Course program (structure and organization)
for the Masters degree program 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** (18 ECTS, yellow) with specific selection according to a mandatory introductory program which shows an Y-model structure tailored for *Psychology for Computer Scientists* and *Computer Science for Psychologists*
- **Core Subject** (18 ECTS, orange) with a mandatory program for all students
- **Special Subject** (18 ECTS, red)
- **Applied Subject** (16 ECTS, blue)
- **Interdisciplinary Subject** (20 ECTS, green)
- **Master's thesis** (30 ECTS, gray)

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Note that the composition of the individual blocks that refer to 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.
**Basic Subject** (Grundlagenfach), 18 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, together with the core subject, provides the basis for later specialisation during the Master’s course program.

The selection of courses is organized in an Y-model such that students with a BSc. degree in Psychology or Computer Science, respectively, receive initial cross-disciplinary training. Furthermore, both groups pass few course offers with computer 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

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

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

**Modules for both BSc students in Computer Science or Psychology**

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

- **VL "Fundamentals of Interactive Systems - Design, Analysis, and Usability"** (Neumann)
  (6 ECTS) (2V+2U, WiSe)

- **VL "Fundamental Approaches to Cognitive Science"** (Ernst)
  (6 ECTS) (2V+2U, SoSe)
Core Subject (Kernfach), 18 ECTS

In Cognitive Systems, it is intended that each student obtains a generic training - other than the very basics - such that all acquire a common level of basic knowledge in the definition and the related scientific contents of the discipline. This is achieved by a mandatory course selection that each student must successfully pass.

The core level education consists of an introduction into Cognitive Science, 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. In addition, a module is included to introduce the basic formal theoretical and mathematical concepts of various aspects underlying cognitive systems and the modeling of functionality. Integral part of the latter course lectures is a mentorium as detailed below.

VL "Foundations and Concepts of Cognitive Systems Modeling" (coordinators: Ernst, Neumann)
(6 ECTS) (2V+1Ü+1Mentorium, WiSe)

Mentorium: Students are supervised by tutors assigned to the course. The mentorium serves to introduce the freshmen students to the core technical facilities @ Ulm 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.

VL "Cognitive Systems I" (several lecturers)
(6 ECTS) (3V+1U, WiSe)

VL "Cognitive Systems II" (several lecturers)
(6 ECTS) (3V+1U, SoSe)
**Special Subject** (Vertiefungsfach), 18 ECTS

The general outline of the program in *Cognitive Systems* is based on the following four core topics, namely (i) *Perception*, (ii) *Learning & Memory*, (iii) *Planning & Reasoning*, and (iv) *Interaction*. Currently, the specialization is offered by individual courses of different types. The following list of courses refer to these topics. Students may freely select among the courses to assemble their individual specialization and to acquire the necessary basis for successfully studying the application as well as interdisciplinary subjects, respectively.

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 18 ECTS. Detailed descriptions and requirements for the individual courses 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.

**VL "Algorithms for Knowledge Representation"** (Kazakov)
Dedicated area: Planning & Reasoning
(6 ECTS) (3V+1Ü, SoSe)

**VL "Automated Planning"** (Intelligente Handlungsplanung)
(language: German) (Biundo-Stephan)
Dedicated area: Planning & Reasoning
(6 ECTS) (3V+1Ü, SoSe)

**VL "Big Data Analytics"** (Theobald)
Dedicated area: Learning & Memory
(6 ECTS) (3V+1Ü, SoSe)

**VL "Computer Graphics I"** (Computer Grafik I – Grundlegende Konzepte)
(language: German) (Ropinski)
Dedicated area: Perception, Interaction
(6 ECTS) (3V+1Ü, WiSe)

**VL "Data Mining"** (language: German) (Schwenker)
Dedicated area: Learning & Memory
(6 ECTS) (2V+2Ü, WiSe)

**VL "Data Visualization"** (Ropinski)
Dedicated area: Perception, Interaction
(6 ECTS) (3V+1Ü, SoSe)
VL "Dialogue Systems" (language: German) (Minker)
Dedicated area: Interaction
(6 ECTS) (2V+2U, WiSe)

VL "Foundations of Semantic Web Technologies" (Glimm)
Dedicated area: Planning & Reasoning
(6 ECTS) (3V+1U, SoSe)

Colloquium "Hands On: Mobile Assessment of Biosignals - Principles and Application" (Herbert)
Dedicated area: Interaction
(4 ECTS) (2S, SoSe)

VL "Information Retrieval and Web Mining" (Theobald)
Dedicated area: Learning & Memory
(6 ECTS) (3V+1U, SoSe)

VL "Introduction to Artificial Intelligence" (Einführung in die Künstliche Intelligenz) (language: German) (Biundo-Stephan)
Dedicated area: Planning & Reasoning
(6 ECTS) (2V+2U, WiSe)

VL "Introduction to Data Science" (Theobald)
Dedicated area: Learning & Memory
(6 ECTS) (2V+2U, WiSe)

VL "Models and Application of Perception and Action" (Ernst)
Dedicated area: Perception
(6 ECTS) (2V+2U, SoSe)

VL "Reinforcement Learning" (Reinforcement Lernen) (language: German, in SoSe 2015) (Schwenker)
Dedicated area: Learning & Memory
(6 ECTS) (2V+2U, SoSe)

Colloquium "Self Regulation: Development, Neuro-Cognition and Psychopathology" (language: German) (Kiefer)
Dedicated area: Learning & Memory
(4 ECTS) (2S, SoSe)
Colloquium "Specialization in Cognitive Psychology" (Huckauf)
Dedicated area: Perception, Learning & Memory
(4 ECTS) (2S, WiSe & SoSe)

VL "Vision in Man and Machine" (Neumann)
Dedicated area: Perception
(6 ECTS) (2V+2Ü, SoSe)
Applied Subject (Anwendungsfach), 16 ECTS

In the Applied Subject the students selects a specific topic to evolve their program along a particular application-oriented direction. Again, the respective topics are related to at least one of the four core topics in Cognitive Systems, i.e. (i) Perception, (ii) Learning & Memory, (iii) Planning & Reasoning, or (iv) Interaction. The individual topics in the Applied Subject are based on the contents of the core and the specialization courses. The main aim is, thus, an immersion of the program in an application topic along a particular research direction.

The Committee of Study Affairs (Studienkommission) finally decides at intervals of one or two years about the coherence of the program offered. Currently, the following topical areas are offered:

- Cognitive Ergonomics
- Cognitive Smart Systems
- Cognitive Vision
- Data Science
- Dialogue Technology for Cognitive Systems
- Multisensory Perception for Action
- Pattern Recognition
- Semantic Web Technology
- User-Centered Planning
- Visual Computing

Topics in the Applied Subject are defined by different contents related to cognitive science and systems. The majority of the offered courses provide practical contents, but may be combined with lectures to deliver additional basic knowledge to pave the grounds for the particular applied subject. However, the extent of the lectures with respect to the total extent is less that 50% (from 16 ECTS).

Cognitive Ergonomics

Note: Details on how to study the applied subject and to make proper selections of the courses to reach the 16 ECTS are provided by the responsible lecturer of the subject. In case of multiple options, the mandatory and selective choices are specified.

- Colloquium "Driver-Vehicle Interaction" (Baumann) (4 ECTS) (2S, WiSe)
- Colloquium "Instructional Design and Technology" (Seufert, Wagner) (4 ECTS) (2S, WiSe)
- Colloquium "Psychology of Automation" (Baumann) (4 ECTS) (2S, WiSe)
- Colloquium "Transportation Human Factors" (Baumann) (4 ECTS) (2S, SoSe)
- Colloquium "Sex and Gender in Human-Technology Interaction" (Oberzaucher) (4 ECTS) (2S, WiSe)
- Project "Cognitive Ergonomics" (Huckauf) (12 ECTS) (2 x 4P, 2 semesters, starts WiSe & SoSe)
Cognitive Smart Systems

Note: Details on how to study the applied subject are provided by the responsible organizer of the subject.

- Project "Cognitive Smart Systems" (Slomka)
  (16 ECTS)  (2 x 4P, 2 semesters, WiSe)

Cognitive Vision

Note: Details concerning the organization of this applied subject and the way the individual courses may be combined (to acquire 16 ECTS) are provided in a separate announcement. Please see the notice-board of the Institute of Neural Information Processing (O27, 4th floor).

- VL "Vision in Man and Machine (in Applied Subject)" (Neumann)
  (4 ECTS)  (2V+1Ü, reduced content of exercises and/or readings, SoSe)
- Colloquium "Vision" (Neumann)
  (4 ECTS)  (2S, SoSe)
- Project & Seminar "Visual Information Processing" (Neumann)
  (8 ECTS)  (2P+2S, WiSe + SoSe)
- Project "Computational Vision and Image Processing " (Neumann)
  (8 ECTS)  (4P, SoSe & WiSe)
- Project "Cognitive Vision - Algorithms and Applications" (Neumann)
  (16 ECTS)  (2 x 4P, 2 semesters, starts SoSe)

Dialogue Technology for Cognitive Systems

Note: Details on how to study the applied subject are provided by the responsible organizer of the subject.

- Project "Dialogue Technology for Cognitive Systems" (Minker)
  (16 ECTS)  (2 x 4P, 2 semesters, SoSe)

Data Science

Note: Details on how to study this topic and how to make proper selections of the course (to reach the 16 ECTS) are provided by the responsible lecturer of the subject.

- VL "Big Data Analytics" (Theobald)
  (6 ECTS)  (3V+1Ü, SoSe)
- VL "Data Mining"
  (language: German) (Schwenker)
  (6 ECTS)  (2V+2Ü, WiSe)
- VL "Introduction to Data Science" (Theobald)
  (6 ECTS)  (2V+2Ü, WiSe)
- VL "Information Retrieval and Web Mining" (Theobald)
  (6 ECTS)  (3V+1Ü, SoSe)
- VL "Business Process Intelligence"
(language: German) (Reichert)
(6 ECTS) (2V+2U, WiSe)

- Colloquium "Research Trends in Data Science" (Theobald)
  (4 ECTS) (2S, WiSe + SoSe)
- Project "Non-Traditional Database Architectures" (Theobald)
  (8 ECTS) (4P, WiSe + SoSe)

Multisensory Perception for Action

**Note:** Details on how to study this topic are provided by the responsible lecturer of the subject.

- Project "Multisensory Perception for Action" (Ernst)
  (16 ECTS) (2 x 4P, 2 semesters, SoSe + WiSe)

Pattern Recognition

**Note:** Details concerning the organization of this applied subject and the way the individual courses may be combined (to acquire 16 ECTS) are provided in a separate announcement. Please see the notice-board of the Institute of Neural Information Processing (O27, 4th floor).

- VL "Neural Networks (in Applied Subject)" (Schwenker)
  (4 ECTS) (2V+1U, reduced content of exercises, WiSe)
- Colloquium "Pattern Recognition" (Schwenker)
  (4 ECTS) (2S, WiSe + SoSe)
- Project "Reinforcement Learning" (Schwenker)
  (8 ECTS) (4P, WiSe)
- Project "Algorithms for Emotion Recognition in Human Computer Interaction" (Schwenker, Traue, Walter, Hazer)
  (16 ECTS) (2 x 4P, 2 semesters, starts WiSe)
- Project "Pattern Recognition and Machine Learning Algorithms" (Schwenker)
  (16 ECTS) (2 x 4P, 2 semesters, starts SoSe)

Semantic Web Technology

**Note:** Details on how to study this topic are provided by the responsible lecturer of the subject.

- Project "Semantic Web Technologies" (Glimm)
  (16 ECTS) (2 x 4P, 2 semesters, WiSe)

User-Centered Planning

**Note:** Details on how to study this topic are provided by the responsible lecturer of the subject.

- Project "User-Centered Planning" (Biundo-Stephan)
  (16 ECTS) (2 x 4P, 2 semesters, SoSe)

Visual Computing
Note: Details concerning the organization of this topic and the way the individual courses may be combined (to acquire 16 ECTS) are provided in a separate announcement. Please see the teaching section of the group’s website viscom.informatik.uni-ulm.de for an up-to-date announcement.

- **VL "Data Visualization (in Applied Subject)"** (Ropinski)  
  (4 ECTS)  
  (3V+0Ü, reduced content that skips exercises, SoSe)

- **Colloquium "Visual Computing"** (Ropinski)  
  (4 ECTS)  
  (2S, SoSe)

- **Project "Visual Computing"** (Ropinski) [Module still needs to be defined]  
  (8 ECTS)  
  (4P, SoSe)
Interdisciplinary Subject (Interdisziplinäres Fach), 20 ECTS

An interdisciplinary subject aims to transfer the theoretical knowledge and application experience to interdisciplinary topics related to Cognitive Systems (for 20 ECTS). The subjects are driven by topics related to cognitive science and systems. Unlike the topics in the Applied Subject, which are offered by individual groups or lecturers, the program to be selected in the Interdisciplinary Subject accomplish the following goals and requirements:

(i) Interdisciplinary research work is conducted in student teams of interdisciplinary composition. Ideally, the teams are composed of members with different backgrounds according to their respective B.Sc. program working at a project topic jointly. The definition of mixed teams might be relaxed depending on the actual number of participants in a selected module or course.

(ii) The interdisciplinary subject aims to define a program with different topical focus directions orthogonal to the four core areas of the Cognitive Systems program. The maximum number of topics in the subject may not exceed an upper limit (five to six). The Committee of Study Affairs (Studienkommission) finally decides at intervals of one or two years about the coherence of the program offered. Currently, the following topical areas are offered:

- Cognitive Agents, Companions, and Cognitive Apps
- Cognitive Modeling
- Cognitive Neuroscience - Experimental Perspective
- Cognitive Neuroscience - Modeling and Computational Perspectives
- Human-Computer Dialogue

(iii) The contents of courses, projects or seminars/colloquia in a specific subject are provided by lecturers from different disciplines. Here, a sufficiently broad scope of scientific content should be offered to allow for a flexible selection by the students. The subjects might be delivered by multi-disciplinary tandems or multiple lecturers (e.g., Computer Science and Psychology, Engineering Sciences and Psychology, or related). Alternatively, lectures from different disciplines, each taught by one lecturer, may be selected and combined to build an interdisciplinary subject. Academic or non-academic institutions might be incorporated, given that the latter contribute interdisciplinary contents to cognitive systems.

In order to define a new topic as Interdisciplinary Subject the Committee of Study Affairs decides about sufficient interdisciplinary content and final acceptance.

A large part of a program in the interdisciplinary subject is practically oriented, but further theoretically oriented training is possible. Additional lectures are offered in interdisciplinary areas to provide further basic knowledge concerning the particular topic. Overall, a specific program in the interdisciplinary subject (composed of lectures and application oriented courses) should be balanced. A relative proportion of lectures of maximum of 60% (related to a total of 20 ECTS) is possible (which corresponds to 12 ETCS lectures).

Cognitive Agents, Companions, and Cognitive Apps

Interdisciplinary coordinator: Reichert (Computer Science)

Note: In order to obtain the 20 ECTS, the following courses need to be taken:

- Colloquium "Cognitive Agents, Companions, and Mobile Apps in Healthcare" (Reichert) (4 ECTS) (2S, WiSe)
- Project "Increasing Patient Engagement Through Cognitive Companions and Apps" (Reichert, Kolassa) (8 ECTS) (4P, SoSe)
- Project "Cognitive Solutions for Mobile Guidance, Assessment and Crowd Sensing" (Reichert, Schickler)
  (8 ECTS) (4P, WiSe + SoSe)

Cognitive Modeling
Interdisciplinary coordinators: Wilhelm, Schmitz (Psychology)
Frühwirth, Schiller (Computer Science)

Note: The individual courses may be combined as follows (to acquire 20 ECTS): The first three courses listed below are mandatory (16 ECTS); from the last 4 courses, the student elects one (for 4 ECTS). Details concerning the organization of this interdisciplinary subject are provided in a separate announcement. Please see the notice-board of the Institute of Artificial Intelligence (O27, 4th floor).

Mandatory courses:
- Colloquium "Cognitive Modeling for Computer Scientists and Psychologists" (Schiller, Schmitz)
  (4 ECTS) (2S, SoSe)
- Colloquium "Computational Psychology" (Frühwirth)
  (4 ECTS) (2S, WiSe)
- Project "Cognitive Modeling"
  (8 ECTS) (4P, WiSe) (Frühwirth)

Elective courses:
- VL "Cognitive and Neural Systems (in interdisciplinary subject)" (Neumann)
  (4 ECTS) (2V+1Ü, WiSe)
- Colloquium "Thinking about Science" (Humboldt-Seminar) (Eckle)
  (4 ECTS) (2S, WiSe)

Cognitive Neuroscience - Experimental Perspectives
Interdisciplinary coordinators: Ernst (Psychology)
Neumann (Computer Science)

Note: Details concerning the organization of this interdisciplinary subject and the way to combine the individual courses (to acquire 20 ECTS) are provided in a separate announcement. Please see the notice-board of the Applied Cognitive Systems group (Univ. West).

Elective courses:
- Colloquium "Topics in Cognitive Psychology" (Ernst)
  (4 ECTS) (2S, WiSe + SoSe)
- Colloquium "Thinking about Science" (Humboldt-Seminar) (Eckle)
  (4 ECTS) (2S, WiSe + SoSe)
- Colloquium "Mind and Body" (Humboldt-Seminar)
Note: This is an elective course contained in the general course program of Ulm. In this seminar, the interdisciplinary perspectives of philosophy and natural sciences are discussed. Details concerning the specific topics are listed in the detailed information to this seminar.

- Colloquium "Literatursalon und Forschungskolloquium: Aktuelle Arbeiten aus der kognitiven Neurowissenschaft und der Kognitionspsychologie"  
  (language: German) (Kiefer)  
  (4 ECTS)  (2S, WiSe + SoSe)  
  Note: This is an elective course contained in the general course program of Ulm. 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. The colloquium is held mainly in German, but English conversation is possible.

- Project "Psychophysical Investigation of Functions in Perception, Cognition and Motor Behavior" (Ernst, Braun, Neumann)  
  (8 ECTS)  (4P, WiSe + SoSe)  
  This project has two specifications: It can be either conducted
  - as a project being supervised by academic partners from different disciplines (topics and supervisors will be announced) or
  - as a project being conducted at a specific industrial research lab or division, which focuses on interdisciplinary experimental work. Inquiries should be first sent to the coordinators (Ernst or Neumann), then the potential options are figured out and specified. Potential partner labs are
    - Zeiss Vision Lab
    - Daimler subgroup - attention assist
    - Max-Planck-Inst. Biological Cybernetics (MPI)
  We are currently negotiating how the particular model might be implemented in detail.

Cognitive Neuroscience - Modelling and Computational Perspectives

Interdisciplinary coordinators: Neumann (Computer Science)  
Ernst (Psychology)

Note: Details concerning the organization of this interdisciplinary subject and the way to combine the individual courses (to acquire 20 ECTS) are provided in a separate announcement. Please see the notice-board of the Institute of Neural Information Processing (O27, 4th floor).

Mandatory courses:

- either
  - VL "Cognitive and Neural Systems" (Neumann)  
    (6 ECTS)  (3V+1U, WiSe)

- or

- VL "Vision in Man and Machine" (Neumann)  
  (6 ECTS)  (2V+2U, SoSe)
Elective courses:

- **VL "Models and Applications in Perception and Action"** (Ernst)  
  (6 ECTS) (2V+2Ü, SoSe)

- **Colloquium "Vision"** (Neumann)  
  (4 ECTS) (2S, SoSe)

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

- **Colloquium "Literatursalon und Forschungskolloquium: Aktuelle Arbeiten aus der kognitiven Neurowissenschaft und der Kognitionspsychologie"** (Kiefer)  
  (4 ECTS) (2S, WiSe + SoSe)

  Note: This is an elective course contained in the general course program of Ulm. In the colloquium recent research article from the fields of cognitive neuroscience and cognitive psychology (language, memory, attention, visual cognition, consciousness) will be read and discussed. The aim is the critical discussion and analysis of scientific findings reported in the literature. The colloquium is held mainly in German, but English conversation is possible.

- **Project "Computational and Technological Investigation of Functions in Perception, Cognition and Motor Behavior"** (Braun, Neumann, Ernst)  
  (8 ECTS) (4P, WiSe + SoSe)

**Human-Computer Dialogue**

Interdisciplinary coordinator: Baumann (Psychology)

Note: Details concerning the organization of this interdisciplinary subject and the way to combine the individual courses (to acquire 20 ECTS) are provided in a separate announcement. Please see the notice-board of the Human Factors group (Univ. West).

- **VL "Mobile Human Computer Interaction"** (Mobile Human-Computer-Interaction)  
  (language: German) (Rukzio)  
  (6 ECTS) (2V + 2Ü, WiSe)

- **Colloquium "Driver-Vehicle Interaction"** (Baumann) To be defined  
  (4 ECTS) (2S, WiSe)

- **Colloquium "Psychology of Automation"** (Baumann)  
  (4 ECTS) (2S, WiSe)

- **Colloquium "Transportation Human Factors"** (Baumann)  
  (4 ECTS) (2S, SoSe)

- **Project "Design, Implementation and Evaluation of Dialogue Systems"** (Baumann, Minker)  
  (16 ECTS) (2 x 4P, 2 semesters, starts WiSe)