Master of Science
Artificial Intelligence Syllabus

Courses description

Knowledge representation and reasoning

Knowledge representation in a model. First order and higher order models. Non-monotonic models. Temporal models. Logical models of higher order. Frame systems. Representing structured knowledge. Description logics and ontologies. Constraint-based representation and associated languages. Systems for maintaining data consistency. Bayesian networks. Plan representation and advanced techniques for automatic planning. Real life applications and usage of knowledge representation and automatic reasoning techniques.

Type systems and functional programming

Functional programming. Untyped Lambda Calculus. Recursion and fixed-point combinators. Operational semantics as a language specification tool. Typed Lambda Calculus. The "type system" concept. Particular monomorphic types: Boolean, natural numbers, product. Recursive types: lists. Parameterized polymorphism. System F. Type reconstruction: unification, principal types, typing rules. The Fw system. Particular problems: types, classes and functors in Haskell.

Data Mining

Introduction in Data mining. Data preprocessing. Association Rules & Sequential Patterns. Supervised learning. Unsupervised learning – Clustering. Partially supervised learning. Information integration. Link analysis. Data warehousing. Dimensional modeling. Building a data warehouse.

Multi-agent systems

Agents and multi-agent systems. Architectures for cognitive and reactive agents. Communication languages and protocols for MAS. Coordination for solving tasks. Distributed planning in MAS. Negotiation techniques and protocols. Learning in MAS. Agent oriented programming. MAS platforms. Applications of multi-agent systems. Personal and Internet agents.

Natural language processing

Introduction in Natural Language Processing. Phonetics and phonology. Finite state transducers, two level morphology, paradigmatic morphology, Stemming and lemmatization. Corpus linguistics. Hidden Markov Models; Naïve Bayes method with applications in NLP. Different classes of grammatical formalisms for natural language. Unification grammars, chart parsing, Earley and CKY algorithms. Part of Speech Tagging Case grammars, Ontologies, Sense disambiguation. LSA, pLSA, LDA. Pragmatics and discourse analysis. Coreferences. Rhetorical schemas and natural language generation. Polyphonic theory. Conversation analysis.

Symbolic and statistical learning

Introductive elements of machine learning, statistics, information theory and decision theory. Linear models for regressions. Linear models for classifications. Kernel methods and Gaussian processes. Sparse kernel methods (Support vector machines and Relevance vector machines). Bayesian methods and graphical methods. Expectation maximization. Principal components analysis and Independent component analysis. Hidden Markov models.

Self-organizing systems

An introduction to self-organizing systems. Bio-inspired self-organizing systems. Self-organizing systems used in economy. Ant Colony Optimization. The social organism. Elements of Evolutionary Computation. Elements of social psychology. Culture in theory and practice. Thinking as a social process. Particle Swarm. Particle Swarm Optimization.

Neural networks

Connectionist paradigm. Rules and learning algorithms of neural networks with feed forward. Universal function approximators feed forward propagation multilayer networks. Recursive Hopfield Networks. Boltzmann Machines. Self-organization principle of and supervised learning. Broomhead & Lowe networks with radial or elliptical basis functions. Cascor Neural Networks. Extracting knowledge from neural networks. Evolutionary intelligent agents to implement neural networks. Social learning.

Software Verification and Validation

Introduction: Software development. Software development methods and models. Extreme programming. Requirements analysis; user specifications; UML. Software testing. Testing techniques and methodologies. Software verification. Methods of software specification. The predictability of software development.

Research activities

The student will develop a research project during the first year of the Master programme. The topic selected can be continued during the second semester and for the Master Thesis or can be changed in the second year.
Example of research projects are:

- UAV (Unmanned Aerial Vehicles) Control
- UAV Swarm Coordination
- Nao Robot Control
- Teaching Nao how to speak and walk
- Ambient Intelligence Applications
- Properties of Extension-Based Semantics
- Normative Multi-Agent Systems with BDI Agents
- Formalizing contexts for modeling relationships in MAS
- Using a Social Trust Model to Secure Routing in a Wireless Sensor Network
- Management of unforeseen faults in multi-agent systems
- The Detection & Interpretation of Computer User Stress Levels
- Detection and Correction of Romanian Malapropisms
- Affective Intelligent Agents
  Machine Learning for personalized newsreader