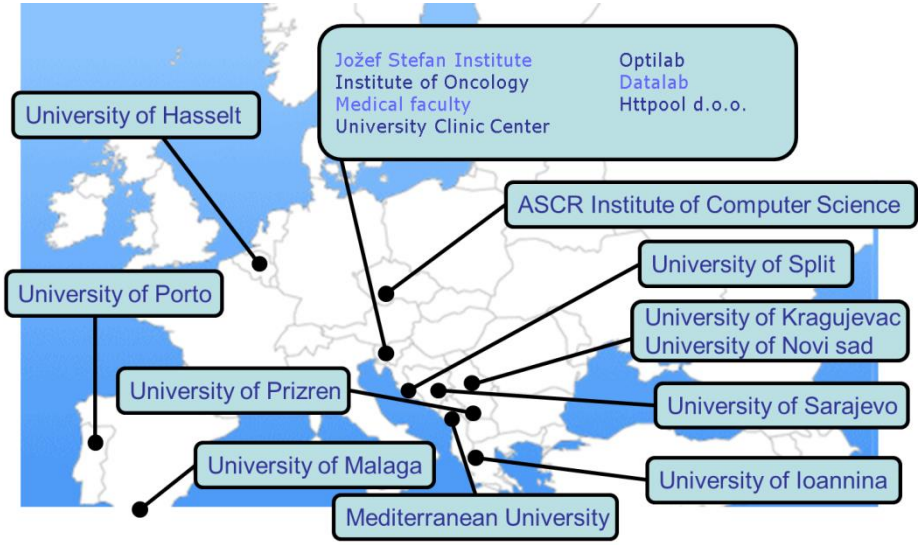
Who are we?

Laboratory for cognitive modeling (LKM) has six permanent members and several collaborators, and at any time also several students engaged in student research projects. LKM members and their research interests are:

- Igor Kononenko, Ph. D., professor and head of the laboratory (applications of machine learning and data mining, algorithms and data structures, machine learning, data mining, artificial intelligence methods),
- Marko Robnik Šikonja, Ph. D., associate professor (machine learning, data mining, data analytics, cognitive modeling, artificial intelligence, natural language processing),
- Matjaž Kukar, Ph. D., assistant professor (spatial data analysis, data stream mining, data mining in databases, reliability estimation, data mining applications in medicine),
- Zoran Bosnić, Ph. D., assistant professor (learning from data streams , user profiling, e-learning, reliability estimation),
- Erik Štrumbelj, Ph. D., assistant professor (statistics , machine learning),
- Petar Vračar, M. Sc., assistant, researcher (sports modeling in team sports),
- Darko Pevec, Ph. D., researcher (machine learning, predictive analytics, statistics, data analysis, visualization, interaction design),
- Matej Pičulin, B. Sc., teaching assistant (swarm intelligence, fuzzy rules),
- Miha Drole, B. Sc., junior researcher (inductive logic programming),
- Kaja Zupanc, B. Sc., teaching assistant (automated essay scoring),
- Domen Košir, B. Sc., junior researcher from industry (web knowledge discovery, social networks analysis).

International Cooperation

We have established a firm cooperation with several foreign research institutions, among others:



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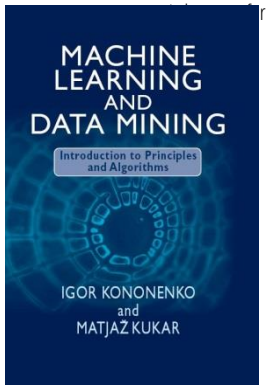
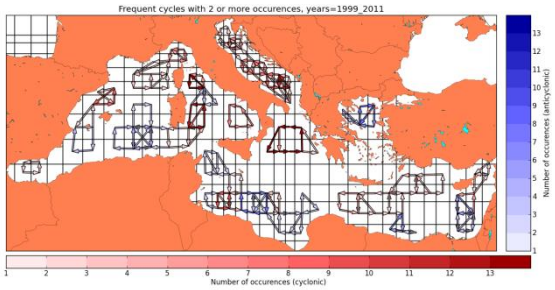


r cognitive modeling (LKM) was established in 2001 as one of successors of Artificial intelligence laboratory (LUI). As one of four laboratories constituting the Artificial intelligence department at the Faculty of computer and information science, we develop state-of-the-art methods for intelligent data analysis and data modeling. LKM members are (co)authors of over 360 scientific papers and 11 books. In June 2007, the book »Machine Learning and Data Mining: Introduction to Principles and Algorithms« by Igor Kononenko and Matjaž Kukar was published by Horwood Publishing (UK). This book is an acknowledgement to the whole research group and rounds up many years of dedicated research work. LKM members' research papers were cited over 1200 times by many international researchers and this further confirms the quality of group's research work.

Research Interests

- machine learning and data mining,
- modeling of numerical, symbolic, spatial, and image data,
- image analysis,
- estimation of data quality and data importance,
- statistical data analysis,
- interactions of various parameters,
- medical diagnostics, recommendation systems, e-learning, web user profiling, modeling of oceanographical data.



Machine learning and data mining search for regularities in moderate to large databases by learning models of data. Generated models can be used for explanation of data, simulations, process control, prediction, and solving new related problems. An example is medical diagnostics, where from previously diagnosed patients a model for diagnosing new, previously unseen patients can be derived. Similar approaches can also be used in insurance or banking businesses, where predictive models can be used for detecting unusual or interesting patterns in a day-to-day business process.

What can we do for you?

- improve your business by implementing business intelligence into your ERP and CRM systems,
- help recognize behaviour of your clients and suit your services to them,
- reduce costs of your business by optimizing business processes,
- consult and educate in data storage and intelligent data analysis,
- enable planning and forecasting of business success in the future,
- explore factors that influence your business success,
- ensure your advantage over business competitors by using modern forecasting tools.

Reference projects

Marketing data analysis

In cooperation with University of Hasselt, Belgium, we have developed a new approach to customer (dis)satisfaction analysis. The new method reaches beyond statistical analysis and correlations between product/service features and satisfaction. It allows introspection into feature dependencies and significance of individual scores as well as their visualization. We have successfully tested the method on customer satisfaction problems in electrical distribution, entertainment industry, and hi-tech product development. Application of the method is not limited to customer satisfaction problem, but can be used on any survey with graded answers.

Analysis of insurance portfolio

We have analysed a portfolio of automobile insurance portfolio of a Slovene subsidiary of an international insurance company. We have detected shortcomings in their system of data collection and analysis as well as market opportunities and portfolio weaknesses. Similar analyses are possible for other insurance, stock-market or bank portfolios. Applications are possible in fraud detection, market opportunities search and improvement of business practices.

CRM for a major local mobile phone operator

Within the CRM portal, developed for a major local mobile phone operator, we developed and implemented various programmer- and user-friendly subsystems for data mining, building upon the Oracle Data Mining platform and Java object-oriented programming paradigm. Developed subsystems significantly shortened the development time, as they could be effectively used without extensive knowledge of data mining methods. Data analysts and end-users were able to easily build, apply, visualize, and validate models for subscriber behaviour (especially churn).

Production process analysis

In a Swedish paper mill, they were trying to solve the problem of large amounts of crumpled (wrinkled) paper. Since several analyses had not produced any results they decided to apply machine learning methods. Before that, a series of measurements of different production parameters were taken. The process outcome (percentage of wrinkled paper) was used as a guideline for building decision trees from the collected data. It became immediately obvious that a single parameter consistently occupied the root node of the decision tree. This parameter had the heaviest influence on the amount of wrinkled paper. If the value of the parameter was held within a certain interval, the amount of wrinkled paper was significantly lower than before. In the production process, the engineers started to observe the critical parameter and maintain its values in the pre-defined interval. This resulted in significantly reduced amounts of wrinkled paper and substantial savings in the production process.

Steel plants

In steel plants, measurements of the liquid steel are used to assess the steel quality and its future uses. The correct assessment is very important, as it influences the steel plant's income. Steel quality assessment is usually carried out by seasoned experts. Because experts are not always readily available (weekends, vacations, illnesses), and the production process must not stop, suboptimal decisions have been made in the past. From the past expert's assessments, a decision tree was constructed and evaluated. It turned out that on the independent data set it performed even better than experts. An expert system was developed and put to routine production use.

Medical diagnostics and prognostics

In contemporary medicine, diagnosis is the foundation of a successful treatment. The diagnosis is made by the physician, according to the patient's signs, symptoms and diagnostic test results (lab tests, x-ray, ultrasound, other image modalities). A similar problem is prognostics, where the physician forecasts the course of the disease. Based on the records of the patients treated in the same hospital for the same (or similar) disease, machine learning methods can be used to induce knowledge (trees, rules) useful for diagnosing (or prognosing) new patients. The induced knowledge may be used as an explanation for diagnoses, and provide insight into the diagnostic problem. Tools based on induced knowledge are also used to assist medical students and inexperienced physicians.

Classification of images

Machine learning (ML) can be used for classification of images by describing images with a set of numerical parameters. Afterwards, we can use any ML algorithm that can induce a classifier. With this methodology, we can classify images, recognize objects from images, and even construct a logical description of the situations, presented by images. We developed two expert systems for supporting medical decisions from scintigraphic images (myocardial perfusion scintigraphy and whole-body scintigrams - for University Medical Centre in Ljubljana) and an expert system for classification of corona types (for the University of St. Petersburg).

Analysis of sport betting markets

For one of the main players in technical betting we have analyzed organized sport betting market. As a result, we developed some new predictive models for specific bet types and found market niches based on market efficiency. Since sport betting market is a twin brother of stock-market, similar analyses are possible for stock-markets, in particular currency exchange rates and other derivative financial instruments.