Appendix 1: Module descriptions

I. Compulsory modules

<table>
<tr><td colspan="3">Name of the module: BM1 - Advanced Natural Language Processing</td><td>Credit points (LP): 9</td></tr>
<tr><td colspan="2">Module type (Compulsory or elective):</td><td colspan="2">Compulsory</td></tr>
<tr><td colspan="2">Content and learning objectives of the module:</td><td colspan="2">Learning objectives:

- Students will acquire broad and in-depth knowledge of the methods and applications of computational linguistics. They will be able to understand and critically evaluate current literature on computational linguistics, as they will have extensive practice in independent work with the literature.

- Students will be able to choose and apply suitable methods to solve concrete tasks in computational linguistics.

- Students can implement algorithms used in computational linguistics in a suitable programming language. They will be acquainted with the commonly available grammars and datasets and will be able to use them to solve problems at hand or to adapt them if necessary.

Content:

The course covers the main applications of computational linguistics as well as the modeling approaches and associated algorithms. Emphasis is placed on symbolic and statistical procedures for parsing, generation, part-of-speech tagging, semantic processing, discourse processing and machine translation. The lectures are accompanied by exercises and intensive self-study based on textbooks and research literature.</td></tr>
<tr><td colspan="2">Examination (number, type, scope):</td><td colspan="2">Written examination (120 min) or final project (project report ca. 10 pages)</td></tr>
<tr><td colspan="2">Individual learning time (in hours):</td><td colspan="2">210</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td rowspan="2">Courses (Type)</td><td rowspan="2">Contact time (in SWS)</td><td colspan="2">Additional examination requirements (Number, type, scope)</td><td>Partial module examination (number, type, scope)</td></tr>
<tr><td>For completing the module</td><td>For being admitted to the module exam</td><td></td></tr>
<tr><td>Lecture</td><td>2</td><td></td><td></td><td></td></tr>
<tr><td>Tutorial</td><td>2</td><td></td><td>Successful completion of weekly exercises</td><td></td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="2">Frequency:</td><td colspan="2">Annually (winter term)</td></tr>
<tr><td colspan="2">Prerequisite for participation:</td><td colspan="2">no</td></tr>
<tr><td colspan="2">Offered by:</td><td colspan="2">Linguistics</td></tr>
</table>

Name of the module: BM2 - Machine Learning and Data Analysis	Credit points (LP): 9
Module type (Compulsory or elective):	Compulsory
Content and learning objectives of the module:	Learning objectives: Students are able to analyse problems in the areas of data analysis and modeling, map them onto machine learning and Bayesian statistics methods, implement solutions (for example, in Matlab and/or R), and assess the quality of the models using appropriate evaluation methods. Content: Types of modeling problems and machine learning methods, basis of Bayesian statistics and empirical inference, linear classification and regression models, linear mixed models, generalized linear (mixed models), core methods, model evaluation, implementation of data analysis methods, for example in Matlab and / or R..
Examination (number, type, scope):	Written examination (150 min), directly followed by an oral interview (15 min)
Individual learning time (in hours):	180

Courses (Type)	Contact time (in SWS)	Additional examination requirements (Number, type, scope)		Partial module examination (number, type, scope)
		For completing the module	For being admitted to the module exam	
Lecture “Linear Modeling”	2			
Lecture “Intelligent Data Analysis”	2			
Tutorial for “Intelligent Data Analysis”	2		Successful solution of weekly exercises	

Frequency:	Annually (summer term)
Prerequisite for participation:	no
Offered by:	Linear Modeling: Linguistics; Intelligent Data Analysis: Informatics

Name of the module: BM3 - Advanced Problem Solving Techniques	Credit points (LP): 9
Module type (Compulsory or elective):	Compulsory
Content and learning objectives of the module:	Learning objectives: Students are able to define and interpret the particular features, limits, terminologies and doctrines in the field of declarative problem solving. This knowledge forms the basis for the development and / or application of independent ideas in the field of declarative problem solving in a research-oriented way. Students have a broad, detailed and critical understanding of the state of the art in selected areas of declarative problem solving. Students will be able to apply their knowledge and understanding of declarative problem solving as well as their problem solving skills to new and unfamiliar situations in a broader or multidisciplinary context. Content: The course is dedicated to declarative problem-solving techniques: the basics, commonly used algorithms, systems and the applications. Declarative problem-solving methods use general problem-solving methods for the automatic solution of (mostly combinatorial) problems. These include design, diagnostics, action planning and scheduling, configuration, and much more. In contrast to traditional programming, no programs are created to solve the problem, instead, the initial problem is (formally) modeled. Problem solving systems today are capable of solving problems on the order of several million variables. The resulting systems are now used in industry, but also in the natural sciences and linguistics.
Examination (number, type, scope):	Written examination (90 min)
Individual learning time (in hours):	180

Courses (Type)	Contact time (in SWS)	Additional examination requirements (Number, type, scope)		Partial module examination (number, type, scope)
		For completing the module	For being admitted to the module exam	
Lecture	2			
Tutorial	2			
Internship	1	Oral interview on attendance certificate (15 min)		
Project seminar	2	Documentation (5 pages)		

Frequency:	Annually (winter term)
Prerequisite for participation:	no
Offered by:	Informatics

II. Elective modules

Name of the module: FM1 - Foundations of Mathematics				Credit points (LP): 6
Module type (Compulsory or elective):		Compulsory, if so decided by the board of examiners in accordance with §5 (1)		
Content and learning objectives of the module:		Learning objectives: Students will have the necessary background knowledge about mathematics in order to successfully complete the basic modules of the study program. They can organize themselves to acquire this knowledge on their own, and will be able to reason about the learned concepts. Content: Analysis: limits, functions, differential calculus, calculation of maxima and minima, integral calculus, integration of rational functions, indefinite integrals, functions of several variables, partial differentiation, multidimensional integrals. Linear algebra: Linear equation systems, Gaussian algorithm, determinants, operations with matrices and vectors, scalar and vector products, lines and planes, differentiating vector functions. The contents are conveyed via suitable online video lectures, e.g. from Coursera or MIT OpenCourseWare.		
Examination (number, type, scope):		Oral examination (20 min)		
Individual learning time (in hours):		150		
Courses (Type)	Contact time (in SWS)	Additional examination requirements (Number, type, scope)		Partial module examination (number, type, scope)
		For completing the module	For being admitted to the module exam	
Video-lecture	0			
Tutorial	2		Successful solution of homework exercises	
yearly (winter term)				
Frequency:		Annually (winter term)		
Prerequisite for participation:		Decision by the board of examiners (§ 5 (1))		
Offered by:		Linguistik		

Name of the module: FM2 - Foundations of Computer Science	Credit points (LP): 6
Module type (Compulsory or elective):	Compulsory, if so decided by the board of examiners in accordance with §5 (1)
Content and learning objectives of the module:	Learning objectives: Students will have the necessary background knowledge about computer science to successfully complete the basic modules of the study program. They can organize themselves to acquire this knowledge on their own, and will be able to reason about the learned concepts. Content: Algorithms and data structures: growth functions and O-notation; Divide and Conquer; Sorting and searching; elementary data structures; dynamic programming; greedy algorithms; elementary graph algorithms. Formal languages: Chomsky hierarchy; regular languages and finite automata; context-free languages and pushdown automata; Finite State Transducer; Turing machines. Theoretical basics: computability; Halting problem; nondeterminism; recursion; inductive definitions (lists, trees). The contents are conveyed via suitable online video lectures, e.g. from Coursera or MIT OpenCourseWare.
Examination (number, type, scope):	Oral examination (20 min)
Individual learning time (in hours):	150

Courses (Type)	Contact time (in SWS)	Additional examination requirements (Number, type, scope)		Partial module examination (number, type, scope)
		For completing the module	For being admitted to the module exam	
Video-lecture	0			
Tutorial	2		Successful solution of homework exercises	

Frequency:	Annually (winter term)
Prerequisite for participation:	Decision by the board of examiners (§ 5 (1))
Offered by:	Informatics

Name of the module: FM3 - Foundations of Linguistics	Credit points (LP): 6
Module type (Compulsory or elective):	Compulsory, if so decided by the board of examiners in accordance with §5 (1)
Content and learning objectives of the module:	Learning objectives: Students obtain the background knowledge in Linguistics that is necessary for successfully completing the Basic Modules of the degree programme. They can organize themselves to acquire this knowledge on their own, and will be able to reason about the learned concepts. Content: Theoretical foundations of syntax, semantics, phonology, and psycholinguistics: structure of words; phrase structure; syntactic dependencies; word order and syntatic relations; basics of Montague semantics; compositionality; scope; conventional and conversational implicatures; Gricean maxims; phonological representations and constraints; theories of word and sentence processing; models of dialog and discourse; language acquisition. Contents can be communicated via suitable online video lectures, such as by Coursera or MIT OpenCourseWare.
Examination (number, type, scope):	Oral examination (20 min)
Individual learning time (in hours):	150

Courses (Type)	Contact time (in SWS)	Additional examination requirements (Number, type, scope)		Partial module examination (number, type, scope)
		For completing the module	For being admitted to the module exam	
(Video-)lecture	0			
Tutorial	2		Successful completion of exercises	

Frequency:	Annually in winter term
Prerequisite for participation:	Decision by the board of examiners (§ 5 (1))
Offered by:	Linguistics

<table>
<tr><td colspan="3">Name of the module: AM11, AM12 - Current Topics in Computational Linguistics 1-2</td><td colspan="3">Credit points (LP): 6</td></tr>
<tr><td colspan="2">Module type (Compulsory or elective):</td><td colspan="4">Elective</td></tr>
<tr><td colspan="2">Content and learning objectives of the module:</td><td colspan="4">Learning objectives:

- Students can independently work with the current relevant literature on a given topic.

- Building on the knowledge acquired in BM1, the students develop a deeper understanding of specific current topics in computational linguistics: What solutions are pursued, what are their strengths and weaknesses?

- Students are able to critically engage with research work, i.e. to question arguments, to test selected solutions for efficiency, and to think of alternatives.

Content:

Topics selected from the current international literature on computational linguistics (conferences, journals) will be developed in greater depth against the background of the knowledge gained from the BM modules.

The courses in this module are usually offered as seminars; depending on the subject, they can also be offered as lectures in individual cases.

The completion of the module AM12 enables the students to further specialize in computational linguistics.</td></tr>
<tr><td colspan="2">Examination (number, type, scope):</td><td colspan="4">If seminar: portfolio review, composed of an oral presentation (60 min) at the seminar and related final paper (about 20 pages); Registration for the module examination takes place with the registration for the seminar. If lecture course: written exam (90 min) or oral exam (20 min).</td></tr>
<tr><td colspan="2">Individual learning time (in hours):</td><td colspan="4">150</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td rowspan="2">Courses (Type)</td><td rowspan="2">Contact time (in SWS)</td><td colspan="2">Additional examination requirements (Number, type, scope)</td><td colspan="2">Partial module examination (number, type, scope)</td></tr>
<tr><td>For completing the module</td><td>For being admitted to the module exam</td><td></td></tr>
<tr><td>Seminar</td><td>2</td><td></td><td></td><td></td></tr>
<tr><td>or Lecture</td><td>2</td><td></td><td></td><td></td></tr>
<tr><td colspan="6"></td></tr>
<tr><td colspan="2">Frequency:</td><td colspan="4">Each term</td></tr>
<tr><td colspan="2">Prerequisite for participation:</td><td colspan="4">No</td></tr>
<tr><td colspan="2">Offered by:</td><td colspan="4">Linguistics</td></tr>
</table>

Name of the module: AM21, AM22 - Current Topics in Machine Learning 1-2	Credit points (LP): 6
Module type (Compulsory or elective):	Elective
Content and learning objectives of the module:	Learning objectives: Students have comprehensive, detailed and specialized knowledge of the latest developments in selected areas of machine learning. They have advanced knowledge in the adjacent area of Bayesian statistics. Students have the ability to analyze modeling problems, map them onto the paradigms of machine learning and Bayesian statistics, develop and implement solutions, and assess the quality of the solutions with appropriate evaluation protocols. They can develop new ideas and procedures, weigh up alternatives under incomplete information and evaluate them according to different evaluation standards. Content: Selection of advanced topics in the field of machine learning, such as graphical models, Gaussian processes, inference, reinforcement learning, online learning, transfer learning, kernel methods, recommendation algorithms. The courses in this module are usually offered as seminars; depending on the subject, they can also be offered as lectures in individual cases. The completion of the module AM22 enables the students to further specialize in machine learning.
Examination (number, type, scope):	If seminar: portfolio review, composed of an oral presentation (60 min) at the seminar and related final paper (about 20 pages); Registration for the module examination takes place with the registration for the seminar. If lecture course: written exam (90 min) or oral exam (20 min).
Individual learning time (in hours):	150

Courses (Type)	Contact time (in SWS)	Additional examination requirements (Number, type, scope)		Partial module examination (number, type, scope)
		For completing the module	For being admitted to the module exam	
Seminar	2			
or Lecture	2			

Frequency:	Each term
Prerequisite for participation:	No
Offered by:	Informatics (50%), Linguistics (50%)

Name of the module: AM31, AM32 - Current Topics in Computational Intelligence 1-2	Credit points (LP): 6
Module type (Compulsory or elective):	Elective
Content and learning objectives of the module:	Learning objectives: Students are able to define and interpret the particularities, limits, terminologies and doctrines in the field of computational intelligence. Students' knowledge will form the basis for the development and / or application of independent ideas in the field of computational intelligence in a research-oriented way. Students will have a broad, detailed and critical understanding of the latest knowledge in selected areas of specialization in the field of computational intelligence. Students will be able to apply their knowledge and understanding as well as their problem-solving skills to new and unfamiliar situations in a broader or multidisciplinary context in the field of knowledge representation and processing. Content: Selection of advanced topics in the field of computational intelligence, such as logical foundations, exact closure, error-tolerant closure, temporal and spatial closure, taxonomic systems, argumentative systems, autonomous systems, action planning, configuration, diagnostics, multidimensional constraint satisfaction problems, etc. The courses in this module are usually offered as seminars; depending on the subject, they can also be offered as lectures in individual cases. The completion of the module AM32 enables the students to further specialize in computational intelligence.
Examination (number, type, scope):	If seminar: portfolio review, composed of an oral presentation (60 min) at the seminar and related final paper (about 20 pages); Registration for the module examination takes place with the registration for the seminar. If lecture course: written exam (90 min) or oral exam (20 min).
Individual learning time (in hours):	150

Courses (Type)	Contact time (in SWS)	Additional examination requirements (Number, type, scope)		Partial module examination (number, type, scope)
		For completing the module	For being admitted to the module exam	
Seminar	2			
or Lecture	2			

Frequency:	Each term
Prerequisite for participation:	No
Offered by:	Informatics

III. Project seminars

Name of the module: PM 1 - Project in Computational Linguistics	Credit points (LP): 12
Module type (Compulsory or elective):	Elective
Content and learning objectives of the module:	Learning objectives: - Students have explored a limited area of expertise in detail and know the current state of research. They are in a position to structure and critically review the ongoing research, and develop their own research questions. They can apply these skills in their later work on other topics. - Students are able to independently define a realistic project topic. They can select appropriate subject-specific methods and apply them effectively to the project. For this they can procure the necessary resources (programs, datasets, grammars, etc.) and adapt them to their own needs or develop them themselves from scratch. - Students are able to plan and organize a research project and assess its feasibility and required resources. They are trained to take responsibility for the success of the project, to work in a team and to lead subprojects. They can organize their own working time and that of their team and work towards a deadline. - Students can present and motivate their research question. The project results can be presented verbally and in writing according to the rules of good scientific communication. They are trained to effectively communicate within their team about solutions, work distribution, resolve occuring conflicts, and to provide constructive feedback to other teams. Content: Students first choose a specialized area of current research in the field of computational linguistics. They explore the relevant literature independently and discuss questions at the seminar. On this basis, teams of students then define their own clearly defined research, experimental or development projects. They work on these projects and present the results. In selecting the content areas, the lecturers are guided by topics discussed in the current research literature.
Examination (number, type, scope):	Portfolio review, composed of a project report (circa 20 pages) and a project presentation (circa 20 min); Registration for the module examination takes place with the registration for the seminar.
Individual learning time (in hours):	330

Courses (Type)	Contact time (in SWS)	Additional examination requirements (Number, type, scope)		Partial module examination (number, type, scope)	
		For completing the module	For being admitted to the module exam		
Seminar	2				

Frequency:	Annually (normally in summer term)
Prerequisite for participation:	No
Offered by:	Linguistics

Name of the module: PM 2 - Project in Machine Learning	Credit points (LP): 12
Module type (Compulsory or elective):	Elective
Content and learning objectives of the module:	Learning objectives: - Students have exploread a limited area of expertise in detail and know the current state of research. They are in a position to structure and critically review the ongoing research, and develop their own research questions. They can apply these skills in their later work on other topics. - Students are able to independently define a realistic project topic. They can select appropriate subject-specific methods and apply them effectively to the project. For this they can procure the necessary resources (programs, datasets, grammars, etc.) and adapt them to their own needs or develop them themselves from scratch. - Students are able to plan and organize a research project and assess its feasibility and required resources. They are trained to take responsibility for the success of the project, to work in a team and to lead subprojects. They can organize their own working time and that of their team and work towards a deadline. - Students can present and motivate their research question. The project results can be presented verbally and in writing according to the rules of good scientific communication. They are trained to effectively communicate within their team about solutions, work distribution, resolve occuring conflicts, and to provide constructive feedback to other teams. Content: Students first choose a specialized area of current research in the field of machine learning. They explore the relevant literature independently and discuss questions at the seminar. On this basis, teams of students then define their own clearly defined research, experimental or development projects. They work on these projects and present the results. In selecting the content areas, the lecturers are guided by topics discussed in the current research literature.
Examination (number, type, scope):	Portfolio review, composed of a project report (circa 20 pages) and a project presentation (circa 20 min); Registration for the module examination takes place with the registration for the seminar.
Individual learning time (in hours):	330

Courses (Type)	Contact time (in SWS)	Additional examination requirements (Number, type, scope)		Partial module examination (number, type, scope)	
		For completing the module	For being admitted to the module exam		
Seminar	2				

Frequency:	Annually (normally in winter term)
Prerequisite for participation:	No
Offered by:	Informatics (50%), Linguistics (50%)

Name of the module: PM 3 - Project in Computational Intelligence	Credit points (LP): 12
Module type (Compulsory or elective):	Elective
Content and learning objectives of the module:	Learning objectives: - Students have exploread a limited area of expertise in detail and know the current state of research. They are in a position to structure and critically review the ongoing research, and develop their own research questions. They can apply these skills in their later work on other topics. - Students are able to independently define a realistic project topic. They can select appropriate subject-specific methods and apply them effectively to the project. For this they can procure the necessary resources (programs, datasets, grammars, etc.) and adapt them to their own needs or develop them themselves from scratch. - Students are able to plan and organize a research project and assess its feasibility and required resources. They are trained to take responsibility for the success of the project, to work in a team and to lead subprojects. They can organize their own working time and that of their team and work towards a deadline. - Students can present and motivate their research question. The project results can be presented verbally and in writing according to the rules of good scientific communication. They are trained to effectively communicate within their team about solutions, work distribution, resolve occuring conflicts, and to provide constructive feedback to other teams. Content: Students first first choose a specialized area of current research in the field of computational intelligence. They explore the relevant literature independently and discuss questions at the seminar. On this basis, teams of students then define their own research, experimental or development projects. They work on these projects and present the results. In selecting the content areas, the lecturers are guided by the research topics of current literature.
Examination (number, type, scope):	Portfolio review, composed of a project report (circa 20 pages) and a project presentation (circa 20 min); Registration for the module examination takes place with the registration for the seminar.
Individual learning time (in hours):	330

Courses (Type)	Contact time (in SWS)	Additional examination requirements (Number, type, scope)		Partial module examination (number, type, scope)	
		For completing the module	For being admitted to the module exam		
Seminar	2				

Frequency:	Annually (normally in summer term)
Prerequisite for participation:	No
Offered by:	Informatics

IV. Scientific research

Name of the module: IM1 - Individual Research Module				Credit points (LP): 15	
Module type (Compulsory or elective):	Compulsory				
Content and learning objectives of the module:	Learning objectives: The student has in-depth detailed knowledge in the field of her or his research topic. S/He can formulate her/his own research question, master the methods of the chosen subject and work on the research question independently. The student can publicly present his or her research results to the body of experts and motivate her or his research questions. Content: The student works on her/his own research project, which is selected in consultation with the lecturer on the basis of current research topics. Finally, the student publicly presents her/his research results and documents these in writing.				
Examination (number, type, scope):	Portfolio review, composed of written term paper (about 30 pages) and a public talk (about 20 min) or poster presentation on the subject of the project. The registration for the module examination takes place with the registration for the course.				
Individual learning time (in hours):	420				
Courses (Type)	Contact time (in SWS)	Additional examination requirements (Number, type, scope)		Partial module examination (number, type, scope)	
		For completing the module	For being admitted to the module exam		
Practicum	2				
Frequency:	Each semester				
Prerequisite for participation:	No				
Offered by:	Informatics (50%), Linguistics (50%)				

Appendix 2: Course schedule (start in winter term)

Semester/ Module	**1. FS (winter)**	**2. FS (summer)**	**3. FS (winter)**	**4. FS (summer)**	**Sum**
I Obligatory modules					
BM1	**9 LP**				
BM2		**9 LP**			
BM3	**9 LP**				**27 LP**
II Elective modules					
	12 LP	**12 LP**			**24 LP**
* FM1	<6>				
* FM2	<6>				
* FM3	<6>				
AM11	<6>	<6>			
AM12	<6>	<6>			
AM21	<6>	<6>			
AM22	<6>	<6>			
AM31	<6>	<6>			
AM32	<6>	<6>			
Total	**12 LP**	**12 LP**			
III Project seminars					
		12 LP	**12 LP**		**24 LP**
PM1		<12>	(<12>)		
PM2		(<12>)	<12>		
PM3		<12>	(<12>)		
IV Scientific research					
IM1			**15 LP**		**15 LP**
Master thesis					
Master thesis				**30 LP**	**30 LP**
Sum	**30 LP**	**33 LP**	**27 LP**	**30 LP**	**120 LP**