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Degree Program and Examination Regulations for the Joint Master's Degree Program Data Science of the Department of Mathematics and Computer Science and the Department of Education and Psychology at Freie Universität Berlin

Disclaimer: Please note that only the German versions of these documents are legally binding. This translation is intended for the convenience of the non-German-reading public and is for information purposes only.

Preamble

On the basis of Section 14.1.1.2 of Freie Universität Berlin's supplemental rules and regulations [*Teilgrundordnung (Erprobungsmodell)*] from October 1998, published in the Freie Universität bulletin No. 24/1998 *(FU-Mitteilungen*), the Joint Commission for the joint master's degree program "Data Science" at the Department of Mathematics and Computer Science and the Department of Education and Psychology at Freie Universität Berlin issued the following degree program and examination regulations for the joint master's degree program "Data Science" at the Department of Mathematics and Computer Science and the Department of Education and Psychology at Freie Universität Berlin: [1]

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[1] These statutes were approved by the Executive Board of Freie Universität Berlin on August 23, 2021.

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Section 1 Scope

(1) These regulations define the objectives, content, and structure of the joint master's degree program "Data Science" within the Department of Mathematics and Computer Science and the Department of Education and Psychology at Freie Universität Berlin. These regulations apply in conjunction with Freie Universität Berlin's framework regulations for degree programs and examinations as they outline the requirements and processes necessary to complete coursework and assessments toward completion of a master's degree program. The Data Science Joint Commission is responsible for the organization of teaching and study related to this program.

(2) The degree program is a consecutive master's degree program as defined by Section 23.3.1.1a of the Berlin Higher Education Act (BerlHG) from July 26, 2011 (GVBl., p. 378), last amended on May 4, 2021 (GVBl., p. 435).

Section 2 Learning Objectives

(1) Graduates of the master's degree program are well-acquainted with the primary methods used in the field of modern data science, as well as the fundamentals specific to the field and related fields, such as mathematics and computer science. They are capable of independently analyzing data analysis problems, comparing different methodological approaches, and evaluating their advantages and disadvantages. They are able to work independently to formalize new data analysis problems as they emerge, develop methods to solve them, implement those solutions in an application-oriented manner,

and interpret them appropriately. Furthermore, graduates are familiar with the ethical, legal, and security related aspects involved in problems and solutions surrounding data. They are also aware of the limits and risks of the methods used in data science. Graduates are aware of the foundations and basic general principles of academic work and good scientific practice and are able to apply these from the start of their academic/scientific activities.

(2) Along with their subject-specific qualifications, graduates also acquire skills in teamwork, communication, and knowledge transfer. They are also familiar with ideas concerning gender and diversity. They are equipped with the techniques required to carry out scientific research, read and compose texts in English, and present their work.

(3) Graduates of the master's degree program are qualified to take on leading professional roles in a wide range of fields related to the collection, management, processing, analysis, and interpretation of digital data. Those areas might include, for example, the Internet economy, health, industry 4.0, or institutions and organizations in industry, research, or administration. Graduates of the master's degree are also qualified to continue to doctoral study and thus gain additional academic qualifications.

Section 3 Curriculum Contents

(1) In this master's degree program students gain the skills they need to deal with the ever-growing field of digitalization and the many areas of society and natural sciences related to it. Some of those skills include the collection, processing, analysis, and interpretation of large digital data sets. In addition, the master's degree program teaches students about central aspects of modern data science that are characterized by a fusion of the fields of mathematics, statistics, computer science, and machine learning, with an emphasis on approaches that look at practical applications. Through in-depth training in the related subfields of mathematics, statistics, and computer science as well as in the relevant fields of natural science based in quantitative application methods, the program provides the knowledge and skills needed to recognize relevant data analytical problems, to develop appropriate mathematical or computer science solutions for them, to apply them and to correctly interpret the results in the context of specific applications. Students also gain knowledge of and experience with the basic tenets of academic and scientific work as well as good scientific practice. During their studies, they are introduced to academic and scientific work.

(2) Students also become familiar with the content and working methods of research-oriented fields of study. Along with specialist skills in selected fields that work intensively with data, they acquire interdisciplinary skills and key qualifications that prepare them for research activities or leadership roles later on.

Section 4 General Academic Advising and Departmental Advising

(1) The Center for Academic Advising and Psychological Counseling at Freie Universität Berlin provides general academic advising for students.

(2) Instructors who teach courses offered in the master's degree program provide departmental advising during their office hours. A student aid is also available to give additional advising support. Furthermore, students are advised to discuss the suitability of their individual curriculum plan with their examinations office.

(3) Students are strongly encouraged to schedule an advising session with the chair of the examination board (or the deputy chair) within the first two weeks of their first semester in the program. This meeting gives them a chance to discuss their individual curriculum plan and the topics(s) on which they plan to focus in their profile area. Ample opportunities for appointments will be made available and communicated to the students in due time.

Section 5 Examination Board

The examination board appointed by the Data Science Joint Commission for this master's degree program is responsible for organizing examinations and the other tasks stipulated by the framework regulations for degree programs and examinations (RSPO).

Section 6 Standard Time to Degree

The standard time to degree is four semesters.

Section 7 Structure and Components; Distribution of Credit Points

(1) In order to complete the master's degree program, students must earn a total of 120 credit points, consisting of modules totaling 90 credit points and a master's thesis with a corresponding colloquium totaling 30 credit points. The master's degree program comprises fundamental modules totaling 30 credit points and profile area modules totaling 60 credit points.

(2) The following modules relating to fundamentals, which must total 30 credit points, are to be completed:

– Module: Introduction to Profile Areas (5 credit points),

– Module: Statistics for Data Science (10 credit points),

– Module: Machine Learning for Data Science (10 credit points), and

– Module: Programming for Data Science (5 credit points).

(3) Students have the choice between one of two profile areas in the master's degree program, "Data Science in Life Sciences" or "Data Science Technologies," which they must complete. Students choose their profile area by completing the required modules in that area. Students may not complete required electives in their profile area if the modules correspond to coursework they have already completed as part of their bachelor's degree program. The examination board has the final say in decisions regarding complicated cases. A decision should be reached before the student selects the module in question. The two profile areas consist of the following:

1. The "Data Science in Life Sciences" profile area comprises 60 credit points:

a) Required modules totaling 30 credit points: The following modules are to be completed:

– Module: Data Science in Life Sciences (15 credit points),

– Module: Research Practices (10 credit points), and

– Module: Ethical Foundations of Data Science (5 credit points).

b) Required electives totaling 30 credit points:

aa) Students must select from the following modules in the "Data Science in Life Sciences" profile area to complete a total of 15 credit points:

– Module: Special Topics in Data Science in Life Sciences (5 credit points)

– Module: Current Research Topics in Data Science in Life Sciences (5 credit points)

– Module: Data Science in Life Sciences Master's Seminar (5 credit points)

– Module: Selected Topics in Data Science in Life Sciences (10 credit points)

– Lecture module: Machine Learning in Bioinformatics (DS/5 credit points),

– Lecture module: Big Data Analysis in Bioinformatics (DS/5 credit points),

– Applied Research Module: Applied Machine Learning in Bioinformatics (DS/5 credit points).

bb) Students must select from the following modules in the other profile area to complete a total of 15 credit points:

– Module: Special Topics in Data Science Technologies (5 credit points)

– Module: Current Research Topics in Data Science Technologies (5 credit points)

– Module: Selected Topics in Data Science Technologies - Module A (10 credit points)

– Module: Selected Topics in Data Science Technologies - Module B (10 credit points)

– Module: Data Science Technologies Master's Seminar (5 credit points)

– Module: Data Science Software Project - Module B (10 credit points)

– Module: Database Systems and Data Science (5 credit points)

– Module: Distributed Systems (5 credit points)

– Module: Mobile Communication (5 credit points)

– Module: Telematics (10 credit points)

– Module: Advanced Algorithms (10 credit points)

– Module: Computer Security (10 credit points)

– Module: Pattern Recognition (5 credit points)

– Module: Network-Based Information Systems (5 credit points)

– Module: Artificial Intelligence (5 credit points)

– Module: Special Topics in Data Management (5 credit points)

– Module: Interdisciplinary Approaches in the Context of Data Science - Module A (5 credit points)

– Module: Interdisciplinary Approaches in the Context of Data Science - Module B (10 credit points)

Upon request and pending the approval of the examination board, students may complete up to 15 credit points in modules from other master's degree programs for their required electives rather than the modules outlined above under Section 7.1.3.1.b.bb, as long as the student is permitted to take courses in those other modules. Additional modules can potentially be selected and recognized as fulfilling requirements for required electives if the modules correspond to the learning objectives of the master's degree program. Such exceptions must be discussed with and approved by the examination board in advance. The individual modules can only be completed once. Before selecting other master's degree modules, students are encouraged to take advantage of the advising services offered by the department.

2. The "Data Science Technologies" profile area comprises 60 credit points:

a) Required modules totaling 15 credit points: The following modules are to be completed:

– Module: Data Science Software Project - Module A (10 credit points) and

– Module: Ethical Foundations of Data Science (5 credit points).

b) Required electives totaling 45 credit points:

aa) Students must select from the following modules in the "Data Science Technologies" profile area to complete a total of 30 credit points.

– Module: Special Topics in Data Science Technologies (5 credit points)

– Module: Current Research Topics in Data Science Technologies (5 credit points)
– Module: Selected Topics in Data Science Technologies - Module A (10 credit points)
– Module: Selected Topics in Data Science Technologies - Module B (10 credit points)
– Module: Data Science Technologies Master's Seminar (5 credit points)
– Module: Data Science Software Project - Module B (10 credit points)
– Module: Database Systems and Data Science (5 credit points)
– Module: Distributed Systems (5 credit points)
– Module: Mobile Communication (5 credit points)
– Module: Telematics (10 credit points)
– Module: Advanced Algorithms (10 credit points)
– Module: Computer Security (10 credit points)
– Module: Pattern Recognition (5 credit points)
– Module: Network-Based Information Systems (5 credit points)
– Module: Artificial Intelligence (5 credit points)
– Module: Special Topics in Data Management (5 credit points)

bb) Students must select from the following modules in the other profile area to complete a total of 15 credit points:

– Module: Special Topics in Data Science in Life Sciences (5 credit points)
– Module: Current Research Topics in Data Science in Life Sciences (5 credit points)
– Module: Data Science in Life Sciences Master's Seminar (5 credit points)
– Module: Selected Topics in Data Science in Life Sciences (10 credit points)
– Lecture module: Machine Learning in Bioinformatics (DS/5 credit points)
– Lecture module: Big Data Analysis in Bioinformatics (DS/5 credit points)
– Applied Research Module: Applied Machine Learning in Bioinformatics (DS/5 credit points)
– Module: Interdisciplinary Approaches in the Context of Data Science - Module A (5 credit points)
– Module: Interdisciplinary Approaches in the Context of Data Science - Module B (10 credit points)

Upon request and pending the approval of the examination board, students may complete up to 15 credit points in modules from other master's degree programs for their required electives rather than the modules outlined above under Section 7.1.3.2.b.bb, as long as the student is permitted to take courses in

those other modules. Additional modules can potentially be selected and recognized as fulfilling requirements for required electives if the modules correspond to the learning objectives of the master's degree program. Such exceptions must be discussed with and approved by the examination board in advance. The individual modules can only be completed once. Before selecting other master's degree modules, students are encouraged to take advantage of the advising services offered by the department.

(5) The module descriptions in appendix 1 provide information on the prerequisites, the contents and learning objectives, the modes of instruction, the workload, the different types of active participation, the various assessments that students must take during the program, information on participation requirements in the different modes of instruction, the standard duration, and how often courses are offered.

For the following three modules, please refer to the degree program and examination regulations for the master's degree program "Bioinformatics" offered by the Department of Biology, Chemistry, Pharmacy, and the Department of Mathematics and Computer Science at Freie Universität Berlin and Charité – Universitätsmedizin Berlin:

– Lecture module: Machine Learning in Bioinformatics (DS/ 5 credit points),
– Lecture module: Big Data Analysis in Bioinformatics (DS/ 5 credit points),
– Applied Research Module: Applied Machine Learning in Bioinformatics (DS/5 credit points).

For the following nine modules, please refer to the degree program and examination regulations for the master's degree program "Computer Science" offered by the Department of Mathematics and Computer Science at Freie Universität Berlin:

– Module: Distributed Systems (5 credit points),
– Module: Mobile Communication (5 credit points),
– Module: Telematics (10 credit points),
– Module: Advanced Algorithms (10 credit points)
– Module: Computer Security (10 credit points)
– Module: Pattern Recognition (5 credit points),
– Module: Network-Based Information Systems (5 credit points),
– Module: Artificial Intelligence (5 credit points),
– Module: Special Topics in Data Management (5 credit points).

(6) Appendix 2 is a standard curriculum plan for completing the master's degree program.

Section 8 Modes of Instruction

(1) The following modes of instruction will be offered as part of the curriculum:

1. In lectures (V) students learn about the course content through presentations prepared and explained by the instructor. Instructors present the content within the context of relevant publications in the field and encourage students to pursue independent study and critical thinking.

2. Practice sessions (Ü) usually accompany lectures and take place in small group settings. In the practice session groups, students review selected content from the lectures and learn how to apply the material covered through assignments with a practical orientation.

3. Seminars (S) focus on topics that cover a manageable area of knowledge and help students engage with curriculum contents as well as theories and methods in specialized fields of bioinformatics. In seminars, students work on course content under the guidance of the instructor, using relevant research literature and empirical findings. This work includes class presentations and discussions.

4. Practical seminars (PrS) provide an opportunity for students to work on more elaborate topics and issues related to practical applications or scientific research in the field. Coursework is done under the guidance of an instructor either alone or in small groups. Project work is oriented toward the process of finding solutions to problems, in other words, the practical application of relevant techniques and approaches in combination with scientific knowledge and methods. In addition, students acquire transferable skills related to team work, communication, and knowledge transfer. They also learn about responsible scholarly conduct and gender sensitivity.

5. Project seminars (ProjS) present students with more comprehensive tasks that require them to use techniques and methods that they have encountered in an accompanying course or from courses in the past. Their work includes formally identifying and categorizing problems, breaking down a problem into parts, defining areas of overlap, and using the methods of project management. Students report regularly on their progress in groups that they form independently. At the end of the seminar, students must submit a well-documented and executable program together with a project report that clearly states their specific contributions to the project. Students acquire skills related to the independent application of knowledge and problem-solving methods in the field of computer science that they can use to complete concrete tasks. In addition, project seminars also give students the opportunity to deepen their understanding of collaborative approaches to completing projects, as well as strengthen their gender and diversity competencies.

6. Seminar-based instruction (sU) presents students with applied knowledge from a clearly defined area. Students work independently on an assignment and present their results to the class, followed by discussion and critique of the results.

7. Off-campus internships (P) help students gain the skills and problem-solving methods they need in the field of data science as they successfully complete a variety of practical assignments. Part of their work includes identifying and categorizing problems and dividing a problem into subparts. Students should regularly follow through with ideas for solutions, demonstrate results, document their work and findings in

writing, and present them. The purpose of internships is to give students the chance to demonstrate that they have a firm grasp of the knowledge they acquired.

8. Lecture series (RV) are a special type of lecture in which students encounter a wide spectrum of field-specific approaches and mentalities related to a specific topic or discipline. In a lecture series, different lecturers provide students an orientation to their field. Lecturers should come from a variety of profile areas and disciplines. Lecture series also include the opportunity for dialogue.

9. Integrated coursework (ILV) involves a mix of different types of courses and modes of instruction. This mode of instruction consists predominantly of active participation in group discussions, assignments or projects, as well as practical applications. Integrated coursework often involves complete projects in conjunction with lectures or seminars. The specifics of this mixed mode of instruction are defined by the individual instructors.

10. Elective courses (WV) provide students with knowledge and skills from a specific discipline or cover transdisciplinary topics. Students are given free choice of their elective courses from the entire range of courses on offer.

(2) The modes of instruction as outlined in Para. 1 can be implemented through blended learning formats. Blended learning combines on-site education with digital, internet-based media (e-learning). In this context, certain educational activities can be offered through Freie Universität Berlin's central e-learning applications. Students can work on these activities individually or in groups. They can complete them on their own or with the guidance of an instructor. Blended learning can be used both as part of the active learning phase (discussing educational materials, sharing solutions to assignments, vigorous communication between instructors and students) and for follow-up activities (evaluating students' progress, applying and transferring knowledge).

Section 9 Master's Thesis

(1) The master's thesis is intended to demonstrate that a student has the ability to work independently on problems in the field of cognitive data science using the relevant research methods. They should be able to present their findings in writing and discuss them orally, as well as critically assess them.

(2) Students will be admitted to work on a master's thesis by submitting a request provided that at the time of the request:

1. they were most recently enrolled in a master's degree program at Freie Universität Berlin,

2. they have successfully completed modules totaling at least 60 credit points in the course of the master's degree program.

(3) The admission request for the master's thesis must be accompanied by proper documentation of the prerequisites listed above under Section 9. 2 above, as well as confirmation from an instructor who is authorized to administer exams that they are willing and able to act as supervisor for the master's thesis.

The relevant examination board is responsible for approving requests. If the request does not include confirmation from an instructor as described above, the examination board will appoint the student a supervisor. The function of supervision is to guide students toward an understanding of and compliance with the rules of good scientific practice in the context of the specific requirements of the given field or subject area. Students have the opportunity to propose topics for their thesis; however, there is no guarantee that their proposed topics will be approved.

(4) The master's thesis should be approximately 70 pages in length.

(5) The examination committee assigns the topic of the master's thesis in coordination with the thesis supervisor. The topic and assignment must be designed in such a way as to ensure the work can be completed before the deadline. The announcement of the assignment and the submission of the master's thesis must be documented and kept on file. When the student submits their master's thesis they must include a written statement confirming that they alone are responsible for the content of the master's thesis and that the list of sources and references included in the thesis is complete (meaning the contents of the thesis are based on documented sources or are the result of a student's own original work).

(6) The student has 23 weeks to complete and submit the master's thesis. The work period for the master's thesis begins with the date that the topic is assigned by the examination board. The topic can be declined once within four weeks of being assigned, in which case it will be deemed not issued. The examination board is responsible for approving requests to decline a topic in consultation with the student's master's thesis supervisor.

(7) The master's thesis must be written in English. Upon request and with proper justification, the examination board may allow a student to write the thesis in German. If a student is prevented from working on their master's thesis for more than eight weeks due to mitigating circumstances, the examination board shall decide whether the student must start the master's thesis process again. If the examination board demands that the master's thesis process be started again, the previous steps in the master's thesis process do not count as an official examination attempt.

(8) The master's thesis will be accompanied by a colloquium that generally takes place within a given working group. Students should hold 30-minute presentations on the progress of their master's thesis. Each student should present once during the course of the colloquium.

(9) Pending the examination board's approval, the master's thesis can be completed outside of the university at a company/business or at a different research institution, as long as one of the examiners of the master's thesis can vouch for the academic supervision.

(10) The master's thesis is graded by two examiners qualified to evaluate academic work at this level. The examination board selects who will serve as examiners. One of the qualified examiners should be the student's supervisor for the master's thesis. One or both of the qualified examiners must be involved in the master's degree program and also be a professor in the Department of Mathematics and Computer Science at Freie Universität Berlin.

(11) The grade for the master's thesis is calculated as the arithmetical mean of the grades awarded by the two examiners. If one of the examiners assigns a grade of "not satisfactory" (5.0) or if the two individual grades assigned by the examiners differ by 2.0 points or more, then the examination board must select a third examiner to evaluate the master's thesis. In this case, the grade for the master's thesis is calculated as the arithmetical mean of the grades awarded by the three examiners. A grade of "sufficient" (4.0) or higher is a passing grade for a master's thesis.

(12) A student's work on a master's thesis elsewhere can be recognized/transferred to Freie Universität Berlin. The recognition request should be submitted to the examination board. In order for the master's thesis to be recognized, the examination conditions and the assignment of the submitted work must not differ substantially in terms of quality, level, learning outcomes, scope, and profile when compared to the examination conditions and the assignment of a master's thesis completed in this master's program, which characterize the type of professional qualification this master's degree program in particular provides.

Section 10 Multiple-Choice Questions

(1) Multiple-choice questions in an examination and any free response questions connected to the multiple-choice questions must be set by two examiners.

(2) If it becomes clear during the grading of multiple-choice questions that certain questions do not fulfill their purpose of obtaining reliable examination results and do not sufficiently reflect the qualification objectives of the relevant module, the grading process must be adjusted so that the examination candidate is not put at a disadvantage in their examination result.

(3) An examination in the form of multiple-choice questions is deemed passed if the candidate receives at least 50 percent of the possible maximum points (absolute passing grade), or if the number of points achieved by the student does not fall more than 10 percent below the average number of points achieved by all candidates who participated in the examination (relative passing grade). If the relative passing grade is used, the candidate must still achieve at least 40 percent of the total possible points in order to pass the examination.

(4) Multiple-choice examinations must be graded as described below. Where the candidate has achieved the minimum number of points as defined above under Section 11.3, they will be graded according to the following criteria:

- "very good" for a number of points that totals at least 75 percent more than the required minimum number of points under Section 11.3;

- "good" for a number of points that totals at least 50 percent, but less than 75 percent, more than the required number of points under Section 11.3;

- “satisfactory” for a number of points that totals at least 25 percent, but less than 50 percent, more than the required number of points under Section 11.3;

– “sufficient” for a number of points up to 25 percent more than the required minimum number of points under Section 11.3.

For the grading system, please also refer to the framework regulations for degree programs and examinations (RSPO).

(5) The grading requirements stipulated above under 11.3 and 11.4 will not be applied if

1. the examiners who set the questions as described in Section 11.1 are also the examiners responsible for grading the multiple-choice answers, or

2. the proportion of maximum points achievable in the multiple-choice section makes up no more than 25 percent of the examination as a whole, where the examination is only partly in multiple-choice format.

Section 11 Electronic (Online) Examinations

(1) If examinations are offered in a digital/online format, the examination and grading for the examination will take place using digital technologies.

(2) The suitability of the chosen technologies for the purpose of carrying out the electronic examination and completing the examination questions must be determined in advance by two examiners.

(3) The identity of the person taking the examination and the validity of the examination results must be authenticated. For this purpose, the examination results must be unambiguously identifiable and permanently assignable to the correct student in the digital system. It must be ensured that the electronic data are unchanged and complete for the purposes of grading and verifying the results.

(4) If an examination has been graded automatically via digital means, the student may request that an examiner verifies the result.

Section 12 Retaking Examinations and Assessments

(1) If a student does not pass their master’s thesis, they can attempt the assessment a second time. For all other exams and assessments in the program, they can retake them three times.

(2) If a student completes the examination/assessment on the original date of the assignment immediately following the end of the course to which the assessment belongs, they may retake it once to improve their grade. This applies to assessments for which students received a grade of “sufficient” or better. The retake

must be completed before the end of the subsequent semester. Only the better of the two grades will count toward their final grade. Students cannot attempt to improve their grades by retaking an examination again.

Section 13 Study Abroad

(1) Students are encouraged to study abroad. While studying abroad students should pursue courses that can be accredited within the master's degree program.

(2) Before starting a study abroad program, a learning agreement must be drawn up between the student, the head of the examination board, and the responsible point of contact at the host university. The agreement covers the length of the study abroad period, the coursework to be completed while studying abroad, which must equate to the courses of the master's degree program in terms of credit points, and the credit points to be allocated to the completed coursework. Coursework completed in accordance with this agreement will be recognized.

(3) The second or third semester in the program lends itself well to study abroad, and students are encouraged to study abroad then.

Section 14 Degree Completion

(1) In order to graduate, students must complete the coursework and assessments outlined in Sections 7 and 9.

(2) A student is not eligible for graduation if they have definitively failed some coursework or assessment or are involved in a pending examination procedure at another university in the same course of study or in a module that is identical or comparable to one of the modules to be completed in the master's degree program here and that will be taken into account when determining their overall grade.

(3) The application request for the award of a degree must be accompanied by documentation showing the student has completed the requirements mentioned in Section 14.1 as well as a guarantee that the applicant is not subject to any of the eligibility restrictions mentioned in Section 14.2. The relevant examination board is responsible for approving the application.

(4) Upon successful completion of the assessment, the student will receive a Master of Science (M.Sc.) university degree. Students receive a certificate of academic record and a degree certificate (appendices 3 and 4) in addition to a diploma supplement (English and German versions). In addition, a degree certificate supplement with details of the individual modules and their components (transcript) is prepared. Additional English versions of the transcript and degree certificate may be issued upon request.

Section 15 Entry into Force and Interim Regulations

(1) These regulations enter into force on the day following their publication in *FU-Mitteilungen* (the official bulletin of Freie Universität Berlin).

(2) The degree program and examination regulations for the master's degree program from April 18, 2019 (*FU-Mitteilungen* No. 15/2019, p. 219), therefore lapse when the new regulations come into force.

(3) These regulations apply to students who are enrolled in this master's degree program at Freie Universität Berlin after its entry into force. Students who have been enrolled in the master's degree program at Freie Universität Berlin before the regulations entered into force shall study and complete coursework on the basis of the degree program and examination regulations stated in Section 15.2 above, provided that they do not submit a request to the examination board to continue their degree program and complete courses of study pursuant to the currently valid regulations. Should this request be granted, the examination board shall decide on the extent to which modules that the student has already begun or completed at the point in time at which the request was submitted shall be recognized and to what extent they can be accredited under the requirements of the currently valid regulations, whereby the requirements of the right to confidentiality and equal treatment shall be taken into account. Once the request for continuation under the newest regulations has been approved, it is final and the student may not then apply to transfer their studies back to the previous regulations.

(4) Students are entitled to complete their degree on the basis of the degree program and examination regulations pursuant to Section 15.2 up until the end of the 2023 summer semester.

Appendix 1: Module Descriptions

Explanatory notes:

These module descriptions address the following aspects for each module in the master's degree program, unless otherwise noted that another set of regulations applies:

- The name of the module
- The person responsible for the module
- The prerequisites needed in order to take a particular module
- The module's content and learning objectives
- Modes of instruction used in the module
- The amount of work required by students to successfully complete a module
- Types of active participation
- Types of assessments/examinations
- Whether or not regular attendance is required
- Credits awarded for the module
- Standard duration of the module
- How often the module is offered (frequency)
- How the module can be applied (applicability)

The information provided on student workload takes the following factors into account:

- Active participation during class sessions
- Time needed to complete small assignments during class sessions
- Time needed for students' preparations before class and follow-up work
- Preparation time required specifically for assessments/examinations
- The time needed for the assessment/examination itself

The amount of time indicated for independent study (including preparing for class, follow-up work, preparing for an exam) are only approximations meant to help students organize their time when planning their workload for modules. The information on the workload corresponds to the number of credit points assigned to the respective module, which serves as a unit of measurement for the amount of work required to successfully complete the module. One credit point equals 30 hours.

If regular attendance is required for the specific type of instruction, then regular attendance, along with active participation in the various modes of instruction and successful completion of assessments, is necessary in order to receive credit points for the specific module. Regular attendance means that a student has attended at least 85 percent of the instruction in the module. If regular attendance is not required in a module, students are still strongly encouraged to attend classes regularly. Instructors teaching courses in which regular attendance is merely encouraged cannot decide that attendance should be required. For modules that include alternative forms of active participation, the type of participation, which must correspond to the workload allotted for active participation in the respective semester, must be determined by the instructor in charge of the course during the first class period at the latest.

To complete each module, the student must complete the module assessment for that module if the module has one. In order to complete a graded module, only one assessment (module assessment) must be completed. The module assessment is based on the module's learning objectives and serves as a way to test whether the objectives have been achieved. The scope of the assessment covers the components necessary to this end. For modules that include alternative assessment forms, the type of assessment for the specific semester must be determined by the instructor in charge of the course before the first day of class.

Active and (if applicable) regular participation in the instruction and successful completion of assessments are necessary in order to receive credit points for the specific module. If a module does not involve a module assessment, then active and regular participation in the instruction is necessary in order to receive credit points for the specific module.

1. Fundamental area

Module: Introduction to Profile Areas

Higher education institution/department/teaching unit: Freie Universität Berlin/Mathematics and Computer Science, Mathematics and Computer Science

Persons responsible for module: Module/course instructors

Admissions requirements: None

Learning objectives:

Students are familiar with sample issues and potential approaches to arriving at solutions from the two profile areas in relation to specific topics and are able to apply these issues and approaches in a manner geared towards problem solving. They recognize where which skills and abilities are needed and are able to analyze a problem specific to a certain area. Students can develop and compare differences and commonalities involved in working across the two different profile areas. They can find suitable literature on specific topics and are able to work on practical problems from the relevant areas.

Content:

The module presents sample problems and approaches to solutions from the profile areas "Data Science in the Life Sciences" and "Data Science Technologies." Students do project work, in teams they work together on concrete tasks on selected topics from the profile areas. They develop and implement specific proposals for solutions to problems geared towards real-world practice and present the results.

Modes of instruction	**Contact hours** (weekly credit hours = SWS)	**Forms of active participation**	**Workload** (hours per semester)	
Lecture (V)	2	Recapitulation of material presented during instruction, working on projects	Contact hours, V	30
			Preparation and follow-up, V	30
Project seminar (ProjS)	2		Contact hours, ProjS	30
			Preparation and follow-up, ProjS	60
Module exam:		None		
Module language:		English		
Mandatory regular participation:		Yes		
Total workload requirement:		150 hours	5 credits	
Duration of module:		One semester		
Frequency of offering:		Each winter semester		
Applicability:		Master's degree program in Data Science		

Module: Statistics for Data Science

Higher education institution/department/teaching unit: Freie Universität Berlin/Mathematics and Computer Science, Mathematics and Computer Science

Persons responsible for module: Course instructors

Admissions requirements: None

Learning objectives:

Students have acquired a deeper understanding of advanced mathematical concepts and methods in the area of statistical data analysis. They are able to formulate customary data analysis methods based on probability theory in mathematical terms and to implement them in algorithm form.

Content:

Fundamentals of measurement and probability theory and statistical modeling, using generalized linear models, Fischer inference, and maximum likelihood estimation as examples (analytical and numerical methods, estimator properties, hypothesis tests), Bayesian inference (parameter estimation and model inference, prior distributions, approximative inference, Markov chain Monte Carlo methodology), probabilistic inference (expectation maximization, Kalman filter and data assimilation, empirical Bayes, variational inference).

Modes of instruction	**Contact hours** (weekly credit hours = SWS)	**Forms of active participation**	**Workload** (hours)	
Lecture (V)	2	Follow-up on lecture content and independently developing supplementary literature	Contact hours, V Preparation and follow-up, V Contact hours, Ü	30 70 30
Exercise (Ü)	2	Work on assigned exercises	Preparation and follow-up, Ü Exam preparation and exam	70 100

Module exam:	Written exam (90 minutes), which may be administered in whole or in part as a multiple choice test or as an electronic exam. This module exam is not evaluated separately.	
Module language:	English	
Mandatory regular participation:	Lecture: participation recommended; exercise: participation mandatory	
Total workload requirement:	300 hours	10 credits
Duration of module:	One semester	
Frequency of offering:	Each winter semester	
Applicability:	Master's degree program in Data Science	

Module: Machine Learning for Data Science

Higher education institution/department/teaching unit: Freie Universität Berlin/Mathematics and Computer Science/Computer Science

Persons responsible for module: Course instructors

Admissions requirements: None

Learning objectives:

Students have an understanding of fundamental applications, concepts, and analytical techniques in the area of machine learning for data sciences. They understand the data situation, algorithms and models of machine learning. They are able to select suitable machine learning algorithms for complex problems and know the strengths and weaknesses of the methods. They know what results can be derived from the relevant data and can execute and evaluate computer-aided procedures appropriately within the field of application and in the relevant scientific context.

Content:

The course provides an overview of the main methods of machine learning and the algorithms used for different classes of problems, especially for supervised, unsupervised, and reinforcement learning.

In the first part of the course, the common methods and algorithms for each of the three classes of learning methods are covered, including the execution of experiments and the evaluation of the models.

In the second part of the course, advanced aspects are considered, such as high-dimensional or non-stationary problems, insufficient labels or unbalanced class distribution in the initial data.

Modes of instruction	**Contact hours** (weekly credit hours = SWS)	**Forms of active participation**	**Workload** (hours per semester)	
Lecture (V)	4	Follow-up on lecture content and independently developing supplementary literature	Contact hours, V	60
			Preparation and follow-up, V	60
			Contact hours, Ü	30
Exercise (Ü)	2	Exercise assignments	Preparation and follow-up, Ü	90
			Examination preparation and examination	60
Module exam:		Written exam (90 minutes), which may be administered in whole or in part as a multiple choice test or as an electronic exam.		
Module language:		English		
Mandatory regular participation:		Lecture: participation recommended; exercise: participation mandatory		
Total workload requirement:		300 hours per semester	10 credits	
Duration of module:		One semester		
Frequency of offering:		Each winter semester		
Applicability:		Master's degree program in Data Science		

Module: Programming for Data Science				
Higher education institution/department/teaching unit: Freie Universität Berlin/Mathematics and Computer Science/Mathematics				
Persons responsible for module: Course instructors				
Admissions requirements: None				
Learning objectives: Students have an in-depth understanding of concepts in programming with a higher programming language (such as C/C++, Java, or Python).				
Content: Introduction to various types of programming techniques.				
Modes of instruction	**Contact hours** (weekly credit hours = SWS)	**Forms of active participation**	**Workload** (hours per semester)	
Practical seminar	2	Working on assignments, short presentations with discussion, discussion of literature and examples of application	Contact hours Preparation and follow-up	60 90
Module exam:		None		
Module language:		English		
Mandatory regular participation:		Yes		
Total workload requirement:		150 hours	5 credits	
Duration of module:		One semester		
Frequency of offering:		Each winter semester		
Applicability:		Master's degree program in Data Science		

Module: Ethical Foundations of Data Science

Higher education institution/department/teaching unit: Freie Universität Berlin/Mathematics and Computer Science/Computer Science

Persons responsible for module: Course instructors

Admissions requirements: None

Learning objectives:

Students are familiar with the fundamental value and norm systems of ethical and legal bases and overall conditions. They are able to use their existing knowledge for expertise that is bound by ethical and legal principles in typical fields of action in data science and recognize ethical issues and dilemmas. They are able to analyze ethical and legal issues relating to professional practice on a targeted basis based on suitable methods and sources and to bring about a reasonable and well-founded solution. The students reflect on their own core moral and ethical stance and how it affects their personal attitudes and actions.

Content:

Explanation and discussion of fundamental terms such as norms, values, morals, and ethics from an interdisciplinary and disciplinary standpoint, social impact of one's own actions, algorithmic bias ("discriminatory algorithms"), fundamentals of ethical discourses, ethics in data science

Modes of instruction	**Contact hours** (weekly credit hours = SWS)	**Forms of active participation**	**Workload** (hours per semester)	
Practical seminar	4	Work on assigned tasks, presentation of results	Contact hours	60
			Preparation and follow-up	90

Module exam:	None	
Module language:	English	
Mandatory regular participation:	Yes	
Total workload requirement:	150 hours	5 credits
Duration of module:	One semester	
Frequency of offering:	Each winter semester	
Applicability:	Master's degree program in Data Science	

Module: Research Practice

Higher education institution/department//teaching unit: Freie Universität Berlin/Mathematics and Computer Science/Mathematics and Computer Science

Persons responsible for module: Course instructors

Admissions requirements: None

Learning objectives:

Students have gained practical research experience in the area of data science and can apply content learned in their study program to research practice. They have experience in project coordination and implementation and have teamwork skills.

Content:

Current research topics in the field of data science in the natural sciences.

Modes of instruction	**Contact hours** (weekly credit hours = SWS)	**Forms of active participation**	**Workload** (hours per semester)	
External internship	270 hours	Internship report and final presentation, supervisory meeting	Contact hours Preparation and follow-up	270 30
Module exam:		None		
Module language:		English		
Mandatory regular participation:		Yes		
Total workload requirement:		300 hours		10 credits
Duration of module:		One semester		
Frequency of offering:		Each semester		
Applicability:		Master's degree program in Data Science		

Module: Data Science in the Life Sciences

Higher education institution/department/teaching unit: Freie Universität Berlin/Mathematics and Computer Science/Mathematics

Persons responsible for module: Course instructors

Admissions requirements: None

Learning objectives:

Students have acquired a deeper understanding of advanced concepts and data analysis methods in the area of life sciences. Based on their knowledge, they are able to evaluate and plan studies in the life sciences and use standard methods to perform them.

Content:

Introduction to various types of data in the life sciences (e.g., omics technologies), especially in the acquisition and pre-processing of data; exploratory analysis techniques for data from the life sciences; concepts and tools for reproducible research; theory and practice for methods and models for analysis of data from the life sciences (statistical inference, regression models, methods of machine learning); introduction to methods of big data analysis.

Modes of instruction	**Contact hours** (weekly credit hours = SWS)	**Forms of active participation**	**Workload** (hours per semester)	
Seminar-based instruction (sU)	4	Specialized discussion, answering discussion questions, discussion of application problems	Contact hours, sU	60
			Preparation and follow-up, sU	140
			Contact hours, ProjS	60
Project seminar (ProjS)	4	Working on assignments, short presentations with discussion, discussion of literature and examples of application	Preparation and follow-up, ProjS	140
			Exam preparation and exam	50
Module exam:		Written summation (approx. 5,000 words) with presentation of the results (approx. 20 minutes) This module exam can also be taken as a group exam.		
Module language:		English		
Mandatory regular participation:		Yes		
Total workload requirement:		450 hours	15 credits	
Duration of module:		One semester		
Frequency of offering:		Each summer semester		
Applicability:		Master's degree program in Data Science		

Module: Special Aspects of Data Science in the Life Sciences

Higher education institution/department/teaching unit: Freie Universität Berlin/Mathematics and Computer Science/Mathematics

Persons responsible for module: Course instructors

Admissions requirements: None

Learning objectives:

Students can apply the main terminology and results of a selected field of data science in the life sciences.

Content:

The module provides insights into a selected area of data science in the life sciences. In addition, research questions and areas of application are touched upon.

Modes of instruction	**Contact hours** (weekly credit hours = SWS)	**Forms of active participation**	**Workload** (hours per semester)	
Lecture (V)	2	Follow-up on lecture content and independently developing supplementary literature	Contact hours, V Preparation and follow-up, V Contact hours, Ü	30 30 30
Exercise (Ü)	2	Work on assigned exercises	Preparation and follow-up, Ü Exam preparation and exam	30 30
Module exam:		Written exam (90 minutes), which may be administered in whole or in part as a multiple choice test or as an electronic exam. or Oral exam (approx. 20 minutes)		
Module language:		English		
Mandatory regular participation:		Participation recommended		
Total workload requirement:		150 hours	5 credits	
Duration of module:		One semester		
Frequency of offering:		Irregular		
Applicability:		Master's degree program in Data Science		

Module: Current Research Topics in Data Science in Life Sciences

Higher education institution/department/teaching unit: Freie Universität Berlin/Mathematics and Computer Science/Mathematics

Persons responsible for module: Course instructors

Admissions requirements: None

Learning objectives:

Students will be able to apply essential terms and research results from a selected area of data science in the life sciences.

Content:

The module provides insights into a selected area of data science in the life sciences. In addition, research questions and areas of application are touched upon.

Modes of instruction	**Contact hours** (weekly credit hours = SWS)	**Forms of active participation**	**Workload** (hours per semester)	
Lecture (V)	2	Follow-up on lecture content and independently developing supplementary literature	Contact hours, V Preparation and follow-up, V Contact hours, Ü Preparation and follow-up, Ü Exam preparation and exam	30 30 30 30 30
Exercise (Ü)	2	Work on assigned exercises		

Module exam:	Written exam (90 minutes), which may be administered in whole or in part as a multiple choice test or as an electronic exam. or Oral exam (approx. 20 minutes)	
Module language:	English	
Mandatory regular participation:	Participation recommended	
Total workload requirement:	150 hours	5 credits
Duration of module:	One semester	
Frequency of offering:	Irregular	
Applicability:	Master's degree program in Data Science	

Module: Selected Topics in Data Science in the Life Sciences

Higher education institution/department/teaching unit: Freie Universität Berlin/Mathematics and Computer Science/Mathematics

Persons responsible for module: Course instructors

Admissions requirements: None

Learning objectives:

Students know the fundamentals in a specific area or applied field of data science in the life sciences. They are able to apply what they have learned proficiently.

Content:

Varying content from the field of life sciences with a strong connection to data science, for example advanced aspects of multi-modal data analysis or data-based modeling and simulation of bio-medical systems.

Modes of instruction	**Contact hours** (weekly credit hours = SWS)	**Forms of active participation**	**Workload** (hours per semester)	
Lecture (V)	4	Follow-up on lecture content and independently developing supplementary literature	Contact hours, V Preparation and follow-up, V Contact hours, Ü	60 60 30
Exercise (Ü)	2	Work on assigned exercises	Preparation and follow-up, Ü Exam preparation and exam	90 60
Module exam:		Written exam (90 minutes), which may be administered in whole or in part as a multiple choice test or as an electronic exam. or Oral exam (approx. 20 minutes)		
Module language:		English		
Mandatory regular participation:		Participation recommended		
Total workload requirement:		300 hours	10 credits	
Duration of module:		One semester		
Frequency of offering:		Irregular		
Applicability:		Master's degree program in Data Science		

Module: Masters Seminar Data Science in the Life Sciences

Higher education institution/department/teaching unit: Freie Universität Berlin/Mathematics and Computer Science/ Mathematics and Computer Science

Persons responsible for module: Course instructors

Admissions requirements: None

Learning objectives:

Students can independently familiarize themselves with a current topic from the field of data science in the life sciences using specialized research literature, process/critically analyse and acquire supplementary background knowledge.

They can also convey a complex topic in a comprehensible manner in a presentation. They can emphasize essential elements over less important elements and conscientiously select and use suitable forms of presentation and media. They are prepared to ask questions in cases of ambiguity; they can participate in a discussion about scientific questions, and they can apply criticism in an objective way.

Content:

This seminar deals with current research topics from the field of data science in the life sciences. In the process, students begin to prepare topics for their master's thesis.

Modes of instruction	**Contact hours** (weekly credit hours = SWS)	**Forms of active participation**	**Workload** (hours per semester)	
Seminar	2	Presentation, written paper, regular contributions to the discussion	Contact hours Preparation and follow-up Exam preparation and exam	30 60 60
Module exam:		Written paper (approx. 4500 words) with oral presentation (approx. 45 minutes).		
Module language:		English		
Mandatory regular participation:		Yes		
Total workload requirement:		150 hours	5 credits	
Duration of module:		One semester		
Frequency of offering:		Irregular		
Applicability:		Master's degree program in Data Science		

Module: Software Project in Data Science A

Higher education institution/department/teaching unit: Freie Universität Berlin/Mathematics and Computer Science/Computer Science

Persons responsible for module: Course instructors

Admissions requirements: None

Learning objectives:

Students master the development of complex software systems for the analysis of large, weakly structured data sets for a scientific environment. They can independently break down a larger project into sub-projects, define suitable interfaces, and create a schedule. They can organize themselves in a team and take on leading functions. They take gender and diversity aspects into account. From their own experience, they have a deeper understanding of quality, effort, acceptance, and success factors and are proficient in communication (oral, written), both internally for successful planning and coordination of the above activities in the project team and externally for negotiating with clients (as in a client-based project). They can confidently apply project management methods, especially in the area of design and realization of software systems (requirements elicitation, specification, architecture design, module design, technology selection, implementation), as well as information extraction from large, weakly structured data sets.

Content:

The software project may have differing focuses. Working as a team, students produce a complex piece of software to solve an application- or data-oriented task from the field of data science, such as artificial intelligence (machine learning, computer vision, or pattern recognition), data management, Web technologies, or applied fields.

Modes of instruction	**Contact hours** (weekly credit hours = SWS)	**Forms of active participation**	**Workload** (hours per semester)	
Project seminar	2	Regular reports regarding the state of the project, regular presentation of interim results	Contact hours ProjS Software development and data processing Exam preparation and exam	30 240 30
Module exam:		Presentation (approx. 15 minutes) or poster presentation (approx. 15 minutes)		
Module language:		English		
Mandatory regular participation:		Yes		
Total workload requirement:		300 hours	10 credits	
Duration of module:		One semester		
Frequency of offering:		At least once per year, partly during the semester and partly outside the normal teaching period offered through block teaching.		
Applicability:		Master's degree program in Data Science		

Module: Software Project in Data Science B

Higher education institution/department/teaching unit: Freie Universität Berlin/Mathematics and Computer Science/Computer Science

Persons responsible for module: Course instructors

Admissions requirements: None

Learning objectives:

Students master the development of complex software systems for the analysis of large, weakly structured data sets for a commercial environment, including public relations. They are able to break down a larger project into sub-projects, define suitable interfaces, and create a schedule. They can organize themselves in a team and take on leading functions. They take gender and diversity aspects into account. From their own experience, they have a deeper understanding of quality, effort, acceptance, and success factors and have mastered communication (verbal, written), both internally for successful planning and coordination of the above activities in the project team and externally for negotiating with clients (as in a client-based project). They can confidently apply project management methods, especially in the area of design and implementation of software systems (requirements elicitation, specification, architecture design, module design, technology selection, implementation), as well as information extraction from large, weakly structured data sets.

Content:

The software project may have differing focuses. Working as a team, students produce a complex piece of software to solve an application- or data-oriented task from the field of data science, such as artificial intelligence (machine learning, computer vision, or pattern recognition), data management, Web technologies, or applied fields.

Modes of instruction	**Contact hours** (weekly credit hours = SWS)	**Forms of active participation**	**Workload** (hours per semester)	
Project seminar (ProjS)	2	Regular reports regarding the state of the project, regular presentation of interim results	Contact hours, ProjS Software development and data processing Exam preparation and exam	30 240 30
Module exam:		Presentation (approx. 15 minutes) or poster presentation (approx. 15 minutes)		
Module language:		English		
Mandatory regular participation:		Yes		
Total workload requirement:		300 hours		10 credits
Duration of module:		One semester		
Frequency of offering:		At least once per year, partly during the semester and partly outside the normal teaching period offered through block teaching.		
Applicability:		Master's degree program in Data Science		

Module: Special Aspects of Data Science Technologies

Higher education institution/department/teaching unit: Freie Universität Berlin/Mathematics and Computer Science/Computer Science

Persons responsible for module: Course instructors

Admissions requirements: None

Learning objectives:

Students are able to apply essential terms and facts from a selected area of data science technologies.

Content:

The module gives insights into a selected area of Data Science technologies. In addition, research questions and applied fields are touched upon.

Modes of instruction	**Contact hours** (weekly credit hours = SWS)	**Forms of active participation**	**Workload** (hours per semester)	
Lecture (V)	2	Follow-up on lecture content and independently developing supplementary literature	Contact hours, V	30
			Preparation and follow-up, V	30
Exercise (Ü)	2	Regular written work on assigned worksheets, two oral presentations, each on the solution to a task in the exercise	Contact hours, Ü	30
			Preparation and follow-up, Ü	30
			Exam preparation and exam	30

Module exam:	Written exam (90 minutes), which may be administered in whole or in part as a multiple choice test or as an electronic exam. or Oral exam (approx. 20 minutes)	
Module language:	English	
Mandatory regular participation:	Participation recommended	
Total workload requirement:	150 hours	5 credits
Duration of module:	One semester	
Frequency of offering:	Irregular	
Applicability:	Master's degree program in Data Science	

Module: Current Research Topics in Data Science Technologies

Higher education institution/department/teaching unit: Freie Universität Berlin/Mathematics and Computer Science/Computer Science

Persons responsible for module: Course instructors

Admissions requirements: None

Learning objectives:

Students are able to apply the main terminology and techniques from a current research area within the field of data science technologies.

Content:

This module, which covers varying content, provides insight into one of the research topics covered in current projects at the Institute of Computer Science.

Modes of instruction	**Contact hours** (weekly credit hours = SWS)	**Forms of active participation**	**Workload** (hours per semester)	
Lecture (V)	2	Follow-up on lecture content and independently developing supplementary literature	Contact hours, V	30
			Preparation and follow-up, V	30
Exercise (Ü)	2	Regular written work on assigned worksheets, two oral presentations, each on the solution to a task in the exercise	Contact hours, Ü	30
			Preparation and follow-up, Ü	30
			Exam preparation and exam	30
Module exam:		Written exam (90 minutes), which may be administered in whole or in part as a multiple choice test or as an electronic exam. or Oral exam (approx. 20 minutes)		
Module language:		English		
Mandatory regular participation:		Participation recommended		
Total workload requirement:		150 hours	5 credits	
Duration of module:		One semester		
Frequency of offering:		Irregular		
Applicability:		Master's degree program in Data Science		

Module: Selected Topics in Data Science Technologies A

Higher education institution/department/teaching unit: Freie Universität Berlin/Mathematics and Computer Science/Computer Science

Persons responsible for module: Course instructors

Admissions requirements: None

Learning objectives:

Students know the fundamentals of a specific area or applied field of data science technologies. They are able to apply what they have learned proficiently.

Content:

Varying content, for example advanced aspects of distributed data storage, model-based analysis, and/or theoretical models of data representation, probabilistic data analysis or machine learning.

Modes of instruction	**Contact hours** (weekly credit hours = SWS)	**Forms of active participation**	**Workload** (hours per semester)	
Lecture (V)	4	Follow-up on lecture content and independently developing supplementary literature	Contact hours, V Preparation and follow-up, V	60 60
Exercise (Ü)	2	Regular written work on assigned worksheets, two oral presentations, each on the solution to a task in the exercise	Contact hours, Ü Preparation and follow-up, Ü Exam preparation and exam	30 90 60

Module exam:	Written exam (90 minutes), which may be administered in whole or in part as a multiple choice test or as an electronic exam. or Oral exam (approx. 20 minutes)	
Module language:	English	
Mandatory regular participation:	Participation recommended	
Total workload requirement:	300 hours	10 credits
Duration of module:	One semester	
Frequency of offering:	Irregular	
Applicability:	Master's degree program in Data Science	

Module: Selected Topics in Data Science Technologies B

Higher education institution/department/teaching unit: Freie Universität Berlin/Mathematics and Computer Science/Computer Science

Persons responsible for module: Course instructors

Admissions requirements: None

Learning objectives:

Students understand in-depth concepts in a special field or an application area of data science technologies. They are able to apply what they have learned proficiently.

Content:

Varying content, for example advanced aspects of distributed data storage, model-based analysis, and/or theoretical models of data representation, probabilistic data analysis or machine learning.

Modes of instruction	**Contact hours** (weekly credit hours = SWS)	**Forms of active participation**	**Workload** (hours per semester)	
Lecture (V)	4	Follow-up on lecture content and independently developing supplementary literature	Contact hours, V	60
			Preparation and follow-up, V	60
Exercise (Ü)	2	Regular written work on assigned worksheets, two oral presentations, each on the solution to a task in the exercise	Contact hours, Ü	30
			Preparation and follow-up, Ü	90
			Exam preparation and exam	60
Module exam:		Written exam (90 minutes), which may be administered in whole or in part as a multiple choice test or as an electronic exam. or Oral exam (approx. 20 minutes)		
Module language:		English		
Mandatory regular participation:		Participation recommended		
Total workload requirement:		300 hours	10 credits	
Duration of module:		One semester		
Frequency of offering:		Irregular		
Applicability:		Master's degree program in Data Science		

Module: Data Science Database Systems

Higher education institution/department/teaching unit: Freie Universität Berlin/Mathematics and Computer Science/Computer Science

Persons responsible for module: Course instructors

Admissions requirements: None

Learning objectives:

At the end of this module, students are able to explain the structure of a database by way of example, explain the processing of commands using the database, create selected database models (such as ER models) from application descriptions, derive a relational model from a database schema, create a database based on a relational model, formalize a query in relational algebra, create queries regarding data analysis and execute these on a database, and create queries regarding a database and schema manipulation and execute these on the database. They can explain the motivation for normalizing data and can apply algorithms for normalizing data. They can explain typical alternative memory structures and compare them semantically. They can implement applications with access to a database. They can schematically illustrate and explain methods for accelerating database queries and implement these with suitable data structures. They can explain and apply the main methods of transaction management on databases and can apply the principles of simultaneous access to databases. They can explain and implement methods of data recovery. They can understand and apply fundamental methods of data mining. They can understand, explain, and apply trends in the area of database systems.

Content:

Database design with entity-relationship models and UML; theoretical basics of relational database systems, relational algebra; functional dependencies, normal forms, relational database development: data definition, foreign keys, other integrity conditions, object-relational mapping, security and protection concepts; transaction concept, transactional guarantees, synchronization of multi-user operation, fault tolerance features.

<table>
<tr><th>Modes of instruction</th><th>Contact hours
(weekly credit hours = SWS)</th><th>Forms of active participation</th><th colspan="2">Workload
(hours per semester)</th></tr>
<tr><td>Lecture (V)</td><td>3</td><td rowspan="2">Written work on assigned worksheets</td><td>Contact hours, V</td><td>45</td></tr>
<tr><td rowspan="2">Exercise (Ü)</td><td rowspan="2">1</td><td>Preparation and follow-up, V</td><td>30</td></tr>
<tr><td></td><td>Contact hours, Ü</td><td>15</td></tr>
<tr><td></td><td></td><td>Preparation and follow-up, Ü</td><td>30</td></tr>
<tr><td></td><td></td><td></td><td>Exam preparation and exam</td><td>30</td></tr>
<tr><td colspan="2">Module exam:</td><td colspan="3">Oral exam (approx. 15 minutes) or written exam (90 minutes), which may be administered in whole or in part as a multiple choice test or as an electronic exam.</td></tr>
<tr><td colspan="2">Module language:</td><td colspan="3">English</td></tr>
<tr><td colspan="2">Mandatory regular participation:</td><td colspan="3">Exercise: Yes, lecture: Participation recommended</td></tr>
<tr><td colspan="2">Total workload requirement:</td><td>150 hours</td><td colspan="2">5 credits</td></tr>
<tr><td colspan="2">Duration of module:</td><td colspan="3">One semester</td></tr>
<tr><td colspan="2">Frequency of offering:</td><td colspan="3">Irregular</td></tr>
<tr><td colspan="2">Applicability:</td><td colspan="3">Master's degree program in Data Science</td></tr>
</table>

Module: Data Science Technologies Master's Seminar

Higher education institution/department/teaching unit: Freie Universität Berlin/Mathematics and Computer Science/Computer Science

Persons responsible for module: Course instructors

Admissions requirements: None

Learning objectives:

Students can independently familiarize themselves with a current research topic in data science technologies using original scientific literature and, if necessary, acquire additional background knowledge. They can also convey a complex topic in a presentation in a comprehensible way and taking into account various aspects, such as ethics and technology. They are able to critically examine the rules of good scientific practice in the topic under consideration. In doing so, they can emphasize essential elements over less important elements, relate individual statements to each other, and summarize their core content. They can conscientiously select and use suitable forms of presentation and media. They are prepared to ask questions in case of ambiguity, they can participate in a discussion about scientific questions and apply criticism in an objective manner. At the same time, students acquire in-depth knowledge in a special topic of Data Science Technologies and are prepared for their own research work, as required for the Master's thesis.

Content:

The module's focus covers varying content from the area of data science technologies.

Modes of instruction	**Contact hours** (weekly credit hours = SWS)	**Forms of active participation**	**Workload** (hours per semester)	
Seminar (S)	2	Presentation, written work, regular contributions to discussions	Contact hours, S	30
			Preparation and follow-up, S	60
			Exam preparation and exam	60

Module exam:	Written paper (approx. 4,500 words) with oral presentation (approx. 45 minutes).	
Module language:	English	
Mandatory regular participation:	Yes	
Total workload requirement:	150 hours	5 credits
Duration of module:	One semester	
Frequency of offering:	Every semester	
Applicability:	Master's degree program in Data Science	

Module: Interdisciplinary Approaches within the Framework of Data Science A

Higher education institution/department/teaching unit: Freie Universität Berlin/Mathematics and Computer Science/Computer Science

Persons responsible for module: Course instructors

Admissions requirements: None

Learning objectives:

Students are able to apply statistical methods in a thematic field. They have knowledge of the relevant theoretical background and are able to select suitable evaluation methods for content-related questions, apply them, and develop an answer to the question. They know specific statistical analysis methods for the respective content area as well as their use in practice.

Content:

Varying content on data analysis topics in other disciplines, such as psychometric models in psychology, procedures for analyzing panel data in sociology or causal analyses in economics. The statistical methods are presented in an application-oriented manner.

Modes of instruction	**Contact hours** (weekly credit hours = SWS)	**Forms of active participation**	**Workload** (hours per semester)	
Elective (WLV)	2	Completing assignments, including written or oral presentation	Contact hours, WLV	30
			Preparation and follow-up, WLV	60
			Examination preparation and examination	60
Module exam:		Written paper (approx. 4,500 words) with oral presentation (approx. 45 minutes).		
Module language:		English		
Mandatory regular participation:		Yes		
Total workload requirement:		150 hours	5 credits	
Duration of module:		One semester		
Frequency of offering:		Irregular		
Applicability:		Master's degree program in Data Science		

Module: Interdisciplinary Approaches within the Framework of Data Science B			
Higher education institution/department/teaching unit: Freie Universität Berlin/Mathematics and Computer Science/Computer Science			
Persons responsible for module: Course instructors			
Admissions requirements: None			
Learning objectives: Students have a deeper understanding of advanced concepts and data analytical methods in the field of empirical quantitative social sciences (e.g., psychology, sociology or economics). On the basis of their knowledge, they can evaluate and plan empirical studies in the social sciences and analyze them using current statistical methods.			
Content: Varying content on advanced topics, such as analysis of log data for psychological characteristics, implementation of online therapies, theory and analysis of survey data or planning and analysis of ambulatory assessments.			
Modes of instruction	**Contact hours** (weekly credit hours = SWS)	**Forms of active participation**	**Workload** (hours per semester)
Election event (WLV)	4	Completing assignments, including written or oral presentation	Contact hours, WLV 60 Preparation and follow-up, WLV 140 Exam preparation and exam 100
Module exam:		Oral examination (approx. 15 minutes) or written examination (90 minutes), which, if applicable, can be conducted in whole or in part in the form of a multiple choice test or in the form of an electronic exam.	
Module language:		English	
Mandatory regular participation:		Yes	
Total workload requirement:		300 hours	10 credits
Duration of module:		One semester	
Frequency of offering:		Irregular	
Applicability:		Master's degree program in Data Science	

For the following three modules, please see the degree program and examination regulations for the master's degree in Bioinformatics of the Departments of Biology, Chemistry and Pharmacy, Mathematics and Computer Science of Freie Universität Berlin and Charité – Universitätsmedizin Berlin:

– V-Module: Machine Learning in Bioinformatics (5 credits),

– V-Module: Big Data Analysis in Bioinformatics (5 credits),

– Practical module: Applied Machine Learning in Bioinformatics (5 credits).

For the following nine modules, please see the degree program and examination regulations for the master's degree program in Computer Science of the Department of Mathematics and Computer Science of Freie Universität Berlin:

– Module: Distributed Systems (5 credits),

– Module: Mobile Communication (5 credits),

– Module: Telematics (10 credits),

– Module: Higher Algorithmics (10 credits),

– Module: Computer Security (10 credits),

- Module: Pattern Recognition (5 credits),
- Module: Network-Based Information Systems (5 credits),
- Module: Artificial Intelligence (5 credits)
- Module: Special Aspects of Data Management (5 credits).

2.1 Sample curriculum for the master's degree program in Data Science with the profile “Data Science in the Life Sciences”

<table>
<tr><th rowspan="3">Semester</th><th colspan="5">Modules</th><th rowspan="3">Credits</th></tr>
<tr><th rowspan="2">Fundamental area</th><th colspan="4">Profile area</th></tr>
<tr><th colspan="3">Mandatory part</th><th>Elective part</th></tr>
<tr><td>FS 1</td><td>Programming for Data Science, 5 credits
Statistics for Data Science, 10 credits
Machine Learning for Data Science, 10 credits
Introduction to Profile Areas, 5 credits</td><td colspan="3"></td><td></td><td>30 credits</td></tr>
<tr><td>FS 2</td><td></td><td rowspan="2">Data Science in the Life Sciences, 15 credits

(of which, 10 credits in FS 2 and 5 credits in FS 3)</td><td></td><td></td><td>Modules from the elective area from the chosen profile, 20 credits</td><td>30 credits</td></tr>
<tr><td>FS 3</td><td></td><td>Research Practice, 10 credits</td><td>Ethical Foundations of Data Science, 5 credits</td><td>Modules from the elective area from a different profile, 10 credits</td><td>30 credits</td></tr>
<tr><td>FS 4</td><td colspan="5">Master’s thesis with accompanying colloquium, 30 credits</td><td>30 credits</td></tr>
</table>

2.2 Sample curriculum for the master's degree program in Data Science with the profile “Data Science Technologies”

Semester	Modules					Credits
	Fundamental area	Profile area				
		Mandatory part			Elective part	
FS 1	Programming for Data Science, 5 credits Statistics for Data Science, 10 credits Machine Learning for Data Science, 10 credits Introduction to Profile Areas, 5 credits					30 credits
FS 2					Modules from the elective area from the chosen profile, 30 credits	30 credits
FS 3			Software Project in Data Science, 10 credits	Ethical Foundations of Data Science, 5 credits	Modules from the elective area from a different profile, 15 credits	30 credits
FS 4	Master’s thesis with accompanying colloquium, 30 credits					30 credits