The Department of Intelligent Systems develops new methods and techniques for intelligent computer systems, with applications in the areas of the information society, computer science and informatics, and network communication systems. The main research areas are ambient intelligence, computational intelligence, agent and multi-agent systems, and language and speech technologies. The department collaborates closely with the Faculty of Computer and Information Science of the University of Ljubljana on the joint research program “Artificial Intelligence and Intelligent Systems”, led by Prof. Ivan Bratko. The department also collaborates closely with industry and contributes significantly the use of intelligent systems in products and services.

Intelligent systems simulate intelligence so that a typical user perceives them as truly intelligent. In reality, these systems use complex mechanisms and implement them on digital computers to imitate human behavior as well as possible, exploiting raw, exponentially growing computer power.

Ambient intelligence is an increasingly established research area introducing technology into our everyday environment in a friendly way that is undemanding for the user. The two key topics of ambient intelligence we work on are (1) telemedicine and elderly care, and (2) smart buildings. On the topic of telemedicine, we successfully completed the European project CHIRON, which is concerned with monitoring chronic heart-disease patients at home. In the past year the project conducted an observational study with real patients, and our department helped analyse the gathered data. We used the CHIRON activity-recognition technology, which utilizes wearable sensors, to win the international EvAAL competition (Evaluating AAL Systems through Competitive Benchmarking). The competition took place in a living laboratory in Velancia, Spain, where an actress performed a sequence of activities, and the competitors had to recognize them with their own equipment. We joined the FP7 project COMMODITY12, which is concerned with monitoring diabetes patients. The role of our department is to analyse the patients’ lifestyle with the sensors they use. This means that we will have to recognize their activities and estimate the energy expenditure. While we already have experience with such tasks from the CHIRON project, recognizing high-level activities, such as work, exercise and eating, will be a new challenge for us. Human energy expenditure was estimated with an advanced context-based AI method and presented at the prestigious UbiComp conference. In the ELKOV22 project, we collaborate with the Development Center Intech-Les to develop the Intelligent e-Doorman System, which was successfully presented at the Slovenian Innovation Forum. The goal of the system is to utilize intelligent computer methods to offer the services of a human doorman, thus improving the security, comfort and energy efficiency. The e-Doorman is installed on a door with an electro-mechanical lock, sensors, a microcontroller and a tablet computer that serves as the user interface. It uses natural language to communicate with the users, it can learn the users’ habits and automatically recognize them, it can detect break-in attempts and other unusual events, and it has a wide range of additional useful functions. In the past year, three pieces of doctoral research were completed: on the detection of unusual and suspicious behaviour of people, on the detection of diseases of the elderly, and on combining expert knowledge and machine learning (for the purpose of ambient intelligence).

Computational intelligence is a study of stochastic search, optimization and learning methods, inspired by physical and biological systems. Research in this area at the Department of Intelligent Systems focuses on evolutionary computation methods. We study extensions of evolutionary algorithms for multi-objective optimization and their speedup, and apply these algorithms in engineering design and optimization problems. In doctoral research projects, we develop a method for the visualization of multi-dimensional fronts of non-dominated solutions in multi-objective optimization, an algorithm for the discovery of optimal car-driving strategies with respect to the traveling time, fuel consumption and driving comfort, and optimization based on...
surrogate models. The key areas of testing and transferring our methods to practice are energy efficiency and production process optimization. In collaboration with partners from five European countries, we successfully carried out the 7th Framework Program project MIRABEL (originally MIRACLE). Its goal was to develop a computer infrastructure to efficiently balance between the generation and consumption of electrical energy for an increased amount of energy from renewable sources. The infrastructure relies on flexible offers for energy generation and consumption, their aggregation and scheduling. For this project we implemented scheduling algorithms for assigning the time and energy amount to the offers. We started a new project COPCAMS, accepted for funding under the Artemis call. Together with the Slovenian industrial partner Kolektor and international partners we design quality-control procedures for production that are based on computer vision, machine learning and optimization. In addition, two research projects aimed at optimizing metallurgical production processes are carried out in collaboration with the University of Nova Gorica, the Institute of Metals and Technology, Ljubljana, and the Štore Steel company.

In the field of agent and multi-agent systems the two key topics are agent decision-making architectures and agent-based simulation. The European project ACCUS is aimed at developing an integration and coordination platform for urban systems to build applications across urban systems, provide adaptive and cooperative control for urban subsystems, and to optimize the combined performance. The system will be implemented in Gdansk and Ljubljana. A similar system is studied within the domestic project OPUS, where the focus is on subsystems within a smart house. In the area of agent-based simulation, the project EUSAS is focused on the development of a new approach to mission training for low level units (security, police force, etc.) facing asymmetric threats in an urban environment. The developed tools can be used to discover the common agent strategy by knowing only low-level agent behaviour and possessing basic domain knowledge. The discovered strategic action descriptions are presented to the user in the form of graph paths, agent actions, roles and corresponding rules. Meaningful behaviour patterns are later used in behaviour cloning, where software agents reproduce the observed human behaviour in a specific domain. The clone is tested in the simulator under all circumstances, thus revealing weak spots and later interactively enabling faster human learning.

In the field of speech and language technologies we work on speech synthesis, semantic analysis of text and question answering. Together with the Amebis company, we develop a new speech synthesizer for Slovene. Special attention is paid to the requirements of elderly, handicapped and visually impaired people. In the past year, we labelled a phonetically rich and balanced speech database for corpus-based speech synthesis using automatic speech-recognition methods. The speech database was recorded in cooperation with the national television and radio, RTV Slovenia. We have established a free text-to-speech conversion service.

Focus points of developmental and research potential of the department are also being expressed over successfully developed, integrated and deployed solutions, available on major digital platforms and applicable to a wide population of users. The methods used in typical applied projects combine procedures of intelligent agents, statistical methods and machine learning, and they serve as a base for user interfaces on telephones, pads or desktop computers. Projects’ services are developed for all key mobile platforms, i.e., Android, iOS, Windows 8 and BlackBerry, and through classic web clients. In the past year, the department obtained and successfully carried out for four innovative projects concerned with the development of e-services and mobile applications for public and private non-profit organizations:

e-Turist (http://www.e-turist.si/) is an application for preparing tourist itineraries adapted to individual users’ interests. It takes into account the location, the available time and the opening hours of the attractions. The itineraries are prepared with the help of a recommender system that evaluates the relevance of attractions for each tourist with the help of expert knowledge and the ratings entered in the past by visitors with similar tastes.
The application helps the users to navigate during the trip, and provides them with written and spoken descriptions of the attractions.

**e-Asistent** ([http://www.projekt-asistent.si](http://www.projekt-asistent.si)) is an intelligent assistant capable of communication in natural language that aims to help the user when searching for information on a web page. The assistant platform can be quickly installed on web pages, e.g., of municipalities and of various associations, so that the general base is adapted within a few days to the target content. The service also accepts the user feedback with comments and answer quality, which is in turn assessed and reported to the contracting authority. E-Asistent is implemented at the Slovene Federation of Pensioners’ Associations (ZDUS) and 10 municipalities, the plan in 2014 is to apply it on 100 municipalities. A similar system Svizc is applied at the Education, Science and Culture Trade Union of Slovenia (SVIZ).

**e-Pedius** ([http://e-pedius.si/](http://e-pedius.si/)) is a mobile and web application named after the Roman painter Quintus Pedius. It is a solution that supports crowdsourcing in assembling the fragments of wall paintings. The restoration of wall paintings from fragments of archaeological sites is difficult due to a large number of fragments, their damage and missing parts, hence it usually requires years of manual expert labour. The new solution e-Pedius is accessible to the wider public, including non-specialists, who can use it to reassemble fragments into new compositions, continue the work of other users, and rate the compositions. The solution is designed as a mobile game in which the users gain points for their achievements, and are encouraged to collaborate with other users.

**e-Govorec** ([http://dis.ijs.si/e-govorec](http://dis.ijs.si/e-govorec)) is a mobile application for the voice interpretation of various Slovenian digital texts. The service enables providers with a wide range of e-content to dynamically deliver information in the spoken form of Slovenian language. e-Govorec comes with an integrated synthesizer of speech and is freely available to any user. The application is built with an ear for groups of people with special needs, such as visually impaired and the elderly.

From 7 to 11 October 2013, the 16th *International Multiconference Information Society – IS 2013* took place at the Jožef Stefan Institute. It consisted of nine independent conferences with 182 papers. Four conference awards were given: for exceptional contribution to the development and promotion of the information society, for current achievements in the field of information society, and the information strawberry and lemon for the best and worst public information-society services. At the main innovation fair in Slovenia we were the only institution presenting tree systems at the final event.

In 2013, the achievements of the department were 12 times presented on national TV, indicating attractive research and development.

Some outstanding publications in the past year


Awards and appointments


Organization of conferences, congresses and meetings

1. 22nd Slovene Workshop on Nature-Inspired Algorithms, AVN, Šmarna gora, Slovenia, 21. 5. 2013
2. 5th Jožef Stefan International Postgraduate School Students Conference, Jožef Stefan Institute, Ljubljana, Slovenia, 23. 5. 2013
3. Co-organization of the student workshop at the conference GECCO 2013 (Genetic and Evolutionary Computation Conference), Amsterdam, The Netherlands, 6.–10. 7. 2013
4. Workshop for municipalities on the usage of the e-service Asistent, 25. 7. 2013
5. Workshop for municipalities on the usage of the e-service Asistent, 26. 9. 2013
6. 16th International Multiconference Information Society, IS 2013, 7.–11. 10. 2013; independent conferences:
   • Intelligent systems
   • Facing demographic challenges
   • Collaboration, software and services in information society
   • Cognitive sciences
   • Data mining and data warehouses
   • Education in information society
   • Human-computer interaction in information society
   • Cognitronics
   • Matcos 2013
7. Workshop for municipalities on the usage of the e-service Asistent, 18. 11. 2013

Patent granted

INTERNATIONAL PROJECTS
1. 7FP - MIRACLE, MIRABEL; Micro-Request-Based Aggregation, Forecasting and Scheduling of Energy Demand, Supply and Distribution
   European Commission
   Prof. Bogdan Filipič
2. 7FP - IntelAct; Intelligent Observation and Execution of Actions and Manipulation
   European Commission
   Prof. Matjaž Gams
3. 7FP - Xperience; Robots Bootstrapped through Learning from Experience
   European Commission
   Prof. Matjaž Gams
4. 7FP - Commodity12; Continuous Multi-Parametric and Multi-Layered Analysis of Diabetes Type 1&2
   European Commission
   Dr. Mitja Luštrek
5. IUSAS; European Urban Simulation for Asymmetric Scenarios
   EADS N.V., Defence and Security Systems
   Prof. Matjaž Gams

RESEARCH PROGRAM
1. Artificial Intelligence and Intelligent Systems
   Prof. Matjaž Gams

R&D GRANTS AND CONTRACTS
1. Advanced Modelling and Simulation of Liquid-Solid Processes
   Prof. Bogdan Filipič
2. Simulation and Optimization of Casting, Rolling and Heat Treatment Processes for Competitive Production of Topmost Steels
   Prof. Bogdan Filipič
3. Open Communication Platform for Service Integration: CC OPCOMM
   Prof. Matjaž Gams
4. E Reader in Slovene for the Blind and Visually Impaired
   Dr. Tomaz Sef
5. Crowdsourcing Support for Reassembly of Wall Painting Fragments
   Prof. Bogdan Filipič
6. Electronic Mobile Tourist Guide
   Dr. Mitja Luštrek
7. Virtual Assistant for Municipalities and Societies
   Prof. Matjaž Gams
8. ARTEMIS, CHIRON; Cyclic and Person-Centric Health Management: Integrated Approach for Home, Mobile and Clinical Environments
   Dr. Mitja Luštrek
9. Adaptive Cooperative Control in Urban (Sub)Systems
   Prof. Matjaž Gams
10. Cognition & Perceptive CAmeras: COPCAMS
    Prof. Bogdan Filipič
11. Optimizing the Management of Energy Efficient Smart Buildings
    Dr. Tomaz Sef
12. Research on Adaptive Predictive Domain Models
    Dr. Boštjan Kaluža

NEW CONTRACTS
1. Research of Intelligent Algorithms Applicability for Sensor Data Processing on Embedded Devices
   Elgoline, d. o. o.
   Prof. Matjaž Gams
2. Research of Intelligent Algorithms Applicability for Sensor Data Processing on Embedded Devices
   Štore Steel, d. o. o.
   Prof. Bogdan Filipič
3. Intelligent Methods for Prediction of Calibration Timing
   Špica International, d. o. o.
   Prof. Matjaž Gams
4. Analysis and Evaluation of Advanced Spoken Language Technologies for Smart Buildings
   Amebis, d. o. o., Kamnik
   Dr. Tomaz Sef
5. Industrial Research aimed at Upgrading the eCampus Learning Management System
   B2, d. o. o.
   Prof. Bogdan Filipič
6. User-Oriented Business Reporting
   Result, d. o. o.
   Prof. Matjaž Gams
   Robotina d. o. o.
   Dr. Tomaz Sef
8. Analysis of Shopping Behavior of Customers in Online Stores
   Creatim Ržišnik Perc, d. o. o.
   Dr. Mitja Luštrek
VISITORS FROM ABROAD

12. Dr. Miha Ličar
13. Dr. Tomaz Šabec
14. Dr. István Szabó
15. Dr. Jana Krivec*
16. Dr. Bogdan Pogorelc
17. Dr. Aleš Tavčar*
19. Iliša Lasič
20. Lana Zemljak

Technical officers
21. Mitja Kolbe*, B. Sc., left 01.07.13
22. Blaž Mahušč, B. Sc.

Technical and administrative staff
24. Vesna Koricki Špetič, B. Sc.
25. Mitja Ličar
26. Iliša Lasič
27. Lana Zemljak

Note: * part-time JFL member

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