



# **M.Sc. in Cognitive Systems**

## **Model Curriculum**

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**School of Informatics  
University of Skövde  
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## **1 Core Courses**

### *Year 1, Semester 1*

Introduction Cognitive Science  
Cognitive Architectures  
Autonomous Systems  
Empirical Modelling of Human Cognition

### *Year 1, Semester 2*

Embodied Cognition  
Learning, Growth, and Development  
Memory, Prospection, and Internal Simulation  
Knowledge, Representation, and Reasoning

### *Year 2, Semester 1*

Social Cognition and Interaction Dynamics  
Artificial Intelligence  
[Two electives]

### *Year 2, Semester 2*

[Dissertation]

## **2 Elective Courses**

Distributed Cognition & Adaptive Ecosystems  
Machine Perception  
Human and Computational Models of Attention  
Natural Language Processing  
Industrial, Mobile, and Humanoid Robotics  
Neural Processing

### 3 Outline Course Syllabi

#### Introduction Cognitive Science

- Paradigms of cognitive science
- Cognitivism, computationalism, and artificial intelligence
- The emergent paradigm
- Connectionism
- Dynamical systems
- Enaction

#### Cognitive Architectures

- Role of a cognitive architecture
- Desirable characteristic for cognitivist and emergent architectures
- Cognitive architecture schemas (e.g. Cognitive-Affective; CogAff)
- Example cognitive architectures (e.g. Soar, DARWIN, ACT-R, ISAC, LIDA, CLARION, and others)

#### Autonomous Systems

- Types of autonomy
- Strength and degree of autonomy
- Robotic autonomy vs. biological autonomy
- Constitutive and behavioural autonomy: homeostasis and allostasis
- Emergence, self-organization, autopoiesis, and organizational closure
- Measures of autonomy

#### Empirical Modelling of Human Cognition

- Probability concepts, sampling, and expectation
- Factorial mixed model experimental designs
- Confidence intervals and hypothesis testing
- Correlation, single and multiple linear regression
- Bayesian statistics
- Signal detection theory

#### Embodied Cognition

- Cognitivist and emergent perspectives on embodiment
- The conceptualization, constitution, and replacement hypotheses
- Mutual dependence of perception and action
- Types of embodiment
- Off-line embodied cognition
- Situated, embedded, grounded, extended, and distributed cognition

#### Learning, Growth, and Development

- Development in natural systems
- Phylogeny and ontogeny
- Developmental psychology
- Imitation
- Value systems and motivation
- Supervised, unsupervised, and reinforcement learning

### Memory, Prospection, and Internal Simulation

- Types of memory: declarative, semantic, episodic, procedural, associative
- Self-projection, prospection, and internal simulation
- Prospection, affect, and hedonic experience
- The simulation hypothesis and internal simulation
- Motor, visual, and mental imagery
- Modes of forgetting

### Knowledge, Representation, and Reasoning

- Representation and anti-representation
- Weak and strong representation
- Radical constructivism
- The symbol grounding problem
- Joint perceptuo-motor representations
- Sensory-motor theory and Ideo-motor theory
- Acquiring and sharing knowledge

### Social Cognition and Interaction Dynamics

- Social interaction
- Reading intentions and theory of mind
- Instrumental helping
- Collaboration
- Joint action, shared intention, and joint attention
- Development and interaction dynamics

### Distributed Cognition & Adaptive Ecosystems

- Dynamic self-configuration and coordination of subsystems
- Group cognition
- Social organizations as cognitive architectures
- Cultural factors
- Eco-system dynamics: growth and development

### Artificial Intelligence

- Intelligent agents
- Problem solving, search, constraint satisfaction
- Knowledge and reasoning: first order logic, probabilistic reasoning, decision making
- Learning by examples, knowledge, learning probabilistic models
- Natural Language Processing & communication
- Perception
- Robotics

### Machine Perception

- Image acquisition, representation, and processing.
- Camera modeling and calibration
- Segmentation: thresholding, edge-, and region-based techniques
- Line and curve detection, Hough transform
- Shape representation and object recognition
- Stereo, motion, and optical flow
- Active vision: overt attention and object tracking

### Human and Computational Models of Attention

- Overt and covert attention
- Inhibition of response and habituation
- Pop out, change blindness, and inattention blindness
- Exogenous and endogenous influences
- Visual search: saccades, scan path patterns, and smooth pursuit
- Prospective control
- Computational models
- The selective routing hypothesis
- The salience map hypothesis
- The temporal tagging hypothesis
- The emergent attention hypothesis

### Natural Language Processing

- Regular Expressions and Automata
- N-grams, part-of-speech tagging
- Hidden Markov and maximum entropy models
- Automatic Speech Recognition
- Formal Grammars, Syntactic Parsing, Statistical Parsing
- Computational Lexical Semantics
- Computational Discourse

### Industrial, Mobile, and Humanoid Robotics

- Kinematics and dynamics
- Inverse kinematics
- Locomotion
- Mobile robot localization, Kalman filtering
- Planning and navigation
- Grasping
- Bipedal locomotion

### Neural Processing

- Artificial neural networks
- Multi-layer perceptrons and back-propagation
- Radial basis functions
- Associative memories
- Adaptive Resonance Theory
- Recurrent networks: Hopfield, Boltzman, Elman and Jordan nets
- Reservoir computing, Echo state networks, Liquid state machines
- Dynamic Field Theory
- Connectionist/symbolic architectures