Faculty of Computer and Information Science

University of Ljubljana

Survey of Activities in 2008

Contents

Prof. Dr. Franc Solina

Foreword

This booklet provides some basic information about the Faculty of Computer and Information Science of the University of Ljubljana. The Faculty is the leading institution in the field of Computer and Information Science in Slovenia. Since its first study program in computer science began in 1973, it has a lengthy roster of alumni, some of which achieved distinction in academic and business circles in Slovenia and abroad. The Faculty has a number of active research groups that attract funding from various EU programs and bilateral state programs as well as funding from Slovenian and foreign industry.

Due to the high demand for graduates in the area of Computer and Information Science in Slovenia the Faculty has avoided the trend of declining enrolment as in some other engineering and science disciplines. However, since the younger generations in Slovenia are smaller in size we have to attract promising students to our educational and research programs in the future from a larger geographical area. We have prepared new study programs designed according to the Bologna principles will have a wider appeal and should help to make the exchange of students even easier. We will start with the new Bologna programs in the academic year 2009/2010.

In the age of globalization the Faculty faces increasing competition in all areas. We have to expand our research competence to a wider spectrum of promising technical areas. In 2007 we established a new Laboratory for e-media headed by the leading Slovenian researcher for managing information systems security and privacy. We plan to expand and strengthen the Faculty in the near future also in some other research areas by attracting experienced researchers. This expansion will be possible only when the Faculty's most pressing problem will be solved – the shortage of space. The location and architectural plans for the new Faculty building are already approved and construction is expected to begin in late in 2009.

I hope that this booklet will forge new links to the international Computer Science community, which is a prerequisite for the Faculty to successfully continue its mission. I am inviting those readers who will find some interesting material in the booklet to establish contacts with our Faculty members.

Franc Solina
Professor of Computer and Information Science and Dean

About FRI

General Information

Dean **Prof. Dr. Franc Solina**
Associate Dean for Education **Prof. Dr.Radko Osredkar**
Associate Dean for Research **Prof. Dr. Blaž Zupan, Doc. Dr. Janez Demšar** (from 1.10.2008)
Associate Dean for Development **Prof. Dr. Nikolaj Zimic**
Head of administration **Lan Vošnjak, Ivan Malešič** (from 11. 2. 2008)

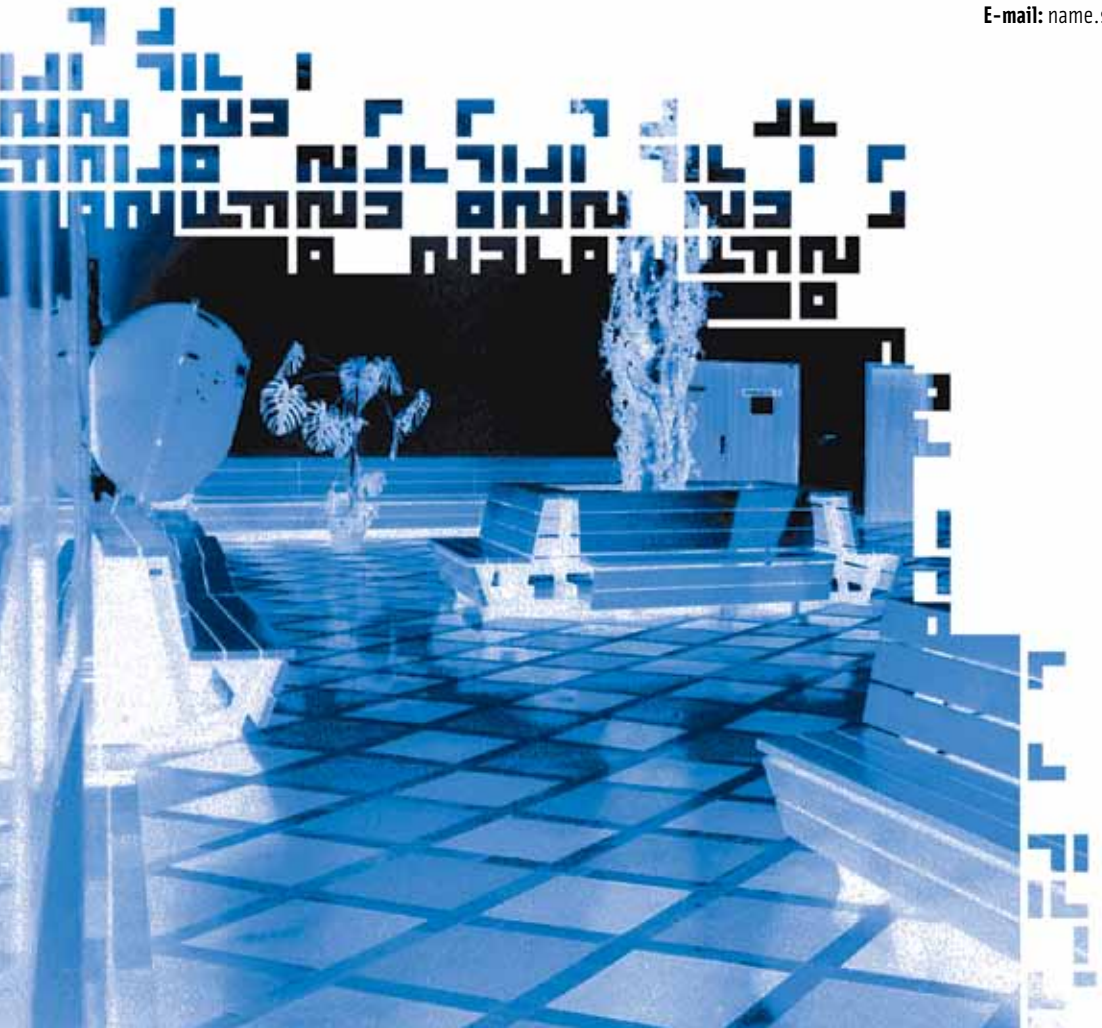
Address:
University of Ljubljana
Faculty of Computer and Information Science
Tržaška cesta 25
SI-1001 Ljubljana
Slovenia

Phone: +386 1 476 84 11

Fax: +386 1 426 46 47

WWW: http://www.fri.uni-lj.si/

E-mail: name.surname@fri.uni-lj.si (for all teaching and research staff)



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 1986 students have completed the undergraduate program in computer science and obtained university degree. At the graduate level more than 320 Master's degrees (M.Sc.) and 103 the Doctoral degrees (Ph.D.) in Computer and Information science have been awarded. Currently, there are about 1700 undergraduate and 120 graduate students at the Faculty. The Faculty has 137 employees, of which 120 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

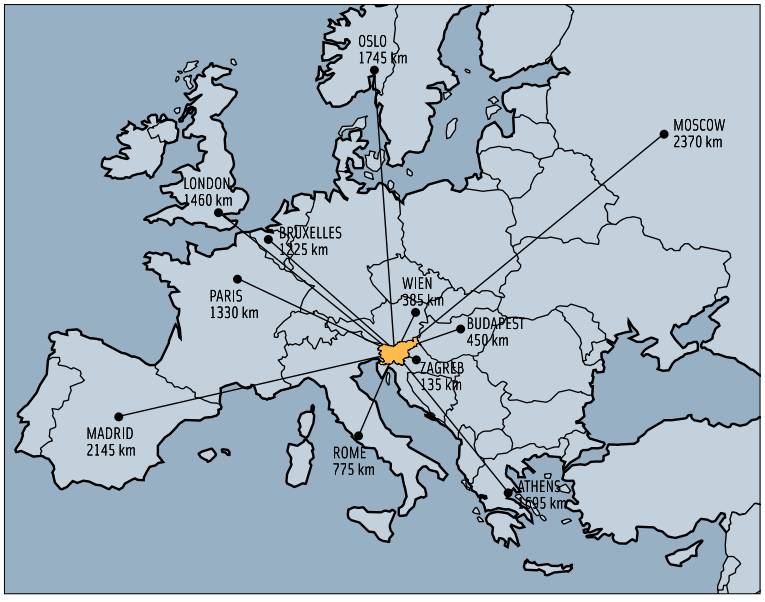


Figure 1: Slovenia in Europe

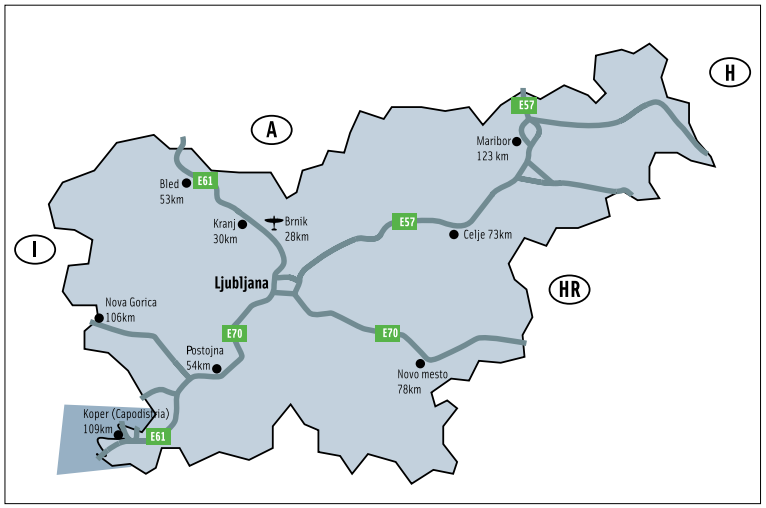


Figure 2: Map of Slovenia

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.

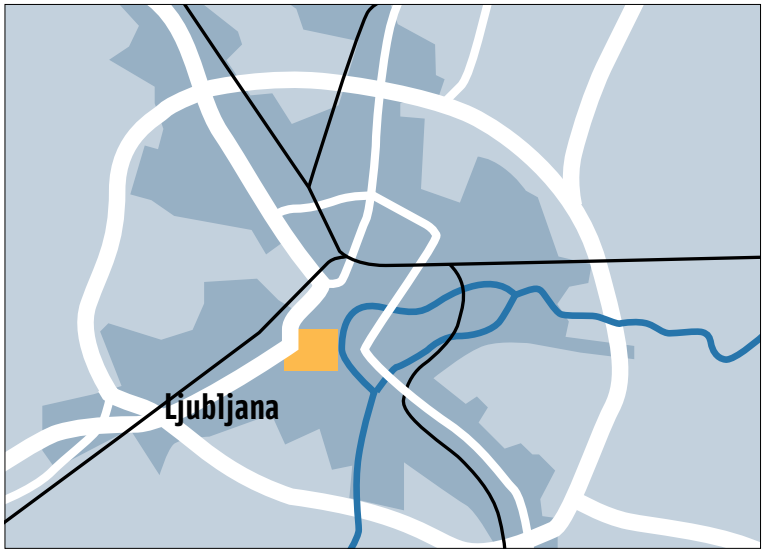


Figure 3: Ljubljana – the Faculty is located within the highlighted area (detailed in Figure 4)

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.

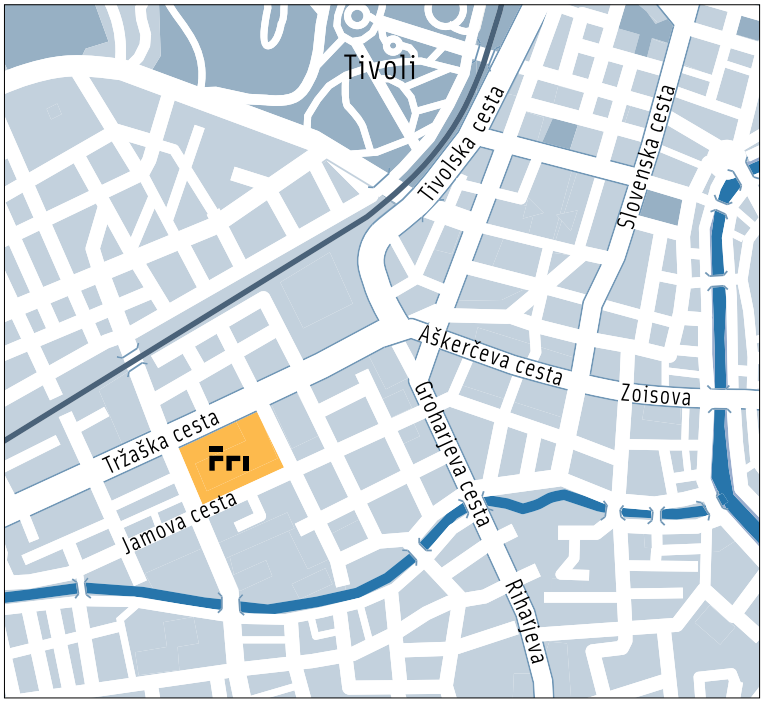


Figure 4: Detailed map of Ljubljana – the location of the Faculty is indicated by the highlighted yellow square

Educational Programs

The academic year at the University of Ljubljana consists of 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 four-year undergraduate 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 consist 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.

NEW PROGRAMS

In the academic year 2009 – 2010 FRI will be offering to the prospective students first enrolments into several new programs, developed in accordance with the Bologna guidelines. Starting with that year the old programs described in this brochure will be phased out, i.e. replaced by the yearly progression of the new programs. There will be 4 B.S. programs offered:

Computer in Information Sciences,

interdisciplinary program Computer Sciences and Mathematics,

interdisciplinary program Management Informatics, and a

technically oriented program of Computer in Information Sciences.

In the 2009 – 2010 academic year a M.S. in interdisciplinary program

Cognitive sciences,
will also be open for enrolment for the first time, and in the academic year 2010 – 2011 the M.S. program

Computer in Information Sciences
will commence.

In the 2009 – 2010 academic year 3 PhD programs will be open for enrolement,

Computer in information sciences,

Interdisciplinary program Biosciences, and

Interdisciplinary program Humanistic and social sciences.

This large expansion of the academic programs offered by the FRI will be facilitated by the new premises of the Faculty, planned to be completed in 2014.

POSTGRADUATE PROGRAMS

Postgraduate programs at the Faculty of Computer and Information Science consist of four semesters, 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
nformation 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	3	0	3	–	–	–	6.5
Design and Management of Information Systems	3	1	2	–	–	–	6.5
Business Analysis	2	0	2	–	–	–	4
Electronic Business	3	0	3	–	–	–	6.5
Distributed Information Systems	–	–	–	3	0	3	7
Information Systems Technology	–	–	–	3	0	3	7
Artificial Intelligence	–	–	–	3	2	1	7
Information Society	–	–	–	3	0	2	5.5
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	3	0	3	–	–	–	7
Seminar	0	0	3	–	–	–	3.5
Parallel Architecture of Computers	–	–	–	3	0	3	7
Process Informatics	–	–	–	3	0	3	6.5
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 and Computer System Diagnostics	–	–	–	2	2	0	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.

Doctoral Program in Computer and Information Science

The doctoral program is comprised of

three required courses

two elective courses from computer and information science

two elective courses from computer and information science or another courses offered at the University of Ljubljana

five seminars

Year 1	Overview course	Elective course from CS	Elective course		Scientific Skills I	Seminar I
Year 2	Elective from CS	Elective course	Research work		Scientific Skills II	Seminar II
	Research work					Seminar III
Year 3	Research work					Seminar IV
	PhD dissertation preparation					Seminar V
	5 ECTS	5 ECTS	5 ECTS	5 ECTS	5 ECTS	5 ECTS

REQUIRED COURSES

The purpose of the **Overview course** is to verify whether the PhD student has a sufficient background in computer science and informatics, as covered by selected undergraduate courses and included in the standard US Graduate Record Examination Subject Test for Computer Science. The other two required courses are **Scientific Skills I** and **Scientific Skills II**, with topics like paper writing, writing project proposals, making good oral and poster presentation, copyright and patent law, ethics in science and similar.

ELECTIVE COURSES

The candidate chooses two of six available elective courses from the list.

Architectures and algorithms for parallel computing

Artificial Intelligence

Computer Systems

Informatics

Selected Topics from Software Development

Topics in Mathematics and Natural Sciences

The other two elective courses can be chosen from the above list, from some courses from the undergraduate study and from other courses offered at the University of Ljubljana.

SEMINARS

There are five seminars, one in each of the first five semesters of the study program. At these seminars the students present their work (e.g. papers, project proposals, posters, theses) to each other and to their mentors.

Research

Research activities (as well as most Diploma, Master and Doctoral theses research) at the Faculty of Computer and Information Science are performed in seventeen research laboratories which are organized in six groups.

The main sources of research funding are Slovenian Research Agency, the Ministry of Higher Education, Science and Technology, Ministry of Defense, European Union programs (COST, 6th and 7th FP), and various bilateral programs with the USA, France (Proteus), Austria, Czech republic, Norway, Portugal, Greece and UK (ALINK). The Ministry of Higher Education, Science, and Technology, together with Slovenian Research Agency also supports the majority of postgraduate students by means of individual scholarships. Many application projects are financed by Slovenian companies.

Besides being at the forefront of basic computer science, our researchers our active in a number of fields of potential interest to partners from industry and government, such as

microcomputer systems, fuzzy and neuro-fuzzy controllers,

process informatics and programmable technologies

GRID technologies and parallel processing

short SIMD processing

intelligent RFID systems

cryptography, security, privacy, digital identity management, intrusion detection

digital libraries and multimedia information retrieval

3D design, visualization and animation, video editing

e-learning environments

numerical simulations of physical phenomena

prototyping of transaction intensive systems

design of people-focused software development methodologies based on best practices

Service Oriented Architecture-based system integration

fraud detection from transaction data (insurance companies, police, banking)

data mining, machine learning, data visualization

mobile robotics, applications of AI in robotics

computer vision, visual cognitive systems

biometry, human face detection and recognition

object recognition and tracking in video streams, visual surveillance and forensic

medical diagnosis and prognosis

biomedical informatics, genomics, drug development

biomedical computer systems and imaging

For more information consult the Web pages of individual laboratories (http://www.fri.uni-lj.si/en/laboratories/), or visit the web page with the list of current projects (http://www.fri.uni-lj.si/en/research/projects/)

Laboratory for Computer Graphics and Multimedia

Head: Professor Dr. Saša Divjak

Fax: (+386 1) 42 64 647

Phone: (+386 1) 47 68 + ext.

WWW: www.fri.uni-lj.si/lgm

Staff	E-mail	Ext.
Professor **Dr. Saša Divjak**	sasa.divjak@fri.uni-lj.si	750
Assistant Professor **Dr. Matija Marolt**	matija.marolt@fri.uni-lj.si	483
Lecturer **Dr. Marko Privošnik**	marko.privosnik@fri.uni-lj.si	483
Lecturer **Dr. Alenka Kavčič**	alenka.kavcic@fri.uni-lj.si	483
Assistant **Dr. Roman Dorn**	roman.dorn@fri.uni-lj.si	758
Researcher **Jernej Južna**	jernej.juzna@fri.uni-lj.si	483
Researcher **Ciril Bohak**	ciril.bohak@fri.uni-lj.si	483

RESEARCH ACTIVITIES

Laboratory of Computer Graphics and Multimedia is involved in activities related to multimedia technologies, computer-based education and learning, human-computer interaction, and virtual/augmented reality. The laboratory is a member of the international consortium CoLoS, together with 18 Universities around the world. 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 activities in the laboratory are dedicated to researches in the following areas:

- digital libraries and multimedia information retrieval,
- educational metadata creation, retrieval and exchange,
- folksonomy and social tagging,
- development of interactive educational content,
- e-learning environments.

Additionally, we are also active in the development of virtual an augmented reality applications, interactive learning systems, and didactic simulations and visualisation of natural phenomena.

The laboratory is well equipped with professional software tools for 3D design, visualization, animation, and video editing. Some presentation and videoconferencing equipment is also available.

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.

RESEARCH PROJECTS

ASPECT: Adopting Standards and Specifications for Educational Content (ECP-2007-EDU-417008), Best Practice Network, eContentplus Programme, European Commission (2008 – 2011).

ETNOKATALOG: retrieval of semantic data from folk song and music, based on melodic and metro-rhythmic analysis (J6-0145), Basic Research and Application Project, Slovenian Research Agency (2008 – 2011).

DIDIKTA: analysis and development of ICT usage didactics in teaching and learning (V5-0425), CRP Project, Slovenian Research Agency and Slovenian Ministry of Education (2008 – 2010).

MELT: a Metadata Ecology for Learning and Teaching (ECP-2005-EDU-038103), eContentplus Programme, European Commission (2006 – 2008).

ETHNOMUSE: multimedia digital archive of Slovenian folk music and folk dance culture (V2-0216), CRP Project, Slovenian Research Agency (2006 – 2008).

Second Click on Slovene - a multimedia CD for learning Slovene as a foreign language, project founded by American Embassy in Ljubljana (2006 – 2008).

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Augmented reality in action

materials. Proceedings of International Conference Enabling education and research with ICT, SIRIKT 2007, Kranjska Gora, 19 - 21 April 2007, pp. 355-359. 2007.

R. Timmers, M. Marolt, A. Camurri, G. Volpe. Listeners' emotional engagement with performances of a Scriabin étude: an explorative case study. Psychology of Music 34: 481-510. 2006.

R. Dorn, F. Jager. Semia: semi-automatic interactive graphic editing tool to annotate ambulatory ECG records. Comput. methods programs biomedicine, Vol. 75, no. 3, pp. 235-249. 2004.

A. Kavčič. Fuzzy User Modeling for Adaptation in Educational Hypermedia. IEEE Transactions on Systems, Man, and Cybernetics, Part C, November 2004, Vol. 34, No. 4, pp. 439-449. 2004.

M. Marolt. A Connectionist Approach to Transcription of Polyphonic Piano Music. IEEE Transactions on Multimedia, June 2004, Vol.6, Issue 3, pp. 439- 449. 2004.

M. Marolt. Networks of Adaptive Oscillators for Partial Tracking and Transcription of Music Recordings. Journal of New Music Research, Vol. 33, No. 1. 2004.

Laboratory for Biomedical Computer Systems and Imaging

Head: Professor Dr. Franc Jager

Fax: (+386 1) 426 4647

Phone: (+386 1) 4768 + ext.

WWW: http://www.fri.uni-lj.si/lbcsi

Staff	E-mail	Ext.
Professor **Dr. Franc Jager**	franc.jager@fri.uni-lj.si	362, 780
Lecturer **Dr. Aleš Smrdel**	ales.smrdel@fri.uni-lj.si	247, 860
Junior Researcher **Gašper Fele-Žorž, B. Sc.**	gasper.felezorz@fri.uni-lj.si	247, 860
Junior Researcher **Jana Faganeli, B. Sc.**	jana.faganeli@fri.uni-lj.si	247, 860

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 and classifying true ischaemic events from non-ischaemic events in biomedical signal data using the LTST DB (Long-Term ST Database) of human-expert annotated ambulatory electrocardiogram (ECG) records.

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-expert 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 ischeamia. See: http://www.physionet.org/physiobank/database/ltstdb/ and http://www.physionet.org/challenge/2003/. From 2007 the database is publicly available. See also: http://lbcsi.fri.uni-lj.si/database/.

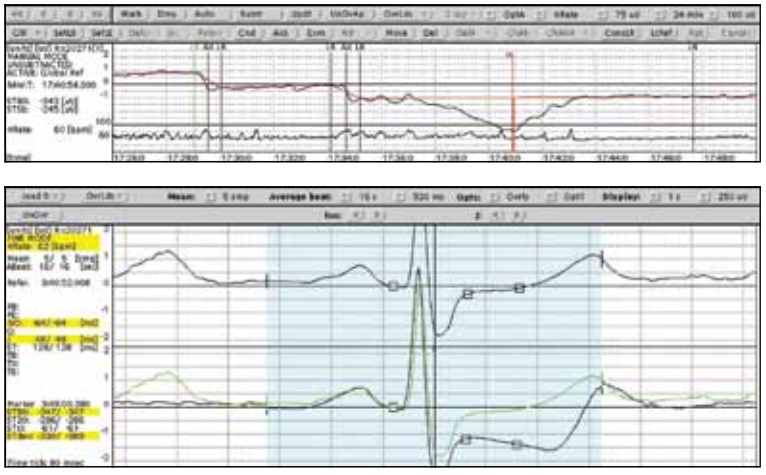
The next research topic is development of interactive graphic user interface editing tools (SEMIA – semi-automatic) to visualize, display and annotate long-term electrocardiograms. SEMIA, version 3.0.1, to view diagnostic and morphology feature-vector time series, and to examinee human annotations of the LTST DB is under GNU General Public Licence and is available from http://www.physionet.org/physiobank/database/ltstdb/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 research topic concerns comparison of various linear and non-linear signal processing techniques to separate uterine electromiogram (EMG) records of term and pre-term delivery groups with the final goal to predict pre-term delivery.

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.



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

EQUIPMENT

Laboratory owns a recording device to record and monitor electroencephalogram (EEG) signals.

RESEARCH PROJECTS

Metabolic and inborn factors of reproductive health, birth (P3-0124), Slovene Research Agency (2004–2009).

Metabolic and inborn factors of reproductive health, birth, II (), Slovene Research Agency (2009–2014).

RESEARCH VISITS

Franc Jager: Division of Health Sciences and technology, Laboratory for computational physiology, Massachusetts Institute of technology, Cambridge, USA, 1. 10. - 5. 10. 2008. Work on joint research topics, help in maintainig PhysioNet Web site (http://www.physionet.org).

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F. Jager. Guideliness for Assessing Performance of ST Analyzers. *Journal of Medical Engineering & Technology*, 22(1):25–30, 1998.

Laboratory of Adaptive Systems and Parallel Processing

Head: Professor Dr. Andrej Dobnikar

Fax: (+386 1) 4768 369

Phone: (+386 1) 4768 + ext.

WWW: http://www.fri.uni-lj.si/laspp/

Staff	E-mail	Ext.
Full Professor **Dr. Andrej Dobnikar**	andrej.dobnikar@fri.uni-lj.si	382
Assistant Professor **Dr. Branko Šter**	branko.ster@fri.uni-lj.si	783
Assistant Professor **Dr. Uroš Lotrič**	uros.lotric@fri.uni-lj.si	874
Junior Researcher **Jernej Zupanc**	jernej.zupanc@fri.uni-lj.si	875
Assistant **Nejc Ilc**	nejc.ilc@fri.uni-lj.si	307

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,
- Identification of dynamic systems with Recurrent neural networks,
- Fuzzy and Neuro-Fuzzy controllers,
- Process Informatics and Programmable Technologies,
- Cellular structures and Complex Systems,
- Information-theoretic modeling
- Parallel processing/programming in GRID environments

RESEARCH PROJECTS

Development and realization of on-line regulation of compound mixer with soft computing methods (IPMT-001/2006/FRI-LASPP-001), Industry-Founded Project, Savatech. d.o.o., Kranj (2006–2008).

SELECTED PUBLICATIONS

A. Dobnikar, B. Šter. Structural Properties of Recurrent Neural Networks. Neural Processing Letters, 2009

B. Šter, A. Dobnikar. Building internal maps of a mobile robot, in V: JING, Xing-Jian (ur.). Mobile robots motion planning: new challenges, (Advanced robotics series).Vienna: I-Tech, cop. 2008, str. 503-516

I. Jeras, A. Dobnikar. Algorithms for computing preimages of cellular automata configurations, Physica-D, 233: 95-111, 2007

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I. Gabrijel, A. Dobnikar. On-line identification and reconstruction of finite automata with generalized recurrent neural networks. Neural Networks, 16(1): 101–121, 2003.

Computing cluster

Fuzzy control system based on video-cameras

Laboratory for Computer Architecture

Head: Associate Professor Dr. Veselko Guštin

Fax: (+386 1) 426 4647

Phone: (+386 1) 4768 + ext.

WWW: http://www.fri.uni-lj.si/lca

Staff	E-mail	Ext.
Associate Professor **Dr. Veselko Guštin**	veselko.gustin@fri.uni-lj.si	384
Assistant Professor **Dr. Mira Trebar**	mira.trebar@fri.uni-lj.si	254
Assistant Professor **Dr. Patricio Bulić**	patricio.bulic@fri.uni-lj.si	361
Retired professor **Dr. Ljubo Pipan**		

RESEARCH ACTIVITIES

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

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. It is a simple method that can be used to filter out data dependences with a sufficiently large distance between memory references. By checking the distance between the memory references we can filter out data dependences that do not prohibit potential SIMD vectorization and that can be excluded from further, possibly more accurate and expensive, tests. The method is based on checking the minimum and maximum distances between two memory references within the iteration space rather than searching for the existence of an integer solution to the dependency equation. This results in greater accuracy and also in a reduction of the time cost as it computes only the bounds of an integer affine function.

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 developing an embedded system with two RISC microprocessors, which is implemented in field-programmable gate.

The latest research activities include studies of radiofrequency identification technology used in supply chain management, wireless

tracking of objects to acquire the information used in classification and prediction models. This part of research includes the use of neural networks, support vector machines and some other methods applicable in design of intelligent RFID systems.

RESEARCH VISITS

Mira Trebar: Coventry University, Faculty of Engineering and Computing, UK, 18.2.-29.2. 2008. Socrates/ Erasmus teaching exchange and research collaboration on support vector classification problems.

SELECTED PUBLICATIONS

M. Trebar, N. Steele. Application of distributed SVM architectures in classifying forest data cover types. *Comput. electron. agric.*, vol. 63, no. 2, 2008.

M. Trebar, Z. Šušterič, U. Lotrič. Predicting mechanical properties of elastomers with neural networks. *Polymer (Guildf.),* vol. 48, iss. 18, 2007.

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P. Bulic, V. Guštin, An efficient way to filter out data dependences with a sufficiently large distance between memory references, *ACM SIGPLAN Notices*, No. 4, Vol. 40, 2005

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M.Trebar, N. Steele, An implementation of a two-layered SVM classifier in Condor = Izvedba dvo-nivojskega SVM klasifikatorja v sistemu Condor. *Elektroteh. vestn.*, letn. 74, št. 3, 2007

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Computer Communications Laboratory

Head: Associate Professor dr. Tone Vidmar

Fax: (+386 1) 426 4647

Phone: (+386 1) 4768 + ext.

WWW: http://www.fri.uni-lj.si/ccl/

Staff	E-mail	Ext.
Associate Professor **dr. Tone Vidmar**	tone.vidmar@fri.uni-lj.si	378
Associate Professor **dr. Mojca Ciglarič**	mojca.ciglaric@fri.uni-lj.si	377
Assistant **dr. Matjaž Pančur**	matjaz.pancur@fri.uni-lj.si	277
Assistant **Andrej Krevl, B. Sc.**	andrej.krevl@fri.uni-lj.si	795

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 2008, we have researched most actively the following areas:

- In the area of distribute systems architecture, we studied the system integration techniques using Service Oriented Architecture principles. We have also studied usability of these architectures in relation to digital identity management systems and took part in a large practically oriented EAI project.
- We have also studied the theory and practice of digital identity management systems and took part in a large-scale project of introducing an IDMS at University of Ljubljana.
- In the area of communication networks we have researched advanced options of IPv6 protocol and its implementations, the strategies for migration from IPv4 to IPv6 and implementations of IPv6 in a wireless environment.
- In the area of software development methodologies, we were researching the properties of agile methodologies, especially test-driven development.
- In the area of information systems security and security policies, we have suggested implementation of the so-called security knowledge cycle, process of continuous education for information systems users in large companies. We have also researched its prototype support implementations.

Interconnecting four servers in a cluster via 20 Gbps low latency Infiniband links

EQUIPMENT

Besides the typical office equipment, Computer Communications Laboratory is equipped with a few pieces of advanced networking / distributed systems hardware and software equipment. *Hardware*: a 20 Gb/s Infiniband DDR network switch, 3 x 24-port Dell Gigabit Switches, Dell Power Vault NAS 745 (4 x 500 GB + 12 x 250 GB), a cluster of 11 Dell PowerEdge R200 servers, 6 Dell Power Edge Servers, IBM eServer xSeries 336, Wireless WiFi and BlueTooth Access Points, various mobile devices, ActivCard SmartCard readers and smart cards.

Software: network management tools and utilities, databases and development tools, SharePoint Portal Server, Microsoft development tools and utilities; several open-source Java development tools and utilities including Mobile Phone development utilities, …

RESEARCH PROJECTS

System and information infrastructure at University of Ljubljana (S-731), Industry-Founded Project, University of Ljubljana (2005–2009).

Digital identity management at University of Ljubljana (V2-0382), Slovene Government-Founded R&D Project (2007–2009).

Enterprise Application Integration at University of Ljubljana, Industry-Founded Project, University of Ljubljana (2007–2009).

Model of information system for Slovenian Ministry of Higher Education (V2-0419), Slovene targeted research program, Government-Founded project, (2008-2009).

SELECTED PUBLICATIONS

M. Bagić Babac, A. Babac, M. Ciglarič. Verifying Epistemic Properties of Multi-agent Systems via Action-based Temporal Logic Proc. International Conference on Intelligent Agents, Web Technology and Internet Commerce - IAWTIC'2008. December 2008. IEEE, cop. 2008.

CIGLARIČ, Mojca, KREVL, Andrej, PANČUR, Matjaž. Strategija upravljanja z digitalnimi identitetami. V: PINTERIČ, Uroš (ur.), ŠINKOVEC, Urša (ur.). Informacijska družba: multidisciplinarni pogledi. Nova Gorica: Fakulteta za uporabne družbene študije, 2008, str. 311-326, ilustr.

A. Krevl, M. Ciglarič. A framework for developing distributed location based applications. Proc. 20th International Parallel and Distributed Processing Symposium, 2006, Rhodes Island, Greece. Piscataway: IEEE, 2006.

M. Ciglarič, A. Krevl, M. Pančur [et al.]: Security policies in military environments, in Dynamic Communications Management (pp. 19-1 – 19-8), Meeting Proceedings RTO-MP-IST-062. Neuilly-sur-Seine, France: RTO. 2006.

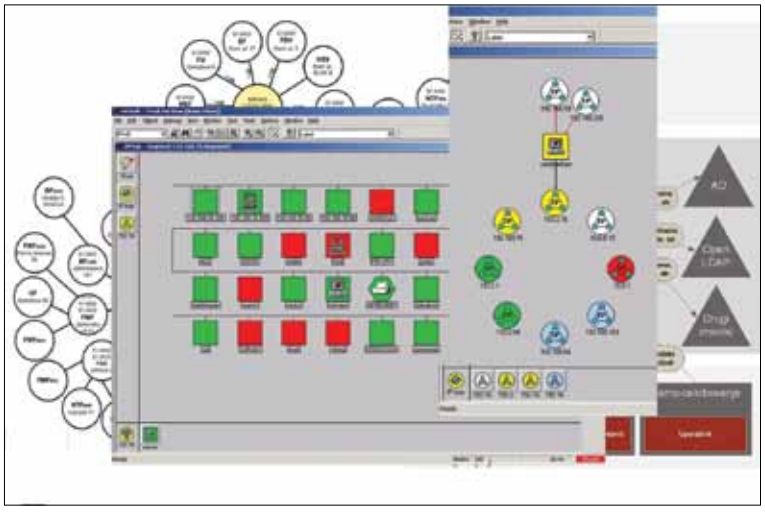
A. Krevl, T. Vidmar [et. al.]: A Framework for Developing Mobile Location Based Applications, in Dynamic Communications Management (pp. 1-10), Meeting Proceedings RTO-MP-IST-062. Neuilly-sur-Seine, France: RTO. 2006.

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

M. Ciglarič, T. Vidmar. Problematika nestrukturiranih sistemov enak z enakim (Problems in unstructured P2P Systems). Electrotech. Review, 2005, Vol. 72, No. 4, pp 164-170.

M. Trampuš, M. Ciglarič, T. Vidmar. Formalizacija varnostnih politik (Security policy Formalization). Electrotech. Review, 2005, Vol. 72, No. 5, pp. 309-315.

M. Ciglarič. Content networks : distributed routing decisions in presence of repeated queries. *Int. j. found. comput. sci.*, 2004, Vol. 15, No. 3, pp. 555-566.



Network management (Tivoli Netview and other tools)

A new server cluster for massive virtualization research.

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, pp. 83-86.

Computer Structures and Systems Laboratory

Head: Professor Dr. Niko Zimic

Fax: (+386 1) 426 4647

Phone: (+386 1) 4768 + ext.

WWW: http://www.fri.uni-lj.si/cssl, http://lrss.fri.uni-lj.si/

Staff	E-mail	Ext.
Professor **Dr. Nikolaj Zimic**	niko.zimic@fri.uni-lj.si	395
Associate Professor **Dr. Miha Mraz**	miha.mraz@fri.uni-lj.si	372
Assistant Professor **Dr. Iztok Lebar Bajec**	iztok.bajec@fri.uni-lj.si	785
Assistant **Andrej Jazbec, M.Sc.**	andrej.jazbec@fri.uni-lj.si	786
Assistant **Primož Pečar, M.Sc.**	primoz.pecar@fri.uni-lj.si	371
Assistant **Miha Moškon**	miha.moskon@fri.uni-lj.si	371
Research Assistant **Miha Janež**	miha.janez@fri.uni-lj.si	371
Technical Assistant **Vito Čehovin**	vito.cehovin@fri.uni-lj.si	371

RESEARCH ACTIVITIES

The primary activities of the Computer Structures and Systems Laboratory are in the field of scientific work and work on the industrial projects besides teaching.

The principal scientific research directions of the laboratory are alternative nanotechnology processing platforms and methods of the future. A lot of effort in the past was dedicated to the research of Quantum Dot Cellular Automata. Our results were published in some of the most respectable journals such as Nanotechnology. Our research work was recently expanded to the field of processing in biological systems (synthetic biology). Our goal is to realize the basic logical primitives like memory cell and logical gates of different types with the aid of National Institute of Chemistry Slovenia. Our research activities on the field of the alternative processing methods were in the past directed toward fuzzy logic, especially fuzzy time, fuzzy automata and implementation of different fuzzy algorithms, such as fire spread prediction model, fuzzy controllers for household devices, fuzzy animats etc. Our research activities are partially financed from European (ESF) partially from national research found (ARRS).

In addition to the scientific research the members of the laboratory actively cooperate with different industrial partners. We can offer them our knowledge on the field of fuzzy controller systems design, intelligent algorithms design, product optimization, efficiency analysis, reliability analysis, product development (hardware and software) etc. Our past industrial partners were Gorenje d.d., Iskratel d.o.o., Konel d.d., OurSpace d.o.o., ComLand d.o.o. We have also cooperated with the government institutions such as General Hospital "dr. Franc Derganc," Slovenian National Assembly, Slovenian Ministry of Defense etc.

RESEARCH PROJECTS

Randomness verification and irregularity analysis of a mechanical random generator that is to be part of a game machine, Industry-Founded Project, Elektrina d.o.o. (2008–2008).

Flexible display with an integrated communication module (TP MIR 07/RR/19), Industry-Founded Project, OurSpace d.o.o. (2007–2009).

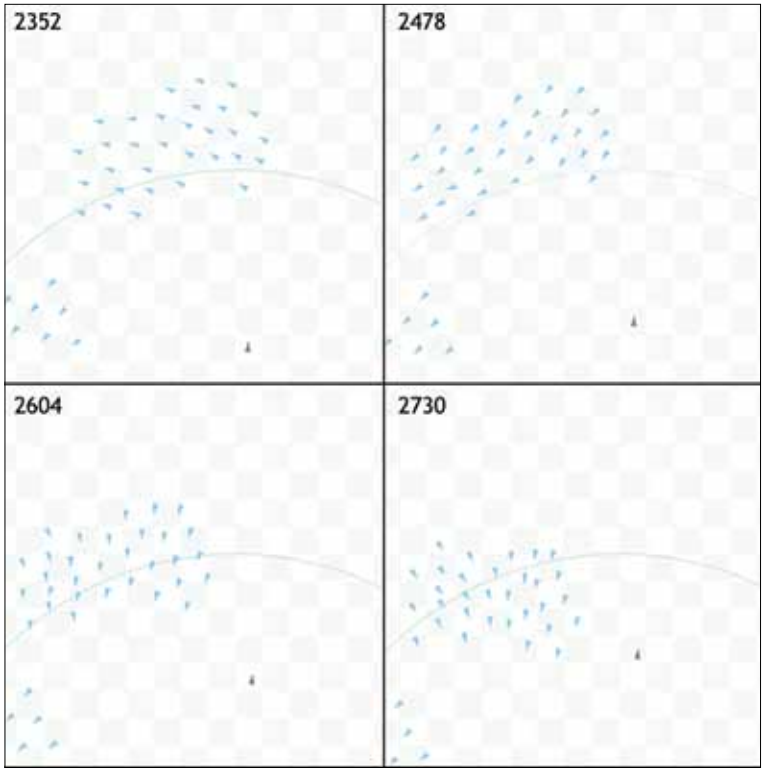
Introduction of fuzzy logic into the process of defence systems management (M2-0170), A Science for Peace and Security Target Research Project, founded by Slovene Research Agency (2006–2008).

Optimization of resiliency and fast convergence in the Ethernet network environment Project (03/FRI-IT/ES-2006), Industry-Founded Project, founded by Iskratel d.o.o. (2006–2009).

LABORATORY GUESTS

Alona Ilchenko, Katerryna Borishko (postgraduate students), Faculty of Automation and Device Building of National Technical University "Kharkiv Polytechnical Institute", Kharkov, Ukraina, 11. 5. – 25. 5. 2008, Research visit.

Dragomir Angelov, Technical University of Varna, Varna, Bulgaria, November 2008 – May 2009.



Fuzzy logic based bird flocking simulation displaying behaviour typical for pigeon flocks, where birds, while performing turns, change their position in the flock

RESEARCH VISITS

Miha Janež, Miha Moškon: National Technical University of Kharkov, 11.4.-25.4.2008., (Preparation of Bilateral projects).

INVITED TALKS AND LECTURES

Miha Moškon: Fuzzy logic applied to modelling of bird flock foraging behavior. Kharkiv: Polytechnic Institute, Ukraina, 23. 4. 2008.

Miha Janež:. Quantum-dot cellular automata logic circuits design. Kharkiv: Polytechnic Institute, Ukraina, 23. 4. 2008.

Miha Mraz, Nikolaj Zimic, Iztok Lebar Bajec: Information Systems Breakdowns, 10. – 11. 1. 2008, an invited talk at the First RISC (Rare Incidents with Strong Social Consequences) Workshop, University of Ljubljana, Ljubljana, Slovenia.

SELECTED PUBLICATIONS

P. Pečar, A.Ramšak, N. Zimic, M. Mraz, I. Lebar Bajec. Adiabatic pipelining : a key to ternary computing with quantum dots. *Nanotechnology*, 19(49): 1-12, 2008.

P. Pečar, M. Mraz, N. Zimic, M. Janež, I. Lebar Bajec. Solving the ternary quantum-dot cellular automata logic gate problem by means of adiabatic switching. *Jpn. j. appl. phys.*, 47(6): 5000-5006, 2008.

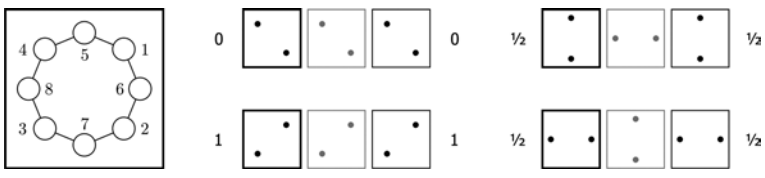
I. Lebar Bajec, N. Zimic and M. Mraz. The computational beauty of flocking: Boids revisited. *Mathematical and Computer Modelling of Dynamical Systems*, 13(4):331–347, 2007.

I. Lebar Bajec and M. Mraz. Multi-valued logic based on quantum-dot cellular automata. *International Journal of Unconventional Computing*, 3(4):311–322, 2007.

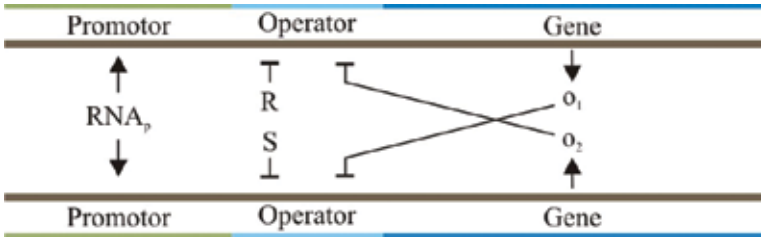
A. Jazbec, M. Mraz, I. Lebar Bajec, N. Zimic. Towards automated cooking process. *Food Research International*, 40(6):733–741, 2007.

I. Lebar Bajec, N. Zimic and M. Mraz. The ternary quantum-dot cell and ternary logic. *Nanotechnology* 17(8):1937–1942, 2006.

I. Lebar Bajec, N. Zimic and M. Mraz. Towards the bottom-up concept: extended quantum-dot cellular automata. *Microelectronic Engineering*, 83(4–9): 1826–1829, 2006.



The ternary quantum-dot cell and ternary wire, where the mechanism of transferring logic values 0, 1/2 or 1 no longer requires electric current but takes advantage of inter-electron Coulomb repulsion



Two parts of DNA strand functioning as RS latch, where RNAp represents RNA polymerase, R and S input proteins and o1 and o2 output proteins.

N. Zimic and M. Mraz. Decomposition of a Complex Fuzzy Controller for the Truck&Trailer Reverse Parking Problem. *Mathematical and Computer Modelling*, 43(5–6):632–645, 2006.

I. Lebar Bajec, N. Zimic and M. Mraz. Simulating flocks on the wing: the fuzzy approach. *Journal of Theoretical Biology*, 233(2):199–220, 2005.

I. Lebar Bajec, P. Trunk, D. Oseli and N. Zimic. Virtual coronary cineangiography. *Computers in Biology and Medicine*, 33(3):293–302, 2003.

M. Mraz, N. Zimic, J. Virant and J. Ficzko. 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.

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

M. Mraz, N. Zimic and J. Virant. Intelligent bush fire spread prediction using fuzzy cellular automata. *Journal of Intelligent and Fuzzy Systems*, 7:203–207, 1999.

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

Information Systems Laboratory

Head: Assistant Professor Dr. Marjan Krisper

Fax: (+386 1) 476 8704

Phone: (+386 1) 4768 + ext.

WWW: http://www.fri.uni-lj.si/infolab/

Staff	E-mail	Ext.
Associate Professor **Dr. Marjan Krisper**	marjan.krisper@fri.uni-lj.si	388
Professor **Dr. Miran Mihelčič**	miran.mihelcic@fri.uni-lj.si	253
Assistant Professor **Dr. Marko Bajec**	marko.bajec@fri.uni-lj.si	814
Senior-Lecturer **Dr. Rok Rupnik**	rok.rupnik@fri.uni-lj.si	814
Senior-Lecturer **Dr. Aljaž Zrnec**	aljaz.zrnec@fri.uni-lj.si	367
Senior-Lecturer **Dr. Damjan Vavpotič**	damjan.vavpotic@fri.uni-lj.si	367
Researcher **Alenka Rožanec, M.Sc.**	alenka.rozanec@fri.uni-lj.si	198
Junior researcher **Dejan Lavbič, B. Sc.**	dejan.lavbic@fri.uni-lj.si	367
Junior researcher **Ana Šaša, B. Sc.**	ana.sasa@fri.uni-lj.si	198
Junior researcher **Štefan Furlan, B. Sc.**	stefan.furlan@fri.uni-lj.si	186
Junior researcher **Lovro Šubelj, B. Sc.**	lovro.subelj@fri.uni-lj.si	186
Junior researcher **Marina Trkman, B. Sc.**	marina.trkman@fri.uni-lj.si	198
Technical assistant **Matej Grom, M.Sc.**	matej.grom@fri.uni-lj.si	782
Assistant-Lecturer **Aleš Kumer, B.Sc.**	ales.kumer@fri.uni-lj.si	186
Assistant-Lecturer **Dr. Tomaž Hovelja**	tomaz.hovelja@fri.uni-lj.si	834
Assistant Professor **Dr. Marko Colnar**	marko.colnar@gov.si	

RESEARCH ACTIVITIES

The Information Systems Laboratory is involved in basic and applied research in the fields 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 - AMT, see figure below) present the most important results of this research. We applied the approach in several Slovenian software companies like Marand, RCC-IRC Celje, Datalab, Comland, and IPMIT. We also developed Unified methodology for system development – EMRIS for Government Centre for Informatics and methodology for strategic planning for Telekom (Slovenian telephony operator).

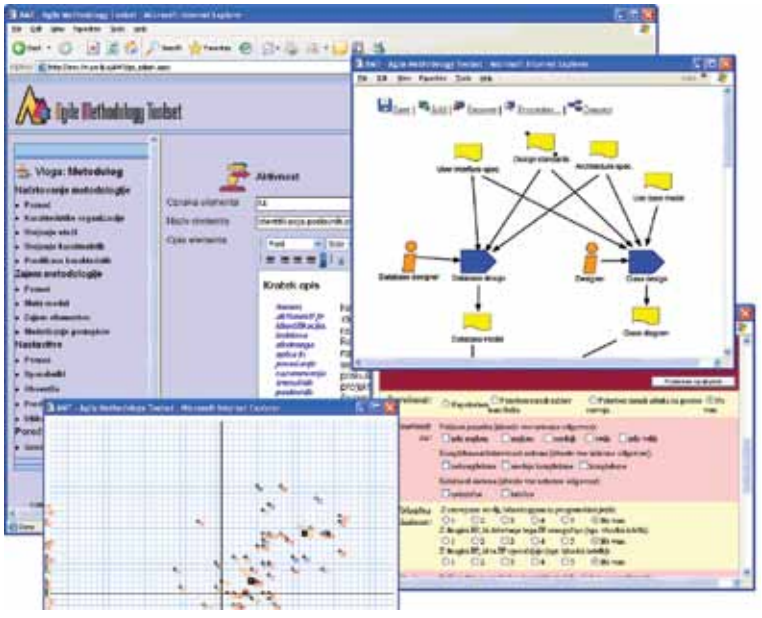
IT/IS Strategy Planning. The strategy planning is one of the research areas that have been traditionally present in the Information systems laboratory since its existence. In the period from 2004 to 2008 we published several methodologies that focus on how to build strategic plans for information systems. The methodologies are based

on many years of practical experiences in developing strategic plans for a range of organisations. We developed several strategic plans for the following organisations: KAD (financial institution), Elektro Ljubljana (electricity distribution operator), ELES (Slovenian electric power transmission company), Slovenian electricity distribution operators association, Informatika, d.d., and Mobitel (Slovenian mobile telephony operator) In the context of IT/IS planning we focus our 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.



Screenshot of the AMT system

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 in 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.

IT governance. We actively analyse IT processes in different organisations. IT process analyses are performed with regard to COBIT model and ITIL standards. We also analyse efficiency of the informatics in the organisations and their business information architectures.

Fraud detection. In the area of fraud detection our members deal with high annual losses of money in the car and health insurance business. Such losses are the result of non-economic measures, mistakes, poor control, incorrect business practices and fraud. It has been proven that the best protection against losses for insurance companies is provided by means of specialized computer solutions – fraud management systems. The members of Infolab developed professional software solution for fraud detection which is already deployed in several Slovenian car and insurance companies, for example we developed fraud detection system for TRIGLAV (health insurance company).

SOA – Service Oriented Architecture. Service-Oriented Architecture (SOA) is a collection of loosely-coupled, distributed services which communicate and interoperate via agreed standards. A service is a mechanism to enable access to one or more capabilities, where the access is provided using a prescribed interface and is exercised consistent with constraints and policies as specified by the service description. Services are independent and can run on different platforms. In this area we do research on how SOA focuses on business processes and how the information technology should support these processes with its main motivation to increase the capability of an organisation to address new business requirements on the short term by reusing existing business logic and data models, thus incurring only minimal cost, resource, and time overheads, while minimizing risks, especially when compared to rewriting entire application systems. From the topic one PhD thesis is being developed. Due to difficulties with complex systems which have become very demanding from the point of view of integration and maintenance, it has become the prevalent paradigm for information system development. We developed IS reengineering and development of SOA based enterprise architecture for Slovenian electricity distribution operators association.

RESEARCH PROJECTS

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

Information system reengineering and development of SOA based enterprise architecture for Slovenian electricity distribution operators association, Informatika, d. d., 2008

The development of a prototype for Revenue Assurance in telecommunications, Industry-Founded Project , founded by Marand, d.o.o. (2007–2008).

The development of a fraud detection system for health insurance companies, Industry-Founded Project, founded by TRIGLAV, Zdravstvena zavarovalnica d.d. (2007–2008).

The development of a prototype system for billing in telecommunications, Industry-Founded Project, founded by Marand, d.o.o.

Analysis of IT processes based on CobIT framework – Industry-Founded Project founded by Informatika d.d., 2008

INVITED TALKS AND LECTURES

Dr. Veljko Milutinović, University of Belgrade, School of Electrical Engineering, Concept Modelling for Knowledge Search

SELECTED PUBLICATIONS

D. Vavpotic, M. Bajec. An approach for concurrent evaluation of technical and social aspects of software development methodologies. In: Information and software technology , Vol. 51, no. 2, pp. 528-545, 2009

M. Bajec, D. Vavpotič. A framework and tool-support for reengineering software development methods. Informatica (Vilnius), 2008, vol. 19, no. 3, str. 321-344

Sasa, Ana; Juric, Matjaz; Krisper, Marjan: Service-Oriented Framework for Human Task Support and Automation, IEEE Transactions on Industrial Informatics, Vol. 4(4), November 2008.

M. Bajec, D. Vavpotič and M. Krisper, Practice-driven approach for creating project-specific software development methods, Inf. softw. technol.. [Print ed.], 2007, vol. 49, no. 4, str. [345]-365

R. Rupnik, M. Kukar and M. Krisper. Integrating data mining and decision support through data mining based decision support system. J. comput. inf. syst., 2007, vol. 47, no. 3, str. 89-104, ilustr.

D. Vavpotič, M. Bajec and M. Krisper. Scenarios for improvement of software development methodologies. Advances in information systems development. Vol. 1, Bridging the gap between academia and industry. New York: Springer, cop. 2006

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

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.

A. Zrnec, D. Vavpotič. An approach to create project-specific software development process. In: Electrotechnical Review, Vol. 75, no. 1/2, pp. 44-49, 2008

A. Šaša, M. B. Jurič and M. Krisper. Agents and People Activities in Web-services based Business processes. 2007 Inaugural IEEE International Conference on Digital Ecosystems and Technologies (IEEE-DEST 2007).

M. B. Jurič, M. Heričko, T. Welzer, I. Rozman, A. Šaša and M. Krisper. Web Services and Java Middleware Functional and Performance Analysis for SOA. 2007 Inaugural IEEE International Conference on Digital Ecosystems and Technologies (IEEE-DEST 2007).

D. Vavpotič and M. Krisper. An approach for rapid creation of a virtual software development team. V: Managing Worldwide Operations and Communications with Information Technology (IRMA 2007 Proceedings), Vancouver, 2007

D. Lavbič, A. Šaša, and M. Krisper. Knowledge management in multi-agent systems. Proceedings of the First International Conference for New Trends in Knowledge Management, Maribor, June 13-14, 2006. Maribor: Faculty of Electrical Engineering and Computer Science, Institute of informatics, 2006, str. 128-133.

M. Krisper and A. Rožanec. Obvladovanje informatike v poslovnih sistemih : pomen strategije in arhitektur. Uporab. inform. (Ljubl.), 2005, letn. 13, št. 4, str. 185-198.

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.

Laboratory for e-media

Head: Associate Professor Dr. Denis Trček

Fax: N/A

Phone: (+386 1) 476 89 18

WWW: http://www.fri.uni-lj.si/en/laboratories/informatics_group/e-mediji/

Staff	E-mail	Ext.
Associate Professor **Dr. Denis Trček**	denis.trcek@fri.uni-lj.si	918
Young Researcher **Damjan Kovač MSc**	damjan.kovac@fri.uni-lj.si	921
Assistant **Iztok Starc BSc**	iztok.starc@fri.uni-lj.si	921

RESEARCH ACTIVITIES

Laboratory of e-media is actively involved in research of security, privacy and identity management with emphasis on cryptographic protocols, formal methods, and also security infrastructure systems like PKI, AAA systems and intrusion detection systems.

Besides, research activities of the laboratory cover qualitative and quantitative modeling of human factor, aiming at development of solutions that support decision making for management of information systems, in particular security policies. The basis for these activities are system approaches.

Results include patented cryptographic protocols that provide security in environments with limited system resources like smart cards and RFIDs. In addition, we are developing simulation models to support management of information systems security, and technological solutions for trust management in global networks. Further, our research results are published in renowned international journals (like those published by Elsevier and IEEE), and in monographs published by Springer and IGI Global.

Besides being involved in national projects, current international collaboration includes projects with Norwegian Computing Centre NR, and collaboration in COST ECONOTEL.

RESEARCH PROJECTS

Advanced technologies for digital forensics, Bilateral Collaboration Project (BI-NO/07-09-0003), 2007?2009

Lightweight services for security, privacy and trust management, Basic Research and Application Project (J2-9649), 2007?2009

COST IS0605 - A Telecommunications Economics COST Network - Econ@Tel, International Project , 2007?2011

Laboratory Guest:

Prof. Dr. Leonid G. Kazovsky, University of Standford, U.S.A., <manjka cas obiska>, Scientific cooperation exchange.

Dr. Lothar Fritsch , Norsk Regnesentral, Norway, <manjka cas obiska>, Collaboration on the *Advanced technologies for digital forensics project.*

Dr. Asmund Skomedal, Norsk Regnesentral, Norway, <manjka cas obiska>, *Collaboration on the Advanced technologies for digital forensics project.*

Dr. Habtamu Abie, Norsk Regnesentral, Norway, <manjka cas obiska>, *Collaboration on the Advanced technologies for digital forensics project.*

INVITED TALKS

Managing Trust in Services Oriented Architectures (plenarno predavanje), The 8th WSEAS International Conference on APPLIED INFORMATICS AND COMMUNICATIONS (AIC'08), 20. – 22. Avgust 2008, Rodos.

»DRM Technologies & Standards«, Smart Event '06 / Smart University '06, 19. – 22. september 2006, Sophia Antiplois.

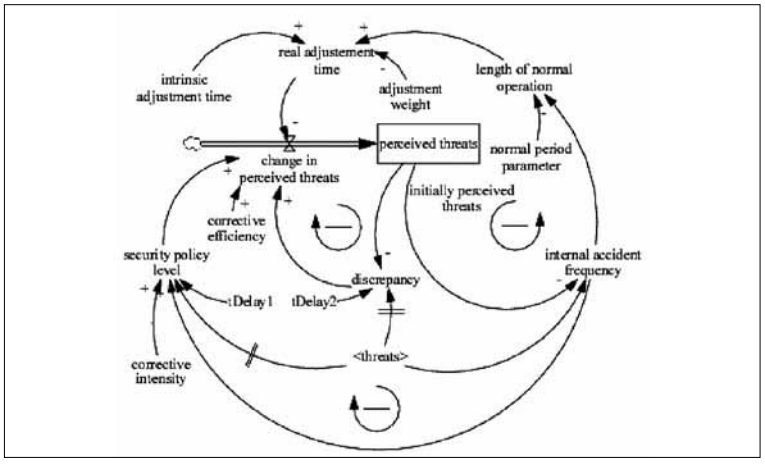
SELECTED PUBLICATIONS

TRČEK, Denis, TROBEC, Roman, PAVEŠIĆ, Nikola, TASIČ, Jurij F. Information systems security and human behaviour. Behav. inf. Technol.. [Print ed.], 2007, vol. 26, št. 2, str. 113-118. [COBISS.SI-ID 19789607]

TRČEK, Denis. A formal apparatus for modeling trust in computing environments. Math. comput. model.. [Print ed.], 2008, str. [1-8], ilustr. http://www.sciencedirect.com/science_ob=ArticleListURL&_method=list&_ArticleListID=764611250&_sort=d&view=c&_acct=C000033658&_version=1&_urlVersion=0&_userid=477686&md5=9e6eb3c158f3db9da10323bdcfd1877e. [COBISS.SI-ID 6557012]

TRČEK, Denis. Using system dynamics for managing risks in information systems. WSEAS transactions on information science and applications, Feb. 2008, vol. 5, no. 2, str. 175-180, ilustr. [COBISS.SI-ID 6489940]

TRČEK, Denis, KOVAČ, Damjan. Formal apparatus for measurement of lightweight protocols. Comput. stand. interfaces. [Print ed.], Feb. 2009, vol. 31, no. 2, str. 305-308, ilustr. [COBISS.SI-ID 2557399]



Modelling IS security with emphasis on human behaviour (system dynamics model)

Laboratory for Algorithms and Data Structures

Head: Professor Dr. Borut Robič

Fax: (+386 1) 426 4647

Phone: (+386 1) 4768 + ext.

WWW: http://www.fri.uni-lj.si/lads/

Staff	E-mail	Ext.
Professor **Dr. Borut Robič**	borut.robic@fri.uni-lj.si	867
Assist. Prof. **Dr. Boštjan Slivnik**	bostjan.slivnik@fri.uni-lj.si	363
Assist. Prof. **Dr. Tomaž Dobravec**	tomaz.dobravec@fri.uni-lj.si	364
Teaching Assistant **Dr. Jurij Mihelič**	jurij.mihelic@fri.uni-lj.si	819
Teaching Assistant **Dr. Uroš Čibej**	uros.cibej@fri.uni-lj.si	837
Retired Professor **Dr. Boštjan Vilfan**	bostjanv@alum.mit.edu	391
Young Researcher **Mitja Bezenšek**	mitja.bezensek@fri.uni-lj.si	364

RESEARCH ACTIVITIES

Staff members perform research in the areas of approximation and randomized algorithms, algorithms for problems in combinatorial optimization (routing, covering, and location problems, flexibility in optimization problems), parallel computation (mapping and scheduling, algorithms in parallel systems), grid computing (data replication on Data Grids, P2P-based distributed search), compiler design (parsing methods and attribute grammars), linear algebra (matrix multiplication), and operating systems design. As of 2006, the Laboratory is a member of the PlanetLab, an open platform for developing, deploying, and accessing planetary-scale services.

RESEARCH PROJECTS

MetaService – Semantic coupling of GRID Services (V2 0215) jointly with Jozef Stefan Institute and the company XLAB, Ltd., funded by the Ministry of Higher Education, Science and Technology, and Slovenian Research Agency (2006-2008).

Computational GRID Technologies for more efficient usage of computer resources in companies (V2 0214) jointly with Jozef Stefan Institute and the company XLAB, Ltd., funded by the Ministry of Higher Education, Science and Technology, and Slovenian Research Agency (2006-2008).

Crisis Managment Simulator (M2-0217), Slovene Government-Founded R&D Project (2007–2009).

SELECTED PUBLICATIONS

J. Mihelič, B. Robič. Flexible-attribute problems. *Computational Optimization and Applications* (accepted for publ.)

T. Dobravec, B. Robič: Restricted shortest paths in 2-circulant graphs, *Computer Communications* (accepted for publ.)

A. Sulistio, Čibej, S. Venugopal, R. Buyya, B. Robič. A toolkit for modelling and simulating Data Grids: An extension to GridSim, *Concurrency and Computation: Practice and Experience*, 20(13):1591-1609, 2008.

R. Trobec, M. Šterk, B. Robič. Computational complexity of the parallel meshless local Petrov-Galerkin method. *Computers and Structures* 87(1,2):81-90,2008.

B. Robič, P. Korošec, J. Šilc. Ant colonies and the mesh partitioning problem. In Olariu S, Zomaya Y.A. *Handbook of bioinspired algorithms and applications* .p. 285-319, Chapman &Hall / CRC, 2006.

U. Čibej, B. Slivnik, B. Robič. The complexity of static data replication in data grids. *Parallel Computing* 31:900-912, 2005.

B. Slivnik, B. Vilfan. Producing the left parse during bottom-up pasing. *Information Processing Letters* 96: 220-224, 2005.

J. Mihelič, B. Robič. Solving the k-center problem efficiently with a dominating set algorithm. *Journal of Computing and Information Technology* 13(3):225-233, 2005.

P.Korošec, J. Šilc, B. Robič. Solving the mesh-partitioning problem with an ant-colony algorithm. *Parallel Computing* 30(5-6):785-801, 2004.

T. Ungerer, B. Robič, J. Šilc. A survey of processors with explicit multithreading. *ACM Comp Surveys* 35(1):29–63,2003.

Laboratory for Architecture and Signal Processing

Head: Professor Dr. Dušan M. Kodek

Fax: (+386 1) 426 4647

Phone: (+386 1) 4768 + ext.

WWW: http://www.fri.uni-lj.si/lasp/

Staff	E-mail	Ext.
Professor **Dr. Dušan M. Kodek**	duke@fri.uni-lj.si	392
Lecturer **Igor Škraba, M.Sc.**	igor.skraba@fri.uni-lj.si	374
Assistant **Dr. Robert Rozman**	robert.rozman@fri.uni-lj.si	788
Assistant **Dr. Andrej Štrancar**	andrej.strancar@fri.uni-lj.si	788
Assistant **Damjan Šonc, M.Sc.**	damjan.sonc@fri.uni-lj.si	788
Assistant **Andraž Božiček**	andraz.bozicek@fri.uni-lj.si	374
Technical Assistant **Zvonimir Petkovšek**	zvonimir.petkovsek@fri.uni-lj.si	374

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 was developed during the course of this work. Various applications of DSP processors are studied and implemented. Among them is a low-cost DSP processor based spectrum and vibration analyzer that is now in production.

3. In Speech Processing: Speech recognition over telephone lines. Trainable high quality speech synthesis. Considerable experience from collaboration in 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 and dynamically adjusted window length was tested and implemented.

RESEARCH PROJECTS

Intrinsically safe control unit for measurements in hazardous areas. Project for TEVE Varnost Elektronika d.d., Contract 4-25/2006 (2006-2008).

ARM9 microcomputer system - education tool for computer science students. Joint project with Asyst Electronic Ltd. (2007-2009).

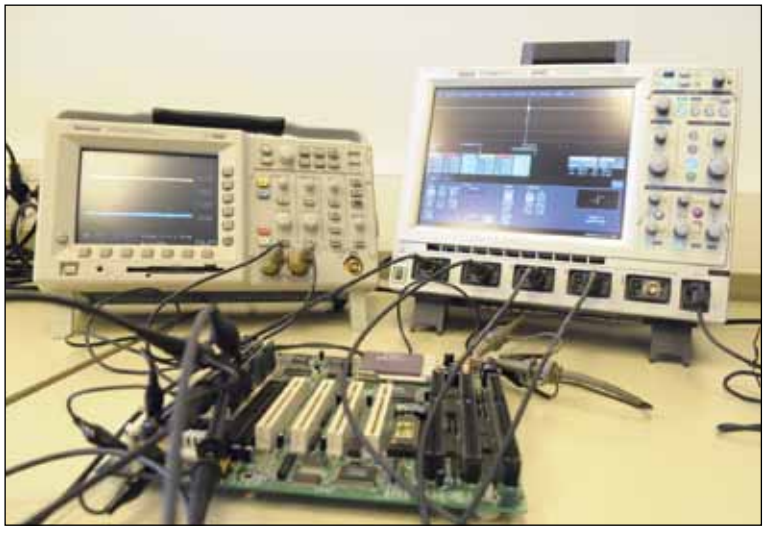
SELECTED PUBLICATIONS

R. Rozman, D. M. Kodek. Using asymmetric windows in automatic speech recognition. *Speech Communication*, vol. 49, no. 4, pp. 268-276, Apr. 2007.

D. M. Kodek and M. Krisper. Telescopic rounding for suboptimal finite wordlength FIR digital filter design. *Digital Signal Processing,* vol. 15, no. 6, pp. 522-535, Nov. 2005.

D. M. Kodek. Performance limit of finite wordlength FIR digital filters. *IEEE Transactions on Signal Processing*, vol. 53, no. 7, pp. 2462-2469, Jul. 2005.

D. M. Kodek and M. Krisper. Optimal algorithm for minimizing production cycle time of a printed circuit board assembly line. *International Journal of Production Research*, vol. 42, no. 23, pp. 5031-5048, Dec. 2004.



Equipment for measuring high frequency signals in modern PCs.

D. Šonc. A version of the byte radix sort algorithm suitable for the implementation in hardware. *Proc. of Eurocon 2003 International Conference on Computer as a Tool,*, Ljubljana, Slovenia, vol. 2, pp. 66-69, Sep. 22-24, 2003.

R. Rozman and D. M. Kodek. Improving speech recognition robustness using non-standard windows. *Proc. of Eurocon 2003 International Conference on Computer as a Tool,*, Ljubljana, Slovenia, vol. 2, pp. 171-174, Sep. 22-24, 2003.

A. Štrancar, R. Rozman, D. M. Kodek. Parametrizacija govornega signala z dinamičnim določanjem dolžine okna. *Proc. of ERK 2003 Conference*, Portorož, Slovenia, pp. 481-484, Sep. 25-26, 2003.

D. M. Kodek and M. Krisper. An algorithm for computing the optimal cycle time of a printed circuit board assembly line. *Informatica (Ljublj.)*, vol. 27, no. 1, pp. 105-114, Apr. 2003.

R. Rozman, A. Štrancar, D. M. Kodek. Uporaba načela "deli in vladaj" v sistemih za razpoznavanje govora. *Proc. of ERK 2002 Conference*, Portorož, Slovenia, vol. B, pp. 239-242, Sep. 23-25, 2002.

D. M. Kodek. An approximation error lower bound for integer polynomial minimax approximation. *Electrotechnical Review,* vol.69 , pp. 266-272, 2002.

D. M. Kodek. Design of optimal finite wordlength FIR digital filters. *Proceedings of the 1999 European Conference on Circuit Theory and Design ECCTD'99,* vol.1, pp. 401-404, Stresa, Italy, 1999.

D. M. Kodek. Limits of finite wordlength FIR digital filter design. *Proceedings of the 1997 IEEE International Conference on Acoustics, Speech, and Signal Processing ICASSP 97,* pp. 2149-2152, Munich, 1997.

D. M. Kodek. Conditions for the existence of fast number theoretic transforms. *IEEE Transactions on Computers,* C-30, pp. 359-361, 1981.

D. M. Kodek and K. Steiglitz. Comparison of optimal and local search methods for designing finite word length FIR digital filters. *IEEE Transactions on Circuits and Systems,* CAS-28, pp. 28-32, 1981.

D. M. Kodek. Design of optimal finite wordlength FIR digital filters using integer programming techniques. *IEEE Trans. on Acoustics Speech and Signal Processing*, vol. ASSP-28, no. 3, pp. 304-308, June 1980.

Software Engineering Laboratory

Head: Associate Professor Dr. Viljan Mahnič

Fax: (+386 1) 426 4647

Phone: (+386 1) 4768 + ext.

WWW: http://www.fri.uni-lj.si/sel/

Staff	E-mail	Ext.
Associate Professor Dr. **Viljan Mahnič**	viljan.mahnic@fri.uni-lj.si	447
Senior Lecturer **Dr. Igor Rožanc**	igor.rozanc@fri.uni-lj.si	366
Teaching Assistant **Marko Poženel, M.Sc.**	marko.pozenel@fri.uni-lj.si	365
Teaching Assistant **Luka Fürst, M. Sc.**	luka.fuerst@fri.uni-lj.si	365
External Collaborator **Nataša Žabkar, M.Sc.**	nzabkar@gmail.com phone: (+386 1) 4762 744	
External Collaborator **Rok Preskar**	rok.preskar@hermes-softlab.com phone: (+386 1) 5865 200	

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 Model-Driven Software Development, Software Quality Management, Software Metrics, Information Systems Development, Information Systems Audit and Control, and Data Warehousing. 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:

1. In Model-Driven Software Development: the use of graph transformations and grammars for solving relevant problems in the area of domain-specific visual programming and modeling languages.

2. In Software Quality Management: Comparative studies of different software quality models (CMMI, ISO 9000 family of standards, SPICE, Bootstrap etc.). Adaptation of CMMI to the needs of small organizations. Personal and Team Software Process.

3. In Software Metrics: Different approaches to software measurements (e.g. GQM, bottom-up). Measuring performance of agile software development methods. Definition of appropriate metrics for the development of applications in a database environment.

4. 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.

5. 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.

RESEARCH PROJECTS

E-student: Web-based student records information system covering enrolment, examination records, degree records, and various statistical surveys. University of Ljubljana, partly supported by the Slovenian Ministry of Information Society (2001-2008).

SELECTED PUBLICATIONS

V. Mahnič, N. Žabkar. Using COBIT Indicators for Measuring Scrum-based Software Development. WSEAS Transactions on Computers, 2008, vol. 7, no. 10, pp. 1605-1617.

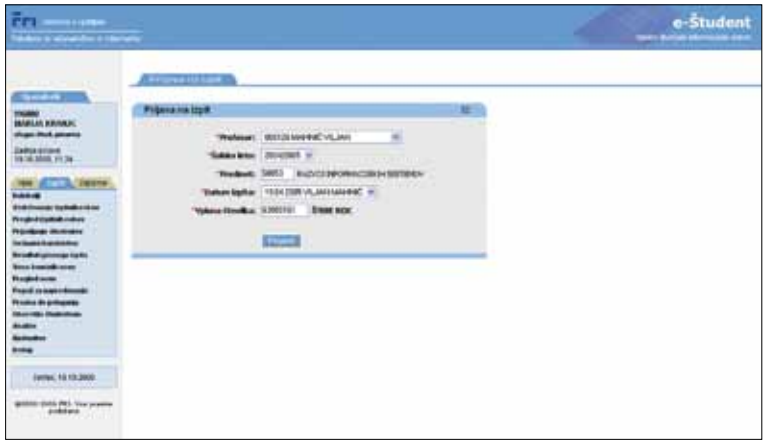
L. Fürst, S. Fidler, A. Leonardis. Selecting features for object detection using an AdaBoost-compatible evaluation function. *Pattern recogn. lett.* (Print), 2008, vol. 29, no. 11, pp. 1603-1612.

V. Mahnič. Teaching information system technology in partnership with IT companies. *Organizacija (Kranj)*, 2008, vol. 41, no. 2, pp. 71-78.

V. Mahnič, I. Vrana. Using stakeholder-driven process performance measurement for monitoring the performance of a Scrum-based software development process. *Elektrotechnical review*, 2007, vol. 74, št. 5, pp. 241-247.

V. Mahnič, N. Žabkar. Introducing CMMI measurement and analysis practices into scrum-based software development process. *International journal of mathematics and computers in simulation*, 2007, vol. 1, no. 1, pp. 65-72, http://www.naun.org/journals/mcs/mcs-11.pdf.

V. Mahnič, B. Grum. An undergraduate course in information systems technology at the University of Ljubljana in partnership with IBM. V: PUDLOWSKI, Zenon J. (ur.). *Reinforcing partnerships in engineering education : conference proceedings*, (Monash engineering education series). Melbourne: Faculty of Engineering, Monash University, cop. 2007, pp. 185-188.



e-Študent: web-based student records information system

M. Poženel, V. Mahnič. Data Webhouse: A tool for monitoring the use of a Web based information system. *Proceedings of the 13th International Conference of European University Information Systems, EUNIS 2007, 26-29 June 2007, Grenoble, France.*

V. Mahnič, S. Drnovšček. Introducing agile methods in the development of university information systems. In: LILLEMAA, Tiia (ur.). *Proceedings of the 12th International Conference of European University Information Systems, EUNIS 2006, 28-30 June 2006, Tartu, Estonia*. Tartu: University of Tartu, pp. 61-68, 2006.

G. Krajnc, V. Mahnič. Pair programming in high schools. *Organizacija*, 39(8): 539-545, 2006.

M. Ferle, V. Mahnič. Real-time streaming ETL. *Uporabna informatika*, 14(1): 5-14, 2006.

I. Rožanc, V. Mahnič. Teaching software quality with emphasis on PSP. *Organizacija*, 38(8): 454 -464, 2005.

V. Mahnič, M. Poženel. The role of data warehousing in university information systems. *Proc.University Information Systems UNINFOS 2005*, pp. 454 -464, 2005.

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

V. Mahnič. Analyzing educational process through a chain of data marts. *Informatica,* 27(3): 305-311, 2003.

Computer Vision Laboratory

Head: Professor Dr. Franc Solina

Fax: (+386 1) 426 4647

Phone: (+386 1) 4768 + ext.

WWW: http://www.fri.uni-lj.si/cvl/

Staff	E-mail	Ext.
Professor **Dr. Franc Solina**	franc.solina@fri.uni-lj.si	389
Assistant Professor **Dr. Aleš Jaklič**	ales.jaklic@fri.uni-lj.si	878
Assistant Professor **Dr. Bojan Kverh**	bojan.kverh@fri.uni-lj.si	878
Assistant Professor **Dr. Peter Peer**	peter.peer@fri.uni-lj.si	878
Assistant **Dr. Borut Batagelj**	borut.batagelj@fri.uni-lj.si	878
Assistant **Dr. Matjaž Jogan**	matjaz.jogan@fri.uni-lj.si	878
Assistant **Dr. Luka Šajn**	luka.sajn@fri.uni-lj.si	878
Technical Assistent **Miha Peternel, M. Sc.**	miha.peternel@fri.uni-lj.si	878
Research Assistant **Tadej Zupančič, B.Sc.**	tadej.zupancic@fri.uni-lj.si	878

RESEARCH ACTIVITIES

The laboratory is involved in basic research in computer vision, trying to extract as much information from pictorial material as possible, with emphasis on object segmentation, recognition and tracking, face detection, face and iris recognition, panoramic imaging, texture processing, range image interpretation, real-time and multimedia applications.

Analysis and tracking of objects in video sequences is applied to studies of human locomotion, roulette gaming instruments and golf. Superquadric models are also used for object tracking in sequences of intensity images.

Biometry is an important research field for us. For human face detection and recognition in difficult illumination conditions, we study the use of skin colour and appearance and fusion of different techniques. Lately we are also interested in use of such techniques in smart advertising, digital signage. In 2008 we also implemented our first test system for iris recognition.

We generate panoramic images in different ways and for different purposes: for depth reconstruction, for mobile robot navigation, for designing efficient user interfaces, for visual surveillance applications.

Possible applications of range image interpretation include automatic creation of CAD models for reverse engineering applications, creation of models for virtual reality applications, and part-based object recognition.

Real-time quality control of products in the production line is another area of research.

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.

Use of unconventional user interfaces based on computer vision in computer games is also of our interest. In 2008 we established a GameTeam within the laboratory with a number of student members working on projects like 3D Maze, Bubbles and Virtual Painter.

From the applicative point of view we are especially interested in biometry systems, image based computer forensic, gaming systems, quality control of products, surveillance applications and smart advertising.

More details about the research and development done in the laboratory are given in the following sections, especially in the Research Projects section and Selected Publications section.

RESEARCH PROJECTS

Computer vision (P2-0214), Basic Research programme funded by the Slovenian Research Agency (2004–2008).

Artificial intelligence and intelligent systems (P2-0209), Basic Research programme funded by the Slovenian Research Agency (2004–2008)

Leonardo EU-NZ (CPT-CPTNZ 1003), multi-national exploration in interaction design education and research, pilot program in cooperation between EU and New Zealand (2004–2008).

Machine Learning of Probabilities with Applications to Web Portals and Medical Diagnostics (BI-PT/06-07-004), Bilateral Collaboration Project (2006–2008)

Lotery On-line, Industry-Founded Project, Loterija SLovenije, d.d. (2003–2008).

PokerTable, Industry-Founded Project, Počkaj, d.o.o. (Alfastreet) (2008)

Search of corresponding points for image mosaicing in the StitchThem project

StitchThem, Industry-Founded Project, 3Ditize, S.L. (2008)

SloPOI, Application Project, Ministry of Higher Education, Science and Technology of the Republic of Slovenia in cooperation with PROSPLET, d.o.o., and Association for development of human abilities (2008)

LABORATORY GUESTS

Simon Lam, Department of Computer Science, University of Waikato, Hamilton, New Zealand, 29.1.–28.04.2008, Collaboration on project Leonardo EU-NZ (CPT-CPTNZ 1003).

Erika Sklenars, Wanganui School of Design, Computer Graphic Design, Wanganui, New Zealand, 10.3.–7.6.2008, Collaboration on project Leonardo EU-NZ (CPT-CPTNZ 1003).

Ngaire Ackerly, University of Waikato, Computer Graphic Design, Hamilton, New Zealand, 23.6.–5.7.2008, Collaboration on project Leonardo EU-NZ (CPT-CPTNZ 1003).

Amanda Lui, University of Waikato, Computer Graphic Design, Hamilton, New Zealand, 23.6.–5.7.2008, Collaboration on project Leonardo EU-NZ (CPT-CPTNZ 1003).

Mohamad Obaid, Canterbury University, HIT Lab New Zealand, Christchurch, New Zealand, 5.7.– 13.7.2008, Collaboration on project Leonardo EU-NZ (CPT-CPTNZ 1003).

Dr. Phillip McKerrow, School of Computer Science and Software Engineering, University of Wollongong, Australia, 1.10.–30.10.2008, invited lecture: "Mimicking the navigation of bats with echolocation", student seminars on multimedia and robotics.

INVITED TALKS AND LECTURES

Peter Peer: Science & art hand in hand @ CVL, 19.-22.7.2008, keynote talk at the International Conference on Advances in the Internet, Processing, Systems, and Interdisciplinary Research, Genoa, Italy.

Having fun in front of the "15 seconds of fame" installation

Franc Solina: ArtNetLab – a collaboration of computer scientists and artists, 23.-24.4.2008, an invited talk at the Academy of Fine Arts, University of Zagreb, Croatia.

SELECTED PUBLICATIONS

L. Šajn, I. Kononenko. Multiresolution image parameterization for improving texture classification. EURASIP Journal on Advances in Signal Processing, 2008(1): 1-12, 2008.

P. Peer and L. G. Corzo. Local Pixel Value Collection Algorithm for Spot Segmentation in Two-Dimensional Gel Electrophoresis Research. Comparative and Functional Genomics, 7(1): 77-85, 2007.

P. Peer and F. Solina. Where physically is the optical center? Pattern recognition letters, 27(10): 1117-1121, 2006.

L. G. Corzo, J. A. Penaranda, P. Peer. Estimation of a fluorescent lamp spectral distribution for color image in machine vision. Machine Vision and Applications, 16(5):306–311, 2005.

F. Solina. 15 sekund slave in virtualno smučanje / 15 Seconds of Fame and Virtual Skiing. Exhibition Catalogue. ArtNetLab, Ljubljana, 2005.

F. Solina. 15 seconds of fame. Leonardo, 37(2):105–110+125, 2004.

J. Krivic, F. Solina. Part-level object recognition using superquadrics. Computer Vision and Image Understanding, 95(2):105–126, 2004.

A. Jaklič, F. Solina. Moments of Superellipsoids and their Application to Range Image Registration. IEEE Transactions on Society, Man and Cybernetics-Part B: Cybernetics, 33(4):648–657, 2003.

P. Peer and F. Solina. Panoramic depth imaging: Single standard camera approach. International Journal of Computer Vision, 47(1/2/3):149–160, 2002.

A. Jaklič, A. Leonardis and F. Solina. Segmentation and Recovery of Superquadrics. Volume 20 of Computational Imaging and Vision. Kluwer, Dordrecth, 2000.

A. Leonardis, F. Solina and R. Bajcsy, editors. Confluence of Computer Vision and Computer Graphics. Volume 84 of NATO Science Series 3. High Technology. Kluwer, Dordrecth, 2000.

B. Prihavec and F. Solina. User interface for video observation over the internet. Journal of Network and Computer Applications, (21):219–237, 1998.

F. Solina and A. Leonardis. Proper scale for modeling visual data. Image and Vision Computing Journal, 16:89–98, 1998.

A. Leonardis, A. Jaklič, and F. Solina. Superquadrics for segmentation and modeling range data. IEEE Transactions on Pattern Recognition and Machine Intelligence, 19(11):1289–1295, November 1997.

F. Solina and R. Bajcsy. Recovery of parametric models from range images: The case for superquadrics with global deformations. IEEE Transactions on Pattern Analysis and Machine Intelligence, 12(2):131–147, 1990.

Visual Cognitive Systems Laboratory

Head: Professor Dr. Aleš Leonardis

Fax: (+386 1) 426 4647

Phone: (+386 1) 4768 + ext.

WWW: http://www.fri.uni-lj.si/vicos/

Staff	E-mail	Ext.
Professor **Dr. Aleš Leonardis**	ales.leonardis@fri.uni-lj.si	868
Assistant Professor **Dr. Danijel Skočaj**	danijel.skocaj@fri.uni-lj.si	189
Assistant **Dr. Matjaž Jogan** *	matjaz.jogan@fri.uni-lj.si	878
Postdoctoral Researcher **Dr. Ondrej Drbohlav**	ondrej.drbohlav@fri.uni-lj.si	189
Postdoctoral Researcher **Dr. Roland Perko**	roland.perko@fri.uni-lj.si	360
Postdoctoral Researcher **Dr. Peter Rulić**	peter.rulic@fri.uni-lj.si	769
Researcher **Dr. Marko Boben** **	marko.boben@fri.uni-lj.si	181
Researcher **Dr. Matej Kristan**	matej.kristan@fri.uni-lj.si	189
Research Assistant **Barry Ridge, M.Sc.**	barry.ridge@fri.uni-lj.si	189
Researcher **Sanja Fidler** **	sanja.fidler@fri.uni-lj.si	181
Research **Assistant Aleš Štimec**	ales.stimec@fri.uni-lj.si	769
Researcher **Dušan Omerčević**	dusan.omercevic@fri.uni-lj.si	360
Researcher **Alen Vrečko**	alen.vrecko@fri.uni-lj.si	769
Researcher **Marko Mahnič**	marko.mahnic@fri.uni-lj.si	769
Research Assistant **Luka Čehovin**	luka.cehovin@fri.uni-lj.si	189

* also with Computer Vision Laboratory

** also with Laboratory for Mathematical Methods in Computer and Information Science

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. Examples include mobile robots, intelligent environments, mobile computing devices, intelligent transportation systems, cognitive assistants, etc. The Visual Cognitive Systems Laboratory is involved in basic research of such systems, with emphasis on visual learning, recognition and categorisation. 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 visually enabled agent and its environment. This requires a vast effort in a multidisciplinary understanding of cognitive processes, involving studies in cognitive psychology, neuroscience, and linguistics.

In the past, our research in the area of visual learning and recognition has primarily focused on subspace methods, 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 lifelong visual learning.

Recently, continuous learning has become a major topic of our research; we have been developing a general framework for continuous learning of visual concepts by learning associations between automatically extracted visual features and words describing the scene. Our research has also shifted towards learning scalable representations suitable for recognition and detection of a large number of object categories. Within this framework, we developed an approach which learns a hierarchy of spatially flexible compositions in an unsupervised, statistics-driven manner. Applications include recognition of objects, scenes, and activities in visual cognitive tasks, such as surveillance and cognitive assistants. In mobile computing, we are developing methods that use visual context and geo-referenced intelligent maps for smart vision-based positioning, and for direct camera based interaction with objects in urban environments.

Our theoretical findings on visual learning and recognition are often grounded in a scenario of spatial orientation of mobile robots (specifically, we use in-door and out-door iRobot mobile platforms equipped with omnidirectional and stereo camera set-ups), which represent a target system 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. We are also implementing direct interaction and object

An artificial cognitive system learning object affordances

manipulation with a Katana HD6M light weighted robot arm with the aim of developing methods for robust and adaptive interaction of the robot with its environment that would enable studying object affordances. Such cognitive agents will ultimately be able to perceive and understand their environment through interaction, to categorise and recognise objects and subjects around them as well as actions they are performing, and will be able to communicate with humans and other agents on a semantic level.

Research in the area of range image interpretation includes range image acquisition (using a structured light range scanner), 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.

RESEARCH PROJECTS

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

COSY - Cognitive Systems for Cognitive Assistants (IST-2002-2.3.2.4 FP6-004250-IP). FP6 IST Programme Project, European Commission (2004-2008).

MOBVIS - Vision Technologies and Intelligent Maps for Mobile Attentive Interfaces in Urban Scenarios (IST-2002-2.3.4.1, FP6-511051-STREP), FP6 IST Programme Project, European Commission (2005-2008).

VISIONTRAIN - Computational and Cognitive Vision Systems: A Training European Network (MRTN-CT-2004-005439, FP6-2002-Mobility-1). FP6 IST Programme Project, European Commission (2005-2009).

Mobile robot localisation using panoramic images, A Slovenian-Czech Intergovernmental Science and Technology Cooperation Project, Slovene Research Agency (2007-2008).

POETICON - The Poetics of Everyday Life: Grounding Resources and Mechanisms for Artificial Agents (FP7-ICT-215843-POETICON). FP7 ICT Programme Project, European Commision (2008-2010).

COGX - Cognitive Systems that Self-Understand and Self-Extend (ICT – 215181) FP7 ICT Programme Project, European Commission (2008-2012).

LABORATORY GUESTS

Alireza Tavakoli Targhi, CVAP, KTH, Stockholm, 7.2. - 7.2. 2008, Collaboration on the MOBVIS project, lecture on Texture Classification with Minimal Training Images.

Luciano Fadiga, University of Ferrara, 25.7. 2008, collaboration on the POETICON project.

Jan Heller, Czech Technical University, Prague, 2.11. - 30.11. 2008, Collaboration on the Slovenian-Czech Intergovernmental Science and Technology Cooperation Project.

Prof. Dr. Jan-Olof Ekhlund, CVAP, KTH, Stockholm, 19. 11. 2008 Invited lecture: Computer Vision and Seeing.

RESEARCH VISITS

Alen Vrečko, Peter Rulić: School of Computer Science, University of Birmingham, UK, 5.2.–9.2.2008. Collaboration on CoSy project; integration of the vision subsystem.

Matjaž Jogan: Czech Technical University, Prague, 30.03. - 28.04. 2008, Collaboration on the Slovenian-Czech Intergovernmental Science and Technology Cooperation Project.

Alen Vrečko, Peter Rulić: School of Computer Science, University of Birmingham, UK, 18.8.–23.8.2008. Collaboration on CoSy project; integration of different modules of the CoSy system.

Danijel Skočaj, Alen Vrečko, Peter Rulić: School of Computer Science, University of Birmingham, UK, 5.9.–12.9.2008. Collaboration on CoSy project; integration of different modules of the CoSy system.

Danijel Skočaj: Deutsches Forschungszentrum für Künstlishce Intelligenz, Saarbrücken, Germany, 10.11.-13.11.2008. Collaboration on CogX project; specification of scenarios.

Danijel Skočaj, Alen Vrečko, Marko Mahnič: Department of Computer Science, Alfred Ludvig University of Freiburg, Germany, 1.12.-4.12.2008. Collaboration on CogX project; specification of requirements.

INVITED TALKS AND LECTURES

Matjaž Jogan: Object categorization with hierarchical matching, 22.04.2008, an invited lecture at the Czech Technical University, Prague, Czech Republic.

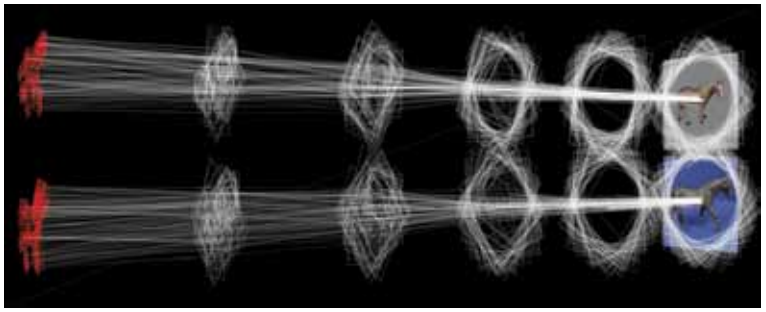
Aleš Leonardis: Learning hierarchical representations of object categories, 22.04.2008, an invited lecture at Max Planck Institute for Biological Cybernetics, Tuebingen, Germany.

Aleš Leonardis, Learning hierarchical representations of object categories, 13. 6. 2008, an invited talk at ECCV 2008 Area Chair Symposium, Marseille, France.

Aleš Leonardis, Learning Hierarchical Compositional Representations of Object Categories, 3. 7. 2008, an invited lecture at University of Freiburg, Autonomous Intelligent Systems, Freiburg, Germany.

Aleš Leonardis, Learning Hierarchical Compositional Representations of Object Categories, 4. 8. 2008, an invited talk at the 2008 Stockholm Workshop on Computational Vision, Rosenon, Stockholm archipelago, Sweden.

Aleš Leonardis, Learning Hierarchical Compositional Representations of Object Categories, 28. 8. 2008, an invited lecture at Graz University of Technology, Institute for Computer Graphics and Vision, Gradec, Austria.



Object categorization by hierarchical matching to a prototype

Aleš Leonardis, Hierarchically learned representations of object categories: From pixels towards semantic parts, 21. 9. 2008, an invited talk at Balkan Vision Science Meeting 2008, Ljubljana, Slovenia.

Danijel Skočaj: Integrated Continuous Interactive Cross-modal Learning - Continuous interactive learning of associations between low level modality-specific features and high level amodal concepts, 22.9.2008, an invited lecture at Institute for Computer Graphics and Vision, Technical University Graz, Austria.

Aleš Leonardis, Learning hierarchical compositional representations of object categories, 18. 10. 2008, an invited talk at ECCV 2008 Workshop on "Vision in Action: Efficient strategies for cognitive agents in complex environments", Marseille, France.

Aleš Leonardis, Learning Hierarchical Compositional Representations of Object Categories, 1. 12. 2008, an invited talk at the Workshop Cognitive Humanoid Vision, KAIST, Daejeon, Korea.

Aleš Leonardis, Learning Hierarchical Compositional Representations of Object Categories, 4. 12. 2008, an invited lecture at Sogang University, School of Media, Seoul, Korea.

Aleš Leonardis, Learning Hierarchical Compositional Representations of Object Categories, 5. 12. 2008, an invited lecture at Seoul National University (The Automation and Systems Research Institute), Seoul, Korea.

Aleš Leonardis, Learning Hierarchical Compositional Representations of Object Categories, 12. 12. 2008, an invited talk at the Workshop Audition, Vision, and their Interactions, INRIA Grenoble Rhone-Alpes, Grenoble, France.

AWARDS

Aleš Leonardis: Outstanding Reviewer Award, June 2008, IEEE Computer Society Conference on Computer Vision and Pattern Recognition, Anchorage, Alaska.

Sanja Fidler: Outstanding Reviewer Award, October 2008, The 10th European Conference on Computer Vision, Marseille, France.

SELECTED PUBLICATIONS

S. Fidler, M. Boben, A. Leonardis. Similarity-based cross-layered hierarchical representation for object categorization.In Proceedings of IEEE Conference on Computer Vision and Pattern Recognition 2008.

A. Lockerd Thomaz, G.J.M. Kruijff, H. Jacobssonn, and D. Skočaj (Editors). Interactive Robot Learning - RSS 2008 workshop. Zurich, Switzerland, June 2008.

B. Leibe, A. Leonardis and B. Schiele. Robust Object Detection with Interleaved Categorization and Segmentation. International Journal of Computer Vision, Special Issue on Learning for Recognition and Recognition for Learning, Vol. 77, no. 1-3, pp. 259-289, 2008.

A. Štimec, , M. Jogan, A. Leonardis. Unsupervised learning of a hierarchy of topological maps using omnidirectional images. International Journal on Pattern Recognition and Artificial Intelligence., Vol. 22, No. 4, pp. 639-665, 2008.

L. Fürst, S. Fidler, A. Leonardis. Selecting features for object detection using an AdaBoost-compatible evaluation function. Pattern Recognition Letters, Vol. 29, No. 11, pp. 1603-1612, 2008.

D. Skočaj and A. Leonardis. Incremental and robust learning of subspace representations. Image and Vision Computing, vol. 26, no. 1, pp. 27-38, 2008.

D. Skočaj, A. Leonardis, and H. Bischof. Weighted and robust learning of subspace representations. Pattern Recognition, vol. 40, no. 5, pp. 1556-1569, May 2007.

A. Leonardis, H. Bischof, and A. Pinz (Editors), 9th European Conference on Computer Vision - ECCV 2006, Proceedings, Parts I-IV, Series: Lecture Notes in Computer Science , Vols. 3951, 3952, 3953, 3954; Springer, 2006.

S. Fidler, D. Skočaj, and A. Leonardis, "Combining reconstructive and discriminative subspace methods for robust classification and regression by subsampling", IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 28, no. 3, pp. 337-350, March, 2006.

H. Bischof, H. Wildenauer, A. Leonardis. Illumination insensitive recognition using eigenspaces. ComputerVision and Image Understanding, Volume 95, no. 1, pp. 86-104, 2004.

M. Jogan, E. Žagar, A. Leonardis. Karhunen-Loeve expansion of a set of rotated templates. IEEE Transactions on image processing, 2003 , Vol 12, No 7, pp. 817– 825, 2003.

M. Jogan, A. Leonardis. Robust Localization using an Omnidirectional Appearance-based Subspace Model of Environment. Robotics and Autonomous Systems, Volume 45, Issue 1, pp. 51–72, Elsevier Science, 2003.

A. Leonardis, H. Bischof, and J. Maver. "Multiple Eigenspaces", Pattern Recognition, 35, no. 11, pp. 2613–2627, 2002. Twenty-Ninth Annual Pattern Recognition Society Award. Selected as the most original manuscript from all 2002 Pattern Recognition issues.

A. Leonardis and H. Bischof. Robust recognition using eigenimages. Computer Vision and Image Understanding, 78(1):99–118, 2000.

A. Jaklič, A. Leonardis and F. Solina. Segmentation and Recovery of Superquadrics, volume 20 of Computational imaging and vision. Kluwer, Dordrecth, 2000.

A. Leonardis and H. Bischof. An efficient MDL-based construction of RBF networks. Neural Networks, 11(5):963–973, July 1998.

H. Bischof and A. Leonardis. Finding optimal neural networks for land use classification. IEEE Transactions on Geoscience and Remote Sensing, 36(1):337–341, January 1998.

A. Leonardis, A. Jaklič, and F. Solina. Superquadrics for segmentation and modeling range data. IEEE Transactions on Pattern Recognition and Machine Intelligence, 19(11):1289–1295, November 1997.

R. Bajcsy, S. Wook Lee, and A. Leonardis. Detection of diffuse and specular interface reflections and inter-reflections by color image segmentation. International Journal of Computer Vision, 17(3):241–272, 1996.

A. Leonardis, A. Gupta, and R. Bajcsy. Segmentation of range images as the search for geometric parametric models. International Journal of Computer Vision, 14:253–277, 1995.

Artificial Intelligence Laboratory

Head: Professor Dr. Ivan Bratko

Fax: (+386 1) 426 4386

Phone: (+386 1) 4768 + ext.

WWW: http://www.fri.uni-lj.si/ailab

Staff	E-mail	Ext.
Professor **Dr. Ivan Bratko**	ivan.bratko@fri.uni-lj.si	393
Associate Professor **Dr. Blaž Zupan**	blaz.zupan@fri.uni-lj.si	402
Assistant Professor **Dr. Janez Demšar**	janez.demsar@fri.uni-lj.si	813
Lecturer **Aleksander Sadikov**	aleksander.sadikov@fri.uni-lj.si	987
Researcher **Gregor Leban**	gregor.leban@fri.uni-lj.si	933
Researcher **Tomaž Curk**	tomaz.curk@fri.uni-lj.si	267
Junior Researcher **Minca Mramor**	minca.mramor@fri.uni-lj.si	933
Junior Researcher **Lan Umek**	lan.umek@fri.uni-lj.si	933
Junior Researcher **Matej Guid**	matej.guid@fri.uni-lj.si	987
Researcher **Martin Možina**	martin.mozina@fri.uni-lj.si	154
Researcher **Jure Žabkar**	jure.zabkar@fri.uni-lj.si	154
Researcher **Damjan Kužnar**	damjan.kuznar@fri.uni-lj.si	987
Researcher **Marko Toplak**	marko.toplak@fri.uni-lj.si	933
Junior Researcher **Miha Štajdohar**	miha.stajdohar@fri.uni-lj.si	816
Junior researcher **Tadej Janež**	tadej.janez@fri.uni-lj.si	154
Researcher **Aljaž Košmerlj**	aljaz.kosmerlj@fri.uni-lj.si	154
Researcher **Lan Žagar**	lan.zagar@fri.uni-lj.si	815
Assistant **Jure Žbontar**	jure.zbontar@fri.uni-lj.si	816
Researcher **Gregor Rot**	gregor.rot@fri.uni-lj.si	815
Technical Assistant **Blaž Strle**	blaz.strle@fri.uni-lj.si	299

RESEARCH ACTIVITIES

The laboratory carries out research in machine learning, data mining, inductive logic programming, qualitative reasoning, and AI approaches to robotics, systems control, bioinformatics, and information visualization. Research results concern the learning from noisy structured (attribute-based) and semi-structured data for classification, regression and clustering, constructive induction and discovery of attribute interactions, combining logical and numerical learning. A notable aspect of much of this research is its application to problems in systems control, game playing and analysis, ecological modeling, reconstruction of human control skill, robotics, and applications of AI in mechanical engineering. Members of the laboratory are also engaged in research in the area of bioinformatics, in particular, in designing computational methods for knowledge discovery in functional genomics and bioinformatics, reconstruction of biological networks, and biomedical diagnosis and prognosis.

Our Research Program "Artificial Intelligence and Intelligent Systems", carried out in part by this laboratory, was in 2006 listed

among the best research programs funded by the Slovenian research agency ARRS. Also in 2006, a former member of this laboratory Aleks Jakulin, received the prestigious best European AI dissertation award, sponsored by ECCAI for his dissertation Attribute Interactions in Machine Learning. This was already the second dissertation award, after Dorian Šuc, received by PhD students who did their work in the Artificial Intelligence Laboratory. In 2007, Ivan Bratko received the national Zois award for outstanding scientific achievements. The members of the laboratory Blaž Zupan and Janez Demšar were elected by students as best professors in respective study programs in 2007/08, and Aleksander Sadikov as best assistant.

The laboratory is also the principal developer of a major open-source data mining package Orange (www.ailab.si/orange), which interfaces with Python and also has an attractive and easy-to-use visual programming interface. Besides being the core development and research tool for the lab, Orange gained its popularity as the principal Python-based data mining tool and has a substantial community of users world-wide. Another popular software product, also developed within the laboratory, is GenePath (www.genepath.org), known to be the only available software package which interactively support epistasis analysis for gene network reconstruction from mutant-based experimental data. Other notable and recent developments include software packages for chess tutoring, qualitative modelling, argument-based machine learning, and web-based visualization and analysis of whole-genome expression and sequence data sets.

RESEARCH PROJECTS

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

X-MEDIA - Large Scale Knowledge Sharing and Reuse Across Media (FP6-26978). FP6 IST Programme project, European Commission (2006-2010).

XPERO – Learning by Experimentation (IST-29427). FP6 IST Programme project, European Commission (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).

Artificial intelligence approaches to knowledge discovery in functional genomics (BI-IT/05-08-011), Slovene Research Agency's Slovene-Italian Bilateral Project (with University of Pavia) (2006-2009).

Knowledge technologies and decision support in health information portals (V2-0221), Slovene Government-Funded R&D Project (2006-2008).

Knowledge discovery and visualization methods for textual data (PROTEUS 07-08), Bilateral Collaboration Project, funded by Slovenian Research Agency (2007–2008).

Computational Phenomics (J2-9699), Basic Research and Application Project funded by the Slovenian Research Agency (2007–2009).

Preventive effects of antioxidants on development of hyperlipidemia and atherosclerosis in the animal model of obesity (V3-0365), Slovene Government-Funded R&D Project (2006-2008).

LABORATORY GUESTS

Prof. Dr. Luis Pineda, UNAM University (Universidada National de Mexico), Mexico City. 4.10 – 6.10.2008. Research visit and seminar.

Prof. Dr. Erwin Prassler and Timo Henne, BRS Univ., Bonn. 23 – 25. 7. 2008. Collaboration in XPERO project.

Prof. Dr. Katsuhiko Nakamura, Tokyo Denki University. 11-13. 12.2008. Research visit and seminar.

Ashok Mohan, BRS Univ., Bonn. 1.3. – 15.5.2008. Collaboration in XPERO project.

RESEARCH VISITS

T. Curk: Baylor College of Medicine, Houston, USA, 9.1. – 18.1.2008, Research in predicting segregation of D. discoideum strains from sequence.

T. Curk: Baylor College of Medicine, Houston, USA, 7.6. – 16.6.2008, Analysis of gene expression by RNA sequencing.

B. Zupan: University of Pavia, Italy. 1.10 – 31.12.2008. Research in bioinformatics.

INVITED TALKS AND LECTURES

I. Bratko. An assessment of machine learning methods for robotic discovery. ITI'08 Conf., Dubrovnik, 24. 6. 2008

I. Bratko. Computer analysis of Chess Champions. Introductory talk at J. Stefan Days, Ljubljana, 25. 3. 2008.

I. Bratko. Computer Analysis of Chess Champions, *Conf. 10th Ann.*

Submersible with intelligent and adaptive buoyancy and stability control

Postgraduate Studies in Computer Sc. INAOE (Instituto Nacional de Astrofisica, Optica y Electronica), Tonantzintla, Puebla, 10. 4. 2008.

I. Bratko. Experiments in robot discovery in XPERO. IIMAS, Universidad Nacional de Mexico, Mexico City, 11. 4. 2008.

M. Možina. Integration of Machine Learning and Argumentation. University of Luxembourg, 10.4.2008.

SELECTED PUBLICATIONS

B. Zupan, J. Demšar. Open-source tools for data mining. *Clin. lab. med.* 28(1): 37-54, 2008.

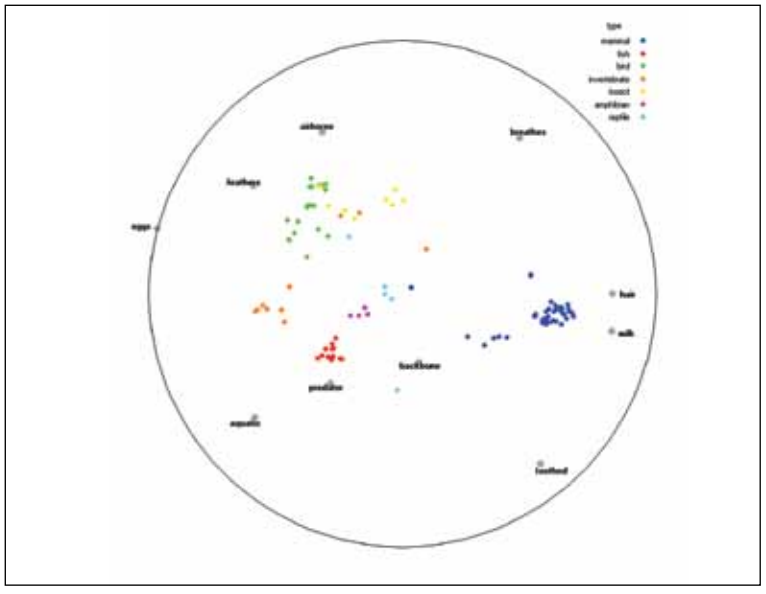
M. Guid, A. Perez, I. Bratko. How trustworthy is Crafty's analysis of world chess champions, *ICGA Journal* 31(3):131-144, 2008.

R. Golouh, T. Čufer, A. Sadikov, P. Nussdorfer. The prognostic value of Stathmin-1, S100A2, and SYK proteins in ER-positive primary breast cancer patients treated with adjuvant tamoxifen monotherapy: an immunohistochemical study. *Breast Cancer Research and Treatment* 110(2): 317-326, 2008.

M. Možina, M. Guid, J. Krivec, A. Sadikov, I. Bratko. Fighting knowledge acquisition bottleneck with argument based machine learning. *Proceedings of the Eighteenth European Conference on Artificial Intelligence (ECAI 2008)*, pp. 234-238, 2008.

A. Sadikov, I. Bratko. LRTA* works much better with pessimistic heuristics. *Proceedings of the Eighteenth European Conference on Artificial Intelligence (ECAI 2008)*, pp. 897-898, 2008.

M. Možina, J. Žabkar, I. Bratko. Argument based machine learning. *Artificial Intelligence Journal* 171(10): 922-937, 2007.



FreeViz - an intelligent visualization approach for class-labeled multidimensional data sets

M. Mramor, G. Leban, J. Demšar, B. Zupan. Visualization-based cancer microarray data classification analysis. *Bioinformatics* 23(16): 2147-2154, 2007.

R. Bellazzi, B. Zupan. Towards knowledge-based gene expression data mining. *Journal of Biomedical Informatics* 40(6): 787-802, 2007.

M. Luštrek, M. Gams, I. Bratko. Is real-valued minimax pathological? *Artificial Intelligence* 170: 620-642, 2006.

M. Guid, I. Bratko. Computer analysis of world chess champions. *ICGA Journal* 29(2): 65-73, 2006.

D. Vladušič, D. Šuc, I. Bratko, W. Rulka. Q2 learning and its application to car modeling. *Applied Artificial Intelligence* 20(8): 675-701, 2006.

A. Sadikov, I. Bratko. Learning long-term chess strategies from databases. *Machine Learning* 63(3): 329-340, 2006.

J. Demšar. Statistical comparisons of classifiers over multiple data sets. *Journal of Machine Learning Research* 7: 1-30, 2006.

J. Žabkar, R. Žabkar, D. Vladušič, D. Čemas, D. Šuc, I. Bratko. Q^2 Prediction of ozone concentrations. *Ecological Modelling*, 191(1): 68-82, 2006.

G. Leban, I. Bratko, U. Petrovič, T. Curk, B. Zupan. VizRank: finding informative data projections in functional genomics by machine learning. *Bioinformatics*, 21(3): 413-414, 2005.

T. Curk, J. Demšar, Q. Xu, G. Leban, U. Petrovič, I. Bratko, G. Shaulsky, B. Zupan. Microarray data mining with visual programming. *Bioinformatics*, 21(3): 396-398, 2005.

N. Van Driessche, J. Demšar, E.O. Booth, P. Hill, P. Juvan, B. Zupan, A. Kuspa, G. Shaulsky. Epistasis analysis with global transcriptional phenotypes. *Nature Genetics*, 37(5): 471-477, 2005.

D. Šuc, D. Vladušić, I. Bratko. Qualitatively faithful quantitative prediction. *Artificial Intelligence*, 158(2): 189-214, 2004.

B. Zupan, J. Demšar J, I. Bratko, P. Juvan, J. A. Halter, A. Kuspa, G. Shaulsky. GenePath: a system for automated construction of genetic networks from mutant data. *Bioinformatics*, 19(3): 383-389, 2003.

I. Bratko. *Prolog Programming for Artificial Intelligence, third edition*. Addison-Wesley/Pearson Education 2001; previous editions also translated into German, Italian, French, Slovene, Japanese, and Russian.

Laboratory for Cognitive Modeling

Head: Professor Dr. Igor Kononenko

Fax: (+386 1) 426 4647

Phone: (+386 1) 47 68 + ext.

WWW: http://lkm.fri.uni-lj.si

Staff	E-mail	Ext:
Professor **Dr. Igor Kononenko**	igor.kononenko@fri.uni-lj.si	390
Assistant Professor **Dr. Matjaž Kukar**	matjaz.kukar@fri.uni-lj.si	914
Assistant Professor **Dr. Marko Robnik Šikonja**	marko.robnik@fri.uni-lj.si	188
Assistant **Dr. Zoran Bosnić**	zoran.bosnic@fri.uni-lj.si	459
Assistant **Petar Vračar**	petar.vracar@fri.uni-lj.si	459
Junior Researcher **Erik Štrumbelj. B.Sc.**	erik.strumbelj@fri.uni-lj.si	459

RESEARCH ACTIVITIES

Laboratory for Cognitive Modeling (LKM) was officially founded in 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, and new approaches to building, evaluation and explanation of models, derived from data. Recent research is related to development of methods for evaluating the utility of ordinal attributes, for evaluating the reliability of single models' predictions in classification and regression, for evaluating the reliability of clustering, for explaining single predictions by arbitrary classification or regression model, and for efficient parametrization of images using a subset of possible image resolutions. 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, and studies of consciousness.

RESEARCH PROJECTS

Machine Learning of Probabilities with Applications to Web Portals and Medical Diagnostics, Bilateral Collaboration Project (BI-PT/06-07-004), 2006–2008

Prediction of Betting Tips from Users' Bets Selections, Research project funded by Intension d.o.o., Maribor, (2008-2009)

Artificial intelligence and intelligent systems (P2-0209). Research Program funded by Slovenian Research Agency (2004-2008).

LABORATORY GUESTS

Prof. dr. Petr Savitsky, University of Prague, 19. - 26. November 2008, research collaboration on Artificial intelligence and intelligent systems.

RESEARCH VISITS

Marko Robnik Šikonja: University of Hasselt, Belgium, 17. August – 30. September 2008. Research cooperation on new method for analysis of ordered data in marketing.

INVITED TALKS AND LECTURES

I. Kononenko: Scientific and holistic medicine are complementary: the same is true for scientific and holistic medicine. In: Proc. *ICHM 2008,* Kottayam: Institute for Holistic Medical Sciences Chathukulam Buildings Parumbaikadu, 2008, pp. 1-11.

Selected Publications

I. Kononenko, M. Kukar: *Machine Learning and Data Mining: Introduction to Principles and Algorithms*, Horwood publ., 2007 (454 pages).

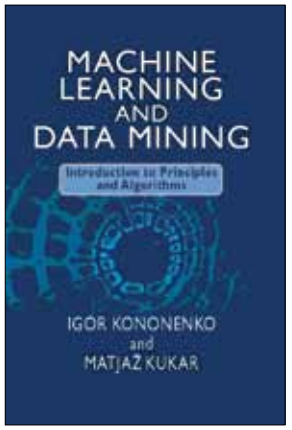
M. Robnik-Šikonja, I. Kononenko: Explaining classifications for individual instances. *IEEE Trans. Knowl. Data Eng.*, 2008, 20:589-600.

I.Kononenko:, M. Robnik-Šikonja: Non-myopic feature quality evaluation with (R)ReliefF. In: LIU, H., MOTODA, H.(Eds.). *Computational methods of feature selection.*. Boca Raton; London; New York: Chapman & Hall/CRC, 2008, pp. 169-191

L. Šajn, I. Kononenko, M. Milčinski: Computerized segmentation and diagnostics of whole-body bone scintigrams. *Comput. med. imaging graph.*. 2007, 31(7) 531-541.

M. Robnik-Šikonja, K. Vanhoof: Evaluation of ordinal attributes at value level. *Data Mining and Knowledge Discovery*, 14:225-243, 2007.

M. Bevk, I.Kononenko: Towards symbolic mining of images with association rules: Preliminary results on textures. *Intelligent Data Analysis*, 10(4)379-393, 2006.



The book by two members of LKM was published by Hoorwood and represents the appreciation of our research work

M. Kukar. Quality assessment of individual classifications in machine learning and data mining. *Knowledge and information systems*, 2006, 9(3) 364-384.

M. Kukar., C. Grošelj. Transductive machine learning for reliable medical diagnostics. J. med. syst., 2005, 29(1)13-32.

Z. Bosnić, I. Kononenko: Estimation of individual prediction reliability using the local sensitivity analysis. *Appl. Intell.*, 2007, 29(3)187-203

Z. Bosnić and I. Kononenko. Comparison of approaches for estimating reliability of individual regression predictions. *Data & Knowledge Engineering* , 67 (3)504-516, 2008,

L. Šajn, I. Kononenko: Multiresolution image parametrization for improving texture classification. *EURASIP J. Adv. Signal Process*, 2008, pp. 1-12.

M. Kukar. Transductive reliability estimation for medical diagnosis. *Artificial Intelligence in Medicine*, 29:81-106, 2003.

M. Robnik-Šikonja, D. Cukjati, I. Kononenko Comprehensible evaluation of prognostic factors and prediction of wound healing. *Artificial Intelligence in Medicine*, 29: 25-38, 2003.

M. Robnik-Šikonja, I. Kononenko. Theoretical and Empirical Analysis of ReliefF and RReliefF, *Machine Learning Journal*, 53: 23-69, 2003.

I. Kononenko: Machine learning for medical diagnosis: History, state of the art and perspective, Invited paper, *Artificial Intelligence in Medicine*, 23(1):89–109, 2001.

We collaborate with several Universities and Institutes from Greece, Portugal, Spain, Czech Republic and Belgium.

Laboratory for Mathematical Methods in Computer and Information Science

Head: Associate Professor Dr. Neža Mramor Kosta

Fax: (+386 1) 426 4647

Phone: (+386 1) 4768 + ext.

WWW: http://www.fri.uni-lj.si/lmmc/

Staff	E-mail	Ext.
Associate Professor **Dr. Neža Mramor Kosta**	neza.mramor@fri.uni-lj.si	258
Associate Professor **Dr. Bojan Orel**	bojan.orel@fri.uni-lj.si	870
Assistant Professor **Dr. Gašper Fijavž**	gasper.fijavz@fri.uni-lj.si	871
Assistant **Damir Franetič, B. Sc.**	damir.franetic@fri.uni-lj.si	866
Assistant **Peter Kink, M.Sc.**	peter.kink@fri.uni-lj.si	866
Assistant **Dr. Polona Oblak**	polona.oblak@fri.uni-lj.si	866
Assistant **Dr. Andrej Vodopivec**	andrej.vodopivec@fri.uni-lj.si	883
Assistant **Martin Vuk, M.Sc.**	martin.vuk@fri.uni-lj.si	883
Assistant **Damjan Vrenčur, B.Sc.**	damjan.vrencur@fri.uni-lj.si	866

RESEARCH ACTIVITIES

The research activities of the our lab involve various fields of mathematics with special emphasis on applications to computer and information science. Special emphasis is on research in the following fields of mathematics and computer science:

- scientific computing and numerical solutions of differential equations, where we study methods for geometric integration of ordinary differential equations, as well as numerical simulations of fluid flow by means of open source tools for CFD (computational fluid dynamics) analisys,
- 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 algebraic invariants of topological spaces with group actions, as well as computational topology and topological data analysis,
- nonlinear dynamical systems and their application in geometry, physics and mechanics,
- 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,

- commutative algebra and linear algebra, in particular, studying the variety of commuting nilpotent matrices over algebraically closed fields and certain classes of matrices over semirings,
- Brownian motion and martingales and their applications to analysis.

Several members of the lab participate in the 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, University of Hamburg, Germany, P.J.Šafarik University in Košice, Slovakia, University of Sevilla, Spain, and others.

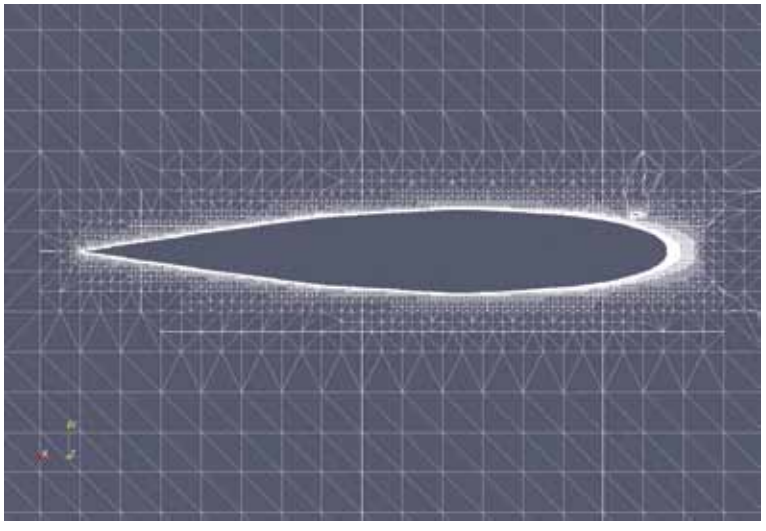
We organize the Mathematical seminar at the FRI, where members of the lab and other researchers report on current work, connected to the research and teaching activities of the lab.

Among applied projects, we are developing a program based on the open source C++ library OpenFoam for numerical simulation of fluid flow and hydrodynamic drag in the context of CFD. Efficient tools for triangulation and mesh generation, and for visualization are also included. In cooperation with the Computer Structures and Systems Laboratory members of the lab are working on algorithms for developing and evaluating mechanical random generators.

RESEARCH PROJECTS

Optimization of the shape of yacht hulls, Industry-Founded Project, Seaway group, d.o.o. (2007–2008), in cooperation with The Laboratory for applied mathematics at the Faculty of Electrical Engineering)

Randomness verification and irregularity analysis of a mechanical random generator that is to be part of a game machine, Industry-Founded Project, Elektrina d.o.o. (2008–2008).



A mesh generated for the purpose of numerical simulation of fluid flow around a yacht hull.

LABORATORY GUESTS

Prof. dr. Hrvoje Jasak, Faculty of Mechanical Engineering and Naval Architectur, University of Zagreb, Croatia, and Wikki Ltd.,London, UK, 8.1 – 10. 1. 2008, joint CFD work on the simulation of hydrodynamic drag and lecture »OpenFOAM: C++ Software in Computational Continuum Mechanics«

Prof. Arieh Iserles, University of Cambridge, Great Britain, 12. 6. – 14. 6. participation at the Seminar on Numerical Analysis and Geometric Integration with lecture »Highly oscillatory Fredholm operators: from spectral methods to modified Fourier expansions«

Prof. Marino Zennaro, University of Trieste, Italy, 12. 6. – 14. 6. participation at the Seminar on Numerical Analysis œand Geometric Integration with lecture »The joint spectral radius of a matrix family: applications and computational aspects«

Prof. Rosana Vermiglio, University of Udine, Italy, 12. 6. – 14. 6. participation at the Seminar on Numerical Analysis and Geometric Integration with lecture »Numerical approximation of characteristic values of Partial Retarded Functional Differential Equations«

Prof. Anne Kvaernoe. University of Trondheim, Norway, 12. 6. – 14. 6. participation at the Seminar on Numerical Analysis and Geometric Integration with lecture »Runge–Kutta methods for stochastic differential- and differential–algebraic equations«

Prof. dr. José Antonio Vilches, University of Sevilla, Spain, 5. 10. – 10. 10. 2008, joint research work and lecture “Non-compact discrete Morse theory”

RESEARCH VISITS

Neža Mramor Kosta: Indiana University, Department of Mathematics, USA, 3. 2. – 19. 2. 2008. Joint research work with Prof. Jan Jaworowski on equivariant topology.

Neža Mramor Kosta: University of Sevilla, Spain, 9. 6. – 16. 6. 2008. Joint research work with on discrete Morse theory.

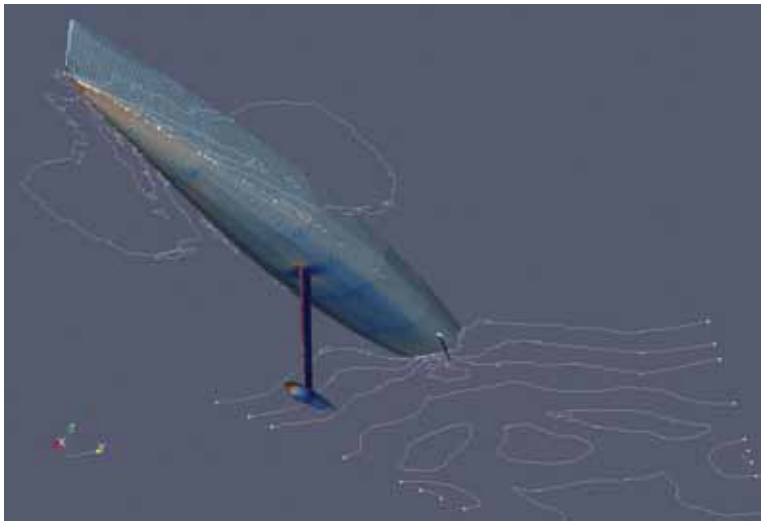
Damjan Vrenčur: University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture, Zagreb, Croatia, 8. 9. - 19. 9. 2008. OpenFOAM Summer School 2008.

Neža Mramor Kosta: Budapest University of Technology and Economics, Department of Mathematics, Budapest, Hungary, 9. 11 – 12. 11. 2008. Joint research on computational geometry.

Gašper Fijavž:, Banff International Research Station, Banff, Canada28. 9. - 3. 10. 2008, workshop on Graph Minors, invited speaker.

INVITED TALKS AND LECTURES

Damjan Vrenčur: Simulation of hidrodynamical properties of boats, 2. Slovenian meeting of mathematicians - researchers, Terme Olimje, Podčetrtek, 7. 11. 2008.



The result of a numerical simulation of hydrodynamic drag using OpenFoam.

Neža Mramor Kosta: The degree of maps between manifolds with free group actions, 13. 2. 2008, an invited lecture at the Indiana University Topology seminar.

Neža Mramor Kosta: Parametric Morse theory, 11. 6. 2008, an invited lecture at the Department of Mathematics, University of Sevilla, Spain.

Neža Mramor Kosta: Discrete Morse theory, 11. 11. 2008, an invited lecture at the Budapest University of Technology and Economics, Hungary.

SELECTED PUBLICATIONS

M. J. Chávez, G. Fijavž, A. Márquez, A. Nakamoto, E. Suárez. Geometric Realization of Möbius Triangulations, SIAM J. Discrete Math., 2009, vol. 23, no. 1, p. 221-232.

D. Bokal, G. Fijavž, D. R. Wood. The minor crossing number of graphs with an excluded minor. Electron. J. Comb. (online journal), 2008, vol. 15, no. 1, r4 (13 p).

G. Jerše, N. Mramor Kosta. Ascending and descending regions of a discrete Morse function. Comput. geom.. [Print ed.], 2008, 13 p.

P. Kink. A martingale on the zero-set of a holomorphic function. Electron. commun. probab. (Online), 2008, vol. 13, p. 606-613.

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P. Oblak. Jordan forms for mutually annihilating nilpotent pairs, Linear Algebra Appl. 428 (2008), 1476-1491.

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G. Fijavž. Contractions of 6-connected toroidal graphs. J. Comb. Theory, Ser. B, 2007, vol. 97, no. 4, str. 553-570.

J. Jaworowski, N. Mramor-Kosta. The degree of maps of free G-manifolds. J. fixed point theory appl. (Print), 2007, vol. 2, no. 2, str. 209-213.

A. Turković, B. Orel, M. Lučić-Lavčević, P. Dubček, M. Pavlović, Z. Crnjak Orel, S. Bernstorff. GISAXS study of temperature evolution in nanostructured CeVO[sub]4 films. Sol. energy mater sol. cells. [Print ed.], 2007, vol. 91, no. 14, str. 1299-1304.

B. Mohar, A. Vodopivec, On polyhedral embeddings of cubic graphs, Combin. Probab. Comput. 15 (2006), 877--893.

H. King, K. Knudson, N. Mramor Kosta. Generating discrete Morse functions from point data. Experimental Math. 14 (2005), 441--450.

M. Vilfan, M. Vuk, Nuclear spin relaxation of mesogenic fluids in spherical microcavities, J. Chem. Phys., 2004, vol. 120, 8638-8644.

Laboratory for cryptography and computer security

Head: Professor Dr. Aleksandar Jurišić

Fax: (+386 1) 2517-281

Phone: +386 1 4768-185

WWW: http://lkrv.fri.uni-lj.si/

Staff	E-mail	Ext.
Professor **Aleksandar Jurišić, Ph.D.**	aleksandar.jurisic@fri.uni-lj.si, aj@fri.uni-lj.si	183
Assistant **Matjaž Urlep, B.Sc.**	matjaz.urlep@fri.uni-lj.si	185
Assistant **Peter Nose, B.Sc.**	peter.nose@fri.uni-lj.si	185
Young Researcher **Janoš Vidali, B.Sc.**	janos.vidali@fri.uni-lj.si	185
Part-time members		
Researcher **Jernej Tonejc, Ph.D.**	jernej.tonejc@guest.arnes.si	185
Researcher **Maruša Stanek, B.Sc.**	marusa.stanek@gmail.com	185
Researcher **Tadej Novak, M.Sc.**	tadej.novak@fri.uni-lj.si	185

RESEARCH ACTIVITIES

Our laboratory focuses on cryptography and computer security. We also study coding theory and statistical design.

With the dramatic development of telecommunications and information processing the demand for information is rapidly increasing. However, with the electronic revolution, information faces new and potentially more damaging security threats. It is namely much easier to intercept and alter electronic information than its paper predecessor, and besides, attack can be delivered remotely.

Information and computer security describes all measures taken to make services available and to prevent unauthorized use of electronic data, regardless whether it takes the form of *disclosure*, *alteration* and *destruction* of the data concerned, or *verification of authenticity* and *data integrity*, such as *digital cash* (carrier of value) and *digital signature*. Among preventive measures, *cryptography* provides the highest security in accordance with its flexibility for digital media. Cryptography and computer security influences cryptographic systems and applications for *networks* (Internet), *finances* (banks, stock market) and *telecommunications*. In particular we focus on public-key cryptosystems based on elliptic curves, algorithmic number theory, applications of finite fields and coding theory.

The main mathematical background for cryptology is algebraic combinatorics (including number theory and discrete mathematics), which is being used in two other important areas of our activity:

statistical design theory and *coding theory.* The first one provides an optimal search for sample-sets and is being used, for example, in the design of digital communications. The second one constructs data carriers known as error-correcting codes (e.g. for CDs, wireless communication, satellites), since it is too expansive and inefficient to prevent all errors and it is easier to correct them (e.g. CD with a hole of 1mm in diameter still produces a perfect sound).

RESEARCH PROJECTS

Certificate Agency with ECC (M1-0139), Slovene Government-Founded R&D Project funded by Slovenian Research Agency (2006-2008).

Anonymization of data (L1-9659), Basic and Applied Research Project funded by Slovenian Research Agency and Ministry of Health (2007-2009).

Cryptosystems with elliptic curves over prime fields and smartcards for use by MO/SV (M2-0206), Slovene Government-Founded R&D Project funded by Slovenian Research Agency (2007-2009).

LABORATORY GUESTS

Prof. Chris Godsil, Department of Combinatorics and Optimization, University of Waterloo, Waterloo, Canada, April 5– 8, 2008.

Prof. Jovan Golić, Telecom Italy, Torino, Italy, Dec. 28, 2008 – January 4, 2009.

RESEARCH VISITS

A. Jurišić, J. Tonejc and M. Urlep, Dept. of Combinatorics and Optimization, University of Waterloo, Waterloo, Canada, Jan. 13-24, 2008.

A. Jurišić and B. Cergol: Combinatorial and Computational Mathematics Centre, PosTech, Pohang, Korea, Jan. 28 – Feb. 8, 2008.

A. Jurišić, Department of Mathematics, University of Wisconsin - Madison, Madison, Wisconsin, U.S.A, Sept. 17 - Oct. 3, 2008.

INVITED TALKS AND LECTURES

Aleksandar Jurišić, "Tight distance-regular graphs", Feb. 4, 2007, workshop held at the Combinatorial and Computational Mathematics Centre, PosTech, Pohang, Korea.

Smart cards enable us to securely store private keys.

Aleksandar Jurišić, "Distance-regular graphs with light tails", Aug. 22, 2008, GAC4 Conference, Oisterwijk, The Netherlands.

Aleksandar Jurišić, "Distance-regular graphs with light tails", Combinatorics Seminar, and "The Mercedes knot problem", Undergraduate Math Club, Sept. both on Sept. 29. 2008, Department of Mathematics, University of Wisconsin - Madison, Madison, Wisconsin, U.S.A

SELECTED PUBLICATIONS

A. Jurišić and P. Terwilliger, Pseudo-1-homogeneous distance-regular graphs, Journal of Algebraic Combinatorics 28 (2008), 509-529.

A. E. Brouwer, A. Jurišić and J. H. Koolen, Characterization of the Patterson graph, J. of Algebra 320 (2008), 1186-1199.

K. Coolsaet and A. Jurišić, Using equality in the Krein conditions to prove nonexistence of certain distance-regular graphs, J. Combin. Theory (A) 115 (2008), 1086-1095.

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A. Jurišić, J. H. Koolen and A. Žitnik, Triangle-free distance-regular graphs of diameter 3 with an eigenvalue multiplicity equal to the valency, Europ. J. Combin. 29 (2008), 193-207.

A. Jurišić and J. H. Koolen, Distance-regular graphs with complete multipartite mu-graphs and AT4 family, Journal of Algebraic Combinatorics 25 (2007), 459 - 471.

A. Jurišić, J. H. Koolen and Š. Miklavič, Triangle- and pentagon-free distance-regular graphs with an eigenvalue multiplicity equal to the valency, Journal Combin. Theory Ser. B 94 (2005) no. 2, 245-258.

A. Jurišić, AT4 family and 2-homogeneous graphs, Discrete Math. 264, no. 1-3 (2003), 127-148.

A. Jurišić and J. Koolen, 1-homogeneous graphs with Cocktail Party mu-graphs, Journal of Algebraic Combinatorics 18 (2003), 79-98.

A. Jurišić and J. Koolen, Krein parameters and antipodal tight graphs with diameter 3 and 4, Discrete Math. 244 (2002), 181-202.

A. Jurišić, J. H. Koolen and P. Terwilliger, Tight distance-regular graphs, Journal of Algebraic Combinatorics 12 (2000), 163 - 197.

A. Jurišić and J. Koolen, A Local Approach to 1-Homogeneous Graphs, Designs, Codes and Cryptography 21 (2000) 127-147.

A. Jurišić and J. Koolen, Nonexistence of some antipodal distance-regular graphs of diameter four, Europ. J. Combin. 21 (2000) 1039-1046.

A. Jurišić, Antipodal covers of strongly regular graphs, Discrete Math. 182 (1998), 177-189.

A. Jurišić and A. Menezes, "Elliptic Curves and Cryptography", Dr. Dobb's Journal, April 1997, 26 - 37.

With error-correcting codes it is possible to receive quality pictures sent by space-probes. We cite Barry Cipra: "Error-correcting codes are a kind of safety net--mathematical insurance against the vagaries of an imperfect material world"

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