University of Applied Sciences and Arts
of Southern Switzerland
SUPSI

Master Research Unit

Intelligent Systems

Intelligent Systems (IS) deals with intelligent behaviour, learning and optimization in machines and robots. This Master Research Unit (MRU) is focused on the design of computational systems that function in a changing, unpredictable and usually incompletely-known environment by displaying high-level abilities. The goal is to draw inspiration from nature, human performance and mathematically-sound problem-solving tools in order to build powerful systems capable of achieving complex goals in complex environments using limited resources.

Intelligent Systems have knowledge, beliefs, preferences and goals, and they have informational as well as motivational attitudes, such as observing, communicating, planning, anticipating and committing. They are able to reason about other systems and about their internal states and they are able to simulate and to optimize their performances. Intelligent Systems adapt to unpredictable and dynamic situations by using learning capabilities, which guarantee a high degree of autonomy.

Students graduating from this program have developed a taste for working on complex problems and will most likely look for careers where they will be able to apply their knowledge in an interdisciplinary area with enhanced analytical and technical skills. Examples include planning, scheduling, control, cognitive and mobile robotics, business forecasting, intelligent searching agents, video games, artificial music, diagnostics, speech recognition.

Internationally known, motivated and active researchers are professors on the Intelligent Systems MRU. They are all involved in Swiss and International research and applied projects and they emphasize close contact with students. Collaborations with industries guarantee the possibility to experiment, test and validate the result of the study materials. Visiting professors from renowned universities complement the top-quality teaching staff.

Intelligent Systems MRU is a SUPSI, DTI IDSIA, Dalle Molle Institute for Artificial Intelligence www.idsia.ch initiative.

Research Areas of MRU Intelligent Systems:

- Optimization, Simulation and Decision Support Systems
- Machine Learning and Artificial Neural Networks
- Uncertain Reasoning and Data Mining
- Cognitive and Mobile Robotics

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Research Area

Optimization, Simulation and Decision Support Systems

Specialization
- ☐ Business Engineering and Production
- ☐ Energy and Environment
- ☐ Industrial Technologies
- ☒ Information and Communication Technologies

Decision Support Systems (DSSs) help decision makers to analyse, understand and explore complex decisional processes and therefore make informed decisions to solve real-world problems. Decision Support Systems integrate optimization, artificial intelligence, operations research, modeling and simulation in a computer-based environment, in order to provide the required level of insight in the decisional problem.
The main goal is to design, implement, simulate and optimize dynamic and complex systems. The development of an effective real-world DSS therefore requires a formalization of the decisional problem, the definition of the preference criteria of the decision makers and possibly of all stakeholders, a simulation of the possible scenarios in order to evaluate their performance, and an exact or heuristic optimization methodology to screen alternatives and focus only on efficient ones. The DSS must be able to access large data sets to support its analyses and provide an intuitive and effective way to display the results and interact with the decision makers.

Research Area

Uncertain Reasoning and Data Mining

Specialization
- ☐ Business Engineering and Production
- ☐ Energy and Environment
- ☐ Industrial Technologies
- ☒ Information and Communication Technologies

How can we teach a computer to reason and take decisions in uncertain situations? For example, we might want to teach a computer to assist a doctor in medical diagnosis; or to support environmental experts in the prediction of natural hazards, such as landslides; or to help recognizing potential terroristic threats carried out over the internet, or by airplanes. We can do this by transferring human expertise into a knowledge base and developing algorithms for logical reasoning under uncertainty that are applied to the knowledge base to perform inferences, such as deductions or predictions.
In some cases human expertise is not available but there are data. It can be data in the medical domain (such as clinical information about patients, or genetic data), in business (e.g., credit cards, insurance), or environmental data, just to say a few. In these cases, it is important to give a computer tools to be able to automatically learn about the domain from the available data. Data mining is the field that enables computers to learn from data how to do predictions, diagnosis, recognition (and more), using with very little human intervention. Applications include again medical diagnosis, predictions, user profiling, recommendations, image/speech recognitions.
Our expertise includes many applications of the above methodologies to real world problems, such as the automated diagnosis of dementia (medicine), the prediction of debris flows (environment), and the identification of flying objects in a no-fly area (defense). At the same time we have a long experience in the field of biomedical modelling and in particular, genomics

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Research Area

Machine Learning and Artificial Neural Networks

Specialization
- ☐ Business Engineering and Production
- ☐ Energy and Environment
- ☐ Industrial Technologies
- ☒ Information and Communication Technologies

Machine learning is needed for a wide range of important applications that become more and more essential for the modern society: text-based web search, image-based web search, movie search, cognitive robotics, mobile robotics and self-driving cars, embedded computing, pattern recognition, image recognition, voice recognition, speech recognition, handwriting recognition, video surveillance, scientific computing, scheduling, optimization, artificial intelligence etc.
Our research activities cover fundamental topics related to machine learning: Bayesian / probabilistic reasoning; hidden Markov models; expectation maximization; feedforward neural networks; recurrent neural networks; support vector machines; reinforcement learning; artificial evolution, unsupervised learning techniques, data mining, pattern classification and regression, empirical evaluation, feature selection, discretization, combining multiple models, data fusion, cluster analysis.
Our team of teachers has produced world-leading research in many of the fields mentioned above

Research Area

Cognitive and Mobile Robotics

Specialization
- ☐ Business Engineering and Production
- ☐ Energy and Environment
- ☐ Industrial Technologies
- ☒ Information and Communication Technologies

Understanding the foundation of robotics is essential for building complete knowledge of artificial systems. Intelligence appears when a physical life-form is interacting with the environment and it can only be observed in an interactive process. Artificial systems cannot be fully understood by simulating these systems, because generalization from real embodies systems to simulated systems leads always to an oversimplification of the real world and its challenges. Upon completion, students learn about the different classes of cognitive and mobile robots, their application areas and their varying concepts of programming and problem solving strategies. Topics: Overview of cognitive and mobile Robotics in Practice and Research; Sensors and Actuators; Low Level Feedback Control; Computer Vision for Robotics; Humanoid Robotics, Robotic Manipulation; Legged Locomotion; High Level Behavior Control; Planning, Execution and Learning; Navigation, Localization and Mapping; Sensor Fusion, Communication and Swarm Robotics.
The learned theoretical skills is applied to projects in the robotic laboratory, helpful for the full understanding of the concepts and for inspiring students' own ideas and further research. The lab is equipped with many robot prototype, 30 E-TUCK Robot, 10 Swarmbots robots, 4 Pioneer3 AT Robot, 2 Neuronics Robot CATANA 6M, 1 Robertino Robot, 1 iCub robot.

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