Course program (structure and organization) for the Masters degree program in *Cognitive Systems*

A generic overview of the structure of the course program and the major contents is presented in the following itemized list (with color palette coding) and the related table:

- **Basic Subject** (18 ECTS, yellow) with specific selection according to the introductory Y-model structure
  - Psychology for Computer Scientists and Computer Science for Psychologists
- **Core Subjects** (18 ECTS, orange)
- **Special Subjects** (18 ECTS, red)
- **Applied Subjects** (16 ECTS, blue)
- **Interdisciplinary Subjects** (20 ECTS, green)
- **Master's thesis** (30 ECTS, gray)

<table>
<thead>
<tr>
<th>Core subjects</th>
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Please 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 Subjects (Grundlagenfach), 18 ECTS

This part defines a mandatory components of the basic education in the master's program. The aim is to communicate a basic level of knowledge in Cognitive Systems depending on the discipline in which the BSc. degree has been acquired. The focus of this specific teaching program is on topics outside the discipline so far. In all, this foundation subject education, together with the core subject, provides the basis for later specialisation during the Master's course program.

For students with a BSc. degree in Psychology or Computer Science, respectively, the selection of courses is defined by the specific topics in the Y-model, as outlined below. For students with a different degree that already reflects a basic interdisciplinary education, e.g., in Cognitive Science or similar, a specific selection of courses will be defined on an individual basis at the beginning of the course program.

Course Program “Psychology for Computer Scientists”

Students with a BSc. in Computer Science or related discipline receive an introductory training program to provide basics in Psychology. This training is structured into the following lectures, namely

- VL "Introduction to Cognitive Psychology for Non-Psychologists" (8 ECTS) (4V, WiSe) (Bittner, Wagner)
- VL "Introduction to Experimental Methods for Non-Psychologists I" (Bittner) (7 ECTS) (3V + 2Ü, WiSe)
- VL "Introduction to Experimental Methods for Non-Psychologists II" (Bittner) (3 ECTS) (2V, SoSe)

Course program Computer Science for Psychologists

Students with a BSc. in Psychology or related discipline receive an introductory training program to provide elementary basics in Computer Science. This training is structured into the following three lectures, namely

- VL "Introduction to Computer Science for Psychologists" (Frühwirth, Glimm) (6 ECTS) (2V + 2Ü, WiSe)
- VL "Fundamentals of Interactive Systems - Design, Analysis, and Usability" (Neumann, Rukzio) (6 ECTS) (2V + 2Ü, WiSe)
- VL "Formal Foundations of Computer Science" (Palm) (6 ECTS) (3V + 1Ü, SoSe)
Core Subjects (Kernfach), 18 ECTS

In Cognitive Systems it is intended that each student passed a generic education such that all get a common level of basic knowledge in the definition and the related scientific content of the discipline. This is achieved by a mandatory course selection that each student much take and successfully pass.

The core level education is delivered by an introduction into Cognitive Science which includes historical aspects, modeling, and methodological basics. A representative cross-section of contents covers key aspects of the field, namely Perception, Interaction, Learning, Planning & Reasoning. In addition, a cycle of lectures driven by researchers in the course program introduces the key research domains established at UUlm. Integral part of this lectures is a mentorium as detailed below.

VL "Cognitive Systems I - Concepts, Modeling, Perception" (several lecturers)
(6 ECTS) (3V + 1Ü, WiSe)

VL "Cognitive Systems II - Higher-Order Cognitive Competencies" (sev.l lecturers)
(6 ECTS) (3V + 1Ü, SoSe)

VL "Cycle of Lectures" (several lecturers)
(6 ECTS) (2V + 1Ü + 1Mentorium, WiSe)

Exercise/tutorium: Students are hosted as an individual group by the lecturer of the recent presentation. The lecturer determines how he/she will organize his/her program in addition to the oral presentation. In general, the contents of the exercise can range from meeting face-to-face and discussing with the students some issues related to the presentation or related literature. The lecturer can set a focus on detailed questionnaire concerning the scientific aspects of the current focus topic presented in the Cycle of Lectures.

Mentorium: Students are hosted by tutors assigned to that introductory course. The mentorium serves to introduce the freshmen students to the campus facilities as well as the social life aspects. The students will benefit from the mentorium to establish themselves as a group. In addition, mentors will provide some help in strategies how to search and analyze the literature, learn new aspects about citation, etc.
Special Subjects (Vertiefung), 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 oder (iv) Interaction. At the moment, the specialization is offered by individual courses of different types. The following list of courses is compiled and associated to the topics. Students can freely select to assemble their individual specialization. The aim is that the students may acquire the necessary basis to successfully conduct their studies in the application as well as in the 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 at a minimum of 18 ECTS. The details of the description and requirements for the individual courses can be found in the most recent version of 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 "Decision-Making and User Experience in Human-Technology interaction" (Bittner)
Dedicated area: Interaction
(6 ECTS) (2V + 2Ü, SoSe)

VL "Dialogue Systems" (language: German) (Minker)
Dedicated area: Interaction
(6 ECTS) (2V + 2Ü, WiSe)

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

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

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

VL "Information Processing in Neural Systems" (Palm, Neumann)
Dedicated area: Perception, Learning & Memory
(6 ECTS) (3V + 1Ü, WiSe)

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

Colloquium "Hands On: Mobile Assessment of Biosignals - Principles and Application" (Herbert)
Dedicated area: Interaction
(4 ECTS) (2S, SoSe)
VL "Reinforcement Learning" (Reinforcement Lernen)
  (language: German, in SoSe 2015) (Schwenker)
Dedicated area: Learning & Memory
(6 ECTS) (2V + 2Ü, SoSe)

Colloquium "Self Regulation: Development, Neuro-Cognition and Psychopathology" (language: German) (Kiefer)
Dedicated area: Learning & Memory
(4 ECTS) (2S, WiSe)

Colloquium "Specialization in Cognitive Psychology" (Huckauf)
Dedicated area: Perception, Learning & Memory
(4 ECTS) (2S, WiSe & SoSe)

VL "Usability Engineering" (Usability Engineering)
  (language: German)
Dedicated area: Interaction
(6 ECTS) (2V + 2Ü, WiSe)

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

These subjects are offered such that the students can select a specific topic to further their program along a particular application-oriented direction. Such subject topics are again related to the four core topics in Cognitive Systems, (i) Perception, (ii) Learning & Memory, (iii) Planning & Reasoning, or (iv) Interaction. The main aim is an immersion of the program in an application along a particular research direction with a majority in the practical content in the course. The individual applied subjects are based on the contents of the core and the specialization courses.

Applied subjects are defined by different contents related to cognitive science and systems. The majority of the offered course program is composed of practical contents but may be combined by lectures to deliver additional basic knowledge to pave the grounds for the particular applied subject. In this case, the extent of the lectures regarding the total extent is less that 50% (from 16 ECTS).

Cognitive Vision

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

Cognitive Ergonomics

Details concerning how to study the applied subject and make the proper selections of the courses in order to reach the requirements of 16 ECTS is provided by the responsible lecturer of the subject. If multiple options are possible 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)
- Project "Cognitive Ergonomics" (Huckauf)
Cognitive Smart Systems
Details concerning how to study the applied subject and make the proper selections of the courses in order to reach the requirements of 16 ECTS is provided by the responsible organizer of the subject.

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

Data Science
Details concerning how to study the applied subject and make the proper selections of the courses in order to reach the requirements of 16 ECTS is 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 + 2Ü, WiSe)
- Colloquium "Research Trends in Data Science" (Theobald)
  (4 ECTS)  (2S, WiSe + SoSe)
- Project "Non-Traditional Database Architectures" (Theobald)
  (8 ECTS)  (4P, WiSe + SoSe)

Pattern Recognition
Note: Details concerning the organization of this applied subject and how to combine the individual courses offered (to acquire 16 ECTS) are provided in a separate announcement. Please see the notice-board of the Institute of Neural Information Processing (O27, 4. floor).

- VL "Neural Networks (in Applied Subject)" (Palm, Schwenker)
  (4 ECTS)  (2V + 1Ü, reduced content of exercises, WiSe)
- Colloquium "Pattern Recognition" (Palm, 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**

Details concerning how to study the applied subject and make the proper selections of the courses in order to reach the requirements of 16 ECTS is provided by the responsible lecturer of the subject.

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

**User-Centered Planning**

Details concerning how to study the applied subject and make the proper selections of the courses in order to reach the requirements of 16 ECTS is 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 applied subject and how to combine the individual courses offered (to acquire 16 ECTS) are provided in a separate announcement. Please see the teaching section of the groups 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 Subjects (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 must be driven by topics related to cognitive science and systems aspects. Unlike the applied subjects (see above) which are associated to individual groups or lecturers and their specializations, the interdisciplinary subjects accomplish the following goal and requirements:

(i) Interdisciplinary research work is furthered in student teams of interdisciplinary composition. In the ideal case teams are composed of members with different backgrounds according to their respective B.Sc. program working at a project topic jointly.

(ii) The interdisciplinary subjects aim to define a program with different topical focus directions orthogonal to the four core areas of the Cognitive Systems program. The maximum number of subjects may not exceed an upper limit (four to five). The Committee of Study Affairs (Studienkommission) should finally decide about the coherence of the program offered.

(iii) The contents of courses, projects or seminars in a specific subject are implemented by lecturers from different disciplines. Here, a sufficiently broad scope of scientific content should be offered to allow flexibility in the selection by the students. The subjects might be delivered by multidisciplinary tandems or more 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 cases of doubt the Committee of Study Affairs will decide about sufficient interdisciplinary content.

A large composition of an interdisciplinary subject's program 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 the program in an 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 Modelling

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

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

- Colloquium "Cognitive Modelling <?Benennung?>" (Schiller, Schmitz)
  (4 ECTS)  (2S, SoSe)

- Colloquium "Computational Modelling of Cognitive Functions" (Palm)
  (4 ECTS)  (2S, WiSe)

- Colloquium "Computational Psychology" (Frühwirth)
  (4 ECTS)  (2S, WiSe)

- Free Elective Module (various lecturers)
  (4 ECTS)  (open, WiSe + SoSe)

Note: This is an elective course to be selected from the general course program offered at UUIm. The particular topic must be related to Cognitive Systems in general and to Cognitive modelling,
in particular. Details concerning the specific topics will be listed in the detailed information to this interdisciplinary subject.

- Project "Cognitive Modelling"
  (8 ECTS) (4P, WiSe) (Frühwirth)

**Cognitive Neuroscience - Experimental and Modelling Perspectives**

Interdisciplinary coordinator: Neumann (Computer Science)

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

- VL "Psychophysics - Methods, Paradigms, and Experimentation" (Neumann, Layher)
  (4 ECTS) (2V+1Ü, SoSe)

- VL "Cognitive and Neural Systems" (Neumann)
  (4 ECTS) (2V+1Ü, WiSe)

- Colloquium "Topics in Cognitive Neuroscience" (NN, Neumann)
  (4 ECTS) (2S, WiSe)

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

**Note:** This is an elective course to be selected from the general course program offered at Ulm. In this seminar, different topics related to basic scientific discourse, the philosophy of science and approaches to experiments in scientific disciplines will be discussed. Details concerning the specific topics will be listed in the detailed information to this seminar.

- Colloquium "Mind and Body" (Humboldt-Seminar) (language: German) (Werneck)
  (4 ECTS) (2S, WiSe)

**Note:** This is an elective course to be selected from the general course program offered at Ulm. In this seminar, the interdisciplinary perspectives of philosophy and natural sciences will be discussed. Details concerning the specific topics will be listed in the detailed information to this seminar.

- Colloquium "Literatur Salon 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 to be selected from the general course program offered at Ulm. In the colloquium recent research articles 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 & Seminar "Visual Information Processing" (Neumann)
  (8 ECTS) (2P+S, WiSe + SoSe)

- Project "Psychophysical Investigation of Functions in Perception, Cognition and Motor Behavior" (NN, Neumann)
  (8 ECTS) (4P, WiSe)
This project can be conducted in two different specifications: It can be either conducted as a project that is supervised by academic partners from different disciplines (topics and supervisors will be announced) or as a project to be conducted at a specific industrial research lab or division that focuses on interdisciplinary experimental work. Inquiries should be first sent to the coordinator (Neumann) and then the potential options will be figured out and specified. Potential partner labs are

- Zeiss Vision Lab
- Daimler subgroup - attention assist

We are currently negotiating how the particular model might be implemented in detail.

**Cognitive Agents, Companions, and Cognitive Apps**

Interdisciplinary coordinator: Reichert (Computer Science)

Details concerning how to study the interdisciplinary subject and to make the proper selections of the courses in order to reach the requirements of 20 ECTS is provided by the responsible lecturers of the subject (organized by the coordinator).

- 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)

**Human-Computer Dialogue**

Interdisciplinary coordinator: Baumann (Psychology)

**Note:** Details concerning the organization of this interdisciplinary subject and how to combine the individual courses offered (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)