

# Laboratory for Cognitive Modeling

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## 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 evaluating the utility of ordinal attributes, evaluating the reliability of single models' predictions in classification and regression, evaluating the reliability of clustering, explaining single predictions by arbitrary classification and regression model, efficient parameterization of images using a subset of possible image resolutions, text summarization using symbolic graphs, analysing of sport data, user profiling by mining the web-logs, learning of imbalanced classification problems, applying evolutionary computation to data mining focused on using ant colony optimization, prediction intervals which represent the distribution of individual future points in a more informative manner, spatial data mining with multi-level directed graphs, employing background knowledge analysis for search space reduction in inductive logic programming, detection of (non)-ischaemic episodes in ECG signals, heuristic search methods in clickstream mining and mining of data streams. A notable aspect of much of this research is its application to problems in image analysis, medical diagnosis, ecological modeling, marketing and financial modeling.

## RESEARCH PROJECTS

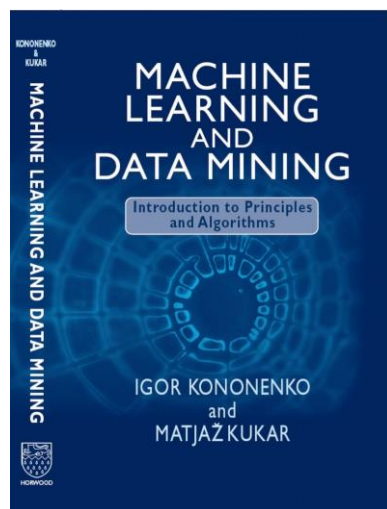
- Artificial Intelligence and Intelligent Systems (P2-0209). Research Programme, Slovenian Research Agency (2009-2014),
- Reliability estimation of drug interactions in pharmaceutical industry. Industry-Funded project, AZ (2011-2012),
- A component for intelligent analysis of data streams. Industry-Funded project, Optilab (2012-2013).

## LABORATORY GUESTS

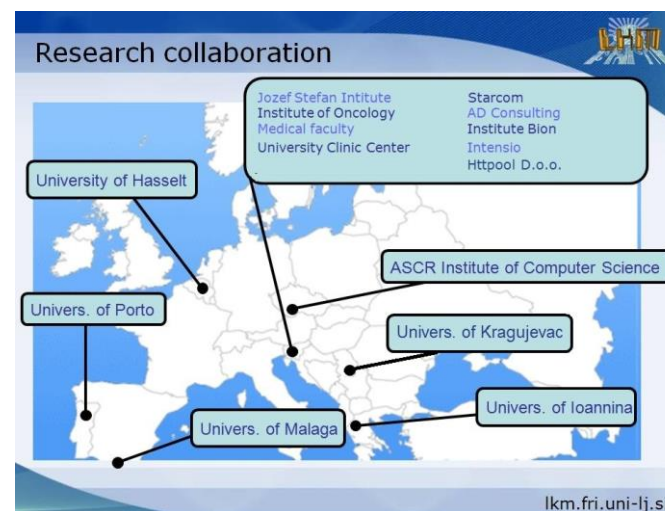
- Ercan Canhas, MSc, University of Prizren, Kosovo. 15.3. 2012 - 25. 3. 2012  
Research collaboration on multidocument summarization based on multilayered graphs.
- Prof. Dr. Joao Gama, University of Porto, Portugal, 4. 10. 2012 - 10. 10. 2012.  
Research collaboration on data streams mining.
- Prof. Dr. Tatjana Zrimec, Univerza na Primorskem, Koper, 3.6. 2012 - 17.6.2012  
Research collaboration on machine learning from medical image data.

## SELECTED PUBLICATIONS

- I. Kononenko, M. Kukar: *Machine Learning and Data Mining: Introduction to Principles and Algorithms*, Horwood publ., 2007 (454 pages).
- Z. Bosnić, P. Vračar, M. Radović, G. Devedžić, N. Filipović, I. Kononenko. Mining data from hemodynamic simulations for generating prediction and explanation models. *IEEE trans. inf. technol. biomed.*, Mar. 2012, vol. 16, no. 2, pp. 248-254, 1A1
- M. Robnik-Šikonja, I. Kononenko, E. Štrumbelj. Quality of classification explanations with PRBF. *Neurocomputing*, Nov. 2012, vol. 96, pp. 37-46, 1A2
- E. Štrumbelj, P. Vračar. Simulating a basketball match with a homogeneous Markov model and forecasting the outcome. *Int. j. forecast.*, 2012, vol. 28, no. 2, pp. 532-542. 1A1
- M. Kukar, I. Kononenko, C. Grošelj. Modern parameterization and explanation techniques in diagnostic decision support system : a case study in diagnostics of coronary artery disease. *Artif. intell. med.*, Jun. 2011, vol. 52, no. 2, pp. 77-90, 1A2
- E. Štrumbelj, M. Robnik-Šikonja. Online bookmakers' odds as forecasts : the case of European soccer leagues. *Int. j. forecast.* 2010, vol. 26, no. 3, pp. 482-488. 1A1
- E. Štrumbelj, I. Kononenko: An efficient explanation of individual classifications using game theory. *J. Mach. Learn. Res.* 2010, 11[1]:1-18. 1A1
- Z. Bosnić, I. Kononenko: Automatic selection of reliability estimates for individual regression predictions. *Knowl. eng. rev.*, 25(1)27-47, 2010. 1A3
- E. Štrumbelj, Z. Bosnić, I. Kononenko, B. Zakotnik, C. Grašič-Kuhar: Explanation and reliability of prediction models: the case of breast cancer recurrence. *Knowledge and information systems*, 24(2)305-324, 2010. 1A1
- 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. 1A2
- 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. 1A1
- I. Kononenko: M. Robnik-Šikonja: Non-myopic feature quality evaluation with (R)ReliefF. In: LIU, H., MOTODA, H. (Eds.). *Computational methods of feature selection*. Boca Raton; London; New York: Chapman & Hall/CRC, 2008, pp. 169-191.
- P. Savicky, M. Robnik Šikonja. Learning random numbers: a MATLAB anomaly, *Applied artificial intelligence*, 22(3):254-265, 2008. 1A3
- Z. Bosnić and I. Kononenko. Comparison of approaches for estimating reliability of individual regression predictions. *Data & Knowledge Engineering*, 67 (3)504-516, 2008. 1A2



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.