# Course program (structure and organization)

for the Masters degree program FSPO 2017 in

Cognitive Systems

An overview of the structure of the course program and the major contents is presented in the following itemized list (with colour palette coding) as well as the related table:

- **Basic Subject** (24 ECTS, yellow) with specific selection according to a mandatory introductory program which shows an Y-model structure tailored in part for

    Psychology for Computer Scientists and

    Computer Science for Psychologists

    as well as module offers for all students

- **Interdisciplinary Subject** (18 ECTS, green) with a mandatory program for all students to cover the interdisciplinary scope of the cognitive systems subject

- **Special Subject** (24 ECTS, red) with an elective program aiming at a further specialization in topics related to cognitive systems

- **Applied Subject** (24 ECTS, blue) with an elective program of in-depth thematic projects in different areas, and

- **Master's thesis** (30 ECTS, gray)
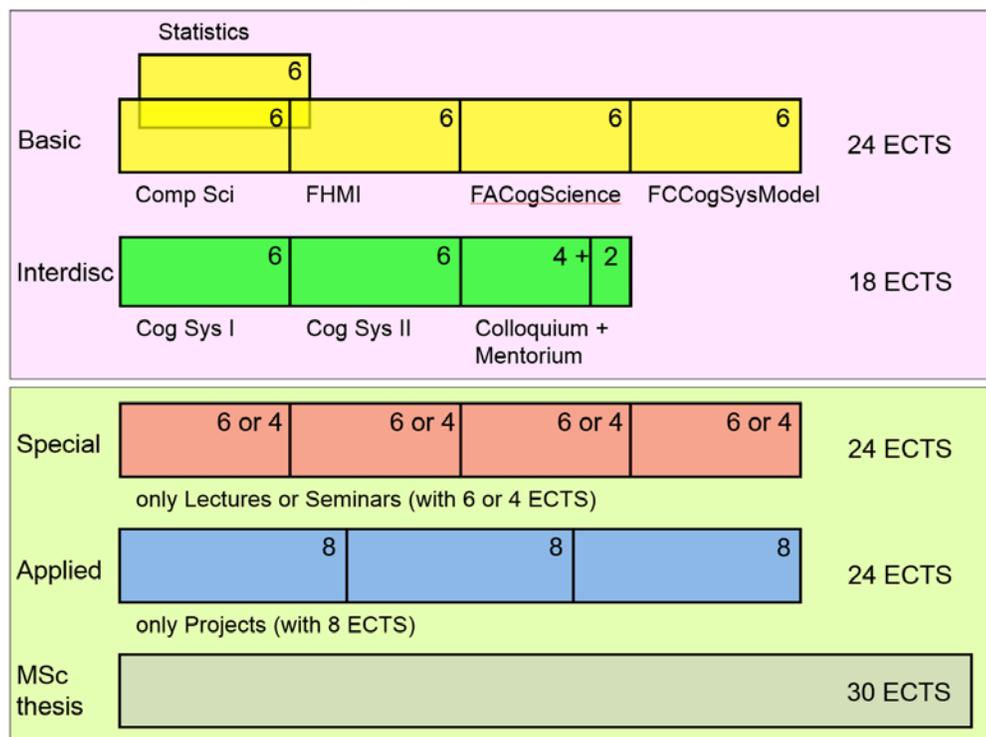
Outline of the structure of the course program. Background colours indicate mandatory selections (magenta) and elective selections (light green).

An example time plan for individual composition of modules follows below.

Basic subject _Comp Sci_	Basic subject	Basic subject	Interdiscipl. subject	Interdiscipl. subject
Statistics 6	6	6	6	6
Basic subject	Interdiscipl. subject	Applied subject	Special subject	Special subject
6	6	8	4	6
Applied subject	Applied subject	Special subject	Special subject	Special subject
8	8	4	4	6
Master's thesis				30

Note that the composition of the individual modules selected from the different subjects in the program have **exemplary character**. The individual modules (with ECTS points) to be chosen by a student depend on the particular selections possible. Different selections and compositions are possible. An MSc thesis can be started already after 60 ECTS points have been successfully accumulated.

Basic Subject (Grundlagenfach), 24 ECTS

This part defines mandatory components of the basic education in the master's program. The aim is to communicate a basic level of knowledge in *Cognitive Systems* that depends in part on the discipline in which the BSc degree was acquired. The focus of this specific program is on topics building up some cross-disciplinary basic knowledge level as well as ensuring that all participants are familiar with some key scientific aspects of cognitive systems research. Altogether, this basic subject education provides the basis for later specialisation during the Master's course program.

The selection of courses is organized in a Y-model such that students with a BSc degree in Psychology or Computer Science or related area, respectively, receive initial cross-disciplinary training. Furthermore, the groups pass course offers with computer science and psychology background, providing students with a sound basic knowledge. For students with a different degree that already reflects a basic interdisciplinary education, e.g., a degree in Cognitive Sciences, a specific selection of courses will be defined on an individual basis at the beginning of the course program.

Module for BSc students in Computer Science

Students with a BSc in Computer Science or related discipline receive an introductory training to provide basics in Psychology, namely

"**Introduction to Psychological Methods and Statistics (for non-psychologists)**" (Ernst)
(6 ECTS)   (2V+2Ü, WiSe)

Module for BSc students in Psychology

Students with a BSc in Psychology or related discipline receive an introductory training to provide basics in Computer Science, namely

"**Introduction to Computer Science (for non-computer scientists)**" (Glimm)
(6 ECTS)   (3V+1Ü, WiSe)

Modules for both BSc students in Computer Science or Psychology

In addition to the separate courses three additional courses of introductory training are provided for all students in the program, namely

"**Foundations and Concepts of Cognitive Systems Modelling**" (Braun)
(6 ECTS)   (2V+2Ü, WiSe)

"**Fundamental Approaches to Cognitive Science**" (Ernst)
(6 ECTS)   (2V+2Ü, SoSe)

"**Fundamentals of Human-Machine Interaction**" (Neumann)
(6 ECTS)   (2V+2Ü, WiSe)

Interdisciplinary Subject (Interdisziplinäres Fach), 18 ECTS

The *Interdisciplinary Subject* aims to transfer the theoretical knowledge and experience from modules in the *Basic Subject* to the interdisciplinary topics across the various areas in *Cognitive Systems*. It is intended that each student acquires a level of basic knowledge in the definition and the related scientific contents of the discipline through the selection of a mandatory modules.

The core level program consists of an introduction into *Cognitive Systems*, which includes historical aspects, modeling basics, and methodological groundwork. A representative cross-section of contents covers key aspects of the field, namely *Perception*, *Interaction*, *Learning*, and *Planning & Reasoning*, and key methodological aspects related to the field. In addition, a module is included, which includes a colloquium with a series of cognitive systems related talks. The program is organized by instructors of the program to host several invited guest lecturers who will present recent developments in the field of *Cognitive Systems*. Integral part of the latter module is a mentorium as detailed below.

"**Cognitive Systems I**" (several instructors)
(6 ECTS)   (3V+1Ü, WiSe)

"**Cognitive Systems II**" (several instructors)
(6 ECTS)   (3V+1Ü, SoSe)

"**Recent Developments in Cognitive Systems Research**" (coordinators: Ernst, Neumann)
(6 ECTS)   (2S+1Mentorium, WiSe & SoSe)

Mentorium: Students are supervised by tutors assigned to the course. The mentorium serves to introduce the students to the core technical facilities @ UUlm as well as to provide a training in searching and analyzing literature, properly citing literature, designing posters, and using some basic tools (e.g. Latex). In addition, social life aspects are considered such that the students benefit from the mentorium establishing themselves as a group.

<u>Special Subject</u> (Vertiefungsfach), 24 ECTS

The general outline of the program in *Cognitive Systems* is based on the following four core areas of the discipline as well as one for general modelling and analysis mechanisms, namely

- Perception,
- Learning & Memory,
- Planning & Reasoning,
- Interaction, and
- Methods, general Concepts & Tools.

In addition, several facilities and methods are of interest and further shape the program and its offers. Together, they are grouped into five different areas. Currently, in the *Special Subject* individual modules of different types are offered. The following list of courses refer to the specific topics which are grouped into different areas. Students may select among the modules to assemble their individual specialization that can be a relevant basis for successfully completing the *Applied Subject* and the *MSc thesis*.

The compositions depend on the type of the individual courses, namely lectures with exercises or seminars. The selection and successful completion requires an amount of at least 24 ECTS. The individual composition of the modules for each student has to select offers from **at least two of the five areas**. Detailed descriptions and requirements for the individual courses (modules) can be found in the Module Handbook (MHB). In order to better plan the selection of individual courses the different semesters (summer, SoSe; winter, WiSe) are indicated below.

The Commission of Study Affairs (Studienkommission) finally decides at intervals of one or two years about the coherence of the program offered. Currently, a list of topical areas is offered. New proposals for inclusion into this list must be sent to the head of the study commission and the program coordinator. The final decision about acceptance will be made by the members of the study commission. A simple majority vote is necessary.

Area: Perception

"**Computer Vision I**" (Neumann)
(6 ECTS)   (3V+1Ü, SoSe)

"**Computer Vision II – Multiple Image Analysis**" (Neumann)
(6 ECTS)   (3V+1Ü, irreg.)

"**Data Visualization**" (Ropinski)
(6 ECTS)   (3V+1Ü, SoSe)

"**Deep Learning for Graphics and Visualization**" (Ropinski)
(6 ECTS)   (3V+1Ü, irreg.)

"**Specialization in Cognitive Psychology**" (Huckauf)
(4 ECTS)   (2S, irreg.)

"**Vision**" (Neumann)
(4 ECTS)   (2S, irreg.)

"**Vision in Man and Machine**" (Neumann)
(6 ECTS)   (2V+2Ü, irreg.)

Area: Learning & Memory

"**Advanced Methods in Data Mining and Machine Learning**" (Scherp)
(6 ECTS)   (2V+2Ü, irreg.)

"**Business Process Intelligence**" (Reichert)
(6 ECTS)   (2V+2Ü, SoSe)

"**Data Mining**" (Schwenker)
(6 ECTS)   (2V+2Ü, SoSe)

"**DeepVision - Deep Learning and Convolutional Neural Networks in Computational Vision**" (Neumann)
(6 ECTS)   (2V+2Ü, irreg.)

"**Graph Analytics and Deep Learning**" (Scherp)
(6 ECTS)   (2V+2Ü, irreg.)

"**Learning Systems I: Introduction to Machine Learning**" (Braun)
(6 ECTS)   (3V+1Ü, irreg.)

"**Learning Systems II**" (Braun)
(6 ECTS)   (3V+1Ü, irreg.)

"**Pattern Recognition**" (Schwenker)
(6 ECTS)   (2V+2Ü, WiSe)

"**Self Regulation: Development, Neuro-Cognition and Psychopathology**"
    (language: German) (Kiefer)
(4 ECTS)   (2S, irreg.)

> Note: This is an elective course contained in the general course program of UUlm. Several mechanisms self-regulation, defined as the ongoing process of managing personal goal pursuit in the face of internal, interpersonal, and environmental forces are illuminated. The influence on motivation, cognition, emotion, and behaviour is investigated.

"**Seminar Trends in Applied Artificial Intelligence, Machine Learning and Deep Learning**" (Belagiannis)
(4 ECTS)   (2S, WiSe & SoSe)

"**Text Analytics and Deep Learning**" (Scherp)
(6 ECTS)   (2V+2Ü, irreg.)

Area: Planning & Reasoning

"**Algorithms for Knowledge Representation**" (Kazakov)
 (6 ECTS)   (3V+1Ü, irreg.)

"**Explainable Artificial Intelligence**" (Lindner)
 (6 ECTS)   (2V+2Ü, SoSe)

"**Foundations of Semantic Web Technologies**" (Glimm)
 (6 ECTS)   (3V+1Ü, irreg.)

"**Knowledge-Based Artificial Intelligence**" (Lindner)
 (6 ECTS)   (3V+1Ü, WiSe)

Area: Interaction

"**The Costs of Free Will in Action**" (Ernst)
(6 ECTS)   (4S, SoSe)

"**Psychology of Automation**" (Baumann)
(6 ECTS)   (2S, WiSe)

"**Human Factors in Transportation**" (Baumann)
(6 ECTS)   (2S, SoSe)

"**Neurotechnology: Brain-Machine-Interfacing**" (Braun)
(6 ECTS)   (2V+2Ü, irreg.)

"**Psychology of Automation**" (Baumann)
(6 ECTS)   (2V+1Ü, WiSe)

Area: Methods, general Concepts & Tools

"**Computation in Cognitive and Neural Systems**" (Neumann)

(6 ECTS)   (3V+1Ü, irreg.)

"**Concepts of intelligence**" (Braun)
(4 ECTS)   (2S, WiSe)

"**Introduction to Human Neuroanatomy and Neurophysiology**" (Dimou)
 (6 ECTS)   (4V, WiSe)

"**Research Colloquium: Recent Developments in Cognitive Neuroscience and Cognitive Psychology**" (Kiefer)
(4 ECTS)   (2S, WiSe & SoSe)

> Note: This is an elective course contained in the general course program of UUlm. In the colloquium, recent research articles from the fields of cognitive neuroscience and cognitive psychology (language, memory, attention, visual cognition, consciousness) are studied and discussed. The aim is the critical discussion and analysis of scientific findings reported in literature.

"**Multilevel Modelling using SPSS**" (Zimprich)
(6 ECTS)   (2S, SoSe)

"**Multinomial Modeling of Cognitive Processes**" (Moshagen)
(4 ECTS)   (2S, irreg.)

"**Programming Concepts for Cognitive Systems**" (Glimm)
(6 ECTS)   (3V+1Ü, SoSe)

"**Thinking about Science**" (**Humboldt-Seminar**) (Eckle)
(4 ECTS)   (2S, WiSe + SoSe)

> Note: This is an elective course contained in the general course program of UUlm. This module belongs to a groups of offers providing general qualifications introducing into scientific work in general.

"**Topics in Cognitive Psychology**" (Ernst)
(4 ECTS)   (2S, WiSe & SoSe)

"**Topics in Cognitive Neuroscience**" (Neumann)
(4 ECTS)   (2S, irreg.)

"**Web Information Retrieval**" (Scherp)
(6 ECTS)   (2V+2Ü, irreg.)

Applied Subject (Anwendungsfach), 24 ECTS

In the *Applied Subject* the students select specific topics to evolve their program along a particular application and practically oriented direction. The individual topics in the *Applied Subject* are continuations of the contents of the courses (modules) in the *Interdisciplinary* and the *Special Subjects*, respectively. All offers in the *Applied Subject* are of a type which is based on projects or combined project and seminar (Projektseminar). The main aim is, thus, to yield an immersion of the program in practical topics along different research directions.

- Perception,
- Learning & Memory,
- Planning & Reasoning,
- Interaction, and
- Applied methods and concepts in Cognitive Systems

The selection and successful completion requires an amount of at least 24 ECTS. The individual composition of the modules for each student has to select offers from **at least two of the aforementioned areas**. Detailed descriptions and requirements for the individual courses (modules) can be found in the Module Handbook (MHB). In order to better plan the selection of individual courses the different semesters (summer, SoSe; winter, WiSe) are indicated below.

Note: In some modules, it is possible to conduct the project at an external institution (e.g., industrial research lab, external research institute), still organized under the topic headline of the module name. Detail can be found in the individual description in the MHB. In addition, it is recommended to approach individual professors who organize projects. Additional offers might exist which are not made explicit in the MHB description. Also, in the outlined cases places might be limited, require certain skill certificates, and planning in some cases must be started ahead of the time of the prospective project start.

The Study Commission (Studienkommission) finally decides at intervals of one or two years about the coherence of the program offered. Currently, the following topical areas are offered. New proposals for inclusion into this list must be sent to the head of the study commission and the program coordinator. The final decision about acceptance will be made by the members of the study commission. A simple majority vote is necessary.

Area: Perception

"**Project and Seminar Visual Information Processing**" (Neumann)
(8 ECTS)   (2P+2S, WiSe & SoSe)

"**Computational Vision and Image Processing**" (Neumann)
(8 ECTS)   (4P, irreg.)

"**Multisensory Perception for Action 1**" (Ernst)
(8 ECTS)   (4P, WiSe & SoSe)

"**Multisensory Perception for Action 2**" (Ernst)
(8 ECTS)   (4P, WiSe & SoSe)

"**Project Algorithms for Affect Recognition in HCI**" (Schwenker)
(8 ECTS)   (4P, WiSe)

"**Project Deep Learning for Graphics and Visualisation**" (Ropinski)
(8 ECTS)   (4P, WiSe & SoSe)

"**Visual Perception and Eye Movements**" (Huckauf)
(8 ECTS)   (2P, SoSe)

Area: Learning & Memory

"**Neuroeconomics – Sensorimotor learning and decision-making**" (Braun)
(8 ECTS)   (4P, irreg.)

"**Learning Robots**" (Braun)
(8 ECTS)   (4P, WiSe & SoSe)

"**Project Algorithms for Pattern Recognition and Machine Learning**" (Schwenker)
(8 ECTS)   (4P, irreg.)

"**Projectseminar Deep Learning Architectures**" (Braun, Schwenker)
(8 ECTS)   (4P, irreg.)

"**Project Deep Learning for Autonomous Cars (Computer Science)**" (Belagiannis)
(8 ECTS)   (4P, SoSe & WiSe)

Area: Planning & Reasoning

"**Project Semantic Web**" (Glimm)
(8 ECTS)   (4P, WiSe & SoSe)

"**Project Advanced Semantic Web**" (Glimm)
(8 ECTS)   (4P, WiSe & SoSe)

"**Project Automated Reasoning**" (Kazakov)
(8 ECTS)   (4P, WiSe & SoSe)

"**Project Advanced Automated Reasoning**" (Kazakov)
(8 ECTS)   (4P, WiSe & SoSe)

"**Project AI for Autonomous Systems**" (Lindner)
(8 ECTS)   (4P, SoSe)

"**Project AI in Games**" (Lindner)
(8 ECTS)   (4P, irreg.)

"**Project Explainable Artificial Intelligence**" (Lindner)
(8 ECTS)   (4P, irreg.)

Area: Interaction

"**Project Design, Implementation and Evaluation of User-Centered Multimodal Dialogue Systems**" (Baumann)
(8 ECTS)   (4P, WiSe)

"**Project Driver-Vehicle Interaction**" (Baumann)
(8 ECTS)   (4P, WiSe & SoSe)

"**Project Brain-Machine-Interfacing**" (Braun)
(8 ECTS)   (4P, irreg.)

"**Introduction into Cognitive Modelling in Human Factors Research**" (Baumann)
(8 ECTS)   (2P, irreg.)

"**Investigations in Cognitive Ergonomics - Basics**" (Huckauf)
(8 ECTS)   (4P, WiSe & SoSe)

"**Investigations in Cognitive Ergonomics - Research Trends**" (Huckauf)
(8 ECTS)   (4P, WiSe & SoSe)

"**Project Dialogue Systems for Cognitive Systems**" (Minker)
(8 ECTS)   (4P, WiSe & SoSe)

Area: Applied methods and concepts in Cognitive Systems

"**Design, Implementation and Evaluation of Humanoid Robots as Cognitive Systems**"
(Baumann, Minker)
(8 ECTS)   (4P, SoSe)

"**Investigating Functions in Perception, Cognition and Motor Behavior**" (Braun,
Neumann, Ernst)
(8 ECTS)   (4P, WiSe & SoSe)

"**Project Data Science on Very Large Data Sets**" (Scherp)
(8 ECTS)   (4P, irreg.)

"**Project Mobile Assessment of Biosignals**" (Herbert)
(8 ECTS)   (4P, SoSe)

"**Project Internet of Medical Things**" (Karlen)
(8 ECTS)   (4P, SoSe)