

DEPARTMENT OF KNOWLEDGE TECHNOLOGIES

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The Department of Knowledge Technologies performs research in advanced information technologies, aimed at acquiring, storing and managing the knowledge used in the development of knowledge-based-society applications. Established areas of knowledge technologies include intelligent data analysis (machine learning, data mining, knowledge discovery and databases), text and web mining, language technologies and computational linguistics, decision support, and knowledge management. The research areas of the department also include the semantic web, virtual organizations, new media and e-science. Besides developing knowledge technologies, we also develop their applications in environmental sciences and ecology, medicine and health care, biomedicine and genetics, economy, and marketing.



Head:
Prof. Nada Lavrač

We developed various methods for intelligent data analysis, including methods for subgroup discovery and for analyzing structured and multi-relational data using background knowledge in the form of ontologies. Subgroup-discovery methods have proved useful for new data-mining tasks, i.e., contrast-set mining and emerging-pattern mining. We developed a new methodology for closed-sets mining and successfully applied it to potato micro-array data to discover the rules that best distinguish between virus-resistant and virus-sensitive transgenic potato lines.

In the EU's 6FP STREP project IQ, coordinated by our department, we have developed a number of inductive querying and constraint-based data-mining methods, most notably methods for learning predictive clustering trees (PCTs). While most predictive modelling methods focus on a single target variable, PCTs can predict several target variables simultaneously, as well as predicting structured targets (such as hierarchies or time series). We have used PCTs to analyze data in the areas of medicine, bio-informatics (functional genomics) and environmental sciences.

Two national projects were concerned with the development of methods for the processing and analysis of remote-sensing data in the area of forestry. We have developed a predictive model for fire risk in the natural environment by using machine learning on data from past fires. The model predicts the probability of fire outbreaks from spatial data, multi-temporal satellite data, and meteorological forecasts. The model and its predictions have been integrated into a geographical information system for civil protection and rescue by the Ministry of Defence.

In the area of decision support, our long-term goal is to develop methods and techniques for decision modelling, implement them in object-oriented software, and integrate them with data-mining systems. In 2006 we continued to develop data-based revision methods for multi-attribute decision models, and the system proDEX for the development and use of probabilistic multi-attribute models. We focused on uncertainty-modelling mechanisms, which are essential for capturing realistic aspects of complex decision problems in ecology and agronomy. In 2006 we published a book *Decision making and modelling*, describing numerous decision-support techniques and our experience gathered in the applications of support methods.

Especially successful were the use of decision-support and data-analysis methods and their transfers into practice in the scope of the ECOGEN, SIGMEA and MediNet+ projects.

In the EU's 5FP project ECOGEN and the 6FP project SIGMEA, we used decision-support and data-mining methods to analyze the ecological and economical effects of genetically modified (GM) crops on the environment. The ECOGEN project, which finished in 2006, focused on the effects at the level of individual farms, more specifically on the soil biota, with respect

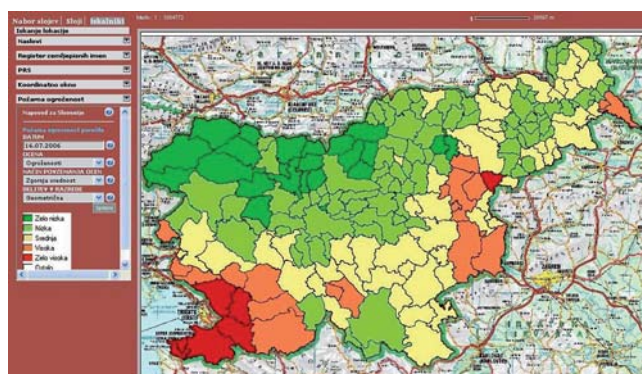


Figure 1: The probability of fire outbreaks in the natural environment, aggregated at the level of municipalities, as predicted by a model learned with machine-learning techniques.

The Department of Knowledge Technologies is a partner in 18 European projects and the coordinator of one 6FP project (IQ).

The book "Decision making and modelling" (Odločanje in modeli) by Marko Bohanec was published. It describes in 300 pages numerous decision-support techniques and our experience gathered in the applications of support methods.

In the scope of the successfully concluded MediNet+ project we developed a methodology and provided analyses with GIS-supported visualization with which the Ministry of Health can model, monitor and further plan the Slovenian health-care network.

using various data-mining methods combined with methods for decision-support, visualization and geographical information systems. We proposed a new methodology for monitoring various health-network indicators and carried out a number of simulations of different methods for the assessment of physicians' workload. The developed model enables the Ministry of Health to improve the planning and monitoring of the public health network in Slovenia.

In the area of text and web mining and the semantic web we successfully concluded the 6FP IP project SEKT (Semantically Enabled Knowledge Technologies), where our major contributions were in (semi)automated ontology generation. We have developed OntoGen, a data-driven interactive system for the (semi)automated construction of topic ontologies and two novel approaches that extend its functionality: an approach for semi-automated ontology

OntoGen, interactive system for ontology building received the best demo award at the 3rd European Semantic Web Conference.

generation from a social network and an approach for scalable population of ontologies with a large number of concepts and instances. We have established a close collaboration with CyC Corp., USA, which has during the past 20 years developed the largest common-sense knowledge base (ontology) in the world. We have jointly formed the European branch of the CyC Company, located in the Ljubljana Technology Park, aimed at joint research within our future 7FP projects. We are now involved in several EU 6FP projects from the semantic web area, including two STREP projects from semantic web services SWING and TAO; one which continues and extends the work undertaken in SEKT by developing lifecycle support for networked ontologies NeOn. Within NeOn we are responsible for the development of the context-sensitivity mechanisms for ontologies; to this end, we organized a tutorial on Context Sensitivity in Knowledge Rich Systems at the Intl. Semantic Web Conf. 2006 in the USA. We are closely collaborating with the UN FAO organization, which is one of the case-study partners of the project; a specific case-study goal is the development of an overfishing alert system.

Our research work in the area of text and web mining in addition to existing work on the 6FP NoE PASCAL and CA KDUBiq projects continued in the direction of combining text and images in the 6FP STREP project IMAGINATION and the direction of machine translation in the 6FP STREP project SMART. We also represent the Jožef Stefan Institute at the World Wide Web Consortium (W3C), which develops and recommends future web standards. We are active

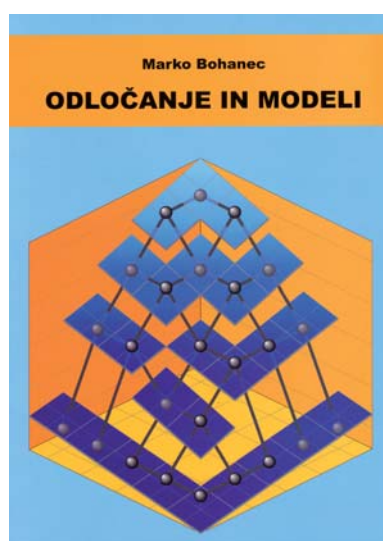


Figure 2: The book "Decision making and modelling" in 300 pages describes numerous decision-support techniques and our experience gathered in the applications of support methods.

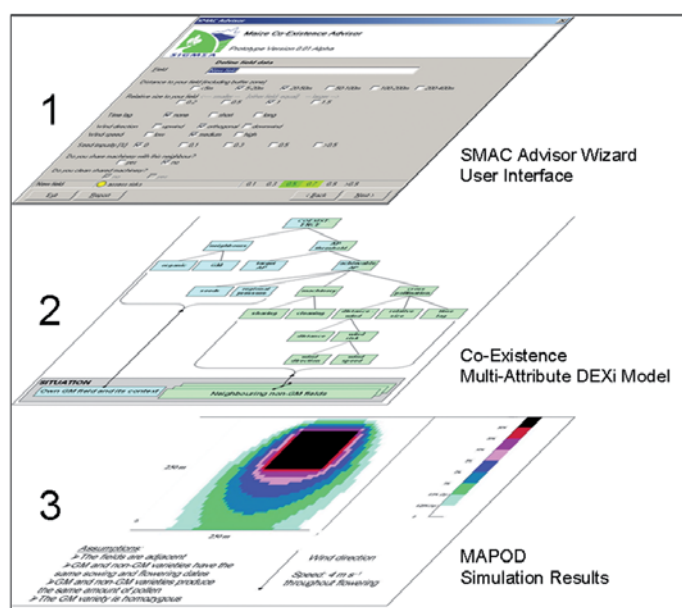


Figure 3: Three-level architecture of the decision-support system SMAC Advisor

members of the Rule Interchange Format working group. In 2006 we chaired the Organizing Committee of the 3rd European Semantic Web Conference, which was held in June 2006 in Budva, Montenegro.

In the area of knowledge management we are a partner in the 6FP IP project ECOLEAD (European collaborative networked organizations leadership initiative). We are involved in the development of a generic reference model for collaborative organizations and in the development of practical software prototypes for supporting virtual organizations. Specifically, we have developed the coFinder software tool which, based on the competencies of a virtual organization and focused web crawling, proposes potential business opportunities to the virtual organization manager. In 2007, demonstrations, trials and evaluations by actual networked organizations will be performed.

In the area of language technologies our aims are to foster the development of computational methods for processing Slovene, primarily through the creation of accessible language resources. In 2006 we successfully concluded the VoiceTRAN Speech Communicator project, led by Alpineon d.o.o., which developed a prototype speech-to-speech translator between Slovene and English. We also released the first Slovene treebank, i.e., a syntactically annotated corpus, which was included in the CoNLL-X shared task on multilingual dependency parsing. We continued the development of the WordNet-based semantic lexicon of Slovene; and significantly extended and improved the online Japanese-Slovene dictionary that we are developing in cooperation with the University of Ljubljana. The department was also involved in organizing and chairing the Fifth Slovenian and First International Conference on Language Technologies held at the JSI. Finally, we became one of the founding members of CLARIN, the European Research Infrastructure to Language Resources. Within a bilateral project completed in 2006, language resources were also developed for the Macedonian language.

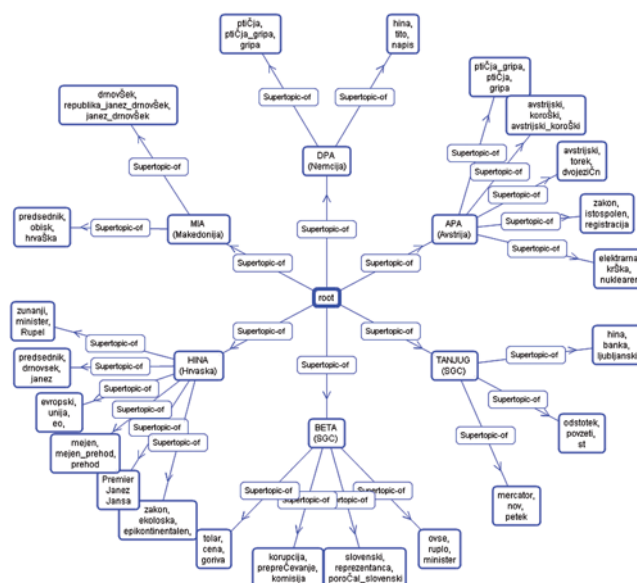


Figure 4: An analysis of foreign-press coverage of Slovenia with OntoGen.

Department members chaired the programme committee of the 9th International Conference on Discovery Science.

Some outstanding publications in the past three years

1. N. Lavrač, B. Kavšek, P. A. Flach, L. Todorovski. Subgroup discovery with CN2-SD. *Journal of Machine Learning Research*, vol. 5, pp. 153–188, 2004.
2. F. Železný, N. Lavrač. Propositionalization-based relational subgroup discovery with RSD. *Machine Learning*, vol. 62, no. 1–2, pp. 33–63, 2006.
3. M. Grobelnik, D. Mladenić. Automated knowledge discovery in advanced knowledge management. *Journal of Knowledge Management*, vol. 9, pp. 132–149, 2005.
4. M. Bohanec. *Odločanje in modeli. (Učbeniki in priročniki)*. Ljubljana: DMFA - založništvo, 2006. XV, 312 pp., ISBN 961-212-190-7. ISBN 978-961-212-190-7.
5. L. Todorovski, S. Džeroski. Integrated knowledge-driven and data-driven approaches to modelling. *Ecological Modelling*, vol. 194, pp. 3–13, 2006.
6. M. Žnidaršič, M. Bohanec, B. Zupan. proDEX - a DSS tool for environmental decision-making. *Environmental Modelling & Software*, 2006, 21(10), pp. 1514–1516

Awards and appointments

1. Blaž Fortuna: Best Demo Award, Budva Montenegro, awarded by ESWC 2006 Conference audience.
2. Blaž Fortuna: Canonical correlation analysis and its application to multilingual text documents, Prešeren Award for best diploma, awarded by Faculty of Mathematics and Physics, University of Ljubljana.

By the end of 2006 the 173rd Solomon seminar was given, disseminating computer science knowledge in Slovenia and abroad – video recordings of most seminars are available on the <http://videolectures.net>

Organization of conferences, congresses and meetings

1. Analysis of environmental data with machine learning methods, Ljubljana, Slovenia, February/March 2006.
2. KDID-2006. 5th Workshop on Knowledge Discovery in Inductive Databases, on ECML/PKDD-2006, Berlin, Germany, September, 2006.
3. Information Society 2006, organization of subconferences: SiKDD-2006, Intelligent Systems and Language Technologies IS-LTC 2006, 9–14 October 2006
4. Workshop organization: LinkKDD-2006 - workshop on KDD-2006 Conference, Philadelphia, USA, 20–23 August 2006
5. Tutorial on “Context Sensitivity” in Knowledge Rich Systems on The 5th International Semantic Web Conference, Athens, Ga, USA, 5–9 November 2006

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3. Marko Debeljak
Coarse woody debris in virgin and managed forest
In: *Ecological indicators*, Vol. 6, pp. 733-742, 2006.
4. Damjan Demšar, Sašo Džeroski, Thomas Larsen, Jan Struyf, Jorgen Axelsen, Marianne Bruns-Pedersen, Paul Henning Krogh
Using multi-objective classification to model communities of soil microarthropods
In: *Ecol. model.*, Vol. 191, pp. 131-143, 2006.
5. Damjan Demšar, Matjaž Gams
Implementing numerical reasoning in ILP
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6. Tomaž Erjavec, Sárossy Bence
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7. Tomaž Erjavec, Kristina Hmeljak Sangawa, Irena Srdanović Erjavec
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Spruce bark beetles (*Ips typographus*, *Pityogenes chalcographus*, Col.: Scolytidae) in the Dinaric mountain forests of Slovenia: monitoring and modeling
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Invited Papers

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4. Dunja Mladenec
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In: Creativity and innovation in decision making and decision support: papers from the IFIP WG8.3 International Conference on Creativity and Innovation in Decision Making and Decision Making and Decision Support, 28 June - 1 July, London, UK, London, LUDIC Publishing, Zv. 2, pp. 817-833.

TEXTBOOKS AND LECTURE NOTES

1. Marko Bohanec
Odločanje in modeli
(Učbeniki in priročniki), Ljubljana, DMFA - založništvo, 2006.
2. Nada Lavrač
Data mining and knowledge discovery: part of "New media and e-science" programme: 2005/2006
(Postgraduate courses in new media and e-science), Ljubljana, Jožef Stefan Institute, 2006.
3. Nada Lavrač, Mitja Jermol, Tanja Urbančič, Dunja Mladenec
New media and knowledge management: part of "New media and e-science" programme and "Statistics" programme: 2005/06
(Postgraduate courses in new media and e-science), Ljubljana, Jožef Stefan Institute, 2006.

THESES

B. Sc. Theses

1. Miha Grčar: Empirical evaluation of algorithms for collaborative filtering (Prof. Ivan Bratko, Asst Prof. Dr. Dunja Mladenec)
2. Blaž Fortuna: Canonical correlation analysis and its application to multilingual text documents (Prof. Bor Plestenjak)
3. Image-based Navigation in Multimedia Archives
IMAGINATION
6. FP: 034626
EC: Clemens van Dinther, Forschungszentrum Informatik an der Universität Karlsruhe, Karlsruhe, Germany
Asst. Prof. Dunja Mladenec, Mitja Jermol, M. Sc.
4. Extended Enterprise Management in Enlarged Europe
E4
6. FP: 027282
EC: Marialuisa Sanseverino, Centro Ricerche Fiat Società Consortile per Azioni, Orbassano (TO), Italy
Asst. Prof. Dunja Mladenec, Marko Grobelnik, Mitja Jermol, M. Sc.
5. Open Source Enterprise Resource Planning and Order Management System for Eastern European Tool and Die Making Workshop
Tool-East

INTERNATIONAL PROJECTS

1. Stimulating Policy Debate on Women and Science Issues in Central Europe
WS DEBATE
6. FP: 036651
EC: Dr. Dora Groo, Eszter Papp, Hungarian Science and Technology Foundation; Tudományos és Technológiai Alapítvány, Budapest, Hungary
Asst. Prof. Dunja Mladenec, Marko Grobelnik, Mitja Jermol, M. Sc.
2. Statistical Multilingual Analysis for Retrieval and Translation
SMART
6. FP: 033917
EC: Nicola Cancedda, Xerox Research Centre Europe, Meylan; Xerox, Aulnay-Sous-Bois, France
Asst. Prof. Dunja Mladenec, Marko Grobelnik, Mitja Jermol, M. Sc.

6. FP; 027802
EC; Dr.-Ing. Volker Stich, Forschungsinstitut fuer Rationalisierung (FIR) and der RWTH Aachen, Research Institute for Operations Management at Aachen University, Aachen, Germany
Asst. Prof. Dunja Mladenič, Marko Grobelnik, Mitja Jermol, M. Sc.
6. Semantic Web Services Interoperability for GoeSpatial Decision Making
SWING; 6. FP; 026514
EC; David Skogan, SINTEF - Stiftelsen for Industriell OG Teknisk Forskning Ved Norges Tekniske Hoegskole, Trondheim; SINTEF ICT, Oslo, Norway
Asst. Prof. Dunja Mladenič, Marko Grobelnik, Mitja Jermol, M. Sc.
7. Lifecycle Support for Networked Ontologies
NEON; 6. FP; 027595
EC; Prof. Enrico Motta, Kmi, The Open University, Milton Keynes, Great Britain
Asst. Prof. Dunja Mladenič, Marko Grobelnik, Mitja Jermol, M. Sc.
8. Transitioning Applications to Ontologies
TAO; 6. FP; 026460
EC; Dr. Kalina Bontcheva, University of Sheffield, Department of Computer Science, Sheffield, Great Britain
Asst. Prof. Dunja Mladenič, Marko Grobelnik, Mitja Jermol, M. Sc.
9. Inductive Queries for Mining Patterns and Models
IQ; 6. FP; 516169
EC; Prof. Sašo Džeroski, Jožef Stefan Institute, Ljubljana, Slovenia
Prof. Sašo Džeroski
10. Knowledge Base for RTD Competencies
IST-WORLD
6. FP; 015823
EC; Prof. Hans Uszkoreit, German Research Center for Artificial Intelligence GmbH (DFKI), Language Technology Lab, Saarbrücken, Germany
Marko Grobelnik, Mitja Jermol, M. Sc.
11. Central European Centre for Women and Youth in Science
CEC-WYS
6. FP; SAS6-CT-2004-003582
EC; Dr. Marcela Linková, Institute of Sociology, Academy of Sciences of the Czech Republic, Prague, Czech Republic
Asst. Prof. Dunja Mladenič, Mitja Jermol, M. Sc.
12. Semantically-Enabled Knowledge Technologies
SEKT; 6. FP; 506826
EC; John Davies, British Telecommunications plc, London, Great Britain
Asst. Prof. Dunja Mladenič, Marko Grobelnik, Mitja Jermol, M. Sc.
13. European Collaborative networked Organizations LEADership initiative
ECOLEAD; 6. FP; 506958
EC; Martin Ollus, Technical Research Centre of Finland, Espoo, Finland
Prof. Nada Lavrač, Mitja Jermol, M. Sc.
14. Sustainable Introduction of GMOs into European Agriculture
SIGMEA; 6. FP; SSPE-CT-2004-501986
EC; Jeremy Sweet, NIAB, Cambridge, Great Britain
Prof. Sašo Džeroski
15. Superpeer Semantic Search Engine
ALVIS; 6. FP; 002068
EC; Wray Buntine, Complex Systems Computation Group at Helsinki Institute for Information Technology, Helsinki University of Technology, Espoo, Finland
Asst. Prof. Dunja Mladenič, Marko Grobelnik, Prof. Matjaž Gams
16. Pattern Analysis, Statistical Modelling and Computational Learning
PASCAL
6. FP; 506778
EC; Prof. John Shawe-Taylor, The University of Southampton, School of Electronics and Computer Science, Highfield, Southampton, Great Britain
Asst. Prof. Dunja Mladenič, Mitja Jermol, M. Sc.
17. KD-ubiq - A Blueprint for Ubiquitous Knowledge Discovery Systems
KD-ubiq
6. FP; 021321
EC; Dr. Michael May, Stephan Kollmer, Fabian Perpeet, Fraunhofer Gesellschaft zur Foerderung der Angewandten Forschung e.V., Muenchen; Sankt Augustin, Germany
Asst. Prof. Dunja Mladenič
18. Soil Ecological and Economic Evaluation of Genetically Modified Crops
ECOGEN
5. FP; QLK5-CT-2002-01666
EC; Dr. Paul Henning Krogh, National Environmental Research Institute, Department of Terrestrial Ecology, Soil Fauna and Ecotoxicology Research Unit, Silkeborg, Denmark
Prof. Sašo Džeroski
19. Knowledge Technologies in Medicine and Healthcare
BI-CZ/06-07-021
Prof. Olga Štěpánková, Czech Technical University in Prague, Faculty of Electrical Engineering Department of Cybernetics, Prague, Czech Republic
Prof. Nada Lavrač
20. Intelligent Data Analysis
BI-FR/05-06/006
PROTEUS
Dr. Michele Sebag, Laboratoire de Recherche en Informatique UMR 8623, Universite de Paris Sud, Orsay Cedex, France
Prof. Nada Lavrač
21. Intelligent Subgroup Discovery
BI-HR/06-07-021
Dr. Dragan Gamberger, Rudjer Boškovic Institute, Zagreb, Croatia
Prof. Nada Lavrač
22. Sustav za automatsku klasifikaciju stranica hrvatskog i slovenskog Interneta
BI-HR/05-06-003
Jasminka Dobša, M. Sc., Fakultet organizacije i informatike, Varaždin, Croatia
Asst. Prof. Dunja Mladenič
23. Gathering, Annotation and Analysis of Macedonian/Slovenian Language Resources
BI-MK/05-06-002
Dr. Katerina Zdravkova, Faculty of Natural Sciences and Mathematics Skopje, Skopje, Republic of Macedonia
Prof. Sašo Džeroski
24. Using Artificial Intelligence in Text and Web Mining
BI-SCG/05-06-019
Prof. Mirjana Ivanović, Faculty of Science, University of Novi Sad, Novi Sad, Serbia and Montenegro
Asst. Prof. Dunja Mladenič
25. Analysis of Dynamic Networks with Graph and Text Mining Methods
BI-US/06-07-032
Faloutsos Christos, Carnegie Mellon University, Pittsburgh, PA, USA
Asst. Prof. Dunja Mladenič

R & D GRANTS AND CONTRACTS

1. Processing lidar data (Development and use of algorithms for mapping and estimating forest biomass and stand structure from LIDAR data and digital multispectral images)
Prof. Sašo Džeroski
2. Digital Critical Editions of Slovene Literature
Asst. Prof. Tomaž Erjavec
3. Semantic GRID environment for ecological modelling
Dr. Ljupčo Todorovski
4. Statistical Semantic Web System
Asst. Prof. Dunja Mladenič
5. Harmonisation of technologies for following genetically modified organisms in food and feed production chain and its co-existence with conventional and ecological production chains
Prof. Nada Lavrač
6. Setting up a Slovene corpus network
Asst. Prof. Tomaž Erjavec
7. Forecasting GIS for natural environment fire hazards
Prof. Sašo Džeroski
8. VoiceTRAN II: Multilingual mobile speech communicator for 21.th century warriors
Asst. Prof. Tomaž Erjavec
9. Methodology for Producing a Digital Map of Forest Stand Height and Canopy Cover
Prof. Sašo Džeroski
10. VoiceTRAN: Multilingual mobile speech communicator for 21.th century warriors
Asst. Prof. Tomaž Erjavec

RESEARCH PROGRAM

1. Knowledge technologies
Prof. Nada Lavrač

NEW CONTRACT

1. Analysis of factors in setting up a network of health care personnel
Ministry of Health
Prof. Nada Lavrač

VISITORS FROM ABROAD

1. Stephan Bloehdorn, Karlsruhe University, Germany, 19–22 June 2006
2. Martin Stein, Karlsruhe University, Germany, 19–22 June 2006
3. Dr. Kathy Astrahantseff, Universitätsklinikum Essen, Germany, 19–25 June 2006
4. Fran Supek, Institut Rudjer Boškovic, Zagreb, Croatia, 19 June 2006
5. Giuseppe Jurman, ITC - IRST, Trento, Italy, 19–20 June 2006
6. Dr. Herwig Rollet, Know-Center, Graz, Austria, 19 June 2006
7. Prof. Bettina Berendt, Humboldt University Berlin, Institute of Information Systems, Berlin, Germany, 3–6 October 2006
8. Brigitte Joerg, DFKI, Saarbrücken, Germany, 18 April 2006
9. Prof. Rich Caruana, Cornell University, Department for Computing, Ithaca, New York, USA, 30 May – 5 June 2006
10. Ethan Dereszynski, Oregon State University, Oregon, USA, 12 May – 11 August 2006
11. Asst prof. Dr. Jasminka Dobša, Faculty for Organization and Informatics, Varaždin, Croatia, 8–10 October 2006
12. Dr. Daniel Radošević, Faculty for Organization and Informatics, Varaždin, Croatia, 8–10 October 2006
13. Dr. Joao Gama, University of Porto, Porto, Portugal, 9 November 2006
14. Dr. Rita Ribeiro, University of Porto, Porto, Portugal, 9 November 2006
15. Dr. Geoff Squire, Scottish crop research institute SCRI, Dundee, Great Britain, 31 March 2006
16. Koraljka Golub, Lund University, Lund, Sweden, 22 May 2006

STAFF

Researchers

1. Prof. Marko Bohanec**
2. Dr. Damjan Bojadžiev
3. Prof. Sašo Džeroski**
4. Asst. Prof. Tomaž Erjavec
5. Prof. Nada Lavrač**, Head
6. Asst. Prof. Dunja Mladenić
7. Prof. Tanja Urbančič*

Postdoctoral associates

8. Asst. Prof. Marko Debeljak
9. Dr. Damjan Demšar
10. Dr. Aleks Jakulin, *left 22.1.2006*
11. Dr. Branko Kavšek*
12. Asst. Prof. Ljupčo Todorovski*

Postgraduates

13. Janez Brank, M.Sc.
14. Blaž Fortuna, B.Sc.
15. Valentin Gjorgjioski, B. Sc.
16. Miha Grčar, B. Sc.
17. Mitja Jermol, M. Sc.

18. Petra Kralj, B. Sc.
19. Simon Krek***, B. Sc
20. Peter Ljubič, B. Sc., *left 1.5.2006*
21. Panče Panov, B. Sc.
22. Joel Plisson, B. Sc.
23. Dr. Miha Volovšek***
24. Miha Vuk, B. Sc.
25. Bernard Ženko, M. Sc.
26. Martin Žnidaršič, univ.dipl.inž. rač. in inf., asis. zač.

Technical officers

27. Asst. Prof. Bojan Cestnik***
28. Dr. France Dacar
29. Dr. Igor Mozetič
30. Nina Novinec, B.Sc.

Technical and administrative staff

31. Tina Anžič
32. Milica Bauer, B.Sc.
33. Marko Grobelnik

* Full-time faculty member

** Part-time faculty member

*** Member of industrial or other organisation