

Faculty of Computer and
Information Science
University of Ljubljana
Survey of Activities in 2011

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Prof. Dr. Nikolaj Zimic

Foreword

This booklet provides some basic information about the Faculty of Computer and Information Science at 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 had a lengthy roster of alumni, some of whom have achieved distinction in academic and professional circles in Slovenia and abroad. The Faculty has a number of active research groups that attract funding from various EU and international programs and as well as funding from Slovenian and foreign industry.

Due to the high demand for computer and information science graduates, the Faculty has avoided the trend of declining enrollment as in some other engineering and science disciplines. We actively promote the study of computer and information science by offering free summer workshops for high school students. During the academic year we also provide help to selected high schools with after-class activities. Besides the core of computer science, recently implemented study programs designed according to the Bologna principles enable an interdisciplinary approach to computer science education and should help to attract students from diverse backgrounds. We also aim at further opening our studies and making them accessible to international students. In 2012, part of the Master Studies and the entire Doctoral Program will be conducted in English. In the age of globalization the Faculty faces increasing competition in all areas. In recent years we have expanded our research competence to a wider spectrum of promising technical areas by attracting experienced researchers and teachers. Currently, the Faculty's most pressing problem is the shortage of space. The construction of the new Faculty building and associated facilities already started in 2010 and is expected to be finished in 2013.

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 find some interesting material in the booklet to establish contacts with our Faculty members.

Nikolaj Zimic

Dean and Professor of Computer and Information Science

About FRI

General Information

Dean **Prof. Dr. Nikolaj Zimic**

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

Associate Dean for Development **Prof. Dr. Marko Robnik Šikonja**

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FRI

The Faculty of Computer and Information Science (FRI) was established in 1996 as an independent faculty of the University of Ljubljana. The undergraduate program in computer science had commenced before, in 1973, when the faculty staff was engaged within the former Faculty of Electrical Engineering and Computer Science. The study program first started as an elective program after the second year of electrical engineering study and started operating as an independent four-year program in 1982. In 2008 the first generation of students was enrolled into the newly designed programs in computer science at all degrees, which are internationally comparable and follow the Bologna guidelines.

Up till now more than 2800 students have completed undergraduate programs in computer science and obtained an undergraduate university degree. At the graduate level more than 350 Master's degrees (M.Sc.) and 120 Doctoral degrees (Ph.D.) in Computer and Information science have been awarded. Currently, there are about 1600 undergraduate and graduate students at the Faculty. The Faculty has 179 employees, of which 154 are teaching and research staff.

The central building that houses FRI is shared with the Faculty of Electrical Engineering. FRI has seven teaching laboratories equipped with a total of about 450 networked personal computers and shares with the Faculty of Electrical Engineering 21 lecture halls. All classrooms are covered by wireless network (Eduroam). Twenty research laboratories are equipped with about 530 personal computers or workstations, and maintain a range of web servers and several medium-sized computational clusters. 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 that is engaged primarily in publishing textbooks for students.

How to Reach Ljubljana

BY AIR

The Ljubljana airport at Brnik is about 20 km North-West from the centre of Ljubljana (see Figure 2). It has fairly good connections with other European airports (Frankfurt, Munich, London, Zurich, Copenhagen, Paris, etc.) and is serviced 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 or Frankfurt and by train, car or plane to Ljubljana (a direct train goes once every day, there are two flights daily from Munich and Frankfurt to Ljubljana)

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

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

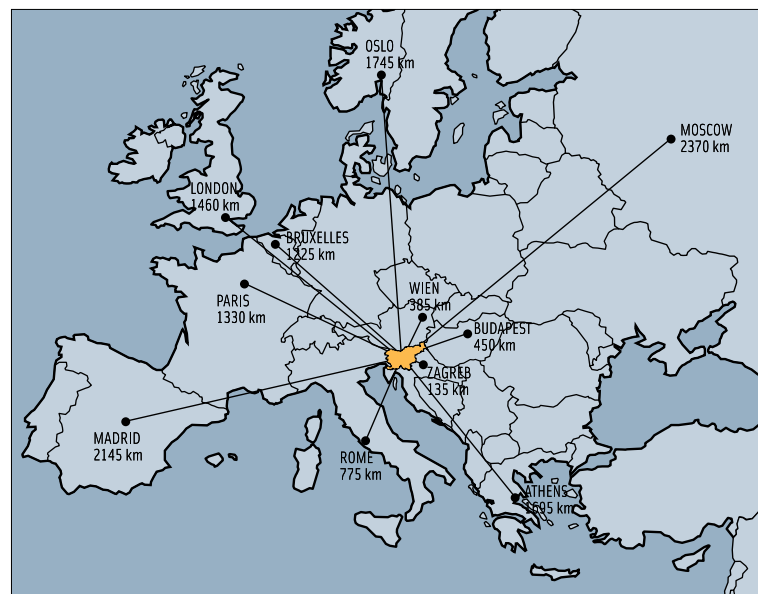


Figure 1: Slovenia in Europe

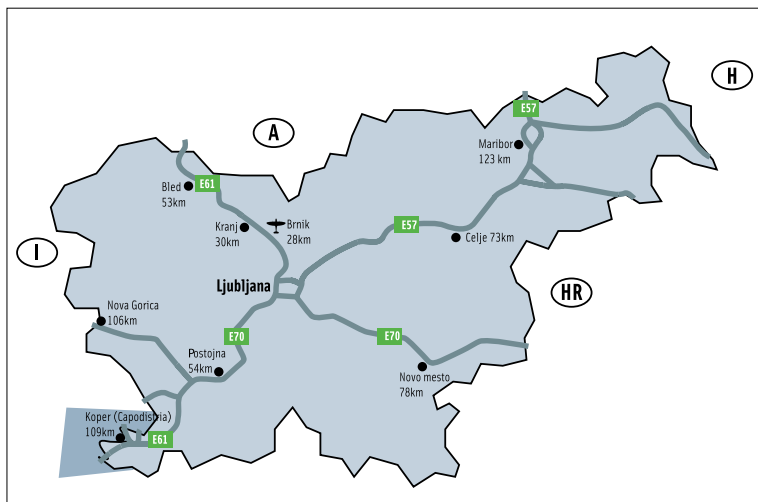


Figure 2: Map of Slovenia

BY RAIL

Ljubljana has good railway links with Austria (Vienna, Klagenfurt, Graz), Germany (Munich), Croatia (Zagreb, Rijeka) and Hungary (Budapest). The above-mentioned cities have good international connections with all 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 centre of Ljubljana. To reach the Faculty from the centre you must take bus line 1 (direction “Mestni log”) or 6 (direction “Dolgi most”). Map on Figure 4 shows how to reach FRI by car.



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 the fall and the spring semester. The courses in the fall semester begin on October 1st and last for 15 full weeks. The spring semester courses start in the second half of February and end in the beginning of June, according to the current academic calendar of the University of Ljubljana. There are three examination periods: winter (from the end of the fall semester until the beginning of the spring semester), spring (a full month after the end of the spring semester) and fall (from mid August until the end of September). At the Faculty of Computer and Information Science the courses consist of lectures, problem solving classes (tutorials), laboratory work, and independent work assigned to the students. All courses last one semester and the student course load per semester, according to the European Credit Transfer System (ECTS), is 30 ECTS. In most study programs the work load is uniformly distributed among the courses, the majority of the courses at all levels have 6 ECTS.

The Faculty of Computer and Information Science 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 Slovenian quality assurance agency for higher education and the European Federation of National Engineering Associations (FEANI) and they meet the criteria for the title EUR ING.

UNDERGRADUATE PROGRAMS

The faculty of computer and information science offers the following 3 year first degree programs:

- university study program Computer and Information Science
- professional study program Computer and Information Science
- interdisciplinary university study program Computer Science and Mathematics (together with the Faculty of Mathematics and Physics)
- interdisciplinary university study program Administrative Information Systems (together with the Faculty of Administration)

All four first degree programs began running in the academic year 2009/2010, when the first year courses were first offered. In the academic year 2011/2012 all three years of the new study programs are running for the first time. All programs consist of six semesters of course work and have a total work load 180 ECTS.



At the second degree level, the following two programs are offered:

- master study program Computer and Information Science
- interdisciplinary program Cognitive Sciences, offered jointly with the Faculty of Education, Faculty of Medicine and the Faculty of Arts of the University of Ljubljana and several other European universities (University of Vienna, Technical University of Budapest, University of Zagreb and Comenius University in Bratislava)

The second degree study programs consist of 4 semesters of course work with a total work load of 120 ECTS.

In addition to these new programs, which follow the Bologna guidelines, two old undergraduate educational programs are still running. In the academic year 2011/2012 the last generation of students in these programs is finishing their fourth year of studies. These programs are:

- a four-year university program (eight semesters of lectures, 6 months of Undergraduate thesis work), which leads to the title “University dipl. eng. of Computer and Information Science”, and
- a four year interdisciplinary university program (eight semesters of lectures, 6 months of undergraduate thesis work), which leads to the title “University dipl. eng. of Computer Science and Mathematics”.

University study program Computer and Information Science

The program leads to the degree “diplomirani inženir računalništva in informatike (UN)”, abbr. “dipl. ing. rač. (UN)”.

The first two years consist mainly of core-curriculum courses including mathematics and the theoretical foundations of computer science, with one major elective course and one general elective course in the fourth semester. In the third year, elective modules including three courses each are offered. The student is required to choose two modules and, in addition, one general elective course.

The study program concludes with an undergraduate thesis with a work load of 6 ECTS in the last semester.

FIRST YEAR COURSES:

Semester	Title	ECTS
Fall	Introduction to Programming	6
	Calculus	6
	Discrete Structures	6
	Introduction to Digital Circuits	6
	Physics	6
Spring	Programming and Algorithms	6
	Linear Algebra	6
	Fundamentals of Databases	6
	Computer Communications	6
	Human-Computer Interaction	6

SECOND YEAR COURSES:

Semester	Title	ECTS
Fall	Algorithms and Data Structures	6
	Computer Systems Architecture	6
	Probability and Statistics	6
	Introduction to Artificial Intelligence	6
	Introduction to Information Systems	6
Spring	Theory of Informations and Systems	6
	Operating Systems	6
	Computer Systems Organization	6
	General elective	6
	Major elective	6

SECOND YEAR MAJOR ELECTIVES:

Title	ECTS
Mathematical Modeling	6
Principles of Programming Languages	6
Computer technologies	6

THIRD YEAR COURSES

Semester	Title	ECTS
Fall	Communication and Project Management	6
	Module 1, course 1	6
	Module 1, course 2	6
	Module 2, course 1	6
	Module 2, course 2	6
Spring	Economics and Entrepreneurship	6
	Module 1, course 3	6
	Module 2, course 3	6
	General elective	6
	Diploma thesis	6

ELECTIVE MODULES:*Information Systems*

- Course 1: Electronic Business
- Course 2: Organization and Management
- Course 3: Business Intelligence

Management of Information Systems

- Course 1: Information Systems development
- Course 2: Data Management Technologies
- Course 3: Informatics Planning and Management

Software Engineering

- Course 1: Software Development Processes
- Course 2: Web Programming
- Course 3: Software Engineering

Computer Networks

- Course 1: Computer Networks Modeling
- Course 2: Communication Protocols
- Course 3: Mobile and Wireless Networks

Computer Systems

- Course 1: Digital Design
- Course 2: Systems Reliability and Performance
- Course 3: Distributed Systems Computer

Algorithms and System Utilities

- Course 1: Computational Complexity and Heuristic Programming
- Course 2: System Software
- Course 3: Compilers

Artificial Intelligence

- Course 1: Intelligent Systems
- Course 2: Machine Perception
- Course 3: Development of Intelligent Systems

Multimedia

- Course 1: Computer Graphics and Game Technology
- Course 2: Multimedia Systems
- Course 3: Introduction to Design

Professional study program

Computer and Information Science

This application oriented study program leads to the degree “diplomirani inženir računalništva in informatike (VS)”, abbr. “dipl. ing. rač. (VS)”.

The first year consists of core-curriculum courses, while the remaining two years are structured so that the students can choose from of list of major electives according to their individual interests and preferences. The courses are grouped into semesters, and the student is required to choose a total of 5 courses corresponding to 30 ECTS in each semester, respecting the required prerequisites for each course. The total work load of the program is 180 ECTS out of which 66 ECTS are mandatory courses, 90 ECTS are major electives, 12 ECTS are general electives, 18 ECTS is practice within the industry and 6 ECTS is the undergraduate thesis.

The general electives are chosen from the available study programs at the University of Ljubljana.

FIRST YEAR COURSES:

Semester	Title	ECTS
Fall	Introduction to Computer Science	6
	Programming I	6
	Computer Architecture	6
	Mathematics	6
	Discrete Structures	6
Spring	Programming II	6
	Databases	6
	Computer Communications	6
	Operating Systems	6
	Introduction to Probability and Statistics	6

SECOND YEAR COURSES:

Semester	Title	Prerequisites	ECTS
Fall	Algorithms and Data Structures I		6
	Electronic and Mobile Business		6
	Databases II		6
	Information Systems		6
	Graphic Design		6
	Communications Protocols and Network Security		6
	Computer Organization		6
	Digital Circuits		6
	Computer Graphics		6
	Artificial Intelligence		6

Semester	Title	Prerequisites	ECTS
Spring	User Interfaces		6
	Compilers and Virtual Machines	<i>Algorithms and Data Structures I</i>	6
	Algorithms and Data Structures II	<i>Algorithms and Data Structures I</i>	6
	Testing and Quality	<i>Algorithms and Data Structures I</i>	6
	Information Systems Development	<i>Information Systems</i>	6
	Multimedia Content Production	<i>Graphic Design</i>	6
	Digital Signal Processing		6
	Web Technologies	<i>Algorithms and Data Structures I, Communications Protocols and Network Security</i>	6
	Input-Output Systems	<i>Algorithms and Data Structures I</i>	6
	Digital Logic Design	<i>Computer Organization, Digital Circuits</i>	6
	Data Mining	<i>Algorithms and Data Structures I, Artificial Intelligence</i>	6

THIRD YEAR COURSES:

Semester	Title	Prerequisites	ECTS
Fall	Project practicum		6
	Software Engineering	<i>Algorithms and Data Structures I</i>	6
	Information Systems Strategic Planning	<i>Information Systems Development</i>	6
	Multimedia Technologies	<i>Digital Signal Processing</i>	6
	Parallel and Distributed Systems and Algorithms	<i>Algorithms and Data Structures I</i>	6
	System Software	<i>Algorithms and Data Structures I</i>	6
	Process Automation	<i>Input-Output Systems</i>	6
	Embedded Systems	<i>Input-Output Systems</i>	6
	Robotics and Machine Perception	<i>Input-Output Systems, Computer Graphics, Artificial Intelligence</i>	6
	Game Technology and Virtual Reality	<i>Algorithms and Data Structures I, Computer Graphics, Artificial Intelligence</i>	6
	Decision Systems	<i>Data Mining</i>	6
	Numerical Methods		6
	Spring	Industrial Practice	
Diploma Thesis			6

University study program Computer Science and Mathematics

This program is oriented towards theoretical computer science and topics in modern discrete and computational mathematics that are closely connected to it. The program leads to the degree “diplomirani inženir računalništva in matematike (UN)”, abbr. “dipl. ing. rač. mat. (UN)”.

The first two years contain mandatory core-curriculum courses. The third year contains three mandatory courses, one elective module from the University program Computer and Information Science, a major elective with a work load of 5 ECTS and general electives with a total load of 10 ECTS. The study program concludes with an undergraduate thesis with a work load of 4 ECTS in the last semester.

FIRST YEAR COURSES:

Semester	Title	ECTS
Fall	Introduction to Programming	6
	Analysis 1	7
	Discrete Structures 1	6
	Introduction to Digital Circuits	6
	Linear algebra	10
Spring	Programming and Algorithms	6
	Fundamentals of Databases	6
	Analysis 2	7
	Discrete Structures 2	6

SECOND YEAR COURSES:

Semester	Title	ECTS
Fall	Algorithms and Data Structures	6
	Computer Systems Architecture	6
	Analysis 3	5
	Introduction to Artificial Intelligence	6
	Combinatorics	7
Spring	Optimization Methods	7
	Operating Systems	6
	Principles of Programming Languages	6
	Computer Communications	6
	Topics in Mathematics	5

THIRD YEAR COURSES:

Semester	Title	ECTS
Fall	Numerical methods	7
	Communication and Project Management	6
	Probability and Statistics	10
	Elective module, courses 1 and 3	12
Spring	Elective module, course 2	6
	Major elective	5
	General electives	10
	Undergraduate thesis	6

The major elective course is chosen from the following list of courses offered at the Faculty of Mathematics and Physics:

- General Topology
- Algebraic Curves
- Introduction to Geometric Topology
- Affine and Projective Geometry
- Coding Theory and Cryptography
- Financial Mathematics 1
- Game Theory
- Mathematical Modeling
- Numerical Methods II

The general elective courses are chosen from the study programs at the University of Ljubljana.

Interdisciplinary University study program Administrative Information Systems

The study program is offered jointly by the Faculty of Administration and the Faculty of Computer and Information Science and leads to the title “diplomirani upravni informatik”.

The joint study program is designed to provide students with knowledge in computer technologies, internet and new information technologies as well as in administration-legislation, economics and management, required for understanding public and business administration.

The first year consists of core courses in both fields with 6 ECTS of elective subjects, while the second and third year courses provide the students with a broad understanding of both study fields. The program concludes with a diploma thesis with a work load of 16 ECTS in the last semester.

FIRST YEAR COURSES:

Title	ECTS
Introduction to Programming	6
Theory of Public Administration	8
Basic Economics	7
Theory of Organisation	7
Fundamentals of Probability and Statistics	6
Informatics	8
Programming and Algorithms	6
Database Basics	6
Elective subjects	6

SECOND YEAR COURSES:

Title	ECTS
Methods and Techniques for Decision-Making Process Support in Public Administration	4
Computer Communication	6
Introduction to Artificial Intelligence	6
Legislative Regulation of Public Administration	6
Human Resource Management in Public Administration	7
Business Process Informatisation in Public Administration	7
Data management technologies	6
Web Programming	6
Elective subjects	12

THIRD YEAR COURSES:

Title	ECTS
Communication and Project management	6
Planning and Governance	6
Information Systems Development	6
Administrative Procedure and Judicial Review of Administrative Acts	8
Information Systems in Public Administration	6
Management in the Public Sector	6
E-business	6
Thesis	16

Second degree Master study program Computer and Information Science

The program leads to the degree “magister računalništva in informatike”, abbr. “mag. inž. rač”.

The first year consists of 4 mandatory courses including mathematics and core-curriculum topics in computer and information science, 4 major elective courses and 2 general electives courses. In the second year, students choose 6 additional major elective courses, while a total work load of 24 ECTS is devoted to the preparation of the master thesis

FIRST YEAR COURSES

Title	ECTS
Mathematics II	6
Programming	6
Major elective	6
Major elective	6
General elective	6
Algorithms	6
Computer systems	6
Major elective	6
Major elective	6
General elective	6

SECOND YEAR COURSES

Title	ECTS
Major elective	6
Major elective	6
Major elective	6
Master thesis	12
Major elective	6
Major elective	6
Major elective	6
Master theis	12

MAJOR ELECTIVE COURSES

Title	ECTS
Artificial Intelligence	6
Wireless Sensors Networks	6
Unconventional Computing	6
Perception in Cognitive Systems	6
Biomedical Signal and Image Processing	6
Advanced Software Development Methods	6
Digital Signal Processing	6
Computability and Computational Complexity	6
E Learning	6
Machine Learning	6
Introduction to Bioinformatics	6
Information Security and Privacy	6
Numerical Mathematics	6
Computer Sound Production	6
Soft and Natural Computing Algorithms	6
Data Mining	6
IT Governance	6
Information and interaction design	6
Cryptography and Computer Security	6
Exploiting Processors' Performance	6
Computer Forensics	6
Contemporary Approches in Information Systems Development	6
Discrete Mathematics	6
Management of production and service processes	6

Doctoral programs

The Faculty of Computer and Information Science offers or participates in the following third degree programs leading towards the degree Doctor of Sciences.

- Computer and Information Science
- Interdisciplinary doctoral program Biosciences, offered jointly with the Biotechnical Faculty, Faculty of Electrical Engineering and the Faculty of Mechanical Engineering
- Humanistics and Social Sciences, offered jointly with the Faculty of Arts, and the Faculty of Social Sciences.

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 either computer and information science or other 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, preparing 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 courses from the undergraduate program and from other courses offered at the third degree level programs of 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 Undergraduate, Master, and Doctoral theses research) at the Faculty of Computer and Information Science are performed in twenty research laboratories that are organized into six groups. The main sources of research funding are the Slovenian Research Agency, the Ministry of Higher Education, Science and Technology, the Ministry of Defence, European Union programs (COST, 6th and 7th Framework Programme), and various bilateral programs including those in USA, France, Austria, Czech Republic, Norway, Portugal, Greece and the UK. The Ministry of Higher Education, Science and Technology, together with the Slovenian Research Agency also supports the majority of postgraduate students by means of individual scholarships. Many application projects are financed by Slovenian and European companies.

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

- microcomputer systems,
- GRID technologies and parallel processing,
- fuzzy and neuro-fuzzy controllers,
- 3D design, visualization and animation, video editing,
- process informatics and programmable technologies,
- short SIMD processing,
- intelligent RFID systems,
- cryptography, security, privacy, digital identity management, intrusion detection,
- digital libraries and multimedia information retrieval,
- 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,
- data mining, machine learning, data visualization,
- mobile robotics, applications of artificial intelligence 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,
- cloud computing,
- biomedical informatics, and
- biomedical computer systems and imaging.

More information on individual laboratories and current projects is provided at the Faculty's web pages at <http://www.fri.uni-lj.si/en>.



Laboratory for Computer Graphics and Multimedia

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RESEARCH ACTIVITIES

Laboratory for Computer Graphics and Multimedia is involved in activities related to multimedia technologies, computer-based education and learning, human-computer interaction, multi-touch technologies, 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 main ongoing activities in the laboratory are dedicated to researches in the following areas:

- digital libraries and multimedia information retrieval,
- natural user interfaces,
- standards and specifications for educational content,
- e-learning environments and virtual laboratories.

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

In the past, members of the laboratory cooperated with other research groups in the development of military training systems, medical imaging applications, simulation tools for computer supported industrial automation, including robotized environments, and computer supported quality control and management systems.

EQUIPMENT

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. The laboratory has also built a multi-touch table, which is used for developing and testing alternative ways of human computer interaction. To support the natural user interface research the laboratory also has some depth sensing equipment - Kinect.

RESEARCH PROJECTS

ASPECT: Adopting Standards and Specifications for Educational Content (ECP-2007-EDU-417008). European Project, 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 Project, Slovenian Research Agency (2008–2011).

Click to homeland: a multimedia presentation of cultural heritage of Slovenian emigrants (V5-1033). Target Research Programme, Slovenian Research Agency and Government's Office for Slovenians Abroad (2010–2012).

SELECTED PUBLICATIONS

A. Kavčič. Implementing Content Packaging Standards. Proceedings of the Eurocon 2011, pp. 1-4, 2011.

A. Kavčič. Importance of Standards and Specifications for Electronic Learning Materials. Invited Lecture at SIRIKT 2011. Proceedings of the International Conference Enabling education and research with ICT, SIRIKT 2011, Kranjska Gora, April 2011, pp. 158-164.

M. Marolt. Automatic Transcription of Bell Chiming Recordings. IEEE Transactions on Audio, Speech, and Language Processing, to be published, 2011.

G. Strle, M. Marolt. Etnomuza : digitalni multimedijski arhiv slovenskih ljudskih pesmi in glasbe. Tradit. - Inšt. slov. narodop. Ljublj., 2010, letn. 39, št. 2, str. 149-166.

M. Marolt, M. Lefebber. It's time for a song - transcribing recordings of bell-playing clocks. Proceedings of ISMIR 2010, Utrecht, The Netherlands. 2010.

J. Južna, A. Kavčič. Packaging standards for electronic learning materials. Proceedings of the International Conference Enabling education and research with ICT, SIRIKT 2010, Kranjska Gora, April 2010, pp. 644-650. 2010.

C. Bohak, M. Marolt. Calculating Similarity of Folk Song Variants with Melody-based Features. Proceedings of ISMIR 2009, Kobe, Japan. 2009.

M. Privošnik. Evolutionary optimization of emergent phenomena in multi-agent systems using heuristic approach for fitness evaluation.



Multi-touch table

Proceedings of 2009 IEEE Congress on Evolutionary Computation, IEEE Press Piscataway, NJ, USA, pp. 1829-1834. 2009.

M. Marolt. A Mid-Level Representation for Melody-based Retrieval in Audio Collections. IEEE Transactions on Multimedia, December 2008, Vol.10, Issue 8, pp. 1617-1625. 2008.

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.

Laboratory for Biomedical Computer Systems and Imaging

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RESEARCH ACTIVITIES

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

- understanding and describing physiological phenomena, using computers in modelling and understanding of physiologic relationships, locally and remotely monitoring physiologic events, graphically displaying anatomic details and physiologic functions, visualizing and representing biomedical signal and imaging data, developing standardized databases to study physiologic mechanisms and to evaluate the performance and robustness of recognition techniques, characterizing data, establishing detection criteria and recognition techniques to automatize the analysis of bioelectric patterns to a high a degree as possible, examinations, procedures, and medical practice, in order to improve the quality and reliability of examinations, and to interpret data and 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 accurately detecting 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 distributing the 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 analysers, and as a reference set to study physiologic mechanisms responsible for ischaemia. See:

- <http://www.physionet.org/physiobank/database/ltstadb/> and
- <http://www.physionet.org/challenge/2003/>.

From 2007 the database is publicly available. See also:

- <http://lbc.si.fri.uni-lj.si/database/>.

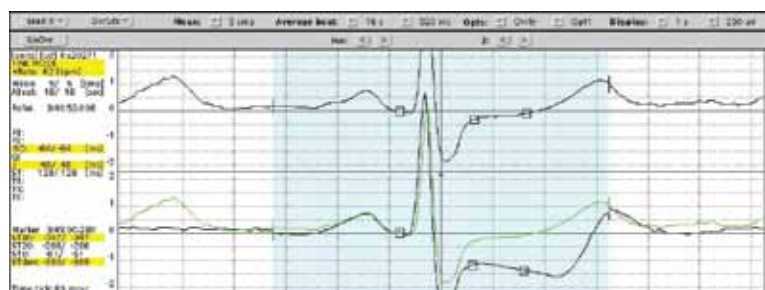
The next research topic is the development of interactive graphic user interface editing tools (SEMIA – semi-automatic) to visualize, display and annotate long-term electrocardiograms. SEMIA, version 3.0.1, to view diagnostic and morphology feature-vector time series, and to examine the human annotations to the LTST DB is under GNU General Public License and is available at <http://www.physionet.org/physiobank/database/ltstadb/semia/>.

Another research topic is the characterization of the 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 the interactive graphic tool EVAL_ST, used to evaluate the performance and robustness of ischaemia analysers. The tool is under GNU General Public License and is available at http://www.physionet.org/physiotools/eval_st/.

Another research topic concerns the comparison of various linear and non-linear signal processing techniques to separate uterine electromyogram (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. Maintenance 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

The laboratory owns two high-speed electroencephalographic recording devices to record and monitor electroencephalogram (EEG) signals.

RESEARCH PROJECTS

Metabolic and inborn factors of reproductive health, birth (P30124). Research Programme, Slovenian Research Agency (2004–2014).

RESEARCH VISITS

Franc Jager visited the Massachusetts Institute of Technology, Cambridge, USA, Laboratory for computational physiology, from 27. 8 – 3. 9. 2011. The purpose of visit was joint work on the Term-Preterm ElectroHysteroGram Database (TPEHG DB) (in the scope of P30124 research project) which we developed and posted on Physionet. The database (<http://www.physionet.org/pn6/tphegdb/>) is intended to serve as a reference set for developing automated techniques to predict preterm birth.

SELECTED PUBLICATIONS

A. Smrdel and F. Jager. Automatic classification of long-term ambulatory ECG records according to type of ischemic heart disease. *BioMedical Engineering OnLine*, 10: 107, 2011.

A. Minchola, F. Jager and P. Laguna. Discrimination between ischemic and artifactual ST segment events in Holter recordings. *Biomedical signal processing control*, 5: 21-31, 2010.

J. Faganeli and F. Jager. Automatic classification of transient ischaemic and transient non-ischaemic heart-rate related ST segment deviation episodes in ambulatory ECG records. *Physiological Measurement*, 31: 323-337, 2010.

G. Fele-Žorž, G. Kavšek, Ž. Novak-Antolič and F. Jager. A comparison of various linear and non-linear signal processing techniques to separate uterine EMG records of term and pre-term delivery groups. *Medical & Biological Engineering & Computing*, 46(9):911-922, 2008.

A. Smrdel and F. Jager. Diurnal Changes of the Heart Rate and Sympathovagal Activity for Temporal Patterns of Transient Ischemic Episodes in 24-hour Electrocardiograms. *EURASIP J, Adv. Signal. Process.* 2007, Article ID 32386, 10 pages, 2007.

F. Jager, G.B. Moody, R.G. Mark. Protocol to assess robustness of ST analysers: A case study. *Physiological Measurement*, 25:629-643, 2004.

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F. Jager, A. Taddei, G.B. Moody, M. Emdin, G. Antoliè, R. Dorn, A. Smrdel, C. Marchesi, R.G. Mark. Long-Term ST Database: A Reference for the Development and Evaluation of Automated Ischaemia Detectors and for the Study of the Dynamics of Myocardial Ischaemia. *Medical & Biological Engineering & Computing*, 41:172–182, 2003.

F. Jager, G.B. Moody, R.G. Mark. Detection of Transient ST-Segment Episodes During Ambulatory ECG-Monitoring. *Computers and Biomedical Research*, 31:305–322, 1998.

F. Jager Guidelines for assessing performance of ST analyzers. *Journal of Medical Engineering & Technology*, 22(1): 25-30, 1998.

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RESEARCH ACTIVITIES

The main research topics include: soft computing, adaptive systems, parallel programming/processing, information theoretic modelling, evolutionary biosynthesis, and natural computing algorithms. Within these areas we are mainly focused on problems where the lack of theoretical knowledge prevents exact solutions and the size of the problems demands a parallel programming and/or processing approach.

The first paradigm requires learning by example and methods based on natural computing algorithms which comprise artificial neural networks, evolutionary algorithms, fuzzy logic and other biologically inspired algorithms. Current work focuses on natural based modelling of sub-cell structures with Boolean networks, and new efficient methods for data clustering.

For the second paradigm we are focusing on parallel cluster programming by using MPI and OpenMP libraries, and parallel processing within different Grid environments like Condor and Microsoft HPC Server. We are also involved in the programming of natural computing algorithms and information-theory based algorithms on graphical processors using NVidia CUDA tools and libraries.

In 2011 the laboratory successfully organized the 10th International conference on adaptive and natural computing algorithms, ICANNGA'11. The submitted papers were published in Springer's LNCS series, and the best selected papers in Neurocomputing journal.

EQUIPMENT

nVidia Tesla C2050 GPU Computing Processor, Computing cluster, FPGA design boards



ICANNGA'11 group photo in front of the University of Ljubljana

RESEARCH PROJECTS

Synergy of the technological systems and processes (P2 – 0241). Basic Research Programme (with the Faculty of Mechanical engineering, University of Ljubljana), Slovenian Research Programme (2009-2013).

Modeling of complex dynamic problems with the methods of soft computing (BI-PL/10-11-014). Bilateral Polish-Slovenian project, Slovenian Research Agency, (2010-2011).

Salus high bay rack warehouse control system, Ljubljana, Slovenia. Industrial research project, Iskra Impuls (2010-2011).

LABORATORY GUESTS

Vojciech Kozinski and Maciej Twardy, Warsaw University of Technology, Institute of Control and Industrial Electronics, Poland. 7. 12. 2011 – 12. 12. 2011. Work on bilateral project.

RESEARCH VISITS

Uroš Lotrič and Branko Šter, Warsaw University of Technology, Institute of Control and Industrial Electronics, Poland. 26. 9. 2011 – 1. 10. 2011. Work on bilateral project.

Andrej Dobnikar, Nejc Ilc, Davor Sluga, Warsaw University of Technology, Institute of Control and Industrial Electronics, Poland. 26. 9. 2011 – 28. 9. 2011. Work on bilateral project.

Jernej Zupanc: Max-Planck-Institut fuer biologische Kybernetik, Tuebingen, Germany, Nov 2010 – Mar 2011. Work towards PhD.

SELECTED PUBLICATIONS

A. Dobnikar, U. Lotrič, B. Šter (ur.): Adaptive and natural computing algorithms: 10th international conference ICANNGA 2011, Ljubljana, Slovenia, April 14-16, 2011, Lecture notes in computer science, 6593, 6594, Berlin, Heidelberg, Springer, 2011.



Nvidia Tesla C2050 GPU computing processor and computing cluster

J. Zupanc, D. Drobne, B. Šter: Markov random field model for segmenting large populations of lipid vesicles from micrographs. *Journal of liposome research*, 21: 215-323, 2011.

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C. Silva, U. Lotrič, B. Ribeiro, A. Dobnikar: Distributed text classification with an ensemble kernel-based learning approach. *IEEE trans. syst. man cybern., Part C Appl. rev.*, 40: 287-297, 2010.

A. Dobnikar, B. Šter: Structural properties of recurrent neural networks. *Neural Process. Lett.*, 29: 75-88, 2009.

B. Šter, Z. Šušterič, U. Lotrič: Combined application of theoretical modelling and neural networks in vulcametry, *Kautschuk-Gummi-Kunststoffe*, 62: 313-318, 2009.

M. Bratina, Z. Šušterič, B. Šter, U. Lotrič, A. Dobnikar: Predictive control of rubber mixing process based on neural network models, *Kautschuk-Gummi-Kunststoffe*, 62: 378-382, 2009.

B. Šter, A. Dobnikar: Building internal maps of a mobile robot, In: X.-J. Jing (ed.): *Mobile robots motion planning: new challenges*, (Advanced robotics series). Vienna: I-Tech, 503-516, 2008.

M. Trebar, Z. Šušterič, U. Lotrič: Predicting mechanical properties of elastomers with neural networks, *Polymer*, 48: 5340-5347, 2007.

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

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RESEARCH ACTIVITIES

Research activities cover computer architectures, software-hardware co-design, parallel processing, embedded systems, programmable logic, soft computing, radiofrequency identification (RFID), and supply chain management.

A majority of research activities include the development of approximate arithmetic circuits for signal processing and adaptive systems. Analysis and research are oriented to the solution of approximate multiplier applicability and squarer in hardware implementation of DSP algorithms and neural networks where a shorter time delay of proposed methods and efficient implementations is more important than accuracy. Another part of work is dedicated to GPU implementation of algorithms for automatic analysis of remote sensing images.

Furthermore, the research activities include also studies and development of cold chain control and shelf life prediction by using radiofrequency identification technology (RFID) in supply chain management and wireless tracking of objects to acquire the information used in traceability systems. For larger amount of collected data is very important to build classification and prediction models by using neural networks, support vector machines (SVMs) and some new methods applicable in design of intelligent RFID systems, or pervasive computing research oriented towards Internet of Things.



QR code used to access traceability data (RFID-F2F)

RESEARCH PROJECTS

RFID-F2F, RFID from Farm to Fork. CIP-ICT-PSP European project, European Commission (2010-2012).

Medical Image Compression (BI-BA/10-11-026). Slovenian-Bosnian Bilateral Collaboration Project (with University of Banja Luka, BiH), Slovenian Research Agency (2010-2011).

LABORATORY GUESTS

Vladimir Risojević, Faculty of Electrical Engineering, University of Banja Luka, 15. 4. 2011 – 17. 4. 2011. Collaboration on “Gabor Descriptors for Aerial Image Classification”.

Dr. Alejandro Alvarez Melcon, Dr. Fernando Quesada Pereira, University of Cartagena, Spain, 16. 5. 2011 – 21. 5. 2011. Collaboration on “Problem of defining RFID events in EPCIS database”.

Aleksej Avramović, Faculty of Electrical Engineering, University of Banja Luka, 19. 9. 2011 – 22. 9. 2011. Collaboration on “Approximate squaring circuits for DSP”.

RESEARCH VISITS

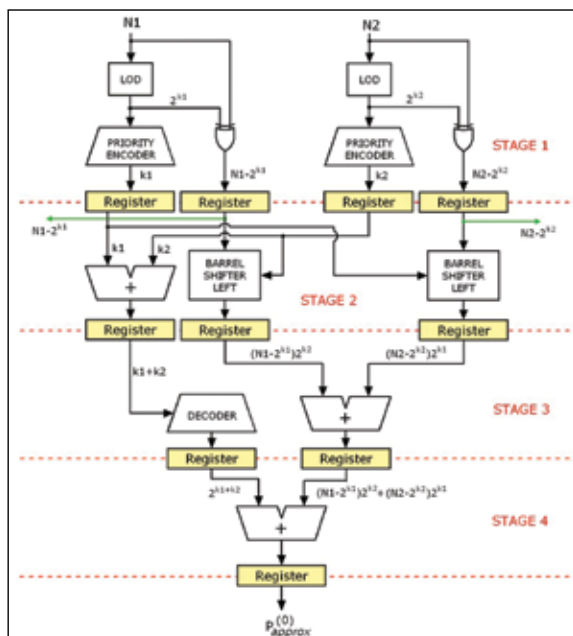
Mira Trebar: University of Cartagena, Spain, 6. 3. 2011 – 16. 3. 2011. Research collaboration on “RFID technology in solving traceability problem in EU F2F-RFID project”.

SELECTED PUBLICATIONS

U. Lotrič, P. Bulić. Applicability of approximate multipliers in hardware neural networks. *Neurocomputing*, 2011, in press.

P. Bulić, V. Guštin, D. Šonc, A. Štrancar. An FPGA-based integrated environment for computer architecture. *Computer applications in engineering education*, 2011, in press.

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Multiplier-Iteration in 4-stages pipeline

Computer Design, ICCD 2011: pervasive computing, Amherst, MA, USA, pp. 162-167, 2011.

Z. Babić, A. Avramović, P. Bulić. An iterative logarithmic multiplier. *Microprocessors and Microsystems*, vol. 35, no. 1, pp. 23-33, 2011.

P. Bulić, T. Dobravec. An approximate method for filtering out data dependencies with a sufficiently large distance between memory references. *Journal of Supercomputing*, vol. 56, no. 2: pp. 226-244, 2011.

R. Češnovar, P. Bulić, T. Dobravec. Optimization of a single seam removal using a GPU. *The 17th International Conference on Parallel and Distributed Processing Techniques and Applications, PDPTA*, pp. 330-335, Las Vegas, USA, 2011.

M. Trebar A. Grah, A. MELCON, A. PARRENO, Towards RFID traceability systems of farmed fish supply chain. *Proc. of 19th International Conference on Software, Telecommunications and Computer Networks, SoftCOM 2011*, pp. 1-6, Split, Croatia, 2011.

L. Finžgar, M. Trebar, Use of NFC and QR code identification in an electronic ticket system for public transport. *Proc. of 19th International Conference on Software, Telecommunications and Computer Networks, SoftCOM 2011*, pp. 1-6, Split, Croatia, 2011.

I. Cuinas, L. Catarinucci, M. TREBAR, RFID from Farm to Fork: traceability along the complete food chain. *Proc. of PIERS 2011 in Marrakesh March 20-23: The Electromagnetics Academy*, pp. 1370-1374, Marakesh, Marocco, 2011.

P. Bulić, Z. Babić, A. Avramović. A simple pipelined logarithmic multiplier. *XXVIII IEEE International Conference on Computer Design, ICCD 2010: embedded systems*, pp. 235-240, Amsterdam, the Netherlands, 2010.

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RESEARCH ACTIVITIES

The main research interests of our laboratory members are distributed systems design and development, computing clouds and grid architectures, service oriented architecture with related technologies, network security and security policies, communication protocols, formal validation and testing, computer networks design, and agile methodologies in the development of software and information systems.

In 2010, we have researched most actively the following areas:

- In the are of e-learning, we have built our virtual laboratory in a cloud for teaching computer communications and other courses. The infrastructure of eleven servers was used by 350 students, each of them with at least three virtual machines. We are continuously improving the virtual lab and evaluating the students' feedback. At the same time we are researching the pedagogical aspects of introducing e-learning in a cloud (e.g. Virtual Computing Lab) into the teaching process: how to enable our students to perform complex exercises that include multiple servers, diverse network topologies and other resources 24/7, regardless of their location.
- In the area of distributed systems architecture, we have studied system integration techniques with Service Oriented Architecture principles. We have studied the usability of these architectures in digital identity management systems, in Enterprise Application Integration, and in e-learning systems.
- In cooperation with University of Ljubljana's IT department we are researching identity management and application integration technologies and systems.
- In the area of agile methodologies, we have studied the impact of test-first programming on productivity, code complexity, tests properties (branch coverage) and the mutation score indicator.

- In the networking area, we were studying transition mechanisms from IPv4 to IPv6 protocol, and wireless routing protocols in vehicular networks.

EQUIPMENT

Besides the typical office equipment, the Computer Communications Laboratory is equipped with a few pieces of advanced networking / cloud computing hardware and software equipment. *Hardware*: one 20 Gb/s Infiniband DDR network switch, two 24-port and two 48-port Dell Gigabit Switches, a Dell Power Vault NAS 745 (2 TB), an IBM dual processor eServer xSeries 336 storage server with 3 TB of locally attached SCSI storage in an HP MSA-20 enclosure, one SuperMicro storage server with 12 TB of locally attached SATA storage, 11 Dell PowerEdge QuadCore R200 servers each with four Gigabit Ethernet ports and an Infiniband SDR 10 Gb/s connection, 4 Dell PowerEdge DualCore Servers and 2 Dell PowerEdge Dual Xeon Processor servers, 4 802.11b/g/n wireless Access Points, various mobile devices, ActivCard SmartCard readers and smart cards.

Software: network management tools and utilities, Vmware virtualization tools, Nexenta and Openfiler storage appliance software, databases and development tools, Redmine project management software, Moinmoin Wiki, Microsoft development tools and utilities; several open-source Java development tools and utilities including Mobile Phone development utilities, ...

RESEARCH PROJECTS

Integration module Esperanto and Identity portal maintenance for the University of Ljubljana. Industry-Funded Project, University of Ljubljana (2010–2011).



Cloud computing - physical infrastructure: servers, storage, Infiniband switch

EPSIAE - Green IT: Entering Sustainability within academic ICT studies. European Project (Framework Programmes), European Commission (2010–2013).

Security inspection and penetration testing. Industry-Funded Project, Humane tehnologije d.o.o. (2011–2011).

Proxy for traffic anonymisation – an inspection. Industry-Funded Project, RETARGET d.o.o. (2011–2011).

KC CLASS - Cloud Assisted Services (3211-10-000467), Structural Funds Project, Ministry of higher education, science and technology (2011–2013).

LABORATORY GUESTS

Dr. Olaf Maennel, Loughborough University, United Kingdom. 5. 7. 2011 - 7. 7. 2011. Lecture: 10 Lessons from 10 Years of Measuring and Modelling the Internet.

RESEARCH VISITS

Andrej Krevl, InHolland University of Applied Sciences, Amsterdam, Netherlands, 20. 2. 2011 - 27. 2. 2011. Research of sustainability-related contents within academic ICT studies.

SELECTED PUBLICATIONS

M. Pančur, M. Ciglarič, Impact of test-driven development on productivity, code and tests: A controlled experiment, *Information and Software Technology* 53 (2011), pp. 557-573 DOI information: 10.1016/j.insof.2011.02.002.

N. Škoberne, M. Ciglarič: Practical Evaluation of Stateful NAT64/DNS64 Translation, *AECE - Advances in Electrical and Computer Engineering*, 2011, in press.

M. Ciglarič, A. Krevl, M. Jeličič, A. Brodnik. Laboratory as a service: architecture, implementation and experiences. *Asia-Pac. collab. educ. journal*, 2010, vol. 6, no. 2, str. 69-86.

M. Ciglarič, S. Mavsar. Raziskovanje omrežnih napadov: muholovec Simx. *Elektroteh. vestn.*, 2010, letn. 77, št. 4, str. 173-178.

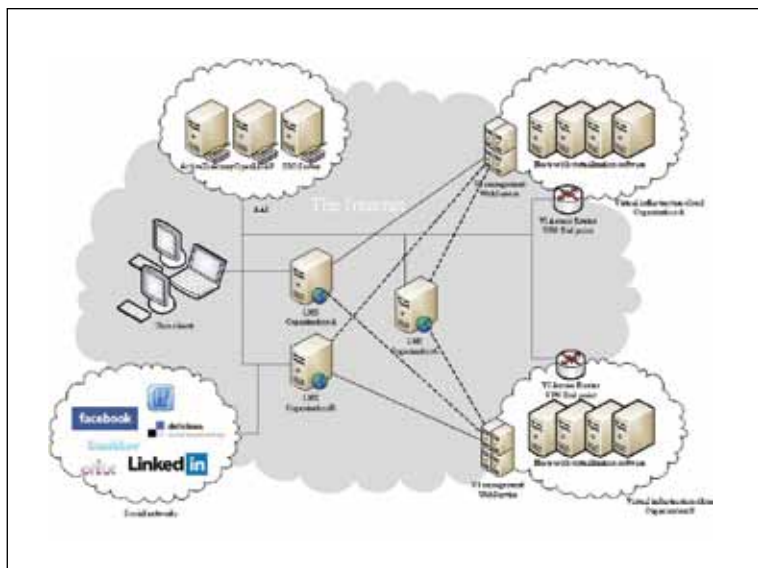
A. Krevl, M. Ciglarič. A framework for developing distributed location based applications. *Proc. 20th International Parallel and Distributed Processing Symposium*, 2006, Rhodes Island, Greece. Piscataway: IEEE, 2006.

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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



Virtual laboratory in a cloud: architecture

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.

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

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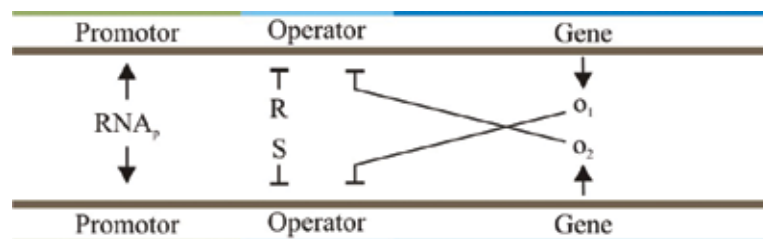
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RESEARCH ACTIVITIES

The principal scientific research directions of the laboratory are alternative processing platforms of the future. A lot of effort is dedicated to the research of ternary processing using Quantum Dot Cellular Automata. Our results have been published in one of the most respectable journals in the field Nanotechnology. In cooperation with the National Institute of Chemistry of Slovenia we are also studying synthetic biology (processing in biological systems). Our goal is to implement the basic logical primitives like memorizing cells and logical gates of different types. Members of the laboratory have acted as co-advisors to students from the University of Ljubljana that attended the iGEM 2010 competition and won the grand prize. Our research activities in the field of alternative processing methods are also committed to fuzzy logic, especially fuzzy time, fuzzy automata, as well as the implementation of different fuzzy algorithms, such as fire spread prediction models, fuzzy controllers for household devices, fuzzy animats, solving logistic problems with fuzzy logic etc. Our research activities are partially financed from European funds (ESF) and partially from the national research funds (ARRS).

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



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

RESEARCH PROJECTS

Pervasive computing (P2-0359). Research Programme, Slovenian Research Agency (2009-2011).

KC OPCOMM - Open Communication Platform for Service Integration (3211-10-000468), Structural Funds Project, Ministry of higher education, science and technology (2011–2013).

RFID-F2F, RFID from Farm to Fork. CIP-ICT-PSP European project, European Commission (2010-2012).

Medical Images Compression, Bilateral Collaboration Project (BI-BA/10-11-026), Slovenian Research Agency (2010–2011).

Computer vision for mobile computing and interaction (J2-221). Basic Research and Application Project, Slovenian Research Agency (2009–2012).

LABORATORY GUESTS

Nikolay Kolev Stefanov, Technical University of Varna, Varna, Bulgaria. June–September 2011. BSc thesis research.

Ayhan Mehmed, Technical University of Varna, Varna, Bulgaria. June–September 2011. Internship.

Hristo Hristoskov, Technical University of Varna, Varna, Bulgaria. October 2011–January 2012. PhD thesis research.

RESEARCH VISITS

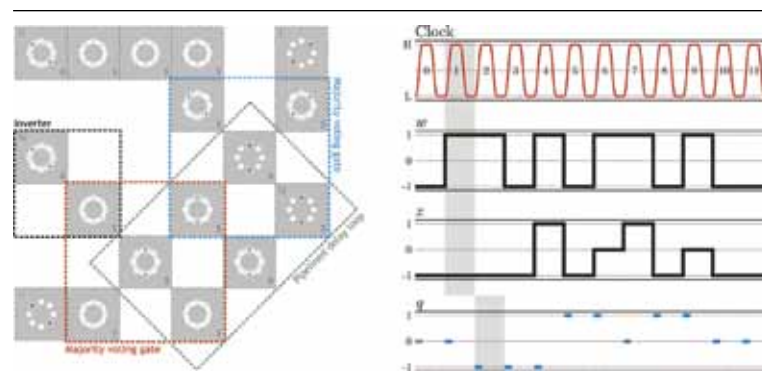
Miha Mraz: Institut of Microwaves and Photonic, Graz University of Technology, Austria, 22. 8. - 4. 10. 2011. Reliability analysis of wireless optical networks.

INVITED TALKS AND LECTURES

Miha Mraz: Biological Computing, 17. 6. 2011, an invited lecture at Beijing University, Beijing, China.

SELECTED PUBLICATIONS

M. Moškon, Š. Novak, M. Medeot, I. Lebar Bajec, N. Zimic, M. Mraz. Solving the logistic problems with optimal resource assignment using fuzzy logic methods, accepted for publication in *Journal of Advanced Transportation*.



The balanced ternary quantum-dot cellular automata memorizing cell WX, with prerequisite $w \neq 0$, and the corresponding simulation results for the sequence of read/write operations: read, write (-1), write (-1), read, write (1), read, write (0), write (1), read, write (0), read, read

I. Lebar Bajec, F.H. Heppner. Organized flight in birds, *Animal behaviour*, 78(4): 777-789, 2009.

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.

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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.

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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. 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.

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RESEARCH ACTIVITIES

The Information Systems Laboratory is involved in basic and applied research in the field of Information 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 methodologically socio-technical suitability to both organisation and project-specific requirements. From this 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, IPMIT, ZZI. We have also developed a Unified methodology for information systems development – EMRIS for Government Centre for Informatics. We also developed a model of resistance to change that evaluates the economic risks of using specific parts of information systems. The model is currently being applied in NLB (the largest Slovenian bank) and Employment Service of Slovenia.

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

the last edition we integrated an enterprise architecture framework, which enables the design of strategic enterprise architecture during plan development. These methodologies are based on many years of practical experiences in developing strategic plans for a wide range of organisations. We developed strategic plans for the following organisations: the Employment Service of Slovenia, KAD (financial institution), Elektro Ljubljana (electricity distribution operator), ELES (Slovenian electric power transmission company), Slovenian electricity distribution operators association, Informatika, d.d., Mobitel (Slovenian mobile telephony operator) and government institutions. Recently, we also developed enterprise architectures, organised and executed workshops for Iskratel (telephony and networks solutions developer) and Employment Service of Slovenia. In the context of IT/IS planning we focus our research on: enterprise architecture, IS/IT architectures, information systems reengineering, business process reengineering, electronic business, COBIT and other IT governance 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 the utilization of intelligent agents and multi-agent systems for business systems and their information systems.

Semantic web and knowledge discovery. Research on Semantic Web as the 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 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 the efficiency of

the informatics in the organisations and their business information architectures.

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 said access is provided using a prescribed interface and is exercised consistently 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 in 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 this 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 systems development. We developed IS reengineering and the development of SOA based enterprise architecture for Slovenian electricity distribution operators association.

RESEARCH PROJECTS

KC CLASS - Cloud Assisted Services (3211-10-000467), Structural Funds Project, Ministry of higher education, science and technology (2011–2013).

KC OPCOMM - Open Communication Platform for Service Integration (3211-10-000468), Structural Funds Project, Ministry of higher education, science and technology (2011–2013).

Pervasive computing (P2-0359), Research Programme, Slovenian Research Agency (2009–2011).

LABORATORY GUESTS

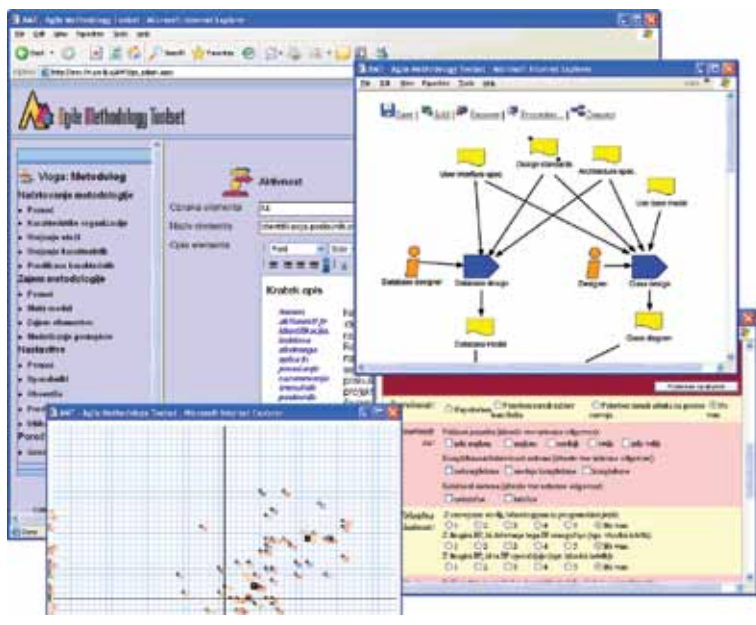
Olegas Vasilecas, Gediminas Technical University, Lithuania. July 2011, Research work in the field of information systems development methodologies, business rules and ontologies.

Veljko Milutinovic and other researchers from Department of Computer Engineering School of Electrical Engineering, Belgrade, 4. 11. 2011 – 6. 11. 2011. Collaboration in the field of method engineering.

RESEARCH VISITS

Marjan Krisper: Computer Engineering School of Electrical Engineering, 12. 5. 2011 - 17. 5. 2011. Research visit in the field of enterprise architectures and e-government.

Marjan Krisper: Centre de Recherche en Informatique, Université Paris 1 Panthéon – Sorbonne, 16. 11. 2011 - 20. 11. 2011. Research visit in the field of method engineering.



Screenshot of the AMT system

SELECTED PUBLICATIONS

D. Vavpotič, O. Vasilecas. An approach for assessment of software development methodologies suitability. *Elektron. elektrotech.*, vol. 114, no. 8, pp. 107-110, 2011.

A. Šaša, O. Vasilecas. Ontology-based support for complex events. *Elektron. elektrotech.*, no. 7, pp. 83-88, 2011.

A. Šaša, M. Krisper. Ontology-based knowledge management in service-oriented systems. *J. inf. organ. sci.*, vol. 35, no. 1, pp. 105-118, 2011.

A. Šaša, M. Krisper. Service-oriented architectural framework for support and automation of collaboration tasks. *J. inf. organ. sci.*, vol. 35, no. 1, pp. 119-133, 2011.

A. Šaša, M. Krisper. Enterprise architecture patterns for business process support analysis. *J. syst. softw.*, 2011, vol. 84, no. 9, str. 1480-1506, 2011.

D. Vavpotič, T. Hovelja. Improving the evaluation of software development methodology adoption and its impact on enterprise performance. *Comput. Sci. Inf. Syst.*, (In Press).

D. Lavbič, O. Vasilecas and R. Rupnik. Ontology-based multi-agent system to support business users and management. *Technological and economic development of economy*, vol. 16, no. 2, pp. 327-347, 2010.

D. Lavbič, I. Lajovic and M. Krisper. Facilitating information system development with Panoramic view on data. *Computer Science and Information Systems*, vol.4, no.7, pp. 737-767, 2010.

D. Lavbič and M. Krisper. Facilitating Ontology Development with Continuous Evaluation. *Informatica*, vol. 21, No. 4, pp. 533-552, 2010.

M. Trkman and P. Trkman. A wiki as intranet : a critical analysis using the Delone and McLean model. *Online inf. rev.*, vol. 33, no. 6, pp. 1087-1102, 2010.

M. B. Jurič, A. Šaša, B. Brumen, I. Rozman. WSDL and UDDI extensions for version support in web services. *J. syst. softw.*, vol. 82, no. 8, pp. 1326-1343, 2009.

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

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

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RESEARCH ACTIVITIES

The Laboratory of e-media is actively involved in research areas of security, privacy and trust management with an emphasis on cryptographic protocols, formal methods, security infrastructure systems like PKI and AAA. In addition, the laboratory's research activities cover quantitative modelling of human factor, aimed at the development of solutions that support decision making for the management of information systems and critical infrastructures. The foundations for these activities are methodologies like system dynamics and quantitative assessment dynamics (QAD).

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 the management of information systems security, and technological solutions for trust management in global networks. Furthermore, our research results have been published in renowned international journals (like those published by Elsevier and IEEE), and in monographs published by Springer, Francis & Taylor (chapter contribution) and IGI Global (chapter contribution).

Finally, laboratory members are (or have been) nominated to serve on board of important EU and international organizations (e.g., MB of ENISA, ISC NATO Panel). They also serve as reviewers for renowned publishers (of scientific journals and monographs), they are examiners and jury members for PhDs at other EU universities, and lecturers at other universities and international events.

RESEARCH PROJECTS

SEMPOC - Simulation Exercise to Manage Power Cut Crises (JLS/2008/CIPS/024). European Project, European Commission (2009–2011).

Pervasive computing (P2-0359), Research Programme, Slovenian Research Agency (2009–2011).

Managing technical, business and social implications of Internet of things in Slovene environment (V2-1022), Target Research Project, Slovenian Research Agency and MVZT (2010–2011).

COST IS0605 - A Telecommunications Economics COST Network. International Project (2007–2011).

COST IC0801 - Agreement Technologies. International Project (2008–2012).

LABORATORY GUESTS

Prof. Dr. Edmundo Monteiro, University of Coimbra, 4. 4. 2011 – 9. 4. 2011.

Dr. Martin Waldburger, University of Zurich, Department of Informatics, 26. 9. 2011 – 30. 9. 2011. Short term scientific mission (STSM), COST Action IC0605, Econ@Tel.

RESEARCH VISITS

David Jelenc, B.Sc.; University of Rey Juan Carlos, Madrid, Spain. 16. 5. 2011 – 16. 6. 2011. Short term scientific mission (STSM), COST Action IC0801, Agreement Technologies.

INVITED TALKS AND LECTURES

Denis TRČEK, Trust Management Methodologies for the Web, Reasoning Web '11, DERI, NUI, Galway, 23. 8. 2011 – 27. 8. 2011.

SELECTED PUBLICATIONS

TRČEK, Denis. Security metrics foundations for computer security. *Comput. j.*, 2010, vol. 53, no. 5, pp. 1106-1112, doi: 10.1093/comjnl/bxp094.

TRČEK, Denis. A formal apparatus for modeling trust in computing environments. *Math. comput. model.*, 2008, pp. 1-8, doi: 10.1016/j.mcm.2008.05.005.

TRČEK, Denis, ABIE, Habtamu, SKOMEDAL, Åsmund, STARC, Iztok. Advanced framework for digital forensic technologies and procedures. *J Forensic Sci*, 2010, pp. 1-10, doi: 10.1111/j.1556-4029.2010.01528.x.

TRČEK, Denis, JÄPINNEN, Pekka. RFID security. V: ZHANG, Yan (ur.), YANG, Laurence Tianruo (ed.), CHEN, Jiming (ed.). *RFID and sensor networks : architectures, protocols, security, and integrations, (Wireless networks and mobile communications)*. Boca Raton: Taylor & Francis, 2010, pp. 147-168.

HERNANTES, Josune, TORRES, Jose M., LAUGE, Ana, SARRIEGI, Jose M., STARC, Iztok, ZUPANČIČ, Eva, TRČEK, Denis. Using GMB methodology on a large crisis model, FRENCH, Simon (ed.), TOMASZEWSKI, Brian (ed.), ZOBEL, Christopher (ed.). *Defining crisis management 3.0 : proceedings*, 2010, pp. 1-5.

TRČEK, Denis. Managing communications in critical infrastructures protection. *Proc. of the ICCEA 2010*, 2010. Vol. 1. Los Alamitos (California); Washington: IEEE Computer Society, cop. 2010, pp. 11-15.

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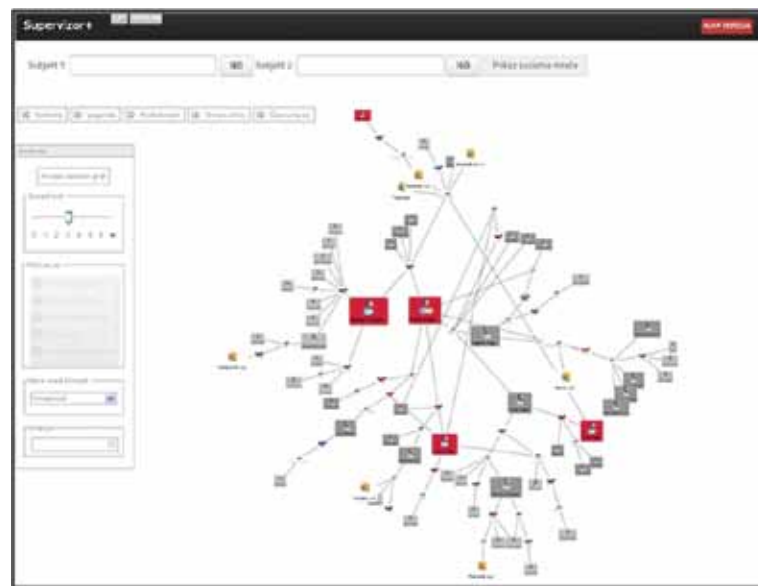
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RESEARCH ACTIVITIES

The Data Technology Laboratory was founded in 2009 and is one among the youngest laboratories at the Faculty for Computer and Information Science. Its members are involved in basic and applied research in the fields of data analysis, data representation, data visualization and semantic web:

Data analysis: is a very broad research area. We focus on the segments of business rules management systems, business intelligence, fraud management and (social) networks. Research is divided between academic research and applicative research. Applicative research is closely connected to the fields of fraud management and transaction intensive information systems architectures.

Data representation: Data entities are typically represented in an ordinary flat form. However such representation is not adequate when we are interested in relations between entities or in patterns in these relations. In that case one must employ some enhanced representation of data-like networks. Networks are the most natural representation of any relational domain (hyper pages, social networks etc.) allowing formulation of complex relations between entities. They allow the analysis of entities in the context of related entities and not in complete isolation. Networks are currently one of the hot topics in many research areas (network analysis, data mining, bioinformatics, etc.). Our research is mainly focused on analysis and mining of networks' data and using networks for fraud detection in different fields.



Identification and visualisation of patterns of relationships among entities

Data visualization: As the volume and complexity of data increases it becomes very difficult for users to effectively explore large-scale datasets. A possible solution for this problem is visualization (graphical representation of data). Visualizing large amounts of data allows us to see patterns that may otherwise remain hidden and it allows us also to quickly grasp and process large amounts of data that would otherwise require a lot of time to study. Visualizations are used in many fields (medicine, education, geovisualizations, data-mining, financial data analysis etc.) and employ different visualization techniques (graphs, cluster diagrams, volume rendering etc.), but just any arbitrary visualization may not be inherently useful and may even lead to flawed conclusions. An important aspect of visualization is also dynamics of representation and interactivity (e.g. dynamical adjustment of mapping in real-time).

Semantic web: The current version of the World Wide Web consists of several mutually connected documents that are presented to human users by computers. These documents originated in interconnected systems where every user could contribute. This also results in the fact that information quality cannot always be guaranteed. The current World Wide Web consists of data, information and knowledge, but the role of computers at this stage is only to deliver and represent the content of the documents that describe knowledge. To integrate different information resources users have to manually interpret these data. Semantic Web tends to improve current World Wide Web with computers processing, interpreting, integrating data on the web and with this approach aiding human users in discovering complex knowledge. Semantic Web is focused towards sharing and reusing of data and not documents. The research area emphasizes the establishment of a common framework to enable the sharing and reusing of data among applications and enterprises.



Tell me more about entities

RESEARCH PROJECTS

KC CLASS - Cloud Assisted Services (3211-10-000467), Structural Funds Project, Ministry of higher education, science and technology (2011–2013).

KC OPCOMM - Open Communication Platform for Service Integration (3211-10-000468), Structural Funds Project, Ministry of higher education, science and technology (2011–2013).

LABORATORY GUESTS

Prof. dr. Olegas Vasilecas, Vilnius Gediminas technical university. 2011. Multiple joint research meetings.

Prof. dr. Veljko Milutinović, IEEE Fellow, University of Belgrade, School of Electrical Engineering. November, 2011. Lecture: Concept Modelling for Knowledge Search.

SELECTED PUBLICATIONS

Šubelj, L. & Bajec, M., 2011. Robust network community detection using balanced propagation. *European Physical Journal B*, 81(3), 353-362.

Šubelj, L. & Bajec, M., 2011. Community structure of complex software systems: Analysis and applications. *Physica A: Statistical Mechanics and its Applications*, 390(16), 2968-2975.

Šubelj, L. & Bajec, M., 2011. Unfolding communities in large complex networks: Combining defensive and offensive label propagation for core extraction. *Physical Review E*, 83(3), 036103.

Šubelj, L., Furlan, Š. & Bajec, M., 2011. An expert system for detecting automobile insurance fraud using social network analysis. *Expert Systems with Applications*, 38(1), 1039-1052.

Lavbič, Dejan, Krisper, Marjan. 2010. Facilitating information system development with Panoramic view on data. *Computer Science and Information Systems*. 7(4), str. 737 - 768.

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B. Žvanut and M. Bajec. A tool for IT process construction. In: *Information and software technology*. Apr. 2010, vol. 52, no. 4, pp. 397-410.

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Š. Furlan and M. Ba jec. Holistic approach to fraud management in health insurance. In: *Journal of information and organizational sciences*, 2008, vol. 32, no. 2, pp. 99-114.

M. Bajec, D. Vavpotič. A framework and tool-support for re-engineering software development methods. In: *Informatika (Vilnius)*, 2008, vol. 19, no. 3, str. 321-344.

M. Bajec, D. Vavpotič and M. Krisper, Practice-driven approach for creating project-specific software development methods, In: *Information and software technology*. 2007, vol. 49, no. 4, pp. 345-365.

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

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RESEARCH ACTIVITIES

Laboratory for Integration of Information Systems has been focusing on the research and development in the field of integration and interoperability of information systems, architectures and platforms. Integration and interoperability is an important topic and covers all aspects of software and information systems development. Laboratory for Integration of Information Systems focuses specifically on software platforms, particularly Java Enterprise Edition and .NET, Service Oriented Architectures (SOA) and Cloud Computing (with focus on IaaS/PaaS/SaaS).

SOA is a set of principles and methodologies for designing and developing software in the form of interoperable services. We research technologies which enable execution, configuration and adaption of business processes in wider and comprehensive scenarios. Cloud Computing represents technologies that provide computation, software, data access, and storage services via the internet. It enables to address new areas and to develop innovative software solutions, IT services, and efficient cost-effective usage of information resources. This technology provides significant progress in the economy, government and academic circles, particularly in the field of competitiveness, business optimization and innovation. Our laboratory conducts research, development and mentoring for the development of complex Java EE and SOA/BPM solutions, e-services

and e-content, and Cloud Computing solutions. This allows to address new areas and to find innovative solutions.

In collaboration with important partners such as Oracle, IBM, and Microsoft we are working on many projects that incorporate following research fields and technologies:

- Integration and interoperability methods of information systems,
- Service-Oriented Architecture (SOA) which include:
 - Integrated SOA + BPM life cycle
 - Evaluation and optimization of SOA
 - Management of SOA architecture
 Service design based on the concept of service science
- Cloud computing (IaaS, PaaS, SaaS):
 - Infrastructure as a Service
 - Platform as a Service
 - Software as a Service
- Multitier architecture
- Java Enterprise Edition, Java EE and .NET platforms
- Architectural and technological aspects of integration and interoperability
- Middleware
- Integration platform technologies
- Service platforms and Web services
- Application and Process Servers

RESEARCH PROJECTS

Semantically Advanced Service Oriented Portal for Information and Knowledge Management (L5-2245), Basic Research and Application Project, Slovenian Research Agency (2009–2012).

KC CLASS - Cloud Assisted Services (3211-10-000467), Structural Funds Project, Ministry of higher education, science and technology (2011–2013).

KC OPCOMM - Open Communication Platform for Service Integration (3211-10-000468), Structural Funds Project, Ministry of higher education, science and technology (2011–2013).

LABORATORY GUESTS

Enrique J. Bravo Castro, Universidad de Chile, Facultad de Ciencias Físicas y Matemáticas, 19. 4. 2011 - 4. 6. 2011. Patterns research for SOA and BPM Governance.

INVITED TALKS AND LECTURES

Matjaž B. Jurič: Novosti Java EE 7 in pogled v oblak, SIOUG 2011, 20.09.2011, Slovenija.

Matjaž B. Jurič, Marcel Križevnik: Praktični prikaz uporabe Oracle BPM Suite 11g in Oracle SOA Suite 11g za upravljanje poslovnih procesov, SIOUG 2011, 20.09.2011, Slovenija.

Matjaž B. Jurič: SOA Architectural Patterns and Anti-Patterns, OpenBlend, 15.10.2011, Slovenija.

Matjaž B. Jurič: Java EE 7 and migration to the cloud, HrOUG, 20.10.2011, Croatia.

Matjaž B. Jurič, Marcel Križevnik: How in the Development and Monitoring of Business Processes using Oracle BPM Suite and SOA Suite, HrOUG, 19.10.2011, Croatia.

Matjaž B. Jurič: Migracija v oblak - priložnosti, zanke in pasti. Ljubljana: Cloud Computing Expo, 2011.

Matjaž B. Jurič: Pregled računalništva v oblaku na nivoju infrastrukture, platforme in storitev, Srečanje uporabnikov KOPA, Ribnica na Pohorju 2011.

SELECTED PUBLICATIONS

JURIČ, Matjaž B., KRIŽEVNIK, Marcel, et al.: Do more with SOA Integration, Packt Publishing, 2011.

JURIČ, Matjaž B.: Extending Web Services with Event-driven Semantics, ICPCA 2011, IEEE, 2011.

JURIČ, Matjaž B., KRIŽEVNIK, Marcel: SCA and SDO in SOA, ODTUG Kscope11, Long Beach, California, 2011.

JURIČ, Matjaž B., KRIŽEVNIK, Marcel: Business activity monitoring unleashed. ODTUG Kscope11, Long Beach, California, 2011.

KRIŽEVNIK, Marcel, JURIČ, Matjaž B.: Upravljanje matičnih podatkov kot osnova pri vpeljavi storitveno usmerjene arhitekture. Uporabna informatika (Ljubljana), 2011.

DUKARIČ, Robert, JURIČ, Matjaž B.: Migracija obstoječih aplikacij na platforme za računalništvo v oblaku, Uporabna informatika (Ljubljana), 2011.

JURIČ, Matjaž B.: Migracija v oblak - priložnosti, zanke in pasti, Finance, 2011

DUKARIČ, Robert, JURIČ, Matjaž B.: Migracija obstoječih rešitev v oblak, konferenca Dnevi slovenske informatike, Slovenija, 2011.

POTOČNIK, Martin, JURIČ, Matjaž B.: Integracija oblačnih storitev z obstoječimi informacijskimi sistemi, konferenca Dnevi slovenske informatike, Slovenija, 2011.

FRECE, Aleš, JURIČ, Matjaž B.: Slabe prakse v storitveno orientirani arhitekturi. konferenca Dnevi slovenske informatike, Slovenija, 2011

HERTIŠ, Matej, JURIČ, Matjaž B.: Obvladovanje prehoda poslovnih procesov iz faze modeliranja v fazo izvajanja. konferenca Dnevi slovenske informatike, Slovenija, 2011.

KRIŽEVNIK, Marcel, JURIČ, Matjaž B.: Uporaba konceptov dogodkovne arhitekture v SOA. konferenca Dnevi slovenske informatike, Slovenija, 2011.

SRDIČ, Gregor, JURIČ, Matjaž B.: Java Persistence API in trajnost podatkov v storitveno orientirani arhitekturi. konferenca Dnevi slovenske informatike, Slovenija, 2011.

Laboratory for Algorithms and Data Structures

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RESEARCH ACTIVITIES

The laboratory performs 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

Parallel and Distributed Systems (P2-0095). Research Programme, jointly with Jozef Stefan Institute and Faculty of Electrical Engineering, University of Ljubljana. Slovenian Research Agency (2009-2013).

SELECTED PUBLICATIONS

P. Bulič, T. Dobravec. An approximate method for filtering out data dependencies with a sufficiently large distance between memory references. *J. supercomput.* 56(2):226-244, 2011.

J. Mihelič, B. Robič. Flexible-attribute problems. *Computat. Optimiz. Appl.* 47:553-566, 2010.

J. Mihelič, A. Mahjoub, C. Rapine, B. Robič. Two-stage flexible-choice problems under uncertainty. *Eur.J.Oper.Res.* 201(2):399-403, 2010.

T. Dobravec, B. Robič: Restricted shortest paths in 2-circulant graphs, *Comput. Commun.* 32(4):685-690, 2009.

A. Sulistio, U.Čibej, S.K.Prasad, R. Buyya. GarQ: An efficient scheduling data structure for advance reservations of grid resources, *Int.j.parallel emergent distr.syst.*, 24(1):1-19, 2009.

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

R. Trobec, M. Šterk, B. Robič. Computational complexity of the parallel meshless local Petrov-Galerkin method. *Comput. Struct.* 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 Comput.* 31:900-912, 2005.

B. Slivnik, B. Vilfan. Producing the left parse during bottom-up parsing. *Inf. Proc. Letters* 96:220-224, 2005.

J. Mihelič, B. Robič. Solving the k-center problem efficiently with a dominating set algorithm. *J.Comput. Inf. Tech.* 13(3):225-233, 2005.

P. Korošec, J. Šilc, B. Robič. Solving the mesh-partitioning problem with an ant-colony algorithm. *Parallel Comput.* 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.

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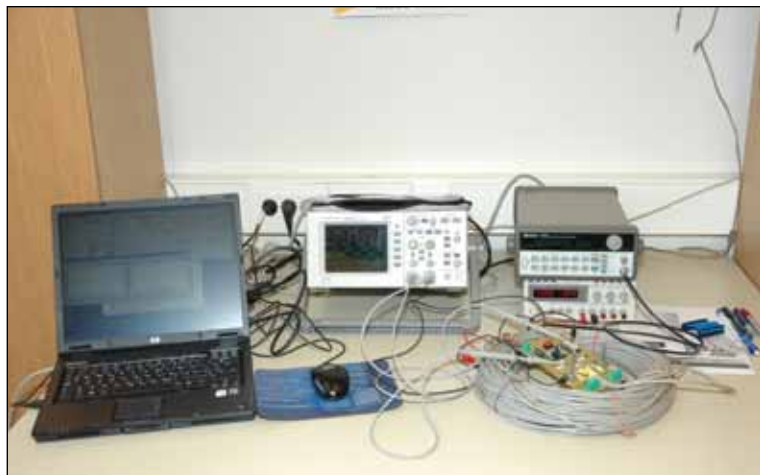
RESEARCH ACTIVITIES

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

1. *In Computer Architecture:* Design and development of special-purpose computers, both hardware and software. Comparative studies of superscalar and VLIW 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 the 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 being 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 has been acquired from collaborating in the COST-232 European project.



Measurement system that students use during I/O systems course.

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

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

Parallel and Distributed Systems (P2-0095). Joint project with Jozef Stefan Institute and Faculty of Electrical Engineering, University of Ljubljana. Basic Research Project, Slovenian Research Agency (2009-2012).

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, November 2005.

D. M. Kodek. Performance limit of finite word length 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.

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 (Ljubljana)*, 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 word length 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

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External Collaborator Rok Preskar	rok.preskar@hermes-softlab.com	

RESEARCH ACTIVITIES

The Software Engineering Laboratory is involved in teaching and researching in the areas of Software Engineering and Information Systems with an emphasis on Software Quality Management, Software Metrics, Information Systems Development, Information Systems Audit and Control, Data Warehousing, and Graph Grammars. 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 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.

2. *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.

3. *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.

4. *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.

5. *In Graph Grammars:* Graph grammars as a generalization of textual grammars. Parsing graph grammars and translating graph-

based languages. Graph grammar induction. Using developed theories and tools for solving relevant problems in various computer science domains.

6. *In Web User Behavior Analysis:* Using stochastic model for user behavior analysis. Separating interleaved web sessions using graph search algorithms.

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 (2001-2011).

SELECTED PUBLICATIONS

V. Mahnič. A capstone course on agile software development using Scrum. *IEEE Transactions on Education*, 2011, <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5765710>, doi: 10.1109/TE.2011.2142311.

L. Fürst, M. Mernik, V. Mahnič. Improving the graph grammar parser of Rekers and Schürr. *IET Software*, 5(2): 246-261, 2011.

V. Mahnič. A case study on agile estimating and planning using Scrum. *Electronics and Electrical Engineering*, 2011. No. 5: 123-128, 2011.

V. Mahnič. Teaching Scrum through team-project work : students' perceptions and teacher's observations. *International Journal of Engineering Education*, 26(1): 96-110, 2010.

M. Požanel, V. Mahnič, M. Kukar. Separation of interleaved Web sessions with heuristic search. 10th IEEE International Conference on Data Mining, 14-17 December 2010, Sydney, Australia., pp. 411-420.

M. Požanel, V. Mahnič, M. Kukar. Separating interleaved HTTP sessions using a stochastic model. *Informatica (Ljublj.)*, 34(2): 199-205, 2010.

V. Mahnič, S. Georgiev, T. Jarc. Teaching Scrum in cooperation with a software development company. *Organizacija (Kranj)*, 43(1): 40-48, 2010.

I. Rožanc. One year later : the effect of the Bologna reform on algorithms and data structures course teaching. In: N. Mastorakis (ed.). *Recent researches in educational technologies*. WSEAS Press, 2011, pp. 221-226

M. Požanel, V. Mahnič, M. Kukar. Heuristic best-first search in separation of interleaved Web sessions. Workshop on Analysis of Complex Networks at ECML PKDD, *ACNE 2010*, pp. 63-74, Barcelona, Spain, 2010.

L. Fürst, M. Mernik, V. Mahnič. A parser for context-sensitive graph grammars, *Proc. 18th International Electrotechnical and Computer Conference ERK 2009*, pp. 255-258, Portorož, Slovenia, 2009.

V. Mahnič, N. Žabkar. Using COBIT Indicators for Measuring Scrum-based Software Development. *WSEAS Transactions on Computers*, 7(10): 1605-1617, 2008.

L. Fürst, S. Fidler, A. Leonardis. Selecting features for object detection using an AdaBoost-compatible evaluation function. *Pattern recognition letters*, 29(11): 1603-1612, 2008.

V. Mahnič. Teaching information system technology in partnership with IT companies. *Organizacija (Kranj)*, 41(2): 71-78, 2008.

V. Mahnič, I. Vrana. Using stakeholder-driven process performance measurement for monitoring the performance of a Scrum-based software development process. *Electrotechnical review*, 74(5): 241247, 2007.

V. Mahnič, N. Žabkar. Introducing CMMI measurement and analysis practices into scrum-based software development process. *International journal of mathematics and computers in simulation*, 1(1): 65-72, 2007.

Computer Vision Laboratory

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RESEARCH ACTIVITIES

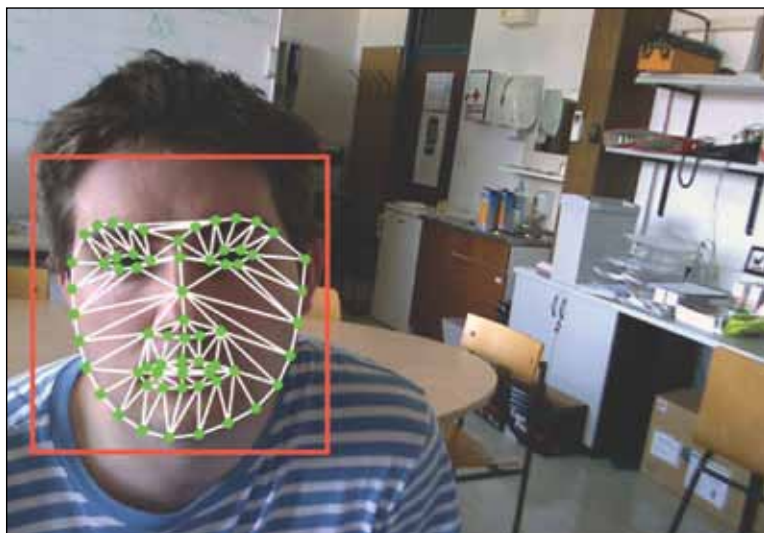
The laboratory is dedicated to research in computer vision and multimedia, with an emphasis on object segmentation, recognition and tracking, face detection, face and fingerprint recognition, text detection in natural scenes, gait recognition, panoramic imaging, texture processing, medical imaging, range 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 used for range image interpretation and also for object tracking in sequences of intensity images. 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.

We have developed a novel method of visualizing concurrent tones in music with colours and we are studying how this method could be used in the context of music understanding and learning.

We are studying human face detection and recognition in difficult illumination conditions. We are interested in using such techniques for smart advertising and digital signage.

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



Face tracking is used in the context of smart advertising

technology. The art projects serve as an excellent frame for testing our research results in practical applications.

We are interested in the use of unconventional user interfaces based on computer vision in the context of art, computer games and mobile platforms. In 2008 we established a GameTeam within the laboratory with a number of student members.

We are involved in applications in the areas of biometry systems, image based computer forensics, gaming systems, visual quality control, surveillance applications and smart advertising.

RESEARCH PROJECTS

Computer vision, Basic Research Programme (P2-0214), Slovenian Research Agency (2009–2014).

Managing technical, business and social implications of Internet of things in Slovene environment, Target Research Programme (V2-1022), Slovenian Research Agency, MVZT (2010–2011).

KC CLASS - Cloud Assisted Services (3211-10-000467), Structural Funds Project, Ministry of higher education, science and technology (2011–2013).

KC OPCOMM - Open Communication Platform for Service Integration (3211-10-000468), Structural Funds Project, Ministry of higher education, science and technology (2011–2013).

Text detection in images of natural scenes. Industry-Funded Project, Iks, d.o.o. (2009–2013).

Gait recognition. Industry-Funded Project, Mega M d.o.o. (2011–2014).

RESEARCH VISITS

Dr. Luka Šajn: The Rudjer Bošković Institute, Zagreb, Croatia, September 2011.

Dr. Peter Peer: CEIT (Centre of Studies and Technical Research), San Sebastian, Spain, July/August 2011.

EXHIBITIONS

Exhibition: Atlas, 5. 12. 2011

Gallery: Kamera, Kino Šiška; opening: 5. 12. 2011 at 19.00

<http://black.fri.uni-lj.si/kinosiska/katalogAtlas2011.pdf>

http://www.kinosiska.si/sl/dogodki/razstave-in-film/2011-12-05/atlas_5_12_2011/452/

<http://layar.it/sVUXmx>

Authors: Narvika Bovcon, Eva Lučka Kozak, Gorazd Krnc, Dominik Mahnič, Vanja Mervič, Evelin Stermitz, Aleš Vaupotič, Tilen Žbona

SELECTED PUBLICATIONS

B. Klemenc, P. Ciuha, F. Solina. Educational possibilities of the project Colour visualization of music. *Organizacija (Kranj)*, 2011, vol. 44, no. 3, pp. 67-75.

A. Ilica, P. Peer. CVL OCR DB, an annotated image database of text in natural scenes, and its usability. *Inf. MIDEEM*, 2011, vol. 41, no. 2, pp. 150-154.

T. Pristovnik, P. Peer, T. Hodnik Čadež. Reševanje problemov iz verjetnosti ob uporabi e-gradiva v četrtem razredu. *Didactica Slovenica / Pedagoš. obz.*, 2011, letn. 26, št. 1/2, str. 102-119.

N. Bovcon, A. Vaupotič. Curating New Media by Focusing on the Recipient's Attitude: Immateriality and Entertainment. *Acta graph.*, 2011, vol. 22, no. 1-2, pp. 33-38.

F. Solina, R. Ravnik. Fixing missing eye-contact in video conferencing systems. 33rd International Conference on Information Technology Interfaces ITI 2011, Cavtat / Dubrovnik, Croatia, pp. 233-236.

B. Kverh, M. Lipanje, B. Batagelj, F. Solina. Piano crossing - walking on a keyboard. *Acta graph.*, 2010, vol. 22, no. 3/4, pp. 25-38.

L. Šajn, M. Kukar. Image processing and machine learning for fully automated probabilistic evaluation of medical images. *Comput. methods programs biomed.*, 2010, doi: doi:10.1016/j.cmpb.2010.06.021.

P. Ciuha, B. Klemenc, F. Solina. Visualization of concurrent tones in music with colours. ACM MM 2010 & co-located workshops, New York, pp. 1667-1680.

F. Solina, R. Ravnik. Georeferencing works of literature. 32nd International Conference on Information Technology Interfaces ITI 2010, Cavtat / Dubrovnik, Croatia, pp. 249-253.

N. Bovcon. *Umetnost v svetu pametnih strojev: novomedijska umetnost Sreča Dragana, Jake Železnikarja in Marka Peljhana*. Raziskovalni inštitut Akademije za likovno umetnost in oblikovanje, Ljubljana, 2009.

P. Peer, B. Batagelj. Art – a perfect testbed for computer vision related research. *Recent advances in multimedia signal processing*

and communications, (Studies in computational intelligence, vol. 231). Berlin; Heidelberg: Springer, 2009, pp. 611-629.

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

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

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

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

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

F. Solina, 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.

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* From September 2011 also with University of Birmingham, School of Computer Science, Centre for Computational Neuroscience and Cognitive Robotics.

** Also with Computer Vision Laboratory. From June 2010 with University of Pennsylvania, Computational Perception and Cognition Laboratory.

*** Also with Laboratory for Mathematical Methods in Computer and Information Science.

**** Also with the Machine Vision Laboratory at the Faculty of Electrical Engineering.

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 modelling and interpretation.

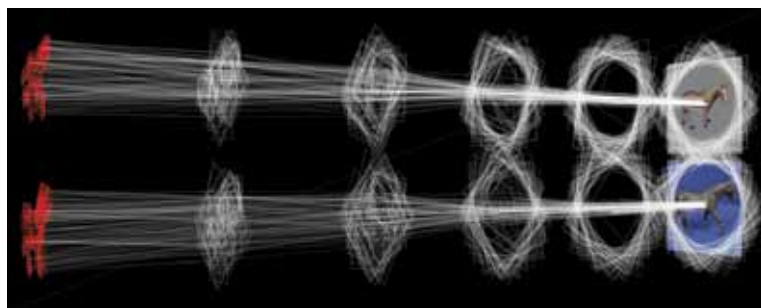
Research in the area of visually enabled cognitive systems focuses on various theories regarding requirements, architectures, forms of representation, kinds of ontologies and knowledge, and varieties of mechanisms relevant to integration and control of vision systems. In this context, cognitive vision 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 life-long 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 linguistic descriptions of the scene. This learning is performed in an interactive manner in a dialogue with a human; we have been exploring different learning strategies ranging from fully autonomous to completely tutor guided learning. 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 integrated and implemented on mobile robots. Specifically, we use two in-door and one out-door mobile platforms equipped with omnidirectional and stereo camera setups. We are also implementing direct interaction and object 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. On the other hand, the research in mobile computing is being integrated and tested on the state of the art mobile phones, which come equipped with



Object categorization by hierarchical matching to a prototype

numerous sensors and enough computing power and connectivity to support the development of ubiquitous visually aware cognitive agents. Both robots and gadgets shall 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 PROJECTS

Computer vision (P2-0214). Basic Research Programme, Slovenian Research Agency (2009-2014).

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

Computer vision for mobile computing and interaction (J2-2221). Basic Research Project, Slovenian Research Agency (2009-2012).

Learning a large number of visual object categories for content-based retrieval in image and video databases (J2-3607). Basic Research Project, Slovenian Research Agency (2010-2013).

Learning, analysis, and detection of motion in the framework of a hierarchical compositional visual architecture (J2-4284). Basic Research Project, Slovenian Research Agency (2011-2014).

Neovision2, Basic Research Project, Teledyne (DARPA), (2010-2011).

LABORATORY GUESTS

Alexander Andreopoulos, York University, Canada, 3. 4. 2011 – 15. 4. 2011. Collaboration on the Neovision2 project.

Michael Zillich, Kai Zhou, Technische Universität Wien, Vienna, Austria, 31. 8. 2011 – 2. 9. 2011. Collaboration on the CogX project.

RESEARCH VISITS

Alen Vrečko: University of Birmingham, UK, 24. 7. 2011 - 29. 7. 2011. Collaboration on the CogX project.
Marko Mahnič, Alen Vrečko: Kungliga Tekniska Högskolan, KTH, Stockholm, Sweden, 9. 10. 2011 - 11. 10. 2011, Collaboration on the CogX project.

INVITED TALKS AND LECTURES

Aleš Leonardis: Learning a Hierarchical Compositional Shape Vocabulary for Multi-class Object Representation, April 2011, an invited lecture at University of Tuebingen, Germany.

Aleš Leonardis: Combining Compositional Shape Hierarchy and Multi-class Object Taxonomy for Efficient Object Categorization, an invited lecture at University of Pennsylvania, July 2011.

Aleš Leonardis: Combining Compositional Shape Hierarchy and Multi-class Object Taxonomy for Efficient Object Categorization, an



Visual tracking of an articulated target

invited talk at REACTS, Workshop on Recognition and Action for Scene Understanding, September 2011, Malaga, Spain.

Aleš Leonardis: Combining Compositional Shape Hierarchy and Multiclass Object Taxonomy for Efficient Object Categorization, an invited lecture at Linköping University, November 2011.

Aleš Leonardis: Combining Compositional Shape Hierarchy and Multiclass Object Taxonomy for Efficient Object Categorization, an invited lecture at University of Innsbruck, December 2011.

Aleš Leonardis: Combining Compositional Shape Hierarchy and Multiclass Object Taxonomy for Efficient Object Categorization, an invited lecture at SISSA (The International School of Advanced Studies), Italy, December 2011.

SELECTED PUBLICATIONS

L. Čehovin, M. Kristan, A. Leonardis, An adaptive coupled-layer visual model for robust visual tracking. In: *ICCV 2011*. [S. l.]: IEEE, cop. 2011, pp. 1363-1370

M. Kristan, A. Leonardis, D. Skočaj, Multivariate online kernel density estimation with Gaussian kernels, *Pattern recogn*, 2011, pp. 2630-2642

J. L. Wyatt, A. Aydemir, M. Brenner, M. Hanheide, N. Hawes, P. Jensfelt, M. Kristan, G. J. Kruijff, P. Lison, A. Pronobis, K. Sjö, A. Vrečko, H. Zender, M. Zillich, D. Skočaj, Self-Understanding and Self-Extension: A Systems and Representational Approach. *IEEE Transactions on Autonomous Mental Development*, Vol. 2, no. 4, pp. 282 - 303, 2010.

O. Drbohlav, A. Leonardis. Towards correct and informative evaluation methodology for texture classification under varying viewpoint and illumination. *Comput. vis. image underst.*, 2010, vol. 114, no. 4, pp. 439-449.

R. Perko, A. Leonardis. A framework for visual-context-aware object detection in still images. *Comput. vis. image underst.* 2010, vol. 114, no. 6, pp. 700-711.

S. Fidler, M. Boben, A. Leonardis. Learning Hierarchical

Compositional Representations of Object Structure. In: *Object Categorization: Computer and Human Vision Perspectives*, Editors: S. Dickinson, A. Leonardis, B. Schiele and M. J. Tarr, Cambridge University Press, 2009.

S. Fidler, M. Boben, A. Leonardis. Evaluating multi-class learning strategies in a hierarchical framework for object detection. *Proc. Advances in Neural Information Processing Systems conference*, pp. 1-9, 2009.

M. Kristan, D. Skočaj and A. Leonardis. Online Kernel Density Estimation for Interactive Learning. *Image and Vision Computing*, 2009.

M. Kristan, J. Perš, S. Kovačič and A. Leonardis. A Local-motionbased probabilistic model for visual tracking. *Pattern Recognition*, Vol. 42, No. 9, pp. 2160-2168, 2009.

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.

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.

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.

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.

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.

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.

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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 intelligent tutoring systems. A notable aspect of much of this research is its application to problems in medicine, systems control, game playing and analysis, ecological modeling, reconstruction of human control skill, robotics, intelligent tutoring systems and applications of AI in mechanical engineering.

In 2009, the laboratory's demo on autonomous robot learning by experimentation (<http://www.ailab.si/xpero/>, part of the XPERO project) was awarded the first prize at the European Exhibition in Future Emergent Technologies, Prague, April 2009. 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. Two former members of this laboratory Aleks Jakulin and Dorian Šuc received the prestigious best European AI dissertation awards, sponsored by ECCAI (European Coord. Committee in AI). In 2007, Ivan Bratko received the national Zois award for outstanding scientific achievements. Aleksander Sadikov was elected by students as best lecturer in teh faculty's study programs in Computer Sc. and Mathematics in 2009 and 2010.

RESEARCH PROJECTS

Artificial Intelligence and Intelligent Systems (P2–0209). Research Programme, Slovenian Research Agency (2009-2014).



The AI Lab's Nao robot at the Future Emergent Technologies Exhibition, Prague, April 2009. The scientific message of the demonstration "A day in the life of the Nao robot" was to show how a robot can autonomously learn by performing experiments in its environment. The demonstration won the first prize at the exhibition

Machine Learning in Building Intelligent Tutoring Systems (J2-4222). Basic Research Project, Slovenian Research Agency (2011-2014).

Molecular and other prognosticators of lung cancer and mesothelioma (J3-4076). Basic Research Project, Slovenian Research Agency (2011-2014).

Prototype Recommender System. Application project for GURU d.o.o. (2010-2011).

Warehouse scheduling system. Application project for 3R d.o.o. (2011-2012).

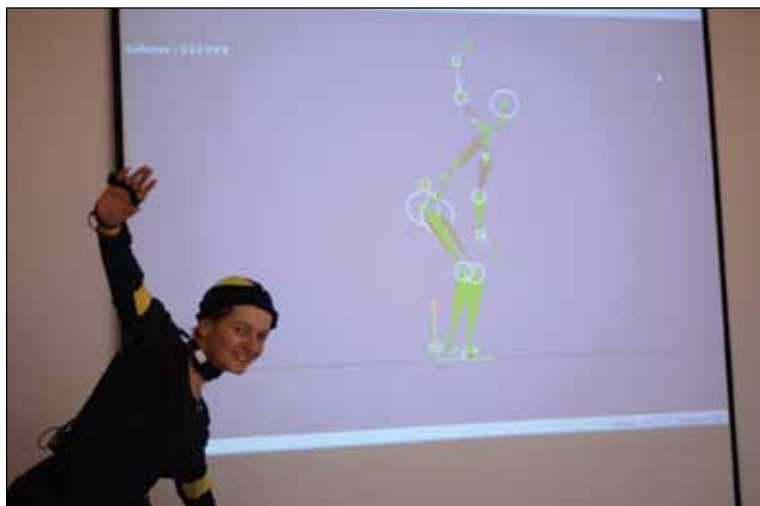
LABORATORY GUESTS

Prof. Claude Sammut, University of New South Wales, Australia. 17. 2. 2011 – 28. 2. 2011. Predavanje na fakultetnem seminarju in pisanje skupnega predloga raziskovalnega projekta.

SELECTED PUBLICATIONS

I. Bratko. Prolog Programming for Artificial Intelligence, fourth edition. Addison-Wesley/Pearson Education 2011; previous editions also translated into German, Italian, French, Slovene, Japanese, and Russian.

ŽABKAR, Jure, MOŽINA, Martin, BRATKO, Ivan, DEMŠAR, Janez. Learning qualitative models from numerical data. Artif.



Computer analysis of human movement with a motion-sensing suit

intell. [Print ed.], 2011, vol. 175, no. 9/10, str. 1604-1619, ilustr. http://www.sciencedirect.com/science?_ob=MIimg&imagekey=B6TYF-5296708-1-1&_cdi=5617&_user=4776866&pii=S0004370211000361&_origin=search&_zone=rslt_list_item&coverDate=06%2F30%2F2011&_sk=998249990&wchp=dGLbVlW-zSkWA&md5=f5ba923d75f2d6aa6e637395ddffbf2f&ie=/sdarticle.pdf. [COBISS.SI-ID 8324436], [JCR, WoS, št. citatov do 6. 9. 2011: 0, brez avtocitatov: 0, normirano št. citatov: 0]

kategorija: 1A1 (Z1); uvrstitev: SCI, ERIHA, MBP; tipologijo je verificiral OSICT

točke: 27.51, št. avtorjev: 4

GUID, Matej, BRATKO, Ivan. Using heuristic-search based engines for estimating human skill at chess. *ICGA journal*, 2011, vol. 34, no. 2, str. 71-81, ilustr. [COBISS.SI-ID 8654932], [JCR, WoS, št. citatov do 6. 11. 2011: 0, brez avtocitatov: 0, normirano št. citatov: 0]

kategorija: 1A2 (Z1); uvrstitev: SCI, MBP; tipologijo je verificiral OSICT

točke: 44.02, št. avtorjev: 2

KOŠMERLJ, Aljaž, BRATKO, Ivan, ŽABKAR, Jure. Embodied concept discovery through qualitative action models. *Int. j. uncertain. fuzziness knowl.-based syst.*, 2011, vol. 19, no. 3, str. 453-475, ilustr. [COBISS.SI-ID 8352084], [JCR, WoS, št. citatov do 24. 5. 2011: 0, brez avtocitatov: 0, normirano št. citatov: 0]

kategorija: 1A3 (Z1); uvrstitev: SCI, MBP; tipologijo je verificiral OSICT

točke: 21.39, št. avtorjev: 3

BRATKO, Ivan. Autonomous discovery of abstract concepts by a robot. *Lect. notes comput. sci.*, part 1, str. 1-11, ilustr. [COBISS.SI-ID 8337748] tipologija 1.08 -> 1.01,

kategorija: 1A4 (Z1); uvrstitev: SCI, MBP; tipologijo je verificiral OSICT

točke: 40, št. avtorjev: 1

GROZNIK, Vida, GUID, Matej, SADIKOV, Aleksander, MOŽINA, Martin, GEORGIEV, Dejan, KRAGELJ, Veronika, RIBARIČ, Samo, PIRTOŠEK, Zvezdan, BRATKO, Ivan. Elicitation of neurological knowledge with ABML. *Lect. notes comput. sci.*, str. 14-23. [COBISS.SI-ID 8469332] tipologija 1.08 -> 1.01,

kategorija: 1A4 (Z1); uvrstitev: SCI, MBP; tipologijo je verificiral OSICT

točke: 4.44, št. avtorjev: 9

OBLAK, Andrej, BRATKO, Ivan. Learning from noisy data using a non-covering ILP algorithm. *Lect. notes comput. sci.*, str. 190-197, ilustr. [COBISS.SI-ID 8440916]

tipologija 1.08 -> 1.01, kategorija: 1A4 (Z1); uvrstitev: SCI, MBP; tipologijo je verificiral OSICT

točke: 20, št. avtorjev: 2

D. S. Nau, M. Luštrek, A. Parker, I. Bratko, M. Gams. When is it better not to look ahead? *Artificial Intelligence* 174 (2010) 1323-1338.

I. Bratko. Comparison of Machine Learning for Autonomous Robot Discovery. In book: *Advances in Machine Learning I: Dedicated to the Memory of Professor Ryszard S. Michalski (Studies in Computational Intelligence)* edited by Jacek Koronacki, Zbigniew W. Ras, Slawomir T. Wierzchon, and Janusz Kacprzyk, Springer 2010, pp. 451-456

I. Bratko, J. Žabkar, M. Možina. Argument Base Machine Learning. In book *Argumentation in Artificial Intelligence*, Edited by Iyad Rahwan, Guillermo Simari, Springer Verlag 2009, pp. 463-482.

A. Sadikov, I. Bratko. LR^{TA}* 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.

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. Žabkar, R. Žabkar, D. Vladušič, D. Èemas, D. Šuc, I. Bratko. Q² Prediction of ozone concentrations. *Ecological Modelling*, 191(1): 6882, 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.

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

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Junior Researcher Darko Pevec, B.Sc.	darko.pevec@fri.uni-lj.si	459
Junior Researcher Miha Drole, B.Sc.	miha.drole@fri.uni-lj.si	459
Visiting Junior Researcher Domen Košir, B.Sc.	domen.kosir@gmail.com	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, for efficient parametrization of images using a subset of possible image resolutions, for text summarization using symbolic graphs, for analysing of sport data, and for user profiling by mining the web-logs. 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

Artificial Intelligence and Intelligent Systems (P2–0209). Research Programme, Slovenian Research Agency (2009-2014).

Electricity load forecasting supported by prediction explanation and prediction reliability estimates (BI-PT/10-11-007). Bilateral Collaboration Project (Slovenia-Portugal), Slovenian Research Agency (2010-2011).

Integration of data mining and high-performance computer modelling for coronary artery disease, (BI-SR/10-11-020). Bilateral Collaboration Project (Slovenia-Serbia), Slovenian Research Agency (2010–2011).

Machine Learning of Imbalanced Data, (BI-CZ/10-11-008). Bilateral Collaboration Project (Slovenia-Czech Republic), Slovenian Research Agency (2010–2011).

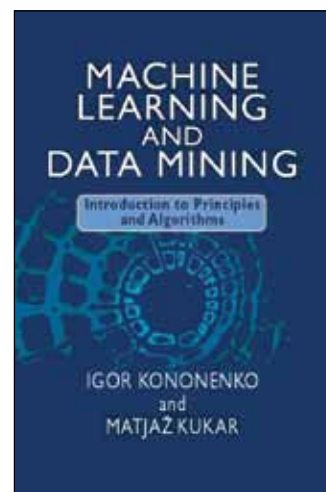
LABORATORY GUESTS

Prof. Dr. Petr Savicky, University of Prague, Czech Republic, 30. 5. 2011 – 10. 6. 2011. Research collaboration on Learning in Imbalanced Data.

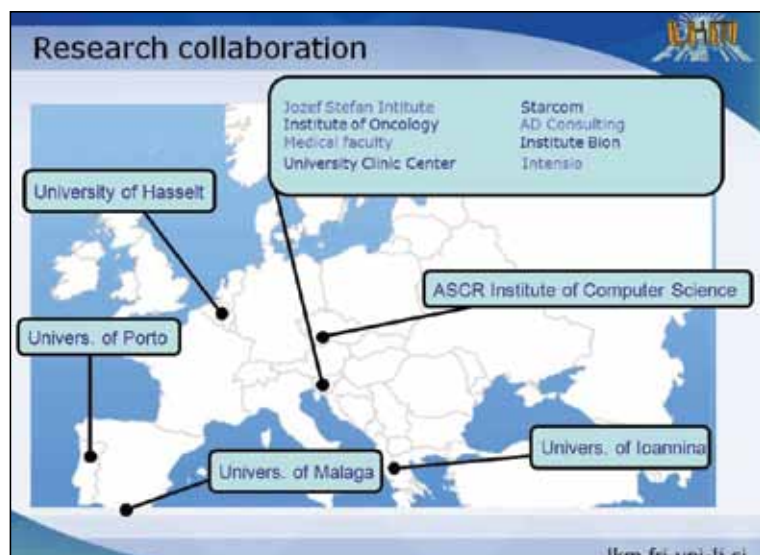
Dr. Pedro Pereira Rodrigues, University of Porto, 29. 6. 2011 - 8. 7. 2011. Research collaboration on data streams mining and electricity load forecasting supported by prediction explanation and prediction reliability estimates.

Ercan Canhas, MSc, University of Prizren, Kosovo. 15.1. 2011 - 30. 6. 2011 and 15.9.2011-11.10.2011. PhD scholarship funded by EU, research multidocument summarization based on multilayered graphs.

Prof. Dr. Joao Gama, University of Porto, Portugal, 4. 7. 2011 - 9. 7. 2011. Research collaboration on data streams mining and electricity load forecasting supported by prediction explanation and prediction reliability estimates.



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



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

Prof. Dr. Nenad Filipović, Miloš Radović and dr. Aleksandar Peulić, University of Kragujevac, Serbia, 20.4.2011 - 22.4. 2011 Research collaboration on the use of machine learning for modeling of coronary artery disease.

Prof. Dr. Tatjana Zrimec, University of New South Wales, Australia, 3.3. 2011 - 20.7.2011 Research collaboration on machine learning from medical image data

Miloš Radović, University of Kragujevac, Serbia, 5.12.2011 – 11.12. 2011 Research collaboration on the use of machine learning for modeling of coronary artery disease.

RESEARCH VISITS

Zoran Bosnić, University of New South Wales, Australia, 20.6.2011 - 20.9.2011, collaboration on medical imaging projects (Content-based image retrieval, statistical analysis for lung modelling and visualization).

Marko Robnik Šikonja, Institute of Computer Scienc, Academy of Sciences of the Czech Republic. 22. 8. 2011 - 26. 8. 2011. Research collaboration on machine learning of imbalanced data sets with emphasis on feature evaluation.

Zoran Bosnić, Petar Vračar, Darko Pevec. University of Porto. 11. 11. 2011 - 16. 11. 2011. Research collaboration on data streams mining and electricity load forecasting supported by prediction explanation and prediction reliability estimates.

Zoran Bosnić, Petar Vračar. University of Kragujevac. 20. 10. 2011 – 22. 10. 2011. Research collaboration on project „Integration of data mining and high-performance computer modeling for coronary artery disease“.

Matjaž Kukar, Petar Vračar, Darko Pevec. Institute of Computer Science, Academy of Sciences of the Czech Republic, Prague. 26. 9. 2011 - 30. 9. 2011. Research collaboration on machine learning of imbalanced data.

INVITED TALKS AND LECTURES

Darko Pevec: *Input dependent prediction intervals for arbitrary regression models*. Porto: Artificial Intelligence and Decision Support Laboratory, University of Porto, 15th of November 2011.

Zoran Bosnić: Correcting data stream regression predictions using a prediction reliability estimate. University of Kragujevac: Faculty of Engineering, 21st of October 2011.

Petar Vračar: Modeling the progression of a basketball match and forecasting the outcome. University of Kragujevac: Faculty of Engineering, 21st of October 2011.

Zoran Bosnić: *Correcting streaming predictions of an electricity load forecast system using a prediction reliability estimate*. Porto: Artificial Intelligence and Decision Support Laboratory, University of Porto, 15th of November 2011.

SELECTED PUBLICATIONS

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

E. Štrumbelj, M. Robnik-Šikonja. Online bookmakers' odds as forecasts : the case of European soccer leagues. *Int. j. forecast.*2010, vol. 26, no. 3, str. 482-488.

E. Štrumbelj, P.Vračar. Simulating a basketball match with a homogeneous Markov model and forecasting the outcome. *Int. j. forecast.*. 2011, str. 1-13.

E. Štrumbelj, I. Kononenko: An efficient explanation of individual classifications using game theory. *J. Mach. Learn. Res.* 2010, 11[1]:1-18.

E. Štrumbelj, I. Kononenko, M. Robnik Šikonja. Explaining instance classifications with interactions of subsets of feature values. *Data & Knowledge Engineering*, 68(10):886-904, 2009.

I. Kononenko. Natural and Machine Learning, Intelligence and Consciousness, In: E. Žerovnik et al. (eds.) *Philosophical Insights about Modern Science*, NY: Nova Science publ., 239-258, 2009.

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

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RESEARCH ACTIVITIES

Bioinformatics Laboratory was established in 2010 as an off-spring of the Laboratory of Artificial Intelligence. Its research niche is the application of artificial intelligence, data mining, data visualization and statistical methods to problems from bioinformatics, in particular system biology, functional genomics, chemogenomics and molecular medicine. One of our core activities is development of a major open-source data mining package Orange (<http://www.ailab.si/orange>) with an attractive and easy-to-use visual programming interface. Orange gained its popularity as the principal Python-based data mining tool and has a substantial community of users world-wide.

In collaboration with various partners worldwide we have developed several web-based biomedical data mining applications. dictyExpress (<http://www.ailab.si/dictyexpress>) is a popular interactive exploratory data analytics tool that provides access to over 1,000 gene expression experiments on social amoeba *Dictyostelium discoideum*. The application was developed in collaboration with Baylor College of Medicine. Our first web-based application, which is nearly 10 years old but still in frequent use in scholar institutions is GenePath (<http://www.genepath.org>), known also as the only software package that supports interactive epistasis analysis for gene network

reconstruction from mutant-based experimental data. In collaboration with MRC Laboratory of Molecular Biology in Cambridge we are developing a computational pipeline for comprehensive analysis of next-generation high-throughput sequencing data (RNA-Seq and iCLIP) with the aim of modeling and understanding the molecular mechanisms associated with neurodegenerative diseases.

RESEARCH PROJECTS

Artificial intelligence and intelligent systems (P2-0209). Research Programme, Slovenian Research Agency (2009–2014).

Qualitative modeling from data (J2-2194). Basic Research Project, Slovenian Research Agency (2009–2012).

CLIP: Mapping functional protein-RNA interactions to identify new targets for oligonucleotide-based therapy (ERC 206726 CLIP). ERC Project, European Research Council (2008–2013).

Modeling the transcriptome (Z7-3665). Basic Research Project, Slovenian Research Agency (2010–2012).

FightingDrugFailure (PITN-GA-2009-238132). EU FP7 Project (2010–2013).

Growth and defense trade-offs in multitrophic interaction between potato and its two major pests (J4-4165). Basic Research and Application Project, Slovenian Research Agency (2011–2014).

Evaluation of neuro-muscular trunk stabilization functions and development of exercise programs for lower back pain prevention (L5-4293). Basic Research and Application Project, Slovenian Research Agency (2011–2014).

Data and knowledge integration methods for network systems biology (J2-2197). Basic Research Project, Slovenian Research Agency (2009–2012).

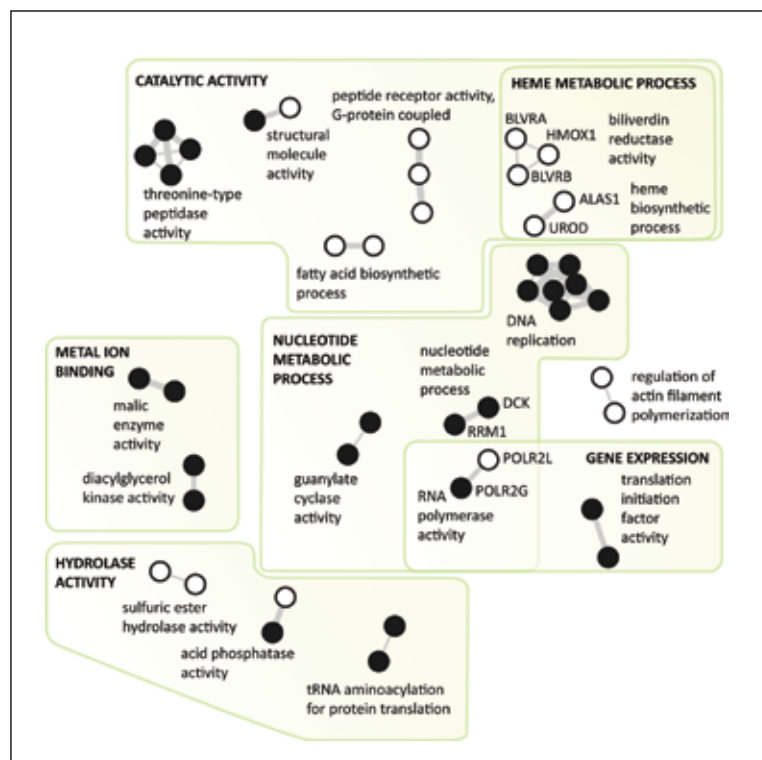
Combination of next generation sequencing and metagenomic analysis in the diagnostics of severe hop stunting (J4-4153). Basic Research and Application Project (2011–2014).

Functional genomics of cholesterol homeostasis: the role of lanosterol 14alpha-demethylase in development of metabolic disorders (J7-4053). Basic Research and Application Project, Slovenian Research Agency (2011–2014).

A next-generation analytics toolbox for integrated high-throughput genomic data analysis (BI-US/11-12-020). Bilateral Collaboration Project, Slovenian Research Agency (2011–2012).

Functional genomics of potato-PVY interactions (J1-4268). Basic Research and Application Project, Slovenian Research Agency (2011–2014).

CARE-MI: Cardio Repair European Multidisciplinary Initiative (FP7-242038). EU FP7-HEALTH Programme project, European Commission (2010–2015).



FragViz makes fragmented networks more interpretable by placing together similar components

LABORATORY GUESTS

Balaji Srinivasan Santhanam, Baylor College of Medicine, Houston, Texas, USA, 26. 10. 2011 – 26. 11. 2011. Collaboration in bilateral project.

Malay Bhattacharyya, Indian Statistical Institute, Machine Intelligence Unit, Kolkata, India. 19. 9. 2011 – 30. 9. 2011. Collaboration in miRNA expression analysis.

Nuzzo Angelo, University of Pavia, Pavia, Italy. 20. 6. 2011 – 7. 7. 2011. Collaboration in bilateral project.

Francesca Mulas, University of Pavia, Pavia, Italy. 1. 5. 2011 – 25. 5. 2011. Collaboration in bilateral project.

Elisa Del Fabbro, University of Pavia, Pavia, Italy. 14. 3. 2011 – 2. 9. 2011. Erasmus exchange student.

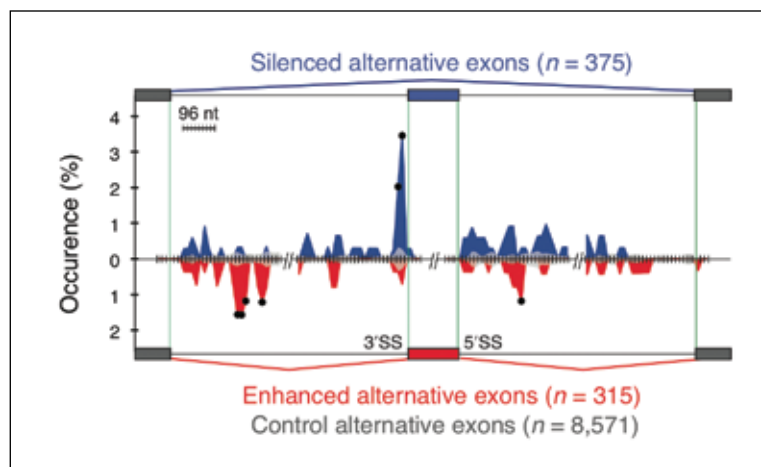
RESEARCH VISITS

Tomaž Curk: MRC Laboratory of Molecular Biology, Cambridge, UK, 4. 3. 2011 – 10. 3. 2011. Development of pipeline for iCLIP data analysis.

Gregor Rot: MRC Laboratory of Molecular Biology, Cambridge, UK, 1. 4. 2011 – 31. 6. 2011. Development of pipeline for pA-seq data analysis.

INVITED TALKS AND LECTURES

Blaž Zupan: Knowledge-based data analysis, 16. 5. 2011, Ricerca traslazionale in ematologia /oncologia: Research Training Workshop, Collegio Ghislieri, University of Pavia.



RNA-maps constructed from massive iCLIP experimental data help us understand molecular mechanisms of gene splicing

Tomaž Curk: Genome-wide protein-RNA mapping and analysis, 12. 9. 2011, International Research Training Group workshop, Justus-Liebig University, Giessen, Germany.

Blaž Zupan: Cell development stage prediction, 16. 9. 2010, From Phenotypes to Pathways: Inferring genetic architecture from perturbation maps, ESF Programme on Frontiers of Functional Genomics, Cambridge, UK.

SELECTED PUBLICATIONS

J. Žabkar, M. Možina, I. Bratko, J. Demšar. Learning qualitative models from numerical data. *Artificial intelligence*, 175(9/10): 1604-1619, 2011.

J. Demšar. Algorithms for subsetting attribute values with Relief. *Machine learning*, 78(3): 421-428, 2010.

J. R. Tollervey, T. Curk, B. Rogelj, M. Briese, M. Cereda, M. Kayikci, J. König, T. Hortobágyi, A. L. Nishimura, V. Župunski, R. Patani, S. Chandran, G. Rot, B. Zupan, C. E. Shaw, J. Ule. Characterizing the RNA targets and position-dependent splicing regulation by TDP-43. *Nature neuroscience*, 14(4): 452-459, 2011.

T. Curk, G. Rot, B. Zupan. SNPsyn : detection and exploration of SNP-SNP interactions. *Nucleic acids research*, doi: 10.1093/nar/gkr321, 2011.

E. Huang, S. Talukder, T. R. Hughes, T. Curk, B. Zupan, G. Shaulsky, M. Katoh. Bzpf is a CREB-like transcription factor that regulates spore maturation and stability in *Dictyostelium*. *Developmental biology*, 358(1): 137-146, 2011.

Z. Wang, M. Kayikci, M. Briese, K. Zarnack, N. M. Luscombe, G. Rot, B. Zupan, T. Curk, J. Ule. ICLIP predicts the dual splicing effects of TIA-RNA interactions. *PLoS biology*, 8(10), 2010.

J. König, K. Zarnack, G. Rot, T. Curk, M. Kayikci, B. Zupan, D. J. Turner, N. M. Luscombe, J. Ule. iCLIP reveals the function of hnRNP

particles in splicing at individual nucleotide resolution. *Nature structural and molecular biology*, 17(7): 909-916, 2010.

A. Parikh, E. R. Miranda, M. Katoh-Kurasawa, D. Fuller, G. Rot, L. Žagar, T. Curk, R. Sugang, R. Chen, B. Zupan, W. F. Loomis, A. Kuspa, G. Shaulsky. Conserved developmental transcriptomes in evolutionarily divergent species. *Genome biology*, 11(3), 2010.

M. Toplak, T. Curk, J. Demšar, B. Zupan: Does replication groups scoring reduce false positive rate in SNP interaction discovery? *BMC Genomics*, 11:58, 2010.

M. Štajdohar, M. Mramor, B. Zupan, J. Demšar. FragViz: visualization of fragmented networks. *BMC bioinformatics*, 11, 2010.

R. Franco-Duarte, L. Umek, B. Zupan, D. Schuller: Computational approaches for the genetic and phenotypic characterization of a *S. cerevisiae* wine yeast collection. *Yeast*, 26(12): 675-692, 2009.

P. Fey, P. Gaudet, T. Curk, B. Zupan, E. M. Just, B. Siddhartha, S. N. Mechant, Y. A. Bushmanova, G. Shaulsky, W. A. Kibbe, R. L. Chisholm. DictyBase - a *Dictyostelium* bioinformatics resource update. *Nucleic acids research*, 37: 515-519, 2009.

G. Rot, A. Parikh, T. Curk, A. Kuspa, G. Shaulsky, B. Zupan: dictyExpress: a *D. discoideum* gene expression database with an explorative data analysis web-based interface. *BMC Bioinformatics*, 10: 265, 2009.

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

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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.

B. Zupan, J. Demšar, 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.

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RESEARCH ACTIVITIES

Members of the laboratory are involved in research in various fields of mathematics:

- algebraic topology, in particular algebraic invariants of topological spaces with group actions, as well as computational topology and topological data analysis,
- Brownian motion and martingales and their applications to analysis,
- scientific computing and numerical solutions of differential equations, where we study methods for geometric integration of ordinary differential equations, as well as numerical simulations,
- graph theory, topological and structural properties of graphs, and colorings problems of graphs, both in connection with graph symmetries and embedding properties,
- 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 modelling,

- 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,
- semigroups and their interaction with automata theory and combinatorics; universal algebra.

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 several institutions from abroad. To mention a few: NTNU Trondheim, Norway, University of Hamburg, Germany, University of Ulm, Germany, University of Tuebingen, Germany, Moscow State University, Russia, P. J. Šafarik University, Košice, Slovakia, University of Sevilla, Spain, Yokohama National University, Japan, Simon Fraser University, Canada, University of Melbourne, Australia.

In cooperation with the Computer Structures and Systems Laboratory members of our laboratory are working on algorithms for developing and evaluating mechanical random generators.

AWARDS

Assit. prof. Polona Oblak received a University Award for outstanding teaching and research achievements for junior teachers.

RESEARCH PROJECTS

Holomorphic mappings and foliations, harmonic analysis and hamiltonian systems (J1-2152). Basic Research Project, Slovenian Research Agency (2009-2012).

Applied and Computational Algebraic Topology (ACAT). European Science Foundation Project (2011-2015).

RESEARCH VISITS

Vin da Silva, Pomona College, California, USA, January 2011 (FRI seminar, 11. 1. 2011), 2 weeks

Bruno Benedetti, Free University of Berlin, June 2011, 4 days.

Jose Antonio Vilches, Universty of Sevilla, Spain, September 2011, 1 week.

Desamapardos Fernandez-Tertero, Universty of Sevilla, Spain, September 2011, 1 week.

INVITED TALKS AND LECTURES

B. Orel, A. Perne: Approximate solution of BVP with nonperiodic Fourier series, invited talk at Norwegian University of Science and Technology, Trondheim, Norway, April 2011.

N. Mramor Kosta: Cohomology of locally free groups, invited talk at Workshop on Wild Topology and Fractals, Strobl, Austria, July 2011.

SELECTED PUBLICATIONS

D. Dolžan, P. Oblak. Invertible and nilpotent matrices over antirings. *Linear algebra appl.*, 2009, vol. 430, iss. 1, pp. 271-278.

D. Dolžan, P. Oblak. Idempotent matrices over antirings. *Linear algebra appl.*, 2009, vol. 431, iss. 5-7, pp. 823-832.

D. Franetič, P. Pavešić. H-spaces, semiperfect rings and self-homotopy equivalences. *Proceedings of the Royal Society of Edinburgh: Section A Mathematics* (2011) 141, pp 1263-1277

G. Jerše, N. Mramor Kosta, Ascending and descending regions of a discrete Morse function, *Comput. Geom.*, 42 (2009), 6-7, 639-651.

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

B. Orel. Accumulation of global error in Lie group methods for linear ordinary differential equations. *Electron. trans. numer. anal.*, 2010, vol. 37, pp. 252-262.

B. Mohar, E. Steffen, A. Vodopivec, Relating embedding and coloring properties of snarks, *Ars Mathematica Contemporanea* 1 (2008), pp. 169-184.

A. Vodopivec, On embeddings of snarks in the torus, *Discrete Mathematics* 380 (2008), pp. 1847--1849.

M. Vuk. Algebraic Integrability of the confluent Neumann system, *Journal of Physics A: Mathematical and Theoretical*, 41(39): 395201 (16p), 2008.

G. Fijavž. D. Wood, Graph Minors and Minimum Degree, *Electron. J. Comb.* (online journal), 2010, vol. 17, no. 1, r151 (30 p).

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

G. Kudryavtseva, Ordered semigroups, upper-triangular reflexive relations and semigroups of languages. *Internat. J. Algebra Comput.* 20, (2010), pp. 6, 823-832.

R. Ayala, J. A. Vilches, G. Jerše, N. Mramor Kosta. Discrete gradient fields on infinite complexes. *Discrete contin. dyn. syst.*, 2011, vol. 30, no. 3, pp. 623-639

K. Cvetko-Vah, D. Kokol Bukovšek, T. Košir, G. Kudryavtseva. Semitransitive subsemigroups of the singular part of the finite symmetric inverse semigroup. *Acta Math. Hungar.* 131 (2011), no. 1-2, pp.1-24.

V. Dujmović, G. Fijavž, G. Joret, T. Sulanke, D. R. Wood. On the maximum number of cliques in a graph embedded in a surface. *Eur. j. comb.*, 2011, vol. 32, no. 8, pp. 1244-1252.

Ž. Virk. Homotopical smallness and closeness. *Topol. appl.*. [Print ed.], 2011, vol. 158, iss. 3, pp. 360-378.

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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



Smart cards enable us to securely store private keys



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«

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 expensive 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).

LABORATORY GUESTS

Michael Lang, Ph.D., Bradley University, United States of America. 29. 1. 2011 –8. 7. 2011. Sabbatical.

Robert Gallant, Ph.D., Memorial University of Newfoundland, Canada. 3. 8. 2011 – Summer 2012. Sabbatical.

EQUIPMENT

Xilinx Virtex 6 FPGA Evaluation Kit
 VIA Artigo Pico-ITX A1000
 VIA Amos-5000
 VIA EITX-3000

SELECTED PUBLICATIONS

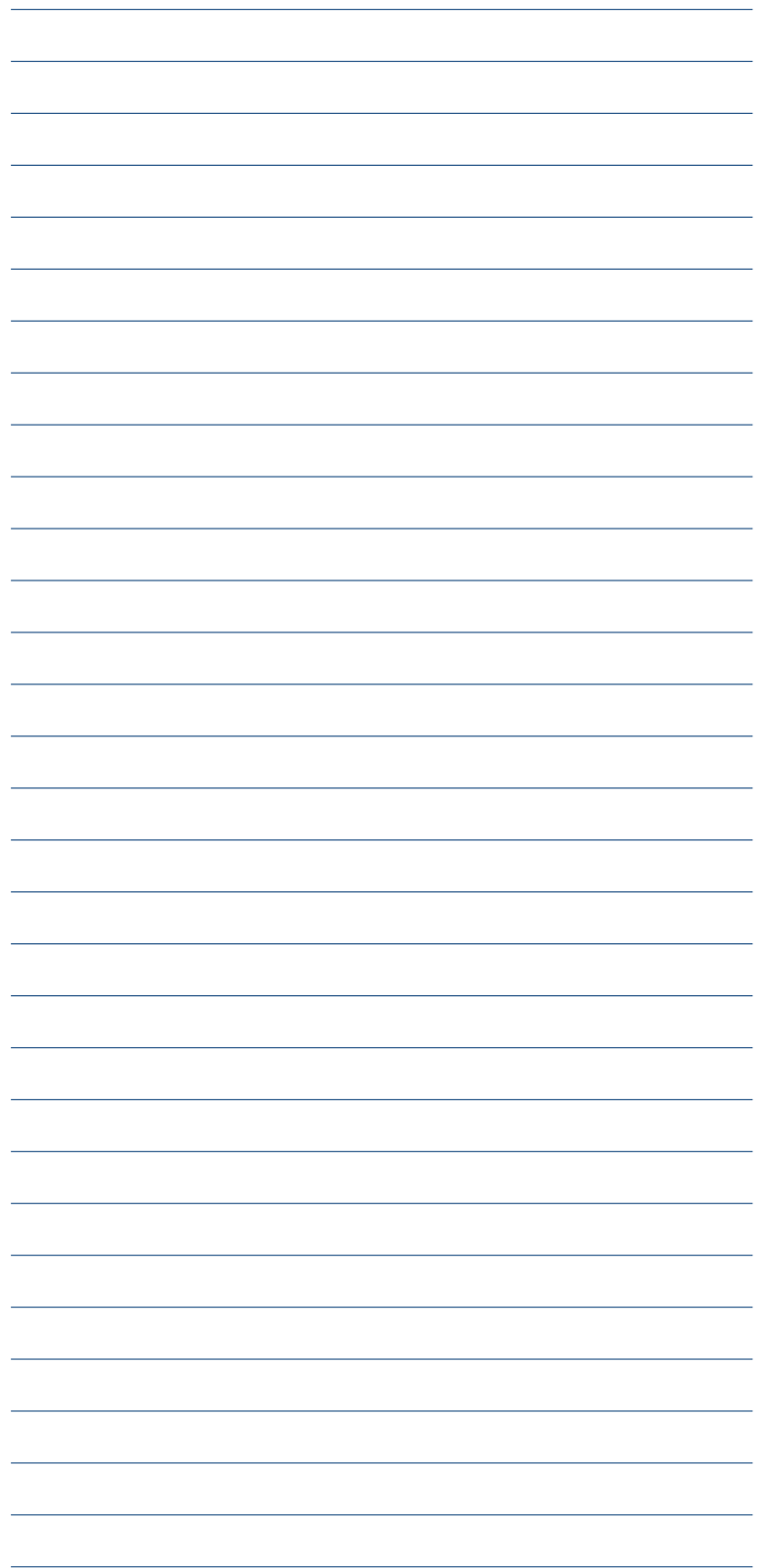
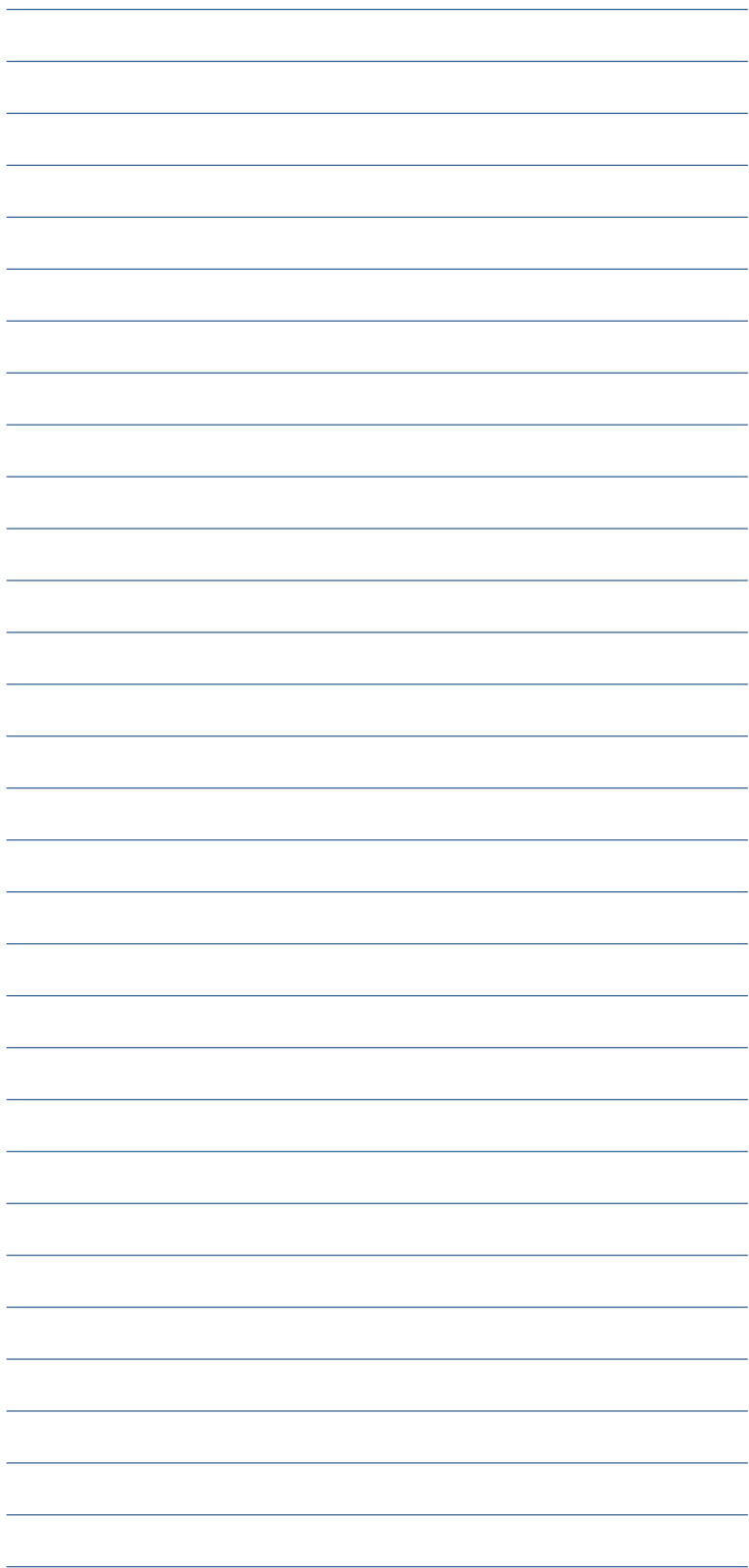
A. Jurišić and J. H. Koolen, Classification of the family $AT_4(qs, q, q)$ of antipodal tight graphs, *J. Combin. Theory (A)* 118 (2011), 842-852.

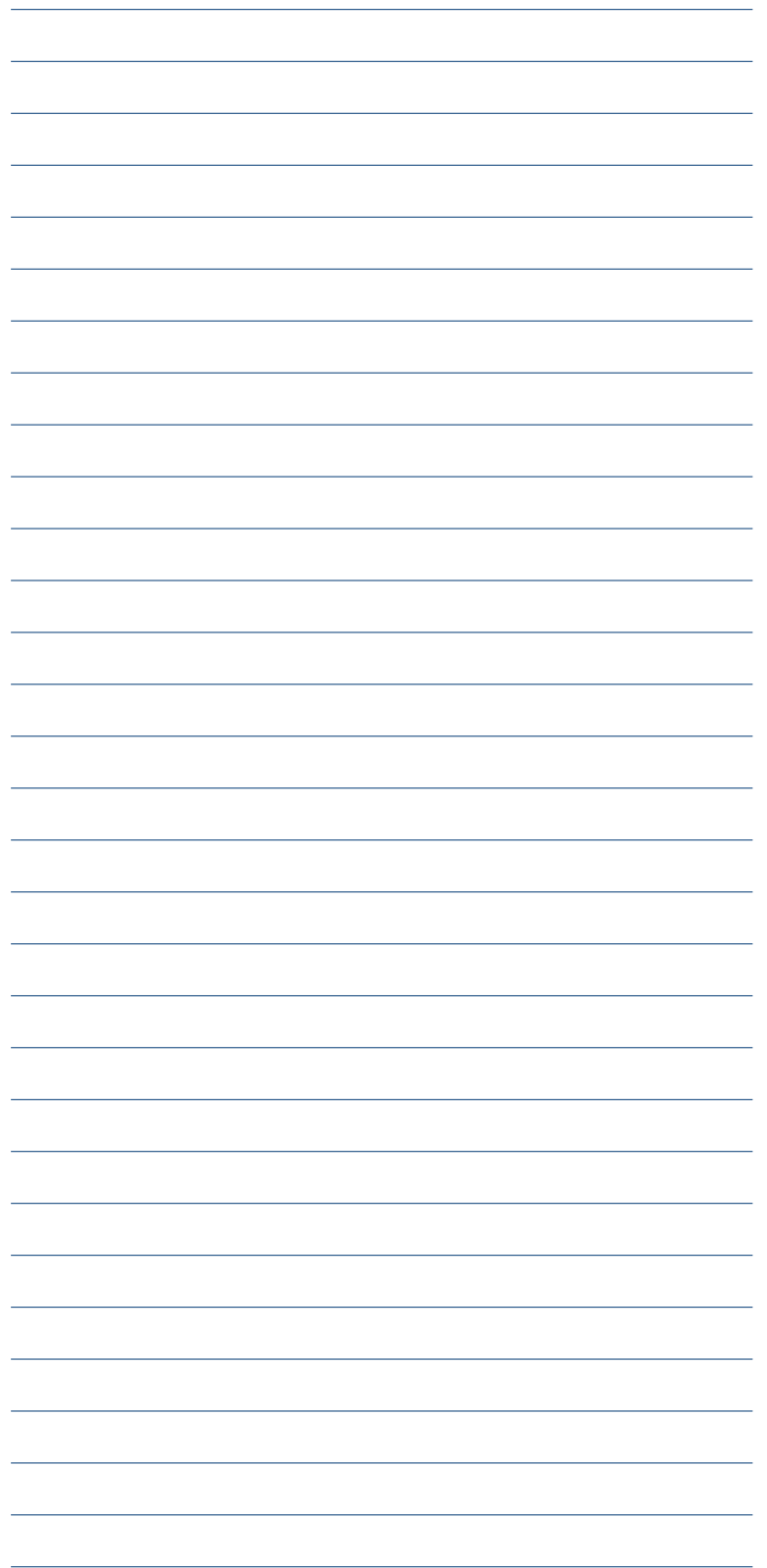
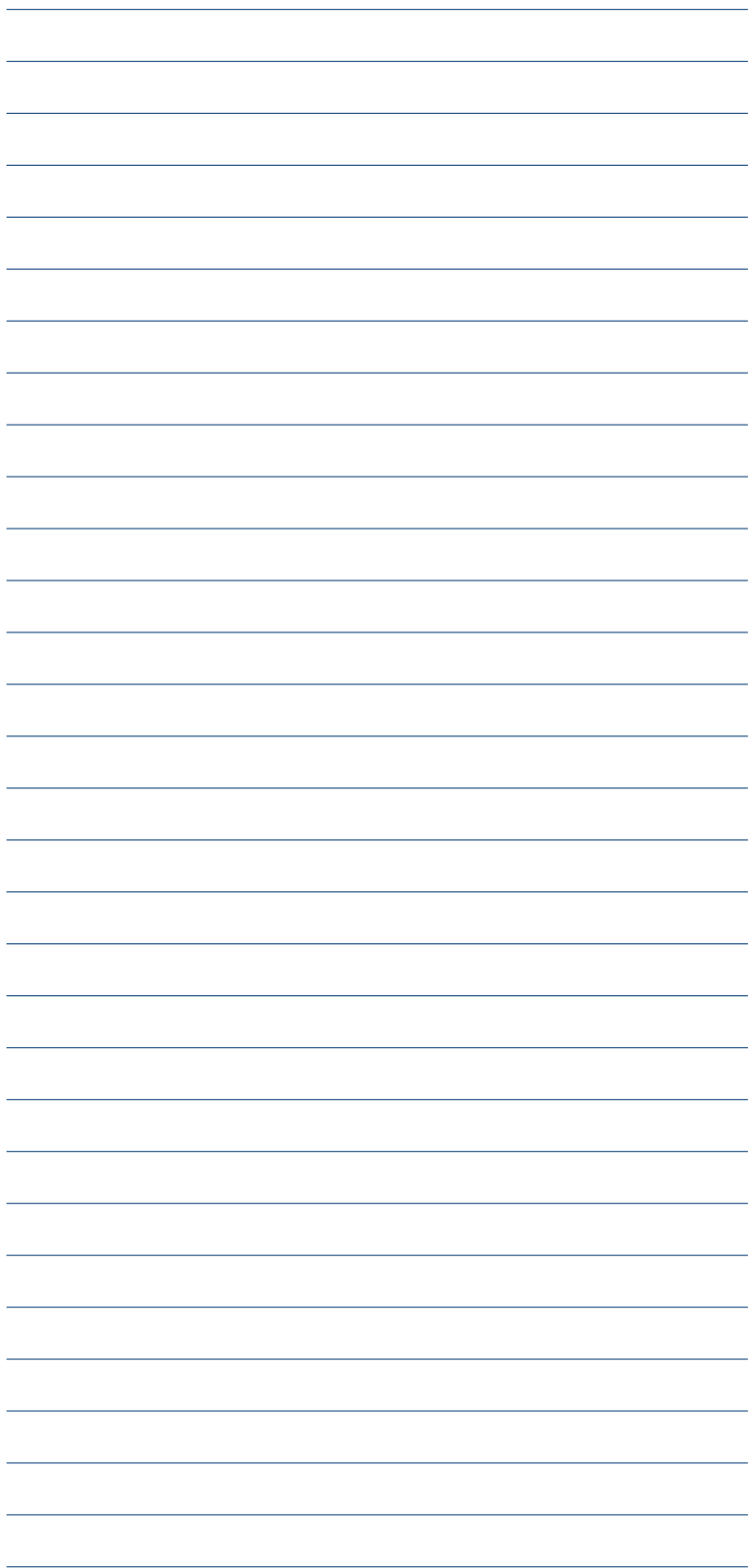
A. Jurišić, P. Terwilliger and A. Žitnik, The Q-polynomial idempotents of distance-regular graphs, *J. Combin. Theory (B)* 100 (2010), 683-690.

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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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