engaged in several projects from the areas of computer network structure, architecture, design and management (University of Ljubljana network backbone), computer network security, information systems design and management and distributed systems design.



Communication infrastructure within the Laboratory

In 2005, the Laboratory members took part in

VIKING - Secure Information-Communication Infrastructure of the Next Generation, (Slovenian Target Research Program), supported by Ministry of Defense and Ministry of Science, Education and Sport), 2004-2006. 404-03-16/2004/124.

Extraction of virtual knowledge from large databases with soft computing and GRID technologies (Slovenian Target Research Program), supported by Ministry of Information Society and Ministry of Education, Science and Sport, 2003-2005. 404-03-35/2003/33.

Relating the Physical Properties of Polymeric Materials by Parallel Implementation of Soft Computing Methods, supported by Ministry of Education, Science and Sport and Sava d.d., 2004-2007. L2-6143-1539-04.

Clinical paths data mining with soft computing, supported by Ministry of Education, Science and Sport and The University Clinic of Respiratory and Allergic Diseases Golnik, 2004-2007. L2-6460-1539-04.

Formal Analysis of Advanced Grid Infrastructure Protocols. A Slovenian-Croatian Intergovernmental Science and Technology Cooperation Project (2005-2007).

Remodeling and Deployment of University Network Infrastructure, University of Ljubljana, 2005.

Management and Control of University System Infrastructure, University of Ljubljana, 2005 - 2006.

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M. Ciglarič. Effective message routing in unstructured peer-to-peer overlays. *IEE proc. Commun.*, October 2005, Vol. 152, No. 5, pp. 673-678.

Distance learning:

M. Ciglarič, T. Vidmar: Use of Internet Technologies for Teaching Purposes, *European Journal of Engineering Education*, Vol. 23, No. 4, 1998, pp. 497 - 502.

Computer networks, distributed systems and security:

M. Ciglarič, M. Pančur, B. Šter, A. Dobnikar. Datamining in grid environment. In: B. Ribeiro, R. F. Albrecht, A. Dobnikar, D. W. Pearson, N. C. Steele (eds.): *Adaptive and natural computing algorithms* : proceedings of the International Conference in Coimbra, Portugal, 2005. Wien; New York: Springer 2005, pp. 522-525.

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M. Trampuš, M. Ciglarič, M. Pančur, T. Vidmar, A. Krevl, P. Rome, Š. Aksentič, G. Berginc: Using smart cards as a secure storage for digitally signed documents. V: ZAJC, Baldomir (ur.), TKALČIČ, Marko (ur.). *The IEEE Region 8 EUROCON 2003 : computer as a tool : 22-24*. September 2003, Faculty of Electrical Engineering, University of Ljubljana, Ljubljana, Slovenia : proceedings. Piscataway: IEEE, cop. 2003, vol. 2, str. [4-7].

M. Trampuš, M. Ciglarič, M. Pančur, T. Vidmar. Are E-commerce users defenceless?. V: *IPDPS, International Parallel and Distributed Processing Symposium*, April 22-26, 2003, Nice, France. Proceedings : e-zbornik. Los Alamitos [etc.]: IEEE Computer Society, 2003, str. [1-7].

T. Vidmar: *Informacijsko komunikacijski sistem* (Information Communication System: Scientific monography in Slovene language), Založba Pasadena, 841 pages, 2002.

Information systems design and development:

M. Pančur, M. Ciglarič, M. Trampuš, T. Vidmar. Towards empirical evaluation of test-driven development in a university environment. V: ZAJC, Baldomir (ur.), TKALČIČ, Marko (ur.). *The IEEE Region 8 EUROCON 2003 : computer as a tool : 22-24*. September 2003, Faculty of Electrical Engineering, University of Ljubljana, Slovenia : proceedings. Piscataway: IEEE, cop. 2003, vol. 2, str. 83-86.

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M. Pančur, M. Trampuš, M. Ciglarič, T. Vidmar. Testno voden razvoj v okoljih Java in .NET. V: A. Novaković, N. Schlamberger, M. Indihar Štemberger, M. Učak, (eds.). *Dnevi slovenske informatike, (Days of Slovenian informatics)* Portorož, Slovenija, 2003. Proceedings: Slovenska informatika za tretje tisočletje: v družbi najrazvitejših. Ljubljana: Slovensko društvo Informatika: = Slovenian Society Informatika, 2003, str. 437-442.

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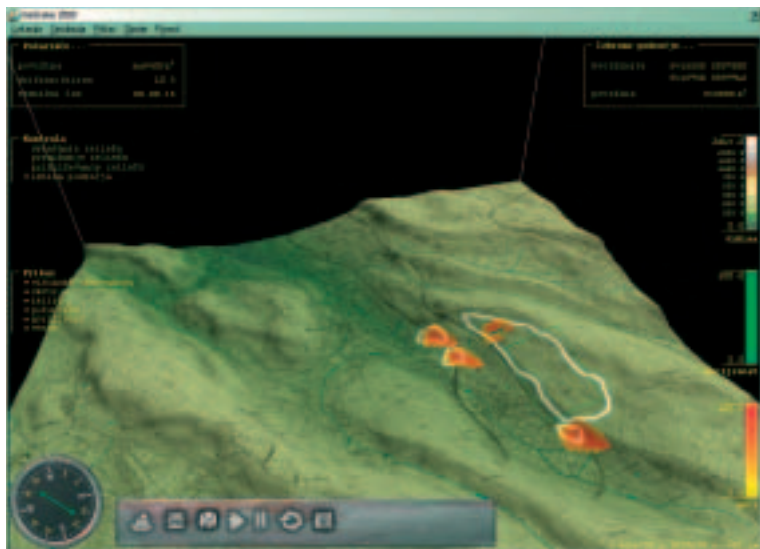
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RESEARCH ACTIVITIES

The principal scientific research directions of the Computer Structures and Systems Laboratory are fuzzy logic applied to distributed processing and processing platforms of the future. With respect to these the most recent research is dedicated to the modeling of the dynamics of organized groups of moving entities (e.g. flocking birds) and to the design of the ternary quantum-dot cell.

One of the past research studies in fuzzy logic based modeling and simulation was the design and development of a software application for computer assisted prediction of wind-driven wild-land fire for the Slovenian Ministry of Defence. Lately, however, the members of the laboratory have been using fuzzy logic for modeling bird flocks. They have recently published an article in the *Journal of Theoretical Biology* that presents a highly believable bird flocking model that is based on simple linguistic descriptions. Indeed, the simulations performed by using their model show that when performing turns, the simulated birds change position so that a bird at the head of a flock will be in the rear of the flock if the latter turns 180 degrees, which is a behaviour that can typically be observed in pigeon flocks. At present the members are devoting a substantial amount of time to the design of the ternary quantum-dot cell, an extension of the binary quantum-dot cell that allows for the construction of quantum-dot cellular automata capable of performing ternary logic operations. Their latest results have been accepted for publication in *Microelectronic Engineering* and the *International Journal of Unconventional Computing*.

In addition to the scientific research the members of the laboratory also cooperate with different industrial partners on projects related



Visualization of wind-driven wild land fire prediction by means of fuzzy logic

to wireless computer networks, performance evaluation and reliability diagnostics. Recently they have been cooperating with the FH Joanneum GmbH, Austria and the Department of Intensive Internal Medicine of the General Hospital “dr. Franc Derganc”, Nova Gorica on Mobile Medical Monitoring; a Bluetooth based system designed to diminish the insecurity when patients are transferred from intensive care to ordinary ward units. Currently the system is undergoing extensive live-testing in the General Hospital “dr. Franc Derganc”.

TEACHING

Theory of Switching Circuits, Computer Modeling and Simulation, Computer Systems Performance and Evaluation, Computer Reliability and Diagnostics, Computer Structures in Nanotechnology, Fuzzy Logic, Logic Design of Computers, Computer Equipment Evaluation, and Introduction to Modeling and Simulation.

EQUIPMENT

The laboratory is equipped with several computers four of which are Silicon Graphics workstations (Octane, Indigo2) and several Pentium 4 PC's. Some of the other equipment available and regularly used in the laboratory are printers (HP LaserJet 2420, EPSON Stylus Photo 2100), Wacom Intuos3 digitizer, a scanner, video input/output equipment from Silicon Graphics, a Hewlett-Packard Logical Analyzer and a Hewlett-Packard Oscilloscope.

PROJECTS

Analysis of new methodology for non-invasive and selective detection of skeletal muscles contractile and activation properties. Industry-Founded Project, funded by TMG-BMC d.o.o., Slovenia (Nov-Dec 2005).

Optimization of products MG6111, CS6111, and ESxxxx. Industry-Founded Project, funded by Iskratel d.o.o., Slovenia (2005-2006).

Wireless communication platforms, Industry-Founded Project, funded by European Structural Funds and Iskra Transmission d.d., Slovenia (2005-).

Optimization of IP BAN on the PowerQuicc II and III platforms, Industry-Founded Project, funded by Iskratel d.o.o., Slovenia (Jan-Jun 2005).

Specification of wireless communication protocols for medical applications, Slovene Government-Founded R&D Project, funded by Slovene Research Agency and Konel d.o.o. (2004-2007).

Mobile Medical Monitoring, Bilateral Collaboration Project, funded by FH Joanneum GmbH, Austria (2004-2005).

Fuzzy logic based analysis of the patient's vital functions for post intensive care, Slovene Government-Founded R&D Project, funded by Slovene Research Agency and Hermes SoftLab d.d. (2003-2005).

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M. Mraz, N. Zimic, J. Virant and J. Ficzk. Fuzzy cellular automata and fuzzy sequential circuits, C.T. Leondes (ed.) *Intelligent Systems: Technology and Applications*, pp. II-211-II-256, Boca Raton, FL: CRC Press, 2003.

M. Mraz. The design of intelligent control of a kitchen refrigerator.

Mathematics and Computers in Simulation, 56:259-267, 2001.

M. Mraz, N. Zimic, I. Lapanja, J. Virant and B. Skrt. Fuzzy techniques in intelligent household appliances, L. Jain and P. De Wilde (eds.) *Practical Applications of Computational Intelligence Techniques*, pp. 121-145, London, UK: Kluwer Academic Publishers, 2001.

M. Mraz, N. Zimic, I. Lapanja and J. Virant. Notes on fuzzy cellular automata. *Journal of the Chinese Institute of Industrial Engineers*, 17(5):469-476, 2000.

J. Virant, N. Zimic and M. Mraz. T-type fuzzy memory cell. *Fuzzy Sets and Systems*, 102:175-183, 1999.

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J. Virant and N. Zimic. Fuzzy automata with fuzzy relief. *IEEE Transactions on Fuzzy Systems*, 3(1):69-74, 1995.

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RESEARCH ACTIVITIES

The Information Systems Laboratory is involved in basic research in the field of Information and Database Systems. The following primary areas of research are currently being pursued:

Software Development Methodologies (SDM). Based on the collaborative practice research we strive to define the methodology and supporting tools for designing new or adapting existing SDMs. Specifically, we focus on the methodology socio-technical suitability to both organisation and project-specific requirements. From the topic two PhD theses have been developed. An approach for reengineering methodologies (Agile methodology framework) and supporting tools (Agile methodology toolset – see figure below) present the most important results of this research.

IT/IS Strategy Planning. The strategy planning is one of the research areas that have been traditionally present in the Information systems laboratory since its existence. In 2004 we published the second edition of the methodology that focuses on how to build strategic plans for information systems. The methodology is based on many years of practical experiences in developing strategic plans for a range of organisations. In the context of IT/IS planning we focus research on: IS/IT architectures, information systems reengineering, business process reengineering, electronic business, and COBIT and other standards.

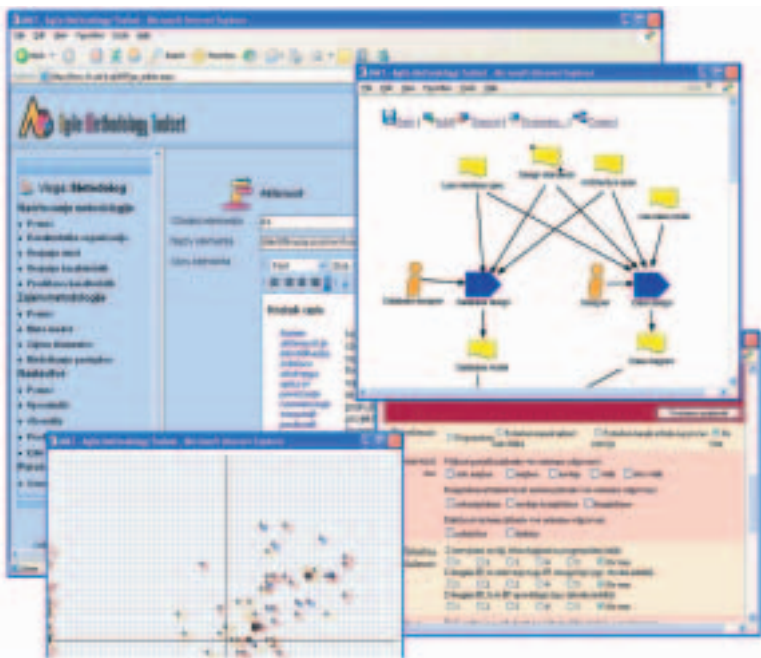
Contemporary approaches to software development. In collaboration with software companies we do research on the maturity level of the new approaches to software development. Recently we have been focusing on: “Model-driven development”, “Business-rule approach”, and “Method engineering”.

Mobile business and mobile applications. We explore different mobile applications models focusing on the research of the context-awareness and context-aware mobile application model. The results have been presented as the Methodology for developing mobile applications.

Intelligent Agents and Multi-Agent Systems. In this area we do research on the development of agents – autonomous entities capable of acting in its environment. The research encompasses: research on mutual communication among agents using ACL and use of rules in several aspects, modelling multi-agent systems, using agent oriented modelling languages (AML, AUML) and other agent based methodologies. We focus on utilization of intelligent agents and multi-agent systems for business systems and their information systems.

Semantic web and knowledge discovery. Research on Semantic Web as a next step in the evolution of the Internet is focused on ontologies, rules, rule engines and Semantic Web languages.

Data Mining applications and Decision Support Systems. Our areas of interest are innovative approaches for decision support. We combine research on this area with the research in the area of mobile applications and as result we do research on mobile decision support. We have also developed data mining decision support system based on Oracle Data Mining API and Engine. In the area of applied research we have created several strategic reports on different models of introduction of data mining to information systems.



Screenshot of the AMT system

TEACHING

Undergraduate: Information Systems, Design and Management of Information Systems, Selected Topics in Informatics, Theory of Information Systems, Information Systems Development, Introduction to Information Systems, Databases, and Introduction to Databases.

Postgraduate: Information systems, Information Systems Development, and Database Systems.

EQUIPMENT

The computing equipment encompasses about 15 PC workstations running Microsoft Windows and Fedora Linux. Single and dual processor servers are running under various operation systems like Microsoft Windows Server, Linux and Solaris. Most powerful servers are hosting virtual machines with research environments. All computers are connected over gigabit local network. Meeting place is equipped with wireless projector.

Software equipment consists of Oracle servers and development tools, Microsoft development tools and server software, ILOG Business Rule Management Suite, and development software tools of vendors like IBM/Rational, Sybase, MySQL, Apache, Tomcat, JADE...

PROJECTS

The Information systems laboratory has been involved in many research and applied projects. The selection of recent project is listed below.

MasterProc – Mastering the development process and information technologies in developing solutions for electronic business. Research project of the Centre of Excellence “Information and Communication Technologies”. Ministry of Education, Science and Sport, Ministry of the Economy, and European Regional Development Fund (ERDF), 2004- 2007.

Research program »Competitiveness of Slovenia 2001-2006«, Research project: “*A methodology and prototype for business rule management in organisations*”. Ministry of Information Society and Ministry of Education, Science and Sport, 2001- 2004.

Research program “Competitiveness of Slovenia in 2001-2006”. Research project “*Design and Development of multiagent systems for innovative decision support*”, Ministry of education, science and sport, 2004-2005

Survey of Multi-agent system implementation and support at multi-agent systems. Marand d.o.o. 2005-2006.

Object Oriented Approach to Application Development - based on modelling language UML and application framework MAF – release 2.0. Marand, d.o.o., 2004-2005

Unified Information Systems Development Methodology (EMRIS), Government centre of informatics, 1998-2004

Applied Research on Multi agent systems and Prototype of Multi agent system on JADE platform, Marand d.o.o., 2005-2006

Information System Development Methodology for Intereuropa IT, d.o.o. Intereuropa IT, d.o.o., 2003

Development of the IT/IS Strategy Plan for Common Functions in Government Institutions. Central Government Agency of Informatics, Ljubljana, 2003-2004

CRM Implementation in Mobitel GSM, Mobitel, 2002 – 2004

Renovation and development of information system for School Administration and Management. Development project funded by the Ministry of Information Society, 2001-2002

Analysis and Development of Mobile and WEB (WAP-WEB) platforms for Decision Support and Customer Care, Mobitel, 2000 - 2003

Development of the IT/IS Strategy Plan for the University of Ljubljana, University of Ljubljana, 2000 – 2001

Development of the IT/IS Strategy Plan for Clinical Centre Hospital Ljubljana, Clinical Centre Hospital Ljubljana, 1999 – 2000

Analysis of the existing IT processes in KAD using COBIT model, Kapitalska družba, 2004-2005

SELECTED PUBLICATIONS

M. Bajec and M. Krisper. A methodology and tool support for business rule management in organisations. *Information Systems*, 30(2005): 423–443, 2005.

R. Rupnik, M. Krisper and M. Bajec. A new application model for mobile technologies. *International Journal of Information Technology and Management*, 3(2/3/4): 282-291, 2004.

M. Bajec, V. Mahnič. Portal as a key component in an integrated, user-centric university information system. *Systems integration*, 10(2): 7-20, 2003.

R. Rupnik and M. Krisper. Data Mining Application Systems as a New Type of Decision Support Systems (in Slovene). *Uporabna informatika* (Ljubljana), 13(2): 61-73, 2003.

D. Kodek and M. Krisper. Optimal algorithm for minimizing production cycle time of a printed circuit board assembly line. *Int. J. Prod. Res.*, 42(23): 5031-5048, 2004.

M. Bajec and M. Krisper. Agile Methodologies (in Slovene). *Uporabna informatika* (Ljubljana), 13(2): 61-73, 2003.

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R. Rupnik and M. Krisper. Context-aware mobile application model. *Electro technical Review*, 71(4): 215-219, 2004.

A. Zrnec. Web Services are not Enough. *Electro technical Review*, 71(5): 249-254, 2004.

M. Bajec, M. Krisper and R. Rupnik. The scenario for constructing flexible, people-focused systems development methodologies. In: T. Leino, T. Saarinen and S. Klein (eds.). *Proc. 12th European conf. on IS*. Turku, Finland, 2004.

D. Vavpotič, M. Bajec and M. Krisper. Measuring and improving software development methodology value by considering technical and social suitability of its constituent elements. In: O. Vasilecas, J. Zupančič (eds.). *Advances in theory, practice and education: Proc. 13th Intern. Conf. on IS Development*, pp. 228-238, Vilnius, Lithuania, 2004.

D. Lavbič. Povezava rezultatov iskanja spletnega inteligentnega agenta s podatki pomembnimi za poslovne odločitve. In: A. Novakovič, N. Schlamberger, M. Indihar Stemberger, M. Učak and J. Drole (eds.). *Management in informatika: Conf. Proc.*, pp. 670-675, Dnevi slovenske informatike, Portorož, 2004

M. Bajec, D. Vavpotič and M. Krisper. An approach for creating project-specific software development methodologies. In: Khalid S. (ed.). *Internet and information technology in modern organizations: challenges & answers: Proc. 5th Intern. Business Information Management Association Conf.*, pp. 1082-1091, Cairo Egypt, 2005.

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RESEARCH ACTIVITIES

Staff members perform research in the areas of approximation and randomized algorithms, algorithms for problems in linear algebra (in particular matrix multiplication), combinatorial optimization (routing and other problems involving circulant graphs, covering and location problems, flexibility in optimization problems), parallel computation (mapping and scheduling, algorithms in parallel systems, hardware supported multithreading), compiler design (parsing methods and attribute grammars), operating systems design, and grid computing (data replication on Data Grids)

TEACHING

Undergraduate: Algorithms and Data Structures 2, Compiler Design, Operating Systems, Operating System Components, Theoretical Computer Science 1, Theoretical Computer Science 2, Introduction to Programming 2, Programming Systems Development 1.

Graduate: Approximation and Randomized Algorithms, Theory of Computation.

EQUIPMENT

Equipment consists of a network of PC's running under Linux and/or Windows XP/W2000 plus miscellaneous additional items of computer infrastructure offering adequate computational support for the staff as well as students performing thesis work, as well as occasional guests.

PROJECTS

“Grid Technology as a Standard Communication-Computing Infrastructure” (CRP/V2-0887) jointly with the Jozef Stefan Institute and the company XLAB, Ltd, funded by the Ministry of Higher Education, Science and Technology, and Slovenian Research Agency (2003-2005).

“Exact and non-exact Algorithms and Techniques” (J2-6688-1539-05), funded by the Ministry of Higher Education, Science and Technology, and Slovenian Research Agency (2004-2007)

“Computational Service on GRID Infrastructure” jointly with Jozef Stefan Institute and the company XLAB, Ltd., funded by the Ministry of Higher Education, Science and Technology, and Slovenian Research Agency (2004-2006).

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Laboratory for Architecture and Signal Processing

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RESEARCH ACTIVITIES

The Laboratory for Architecture and Signal Processing is dedicated to research, undergraduate, and postgraduate education in computer architecture and digital signal processing. The laboratory is engaged in national and international research projects that include development projects for the industry. The following areas of research are currently being pursued:

1. *In Computer Architecture:* Design and development of special-purpose computers, both hardware and software. Comparative studies of RISC vs. CISC processors. DSP processor design and architecture. Cache replacement and coherence preservation strategies. Input/output architectures. Integrated entertainment and automation systems for “smart home” houses.

2. *In Digital Signal Processing:* Design and development of algorithms, hardware and software. Complexity of integer minimax approximation problem. Theoretical aspects and performance bounds for finite wordlength digital filters. In particular, bounds for minimax integer polynomial approximation over collections of non-overlapping intervals are investigated. A general purpose finite wordlength FIR design program has been developed during the course of this work. Spectrum and vibration analyses. DSP processor applications. A low-cost DSP processor based spectrum and vibration analyzer was developed and is in production.

3. *In Speech Processing:* Speech recognition over telephone lines. Considerable experience from collaborating on the COST-232 European project has been acquired. The laboratory contributed to the collection of the European multi-English database. In the framework of a project with the Slovenian Telekom one of the first real-time systems

for speaker-independent recognition of Slovenian digits and control words over the telephone has been developed. A national database of 780 speakers from all across Slovenia has been collected. A new technique that uses asymmetrical window functions for feature extraction is being evaluated.

TEACHING

Undergraduate level (5-year “University” program): Computer Architecture 1, Computer Architecture 2, Digital Signal Processing, Input/Output Systems.

Undergraduate level (4-year program): Principles of Computer Architecture 1, Principles of Computer Architecture 2, Digital Signal Processing, Input/Output Devices.

Postgraduate level: Architecture and Organization of Computer Systems, Digital Signal Processing.

EQUIPMENT

Computing equipment consists of PC computers running Windows and/or Linux operating systems, scanners, and printers. The special equipment for speech and digital signal processing consists of internal and external DSP boards with several different DSP processors from Texas Instruments and Analog Devices. In addition to standard general-purpose software, the laboratory also has a speech recognition software tools like HMM Toolkit, CSLU Toolkit, and a real-time working demo of an isolated word recognition system over the telephone line.

PROJECTS

Adaptive system for computer recognition of Slovenian speech. Research project funded by the Slovenian Ministry of Education, Science, and Sport and the Ministry for Information Society (2003-2005).

Industrial low-bit wireless local network. Project for Elatec Inženiring d.o.o. (2005-2006).

Battery powered multilingual translator. Project for Elatec Inženiring d.o.o. (2005-2006).

Low cost spectrum and vibration analyzer. Project for Resa d.d. (2004-2006).

Deployment of SCADA system in the control center of hydro power plants on river Sava. Project for Liko Pris d.d. (2005-2006).

Development of a universal protocol converter. Project for Liko Pris d.d. (2005-2006).

Algorithms for static and dynamic correction of the wind speed measurement for ultrasonic anemometer on an oceanographic buoy. Project for Morska biološka postaja Piran (2005-2006).

Development of a data acquisition system for an oceanographic buoy. Project for Morska biološka postaja Piran (2005-2006).

Voice commands for motor vehicle remote control. Project for Amebis d.o.o. (2005-2006).

VOIP technologies in corporate communication systems. Project for Comutel d.o.o. (2005-2006).



Student working on low-bit wireless modules

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Software Engineering Laboratory

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RESEARCH ACTIVITIES

The Software Engineering Laboratory is involved in teaching and research in the areas of Software Engineering and Information Systems with an emphasis on Software Quality Management, Software Metrics, Information Systems Development, Information Systems Audit and Control, and Data Warehouses. The staff has recently worked on two international projects within the EC TEMPUS and INCO-COPERNICUS programs, as well as on several development projects for the industry. The following areas of research are currently being pursued:

- In Software Quality Management:* Comparative studies of different software quality models (SW-CMM, ISO 9000 family of standards, SPICE, Bootstrap etc.). Adaptation of SW-CMM to the needs of small organizations. Personal and Team Software Process.
- In Software Metrics:* Different approaches to software measurements (e.g. GQM, bottom-up). Definition of appropriate metrics for the development of applications in a database environment. Development of a metrics model to support the level 4 of SW-CMM in small organizations.
- In Information Systems Audit and Control:* Investigation of systematic approaches (such as COBIT) to IT control and audit in order to help IT professionals in developing and maintaining information systems that would satisfy fiduciary, security and quality requirements.
- In Information Systems and Data Warehouses:* Agile methodologies for information systems development. Development of administrative and management information systems for higher education institutions. Information quality assessment and improvement.

TEACHING

Undergraduate level: Introduction to Programming I, Basic Algorithms and Data Structures I, Software Systems Development II, Programming I, Software Technology, Technology of Information Systems.

Postgraduate level: Information Systems Development, Special Course in Programming Technology.

EQUIPMENT

Laboratory is equipped with three Oracle servers (Oracle Portal, Oracle 9i, Forms and Report Server running under Windows 2000), SQL Server (running under Windows 2000), Web server (running under Linux), several PC computers (running under Windows XP and Windows 2003 Server), and two printers: HP LaserJet 2100 M and HP OfficeJet G55.

PROJECTS

A metrics model for quantitative management and control of database oriented applications development satisfying the requirements of SW-CMMI level 4. An independent Ph.D. student research project.

Data warehouse for the University of Ljubljana. Integration of data from different member institutions in order to support analytical processing at the university level.

E-student: Web-based student records information system covering enrolment, examination records, degree records, and various statistical surveys (partly supported by the Slovenian Ministry of Information Society).

CONFERENCES

Members of the laboratory organized the 10th Conference of European University Information Systems Organization EUNIS 2004 that took place in Bled on 29 June - 2 July 2004.

OTHER ACTIVITIES

Membership: V. Mahnič member of the Program Committee for the EUROMEDIA APTEC 2002 Conference, Modena, Italy, April 2002.

Membership: V. Mahnič member of the Board of Directors of EUNIS (European University Information Systems Organization).

Membership: V. Mahnič member of the Scientific Committee for the EUNIS 2003, the 9th International Conference of European University Information Systems Organization, Amsterdam, July 2003.

Membership: V. Mahnič and I. Rožanc members of the Scientific Committee for the EUNIS 2004, the 10th International Conference of European University Information Systems Organization, Bled, 29 June - 2 July 2004.

Membership: V. Mahnič member of the Scientific Committee for the EUNIS 2005, the 11th International Conference of European University Information Systems Organization, Manchester, June 2005.

Membership: V. Mahnič member of the Program Committee for the UNINFOS 2005, the International Conference on University Information Systems, Banska Bystrica, September 2005.

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M. Bajec, V. Mahnič. Portal as a key component in an integrated, user-centric university information system. *Systems Integration*, 10(2): 7-20, 2003.

V. Mahnič, M. Gams. Some experiences in teaching introductory programming at the faculty level, *World transactions on engineering and technology education*, 2(3): 441-444, 2003.

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V. Mahnič. On Teaching the First Programming Course at the University Level: Teacher's Experience and Students' Opinions. *Organizacija*, 37(8): 507-513, 2004.

V. Mahnič, M. Požanel. Data warehousing in university environment: the case of the University of Ljubljana. *Uporabna informatika*, 12(4): 237 -247, 2004.

N. Žabkar, V. Mahnič. IT Risk Management in the University Environment. *Uporabna informatika*, 12(4): 248-258, 2004.

V. Mahnič, S. Drnovšček. Agile software project management with scrum, *Proc. European University Information Systems EUNIS 2005*, pp. 1-6, Manchester, U.K., 2005.

V. Mahnič, M. Požanel. The role of data warehousing in university information systems. *Proc. University Information Systems UNINFOS 2005*, pp. 166 -178, 2005.

I. Rožanc, V. Mahnič. Teaching Software Quality with Emphasis on PSP. *Organizacija*, 38(8): 454 -464, 2005.

Computer Vision Laboratory

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RESEARCH ACTIVITIES

The laboratory is involved in basic research in computer vision, with emphasis on range image interpretation, object recognition and tracking, face detection and face recognition, panoramic imaging, and multimedia applications.

Range image interpretation includes range image acquisition, segmentation of range images using the "recover-and-select" paradigm and modeling of shapes using different types of parametric models (i.e. superquadrics, surface patches). Possible applications include automatic creation of CAD models for reverse engineering applications, creation of models for virtual reality applications, part-based object recognition, and next-view planning for intelligent image acquisition. Superquadric models are used also for object tracking in sequences of intensity images.

We generate panoramic images by assembling multiple images captured in sequence by moving the camera using a pan-tilt robotic manipulator. The sequential image acquisition using the robotic manipulator makes possible also the generation of panoramic stereo pairs and panoramic depth images as a consequence. We use panoramic images for mobile robot navigation, for designing efficient user interfaces for remote camera manipulation and for visual surveillance applications.

For human face detection and recognition in difficult illumination conditions we study the use of skin colour and appearance.

An ongoing collaboration with the New media department of the Academy of Fine Arts at the University of Ljubljana supports the creation of interactive art installations using the latest information technology. The art projects serve as an excellent frame for testing our

research results in practical applications, in particular we applied face detection in the installation "15 seconds of fame", body position tracking in "Virtual skiing" and locomotion-based person identification in "Coincidence-matrix-dating club" project.



The interactive installation "Virtual skiing" enables a visual immersion into the feelings of gliding on snow through a winter landscape. The computer rendered winter landscape is displayed over the entire wall in front of the skier. As on carving skis you can turn by shifting your body to the right or left to evade the trees. The speed of descent can be regulated by lowering or raising your body so that the air resistance is decreased or increased. The interface to the virtual world is implemented by computer vision techniques which capture the posture of the skier's body in real time.

TEACHING

Teaching at the undergraduate and graduate level: Introductory computer science, Software engineering, User interface design, Computer vision, Methods of communication, Project management.

EQUIPMENT

Network of about 20 Linux/Windows/Macintosh computers. The special vision equipment consists of a structured light range scanner with a translational and rotational computer-controlled table, several pan/tilt units, video, CCD, panoramic and web cameras.

CURRENT PROJECTS

Computer vision, 1539-0214. A basic research program funded by the Slovenian Research Agency (2004-2008).

Development of a thin client for Loterija Slovenija (2003-2005).

Leonardo: A multi-national exploration in interaction design education and research, Pilot program in cooperation between EU and New Zealand (2004-2007).

XML-based data-format for image analysis results. A postdoctoral program financed by Slovenian Research Agency (2004-2005)

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RESEARCH ACTIVITIES

Visually enabled cognitive systems are intelligent artificial systems that use vision among other sensors in order to act and interact in everyday situations that emerge in natural and urban environments. This includes a plethora of devices, ranging from mobile robots to intelligent environments, personal devices, and cognitive assistants. The Visual Cognitive Systems Laboratory is involved in basic research of such systems, with emphasis on visual learning and recognition. Other activities include panoramic imaging for mobile robotics and range image modeling and interpretation.

Research in the area of visually enabled cognitive systems focuses on various theories regarding requirements, architectures, forms of representation, kinds of ontologies and knowledge, and varieties of mechanisms relevant to integration and control of vision systems. In this context, cognitive vision implies functionalities for knowledge representation, learning, reasoning about events and structures, recognition and categorization, and goal specification, all of which are concerned with the semantics of the relationship between the visual agent and its environment. This requires a vast effort in a multidisciplinary understanding of cognitive processes, involving studies in cognitive psychology, neuroscience, and linguistics.

Research in the area of visual learning and recognition has so far focused on subspace methods, such as Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), Independent Component Analysis (ICA), Canonical Correlation Analysis (CCA), Support Vector Machines (SVM), etc., which enable direct view-based building of visual representations and subsequent visual recognition of objects,

scenes, and activities. Our main research achievement in the framework of subspace methods is development of robust approaches to both learning and recognition. We have also developed methods for incremental subspace learning that enable updating of representations and therefore facilitate continuous life-long visual learning. Applications include recognition of objects, scenes, and activities in visual cognitive tasks, such as surveillance and smart vision-based positioning using wearable computing in urban environments as well as in other applications of cognitive systems, such as mobile robots and cognitive assistants.

Our theoretical findings on visual learning and recognition very often ground in a realistic scenario of spatial orientation of mobile robots, which represent a target platform for many of the methods developed. In the long run, we aim at developing algorithms for autonomous exploration and building of cognitive maps which can be used by agents for navigation and spatial reasoning in unbounded environments. Such cognitive agents will ultimately be able to perceive and understand their environment, to categorise and recognise objects and subjects around them as well as actions they are performing, and will be able to interact with the environment and communicate with humans and other agents on a semantical level.

Research in the area of range image interpretation includes range image acquisition, segmentation of range images using the “recover-and-select” paradigm and modeling of shapes using different types of parametric models. Possible applications include automatic creation of CAD models for reverse engineering applications, creation of models for virtual reality applications, and part-based object recognition.

TEACHING

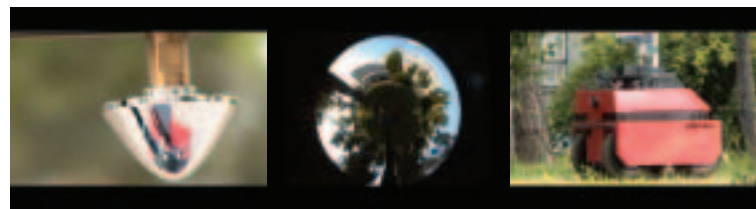
Teaching at the *undergraduate and graduate level*: Multimedia systems, Machine Perception, Intelligent distributed software technologies, Computer vision, Visual information in information systems (Faculty of Computer and Information Science); Introductory computer science, Computer graphics, Algorithms and data structures (Faculty of Education).

EQUIPMENT

Network of about 10 Linux/Windows computers. In-door and out-door iRobot robots for visual learning and navigation experiments, shared with the Computer Vision Laboratory. A Katana HD6M light weighted robot arm with 6 degrees of freedom. The special vision equipment consists of a structured light range scanner (shared with the Computer Vision Laboratory) with a translational and rotational computer-controlled table, panoramic cameras, digital IEEE-1394 cameras, an IEEE-1394 two-lens stereo vision camera system, DV video cameras and equipment for digital photography.

CURRENT PROJECTS

Computer vision, 1539-0214. A basic research program funded by the Slovenian Ministry of Higher Education, Science and Technology (2004-2008).



Mobile robot localization using panoramic vision

Cognitive Systems for Cognitive Assistants-CoSy FP6-004250-IP (2004-2008).

Vision Technologies and Intelligent Maps for Mobile Attentive Interfaces in Urban Scenarios - MOBVIS, FP6-STREP (2005-2008).

Computational and Cognitive Vision Systems: A Training European Network - VISIONTRAIN, FP6-2002-Mobility-1 (2005-2009).

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Development of new techniques for recognition and categorization, A Slovenian-Greek Intergovernmental Science and Technology Cooperation Project (2005-2006).

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RESEARCH ACTIVITIES

The laboratory carries out research in machine learning, inductive logic programming, AI approaches to systems control, qualitative reasoning, and information visualization. Research results concern the learning from noisy data in attribute-based learning for classification and regression, evaluation of attributes in machine learning, the automatic discovery of concept hierarchies and constructive induction in machine learning, combining logical and numerical learning, applying machine learning to systems control and qualitative modeling, and reconstruction of human control skill. A notable aspect of much of this research is its application to problems in functional genomics and bioinformatics, medical diagnosis and prognosis, ecological modeling, and mechanical engineering.

TEACHING

The staff of the AI Laboratory is engaged in teaching the following courses: Artificial Intelligence and Symbolic Programming, Principles of Programming Languages, Decision Models and Systems, Artificial Intelligence Methods, Tools and Application Development, Projects and Organization of Information Systems, Standards and Quality of Information Systems, Decision Systems, Methods of Artificial Intelligence (postgraduate), Theory of Programming Languages (postgraduate), and Data mining (postgraduate).

EQUIPMENT

The computer equipment at the laboratory consists of a network of a dozen Windows XP, Windows 2000, Mac Os X and Linux-based personal computers and servers, and several laser and ink jet printers and scanners.

RECENT AND CURRENT PROJECTS

Artificial intelligence approaches to knowledge discovery in functional genomics, Slovene Research Agency's Slovene-Italian Bilateral Project (2006-2009).

STEROLTALK - Functional genomics of complex regulatory networks from yeast to human: cross talk of sterol homeostasis and drug metabolism (FP6-2003-LIFESCIHEALTH-I 512096). Project funded by the EU 6th Framework Programme (2005-2008).

FACTORY qSPA1 - Quality Control In The Production Line Of Sandwich Panels With AI Methods. Project founded by Slovene Ministry of the Economy and EUREKA (2005-2007).

Artificial Intelligence Approaches for Knowledge Discovery in Functional Genomics, Slovene Research Agency's USA-SI Collaboration Grant (2005-2006).

Development of Machine Learning Tools for Medical Research and Practice, Slovene Research Agency's USA-SI Collaboration Grant (2005-2006).

Artificial Intelligence and Intelligent Systems. Research Program funded by Slovenian Research Agency (2004-2008).

ASPIC - Argumentation Service Platform with Integrated Components. Project funded by the EU 6th Framework Programme (2004-2006).

Research, Development and Practical Evaluation of Tools for Data Mining and Decision Support in Medicine, SMESS USA-SI Collaboration Grant (2003-2004).

Knowledge-based Data Mining Approach for Discovery of Genetic Pathways from Mutant Data, SMESS USA-SI Collaboration Grant (2003-2004).

Knowledge discovery methods for functional genomics, Basic research project funded by SMESS (2001-2004).

CLOCKWORK - Creating Learning Organisation with Contextualised Know-ledge-Rich Artifacts. European IST Programme Project, funded by the European Commission (2000-2003).

The AI Laboratory also participated in European Networks of Excellence: *KDNet - European Knowledge Discovery Network of Excellence* and *MONET - European Network of Excellence in Model-Based and Qualitative Reasoning*.

VISITORS AND INVITED LECTURES IN 2005

Donald Michie (UK): *SOPHIE - a conversational agent*. 25-28 May 2005.

Johann Eder (University of Klagenfurt, Austria). 24 June 2005.

Jaap van den Herik (Universiteit Maastricht, The Netherlands): *When will chess be solved?* 29 August 2005.

Lucia Sacchi (Universita di Pavia, Italy): *Temporal abstraction-based classification of transcriptional phenotypes*. 15 September - 26 December 2005.

Gad Shaulsky (Baylor College of Medicine, Houston, USA): *Dictyos-telium bioinformatics*, 13-15 November 2005.

SYSTEMS DEVELOPED

A number of software systems have been developed or are under development by members of this laboratory. These include:

Orange: a machine learning suite that can be used either through scripting in Python or with an intuitive and easy to use, yet powerful graphical user interface. Includes methods such as induction of decision and regression trees, naive Bayes classification, association rules, clustering, function decomposition, support vector machines, logistic-regression, evaluation methods, data pre-processing, visualization, specialized tools for genomic research, etc. Runs on MS Windows, Mac OS X, Linux and Solaris. (<http://www.ailab.si/orange>)

GenePath: a web-enabled tool for reconstruction of genetic networks from genetic experimental data. Features what-if analysis, explanation, visualization of networks, and methods that allow incorporating background knowledge (<http://www.genepath.org>). In November 2003, GenePath was awarded an entry in NetWatch: Best of the Web review of Science magazine.

LR: learning regression trees, including bagging and boosting. (<http://ai.fri.uni-lj.si/dorian/software.htm>)

QUIN: machine learning tool for induction of qualitative trees from numerical data.

QCGrid: system for transformation of qualitative trees into numerical predictors.

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D. Šuc, I. Bratko. Combining Learning Constraints and Numerical Regression. In L. P. Kaelbling, A. Saffiotti (editors). *IJCAI-05: proceedings of the Nineteenth International Joint Conference on Artificial Intelligence*, Edinburgh, Scotland. Denver: International Joint Conferences on Artificial Intelligence, 596-602, 2005.

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N. Aoki, M. Wall, J. Demšar, B. Zupan, T. Granchi, M.Schreiber, J. Holcomb, M. Byrne, K.R. Liscum, G. Goodwin, R.J. Beck, K.L. Mattox. Predictive model for survival at the conclusion of a damage control laparotomy. *American Journal of Surgery*, 180: 540-545, 2000.

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B. Cestnik, I. Kononenko, I. Bratko. ASSISTANT 86: A knowledge elicitation tool for sophisticated users. In I. Bratko, N. Lavrač, editors, *Progress in Machine Learning*, 31-45. Sigma Press, Wilmslow, UK, 1987.



Submersible with intelligent and adaptive buoyancy and stability control.

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RESEARCH ACTIVITIES

Laboratory for Cognitive Modeling (LKM) was officially founded in December 2001. LKM carries out research in cognitive modeling, machine learning, neural networks, picture and data mining. Research results concern the modeling of noisy data related to cognitive, medical, biological and other processes. We are developing, testing and applying new approaches and algorithms for modeling from numeric, symbolic and pictorial data. LKM collaborates with psychologists, physicians, biologists, physicists and chemists. A notable aspect of much of this research is its application to problems in image analysis, medical diagnosis, ecological modeling, alternative medicine, studies of consciousness and manifestation of cognitive processes and consciousness through subtle energies.

TEACHING

The staff of LKM is engaged in teaching the following courses: Programming Languages, Artificial Intelligence Methods, Algorithms and Data Structures 1, Knowledge Engineering, Fundamentals of Algorithms and Data Structures 2, Database Systems 1 and 2, Introduction to Databases, Machine Learning (postgraduate), Knowledge Discovery in Databases (postgraduate).

EQUIPMENT

The computer equipment consists of a network of a dozen Windows and Linux-based personal computers and servers, laser and ink jet printers. We also use Crown-TV camera for Gas Discharge Visualization and Olympus BX51 Microscope with digital camera.

RECENT PROJECTS AND COLLABORATION

Knowledge synthesis from data and background knowledge: Basic research project funded by Slovenian Ministry of Education, Science and Sports.

Reliable and Comprehensible Machine Learning Approaches with Applications to Medical Diagnostics and Bioinformatics: Bilateral project funded by Slovenian and Greek Ministry of science.

Cost sensitive intelligent data analysis: Postdoc research project funded by Slovenian Ministry of Education, Science and Sports.

Intelligent data analysis in medicine: Basic research project funded by Slovenian Ministry of Science and Technology.

Several applicative projects concerning intelligent data analysis and data mining.

Several applicative projects concerning the analysis of various subtle influences on human and plant GDV pictures.

COLLABORATION WITH ACADEMIC INSTITUTIONS

Technical University SPIFMO, St. Petersburg, Russia, University of Sydney, Australia, University of Stuttgart, Germany, Limburg's University Center, Belgium, University of Ioannina, Greece, University of Porto, Portugal, Biotechnical Faculty, University of Ljubljana, Faculty of Arts, University of Ljubljana, Faculty of Public Administration, University of Ljubljana, FRI, Computer Vision Lab and Artificial Intelligence Lab.

COLLABORATION WITH RESEARCH INSTITUTIONS

Research Institute of Organic Agriculture, Frick, Switzerland, Research Institute Aco de Paou, Valernes, France, Institute for Bioelectromagnetics and New Biology BION, Ljubljana, Jozef Stefan Institute, Ljubljana, University Clinical Center, Ljubljana.

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RESEARCH ACTIVITIES

The research activities of the laboratory involve various fields of mathematics with special emphasis on applications to computer and information science. The following areas of mathematics are studied:

scientific computing and numerical solutions of differential equations, in particular, methods for geometric integration of differential equations,

graph theory, mostly topological and structural properties of graphs, vertex -colorings of graphs and weighted graphs as a natural generalization of the channel assignment problem,

algebraic topology, in particular cohomology of topological spaces with group actions, applications of topology to computer science, and computational topology,

nonlinear dynamical systems and their application in geometry, physics and mechanics,

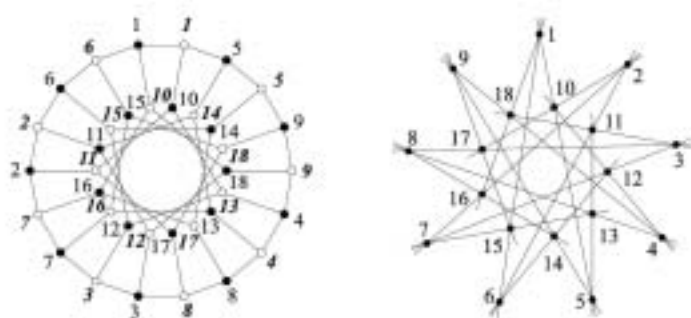
linear and nonlinear mathematical techniques in appearance based models and their application to computer vision (in cooperation with the Visual Cognitive Systems Laboratory),

computational geometry and geometry of cycles (in cooperation with members of the Faculty of Electrical Engineering and the Faculty of Mathematics and Physics) with applications to surface modeling,

in the area of incidence structures we study problems related to combinatorial and geometric configurations (the study of combinatorial properties of configurations via their incidence graphs, and the study of possibility of the realization of configurations in other incidence structures).

The laboratory organizes the Mathematical seminar at the FRI, where members of the lab and other researchers report on current work, connected to the research and teaching activities of the lab.

Several members of the lab are also members of research groups of the Institute of Mathematics, Physics, and Mechanics. Members of the lab are involved in joint research work with other research groups at the Faculty of Computer and Information Science and the Faculty of Electrical Engineering and with the following institutions: NTNU Trondheim, Norway, and University in Bergen, Norway.



Left: The Levi graph of a triangle free combinatorially selfpolar configuration. This is the generalized Petersen graph $G(18, 5)$.

Right: A geometrically selfpolar astral realization of a triangle-free configuration given by the graph on the right.

TEACHING

Members of the lab teach courses on the undergraduate level on calculus, numerical mathematics, discrete mathematics and statistics with data analysis. Several of these courses are strongly supported by standard packages for visualization and computation like Mathematica or Matlab. On the graduate level, the courses Differential and computational geometry, Numerical linear algebra, and Topology in Computer Science are offered.

EQUIPMENT

The laboratory is equipped with computers connected into a local network with relevant computer algebra systems like Mathematica and Matlab. The computers run under Linux operating system and, as much as possible, public domain software is used.

PROJECTS

Algorithms for control of scanning probe microscopes using quartz tuning forks (L2-6045), funded by Slovenian Research Agency and Elatec, electronic engineering, d.o.o. Ljubljana (2004 - 2006).

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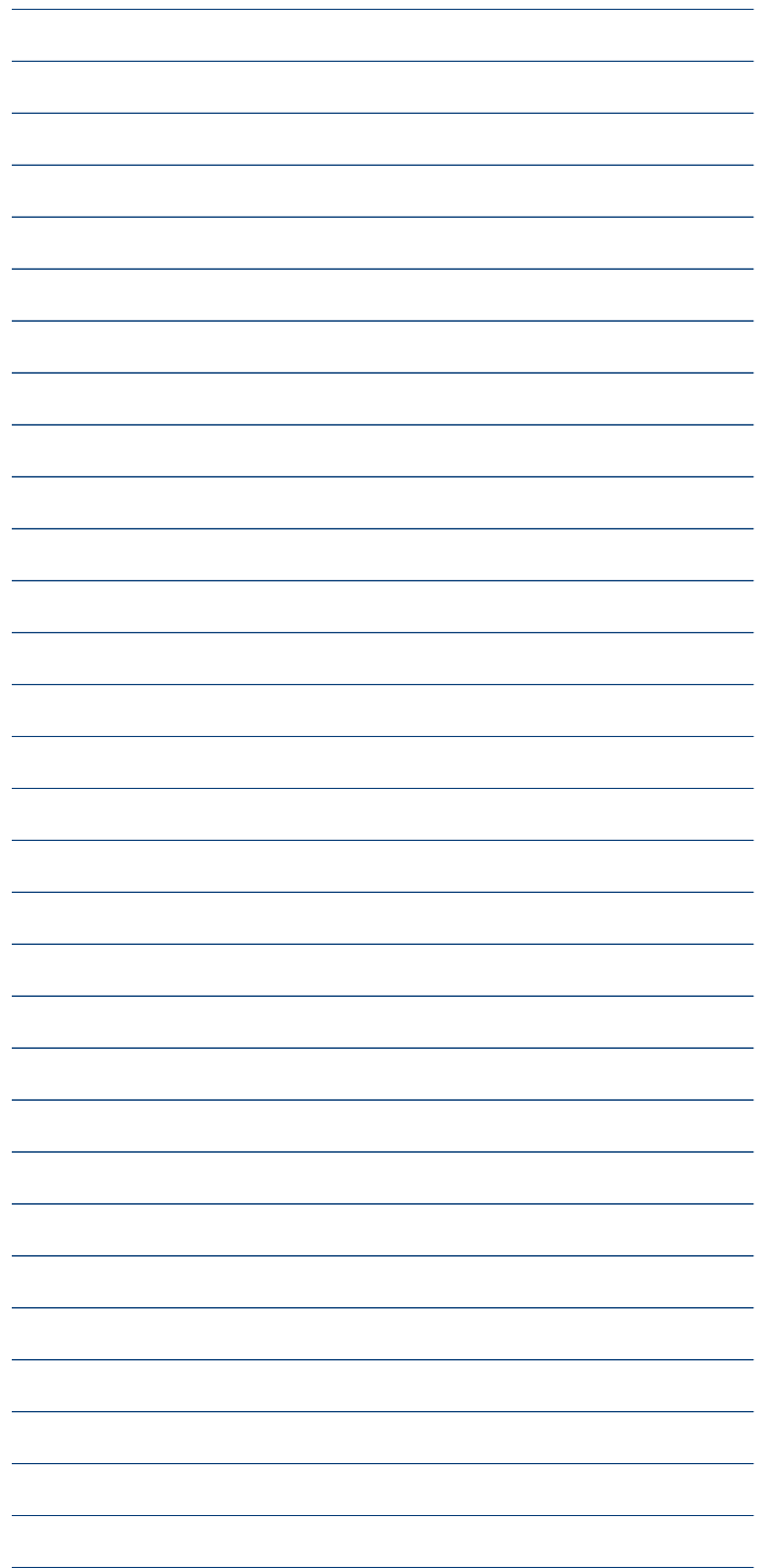
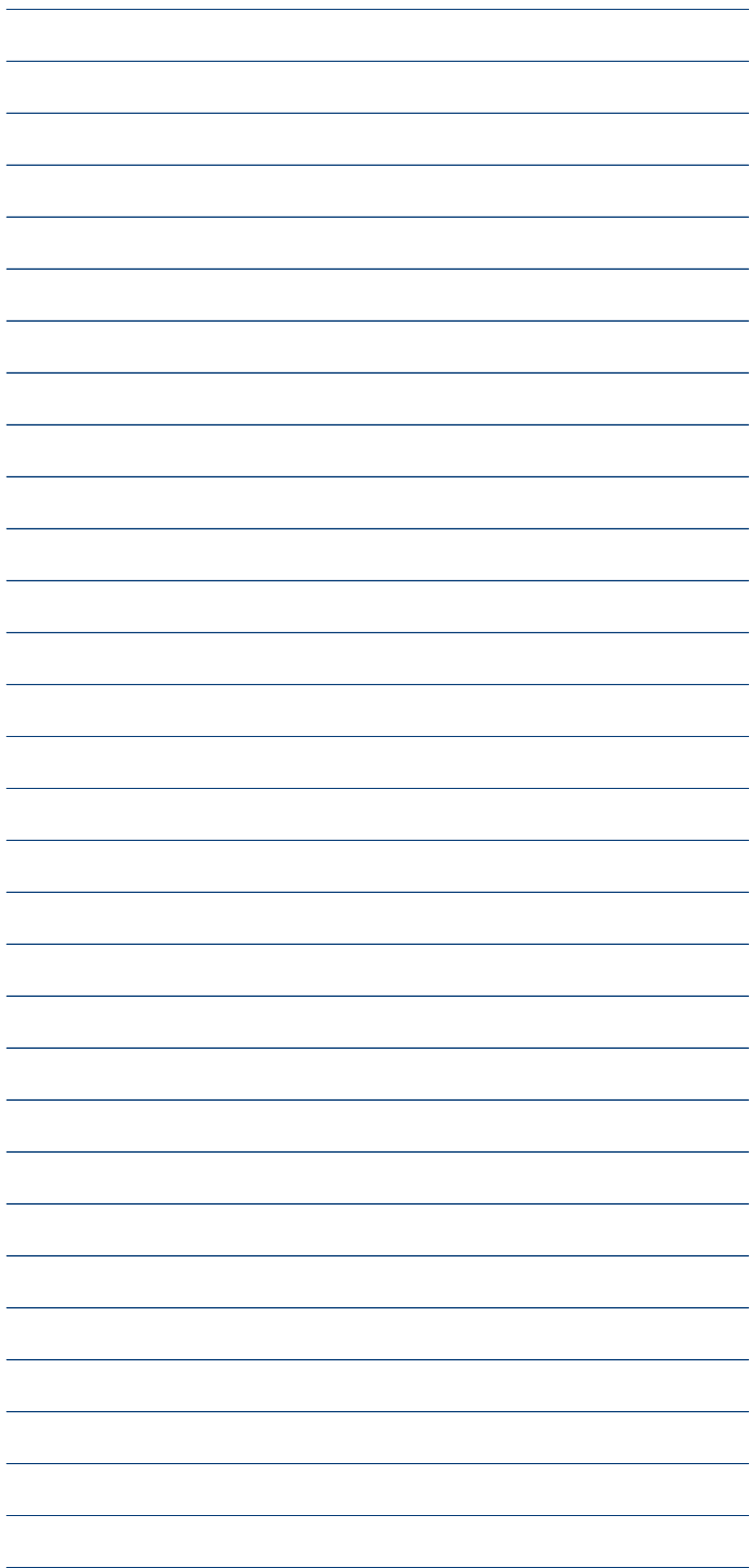
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