

Intelligent Systems and Agents

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Intelligent systems simulate intelligence so that a typical user perceives them as truly intelligent. In reality, these systems have more or less pre-programmed patterns of human behaviour. Due to limited application areas in real-life domains, most standard replies can be pre-programmed in advance through special methods and techniques. Intelligent systems are aimed at extending the applicability of computers, and providing a technological basis for new and improved information services.



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Another important factor is the growth of the information society. A growing number of functions are supported by computers at the same time as humans are becoming overloaded with information. Huge amounts of data are processed by computers several orders of magnitude faster than by humans. Technical possibilities in recent years have grown much faster than they have been exploited. In reality this means that we are dealing with a huge space of generally available intelligent information technology (IT) capabilities. Intelligent systems in the information age enable more new applications than we actually manage to implement. This is analogous to those times when all that was needed to grab new land was a good horse, a good idea and determination. IT "horses" are cheap and available.

One of the most promising intelligent approaches is based on intelligent agents. Agents have two basic properties: autonomy and sociability. Autonomy denotes the capability of an agent to perform actions on its own. This is unlike previously programmed systems, which were nearly always used as tools or slaves. Information overload disables humans from making decisions entirely on their own. To achieve better performance, a certain amount of free will is delegated to agents. The other ability – sociability – makes agents in principle potentially stronger than universal Turing machines.

The Department of Intelligent Systems focuses its activities on the development of methods and techniques for

intelligent computer systems, with applications in the areas of information society, computer science and informatics, Slovene language and speech processing, and network communication systems. The main research areas are language and speech technologies, agent technologies, the semantic Web, evolutionary computing, data mining, search algorithms, decision support, intelligent sensors, distributed supervisory systems and network voice services. The department collaborates closely with the Faculty of Computer and Information Science of the University of Ljubljana on the joint research programme "Artificial intelligence and intelligent systems", led by Prof Ivan Bratko.

The department was founded in 1979, initially as an Artificial Intelligence (AI) group. In the first ten years, the emphasis was on theoretical research that provided a solid background for later application projects. In 1982, the development and implementation of AI tools started and soon resulted in practical applications. By now, over 60 projects with several high-impact practical applications have been completed in different domains such as intelligent information systems, data analysis, decision-making, intelligent agents, medicine, ecology, language and speech processing, intelligent manufacturing, security systems, and the economy, including business and management, technical domains, and medicine.

With more than 30 years of tradition in AI research and development (R&D), the "Artificial Intelligence and Intelligent Systems" joint research group was proclaimed in 2006 by the Slovenian ministry of science and education to be one of the best ever research groups and first in the field of information and computer technologies.

Members of our research group have introduced several new R&D fields in Slovenia, from AI, intelligent systems, and intelligent agents to intelligent services in information society.

In our vision, Slovenia has to move faster towards an intelligent information society to foster efficient progress and a better life.

Intelligent systems are becoming more and more advanced intelligent assistants, and they are improving their communication skills in terms of speech and expression. Intelligent robots, such as the Roomba cleaner, are entering our homes at affordable costs. Intelligent systems are becoming part of our everyday life and Slovenia is joining progress in this area.

The international Information Society multiconference

A traditional activity of the Department of Intelligent Systems is the organisation of the international Information Society multiconference. In October 2007, the 10th multiconference was held in Ljubljana, consisting of six independent conferences: intelligent systems, cognitive sciences, data mining and data warehouses, education in information society, collaboration in information society, and Slovenian demographic challenges in the 21st century.

The Information Society multiconference (<http://is.ijs.si>) continues as one of the leading conferences in Central Europe gathering the scientific community with a wide range of research interests in the information society. The information society displays a complex interplay of social, economic, and technological issues that attract the attention of many scientific events around Europe. The broad range of topics makes our event unique among similar conferences.

The motto of the multiconference is synergy of different interdisciplinary approaches dealing with the challenges of the information society. The major driving forces of the multiconference are the search and demand for new knowledge related to information, communication and computer services. We present, analyse and verify new discoveries in order to prepare the ground for their enrichment and development in practice. The main objective of the multiconference is presentation and promotion of research results, to

encourage their practical application in new ICT products and information services in Slovenia and the broader region.

The most recent multiconference ran in parallel sessions for five days and featured over 150 presentations of scientific papers. The papers were published in the conference proceedings, and in two special journal issues – one of them *Informatica*, with its 30-

year tradition of excellence in research publications.

The multiconference is co-organised and supported by several major research institutions and societies, among them ACM Slovenia (the Slovenian chapter of ACM), and SLAIS i.e. (Slovenian society of the European AI association, ECCAI). The conference is supported by the Slovenian Government, in particular through the Ministry of Higher Education, Science and Technology and the Slovenian Research Agency.



Figure 1: In 2007, the Information Society multiconference rewarded academician Prof Dr Ivan Bratko for the introduction of the information society in Slovenia.

Multi-agent learning

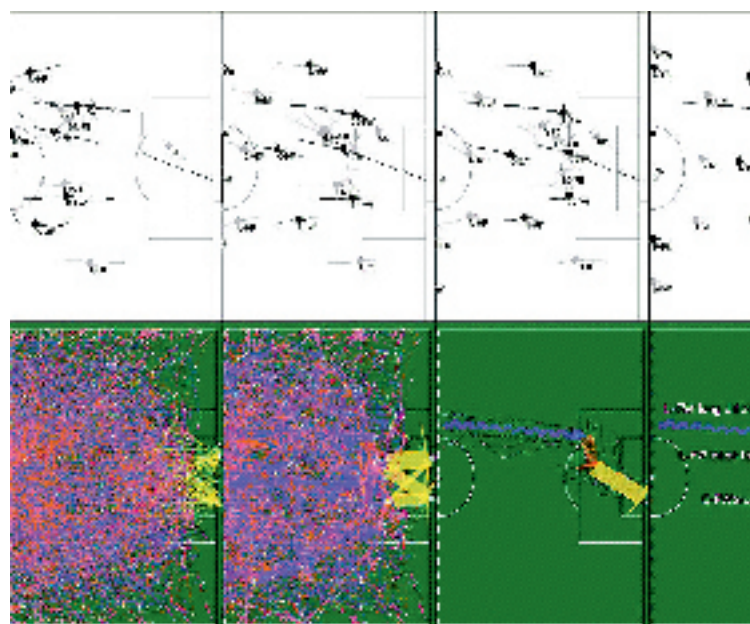
The department introduced agents into Slovenia. In a recent PhD by Andraž Bežek, the Multi-Agent Strategy Discovering Algorithm was designed; this is able to discover and describe successful soccer strategies based only on simple domain knowledge and a multi-agent game trace.

By tracking low-level agent behaviour and basic domain knowledge, it is able to discover a common agent strategy which represents an important achievement in terms of computer creativity. Efficiency was confirmed with testing: measurements of accuracy, recall and precision, domain expert analysis confirmed the strategies obtained.

Our department also has recent experience with multi-agent software

engineering. We designed and implemented a highly efficient load-balancing system. The multi-agent approach enabled high scalability, increased fault tolerance and better upgradeability.

Figure 2: Modelling strategic multi-agent behaviour with the Multi-Agent Strategy Discovering Algorithm (MASDA) in the robot soccer domain



Intelligent access control

The Department of Intelligent Systems developed an intelligent event-driven supervisory system for near-real-time and mission-critical operations with biometric-based access control and an intelligent expert system (CIVABIS) for the Slovenian Armed Forces. The project was sponsored by the Ministry of Defence of the Republic of Slovenia,

and was developed in collaboration with the industrial partner Spica International and the Faculty of Electrical Engineering.

The network of Spica companies is the leading supplier of data collection systems in the Adriatic region. Spica International was founded in 1989 in Ljubljana, Slovenia. R&D has always been the key component of Spica's strategy, and the company's current

successful operation is undoubtedly rooted in firm reliance on its own knowledge base and the skills built through systematic R&D programs.

Spica has offices in five West-Adriatic countries, where it acts as the leading regional AIDC (automatic identification and data collection) distributor-reseller and integrator. An impressive market share of about 50% could not possibly be achieved without a strong network of local partners in each country.

For local AIDC markets, Spica turned to a selected group of world-leading vendors. Spica's partnership policy relies on long-term co-operation and intensive exchange of expert knowledge, which enables the company to provide state-of-the-art solutions that fully meet international standards.

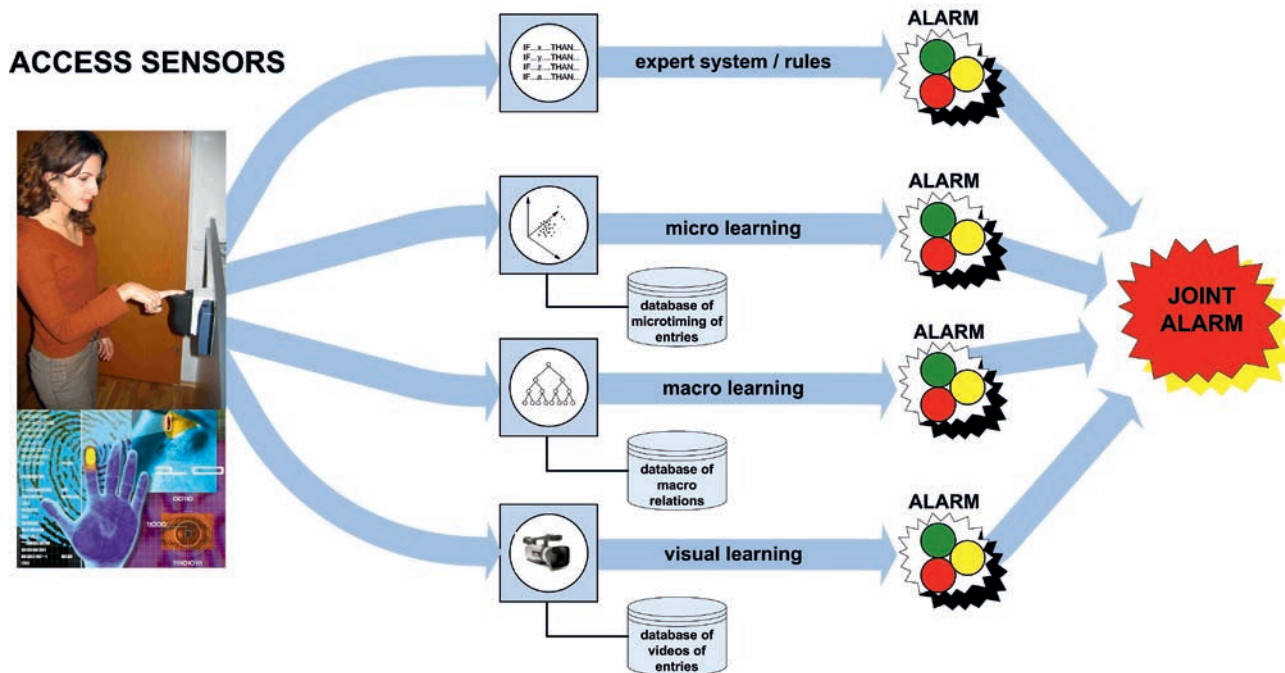


Figure 9: Schema of the intelligent multi-modal biometric access control system



The joint Civabis research group.

International co-operation

The department took part in seven FP6 projects and several other international projects with emphasis on collaboration with industrial partners:

- ALVIS (Superpeer Semantic Search Engine)
- SEKT (Semantically Enabled Knowledge Technologies)
- WINDECT (Wireless Local Area Network with Integration of Professional-Quality DECT Telephony)
- COST 526 (Automatic Process Optimisation in Materials Technology, APOMAT)
- We-go (Enhancing Western Balkan e-government Expertise)

- AgentLink III (Co-ordination Action for Agent-Based Computing)
- ASPIC (Argumentation Service Platform with Integrated Components)

The Alvis project conducted research into the design, use and interoperability of topic-specific search engines with the goal of developing an open source prototype of a distributed, semantic-based search engine. Aleksander Pivk's PhD was closely related to the Alvis project, dealing with HTML tables in relation to the semantic web.

The Department of Intelligent Systems also developed methods for automatic classification of web pages into genres for the project.



Figure 6: The “We-Go” project aims to transfer and to successfully adapt “e-Government Good Practice and Knowledge” and will enable follow-up implementation projects including accompanying measures targeted at reinforcing and producing innovation in e-Government research

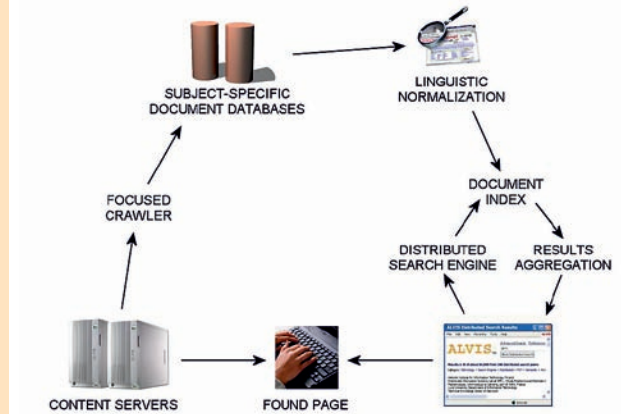
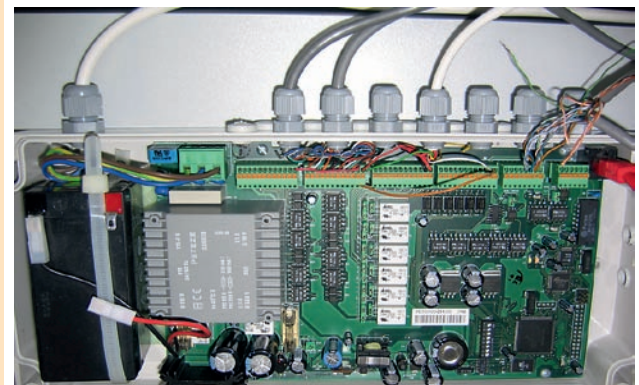


Figure 8: Distributed semantic search engine ALVIS



DOX - entry controller.

Intelligent interfaces

In co-operation with the Slovenian tax office, the Department of Intelligent Systems provided expert advisory support, analysis, consultations and proposed modifications to “Vida”, the virtual assistant for Slovenian taxpayers. Placed on the website of the Slovenian tax office, “Vida” provides answers to common taxpayers’ questions and provides an alternative high-quality tax-related information source as part of Slovenian e-government services.

In the area of language and speech technologies, the Department of Intelligent Systems developed new language resources for the Slovene language, new algorithms and procedures for Slovene speech synthesis, and was engaged in syntactic parsing of Slovene texts. In co-operation with other research groups, the department continued the development of the syntactically annotated corpus of Slovene text (the “Slovene Dependency Treebank”). Its current size is about 35,000 words. The corpus is intended to serve in research of automatic syntactic parsing of Slovene text.

Together with the Amebis company, the department’s researchers developed a new version of the Slovene text-to-speech (TTS) system, Govorec (Speaker). It is the first and only widely available commercial TTS system for

the Slovenian language. It is capable of automatic conversion of any Slovenian text into speech. For example, it is also integrated into the teletext service provided by national Radio-television Slovenia. It was designed for and donated



Figure 3: “Vida”, the virtual assistant for Slovenian taxpayers

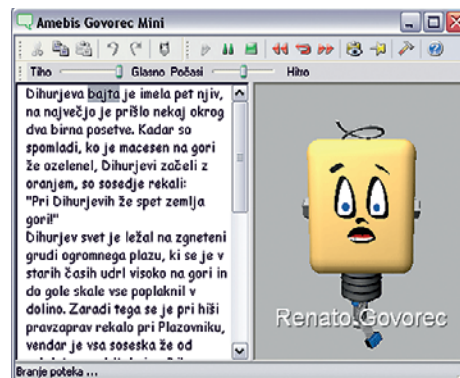


Figure 4: The Govorec interface (from the Amebis web site).

to blind and partially-sighted people as a tool for keeping up-to-date with news. The system was awarded the first prize for innovation in the field of life improvements for people with disabilities by the Government Office for the Disabled and Chronically Sick of the Republic of Slovenia.



Defence Ministry experts evaluating the research prototype.